

# LD1016H

16 Channel Constant current LED Driver

Ver. 2.0 / Jun, 2011

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## INTRODUCTION

The LD1016H is specifically designed for LED display applications. The constant current output can be preset through an external resistor ( $I_{OUT} = 3mA$  to  $90mA$ ). The device consists of 16bit shift register, latch and constant current output driver. The LD1016H provides a constant output current for driving the LEDs against the variation of LED forward voltage ( $V_f$ ). The LD1016H's excellent current matching characteristics among the output ports and fast output response time will give you the best display quality for LED display system.

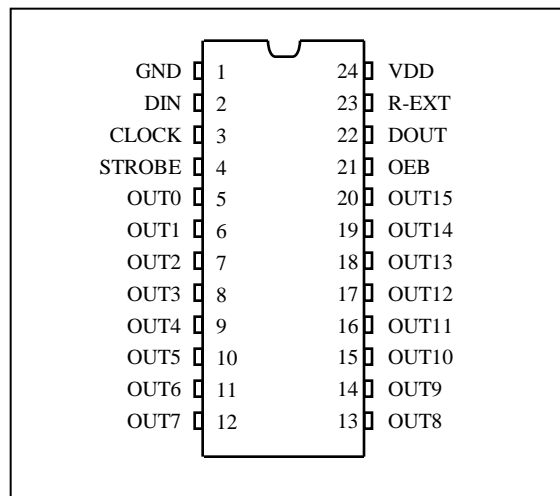
## FEATURES

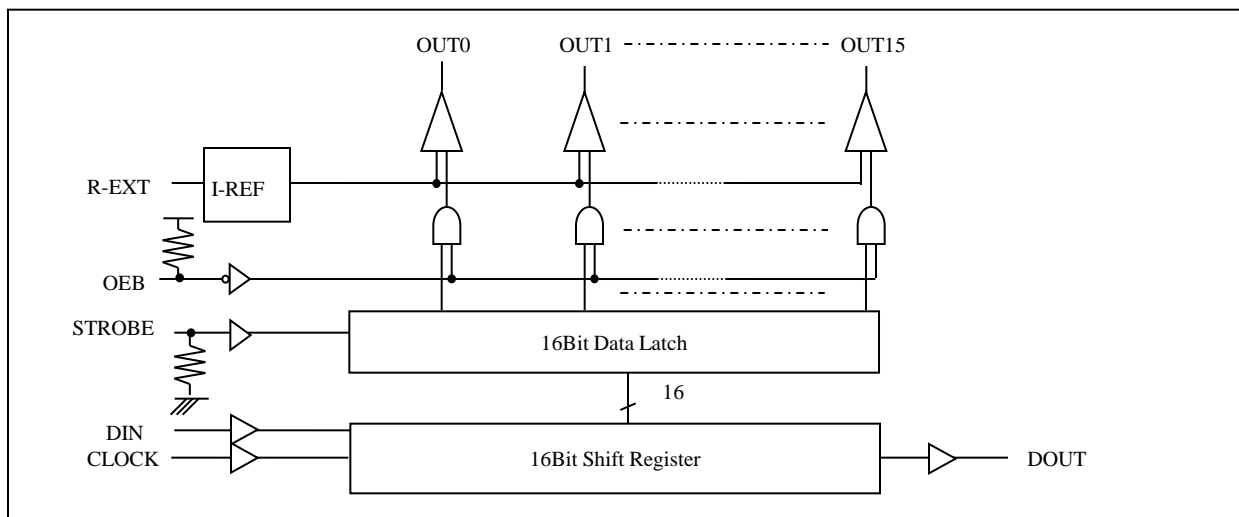
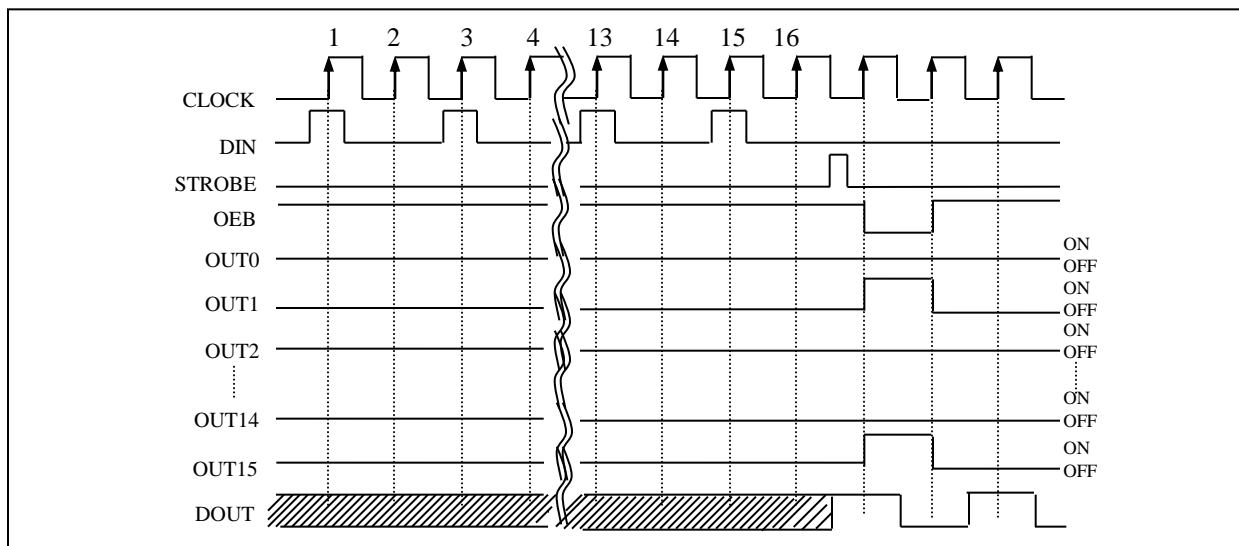
- 16 constant-current output channels
- Output current : set -up at 3mA to 90mA with an external resistor
- Pin to pin deviation : max  $\pm 1.5\%$
- Chip to chip deviation : max  $\pm 3.0\%$
- 5V CMOS compatible input
- Delayed output to prevent inrush current
- Maximum data transfer rate : max 30MHz
- Fast response of OEB - OUTn (min) : 60ns @ $V_{DD}=5V$ , 100ns
- 5V supply voltage
- Package : LD1016H-SP (SOP-24), LD1016H-SS (SSOP-24)
- "Pb\_free & Green" Package




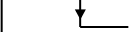

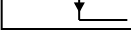
## ORDERING INFORMATION

PART NUMBER	PACKAGE	Ta
LD1016H-SS	24 SSOP	-40°C to 85 °C
LD1016H-SP	24 SOP	-40°C to 85 °C

## PIN CONNECTION (TOP VIEW)



**BLOCK DIAGRAM**

**TIMING DIAGRAM**

**TRUTH TABLE**

Input				Output		
CLOCK	STROBE	OEB	DIN	OUT0 ..... OUT7 ..... OUT15	DOUT	
	H	L	$D_n$	$D_n$ ..... $D_{n-7}$ ..... $D_{n-15}$	No Change	
	L	L	$D_n$	No change		
	*	H	$D_n$	OFF ..... OFF ..... OFF	No Change	
	H	L	$D_n$	$D_n$ ..... $D_{n-7}$ ..... $D_{n-15}$	$D_{n-15}$	
	L	L	$D_n$	No change		
	*	H	$D_n$	OFF ..... OFF ..... OFF	$D_{n-15}$	

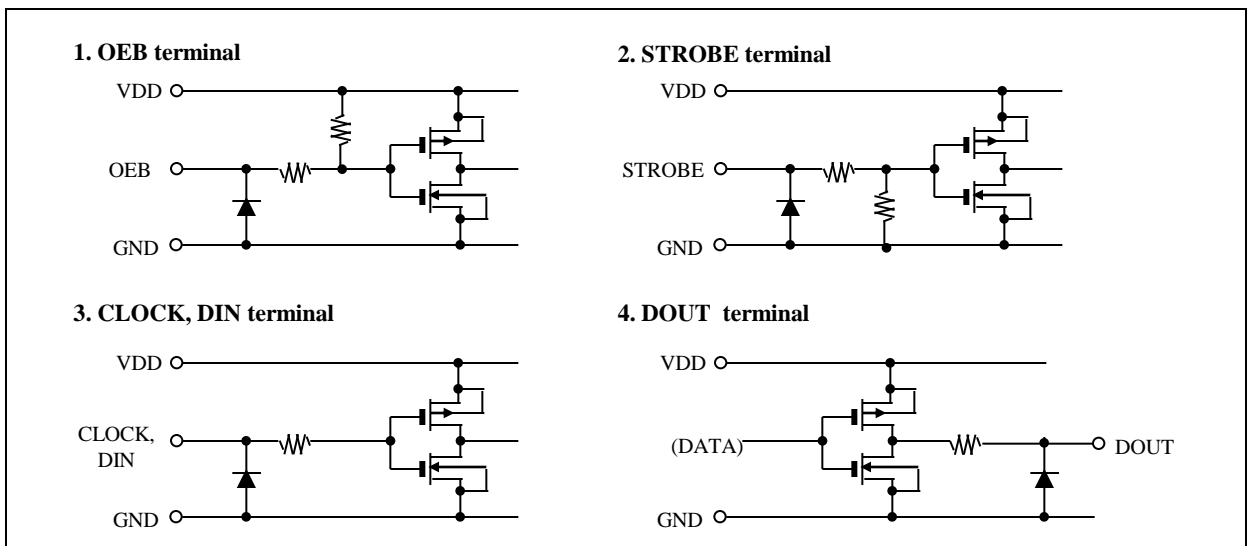
[Note] 1) When the state of  $D_n \sim D_{n-15}$  is "H", the  $OUT_n$  is turned ON ("L" :  $OUT_n$  is turned OFF ).

2) \* : Don't Care

## TERMINAL DESCRIPTION

Pin No.	Pin Name	Function
1	GND	Ground terminal
2	DIN	Serial input data
3	CLOCK	Shift input clock for serial input data DIN( Rising Edge Clcking)
4	STROBE	Data is transferred to the output latch at STROBE rising edge
5 ~ 20	OUTn	Constant current outputs for LEDs, n = 0 ~ 15
21	OEB	Output Enable. Active Low
22	DOUT	Serial data output terminal for shifting the data to next chip
23	R-EXT	Connect the resistor between this pin and GND to set up the constant output current for all the OUTn.
24	VDD	Supply voltage

## EQUIVALENT CIRCUIT OF INPUTS AND OUTPUTS



## MAXIMUM RATINGS

(Ta = 25°C unless otherwise noted)

Characteristic	Symbol	Rating	Unit
Supply Voltage	$V_{DD}$	0 ~ 7.0	V
Output Voltage	$V_{OUT}$	-0.5 ~ 7.0	V
Output Current	$I_{OUT}$	90	mA
Input Voltage	$V_{IN}$	-0.4 ~ $V_{DD} + 0.4$	V
GND Terminal Current	$I_{GND}$	1440	mA
CLOCK Frequency	$F_{CLK}$	30	MHz
Power Dissipation ( On PCB, TA = 25 °C )	SOP	$P_D$	W
	SSOP		
Thermal Resistance ( On PCB, TA = 25 °C )	SOP	$R_{th(j-a)}$	°C/W
	SSOP		
Operation Temperature	$T_{opr}$	-40 ~ 85	°C
Storage Temperature	$T_{stg}$	-55 ~ 150	°C

**ELECTRICAL CHARACTERISTICS**

(Ta = 25°C unless otherwise noted)

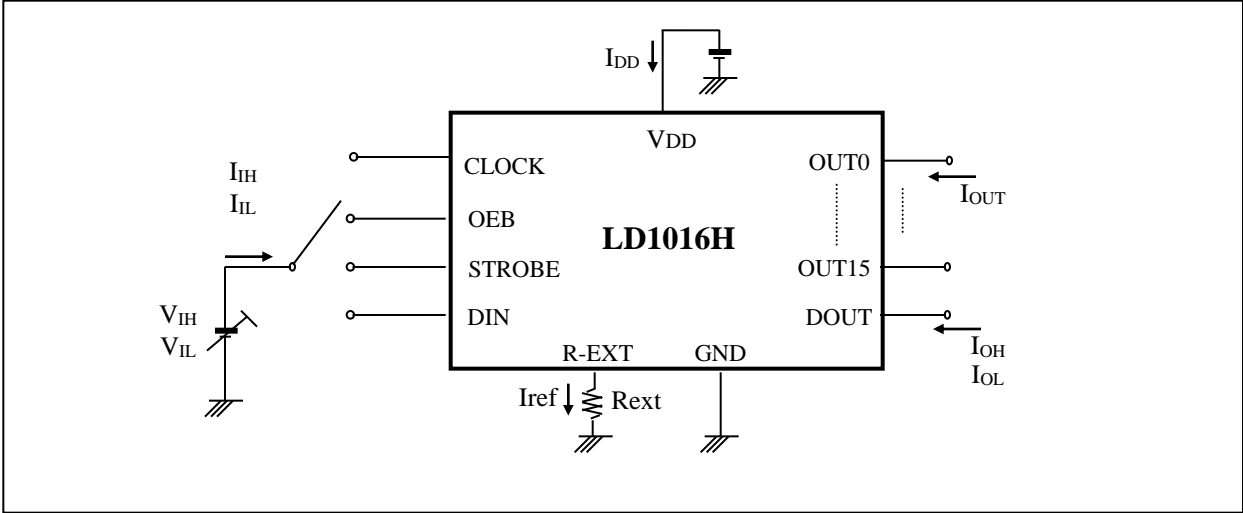
Characteristics		Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage		$V_{DD}$		4.5	5.0	5.5	V
Output Voltage		$V_{OUT}$				5.5	-
Output Current	OUTn	$I_{OUT}$		3		90	mA
	DOUT	$I_{OH}$		-1.0			
		$I_{OL}$				1.0	
Input Voltage	'H' Level	$V_{IH}$		$0.8V_{DD}$	-	$1.0V_{DD}$	V
	'L' Level	$V_{IL}$		GND	-	$0.2V_{DD}$	
Output Voltage	DOUT	$V_{OL}$		GND	-	$0.2V_{DD}$	V
	'L' Level	$V_{OH}$		$0.8V_{DD}$	-	$V_{DD}$	
Output	Current1	$I_{OL1}$	$R_{EXT} = 1.1\text{ k}\Omega$		20		mA
	Delta IOU	$\Delta I_{OL1}$	$R_{EXT} = 1.1\text{ k}\Omega$ $I_{OUT} = 20\text{mA}$			$\pm 1.5$	
Output	Current2	$I_{OL2}$	$R_{EXT} = 0.53\text{ k}\Omega$		40		mA
	Delta IOU	$\Delta I_{OL2}$	$R_{EXT} = 0.53\text{ k}\Omega$ $I_{OUT} = 40\text{mA}$			$\pm 1.5$	
Output Current vs. Supply Voltage Regulation		$\%/V_{DD}$	$R_{EXT} = 0.53\text{ k}\Omega$			+6.0	%
Pull Up Resistor		$R_{UP}$		100	200	400	$\text{k}\Omega$
Pull Down Resistor		$R_{DOWN}$		100	200	400	$\text{k}\Omega$
Supply Current		$I_{DD(off)1}$	$R_{EXT} = \text{OPEN}$		1	2	mA
		$I_{DD(off)2}$	$R_{EXT} = 1.1\text{ k}\Omega$ $I_{OUTn} = 20\text{mA}$		3	5.4	
		$I_{DD(off)3}$	$R_{EXT} = 0.53\text{ k}\Omega$ $I_{OUT} = 40\text{mA}$		6	8	
		$I_{DD(on)1}$	$R_{EXT} = 1.1\text{ k}\Omega$ $I_{OUTn} = 20\text{mA}$		3	5.4	
		$I_{DD(on)2}$	$R_{EXT} = 0.53\text{ k}\Omega$ $I_{OUT} = 40\text{mA}$		6	8	

SWITCHING CHARACTERISTICS ( $V_{DD}=5.0V$ )

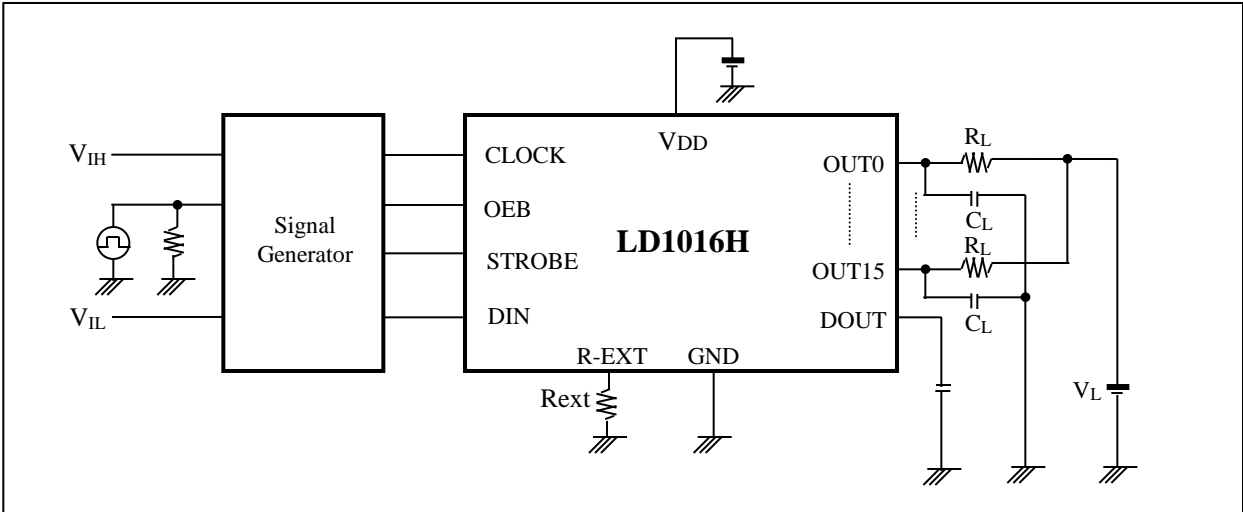
(Ta = 25°C unless otherwise noted)

Characteristics		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time (Low to High)	CLOCK-OUTn	$T_{pLH1}$	$V_{DD} = 5.0V$ $V_{OUT} = 1.0V$ $V_{IH} = V_{DD}$ $V_{IL} = GND$ $f_{CLK} = 10MHz$ $R_{EXT} = 0.53k\Omega$ $I_{OUTn} = 40mA$ $V_L = 3.0V$ $C_L = 10.0pF$ $R_L = 50\Omega$	-	45	55	ns
	CLOCK-DOUT	$t_{pLH}$		-	-	25	ns
	STROBE-OUTn	$t_{pLH2}$		-	55	120	ns
	OEB-OUTn	$t_{pLH3}$		-	-	100	ns
Propagation Delay Time (High to Low)	CLOCK-OUTn	$t_{pHL1}$		-	45	55	ns
	CLOCK-DOUT	$t_{pHL}$		-	-	25	ns
	STROBE-OUTn	$t_{pHL2}$		-	55	150	ns
	OEB-OUTn	$t_{pHL3}$		-	45	55	ns
Pulse Width	CLOCK	$t_{W\_CLK}$		10	20		ns
	STROBE	$t_{W\_STB}$		40			ns
	OEB	$t_{W\_OEB}$		60	-		ns
Maximum CLOCK Frequency		$f_{CLKMAX}$				30	MHz
Data Setup Time		$t_{sD}$		10	-	-	ns
Data Hold Time		$t_{hD}$		10	-	-	ns
STROBE Setup Time		$t_{sS}$		10	-	-	ns
STROBE Hold Time		$t_{hS}$		10	-	-	ns
Maximum Clock Rise Time		$t_r$			50	ns	
Maximum Clock Fall Time		$t_f$			50	ns	
Maximum Output Rise Time		$t_{or}$			25	ns	
Maximum Output Fall Time		$t_{of}$			25	ns	

DC CHARACTERISTIC TEST CIRCUIT



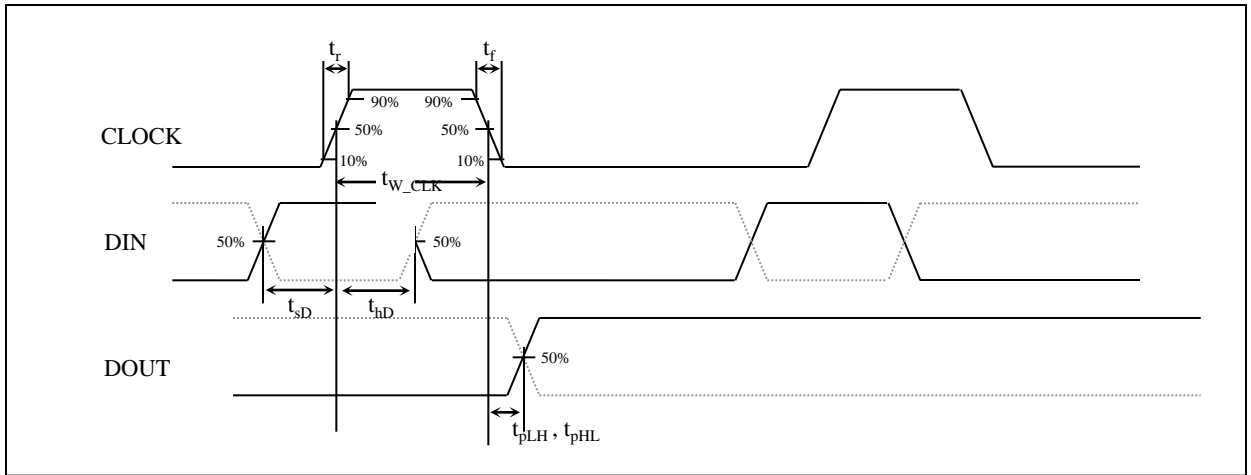
AC CHARACTERISTIC TEST CIRCUIT



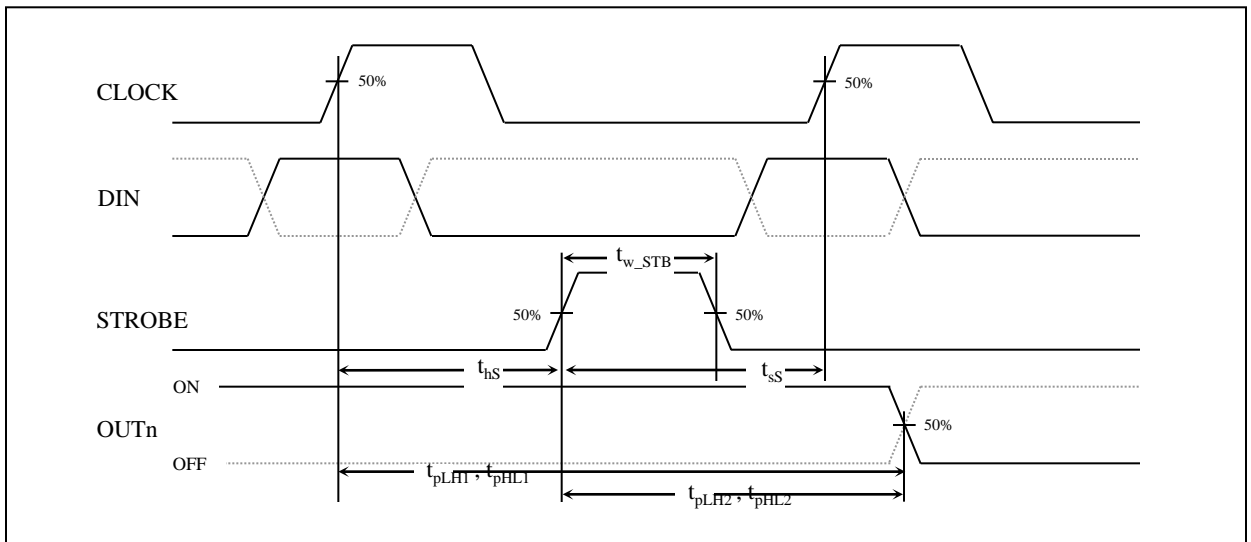


## TIMING WAVEFORM

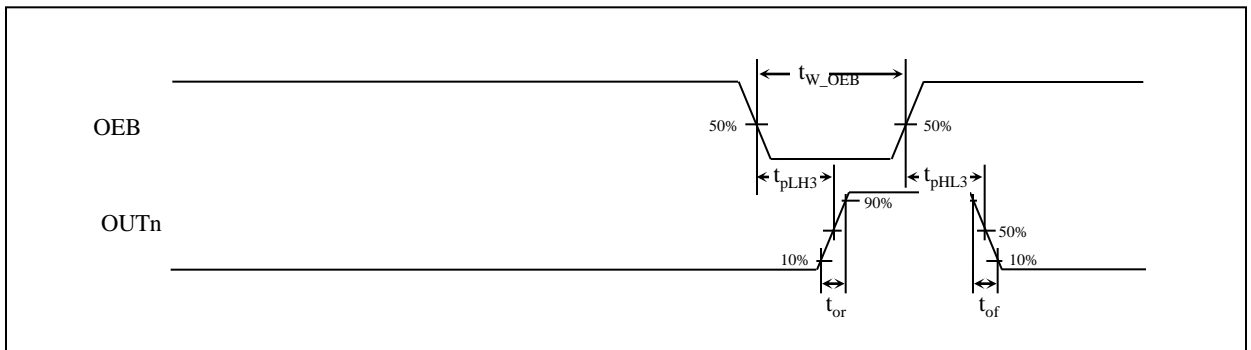
### 1. CLOCK-DOUT, OUTn



### 2. CLOCK-STROBE



### 3. OEB



## ADJUSTING OUTPUT CURRENT

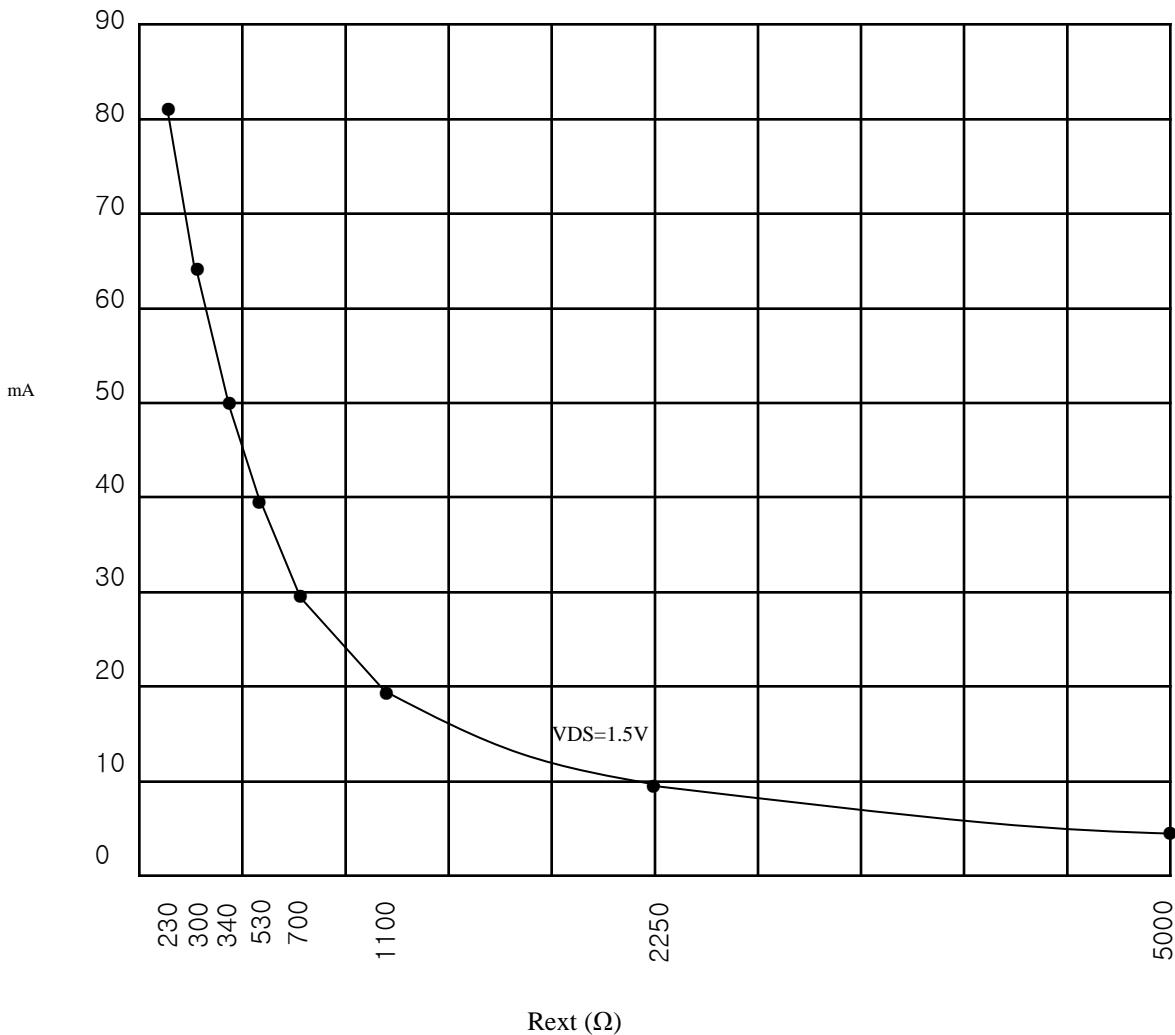
The output current is determined by an external resistor. The relationship between  $I_{OUT}$  and  $R_{EXT}$  is as follows;

VDD = 5V

$$I_{OUT}[A] = \{1.16/(50+R_{EXT})\} * 20$$

VDD = 5.0V

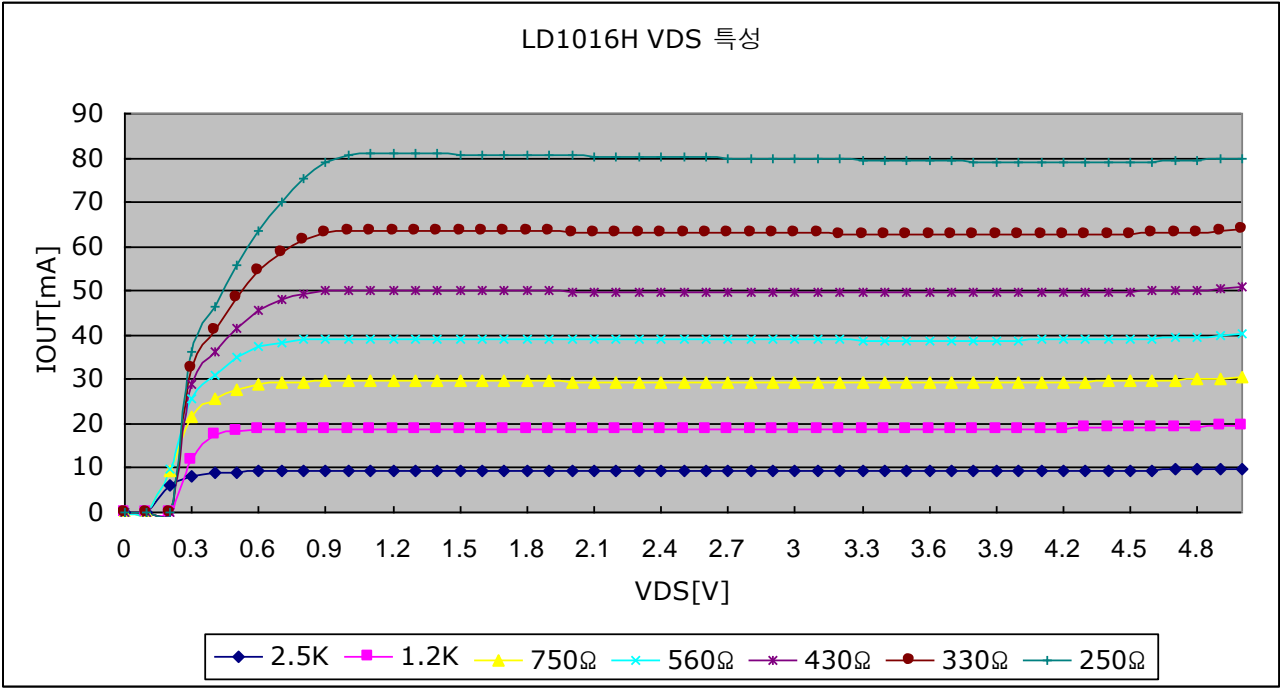
Rext — Iout



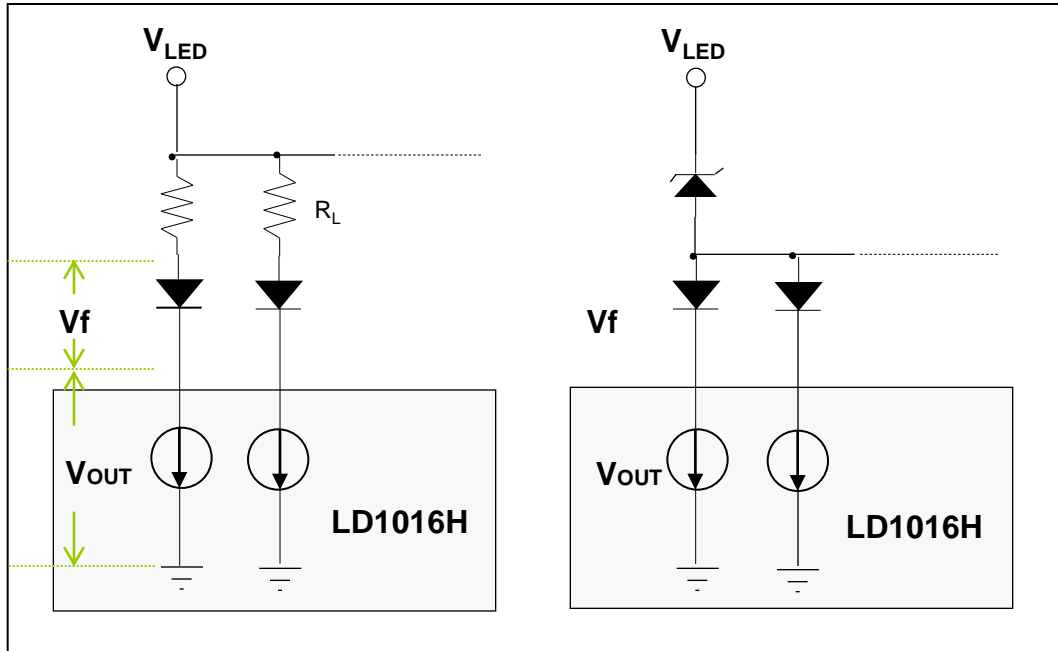
# CONSTANT OUTPUT CURRENT

The LD1016H provides a constant current output characteristics for LED display application. The pin to pin deviation is max +/- 1.5% and chip to chip deviation is max +/- 3%.

When VDD = 5.0V



## LED SUPPLY VOLTAGE( $V_{LED}$ )



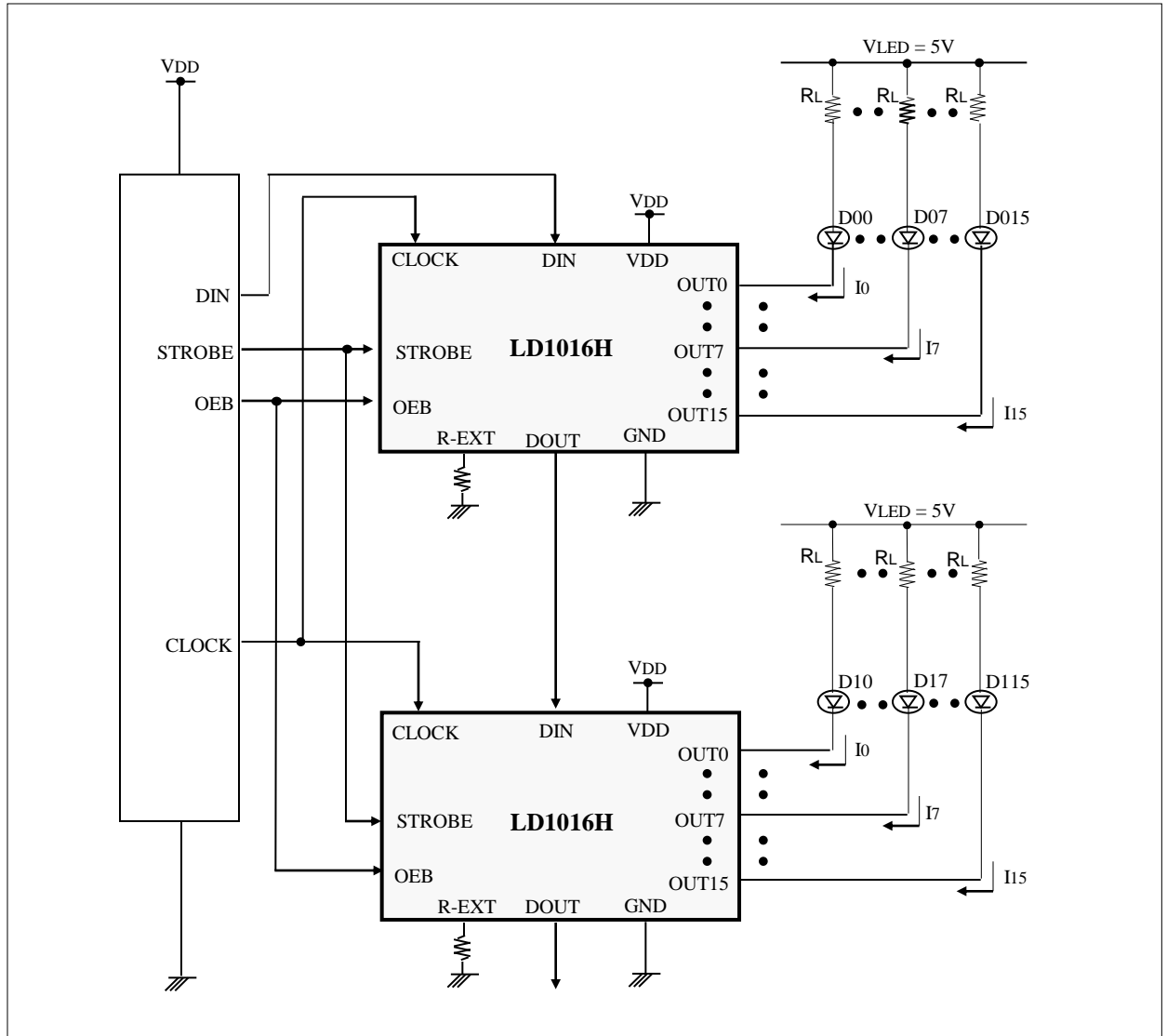
It is very important to select the proper value of Load Resistor(  $R_L$  ). Because the optimal  $V_{OUT}$  value guarantees the constant output current and long life time of LED driver IC without over power consumption.

For example, let's calculate the Load Resistor value at  $V_{LED}=5V$ ,  $I_{out}=20mA$ , LED Forward Voltage( $V_f$ )=3V.

- 1) The full current of LD1016H =  $20mA \times 16$  (channels) = 320mA
- 2) The power consumption is 320mA x  $V_{OUT}$  voltage.
  - when  $V_{OUT} = 1V$ , the power consumption is 320mW.
  - when  $V_{OUT}= 2V$ , the power consumption is 640mW.

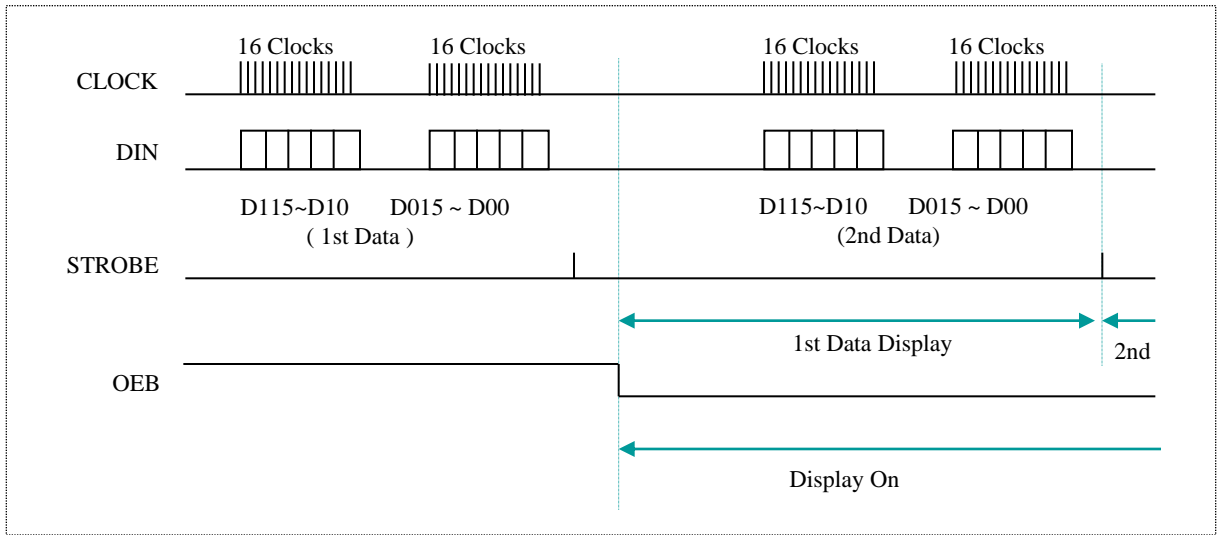
$$\begin{aligned}
 \text{Therefore, the Load Resistor } (R_L) &= (V_{LED} - V_{OUT} - V_f) / I_{out} \\
 &= (5V - V_{OUT} - 3V) / 20mA \\
 &= \underline{50\Omega} \text{ (When } V_{OUT} = 1V)
 \end{aligned}$$

**APPLICATION CIRCUIT 1 (16x2 Static Type)**

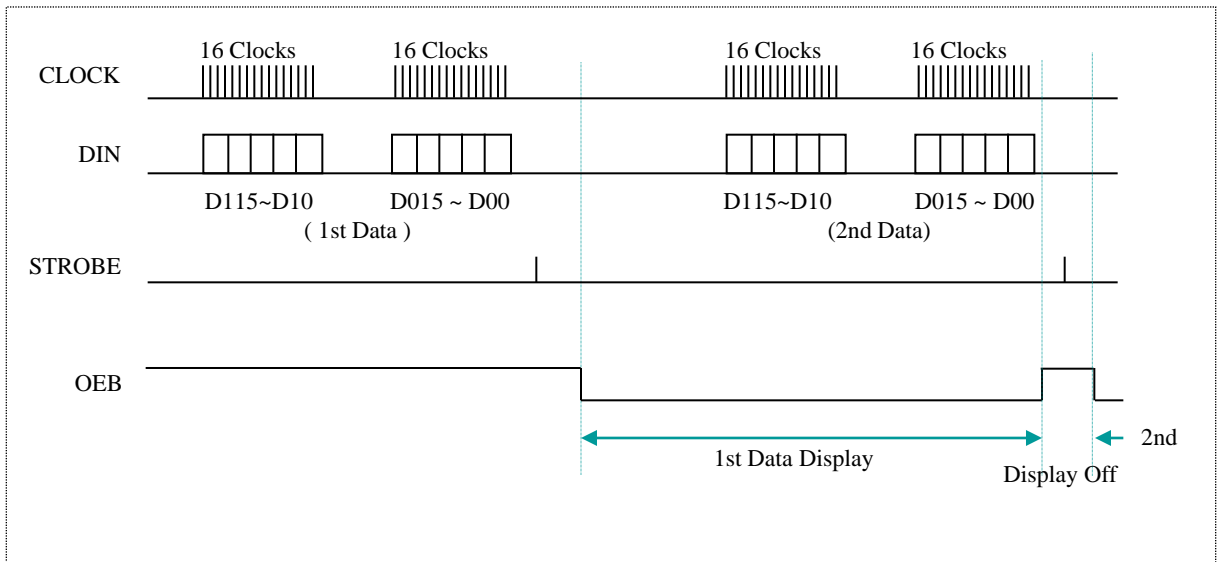


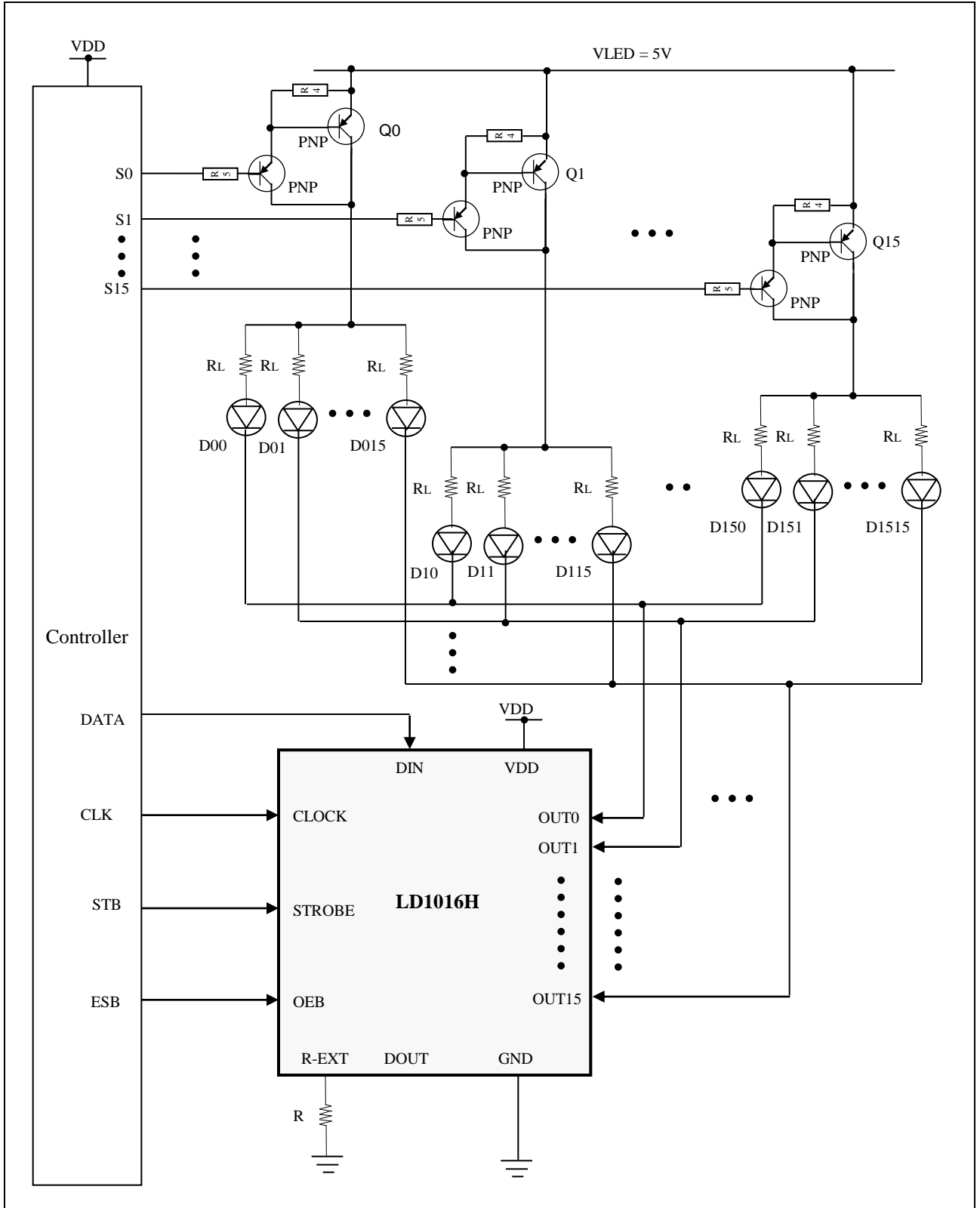
**Data & Control Signal Connection for 16x2 Static Type Application**

**Timing Diagram for Application Circuit 1 (16x2 Static Type)**

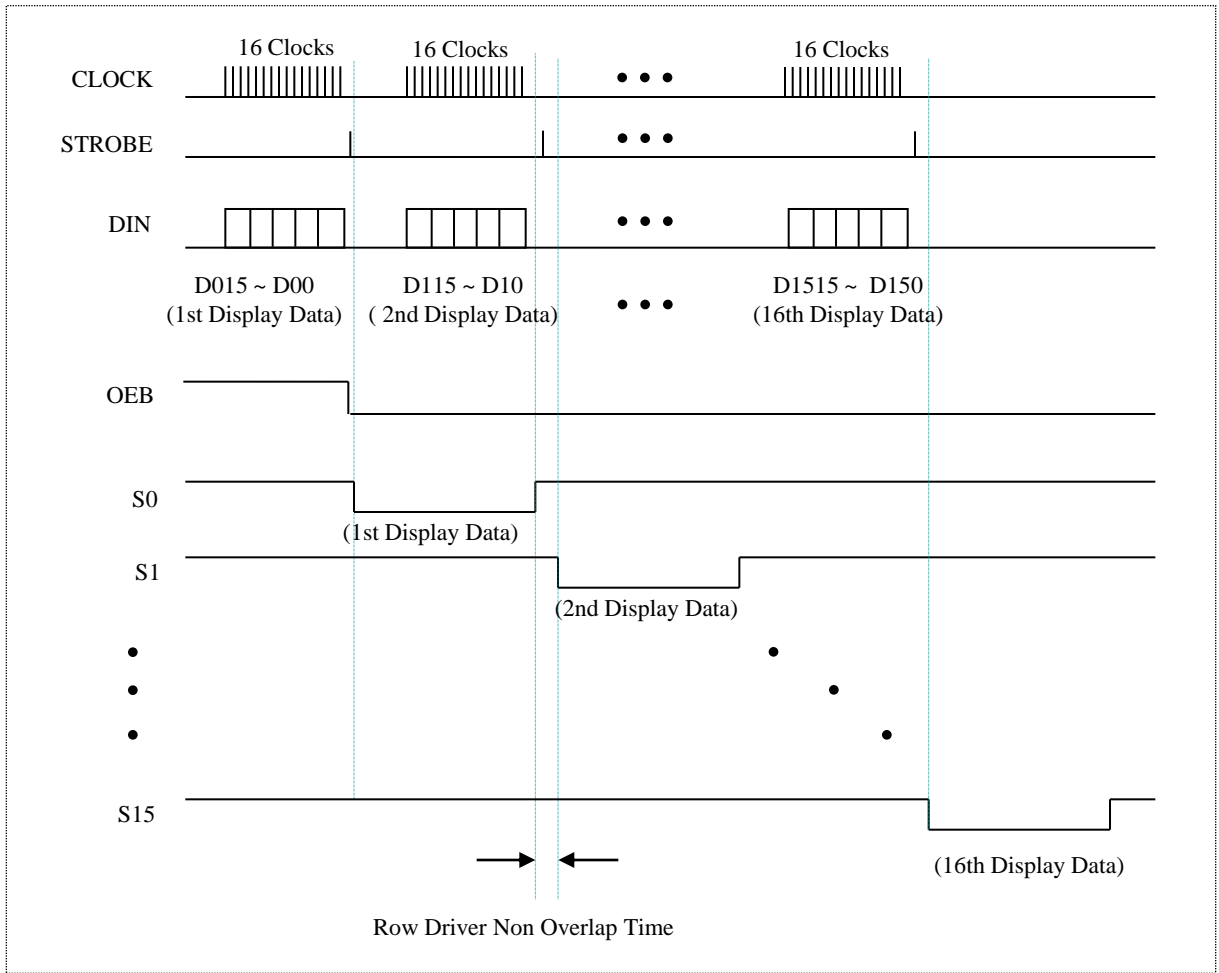


**Timing Diagram for Application Circuit 1 (16x2 Static Type) : Another Case**



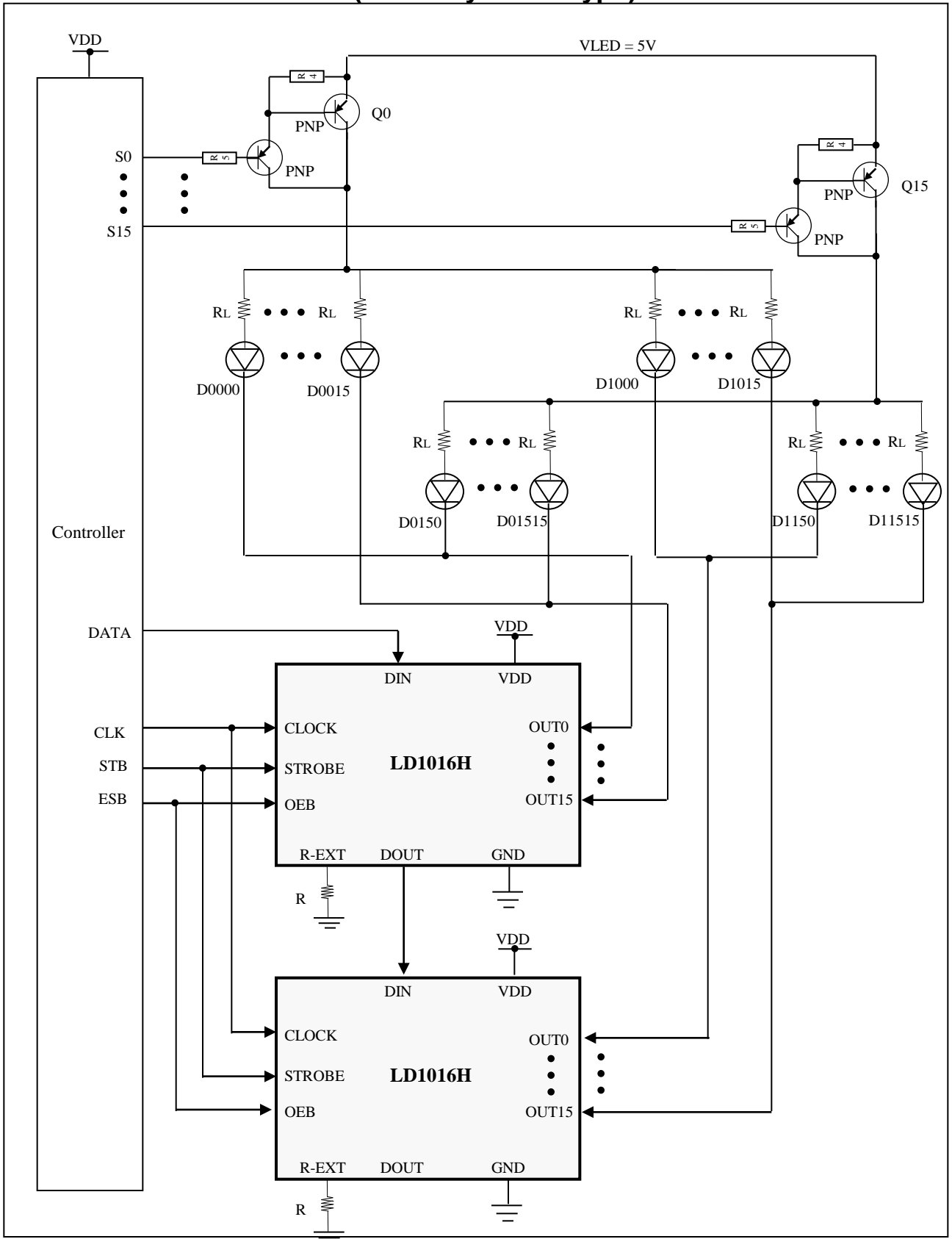
**APPLICATION CIRCUIT 2 (16x16 Dynamic Type)**

**Data & Control Signal Connection for 16x16 Dynamic Type Application**

Timing Diagram for Application Circuit 2 (16x16 Dynamic Type)



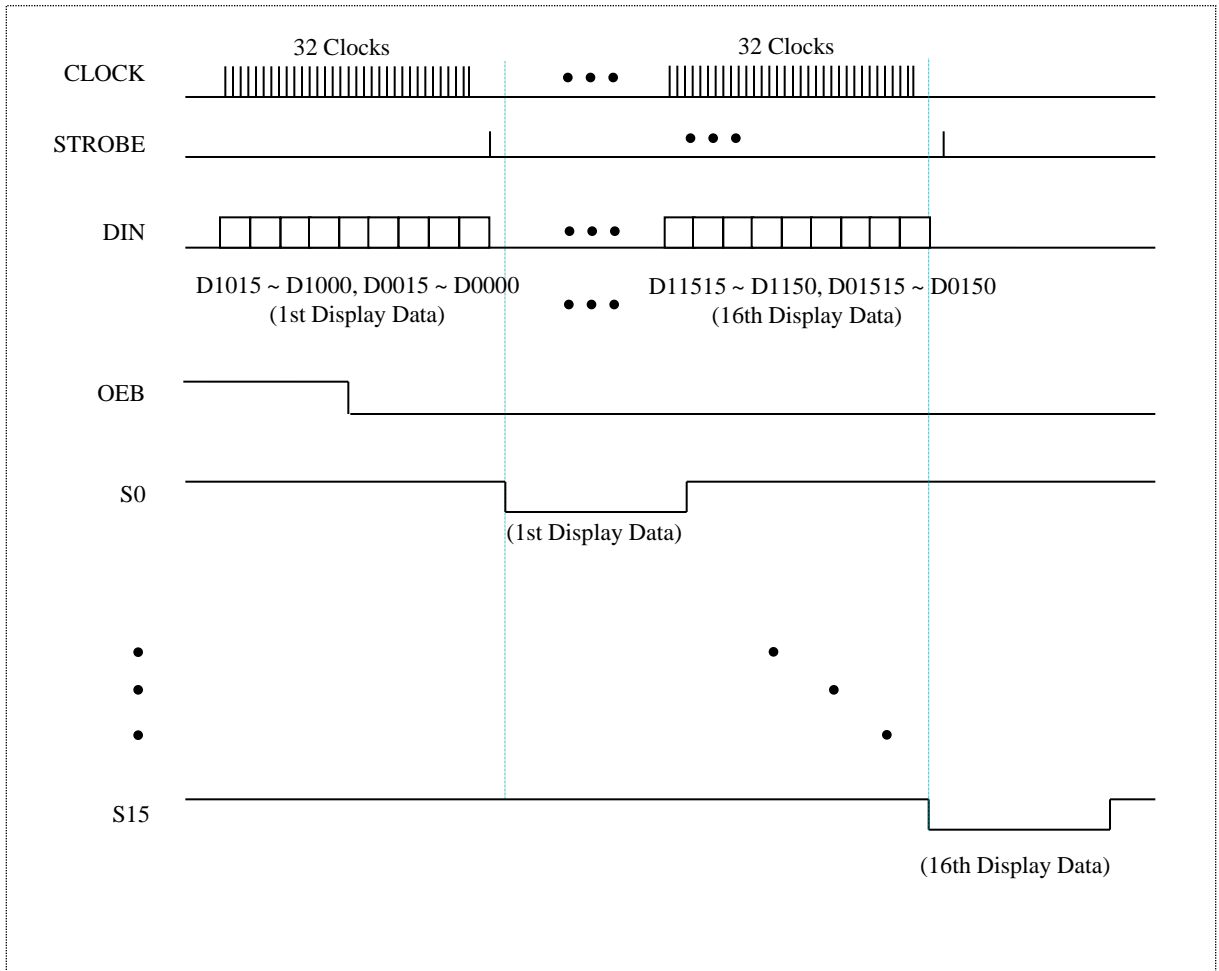


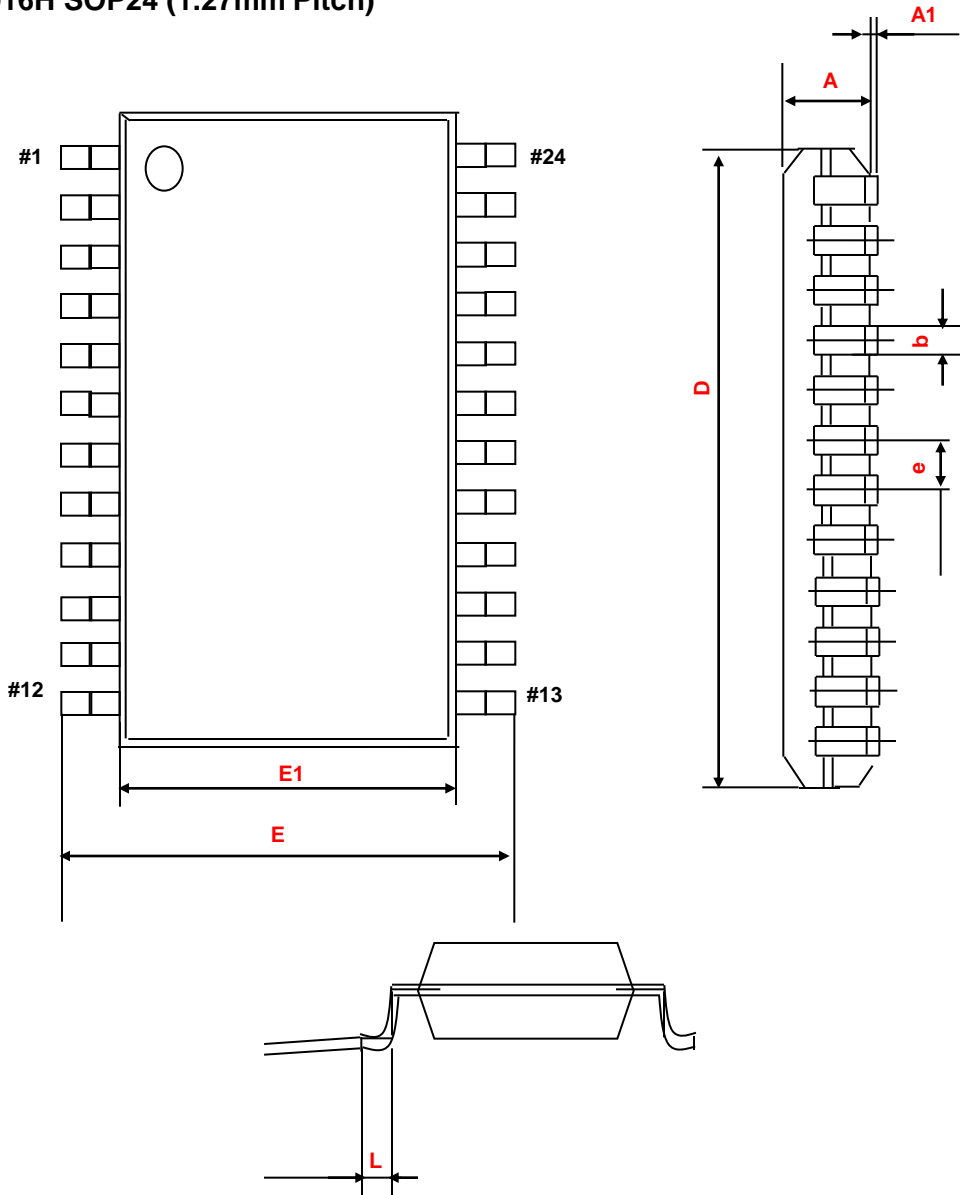
APPLICATION CIRCUIT 3 (32x16 Dynamic Type)



Data & Control Signal Connection for 32x16 Dynamic Type Application

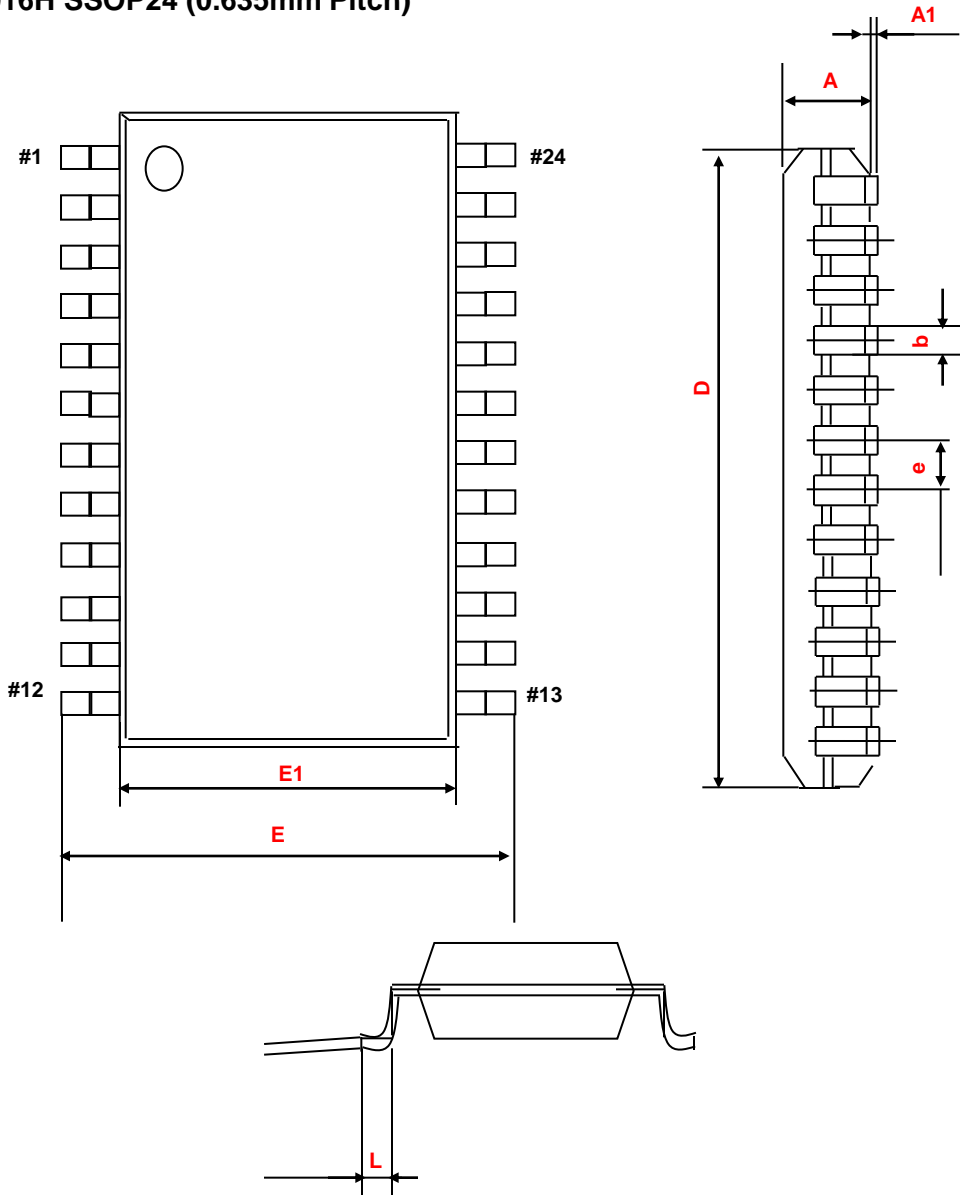
**Timing Diagram for Application Circuit 3 (32x16 Dynamic Type)**





SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	-	-	2.65
A1	0.1		0.3
b	0.31		0.51
D	15.14	15.4	15.54
E	10.0	10.3	10.6
E1	7.3	7.5	7.7
e	1.27 BSC		
L	0.4		1.27
Θ	0		8

### LD1016H SSOP24 (0.635mm Pitch)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	-	-	1.75
A1	0.1		0.25
b	0.2		0.31
D	8.45	8.65	8.85
E	3.7	3.9	4.1
E1	5.8	6	6.2
e	0.635 BSC		
L	0.40	0.45	1.27
Θ	0		8

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