19-1107; Rev 0; 11/07

High-Voltage, Three-Channel Linear High-Brightness LED Drivers

General Description

The MAX16824/MAX16825 three-channel LED drivers operate over a 6.5V to 28V input voltage range. These devices provide three open-drain constant-current-sinking outputs that are rated to 36V and deliver up to 150mA of current to each string of high-brightness LEDs (HB LEDs). The current at each output is programmable by means of an external current-sense resistor. The MAX16824 features three PWM inputs that control the duty cycle of the output current, allowing a wide LED dimming range to be implemented. The PWM inputs also function as on/off control for each corresponding output. The MAX16825 offers a 2Mbps, 4-wire serial interface, a 3-bit shift register, and a 3-bit transparent latch. The serial interface allows a microcontroller to configure the output channels using four inputs (DIN, CLK, LE, $\overline{\text{OE}}$) and a data output (DOUT). DOUT allows multiple drivers to be cascaded and operated together.

The MAX16824/MAX16825's on-board pass elements minimize the need for external components, while at the same time, providing ±5% LED current accuracy. Additional features include a +5V (±5%) regulated output with 4mA output current capability and thermal protection.

The MAX16824/MAX16825 are available in a thermally enhanced 16-pin TSSOP-EP package and specified over the -40°C to +85°C temperature range.

Applications

Industrial Lighting

Architectural and Decorative Lighting

Mood Lighting

Indoor and Outdoor LED Video Displays

Automotive Lighting

LCD Display Backlighting

Features

- **6.5V to 28V Operating Range**
- **Outputs Connected to 36V Supply for Long LED Strings**
- **Three 36V-Rated Output Channels with Independently Adjustable LED Current**
- **150mA Output Current Per Channel**
- **±5% LED Current Accuracy**
- **PWM Dimming**
  - **Three Independent Dimming Control Inputs (MAX16824)**
  - **4-Wire Serial Interface LED Current Chopping (MAX16825)**
- **+5V (±5%) Regulated Output with 4mA Source Capability**
- **Fast Transient Dimming Response**
- **200mV Current-Sense Reference Reduces Power Loss**
- **Thermal Shutdown**
- **-40°C to +85°C Operating Temperature Range**
- **Thermally Enhanced, 16-Pin TSSOP Exposed Paddle Package**

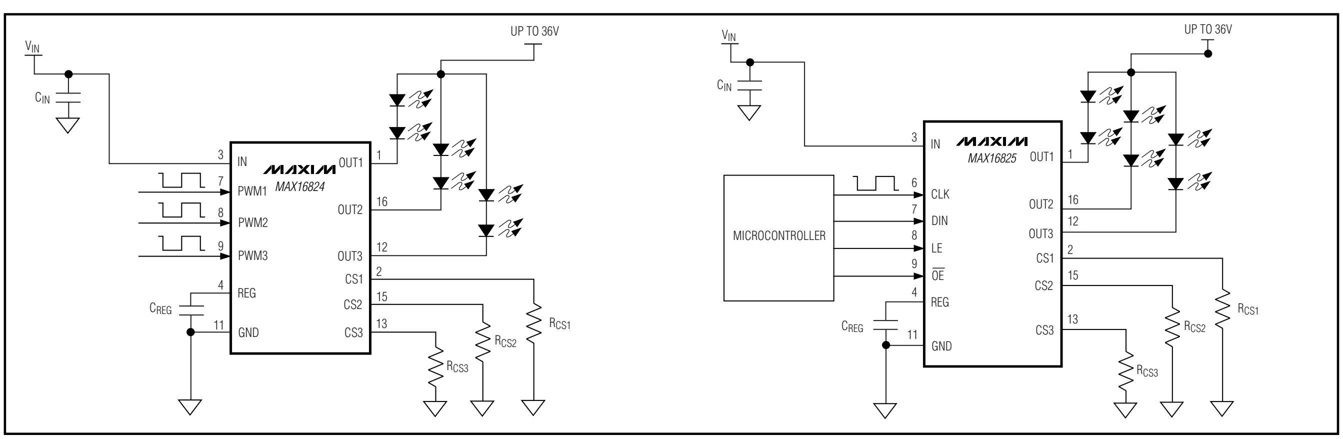
Ordering Information

PART	TEMP RANGE	PIN PACKAGE	PKG CODE
MAX16824EUE+	-40°C to +85°C	16 TSSOP-EP*	U16E-3
MAX16825EUE+	-40°C to +85°C	16 TSSOP-EP*	U16E-3

+Denotes a lead-free package.
**EP = Exposed paddle.*

Pin Configurations appear at end of data sheet.

Typical Operating Circuits



High-Voltage, Three-Channel Linear High-Brightness LED Drivers

ABSOLUTE MAXIMUM RATINGS

IN to GND ....-0.3V to +30V
OUT1, OUT2, OUT3 to GND ....-0.3V to +40V
CS1, CS2, CS3, REG to GND..................................-0.3V to +6V
PWM1, PWM2, PWM3 to GND ....-0.3V to +6V
DIN, CLK, LE, $\overline{OE}$, DOUT to GND ....-0.3V to +6V
Maximum Current into Any Pin
(except OUT1, OUT2, OUT3) ....±20mA
Maximum Current into OUT1, OUT2, OUT3......................160mA
Continuous Power Dissipation (T_A = +70°C)
16-Pin TSSOP-EP (derate 18.9mW/°C above +70°C)....1500mW
Operating Temperature Range ....-40°C to +85°C
Junction Temperature ....+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 12V, C_{REG} = 1µF to GND, I_{REG} = 0, $R_{CS\_}$ = 2Ω from CS_ to GND, $T_J = T_A$ = -40°C to +85°C, unless otherwise noted. Typical values are at $T_J = T_A$ = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{IN}		6.5		28.0	V
GND Current	I_{GND}	$I_{OUT1} = I_{OUT2} = I_{OUT3}$ =100mA		5	10	mA
LED Current-Sense Accuracy (Note 2)		10mA < $I_{OUT\_}$ < 100mA, 0°C ≤ T_J ≤ 85°C			5	%
		10mA < $I_{OUT\_}$ < 100mA, -40°C ≤ T_J ≤ 85°C			7	
Dropout Voltage (Note 3)	ΔV_{DO}	$I_{OUT\_}$ = 100mA (current pulsed)		0.75	1.5	V
		$I_{OUT\_}$ = 150mA (current pulsed)		1.2	2.25	
Output Current Slew Rate		Current rising, V_{OUT} = 4V		100		mA/µs
Output Current Leakage	I_{LEAK}	PWM1 = PWM2 = PWM3 = 0V			1	µA
CURRENT SENSE						
Regulated CS_ Voltage	$V_{CS\_}$	$V_{CS1} = V_{CS2} = V_{CS3}$, 0°C ≤ T_J ≤ +85°C	190	200	210	mV
		$V_{CS1} = V_{CS2} = V_{CS3}$, -40°C ≤ T_J ≤ +85°C	186	200	214	
OVERTEMPERATURE PROTECTION						
Thermal Shutdown Temperature				165		°C
Thermal Shutdown Hysteresis				23		°C
+5V REGULATOR (REG)						
Output Voltage	V_{REG}	I_{REG} = 0mA (Note 4)	4.75	5	5.25	V
REG Output Current	I_{REG}	4.75V < V_{REG}	4			mA
REG Short-Circuit Current	I_{REGSC}	V_{REG} = 0V (Note 5)	15	40	90	mA
LOGIC INPUT (PWM1, PWM2, PWM3)						
PWM_ Input Bias Current	I_{PWM}	$V_{PWM1} = V_{PWM2} = V_{PWM3}$ = 5V			1	µA
PWM_ Input-Voltage High	V_{IH}		4			V
PWM_ Input-Voltage Low	V_{IL}				0.6	V
PWM_ Turn-On Delay		50% of $V_{PWM\_}$ to 50% of $\Delta V_{OUT\_}$			475	ns
PWM_ Turn-Off Delay		50% of $V_{PWM\_}$ to 50% of $\Delta V_{OUT\_}$			150	ns

ELECTRICAL CHARACTERISTICS (continued)

(V_{IN} = 12V, C_{REG} = 1µF to GND, I_{REG} = 0, $R_{CS\_}$ = 2Ω from CS_ to GND, T_J = T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_J = T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
OUTPUTS (OUT1, OUT2, OUT3)						
Turn-On Time	t_R	PWM_ rising time, t_R, is measured from 20% to 80% of I_{OUT}			1	µs
Turn-Off Time	t_F	PWM_ falling time, t_F, is measured from 80% to 20% of I_{OUT}			1	µs
SPI INTERFACE (CLK, LE, $\overline{OE}$, DIN, DOUT) (Figures 3 and 4)						
DIN, CLK, LE, $\overline{OE}$ Input Bias Current		DIN = CLK = LE = $\overline{OE}$ = 0 or 5V			1	µA
DIN, CLK, LE, $\overline{OE}$ Input-Voltage High	V_{IH}		2.2			V
DIN, CLK, LE, $\overline{OE}$ Input-Voltage Low	V_{IL}				0.5	V
CLK Clock Period	t_{CP}	50% of CLK rising to 50% of next CLK rising, Figure 3	50			ns
CLK Pulse-Width High	t_{CH}	50% of CLK rising to 50% of CLK falling, Figure 3	24			ns
CLK Pulse-Width Low	t_{CL}	50% of CLK falling to 50% of CLK rising, Figure 3	24			ns
DIN Setup Time	t_{DS}	50% of DIN rising to 50% of CLK rising, Figure 3	5			ns
DIN Hold Time	t_{DH}	50% of CLK rising to 50% of DIN falling, Figure 3	10			ns
DOUT Propagation Delay	t_{DO}	50% of CLK rising to 50% of DOUT rising/falling, Figure 3	5			ns
DOUT Rise/Fall Time	t_{DR}/t_{DF}	C_{DOUT} = 10pF, 10% to 90% of DOUT rising/falling edge (Note 6)			15	ns
DOUT Voltage High	V_{DOH}	I_{SOURCE} = 4mA	4.5			V
DOUT Voltage Low	V_{DOL}	I_{SINK} = 4mA			0.5	V
LE Pulse-Width High	t_{LW}	50% of LE rising to 50% of LE falling, Figure 3	20			ns
LE Setup Time	t_{LS}	50% of CLK rising to 50% of LE rising, Figure 3	15			ns
LE Rising to OUT_ Rising Delay	t_{LRR}	50% of LE rising to 50% of OUT_ rising, Figure 4			150	ns
LE Rising to OUT_ Falling Delay	t_{LRF}	50% of LE rising to 50% of OUT_ falling, Figure 4			475	ns

High-Voltage, Three-Channel Linear High-Brightness LED Drivers

ELECTRICAL CHARACTERISTICS (continued)

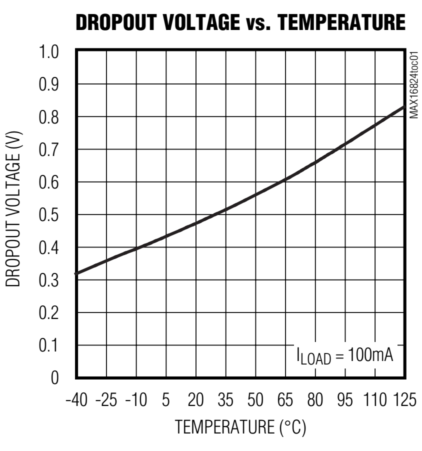
(V_{IN} = 12V, C_{REG} = 1µF to GND, I_{REG} = 0, $R_{CS\_}$ = 2Ω from CS_ to GND, T_J = T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_J = T_A = +25°C.) (Note 1)

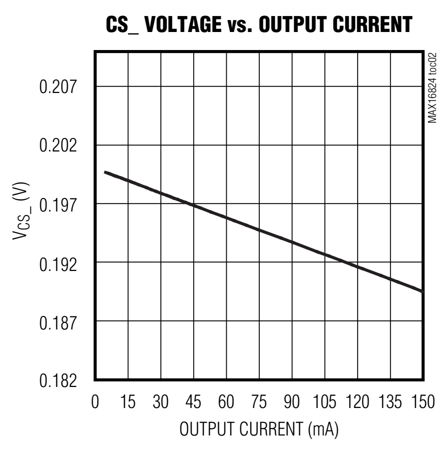
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
CLK Rising to OUT_ Rising Delay	t_{CRR}	50% of CLK rising to 50% of OUT_ rising, Figure 4			150	ns
CLK Rising to OUT_ Falling Delay	t_{CRF}	50% of CLK rising to 50% of OUT_ falling, Figure 4			475	ns
$\overline{OE}$ Rising to OUT_ Rising Delay	t_{OEH}	50% of $\overline{OE}$ rising to 50% of OUT_ rising, Figure 3			150	ns
$\overline{OE}$ Falling to OUT_ Falling Delay	t_{OEL}	50% of $\overline{OE}$ falling to 50% of OUT_ falling, Figure 3			475	ns

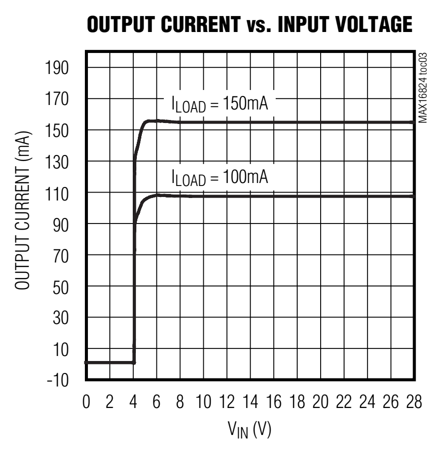
Note 1: All devices are 100% production tested at T_J = +25°C and T_J = +85°C. Limits to -40°C are guaranteed by design.
Note 2: This specification does not include sense resistor tolerance and ground error.
Note 3: Dropout is measured as follows: $R_{SC\_}$ = 1.21Ω from CS_ to GND. Force 100mA into OUT_ and measure the dropout voltage from OUT_ to CS_. DVDO = (ΔOUT_ - $V_{CS\_}$).
Note 4: OUT's current regulation varies with load across REG (see the *Typical Operating Characteristics*).
Note 5: Overtemperature protection does not function if the output of the 5V reference (REG) is shorted to ground.
Note 6: Guaranteed by design, not production tested.

Typical Operating Characteristics

(V_{IN} = 12V, C_{REG} = 1µF to GND, I_{REG} = 0, $R_{CS\_}$ = 2Ω from CS_ to GND, T_A = +25°C, unless otherwise noted. Typical values are at T_A = +25°C.)



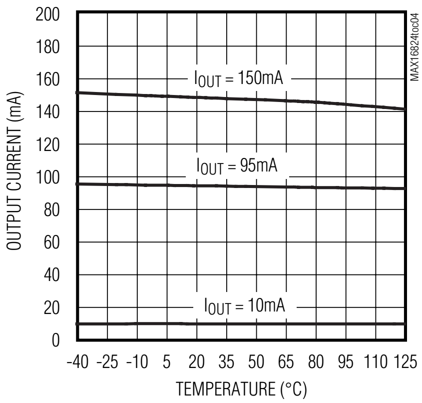




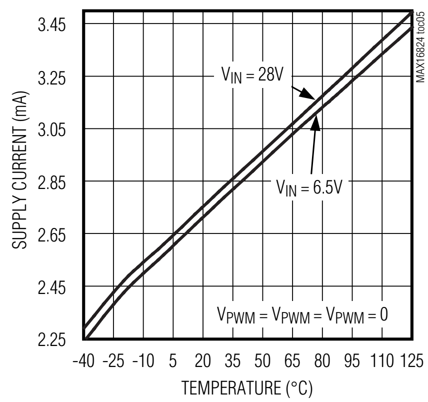
Typical Operating Characteristics (continued)

(V_{IN} = 12V, C_{REG} = 1µF to GND, I_{REG} = 0, $R_{CS\_}$ = 2Ω from CS_ to GND, T_A = +25°C, unless otherwise noted. Typical values are at T_A = +25°C.)

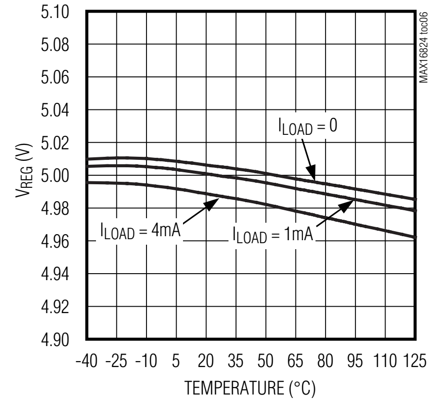
OUTPUT CURRENT vs. TEMPERATURE



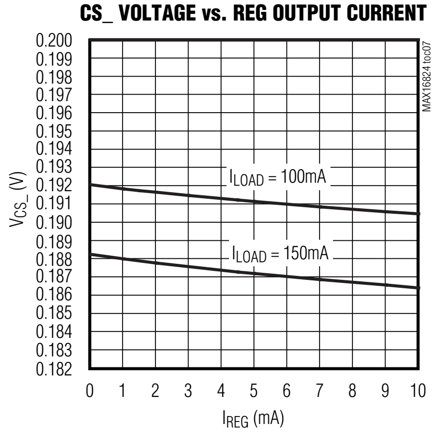
SUPPLY CURRENT vs. TEMPERATURE



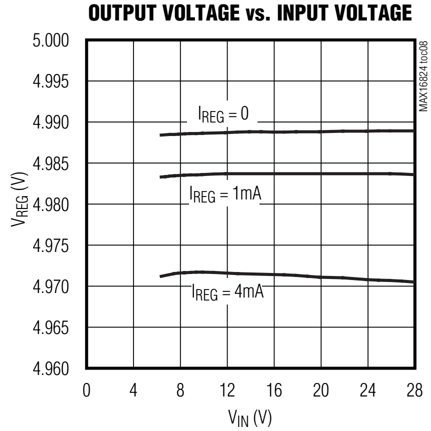
OUTPUT VOLTAGE vs. TEMPERATURE



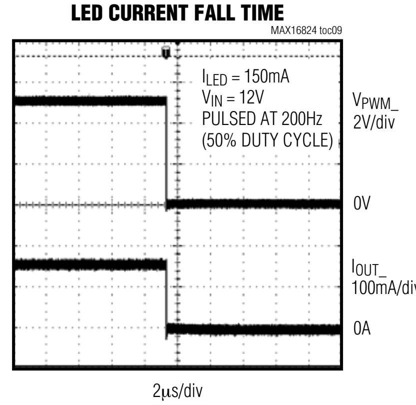
CS_ VOLTAGE vs. REG OUTPUT CURRENT



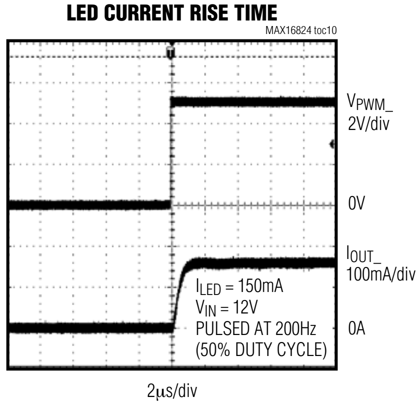
OUTPUT VOLTAGE vs. INPUT VOLTAGE



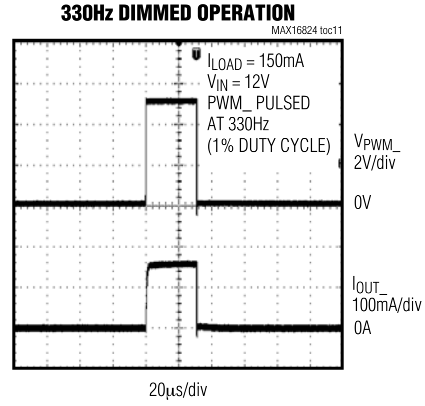
LED CURRENT FALL TIME



LED CURRENT RISE TIME



330Hz DIMMED OPERATION



High-Voltage, Three-Channel Linear High-Brightness LED Drivers

Pin Description

PIN		NAME	FUNCTION
MAX16824	MAX16825		
1	1	OUT1	Channel 1 LED Driver Output. OUT1 is an open-drain, constant-current-sinking output rated to 36V.
2	2	CS1	Channel 1 Sense Amplifier Negative Input. Connect a current-sense resistor between CS1 and GND to program the output current level for channel 1.
3	3	IN	Positive Input Supply. Bypass with a 0.1µF (min) capacitor to GND.
4	4	REG	+5V-Regulated Output. Connect a 1µF capacitor from REG to GND.
5, 6, 10, 14	5, 14	N.C.	No Connection. Must be left unconnected.
7	—	PWM1	Dimming Input 1. PWM1 is a dimming input for channel 1. A logic-low turns off OUT1 and a logic-high turns on OUT1.
8	—	PWM2	Dimming Input 2. PWM2 is a dimming input for channel 2. A logic-low turns off OUT2 and a logic-high turns on OUT2.
9	—	PWM3	Dimming Input 3. PWM3 is a dimming input for channel 3. A logic-low turns off OUT3 and a logic-high turns on OUT3.
11	11	GND	Ground
12	12	OUT3	Channel 3 LED Driver Output. OUT3 is an open-drain, constant-current-sinking output rated to 36V.
13	13	CS3	Channel 3 Sense Amplifier Negative Input. Connect a current-sense resistor between CS3 and GND to program the output current level for channel 3.
15	15	CS2	Channel 2 Sense Amplifier Negative Input. Connect a current-sense resistor between CS2 and GND to program the output current level for channel 2.
16	16	OUT2	Channel 2 LED Driver Output. OUT2 is an open-drain, constant-current-sinking output rated to 36V.
—	7	DIN	Serial-Data Input. Data is loaded into the internal 3-bit shift register on the rising edge of CLK.
—	8	LE	Latch-Enable Input. Data loaded transparently from the internal shift register to the output latch while LE is high. Data is latched into the output latch on the LE's falling edge and retained while LE is low.
—	9	$\overline{OE}$	Output Enable Input. Drive $\overline{OE}$ high to place all outputs into a high-impedance mode without altering the contents of the output latches. Drive $\overline{OE}$ low to force all outputs to follow the state of the output latches.
—	10	DOUT	Serial-Data Output. Data is clocked out of the internal 3-bit shift register to DOUT on the rising edge of CLK. DOUT is a replica of the shift register's last bit.
—	6	CLK	Clock Input
—	—	EP	Exposed Paddle. Connect EP to a large-area ground plane for effective power dissipation. Do not use as the IC ground connection.

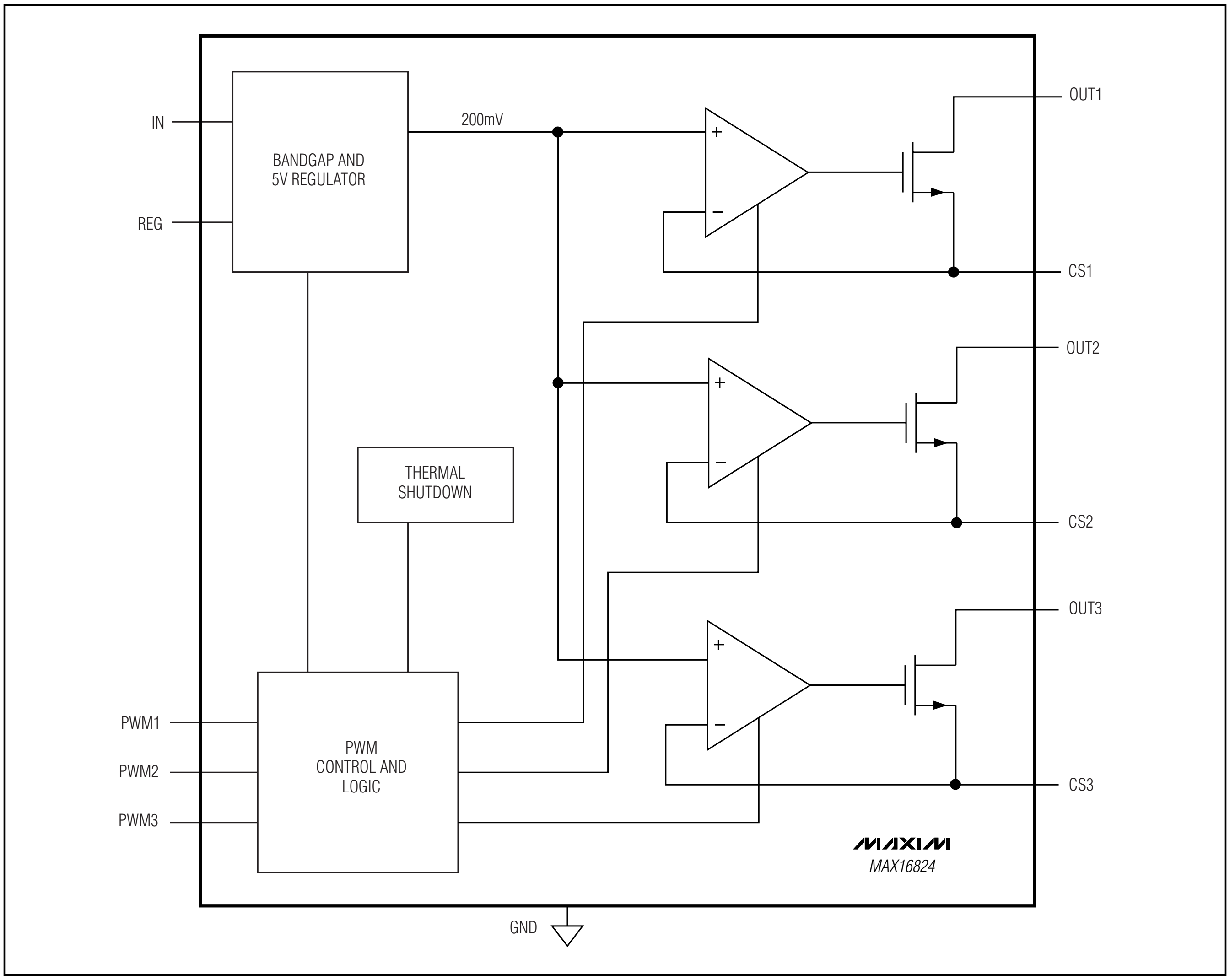


Figure 1. Internal Block Diagram (MAX16824)

Detailed Description

The MAX16824/MAX16825 are three-channel LED drivers that operate from a 6.5V to 28V input voltage range. These devices provide three independent open-drain, constant-current-sinking outputs rated to 36V and deliver up to 150mA of current to each HB LED string. The current in each channel is programmable using an external current-sense resistor in series with each internal power MOSFET's source. The MAX16824 features three separate PWM inputs that allow a wide range of independent dimming level at each of the three outputs. The PWM inputs also function as on/off control inputs for each corresponding output (Figure 1).

The MAX16825 includes a 2Mbps, 4-wire serial interface to control the state of each output (Figure 2).

The 4-wire serial interface comprises a 3-bit shift register and a 3-bit transparent latch. The shift register is updated using a clock input CLK and a data input DIN. DOUT is the last bit of the shift register. This feature allows multiple drivers to be cascaded and operated together. The latch is transparent from the shift register outputs to the LED output when LE is high while it latches the shift register state on the falling edge of LE. The output-enable input $\overline{OE}$ allows simultaneous enabling or disabling of all three outputs.

High-Voltage, Three-Channel Linear High-Brightness LED Drivers

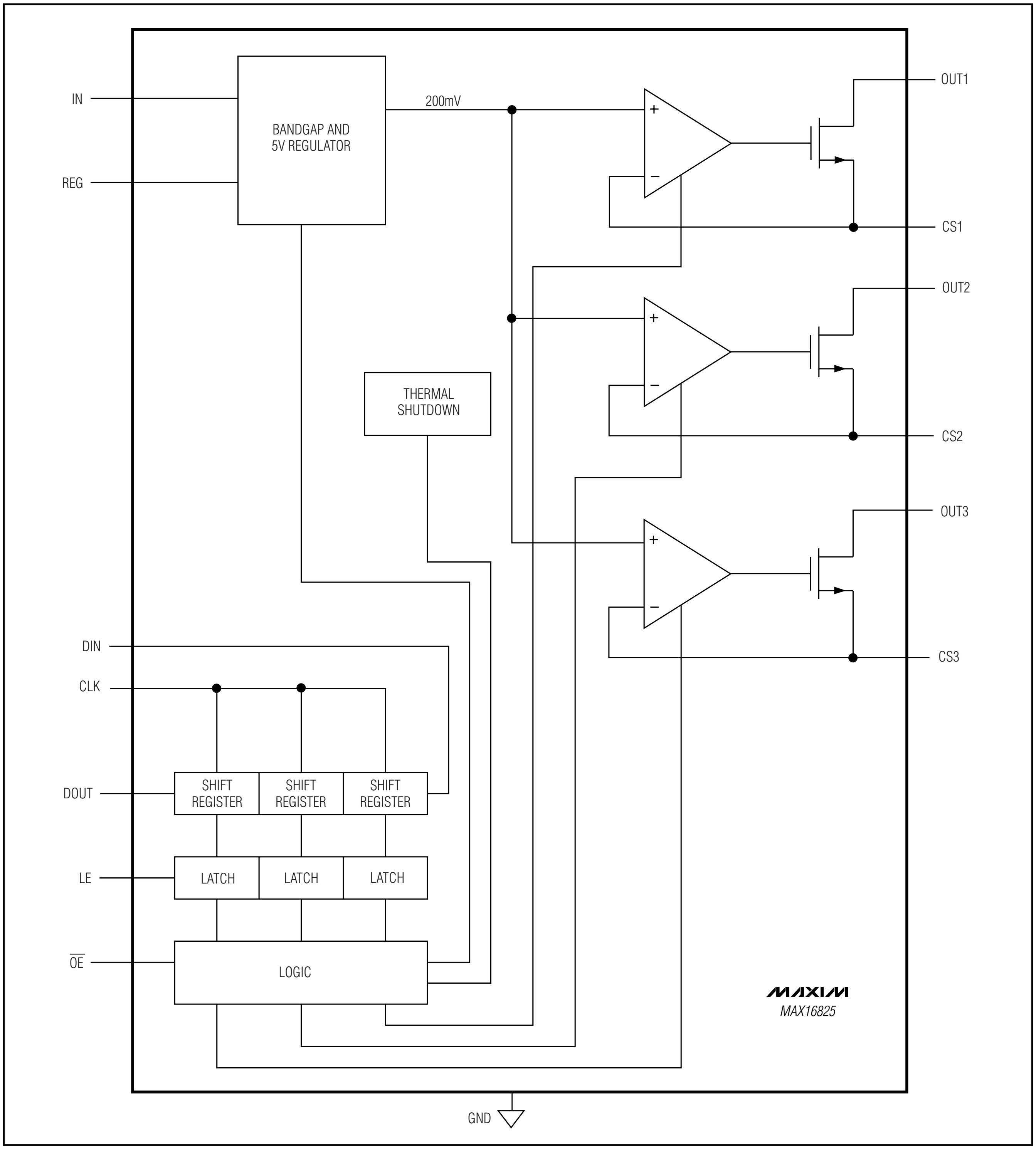


Figure 2. Internal Block Diagram (MAX16825)

On-board pass elements minimize the need for external components while providing ±5% LED current accuracy. Additional features include a +5V (±5%) regulated output with 4mA output current capability and thermal protection.

The MAX16824/MAX16825 use a feedback loop to linearly control the current at each output. The voltage across each sense resistor is regulated to 200mV by the internal feedback loop. The output current is set by selecting the value of R_{CS}.

+5V Regulator (REG)

The MAX16824/MAX16825 include a fixed +5V output regulator that delivers up to 4mA of load current for auxiliary low power applications throughout the 6.5V to 28V input voltage range. Connect a 1µF compensation capacitor from REG to ground.

Thermal Protection

The MAX16824/MAX16825 enter a thermal shutdown mode in the event of overheating. When the junction temperature exceeds T_J = +165°C, the internal thermal protection circuit turns off the series pass elements. The MAX16824/MAX16825 recover from thermal shutdown mode when the junction temperature drops by 23°C. The thermal protection does not operate if the regulator (REG) is in a short-circuit condition.

4-Wire Serial Interface (MAX16825)

The MAX16825 features a 4-wire serial interface (DIN, CLK, LE, $\overline{OE}$) and a data output (DOUT) that allows the use of a microcontroller to write brightness data to the MAX16825. The serial-interface data word length is 3 bits (D0, D1, D2). The functions of the interface inputs are as follows: DIN is the serial-data input, which must be stable when it is sampled by the MAX16825 on the rising edge of CLK. Data shifts in with the MSB first. This means that data bit D2 is clocked in first, followed by 2 more data bits (D1 and finishing with the LSB D0). CLK is the serial-clock input, which shifts data at DIN into the MAX16825's 3-bit shift register on the rising edge. LE is the latch-enable input that allows the transfer of data from the MAX16825's 3-bit shift register to its 3-bit latch when LE is high (transparent latch) and latches the data on the falling edge of LE (Figure 4).

Output enable ($\overline{OE}$) provides simultaneous control of the output drivers. Driving $\overline{OE}$ high places outputs OUT1, OUT2, and OUT3 into a high-impedance mode without altering the contents of the output latches. Driving $\overline{OE}$ low allows outputs OUT1, OUT2, and OUT3 to follow the state of the output latches.

$\overline{OE}$ is independent of the operation of the serial interface. Data can be shifted into the serial-interface shift register and latched regardless of the state of $\overline{OE}$. DOUT is the serial-data output that shifts data out from the MAX16825's 3-bit shift register on the rising edge of CLK. Data at DIN propagates through the shift register and appears at DOUT three clock cycles later.

Applications Information

Programming the LED Current

The MAX16824/MAX16825 use sense resistors to set the output current in each channel. To set the LED current for a particular channel, connect a sense resistor across the corresponding current-sense input (CS_) and GND. For better performance, connect the low side of the current-sense resistors to the IC's ground terminal and the high side to the CS_ terminal with short traces. The value of the sense resistor for a given desired current is calculated with the following equation:

$$R_{CS\_}(\Omega) = \frac{V_{CS\_}(V)}{I_{OUT\_}(A)}$$

where $V_{CS\_}$ is 200mV and $I_{OUT\_}$ is I_{LED} (see the *Electrical Characteristics* table).

Input Voltage Considerations

For proper operation, the minimum input voltage must always be:

$$V_{IN(MIN)} \geq V_{CS\_} + V_{FT(MAX)} + \Delta V_{DO}$$

where $V_{CS\_}$ is the voltage drop across the sense resistor $R_{CS\_}$, $V_{FT(MAX)}$ is the total forward voltage of all series connected LEDs and ΔV_{DO} is the maximum dropout voltage of the regulator. The minimum operating voltage of the device is 6.5V. If the device is operated below 6.5V, the output current may not meet the full regulation specification (see the *Typical Operating Characteristics*).

Pulse-Width Dimming (MAX16824)

The MAX16824 includes pulsed-width current dimming inputs (PWM_) to control the LED brightness. An application of up to 5kHz signal or less is recommended at PWM_ input for proper operation. PWM_ also functions as an active-high enable input for each output channel. A logic-low at PWM_ turns off OUT_ and a logic-high turns on OUT_.

High-Voltage, Three-Channel Linear High-Brightness LED Drivers

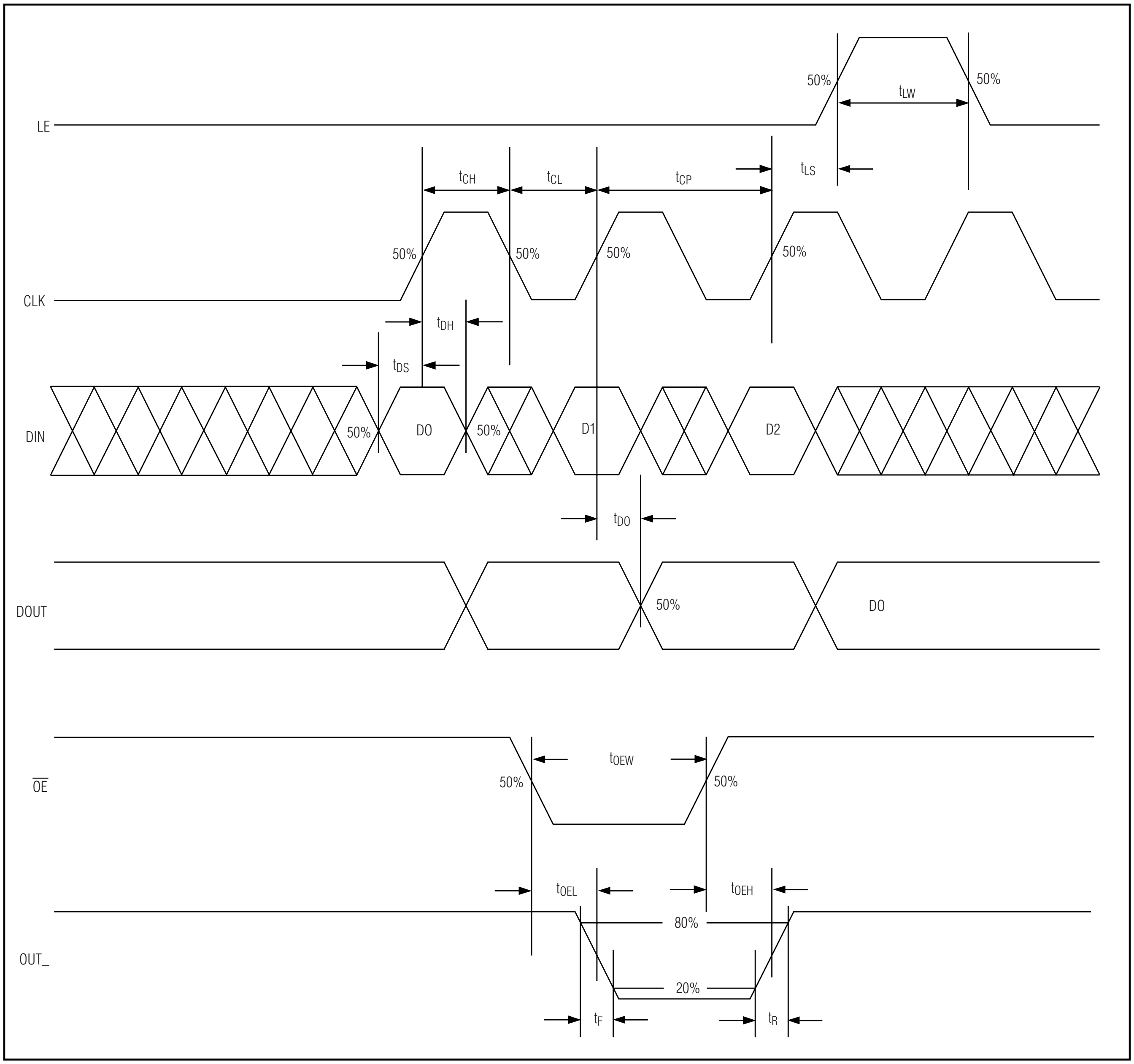


Figure 3. 4-Wire Serial-Interface Timing Diagram

Pulse-Width Dimming (MAX16825)

The MAX16825 provides three methods of pulsed-width current dimming.

One method of pulse dimming the output channels is to drive $\overline{OE}$ low while latching a different set of three bits data. Holding $\overline{OE}$ low allows the output channels to follow the state of the output latches. The duty cycle depends on LE's frequency. All output channels are affected at the same time.

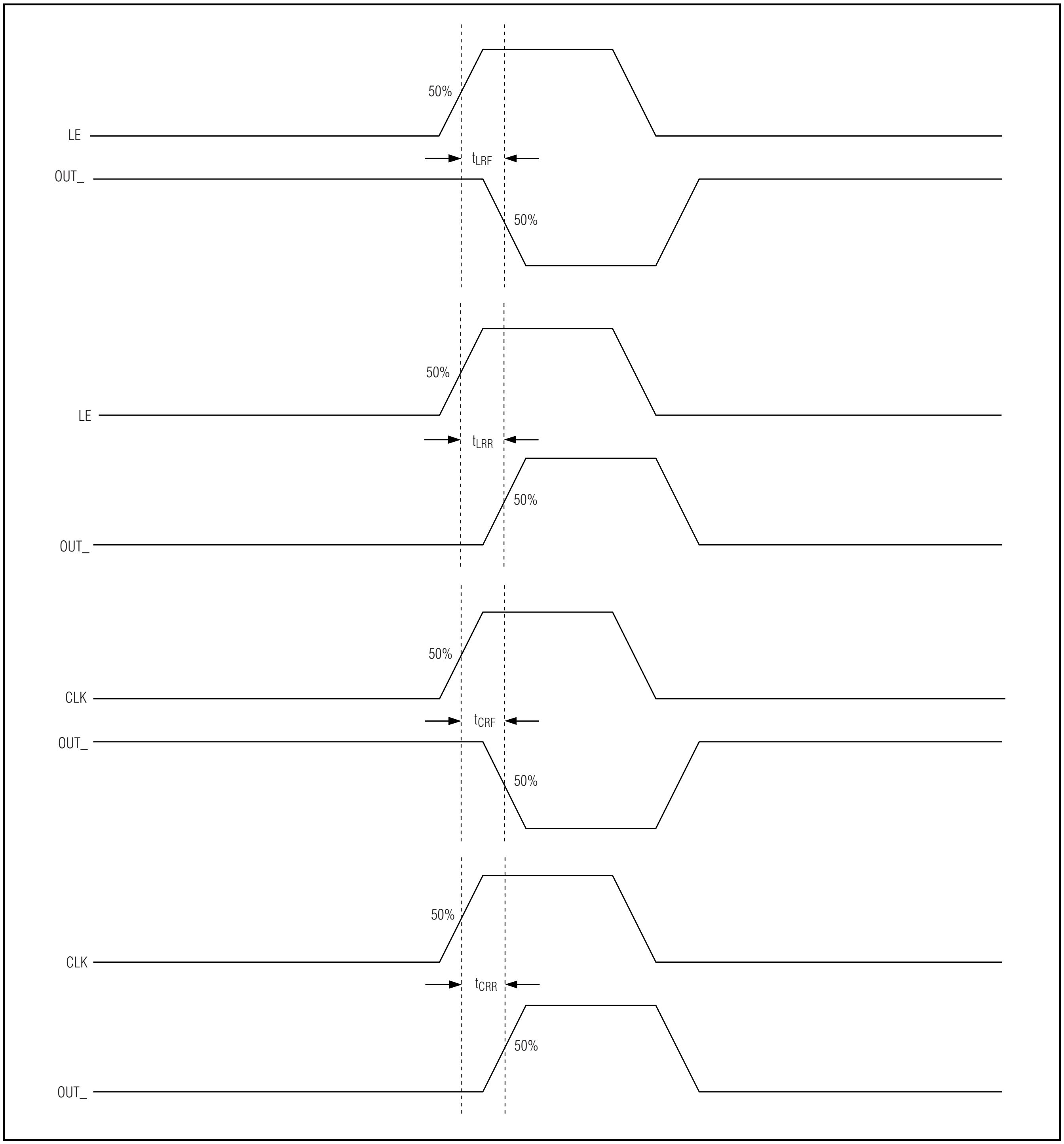


Figure 4. LE and CLK to OUT_ Timing

Another method of pulse dimming the outputs is to hold LE high and drive $\overline{OE}$ with a PWM signal. Because the input bits are always latched, the serial input constantly refreshes the register. The control bits must be carefully selected to dim the outputs properly.

A third method is to hold both LE and $\overline{OE}$ in the enabled state. This allows the data bits to directly control the output channels, and hence, pulse dim the output current. Make sure that the clock frequency does not exceed the maximum rate at which the device can change the state of the output channels.

Power Dissipation

The power dissipation (P_D) of the MAX16824/MAX16825 is determined from the following equation:

$$P_D = (V_{IN} \times I_{IN}) + (V_{INL} - V_{LED1} - V_{CS1}) \times (I_{LED1} \times DUTY1) + (V_{INL} - V_{LED2} - V_{CS2}) \times (I_{LED2} \times DUTY2) + (V_{INL} - V_{LED3} - V_{CS3}) \times (I_{LED3} \times DUTY3)$$

where:

V_{IN} = supply voltage

V_{INL} = supply Voltage to the LED strings

I_{IN} = supply current

$V_{LED\_}$ = total forward voltage for one LED string

$I_{LED\_}$ = LED current

V_{CS} = 200mV drop across $R_{CS\_}$

DUTY = PWM_ duty cycle

The worst-case power dissipation occurs when the drop across each internal MOSFET is at its maximum with all three channels delivering the maximum allowable output current. The maximum drop across the internal MOSFETs is determined by:

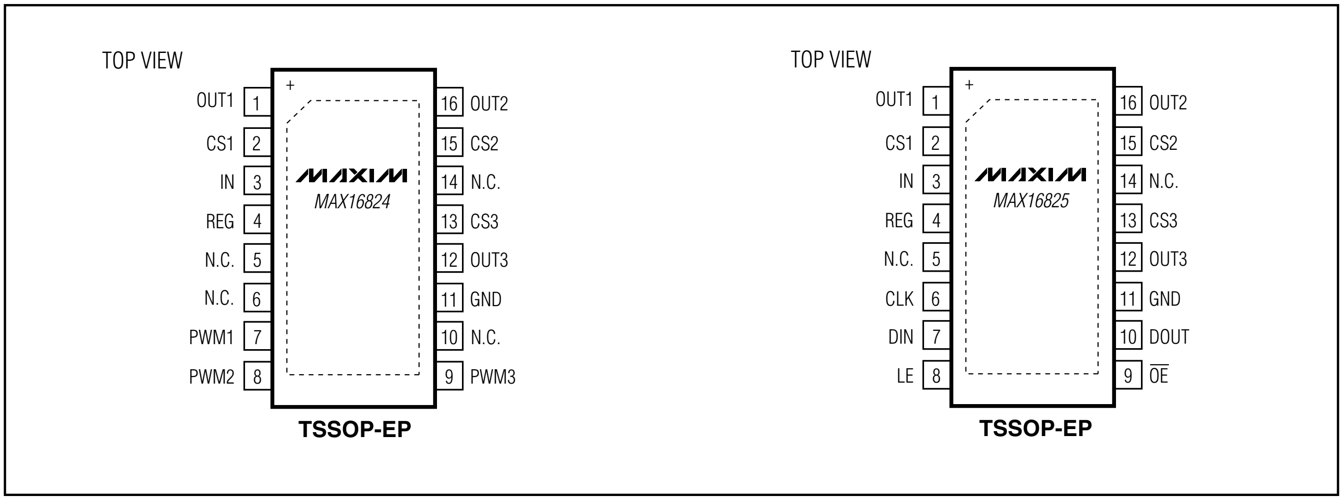
V_{INL} - $V_{LED\_}$ - $V_{CS\_}$ when $V_{LED\_}$ is at its minimum.

Higher ambient temperature increases the thermal stress even further due to the reduction in voltage drop across the LEDs. The MAX16824/MAX16825 thermal specifications are given according to the JEDEC-51 guidelines. Good mechanical/thermal design practices must be applied to help maintain the device junction temperature below the absolute maximum ratings at all times.

Chip Information

PROCESS: BiCMOS-DMOS

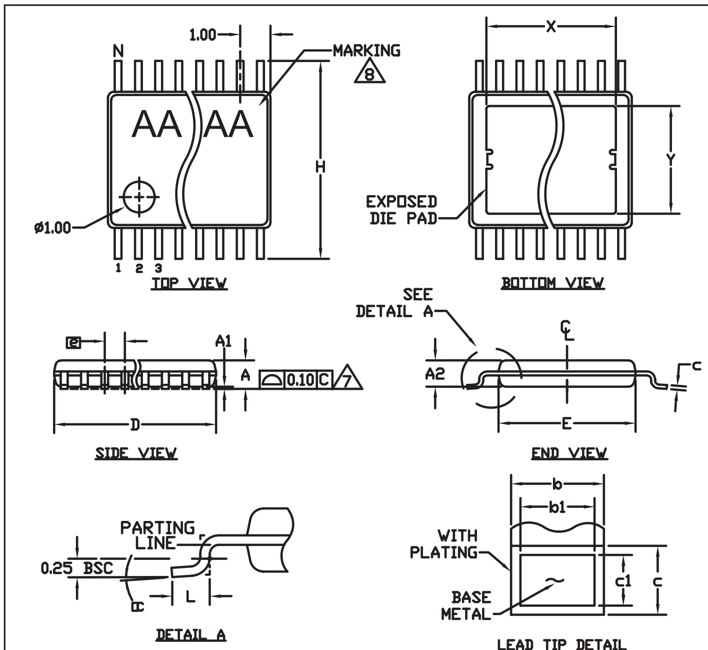
Pin Configurations



Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

TSSOP 4.4mm BODY.EPS



SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	--	1.10	--	0.043
A1	0.05	0.15	0.002	0.006
A2	0.85	0.95	0.033	0.037
b	0.19	0.30	0.007	0.012
b1	0.19	0.25	0.007	0.010
c	0.090	0.20	0.004	0.008
c1	0.090	0.135	0.004	0.0053
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	0.169	0.177
e	0.65 BSC		0.026 BSC	
H	6.25	6.50	0.246	0.256
L	0.50	0.70	0.020	0.028
N	SEE VARIATIONS		SEE VARIATIONS	
Y	2.85	3.15	0.112	0.124
α	0°	8°	0°	8°
PKG. CODES	U14E-3; U16E-3; U20E-1; U20E-4; U28E-4; U28E-5			

JEDEC			VARIATIONS			
MO-153	N		MILLIMETERS		INCHES	
			MIN.	MAX.	MIN.	MAX.
ABT-1	14	D	4.90	5.10	0.193	0.201
		X	2.95	3.25	0.116	0.128
ABT	16	D	4.90	5.10	0.193	0.201
		X	2.85	3.15	0.112	0.124
ACT	20	D	6.40	6.60	0.252	0.260
		X	4.00	4.34	0.157	0.171
AET	28	D	9.60	9.80	0.378	0.386
		X	5.35	5.65	0.211	0.222

NOTES:
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE.
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC OUTLINE MO-153. SEE JEDEC VARIATIONS TABLE.
5. "N" REFERS TO NUMBER OF LEADS.
6. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".
7. THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED.
8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
9. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
10. ALL DIMENSIONS APPLY TO BOTH LEADED (-) AND PbFREE (+) PKG. CODES.

-DRAWING NOT TO SCALE-

MAXIM			
TITLE: PACKAGE OUTLINE, TSSOP 4.4mm BODY, EXPOSED PAD			
APPROVAL	DOCUMENT CONTROL NO. 21-0108	REV. F	1/1