



## L16B06

CMOS IC

### 16-BIT CONSTANT CURRENT LED DRIVER

#### DESCRIPTION

The **L16B06** is a constant-current sink driver specifically designed for LED display applications. The device incorporates shift registers, data latches, and constant current circuitry on the silicon CMOS chip. The maximum output current value of all 16 channels is adjustable by a single external resistor.

#### FEATURES

- \*Constant-current outputs: 3mA to 60mA adjustable by one external resistor
- \*Maximum output voltage: 17V
- \*Maximum clock frequency: 25MHz
- \*Power supply voltage: 3.3V to 5V
- \*In-rush current control
- \*Bit-to-bit skew:  $\pm 3\%$     Chip-to-chip skew:  $\pm 6\%$
- \*Package and pin assignment compatible to conventional LED drivers

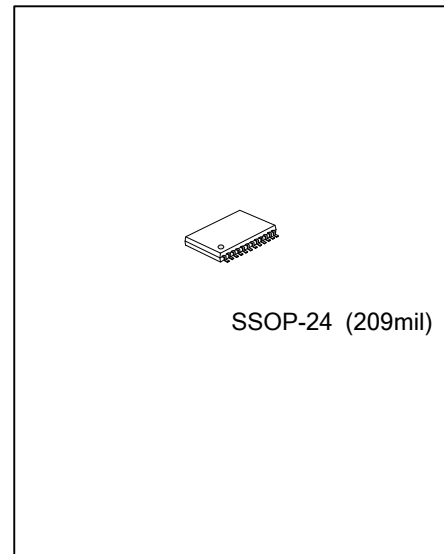
#### APPLICATIONS

- \*Indoor/Outdoor LED Video Display
- \*LED Variable Message Signs (VMS) System

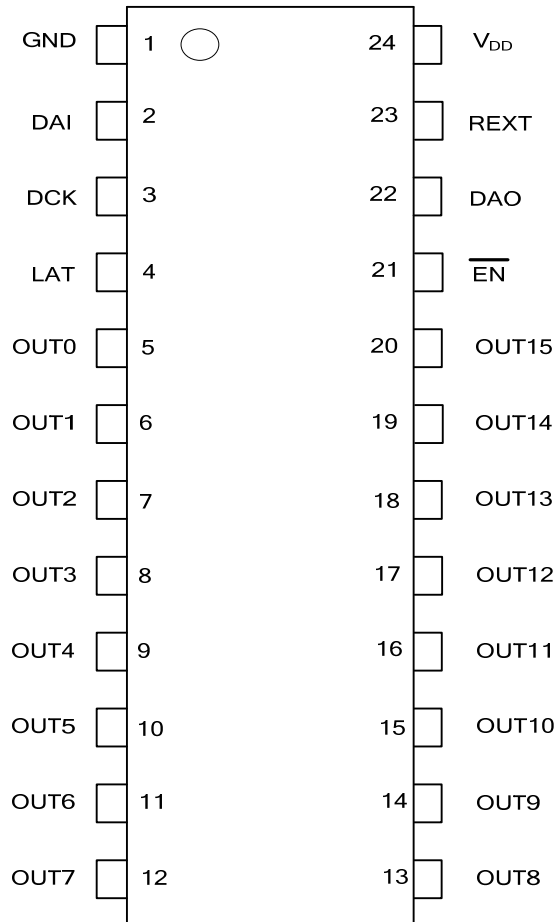
#### ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
L16B06L-R24-T	L16B06G-R24-T	SSOP-24	Tube
L16B06L-R24-R	L16B06G-R24-R	SSOP-24	Tape Reel

<p>L16B06L-R24-T</p> <p>(1) Packing Type</p> <p>(2) Package Type</p> <p>(3) Lead Free</p>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) R24: SSOP-24</p> <p>(3) L: Lead Free, G: Halogen Free</p>
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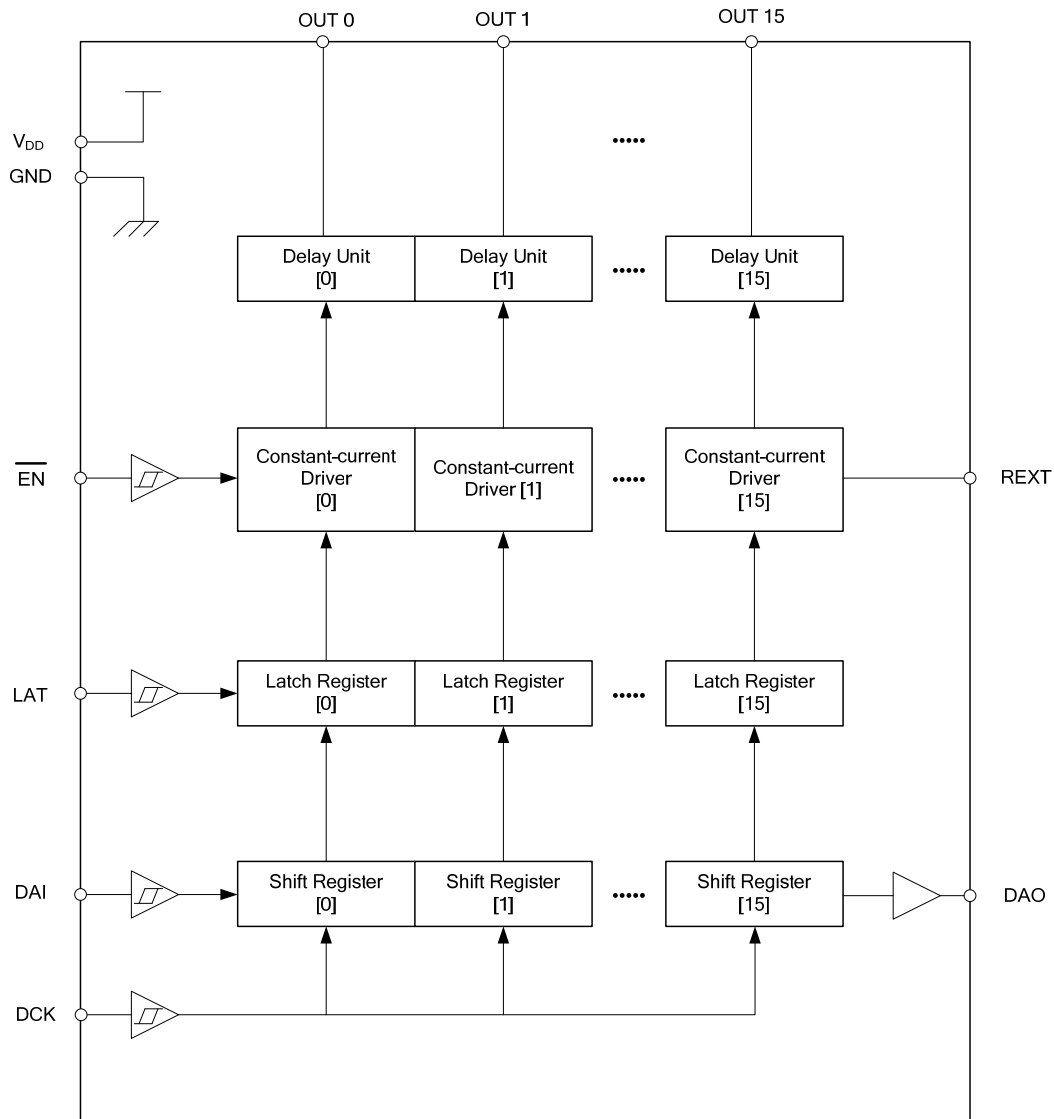
■ PIN CONNECTION



■ PIN DESCRIPTION

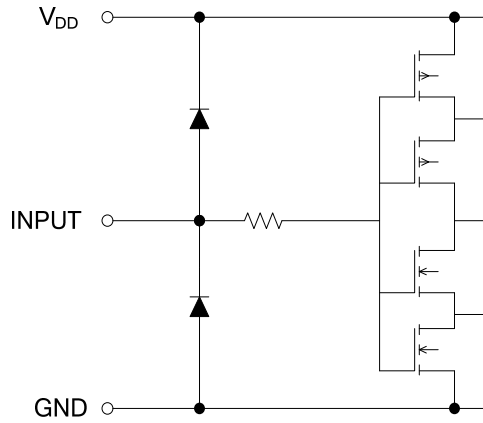
PIN No.	PIN NAME	FUNCTION
1	GND	Ground terminal.
2	DAI	Serial data input terminal.
3	DCK	Synchronous clock input terminal for serial data transfer. Data is sampled at the rising edge of DCK.
4	LAT	Input terminal of data strobe. Data on shift register goes through at the high level of LAT (level trigger). Otherwise, data is latched.
5-20	OUT0-15	Sink constant-current outputs (open-drain).
21	$\overline{\text{EN}}$	Output enable terminal: 'H' for all outputs are turned off, 'L' for all outputs are active.
22	DAO	Serial data output terminal.
23	REXT	External resistors connected between REXT and GND for output current value setting.
24	V <sub>DD</sub>	Supply voltage terminal.

## ■ BLOCK DIAGRAM

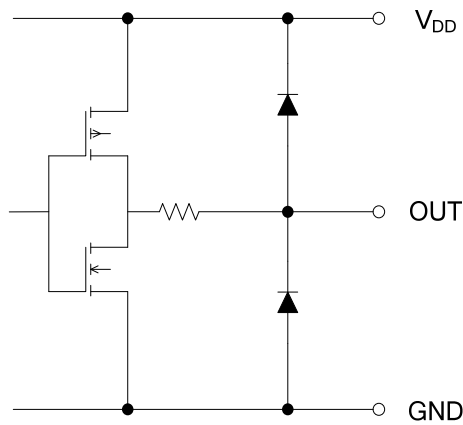


## ■ EQUIVALENT CIRCUIT OF INPUTS AND OUTPUTS

### 1. DCK, DAI, LAT, $\overline{EN}$ TERMINALS



### 2. DAO TERMINALS



■ MAXIMUM RATINGS ( $T_A=25^{\circ}\text{C}$ ,  $T_J=150^{\circ}\text{C}$ )

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	$V_{DD}$	-0.3 ~ 7.0	V
Input Voltage	$V_{IN}$	-0.3 ~ $V_{DD}+0.3$	V
Output Current	$I_{OUT}$	70	mA
Output Voltage	$V_{OUT}$	-0.3 ~ 17	V
Input Clock Frequency	$F_{DCK}$	25	MHz
Operating Temperature	$T_{OPR}$	-40 ~ 85	$^{\circ}\text{C}$
Storage Temperature	$T_{STG}$	-55 ~ 150	$^{\circ}\text{C}$

■ RECOMMENDED OPERATING CONDITION

CHARACTERISTIC	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage	$V_{DD}$		3.3	5.0	5.5	V
Output Voltage	$V_{OUT}$	Driver On	1.0		$0.5 \times V_{DD}$	V
Output Voltage	$V_{OUT}$	Driver Off			17	V
Output Current	$I_O$	OUTn	5		60	mA
Input Voltage	$V_{IH}$	$V_{DD}=3.3\text{V} \sim 5.5\text{V}$	$0.8 \times V_{DD}$		$V_{DD}$	V
	$V_{IL}$		0.0		$0.2 \times V_{DD}$	

■ ELECTRICAL CHARACTERISTICS ( $V_{DD}=5.0\text{V}$ ,  $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

CHARACTERISTIC	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Input Voltage "H" Level	$V_{IH}$	CMOS logic level	$0.8 \times V_{DD}$		$V_{DD}$	V
Input Voltage "L" Level	$V_{IL}$	CMOS logics2 level	GND		$0.2 \times V_{DD}$	V
Output Leakage Current	$I_{OL}$	$V_{OH}=17\text{V}$			$\pm 1$	$\mu\text{A}$
Output Voltage (DAO)	$V_{OL}$	$I_{OL}=1.5\text{mA}$			0.2	V
	$V_{OH}$	$I_{OH}=1.4\text{mA}$	$V_{DD}-0.2$			V
Output Current Skew (Channel-to-Channel)	$I_{OL1}$	$V_{OUT}=1.0\text{V}$ , $R_{REXT}=2.2\text{K}\Omega$			$\pm 3$	%
Output Current Skew (Chip-to-Chip)	$I_{OL2}$				$\pm 6$	%
Output Voltage Regulation	% / $V_{OUT}$	$R_{REXT}=2.2\text{K}\Omega$ , $V_{OUT}=1\text{V} \sim 3\text{V}$		$\pm 0.1$	$\pm 0.5$	%/V
Supply Voltage Regulation	% / $V_{DD}$	$R_{REXT}=2.2\text{K}\Omega$		$\pm 1$	$\pm 4$	

## ■ ELECTRICAL CHARACTERISTICS(Cont.)

CHARACTERISTIC	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Current	$I_{DD(OFF)}$	power on all pins are open unless $V_{DD}$ and GND		3	4	mA
	$I_{DD(OFF)}$	input signal is static $R_{REXT}=2.9K\Omega$ all outputs turn off		5	6	mA
	$I_{DD(ON)}$	input signal is static $R_{REXT}=2.9K\Omega$ all outputs turn on		5	6	mA
	$I_{DD(OFF)}$	input signal is static $R_{REXT}=1.05K\Omega$ all outputs turn off		9	10	mA
	$I_{DD(ON)}$	input signal is static $R_{REXT}=1.05K\Omega$ all outputs turn on		9	10	mA

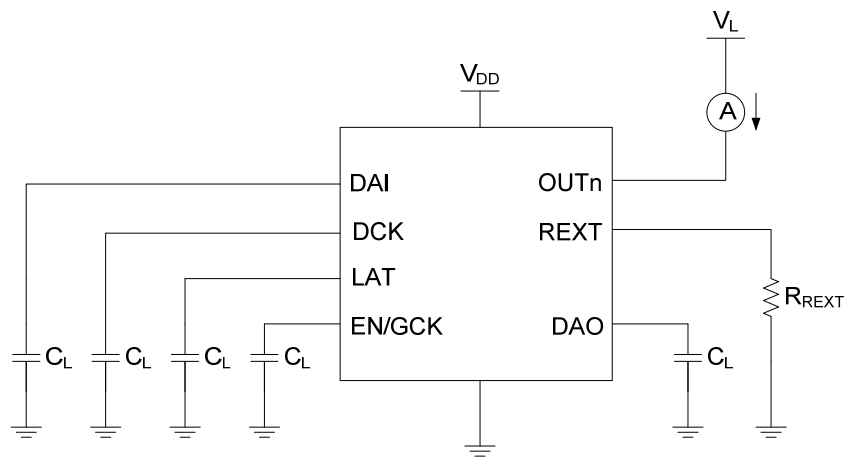
## ■ SWITCHING CHARACTERISTICS ( $V_{DD}=5.0V$ , $T_A=25^\circ C$ , unless otherwise specified)

CHARACTERISTIC	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT	
Propagation Delay ('L' to 'H')	EN-to-OUT0	$V_{IH}=V_{DD}$ , $V_{IL}=GND$ $R_{REXT}=2.2k\Omega$ , $V_L=5.0V$ , $C_L=13pF$		52		ns	
	LAT-to-OUT0			49		ns	
	DCK-to-DAO			20		ns	
Propagation Delay ('H' to 'L')	EN-to-OUT0			22		ns	
	LAT-to-OUT0			75		ns	
	DCK-to-DAO			19.5		ns	
Output Current Rise Time	$t_{OR}$				33.5		ns
Output Current Fall Time	$t_{OF}$				6		ns
Output Delay Time (OUT(n)-to-OUT(n+1))	$t_{OD}$				5		ns

## ■ SWITCHING CHARACTERISTICS ( $V_{DD}=3.3V$ , $T_A=25^\circ C$ , unless otherwise specified)

CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	
Propagation Delay ('L' to 'H')	EN-to-OUT0	$V_{IH}=V_{DD}$ , $V_{IL}=GND$ $R_{REXT}=2.2K\Omega$ $V_L=5.0V$ , $C_L=13pF$		51		ns	
	LAT-to-OUT0			21.5		ns	
	DCK-to-DAO			12		ns	
Propagation Delay ('H' to 'L')	EN-to-OUT0			23		ns	
	LAT-to-OUT0			49		ns	
	DCK-to-DAO			11.5		ns	
Output Current Rise Time	$t_{OR}$				35		ns
Output Current Fall Time	$t_{OF}$				10		ns
Output Delay Time (OUT(n)-to-OUT(n+1))	$t_{OD}$				10		ns

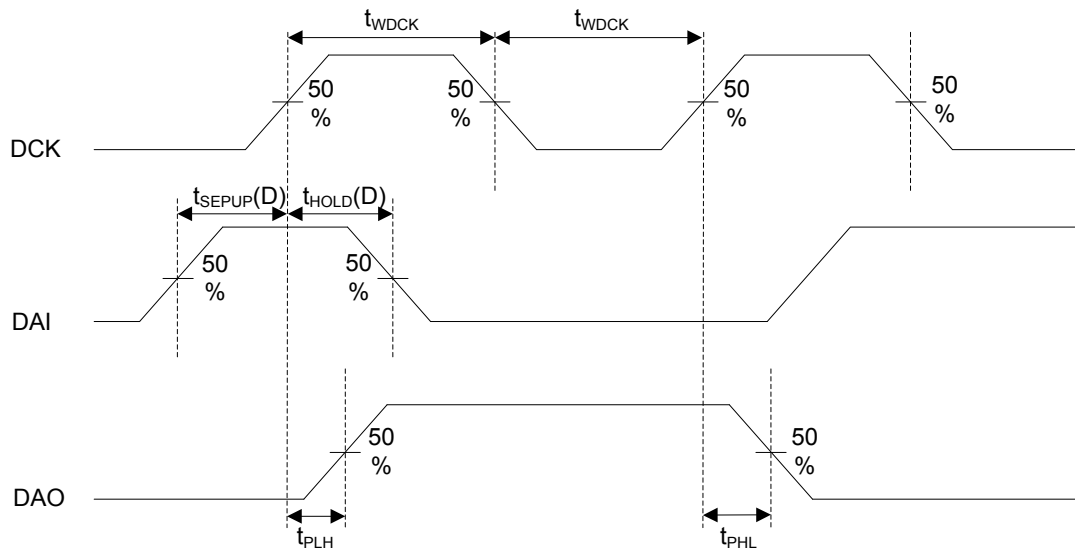
■ SWITCHING CHARACTERISTICS(Cont.)



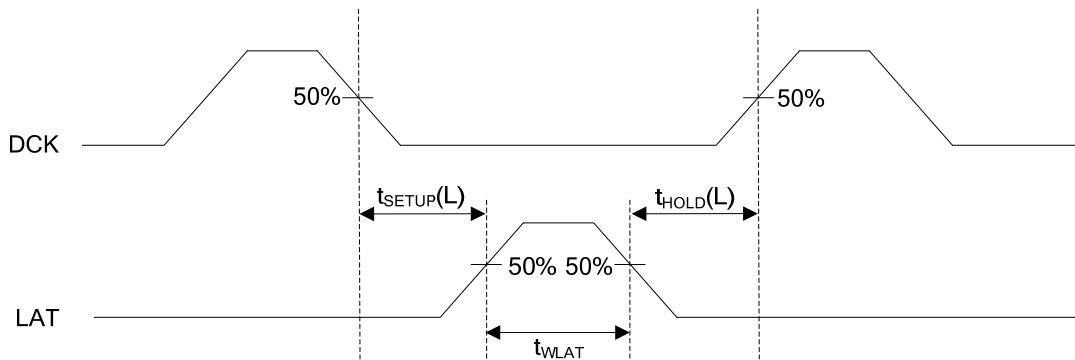
Switching Characteristics Test Circuit

## ■ TIMING DIAGRAM

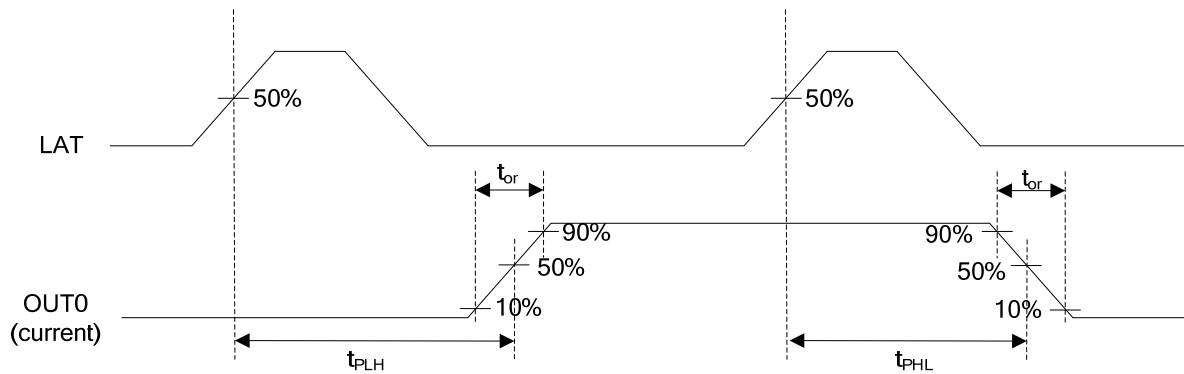
### 1. DCK-DAI, DAO



### 2. DCK-LAT



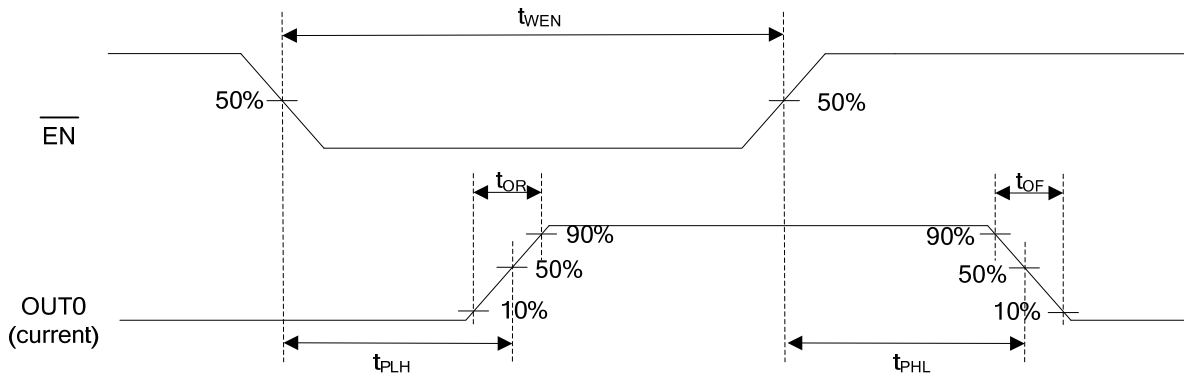
### 3. LAT-OUT0



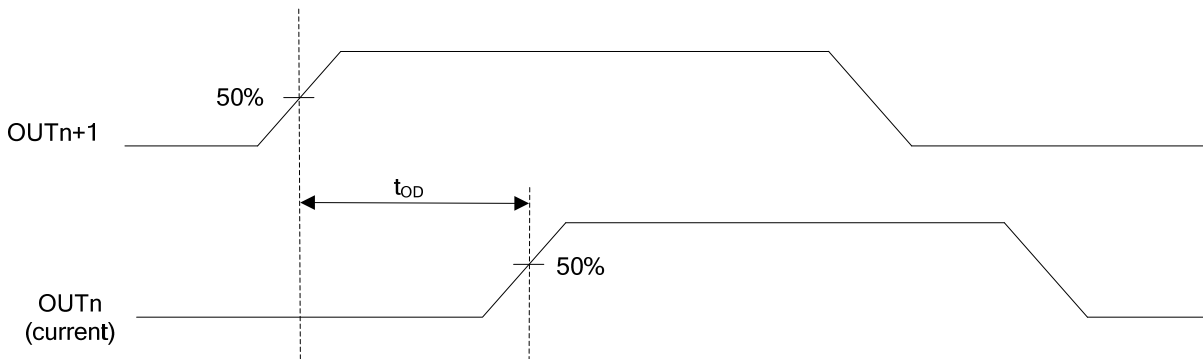


## ■ TIMING DIAGRAM(Cont.)

### 4. $\overline{EN}$ -OUT0



### 5. $OUT_{n+1}$ - $OUT_n$



## ■ CONSTANT-CURRENT OUTPUT

Constant-current value of each output channel is set by an external resistor connected between the REXT pin and GND. Varying the resistor value can adjust the current scale ranging from 3mA to 60mA. The reference voltage of REXT terminal ( $V_{REXT}$ ) is approximately 1.2V. The output current value is calculated roughly by the following equation:

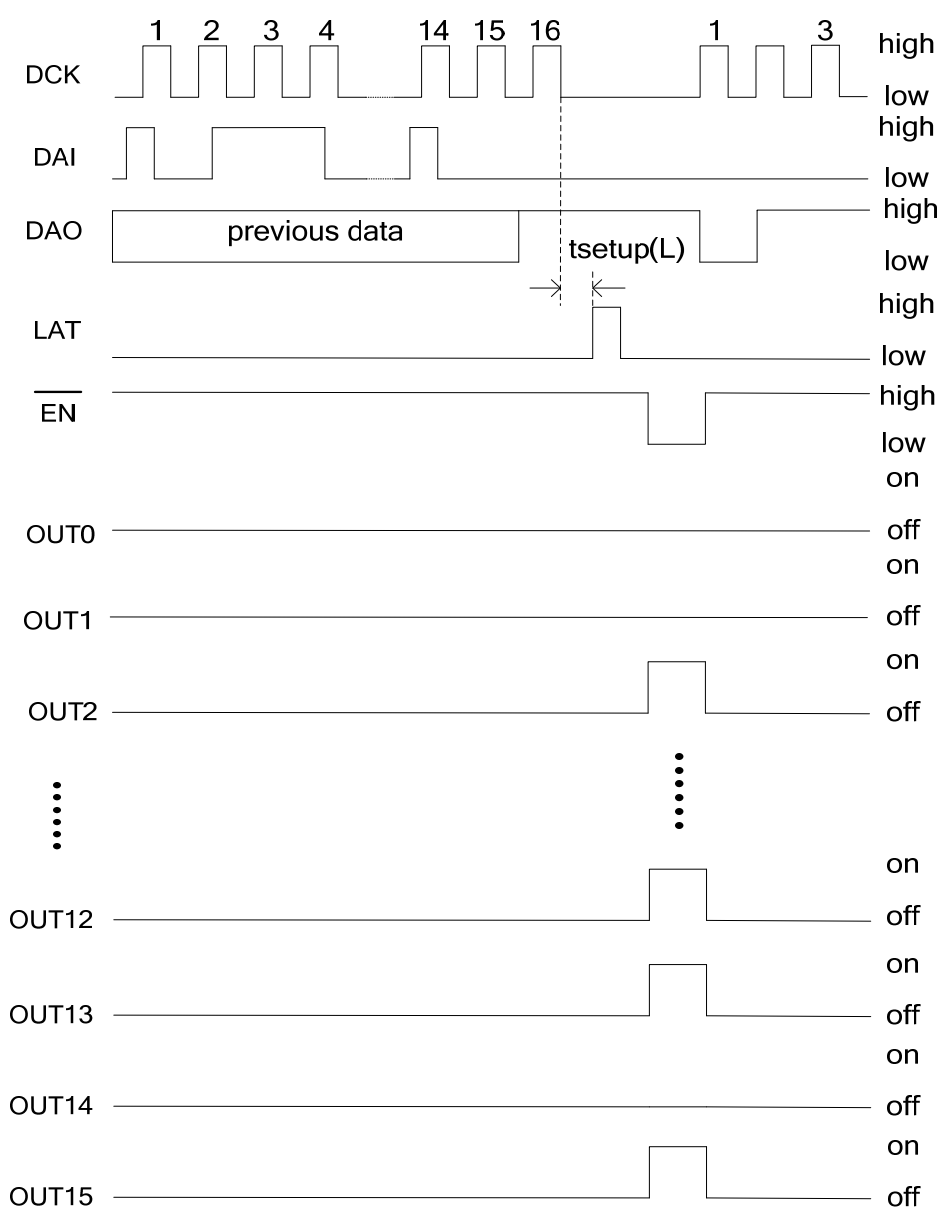
$$I_{OUT}(mA) \cong \frac{V_{REXT}(V)}{R_{REXT}(K\Omega)} \times M$$

$I_{OUT}(mA)$	3	5	10	20	30	40	50
M	55	54.1	50	46.6	45	43.3	41.6s

In order to obtain a good performance of constant-current output, a suitable output voltage is necessary.

## ■ SERIAL DATA INTERFACE

The serial-in data (DAI) will be clocked into 16 bit shift register synchronized on the rising edge of the clock (DCK). The data '1' represents the corresponding current output 'ON', while the data '0' stands for 'OFF'. The data will be transferred into the 16 bit latch register when the strobe signal (LAT) is 'H' (level trigger); otherwise, the data will be held. The trigger timing of the serial-out data (DAO) will be shifted out on synchronization to the rising edge of the clock. All outputs are turned off while enable terminal (EN) is kept at high level. And they are active when EN shifts to low.

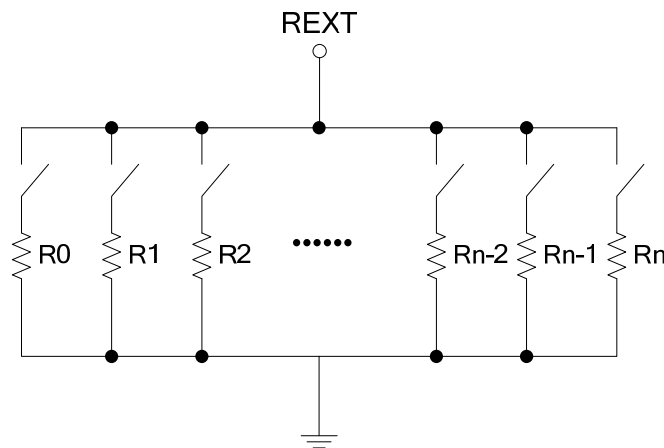


## ■ OUTPUTS DELAY

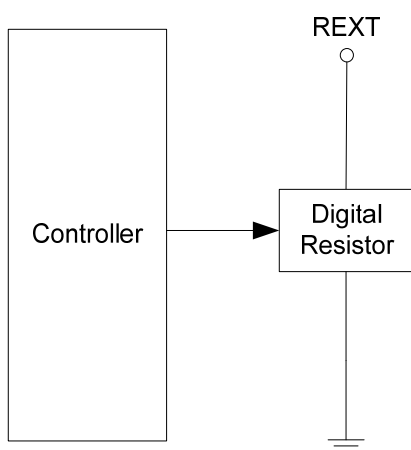
Large in-rush currents will occur when the system activates all the outputs at once. To reduce this effect, **L16B06** is designed to have a constant unit of delay (around 5ns) between outputs. The delay sequence for every output goes like this: OUT0 (no delay) → OUT15 → OUT1 → OUT14 → OUT2 → OUT13 → OUT3 → OUT12 → OUT4 → OUT11 → OUT5 → OUT10 → OUT6 → OUT9 → OUT7 → OUT8 (the largest delay).

## ■ GLOBAL BRIGHTNESS CONTROL

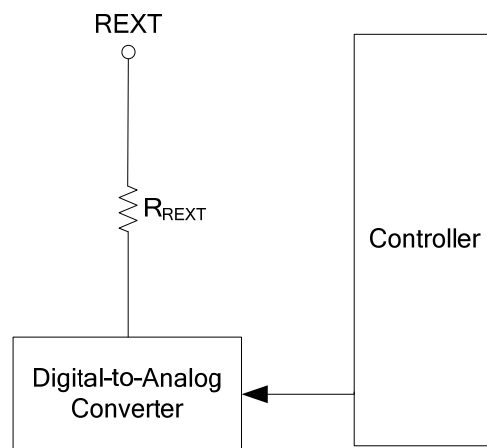
**L16B06** has no built-in global brightness control feature. In order to obtain a lower resolution of global brightness control effect, two methods could be utilized. One is providing PWM signal synchronized on latch pulse to modulate the output enable terminal ( $\overline{EN}$  pin). The other is to adjust the  $R_{REXT}$  value or voltage drop across the external resistor. Please see the reference circuit below:



Global Brightness Control with Resistor Ladder



Global Brightness Control with Digital Resistor



Global Brightness Control with D/A Converter

## ■ POWER DISSIPATION

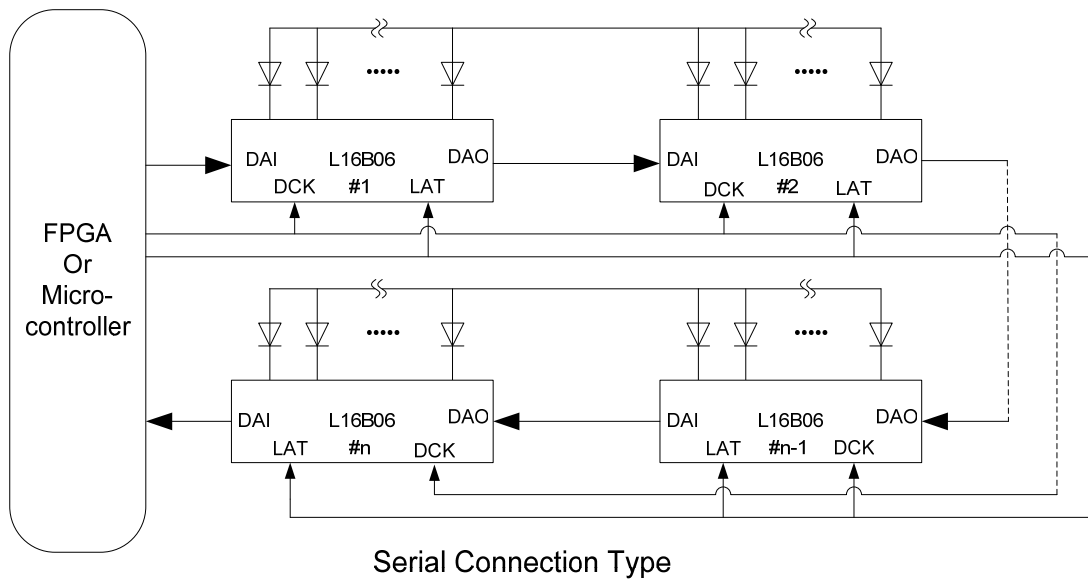
The power dissipation of a semiconductor chip is limited to its package and ambient temperature, in which the device requires the maximum output current calculated for given operating conditions. The maximum allowable power consumption can be calculated by the following equation:

$$P_D(\text{max})(\text{watt}) = \frac{T_J (\text{Junction temperature})(\text{max})(^\circ\text{C}) - T_A (\text{Ambient Temperature})}{R_{TH} (\text{Junction - to - air thermal resistance})(^\circ\text{C}/\text{watt})}$$

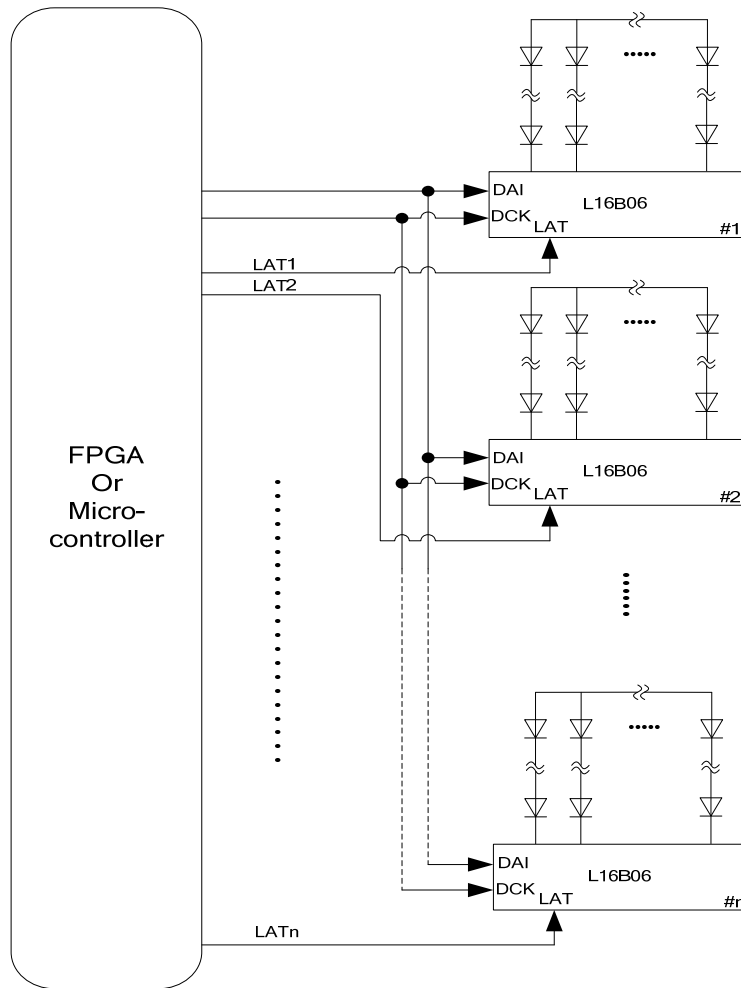
The power consumption of IC can be determined by the following equation and should be less than the maximum allowable power dissipation:

$$P_D(\text{W}) = V_{CC}(\text{V}) \times I_{DD}(\text{A}) + V_{OUT\ 0} \times I_{OUT\ 0} \times D_{UTY\ 0} + \dots + V_{OUT\ 15} \times I_{OUT\ 15} \times D_{UTY\ 15} \leq P_D (\text{max})(\text{W})$$

## ■ TYPICAL APPLICATION



## ■ TYPICAL APPLICATION(Cont.)



Parallel Connection Type

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