LP5560 Programmable LED Driver with Single-Wire Interface

Check for Samples: LP5560

FEATURES

- **Programmable Blinking Sequence with Current Rise and Fall Time Control**
- **Default Blinking Sequence for Simple Systems without Programming Capabilities**
- **Single-Wire Interface**
- **Constant Current High Side Output Driver**
- **Ultra-Small Solution Size**
  - **No External Components**
  - **0.891 mm (Max.) x 0.891 mm (Max.) x 0.6 mm DSBGA Package with 0.4 mm Pitch**
- **Very Low Headroom Voltage (40 mV typ.)**
- **Adjustable Output Current from 2.8 mA to 19.5 mA**
- **Wide Input-Voltage Range: 2.7V to 5.5V**

APPLICATIONS

- **Indicator LEDs in Cell Phones and Other Portable Devices**

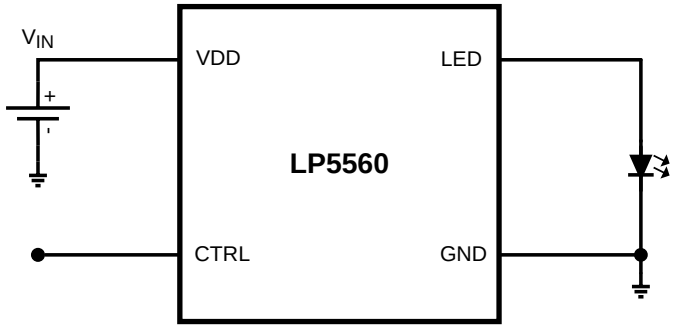
DESCRIPTION

LP5560 is a programmable LED driver that can generate variety of blinking sequences with up to three pulses of different length per sequence. Blinking sequences can be programmed through single wire interface. Programmable parameters include on and off times as well as rise and fall times. Default sequence is programmed into LP5560 to enable the use of device in simple systems without programming capabilities.

Very low headroom voltage eliminates the need for boost converter. Indicator LEDs can be driven directly from the battery. Small package size combined with zero external components minimizes the solution size.

LP5560 is available in TI's tiny 4-bump DSBGA package with 0.4 mm pitch.

Typical Application



Connection Diagram

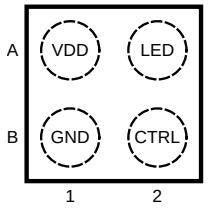


Figure 1. Top View

PIN DESCRIPTIONS(1)

Pin	Name	Type	Description
A1	VDD	P	Power supply pin
A2	LED	A	Current source output
B1	GND	G	Ground
B2	CTRL	DI	Single-wire interface input

(1) A: Analog Pin D: Digital Pin G: Ground Pin P: Power Pin I: Input Pin

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings(1)(2)(3)

Voltage on VDDpin		−0.3V to +6.0V
Voltage on other pins (CTRL,LED)(4)		−0.3V to VDD +0.3V with 6.0V max
Continuous Power Dissipation(5)		Internally Limited
Junction Temperature (T_{J-MAX})		125°C
Storage Temperature Range		−65°C to +150°C
Maximum Lead Temperature (Reflow soldering, 3 times)(6)		260°C
ESD Rating(7)	Human Body Model	2.0kV
	Charged Device Model	1000V

(1) Absolute Maximum Ratings indicate limits beyond which damage to the component may occur. Operating Ratings are conditions under which operation of the device is ensured. Operating Ratings do not imply ensured performance limits. For ensured performance limits and associated test conditions, see the Electrical Characteristics tables.
(2) All voltages are with respect to the potential at the GND pins.
(3) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications. Voltage
(4) Under-voltage lockout (UVLO) shuts down the LED driver with V_{IN} drops to 2.3V (typ.). Power-on reset (POR) trips at V_{IN} = 2.0V (typ.).
(5) Internal thermal shutdown circuitry protects the device from permanent damage. Thermal shutdown engages at T_J=160°C (typ.) and disengages at T_J=140°C (typ.).
(6) For detailed soldering specifications and information, please refer to Application Note AN1112 : Micro SMD Wafer Level Chip Scale Package (SNVA009) .
(7) The Human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin. MIL-STD-883 3015.7

Operating Ratings(1)(2)

Voltage on power pin (VDD)	2.7V to 5.5V
Junction Temperature (T_J) Range	−30°C to +125°C
Ambient Temperature (T_A) Range(3)	−30°C to +85°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the component may occur. Operating Ratings are conditions under which operation of the device is ensured. Operating Ratings do not imply ensured performance limits. For ensured performance limits and associated test conditions, see the Electrical Characteristics tables.
(2) All voltages are with respect to the potential at the GND pins.
(3) In applications where high power dissipation and/or poor package thermal resistance is present, the maximum ambient temperature may have to be derated. Maximum ambient temperature (T_{A-MAX}) is dependent on the maximum operating junction temperature ($T_{J-MAX-OP}$ = 125°C), the maximum power dissipation of the device in the application (P_{D-MAX}), and the junction-to ambient thermal resistance of the part/package in the application (θ_{JA}), as given by the following equation: $T_{A-MAX} = T_{J-MAX-OP} – (\theta_{JA} \times P_{D-MAX})$.

Thermal Properties

Junction-to-Ambient Thermal Resistance (θ_{JA}), YFQ0004 Package(1)	120°C/W

(1) Junction-to-ambient thermal resistance is highly application and board-layout dependent. In applications where high maximum power dissipation exists, special care must be paid to thermal dissipation issues in board design.

Electrical Characteristics(1)(2)

Limits in standard typeface are for T_A = 25°C. Limits in **boldface** type apply over the operating ambient temperature range (−30°C < T_A < +85°C). Unless otherwise specified: V_{IN} = 3.6V, CTRL = 3.6V, V_{LED} = 3.1V.

Symbol	Parameter	Condition	Min	Typ	Max	Units
I_{SD}	Shutdown Supply Current	CTRL = 0V		0.4	**0.75**	µA
I_Q	Quiescent Supply Current	I_{LED} = 0 mA		25	**30**	
I_{LED}	LED Output current	ISET = 0	**2.26**	2.8	**3.34**	mA
		ISET = 1 (default)	**4.61**	5.3	**5.99**	
		ISET = 2	**6.78**	7.8	**8.82**	
		ISET = 3	**8.87**	10.2	**11.53**	
		ISET = 4	**10.96**	12.6	**14.24**	
		ISET = 5	**13.50**	15.0	**16.50**	
		ISET = 6	**15.05**	17.3	**19.55**	
		ISET = 7	**16.96**	19.5	**22.04**	
$\Delta I_{LED}\%/\Delta V_{IN}$	Line regulation	2.7V ≤ V_{IN} ≤ 4.5V, I_{DX} = 5.3mA, Vf = 2.5V	**−3%**		**3%**	%/1V
$\Delta I_{LED}\%/\Delta V_{LED}$(3)	Load regulation	1.7V≤ V_{LED} ≤ 3.4V, I_{LED} = 5.3mA		0.6		
V_{HR}	Headroom Voltage(4)	I_{LED} = 5.3mA		40	**100**	mV
		I_{LED} = 19.5mA		40		
V_{IH}	Logic Input High level	V_{IN} = 2.7V to 5.5V	**1.1**			V
V_{IL}	Logic Input Low level	V_{IN} = 2.7V to 5.5V			**0.6**	V
I_{CTRL}	CTRL pin leakage current	CTRL = 1.8V			**400**	nA
T_cycle_H	LED On time	adjustable(5)	13.2		3009.6	ms
T_cycle_L	LED OFF time		26.4		6019.2	ms
T rise	LED current rise time(6)		0		1584	ms
T fall	LED current fall time(6)		0		1584	ms
Fade resolution	Rise/fall time resolution	See(5)		105.6		ms

(1) All voltages are with respect to the potential at the GND pins.
(2) Min and Max limits are specified by design, test, or statistical analysis. Typical numbers are not ensured, but do represent the most likely norm.
(3) I_{LED} = LED output current, V_{LED} = LED forward voltage.
(4) For LED output pin, headroom voltage is defined as the voltage across the internal current source when the LED current has dropped 10% from the value measured at VIN – 0.5V. If headroom voltage requirement is not met, LED current regulation will be compromised.
(5) Specified by design.
(6) LED current ramp up and ramp down uses a combined PWM / current adjustment.

Single-Wire Interface Timing Characteristics(7)

Symbol	Parameter	Condition	Min	Typ	Max	Units
T_{C_ON}	Command pulse on time	See(1)	15			µs
T_{C_OFF}	Command pulse off time		30			µs
T_{T_ON}	Minimum training pulse on time(2)		200			µs
T_{T_OFF}	Minimum training pulse off time(3)		200			µs
T_{CAL}	Calibration pulse length		0.35		8	ms
T_{ENTER}	Command entering period		500			µs
$T_{ENTER}+T_{BLANK}$	Command entering period + Blank period				1500	µs

(7) Min and Max limits are specified by design, test, or statistical analysis. Typical numbers are not ensured, but do represent the most likely norm.
(1) Specified by design.
(2) All CTRL signal high times between calibration pulse and training end are considered as training pulse on times.
(3) All CTRL signal low times between calibration pulse and training end are considered as training pulse off times.

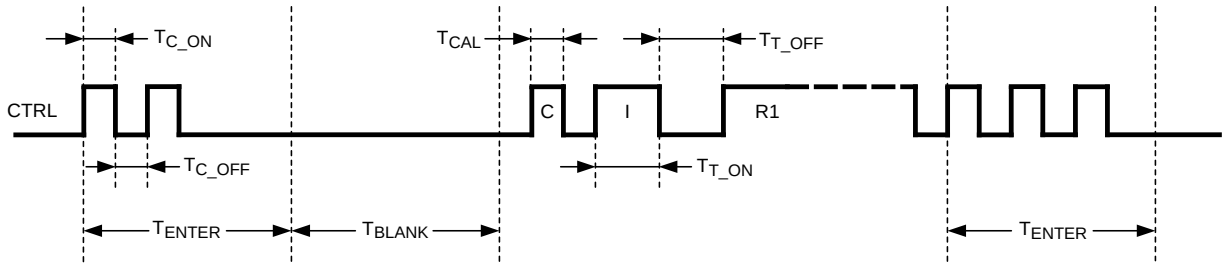


Figure 2. Interface Timing

Typical Performance Characteristics

T_J = 25°C. Unless otherwise noted, typical performance characteristics apply to the LP5560 Block Diagram with: V_{IN} = 3.6V, R_{ISET} = 24 kΩ, C_{IN} = 100 nF.

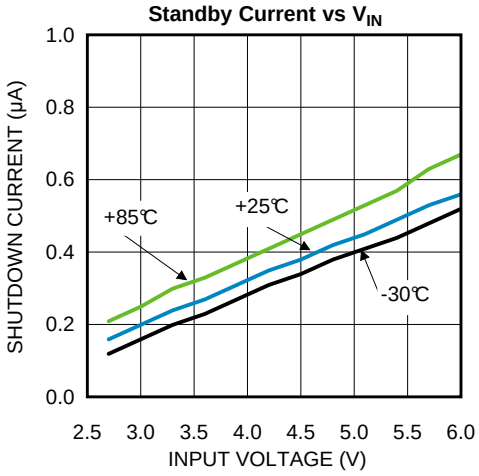


Figure 3.

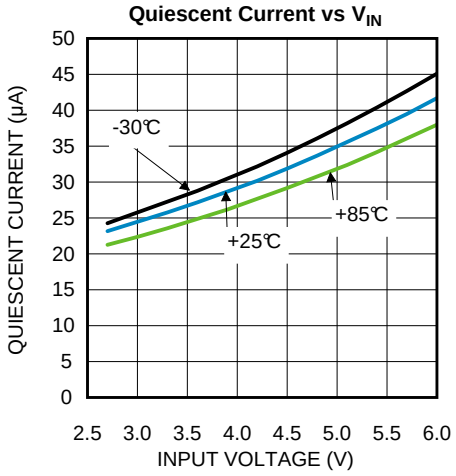


Figure 4.

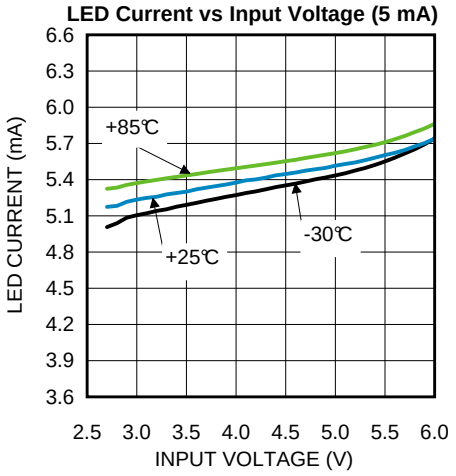


Figure 5.

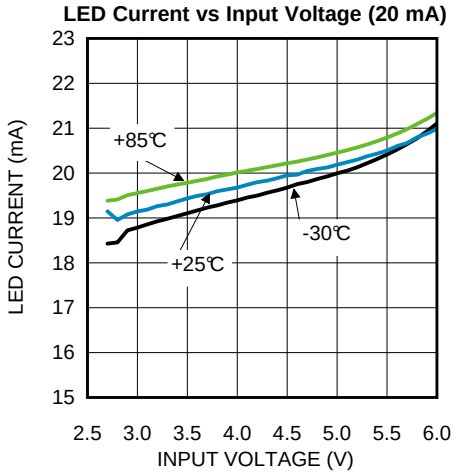


Figure 6.

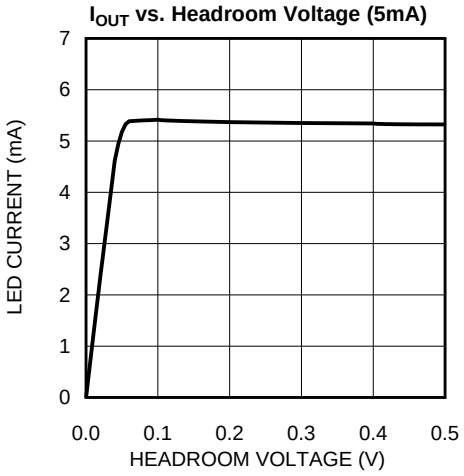


Figure 7.

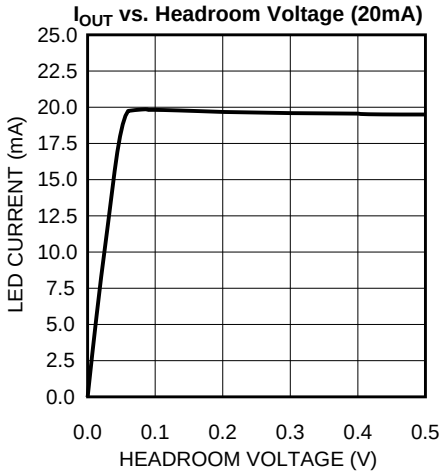
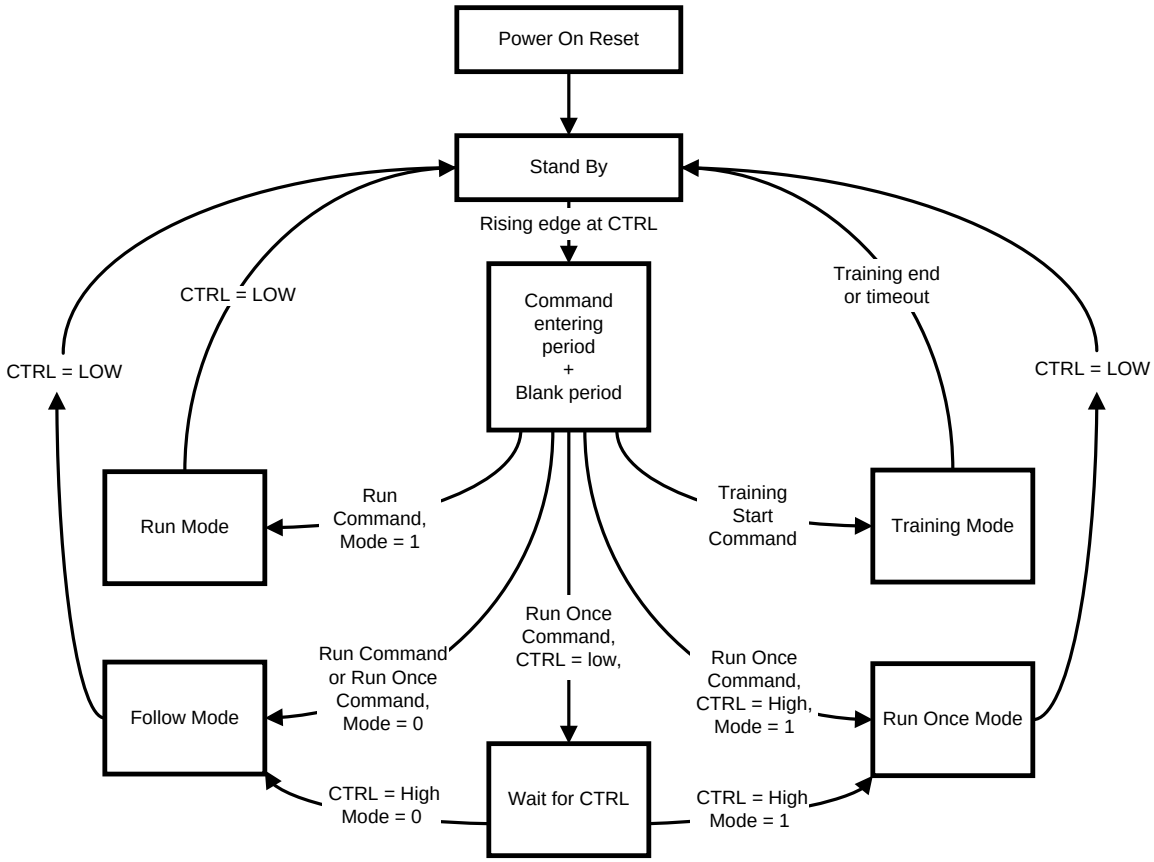


Figure 8.

Operating Modes



POWER-ON RESET When input voltage is applied to VDD pin device goes through Power On Reset (POR). During POR defaults are set into control registers.

STANDBY: After POR device goes to standby. This is the low power mode when all the internal blocks are shut down.

COMMAND ENTERING PERIOD + BLANK PERIOD: Rising edge of the CTRL signal activates the circuit and starts a command entering period. During the command entering period all rising edges are counted. After command entering period there is a blank period when no rising edges are allowed.

RUN: If mode bit is “1” (run mode) and run command has been detected device goes into run mode. In run mode LP5560 generates the programmed blinking sequence.

FOLLOW MODE: If mode bit is “0” (follow mode) and run command or run once command has been detected LP5560 goes into follow mode. In follow mode LED stays on as long as CTRL pin is held high.

RUN ONCE MODE: If run once command has been detected and mode bit is “1” (run mode) device goes into run once mode. In run once mode LP5560 generates the programmed blinking sequence once. CTRL must be high as long as blinking sequence is running.

TRAINING: If training start command has been detected device goes into training mode. In training mode a new blinking sequence can be programmed into the device.

APPLICATION INFORMATION

LP5560 is a programmable LED driver with single-wire interface. It is designed to drive single indicator LED with different blinking sequences. Up to three pulses with different on and off times can be programmed into the device. LED current rise and fall times can also be independently controlled. Blinking sequence is stored into volatile memory, thus removing input voltage V_{IN} resets the memory into default state.

High-side LED driver has very low headroom voltage requirement and can drive most indicator LEDs directly from battery voltage. Single CTRL pin is used to control the device on and off and to change settings of the device. A default blinking sequence is programmed into the device to enable use of the devices in simply applications without programming capabilities.

LED DRIVER HEADROOM VOLTAGE

Current source is connected internally between VDD and LED output pins. The voltage across the current source, (V_{VDD} − V_{LED}), is referred as headroom voltage (V_{HR}). The current source requires a sufficient amount of headroom voltage to be present across it in order to regulate the output current properly. LP5560 headroom voltage requirement is 40 mV (typ.) and does not depend on the current setting.

SINGLE-WIRE INTERFACE

LP5560 has one digital control input (CTRL). Threshold levels of CTRL input are fixed to support control from low-voltage controller. CTRL signal is used to control the mode of the circuit. Rising edge of the CTRL signal activates the circuit and starts a command entering period. During the command entering period all rising edges are counted. After command entering period there is a blank period when no rising edges are allowed. If there are any rising edges during blank period these are not detected. User must take care not to start the training sequence before blank period has elapsed or the training sequence will be corrupted.

If CTRL is left high after command entering period, the consequent command is performed right after the blank period. In case of run once command CTRL pin can be set low after the command entering period and execution of the command starts once CTRL pin is pulled high after blank period.

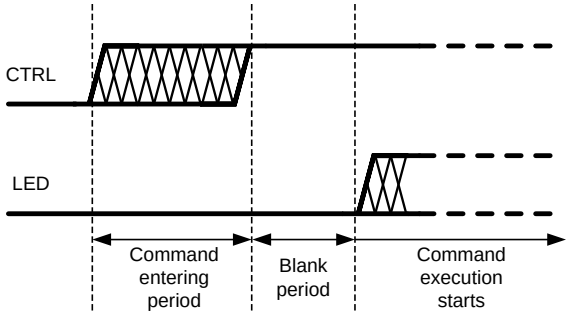


Figure 9. Single Wire Interface

LP5560 has four different commands. Command depends on the number of rising edges during command entering period. If there are more than 4 rising edges during command entering period command is ignored. Note that even in this case blank period needs to elapse before next command can be given.

Command	Number of Rising Edges During Command Entering Period
Run	1
Training start	2
Training end	3
Run once	4

Run Command

One rising edge of CTRL signal within command entering period is interpreted as Run command. CTRL pin must be kept high during blank period. If CTRL pin is pulled low during command entering period or blank period device goes to stand by. In run mode (mode bit = 1) blinking sequence is started right after Blank period and it is repeated as long as CTRL signal is kept high. When CTRL signal is set low device goes into Standby mode (Figure 10).

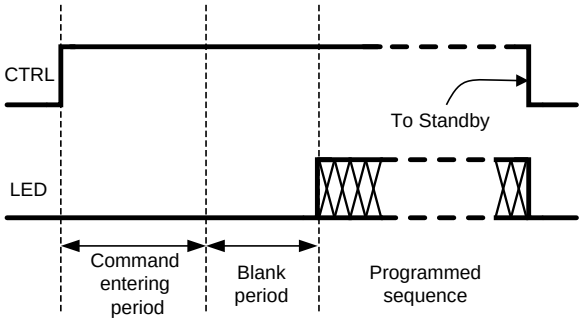


Figure 10. Run Mode

In follow mode (mode bit = 0) LED is turned on right after Blank period and it stays on as long as CTRL is kept high. When CTRL signal is set low LED is turned off and device goes into Standby mode (Figure 11).

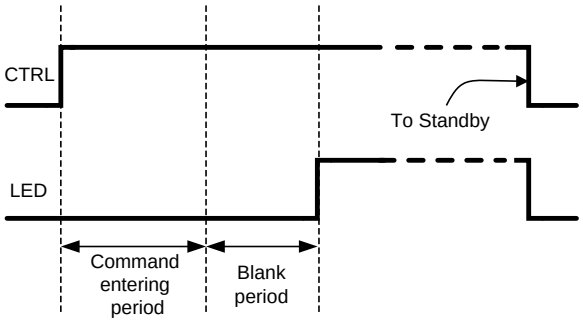


Figure 11. Follow Mode

Training Start Command

Two rising edges of CTRL signal within command entering period is interpreted as Training start command. Training start command starts training sequence. Different blinking sequences can be trained into device in training mode. Training mode is described in more details in chapter TRAINING MODE.

Training End Command

Three rising edges of CTRL signal within command entering period is interpreted as Training end command. Training end is used to stop the training sequence.

Run Once Command

Four rising edges of CTRL signal within command entering period is interpreted as Run Once command. Programmed blinking sequence is performed once after Run Once command. If CTRL is kept high after command entering period the programmed blinking sequence starts right after the blank period has elapsed (Figure 12). CTRL signal must stay high as long as programmed blinking sequence is executed. If CTRL is set low during execution of blinking sequence, device goes to standby and execution of blinking sequence is stopped.

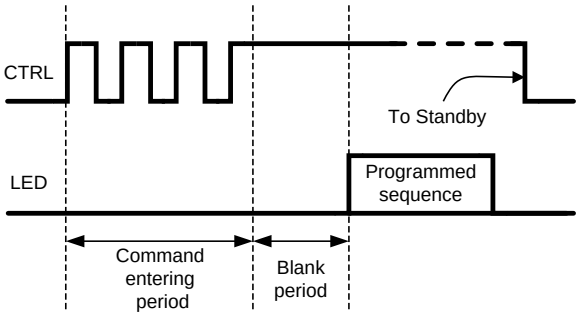


Figure 12. Run Once Command

If CTRL signal is low after command entering period, blinking sequence is executed once the CTRL is set high (Figure 13).

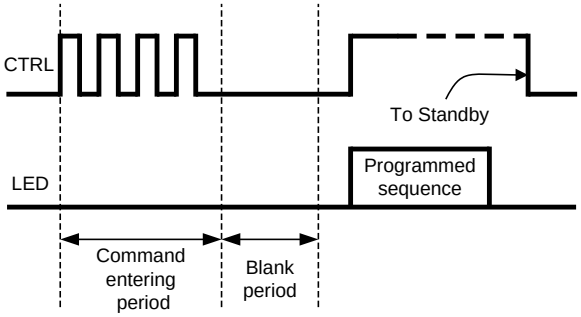


Figure 13. Delayed Run Once Command

If device is in follow mode (mode bit is “0”) run once command turns LED on and it is kept on as long as CTRL is held high.

TRAINING MODE

Figure 18 shows an example of full training sequence with 3 pulses. Training mode starts with training start command. Training start command is followed by blank time during which no rising edges are allowed. Blank time is followed by calibration pulse. Calibration pulse length (T_{CAL}) defines the speed of the training sequence and can vary from 300 µs to 10 ms. During parameter settings register values are incremented at speed defined by T_{CAL}. For example if calibration pulse length is 1 ms and current setting pulse length is 3.3 ms current setting value is 3 (current set register is incremented 3 times). If parameter setting pulse is shorter than calibration pulse setting is 0.

Next rising edge after calibration pulse starts LED driver current setting (I). LED driver current is recorded once CTRL is pulled low. Note that there are “empty” low times before and after current setting pulse. For the following pulses both CTRL high and CTRL low times are used to set the parameters. Next CTRL high time defines LED current rise time setting for pulse 1 (R1). When R1 setting is started Mode bit is set to “0”. This sets LP5560 into follow mode. Mode bit is set to “1” after first off time has been saved into register. This means that at least one full pulse needs to be trained into memory to set the device into run mode.

CTRL low time after R1 defines the LED on time for pulse 1 (ON1). CTRL high time after ON1 sets the LED current fall time (F1). CTRL low time after F1 sets pulse 1 off time (OFF1). Once rising edge of CTRL is detected after first off time setting mode bit is set to “1” (run mode) and number of pulses register (NOP[1:0]) is set to 1. This indicates that one full pulse has been trained into memory.

Rise-, on-, fall- and off times for pulse 2 and 3 are set the same way as for pulse 1. Note that NOP register is always incremented after OFFx time setting. This means that all pulse parameters (rise-, on-, fall- and off time) need to be trained for each pulse make it valid. Training sequence is ended with training end command.

Ending the Training Sequence

Training end command can be given at any time of the training sequence except during blank time. Outcome of the training sequence depends on the place of the Training end command. If Training end command is given after any of the off time setting (OFF1, OFF2 or OFF3) mode bit is set to “1” and corresponding number of pulses are stored into memory. If training end command is given after any of the other pulse parameters (Rx, ONx or Fx) that pulse is ignored. For example if training end command is given after ON2 pulse 2 is ignored and blinking sequence will include only pulse 1.

Reset to Default

If Training end command is given right after Training start command LP5560 is reset back to factory defaults (Figure 14). In this case the mode bit is set to "1" (run mode) with factory set default blinking sequence.

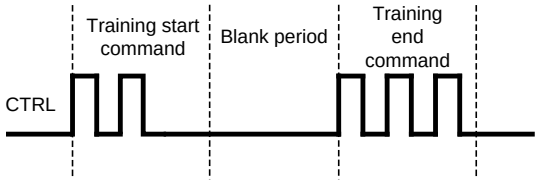


Figure 14. Reset to Default

Changing LED Current

LP5560 allows changing the LED output current without the need to reprogram the previously programmed blinking sequence. This is done by giving the Training end command after current setting (Figure 15). In this case only the current setting changes. If blinking sequence was programmed into LP5560 it remains unchanged. If mode bit was "0" (follow mode) before the training sequence it remains "0".

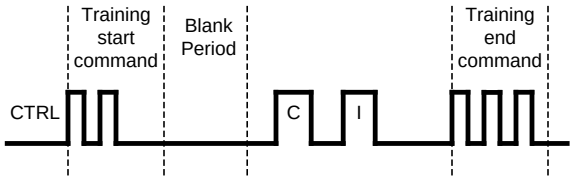


Figure 15. Current Programming Sequence

Entering Follow Mode

Mode bit can be set to "0" (follow mode) in two ways. If Training end command is given after calibration pulse mode bit is set to "0" (follow mode) and the previously set LED output current setting remains unchanged (Figure 16).

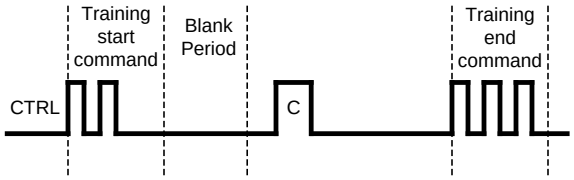


Figure 16. Entering Follow Mode

If training end command is given after R1, ON1 or F1 mode bit is set to "0" (follow mode) and new current setting is stored to current register (Figure 17). If Training end command is given after F1 CTRL low time before training end command needs to be less than Minimum training pulse off time (200 µs). Otherwise off time OFF1 will be set to minimum value and pulse 1 will be stored into memory.

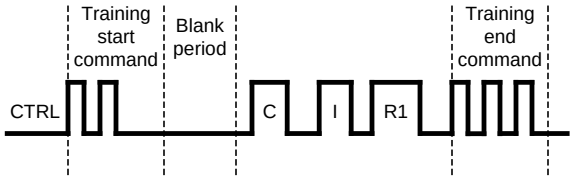


Figure 17. Entering Follow Mode with New Current Setting

Timeout

If during training CTRL stays constant for more than 127 * T_{CAL} time this is interpreted as timeout. For example, if calibration pulse length T_{CAL} is 1ms timeout time is 127 ms. Timeout ends the training sequence. Timeout is considered as a false training and it is a good practice to always give a complete training sequence after timeout to ensure correct data is stored into memory.

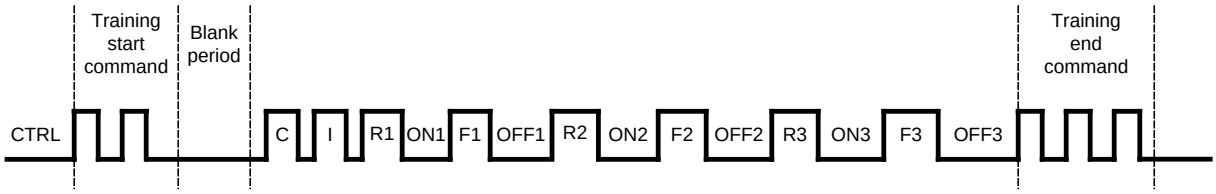


Figure 18. Full Training Sequence

LED OUTPUT CURRENT SETTING

LED output current can be set from 2.8 mA to 19.5 mA in 7 steps. Duration of the current setting pulse (I) defines the current setting.

Current Settting	LED Current (mA)
0	2.8
1	5.3 default
2	7.8
3	10.2
4	12.6
5	15.0
6	17.3
7	19.5

RISE/FALL TIME SETTING

Rise and fall times of each pulse can be programmed independently. Rise and fall time can be set from 0 to 1584 ms with 105.6 ms steps. Rise and fall times are generated using a combined PWM and current control. Ramp has 32 PWM steps. For the first 8 steps LED current is decreased to 12.5%. For the remaining steps current is set to 100%. Each step is 3.3 ms long. This result's the minimum ramp time of 3.3 ms * 32 = 105.6 ms. When ramp time is increased each PWM step is done multiple times. When setting rise and fall times they are always rounded down. For example if calibration pulse length is 1 ms and rise time setting pulse is 2.9 ms rise time is set to 2 which is 211.2 ms. Rise and fall times can be set to zero by giving pulse that is shorter than calibration pulse.

Ramp setting	Ramp time (ms)
0	0
1	105.6
2	211.2
3	316.8
4	422.4
5	528 default
6	633.6
7	739.2
8	844.8
9	950.4
10	1056
11	1161.6
12	1267.2
13	1372.8
14	1478.4
15	1584

LED ON-TIME SETTING

LED on time has 5-bit control. On time can be controlled from 13.2 ms to 3009.6 ms in 31 steps. Step size is not constant to increase resolution on shorter ON times. With longer on times also the step size is increased. The table below shows the available on times.

Setting	LED On time (ms)
0	13.2
1	26.4
2	52.8
3	105.6
4	158.4
5	211.2
6	264
7	316.8
8	369.6
9	435.6
10	501.6 default
11	594
12	699.6
13	805.2
14	910.8
15	1016.4
16	1122
17	1227.6
18	1353
19	1478.4
20	1603.8
21	1729.2
22	1854.6
23	1980
24	2105.4
25	2230.8

Setting	LED On time (ms)
26	2356.2
27	2481.6
28	2613.6
29	2745.6
30	2877.6
31	3009.6

LED OFF-TIME SETTING

LED off time has also 5-bit control. Off time can be controlled from 26.4 ms to 6019.2 ms in 31 steps. Off time is always twice as long as on time with same setting.

Setting	LED Off time (ms)
0	26.4
1	52.8
2	105.6
3	211.2
4	316.8
5	422.4
6	528
7	633.6
8	739.2
9	871.2
10	1003.2
11	1188
12	1399.2
13	1610.4 default
14	1821.6
15	2032.8
16	2244
17	2455.2
18	2706
19	2956.8
20	3207.6
21	3458.4
22	3709.2
23	3960
24	4210.8
25	4461.6
26	4712.4
27	4963.2
28	5227.2
29	5491.2
30	5755.2
31	6019.2

DEFAULT SEQUENCE

Default blinking sequence is programmed into LP5560 to enable the use of a device in simple systems without programming capabilities. Default sequence has a single pulse with following parameters:

I = 5.3mA
R1 = 528 ms
ON1 = 501.6 ms
F1 = 528 ms
OFF1 = 1610.4 ms

CONTROL REGISTERS

Control registers are shown only for a reference. There is no direct way to write or read these registers. Register values are set in the training mode as described earlier in the document.

7	6	5	4	3	2	1	0
F1[3:0]				R1[3:0]			
F2[3:0]				R2[3:0]			
F3[3:0]				R3[3:0]			
MODE	NOP[1:0]		ON1[4:0]				
I_LED[2:0]			OFF1[4:0]				
n/a			ON2[4:0]				
n/a			OFF2[4:0]				
n/a			ON3[4:0]				
n/a			OFF3[4:0]				

REVISION HISTORY

Changes from Revision B (April 2013) to Revision C	Page
• Changed layout of National Data Sheet to TI format	14

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LP5560TME/NOPB	ACTIVE	DSBGA	YFQ	4	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM			Samples
LP5560TMX/NOPB	ACTIVE	DSBGA	YFQ	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM			Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

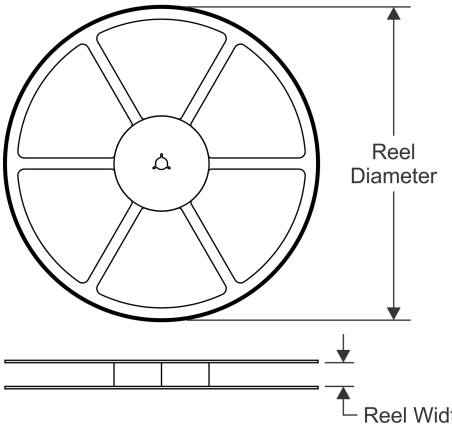
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

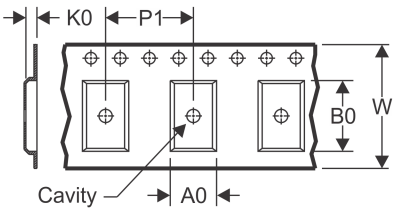
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

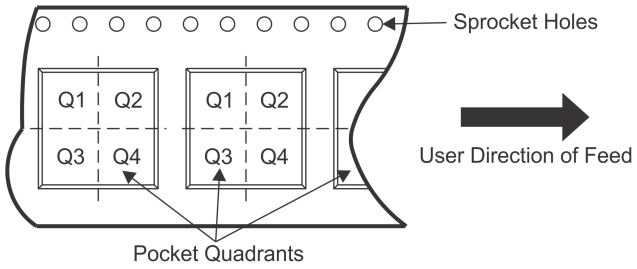


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

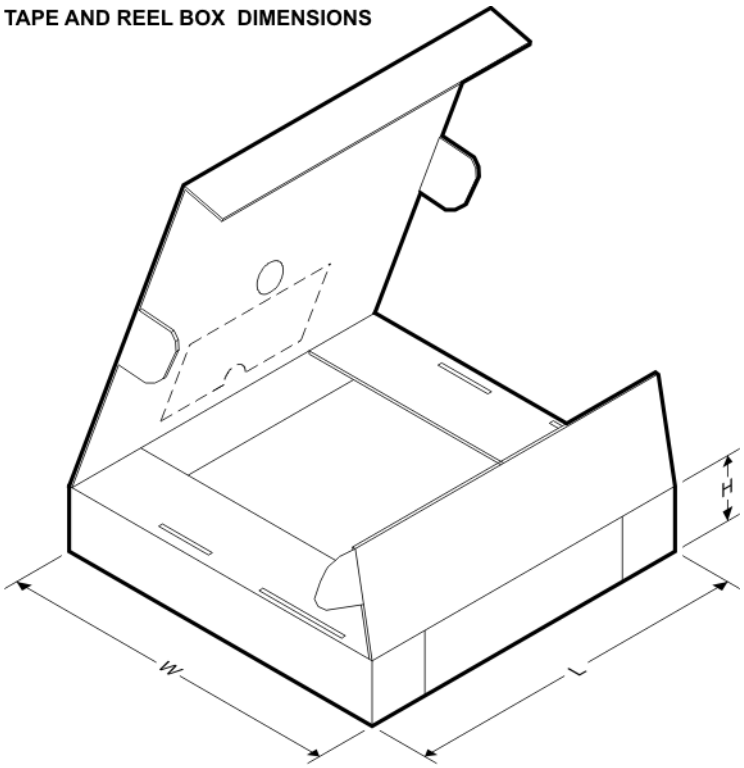
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LP5560TME/NOPB	DSBGA	YFQ	4	250	178.0	8.4	0.92	0.99	0.7	4.0	8.0	Q1
LP5560TMX/NOPB	DSBGA	YFQ	4	3000	178.0	8.4	0.92	0.99	0.7	4.0	8.0	Q1

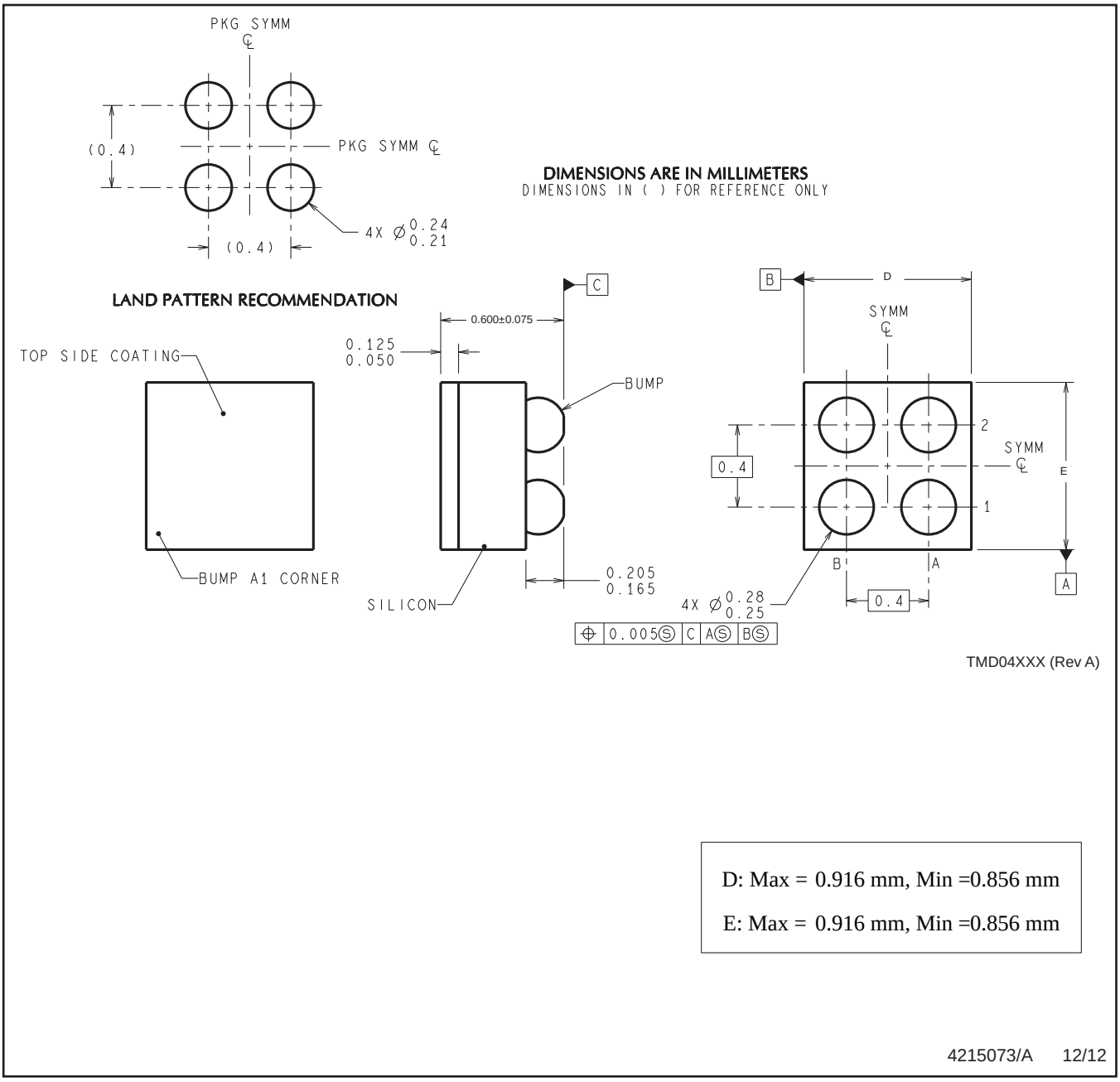
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LP5560TME/NOPB	DSBGA	YFQ	4	250	210.0	185.0	35.0
LP5560TMX/NOPB	DSBGA	YFQ	4	3000	210.0	185.0	35.0

YFQ0004



NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
B. This drawing is subject to change without notice.

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