

LD1016

16-CHANNEL CONSTANT Current LED Drivers

Ver. 1.0 / Feb. 2003

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LDT Inc. does NOT assume any responsibility for use of circuits described.

**LD1016 Revision History**

Version	Contents	Transfer Date
1.0	– First Version	2003.02.12

DESCRIPTION

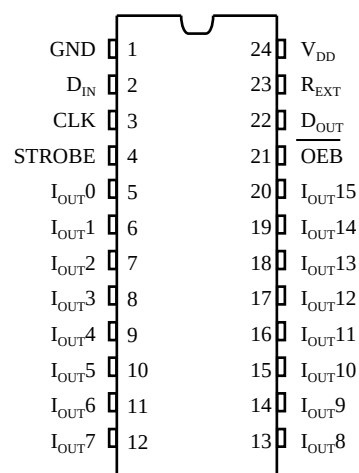
The LD1016(LD71D0016) is specifically designed for LED display. LD1016 contains a serial buffer and data latches which convert serial input data to parallel output format. At LD1016 output stage, sixteen regulated current ports are designed to provide uniform and constant current for driving LED within a large range of V_{DS} variations.

Users may adjust the output current from 5mA to 90mA through an external resistor, R_{EXT} which gives users flexibility in controlling the light intensity of LED. The high clock frequency, 25MHz, also satisfies the high speed system requirements.

FEATURES

- 16 Constant Current Output Channels
- Constant output current range : 5mA up to 90mA.
- Output current adjustment through an external resistor.
- Excellent Output Current Uniformity
- Deviation of between channels : $\pm 3\%$ (Max)
- Deviation of between IC : $\pm 6\%$ (Max)
- High Speed Operation
- 25MHz clock frequency
- Fast response of output current, OE : 200ns(Min.)
- 5V CMOS Compatible Input
- Variety of Package Type
- PDIP/ SSOP / SOP – “Pb-free” Package

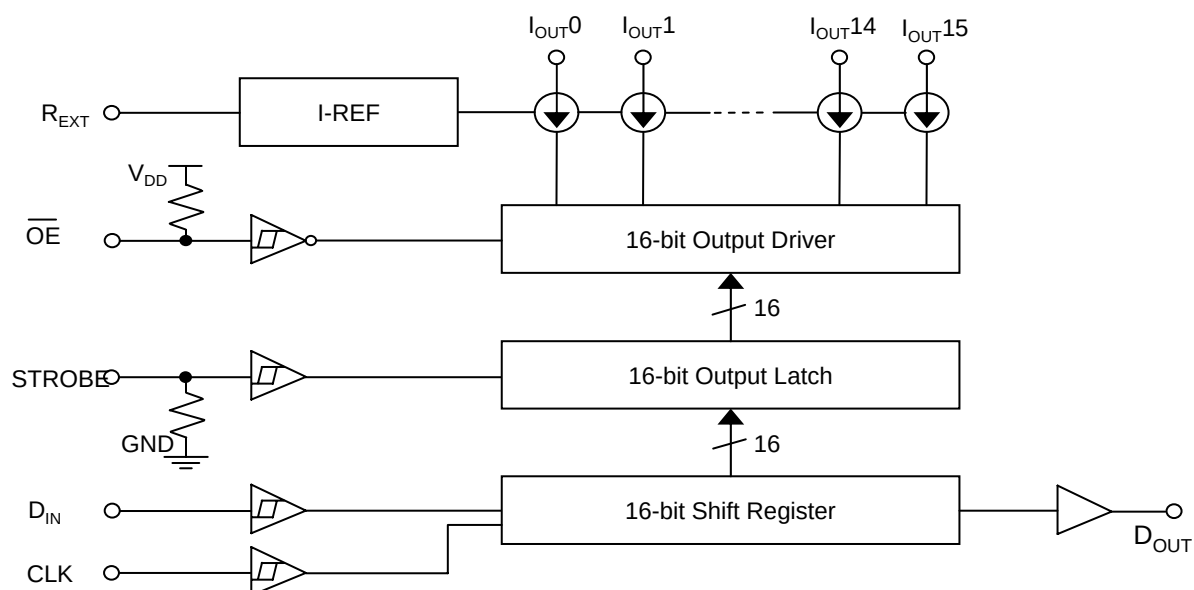
PIN CONFIGURATION



ORDERING INFORMATION

PART NUMBER	PACKAGE TYPE	TOP MARKING	TA
LD1016-PD	24-DIP(300MIL)	LD71D0016A-P	-40°C to 85 °C
LD1016-SP	24-SOP(375MIL)	LD71D0016A-S	-40°C to 85 °C
LD1016-SK	24-SSOP(300MIL)	LD71D0016A-SS	-40°C to 85 °C

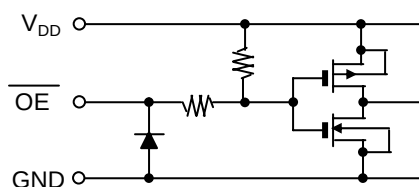
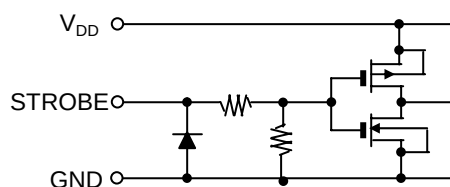
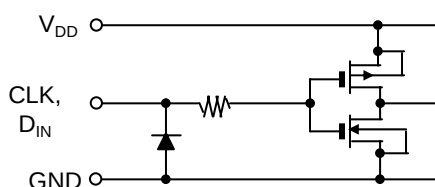
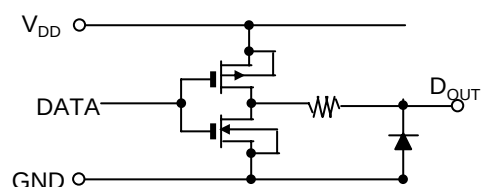
FUNCTIONAL BLOCK DIAGRAM



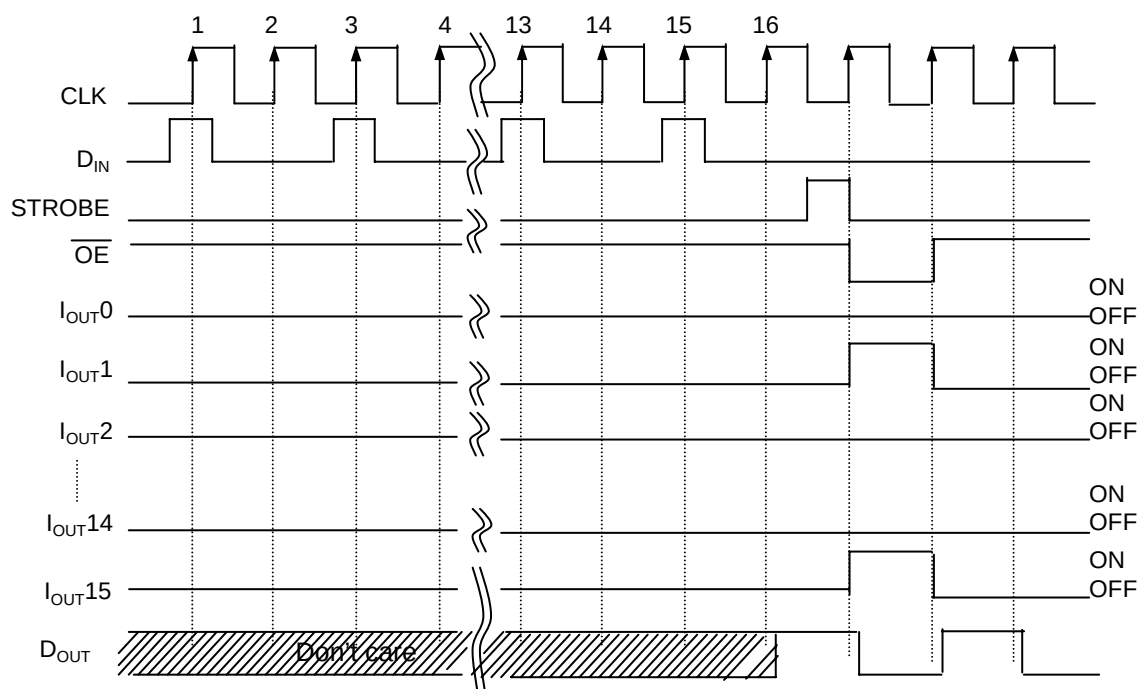
TERMINAL DESCRIPTION

PIN NO	Pin Name	Description
1	GND	GND terminal for control logic and current sink
2	D_{IN}	Serial data input terminal for shift register
3	CLK	Clock input terminal for data shift to up-edge
4	STROBE	Serial data is transferred to the output latch when STROBE is high. The data is latched when STROBE goes low
5-20	$I_{OUT}[0:15]$	Constant current output terminals
21	OEB	Output enable terminal When OE is low, the output drivers are enabled; when OE is high, all output drivers are turned off
22	D_{OUT}	Serial data output to the following D_{IN} of next driver IC
23	R_{EXT}	Input terminal used to connect an external resistor for setting up output current for all output channels
24	V_{DD}	Supply voltage terminal

EQUIVALENT CIRCUIT

OEB Terminal

STROBE Terminal

CLK, D_{IN} Terminal

D_{OUT} Terminal


TIMING DIAGRAM



TRUTH TABLE

CLK	STR	OE	D _{IN}	I _{OUT} [0] I _{OUT} [7] I _{OUT} [15]	D _{OUT}
	H	L	D _n	D _n D _{n-7} D _{n-15}	D _{n-15}
	L	L	D _{n+1}	•No Change	D _{n-14}
	H	L	D _{n+2}	D _{n+2} D _{n-5} D _{n-13}	D _{n-13}
	X	L	D _{n+3}	D _{n+2} D _{n-5} D _{n-13}	D _{n-13}
	X	H	D _{n+3}	OFF	D _{n-13}

※NOTE: D_n~D_{n-15} = "H" then I_{OUT}[0:15] is ON, "L" then I_{OUT}[0:15] is OFF

MAXIMUM RATINGS

Ta = 25°C

CHARACTERISRIC	SYMBOL	RATING	UNIT
Supply Voltage	V _{DD}	0~7.0	V
Output Voltage	V _{OUT}	-0.5~8.0	V
Output current	I _{OUT} [0:15]	90	mA
Input Voltage	V _{IN}	-0.4~V _{DD} +0.4	V
GND Terminal Current	I _{GND}	1440	mA
Clock Frequency	f _{CK}	25	MHz
Power Dissipation	P _D	1.78	W
Operating Temperature	T _{opr}	-40~85	°C
Storage Temperature	T _{stg}	-55~150	°C

RECOMMENDED OPERATING CONDITION

 $T_a = 25^{\circ}\text{C}$

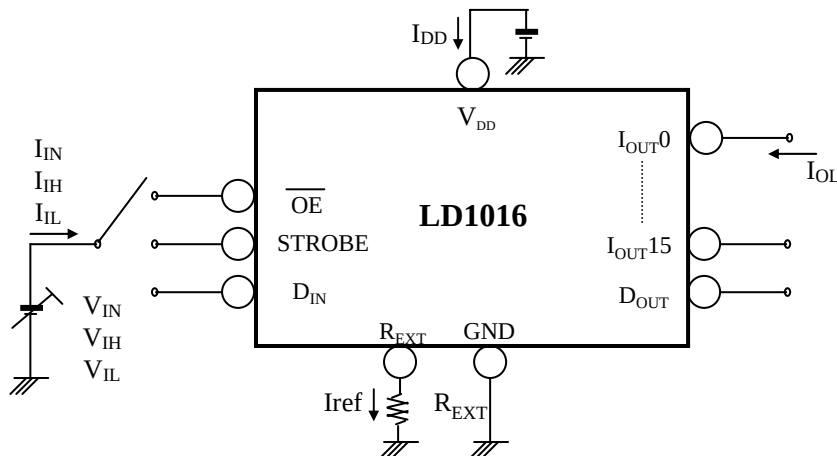
CHARACTERISRIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	-	4.5	5.0	5.5	V
Output Voltage	V_{OUT}	-	-	-	8.0	-
Output Voltage	$I_{OUT}[0:15]$	I_{OUT}	-	-	90	mA
	D_{OUT}	I_{OH}	-	-	-1.0	
		I_{OL}	-	-	1.0	
Input Voltage	V_{IN}	-	0	-	V_{DD}	V
Data Set Up Time	$t_{setup}(D)$	-	20	-	-	ns
Data Hold Time	$t_{hold}(D)$	-	20	-	-	ns
STROBE Set up Time	$t_{setup}(S)$	-	20	-	-	ns
STROBE Hold Time	$t_{hold}(S)$	-	20	-	-	ns
CLK Pulse Width	$t_w \text{ CLK}$	-	15	-	-	ns
	$t_w \overline{\text{CLK}}$	-	15	-	-	
STROBE Pulse Width	$t_w \text{ STB}$	-	20	-	-	ns
	$t_w \overline{\text{STB}}$	-	20	-	-	
CLK Pulse Width	f_{CK}	Cascade Operation	-	-	25.0	MHz
Power Dissipation	P_D	$T_a = 85^{\circ}\text{C}$	-	-	0.74	W

ELECTRICAL CHARACTERISTICS

 $T_a = 25^\circ\text{C}$

CHARACTERISRIC		SYMBOL	TEST CIR- CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage	“H” Level	V _{IH}	-	-	0.7V _{DD}	-	V _{DD}	V
	“L” Level	V _{IL}	-	-	GND	-	0.3V _{DD}	
Output Leakage current		I _{OZ}	-	V _{OH} = 6.0V		-	1	uA
Output Voltage	D _{OUT}	V _{OL}	-	-	-	-	0.2V _{DD}	V
		V _{OH}	-	-	0.8V _{DD}	-	-	
Output Current1		I _{OL1}	-	R _{EXT} = 14kW	37	40.0	43.0	mA
	Delta I _{OUT}	Δ I _{OL1}	-	R _{EXT} = 14 kW I _{OUT} = 40mA, V _{OUT} = 1V	-	± 1.5	± 6.0	%
Output Current2		I _{OL2}	-	R _{EXT} = 7.0 kW	70.0	75.0	80.0	mA
	Delta I _{OUT}	Δ I _{OL2}	-	R _{EXT} = 7.0 kW I _{OUT} = 75mA, V _{OUT} = 1V	-	± 1.5	± 6.0	%
Supply Voltage Regulation		%/V _{DD}	-	R _{EXT} = 14 kW	-	1.5	5.0	%/V
Reference Voltage		V _{ref}	-	R _{EXT} =14 kW,Ta =-40~85°C	-	1.12	-	V
Pull up resistor		R _{IN} (up)	-	-	100	200	400	kW
Pull down resistor		R _{IN} (down)	-	-	100	200	400	
Supply current		I _{DD} (off) 1	-	R _{EXT} = OPEN, OUTn = OFF	-	0.3	0.6	V
		I _{DD} (off) 2	-	R _{EXT} = 14 kW, OUTn = OFF	0.5	1.0	1.5	mA
		I _{DD} (off) 3	-	R _{EXT} = 7.0 kW, OUTn = OFF	1.0	2.0	3.0	

Test Circuit for Electrical Characteristics



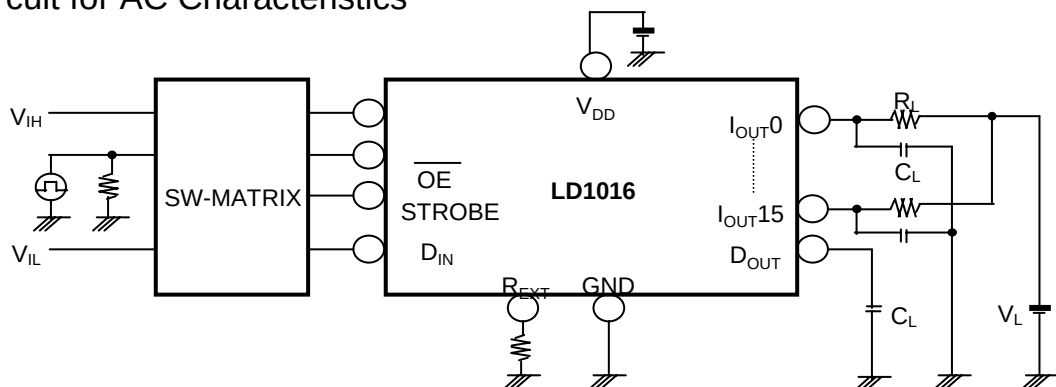
AC CHARACTERISTICS

Ta = 25C

CHARACTERISRIC		SYMBOL	TEST CIR- CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time ("L" to "H")	CLK-D _{OUT}	t _{PLH}	-	V _{DD} = 5.0V V _{OUT} = 1.0V V _{IH} = V _{DD} V _{IL} = GND f _{CK} = 10MHz R _{EXT} = 10 kΩ I _{OUT} = 40mA V _L = 3.0V C _L = 10.0pF R _L = 65W	-	30	70	ns
	CK-OUTn				-	600	1500	
	STROBE-OUTn				-	600	1500	
	OE-OUTn				-	600	1500	
Propagation Delay Time ("H" to "L")	CK-D _{OUT}	t _{PHL}	-		-	30	70	ns
	CK-OUTn				-	350	1000	
	STROBE-OUTn				-	350	1000	
	OE-OUTn				-	350	1000	
Max. Clock Frequency		f _{CKMAX} (*1)	-		-	10	25	MHz
Propagation Delay Time ("H" to "L")	CLK	t _{WCK}	-		-	20	50	ns
	STROBE	t _{W STB}	-		-	10	40	
Data Set Up Time		t _{setup} (D)	-		-	10	30	ns
Data Hold Time		t _{hold} (D)	-		-	10	30	
STROBE Setup Time	LH	t _{STB setup}	-		-	10	20	ns
	HL				-	0	20	
STROBE Hold Time	LH	t _{STB hold}	-		-	10	20	ns
	HL			-	0	20		
Max. Clock Rise Time		t _r	-	-	-	10	ns	
Max. Clock Fall Time		t _f		-	-	10		
Min. Output Rise Time		t _{or}	-	-	300	1000	ns	
Min. Output Rise Time		t _{of}		-	150	600		

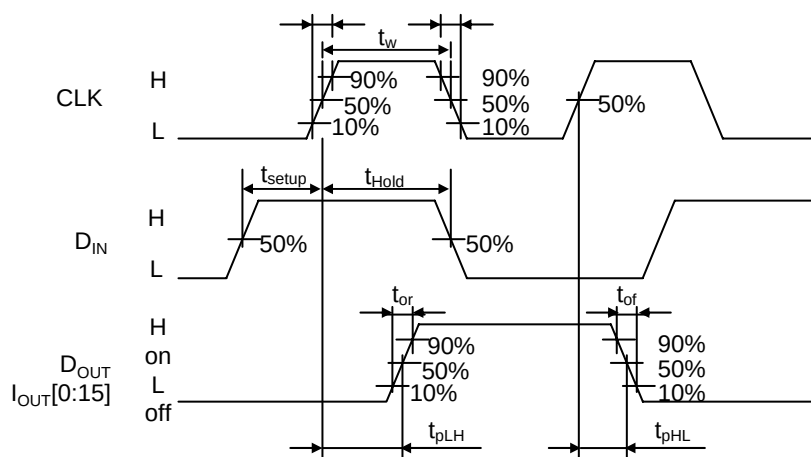
*NOTE: . *1 : Cascade Operation

Test Circuit for AC Characteristics

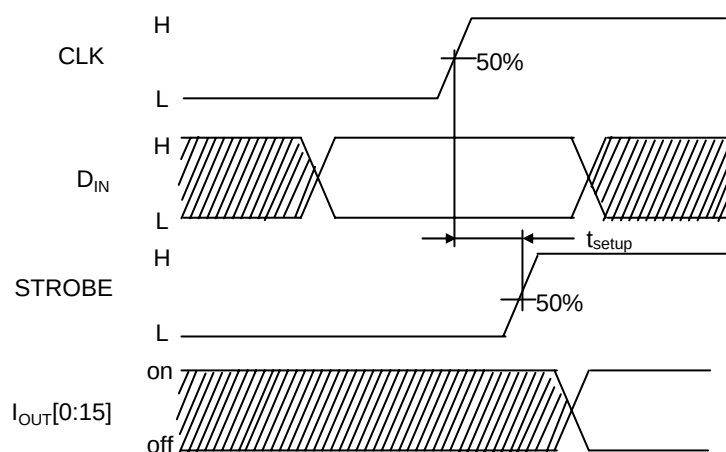


TIMING WAVEFORM

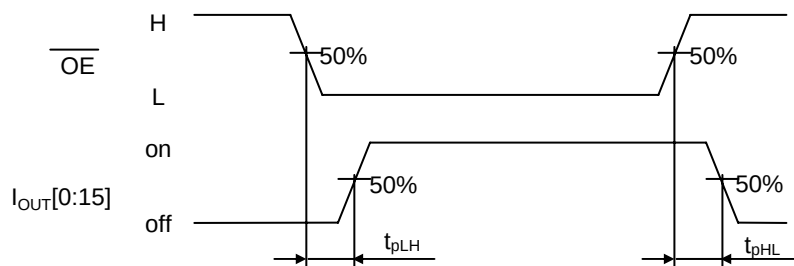
CLK to D_{OUT} , $I_{OUT}[0:15]$



CLK to STROBE



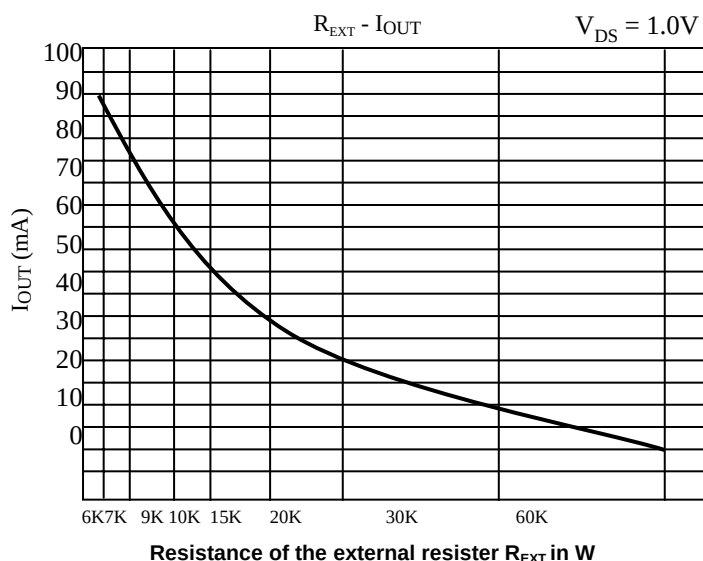
OE to $I_{OUT}[0:15]$



APPLICATION GUIDE

Adjusting Output Current

The output current of each channel (I_{OUT}) is set by an external resistor R_{EXT} . The relationship between I_{OUT} and R_{EXT} is shown in the following figure.



R_{EXT}	I_{OUT}
6 k Ω	85mA
7 k Ω	75mA
9 k Ω	60mA
11 k Ω	50mA
14 k Ω	40mA
19 k Ω	30mA
29 k Ω	20mA
59 k Ω	10mA

Also, the output current can be calculated from the equation:

$$V_{R-EXT} = 1.2V ; \text{ Internal resistance } R_{INT} = 1K\Omega$$

$$I_{OUT} = [V_{R-EXT} / (R_{EXT} + R_{INT})] \times 480$$

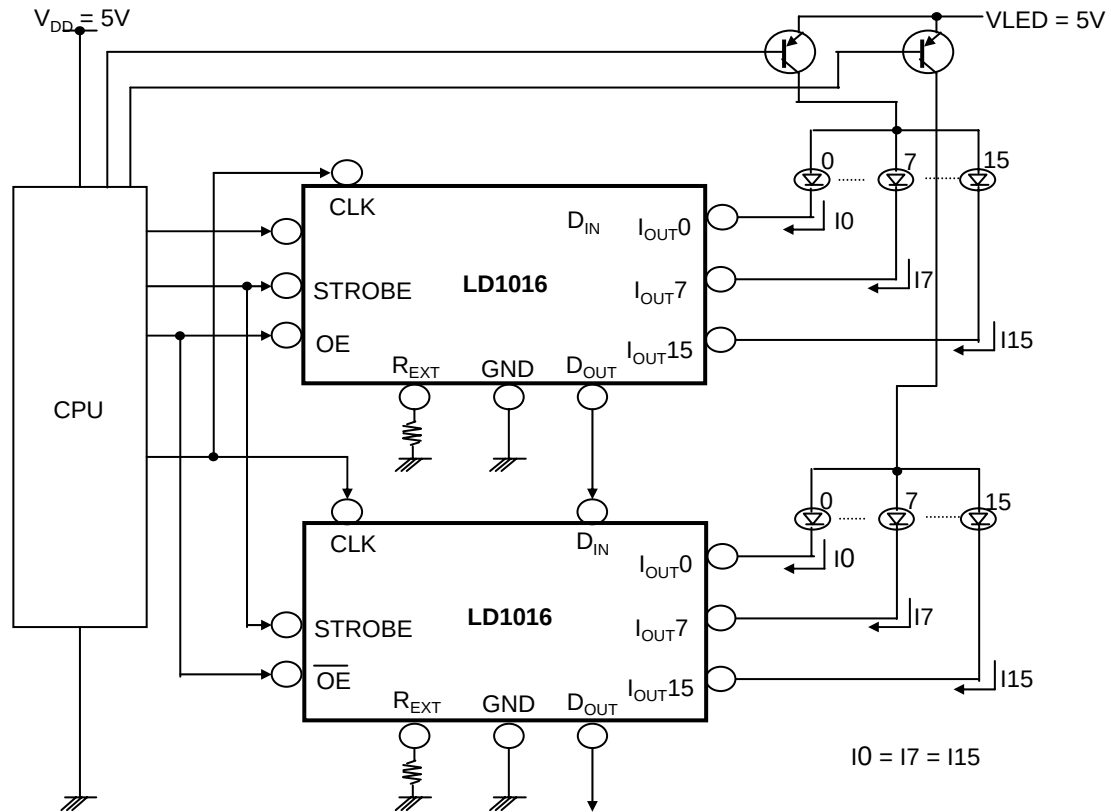
where R_{EXT} is the resistance of the external resistor connected to R_{EXT} terminal and V_{R-EXT} is the voltage of R_{EXT} terminal. The magnitude of current (as a function of R_{EXT}) is around 40mA at 14K Ω and 20mA at 29K Ω

Constant Current

In LED display application, LD1016 provides nearly no variation in current from channel to channel and IC to IC. This can be achieved by:

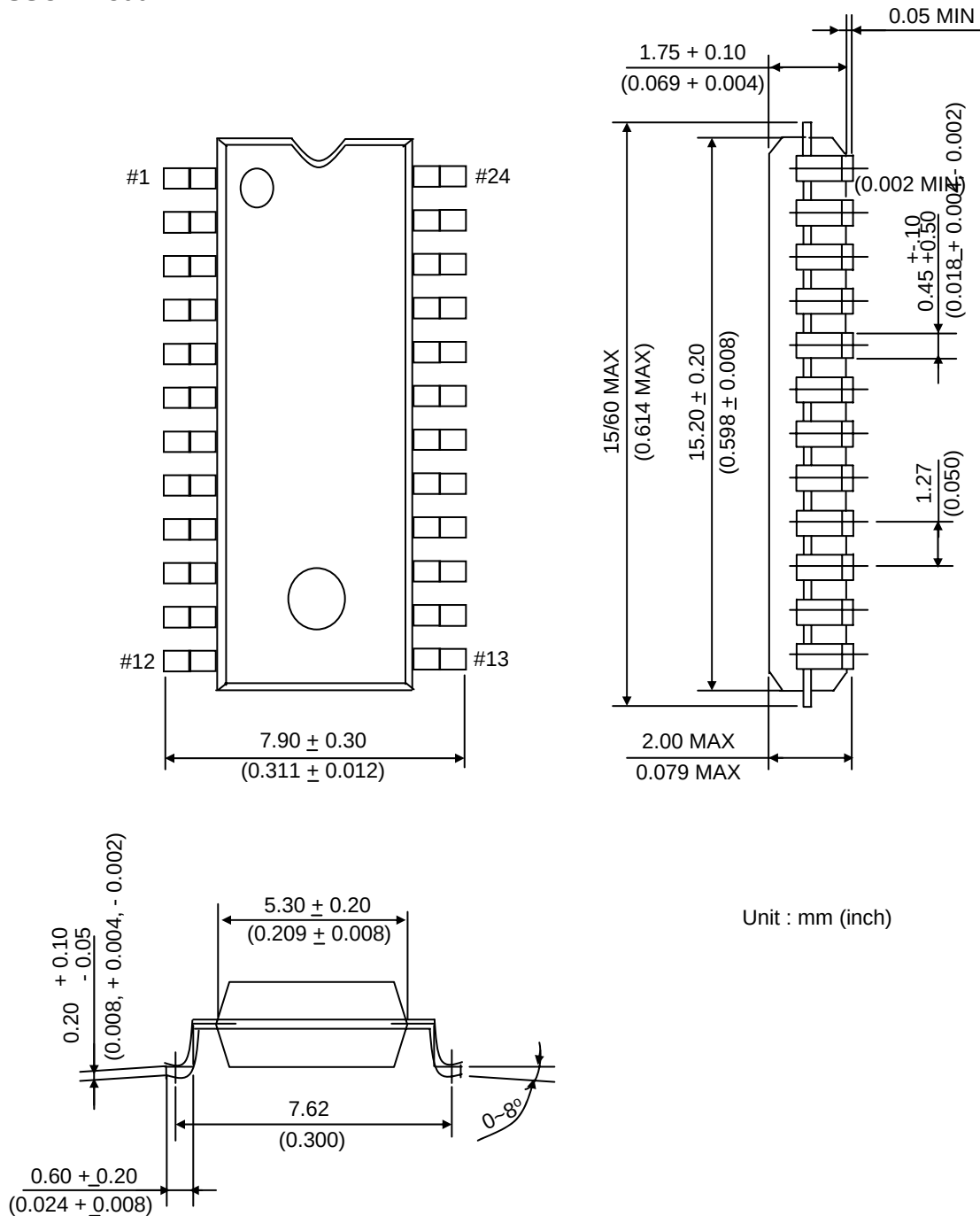
- 1) The maximum current variation between channels is less than $\pm 3\%$, and that between ICs is less than $\pm 6\%$.
- 2) In addition, the current characteristic of output stage is flat. The output current can be kept constant regardless of the variations of LED forward voltage. This perform as a perfection of load regulation.

APPLICATION EXAMPLE



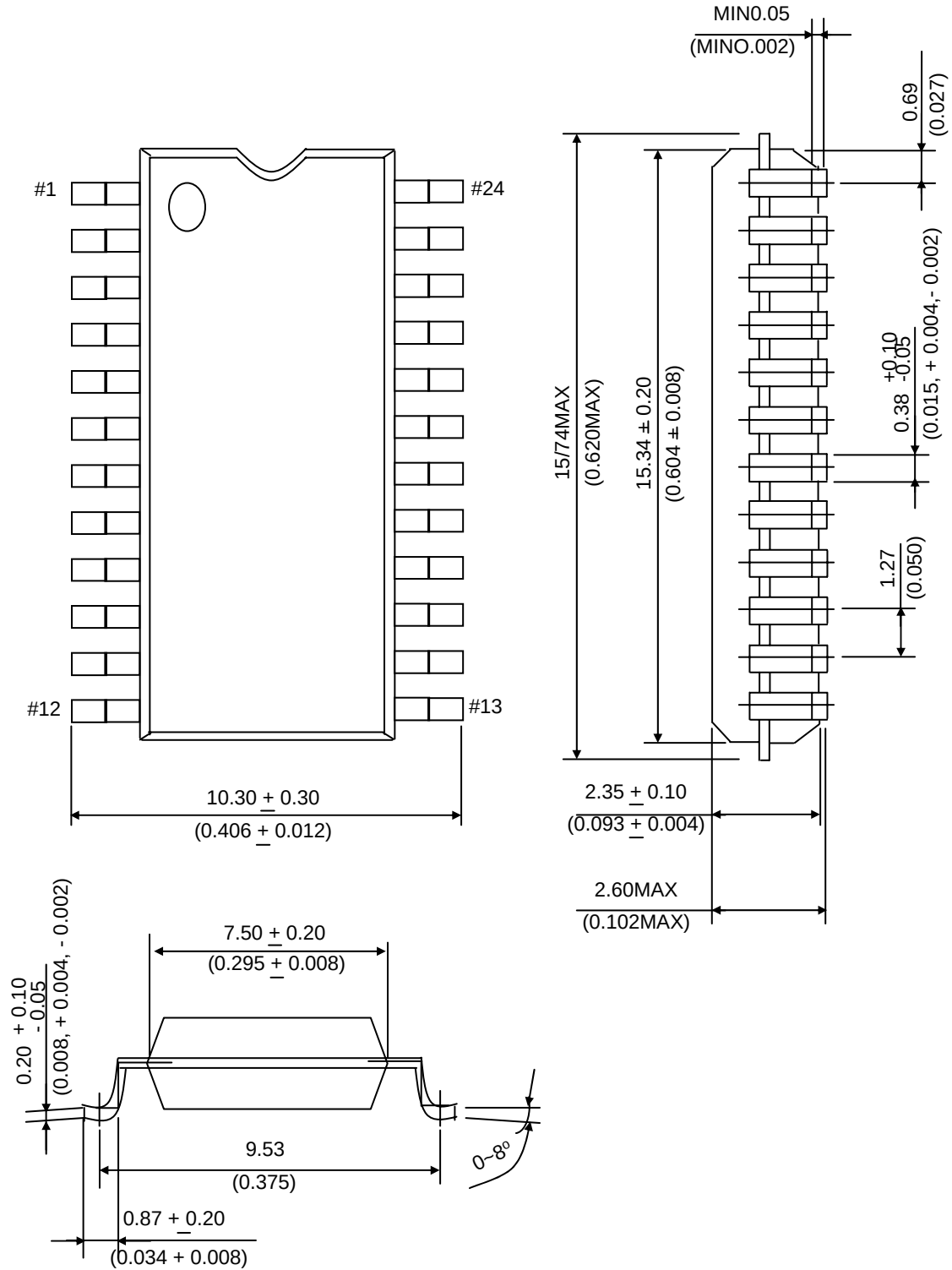
PACKAGE INFORMATION

24 SSOP – 300 mil



24 SOP – 375mil

Unit : mm (inch)



24 PDIP – 300mil

Unit : inch

