Datasheet

Automotive LED Driver Series

50 V 1.5 A 1ch LED Driver for 2 Wheeler Turn Indicator

BD18327EFV-M

General Description
BD18327EFV-M is 50 V-withstanding 1.5 A 1ch LED Driver for 2 Wheeler Turn Indicator. It has built-in CR Timer for LED blinking control. The IC provides high reliability because it has LED open detection, short circuit protection, over voltage protection. In case of LED open detection, output blinking rate is doubled. Under high input voltage condition, output PWM ON Duty reduces to control heat dissipation across the IC and protect the LED load.

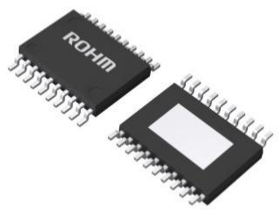
Key Specifications
- Input Voltage Range: 6.0 V to 18.0 V
- OUT Pin Maximum Output Current: 1.5 A
- OUT Pin ON Resistance for High Mode: 0.8 Ω (Max)
- Circuit Current at Power Saving Mode: 100 µA (Max)
- CR Timer Frequency Range: 150 Hz to 1 kHz
- Operating Temperature Range: -40 °C to 125 °C

Features
- AEC-Q100 Qualified(Note 1)
- Functional Safety Supportive Automotive Products
- Flasher SW Resistance Detection
- Power Saving Mode
- Built-in CR Timer
- LED Open Detection
- Disable LED Open Detection Function at Reduced-voltage
- Short Circuit Protection (SCP)
- Over Voltage Protection (OVP)
- Output PWM ON Duty Control during High Input Voltage

(Note 1) Grade1

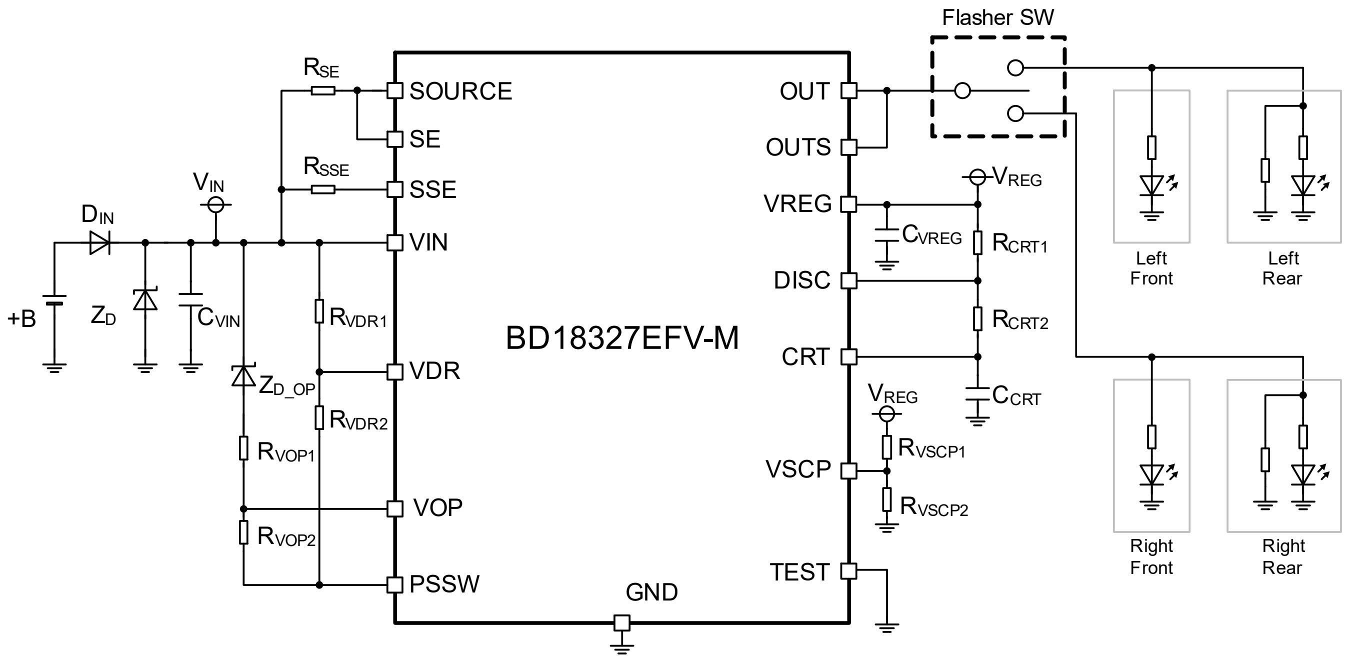
Package

Package	W (Typ) x D (Typ) x H (Max)
HTSSOP-B20	6.5 mm x 6.4 mm x 1.0 mm



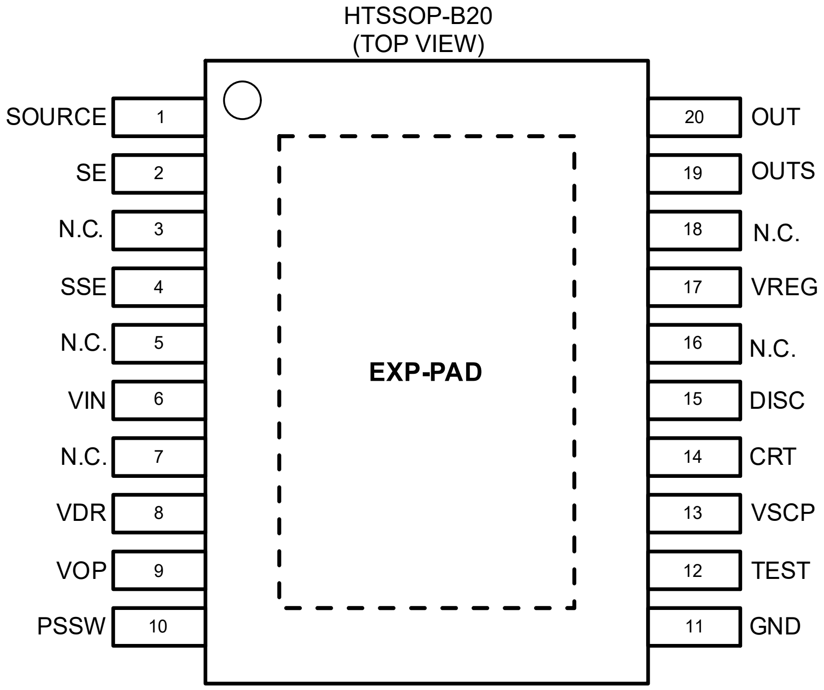
Applications
- 2 Wheeler Turn Indicator

Typical Application Circuit



○Product structure : Silicon integrated circuit ○This product has no designed protection against radioactive rays.

Pin Configuration

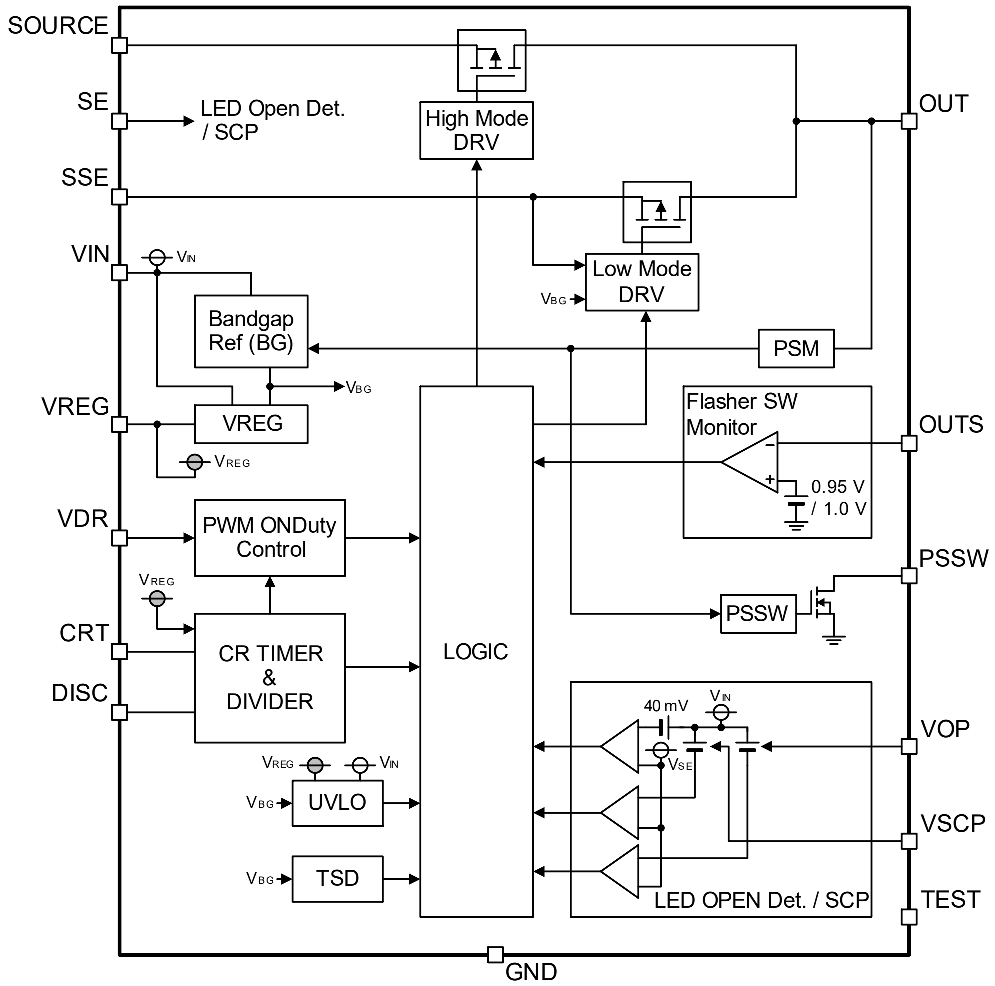


Pin Description

Pin No.	Pin Name	Function
1	SOURCE	Power PMOS source pin
2	SE	Output current sense input pin
3	N.C.	No internal connection*(Note 1)*
4	SSE	Output current sense input in Low Mode
5	N.C.	No internal connection*(Note 1)*
6	VIN	Power supply input
7	N.C.	No internal connection*(Note 1)*
8	VDR	PWM ON Duty setting
9	VOP	Open detection threshold setting pin
10	PSSW	Programmable ground pin
11	GND	GND
12	TEST	The test pin connects to GND
13	VSCP	Short detection threshold setting pin
14	CRT	CR timer setting1
15	DISC	CR timer setting2
16	N.C.	No internal connection*(Note 1)*
17	VREG	Regulated voltage pin
18	N.C.	No internal connection*(Note 1)*
19	OUTS	Output sense pin
20	OUT	Output pin
-	EXP-PAD	The EXP-PAD connect to GND.

(Note 1) Leave this pin unconnected.

Block Diagram



Description of Blocks
(Unless otherwise specified, Ta = 25 °C, V_{IN} = 13 V, and numbers are “Typical” values.)

1 Operation mode description

1.1 Power Saving Mode (PS Mode)

After power on, the IC starts up in power saving mode. The current consumption of the IC is limited to 100 µA or less, and it is possible to reduce the power consumption when the Flasher SW is off. In the PS mode, the MOSFET built into the PSSW pin can be turned off to shut off the current flowing to the external resistor. When the Power Saving Mode is released, the IC monitors the VIN pin voltage, and when the UVLO VIN Release Voltage (5.0 V (Typ)) is exceeded, the IC shifts to Flasher SW Monitor Mode. The release condition for the power saving mode is expressed by the following equation.

$$I_{OUT\_PSM} \times R_{PSM} \times > V_{PSM\_REL}$$

$$and$$

$$V_{IN} > V_{UVLOR}$$

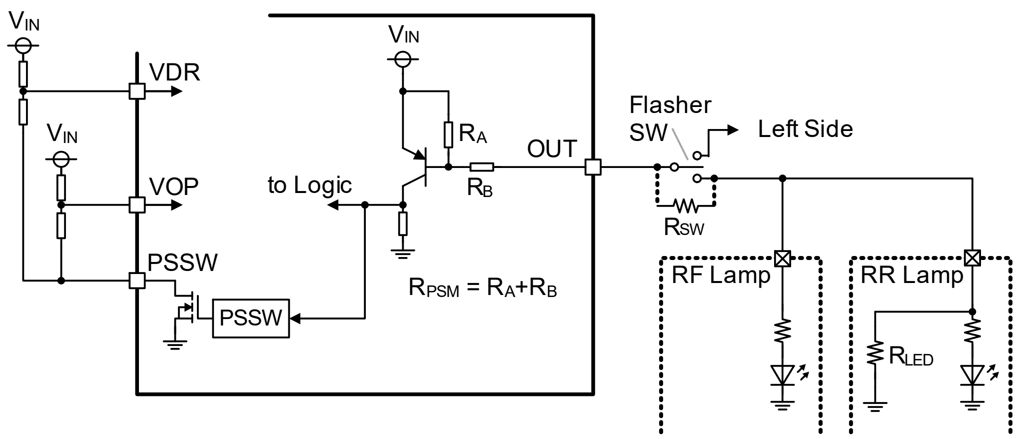
$$I_{OUT\_PSM} = \frac{V_{IN}}{R_{PSM}+R_{SW}+R_{LED}}$$

where:

I_{OUT_PSM}	is the OUT pin current in Power Saving Mode.
R_{PSM}	is the Power Saving Mode Internal Resistance.
V_{PSM_REL}	is the Power Saving Mode Release Threshold.
V_{IN}	is the VIN pin voltage.
V_{UVLOR}	is the UVLO VIN Release Voltage.
R_{LED}	is the LED board resistance.
R_{SW}	is the Flasher SW resistance.

Solving above equation for R_{SW}

$$R_{SW} < R_{PSM} \times \frac{V_{IN}}{V_{PSM\_REL}} - R_{PSM} - R_{LED}$$



1 Operation mode description – continued

1.2 Flasher SW Monitor Mode

When PS Mode is released, the IC shifts to Flasher SW Monitor Mode. When the IC shifts to Flasher SW monitor mode, the constant current source for SW resistance monitoring turns on and monitoring of the OUTS pin voltage starts.
The constant current source turns ON only in the ON Duty section set by CR timer, and the judgment of the SW monitor also becomes only in this section. After switching from PS mode, if the OUTS pin voltage is V_{OUTS_ON} (0.95 V (Typ)) or more within 8 CLK cycle, the IC returns to PS mode again.

Condition for IC to go from Flasher SW Monitor Mode to Blinking High Mode:
After switching from PS mode, if the OUTS pin voltage falls below V_{OUTS_ON} (0.95 V (Typ)) within 8 CLK cycles, the IC shifts to the blinking High mode. The Blinking High Mode transition conditions are as follows.

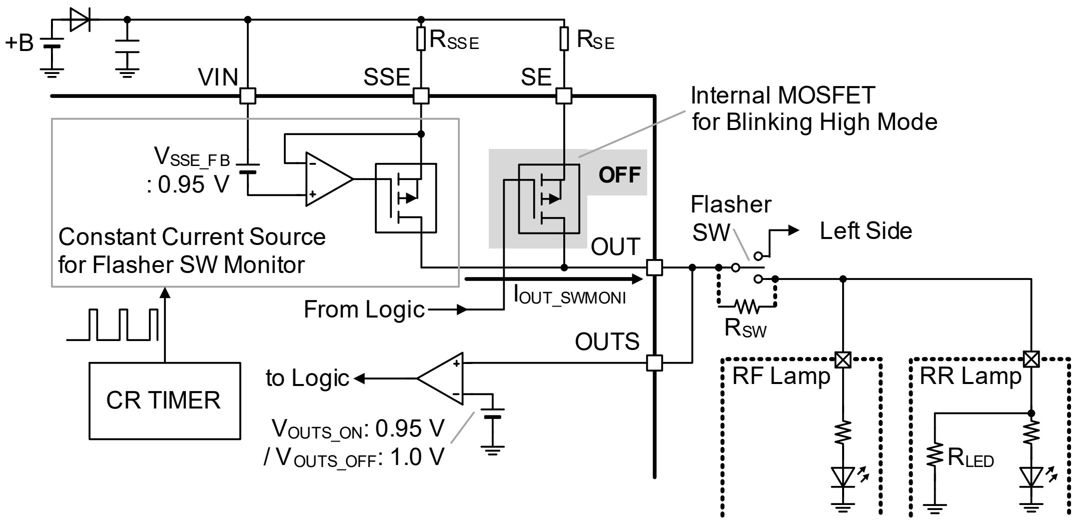
$$V_{OUTS} = I_{OUT\_SWMONI} \times (R_{SW} + R_{LED}) < V_{OUTS\_ON}$$

$$I_{OUT\_SWMONI} = \frac{V_{SSE\_FB}}{R_{SSE}}$$

$$\frac{(R_{SW}+R_{LED})}{R_{SSE}} < K_{BLON}$$

where:

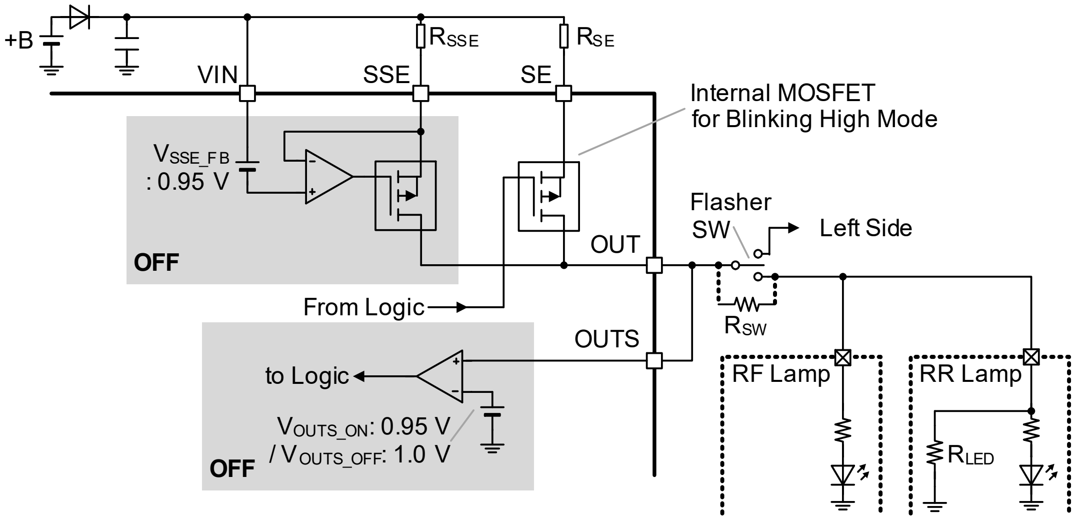
V_{OUTS}	is the OUTS pin voltage.
I_{OUT_SWMONI}	is the OUT pin current in Flasher SW Monitor Mode.
V_{SSE_FB}	is the SSE pin Feedback Voltage.
R_{SSE}	is the Constant Current Setting Resistor.
R_{SW}	is the Flasher SW resistance.
R_{LED}	is the LED board resistance.
V_{OUTS_ON}	is the Blinking ON Threshold Voltage.
K_{BLON}	is the Blinking ON Threshold Constant. ($K_{BLON} = V_{OUTS\_ON} / V_{SSE\_FB}$)



1 Operation mode description – continued

1.3 Blinking High Mode

The Blinking High mode continues for 256 CLK cycles. During Blinking High Mode, the constant current source for Flasher SW monitoring and the comparator built into the OUTS Pin turn off. During this period, the IC performs LED Open Detection, SW Open Detection and Short Circuit Protection. After 256 CLK cycles, the IC shifts to Blinking Low Mode.



1.4 Blinking Low Mode

When the IC enters Blinking Low Mode, the internal counter starts counting. After 256 CLK cycles, the IC shifts to Blinking High Mode. If the OUTS pin voltage reaches V_{OUTS_OFF} (1.0 V (Typ)) or more before 256 CLK cycles elapse, the IC returns to Flasher SW Resistance Monitor Mode again. The Flasher Switch Monitor Mode transition conditions are as follows.

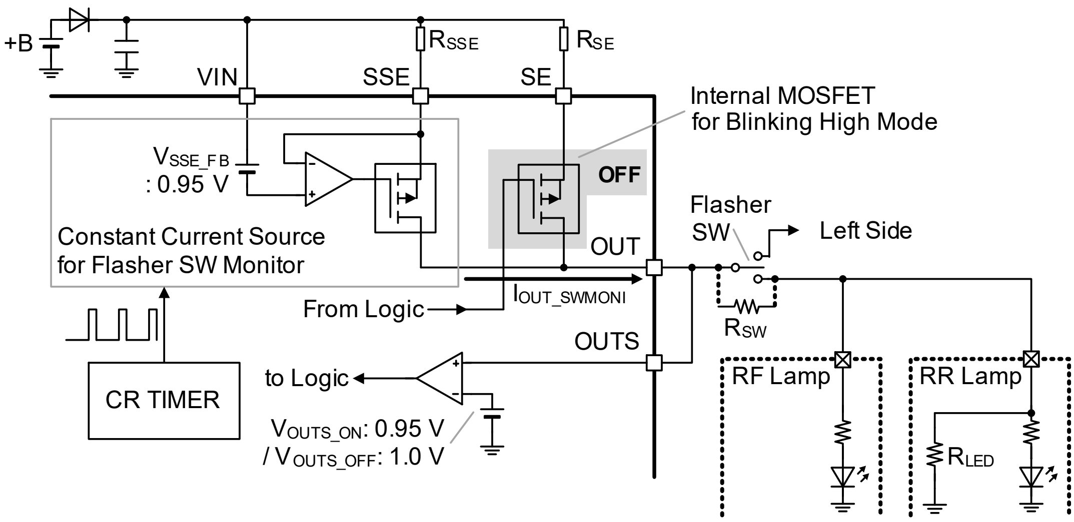
$$V_{OUTS} > V_{OUTS\_OFF}$$

$$\frac{(R_{SW}+R_{LED})}{R_{SSE}} > K_{BLOFF}$$

where:

V_{OUTS_OFF} is the Blinking OFF Threshold Voltage.

K_{BLOFF} is the Blinking OFF Threshold Constant. ($K_{BLOFF} = V_{OUTS\_OFF} / V_{SSE\_FB}$)



1 Operation mode description – continued

1.5 Flasher SW Open Detection (SWOP)

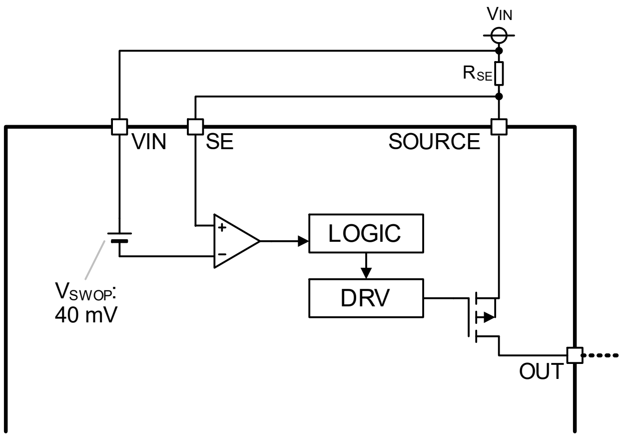
If voltage drop across external resistance R_{SE} drops below a certain value, Flasher SW open is detected.
When the Flasher SW open is detected, the IC shifts from Blinking High mode to Power Saving Mode.
Flasher SW Open detection can only be detected in Blinking High Mode.
The Flasher SW Open Detection condition can be calculated by the following formula.

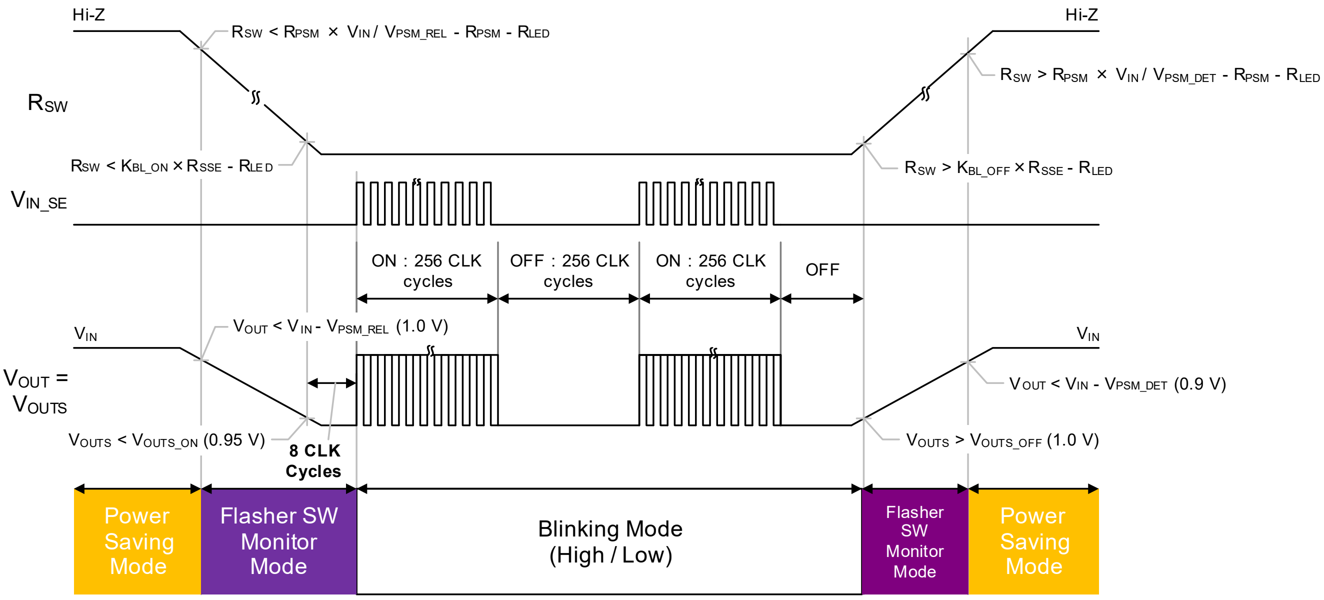
$$V_{IN\_SE} > V_{SWOP}$$

where:

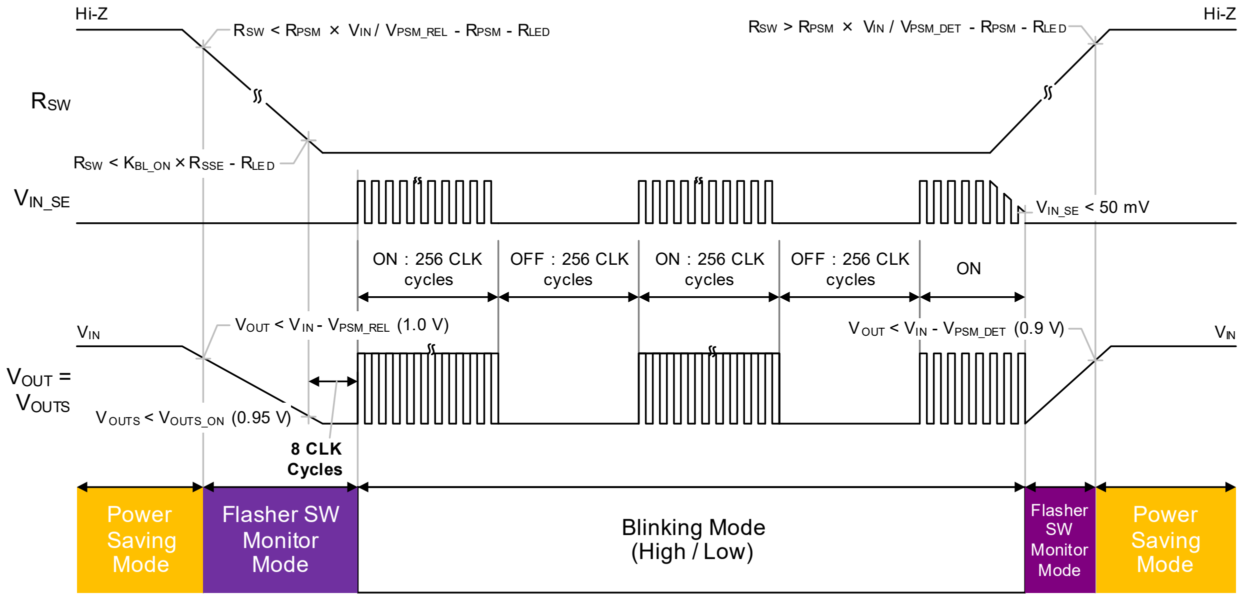
V_{IN_SE} is the VIN to SE voltage.

V_{SWOP} is the Flasher SW Open Detection Threshold.





1.5 Flasher SW Open Detection (SWOP) – continued



1 Operation mode description – continued

1.6 LED Open Detection Mode (LEDOP)

This LSI can detect LED open. In case of LED open inform the fault condition to user by double blinking. On detection of fault IC starts operating the outputs on almost 1/2 blinking period (double blink operation). If voltage drop across external resistance R_{SE} drops below a certain value, LED open is detected. The LED open detection condition can be calculated by the following formula.

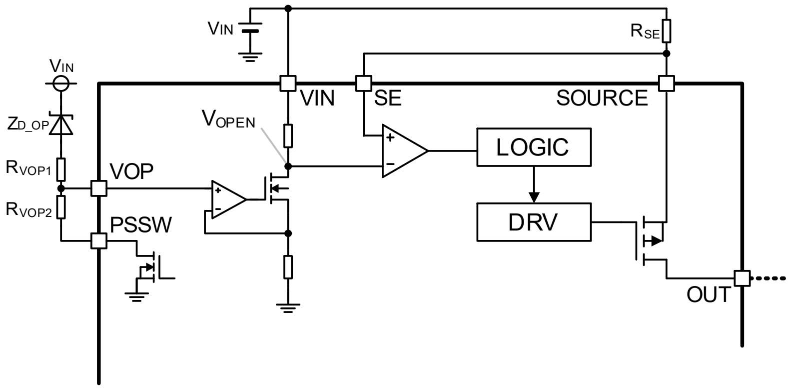
$$V_{IN\_SE} < V_{OPEN} \ \& \ V_{IN} > V_{IN\_OPM}$$

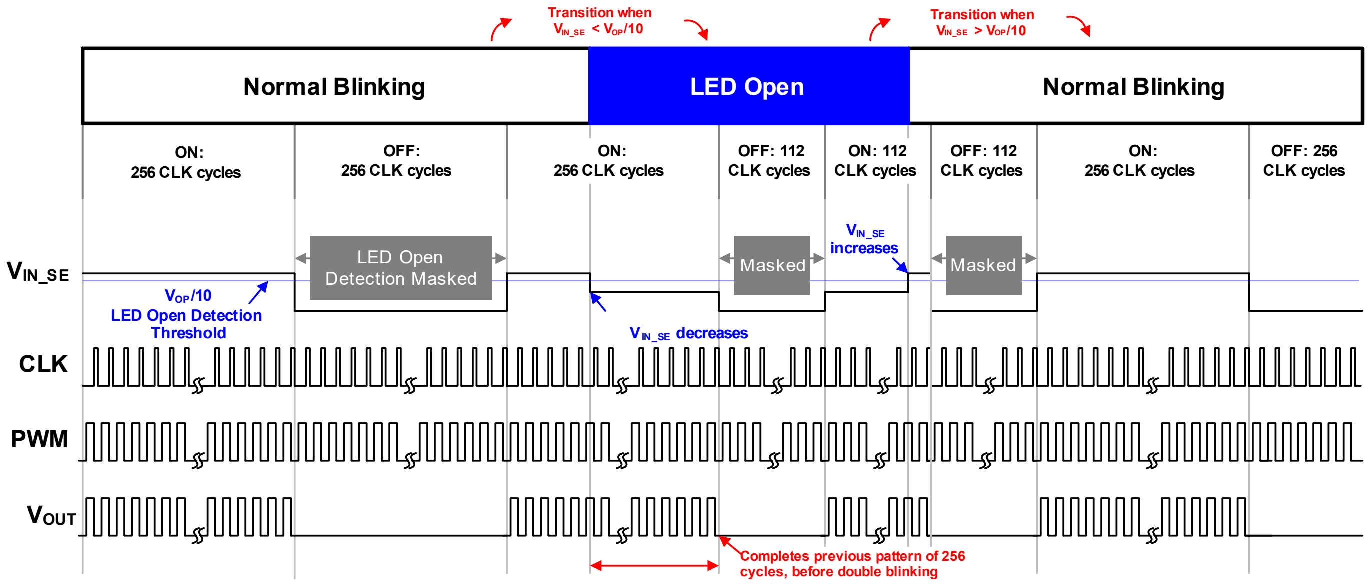
$$V_{OPEN} = \frac{V_{OP}}{10}$$

$$V_{OP} = (V_{IN} - V_{ZD\_OP}) \times \frac{R_{VOP2}}{R_{VOP1}+R_{VOP2}}$$

where:

V_{IN_SE}	is the VIN to SE voltage.
V_{OPEN}	is the LED Open Detection Threshold Voltage.
V_{IN}	is the VIN pin voltage.
V_{IN_OPM}	is the Disable LED Open Detection Function at Reduced-voltage.
V_{OP}	is the VOP pin voltage.
V_{ZD_OP}	is the characteristic Zener voltage of diode Z_{D_OP} (chosen based on output voltage).
R_{VOP1}	is the LED Open Detection Threshold Setting Resistor 1.
R_{VOP2}	is the LED Open Detection Threshold Setting Resistor 2.





1 Operation mode description – continued

1.7 Short Circuit Protection Mode (SCP)

When voltage drop across R_{SE} rises above a certain value, short circuit is detected.
When short circuit is detected, the MOSFET connected to the OUT pin is turned off to prevent overcurrent from flowing into the IC. The Short Circuit Protection condition can be calculated by the following formula.

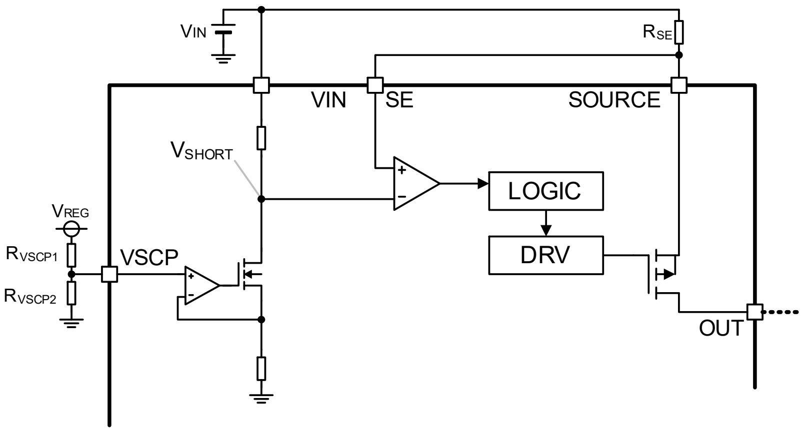
$$V_{IN\_SE} > V_{SHORT}$$

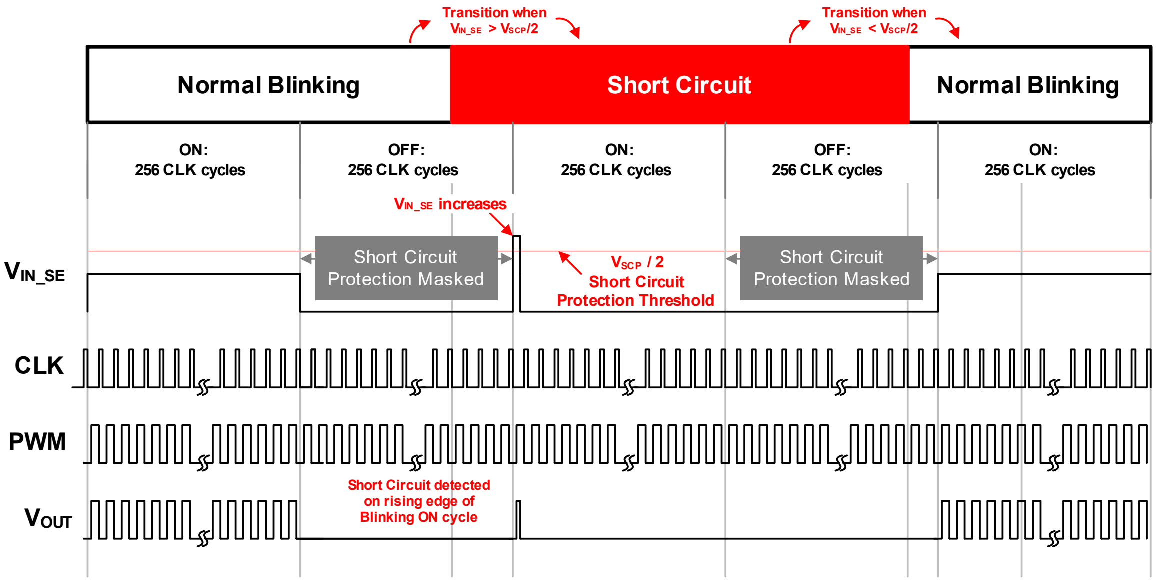
$$V_{SHORT} = \frac{V_{SCP}}{2}$$

$$V_{SCP} = V_{REG} \times \frac{R_{VSCP2}}{R_{VSCP1}+R_{VSCP2}}$$

where:

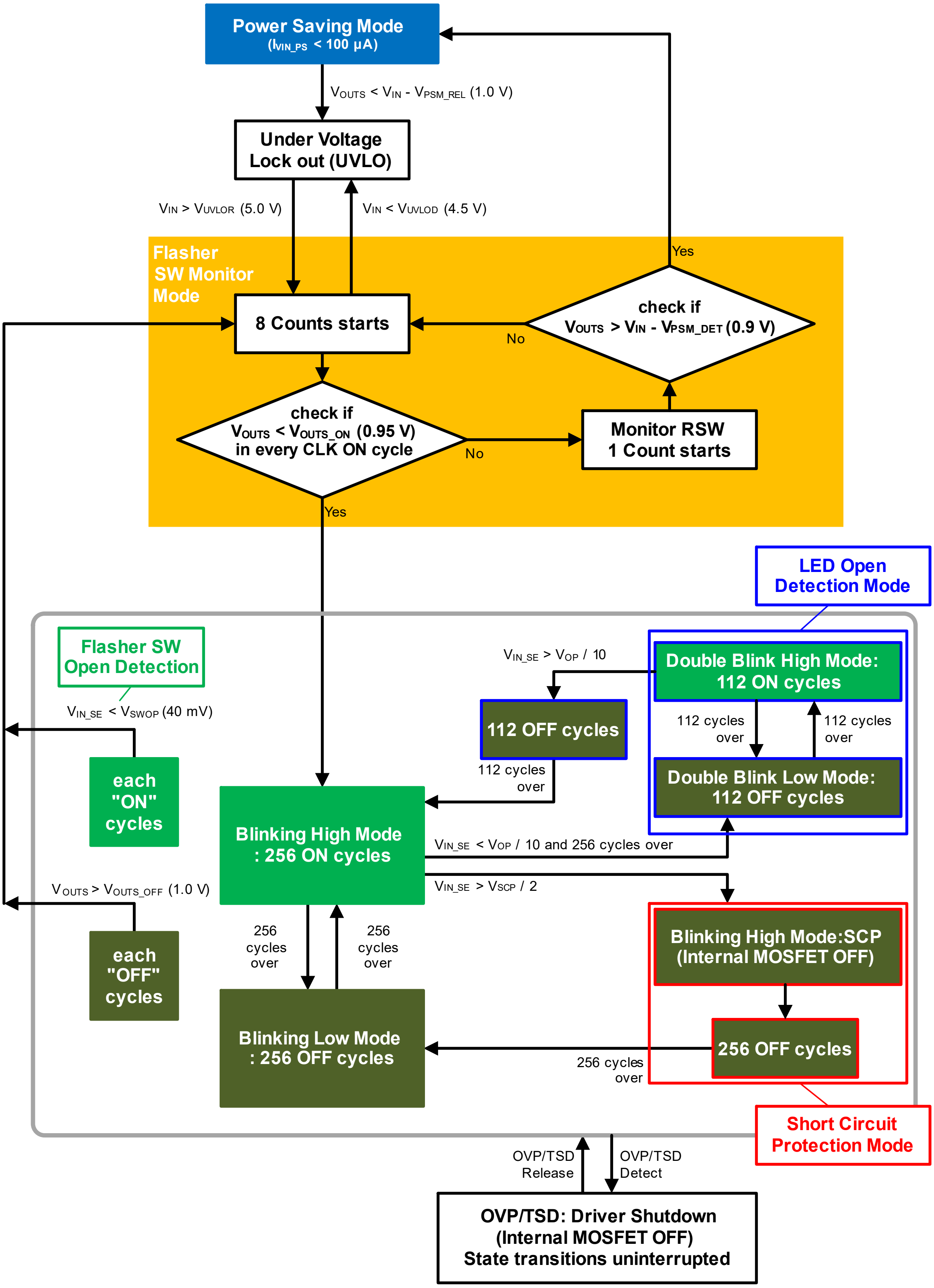
V_{IN_SE}	is the VIN to SE voltage.
V_{SHORT}	is the Short Circuit Protection Threshold Voltage .
V_{SCP}	is the VSCP pin voltage.
R_{VSCP1}	is the SCP Threshold Setting Resistor 1.
R_{VSCP2}	is the SCP Threshold Setting Resistor 2.





Description of Blocks – continued

2 State Transition Diagram



Description of Blocks – continued

3 CR Timer

This IC determines the flasher cycle from the internal clock generated by CR timer. The CR timer period, ON Duty, can be set by the external resistor R_{CRT1}, R_{CRT2} and the capacitance C_{CRT}.

(1) CRT ramp up Time t_1 and CRT ramp down Time t_2
CRT ramp up Time t_1 and CRT ramp down Time t_2 can be defined from the following equations.
Make sure that t_2 is set PWM Minimum Pulse Width t_{MIN} (100 µs) or more.

$$t_1 = \frac{(R_{CRT1}+R_{CRT2})\times C_{CRT}}{N_{CHA}} \quad [s]$$

$$t_2 = \frac{(R_{CRT2}+R_D)\times C_{CRT}}{N_{DIS}} \quad [s]$$

When $R_{CRT2} >> R_D$

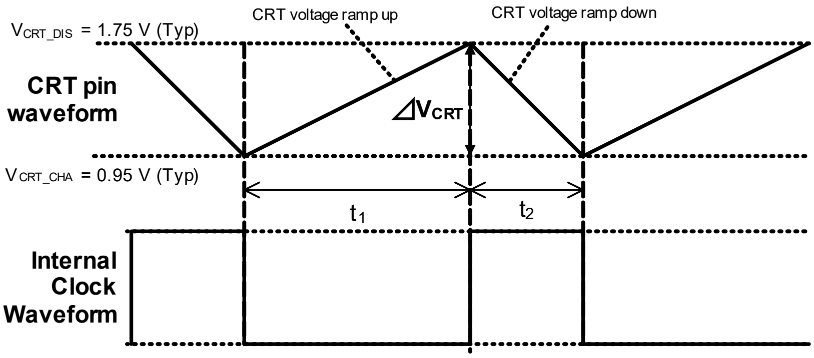
$$t_2 = \frac{R_{CRT2}\times C_{CRT}}{N_{DIS}} \quad [s]$$

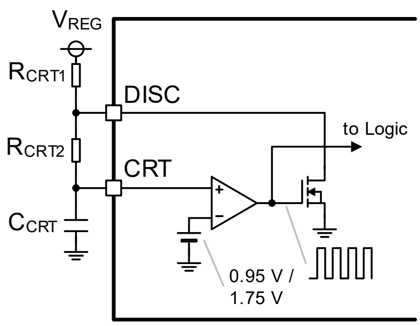
where:
R_{CRT1} is the CR Timer Time Setting Resistor 1.
R_{CRT2} is the CR Timer Time Setting Resistor 1.
R_D is the DISC Pin ON Resistance.
C_{CRT} is the CR Timer Time Setting Capacitor.
N_{CHA} is the CR Timer Charge Constant.
N_{DIS} is the CR Timer Discharge Constant.

(2) Internal clock frequency f_{CLK} and ON Duty D_{ON}
Internal clock frequency and internal clock ON Duty is defined by t_1 and t_2.

$$f_{CLK} = \frac{1}{t_1+t_2} \quad [Hz]$$

$$D_{ON} = \frac{t_2}{t_1+t_2} \quad [\%]$$





Description of Blocks – continued

4 Output PWM ON Duty Control during high input voltage

This IC has built in Output PWM ON Duty Control during high input voltage which protects the output LEDs.
VDR pin voltage which is generated externally by dividing VIN pin voltage is compared with CRT pin voltage to generate PWM signal. When VDR > VCRT, the internal MOSFET for Blinking High Mode is turned off and the increase in average current flowing to the LED can be reduced.

Output PWM ON Duty D_{ON_PWM} is represented by following expression.

$$D_{ON} = \frac{V_{CRT\_DIS} - V_{DR}}{V_{CRT\_DIS} - V_{CRT\_CHA}} \; [\%]$$

$$V_{DR} = V_{IN} \times \frac{R_{VDR2}}{R_{VDR1} + R_{VDR2}} \; [\%]$$

where:

V_{CRT_DIS}	is the CRT Pin Discharge Voltage.
V_{CRT_CHA}	is the CRT Pin Charge Voltage.
V_{DR}	is the VDR pin voltage.
V_{IN}	is the VIN pin voltage.
R_{VDR1}	is the Output ON Duty Setting Resistor 1.
R_{VDR2}	is the Output ON Duty Setting Resistor 2.

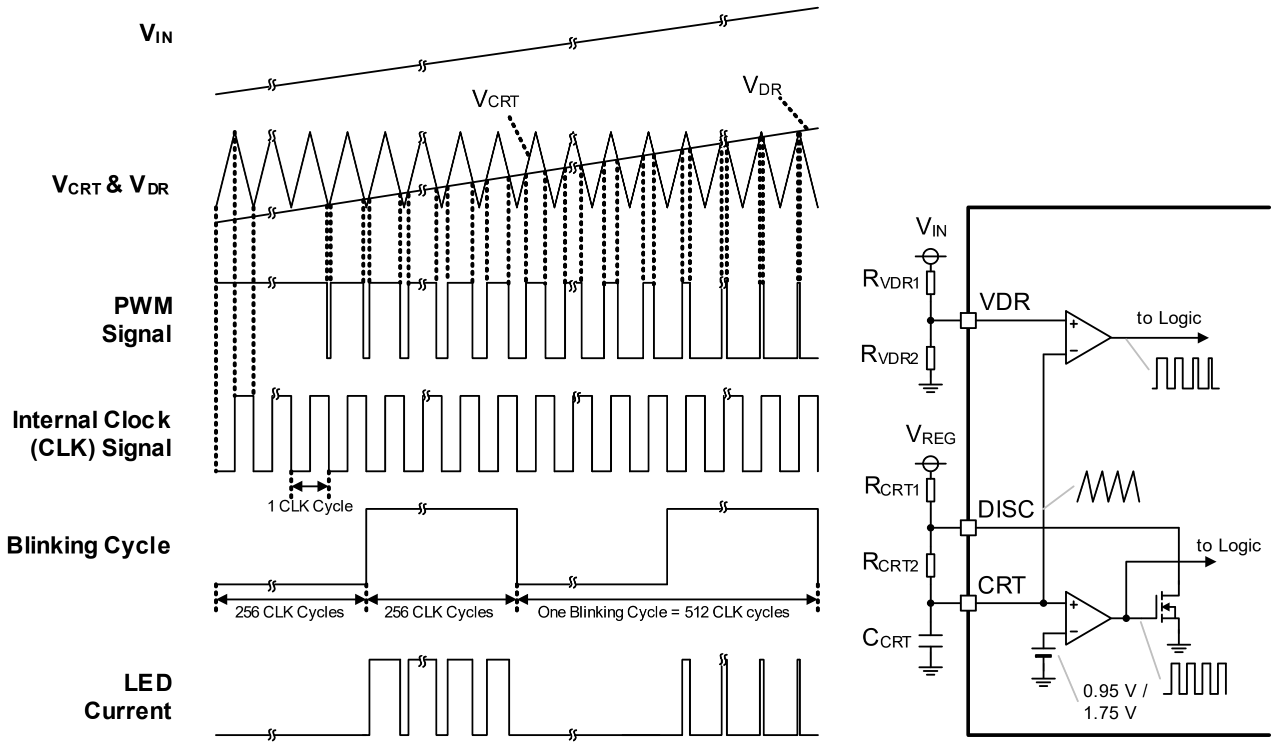
However,

$V_{DR} \le V_{CRT\_CHA}$: ON Duty = 100 %
$V_{DR} \ge V_{CRT\_DIS}$: ON Duty = 0 %

Make sure to connect resistors for voltage division of VIN to fix the voltage on the VDR pin as shown in figure.

Example-
For R_{VDR1} = 47 kΩ and R_{VDR2} = 3.4 kΩ
When V_{IN} = 14 V, V_{DR} = 0.944 V & ON Duty = 100 %
When V_{IN} = 18 V, V_{DR} = 1.214 V & ON Duty = 66 %

So as VIN increases the PWM duty cycle decreases.



Description of Blocks – continued

5 Reference Voltage (VREG)

Reference voltage VREG 5.0 V (Typ) is generated from VIN input voltage. This voltage is used as power source for the internal circuit, and also used to fix the voltage of pins outside LSI to HIGH side. The VREG pin must be connected with C_{VREG} = 1.0 µF to 10 µF to ensure capacity for the phase compensation. If C_{VREG} is not connected, the circuit behavior would become extraordinarily unstable, for example with the oscillation of the reference voltage.
The VREG pin voltage must not be used as power source for other devices than this LSI.
VREG circuit has a built-in UVLO function. The IC is activated when the VREG pin voltage rises to 3.5 V (Typ) or higher, and shuts down when the VREG pin voltage drops to 2.0 V (Typ) or lower.

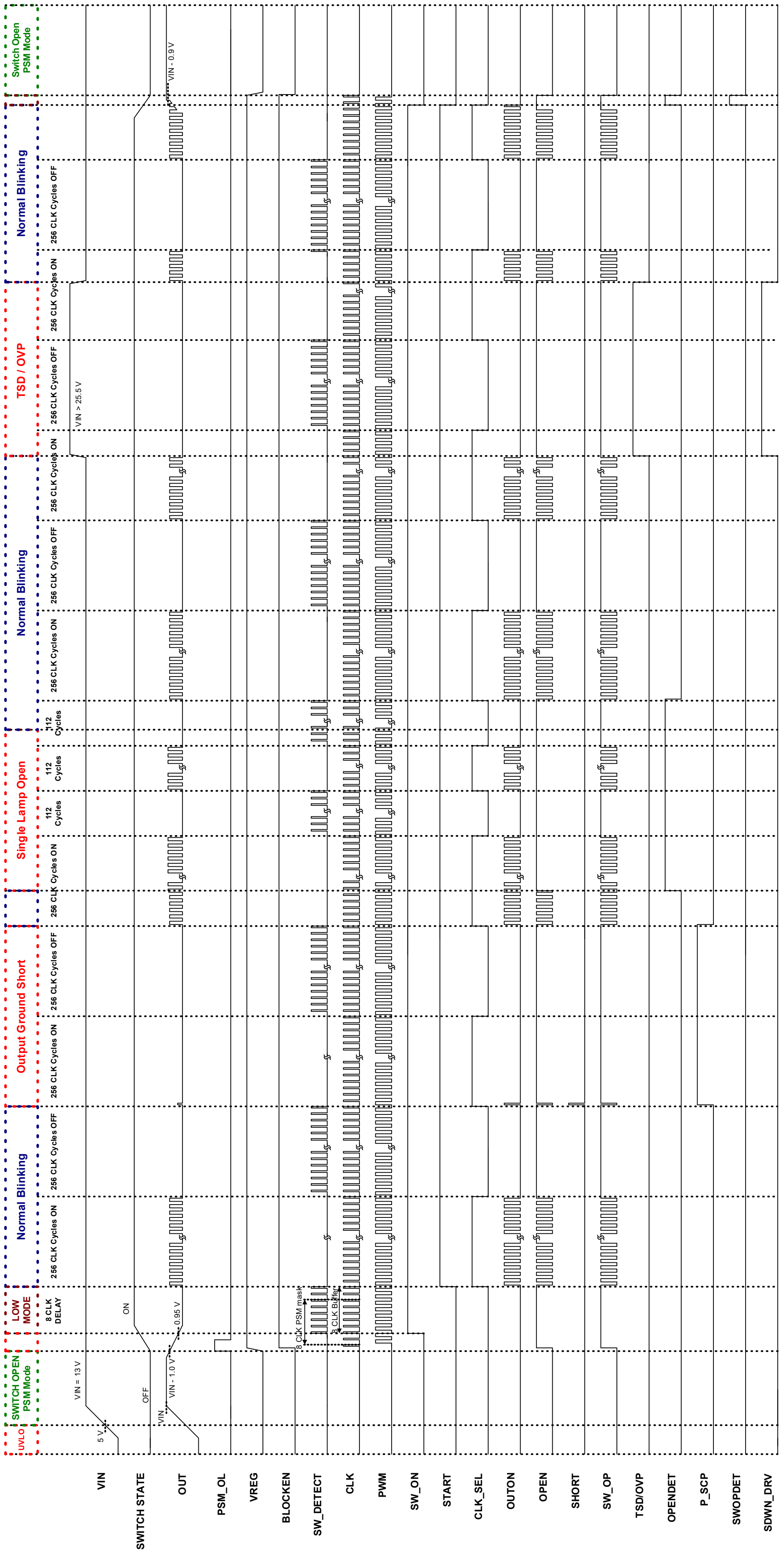
6 Under Voltage Lock-Out (UVLO)

This IC has built-in under voltage lock-out function (UVLO).
For VIN ramp-up UVLO is active till VIN = 5.0 V (Typ). For VIN ramp down UVLO gets active when VIN = 4.5 V (Typ).
UVLO shuts down all circuit blocks other than regulator (VREG) block.
UVLO is also dependent on VREG voltage. At ramp-up UVLO is released when VREG > 3.5 V and at ramp down UVLO is enabled when VREG = 2.0 V.

7 Over Voltage protection (OVP)

This LSI has a function to turn off output and prevent deterioration of load when VIN Pin voltage exceeds 25.5 V (Typ).
When OVP is detected, after the supply voltage drops more than hysteresis width of 500 mV (Typ) below OVP, it returns to normal state.

Timing Chart



Absolute Maximum Ratings (Ta = 25 °C)

Parameter	Symbol	Rating	Unit
VIN Voltage	V_{IN}	-0.3 to +50.0	V
SOURCE, SE, SSE, OUT, OUTS, PSSW, VDR, VOP Voltage	V_{SOURCE}, V_{SE}, V_{SSE}, V_{OUT}, V_{OUTS}, V_{PSSW}, V_{DR}, V_{OP}	-0.3 to +V_{IN}+0.3 V	V
VIN to SOURCE, VIN to SE, VIN to SSE Voltage	V_{IN_SOURCE}, V_{IN_SE}, V_{IN_SSE}	-0.3 to +5.0	V
VREG Voltage	V_{REG}	-0.3 to +7.0	V
DISC, CRT, VSCP, TEST Voltage	V_{DISC}, V_{CRT}, V_{SCP}, V_{TEST}	-0.3 to V_{REG}+0.3 V	V
Storage Temperature Range	Tstg	-55 to +150	°C
Maximum Junction Temperature	Tjmax	150	°C

Caution 1: *Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.*

Caution 2: *Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

Thermal Resistance *(Note 1)*

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s *(Note 3)*	2s2p *(Note 4)*	
HTSSOP-B20				
Junction to Ambient	θ_{JA}	103.50	31.40	°C/W
Junction to Top Characterization Parameter *(Note 2)*	Ψ_{JT}	10.00	4.00	°C/W

(Note 1) Based on JESD51-2A (Still-Air), using a BD18327 Chip.
(Note 2) The thermal characterization parameter to report the difference between junction temperature and the temperature at the top centre of the outside surface of the component package.
(Note 3) Using a PCB board based on JESD51-3.
(Note 4) Using a PCB board based on JESD51-5, 7.

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	114.3 mm x 76.2 mm x 1.57 mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	70 µm

Layer Number of Measurement Board	Material	Board Size	Thermal Via *(Note 5)*	
			Pitch	Diameter
4 Layers	FR-4	114.3 mm x 76.2 mm x 1.6 mmt	1.20 mm	Φ0.30 mm

Top		2 Internal Layers		Bottom	
Copper Pattern	Thickness	Copper Pattern	Thickness	Copper Pattern	Thickness
Footprints and Traces	70 µm	74.2 mm x 74.2 mm	35 µm	74.2 mm x 74.2 mm	70 µm

(Note 5) This thermal via connects with the copper pattern of all layers.

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage(Note 1)	V_{IN}	6.0	13.0	18.0	V
OUT Pin Maximum Output Current	I_{OUT_MAX}	-	-	1.5	A
PWM Minimum Pulse Width	t_{MIN}	100	-	-	μs
PWM Frequency	f_{PWM}	150	-	1000	Hz
Operating Temperature	Topr	-40	-	+125	°C

(Note 1) ASO should not be exceeded.

Recommended Setting Parts Range

Parameter	Symbol	Min	Max	Unit
Power Supply Input Capacitor	C_{VIN}	1.0	10.0	μF
Reference Voltage Output Pin Capacitor	C_{VREG}	1.0	10.0	μF
Constant Current Setting Resistor	R_{SSE}	0.04	10	kΩ
Output Current Sense Resistor	R_{SE}	0.065	10	Ω
CR Timer Time Setting Resistor 1	R_{CRT1}	1.0	100	kΩ
CR Timer Time Setting Resistor 2	R_{CRT2}	1.0	100	kΩ
CR Timer Time Setting Capacitor	C_{CRT}	0.01	1.00	μF
SCP Threshold Setting Resistor 1	R_{VSCP1}	10	100	kΩ
SCP Threshold Setting Resistor 2	R_{VSCP2}	4.7	100	kΩ
LED Open Detection Threshold Setting Resistor 1	R_{VOP1}	10	100	kΩ
LED Open Detection Threshold Setting Resistor 2	R_{VOP2}	4.7	100	kΩ
Output PWM ON Duty Setting Resistor 1	R_{VDR1}	4.7	100	kΩ
Output PWM ON Duty Setting Resistor 2	R_{VDR2}	4.7	100	kΩ

Electrical Characteristics
(Unless otherwise specified V_{IN} = 13 V Ta = -40 °C to + 125 °C, C_{VREG} = 4.7 µF)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Circuit Current at Normal Mode	I_{VIN_NOM}	-	-	10	mA	
Circuit Current at Power Saving Mode	I_{VIN_PS}	-	-	100	µA	OUT: OPEN
[VREG]						
Reference Voltage	V_{REG}	4.750	5.000	5.250	V	I_L = 2 mA
[Current Driver for Low Mode]						
SSE Pin Feedback Voltage	V_{SSE_FB}	-	0.95	-	V	
[Flasher SW Resistance Monitor Mode]						
Blinking ON Threshold Voltage	V_{OUTS_ON}	-	0.95	-	V	V_{OUTS} = Sweep down
Blinking OFF Threshold Voltage	V_{OUTS_OFF}	-	1.00	-	V	V_{OUTS} = Sweep up
Blinking ON Threshold Constant	K_{BLON}	0.95	1.00	1.05	-	$K_{BLON} = V_{OUTS\_ON} / V_{SSE\_FB}$
Blinking OFF Threshold Constant	K_{BLOFF}	1.00	1.05	1.11	-	$K_{BLOFF} = V_{OUTS\_OFF} / V_{SSE\_FB}$
[Power Saving Mode]						
Power Saving Mode Release Threshold	V_{PSM_REL}	0.5	1.0	1.5	V	V_{OUT} = Sweep down
Power Saving Mode Detect Threshold	V_{PSM_DET}	0.4	0.9	1.4	V	V_{OUT} = Sweep up
Power Saving Mode Internal Resistance	R_{PSM}	8	15	21	kΩ	
[Output Section]						
OUT Pin ON Resistance for High Mode	R_{ON_OUT}	-	0.4	0.8	Ω	I_{OUT} = 0.5 A
OUT Pin ON Resistance for Low Mode	R_{LON_OUT}	-	10	-	Ω	I_{OUT} = 20 mA
OUT Pin Leakage Current	I_{LEAK_OUT}	-	-	10	µA	V_{OUT} = 13 V
[CR Timer Section]						
CRT Pin Charge Voltage	V_{CRT_CHA}	V_{REG} x 0.18	V_{REG} x 0.19	V_{REG} x 0.20	V	V_{CRT} = Sweep down
CRT Pin Discharge Voltage	V_{CRT_DIS}	V_{REG} x 0.33	V_{REG} x 0.35	V_{REG} x 0.37	V	V_{CRT} = Sweep up
DISC Pin ON Resistance	R_D	-	10	20	Ω	I_L = 10 mA
CR Timer Charge Constant	N_{CHA}	4.31	4.54	4.77	-	
CR Timer Discharge Constant	N_{DIS}	1.55	1.64	1.73	-	
[COUNTER Section]						
Flasher SW Resistance Detection Circuit Count Number	N_{COUNT}	7	-	10	-	
Blinking Cycle Time at Normal Mode	T_{BL_NOM}	1 / f_{CLK} x 511	1 / f_{CLK} x 512	1 / f_{CLK} x 513	s	
Blinking Cycle Time at LED Open Detection	T_{BL_LEDOP}	1 / f_{CLK} x 223	1 / f_{CLK} x 224	1 / f_{CLK} x 225	s	
Blinking ON Duty	D_{ON}	49	50	51	%	

Electrical Characteristics - continued
(Unless otherwise specified V_{IN} = 13 V Ta = -40 °C to + 125 °C, C_{VREG} = 4.7 µF)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
[PSSW Section]						
PSSW ON Resistance	R_{PSSW}	-	4	10	Ω	I_{PSSW} = 30 mA
[LED Open Detection/ Short Circuit Protection]						
Disable LED Open Detection Function at Reduced-voltage	V_{IN_OPM}	7.85	8.25	8.65	V	V_{IN} = Sweep down Detect
		8.00	8.45	8.90	V	V_{IN} = Sweep up Release
		-	0.20	-	V	V_{IN} Hysteresis
VOP Pin Input Voltage Range	V_{OP_RANGE}	1.0	-	V_{IN} – 4.0	V	V_{IN} < 14 V
		1.0	-	10.0	V	V_{IN} > 14 V
VSCP Pin Input Voltage Range	V_{SCP_RANGE}	1.0	-	2.5	V	
LED Open Detection Threshold Voltage 1	V_{OPEN1}	(V_{OP} /10) - 5	V_{OP} /10	(V_{OP} /10) + 5	mV	V_{IN_SE} = Sweep down V_{OP} ≤ 2.5 V
LED Open Detection Threshold Voltage 2	V_{OPEN2}	(V_{OP} /10) - 6.5	V_{OP} /10	(V_{OP} /10) + 6.5	mV	V_{IN_SE} = Sweep down V_{OP} > 2.5 V
Flasher SW Open Detection Threshold Voltage	V_{SWOP}	27	40	53	mV	V_{IN_SE} = Sweep down
Short Circuit Protection Threshold Voltage	V_{SHORT}	V_{SCP}/2 -0.065	V_{SCP}/2	V_{SCP}/2 +0.065	V	V_{IN_SE} = Sweep up
[VIN UVLO]						
UVLO VIN Detect Voltage	V_{UVLOD}	4.0	4.5	5.0	V	V_{IN} = Sweep down
UVLO VIN Release Voltage	V_{UVLOR}	4.5	5.0	5.5	V	V_{IN} = Sweep up, V_{REG} > 3.5 V
[Overvoltage Protection]						
Over Voltage Protection Threshold Voltage	V_{OVP}	22.95	25.50	28.05	V	V_{IN} = Sweep up
Over Voltage Protection Hysteresis Voltage	V_{OVPHYS}	250	500	750	mV	V_{IN} = Sweep down

Typical Performance Curve
(Unless otherwise specified V_{IN} = 13 V Ta = -40 °C to + 125 °C, C_{VREG} = 4.7 µF)

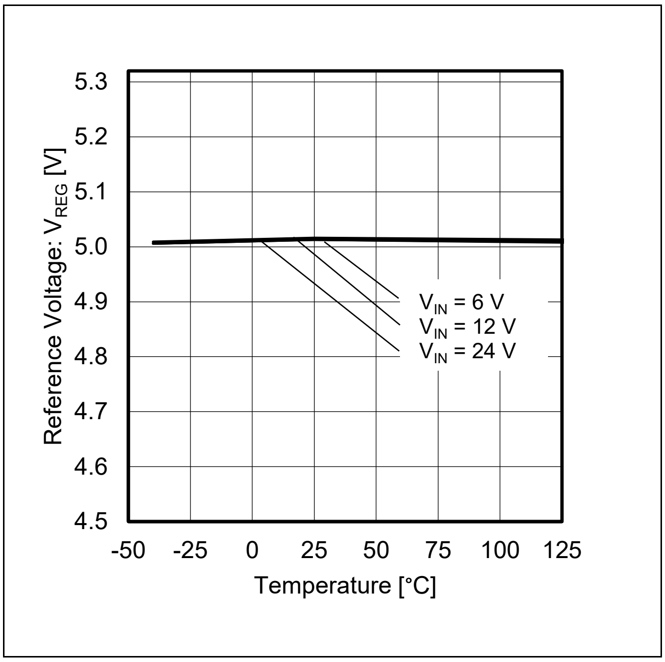


Figure 1. Reference Voltage vs Temperature

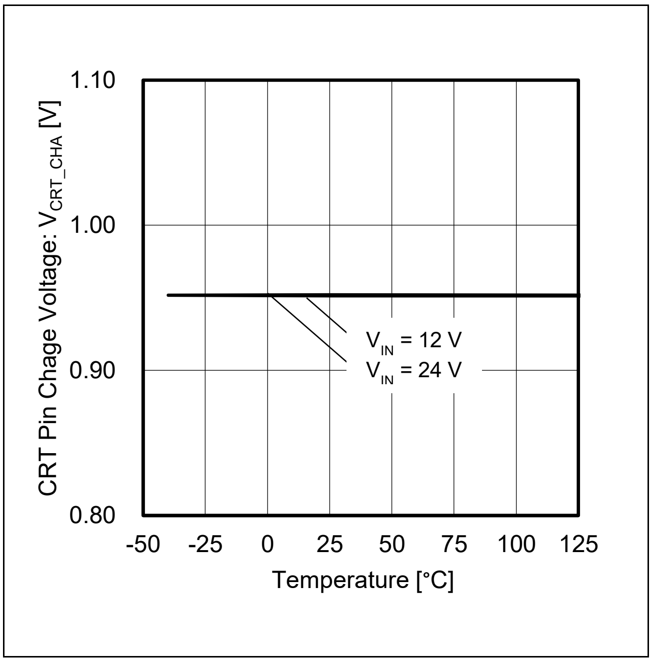


Figure 2. CRT Pin Charge Voltage vs Temperature

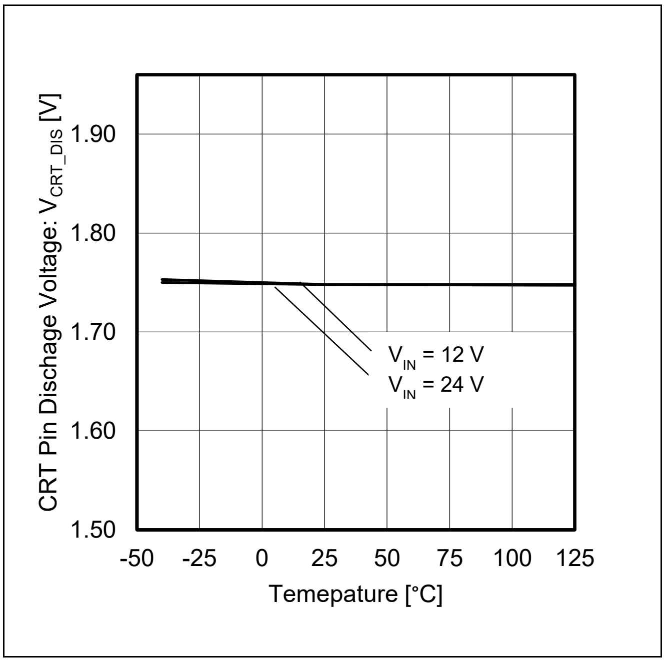


Figure 3. CRT Pin Discharge Voltage vs Temperature

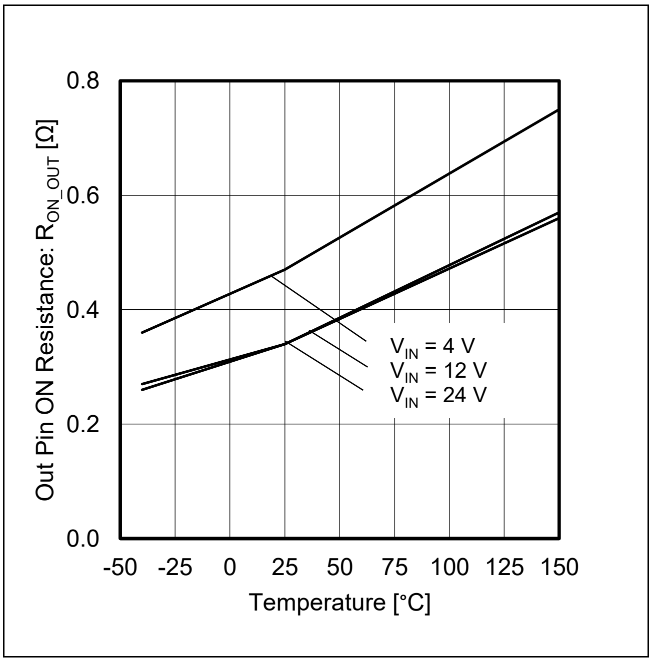


Figure 4. Out Pin ON Resistance for High Mode vs Temperature

Typical Performance Curve - continued

(Unless otherwise specified V_{IN} = 13 V Ta = -40 °C to + 125 °C, C_{VREG} = 4.7 µF)

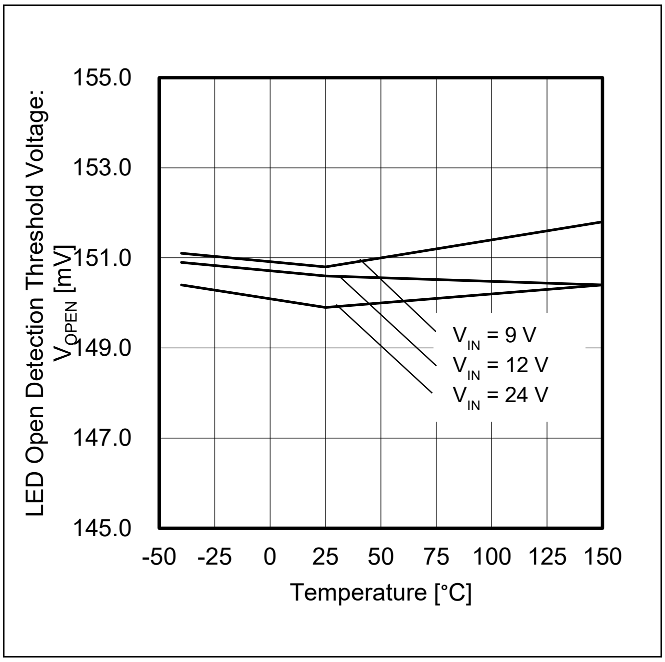


Figure 5. LED Open Detection Threshold Voltage at V_{OP} = 1.5 V, V_{OPEN} = 150 mV vs Temperature

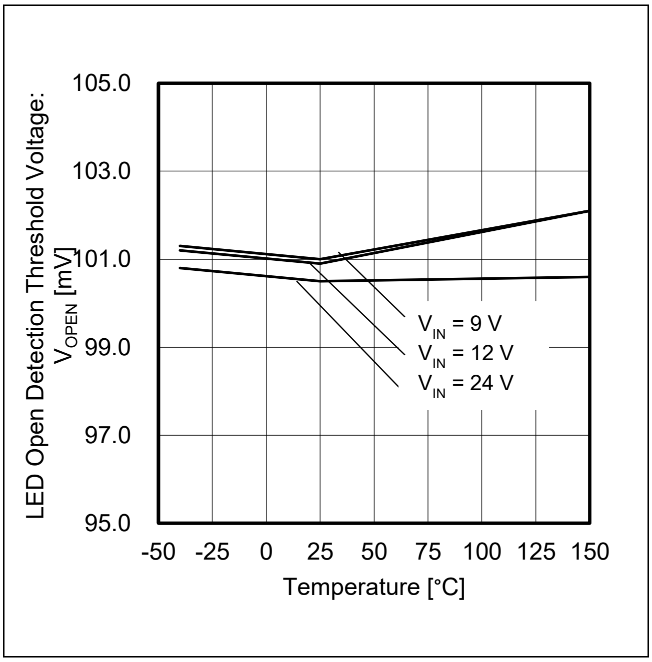


Figure 6. LED Open Detection Threshold Voltage at V_{OP} = 1.0 V, V_{OPEN} = 100 mV vs Temperature

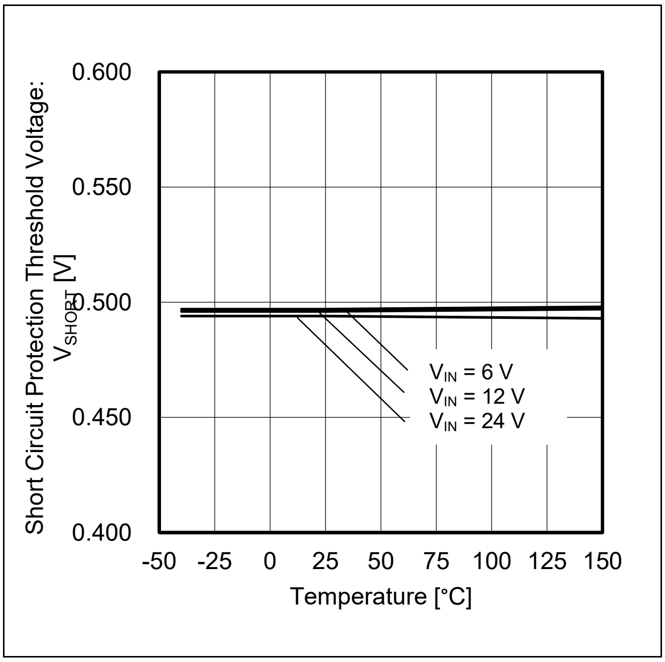


Figure 7. Short Circuit Protection Threshold Voltage at V_{SCP} = 1.0 V, V_{SHORT} = 0.500 V vs Temperature

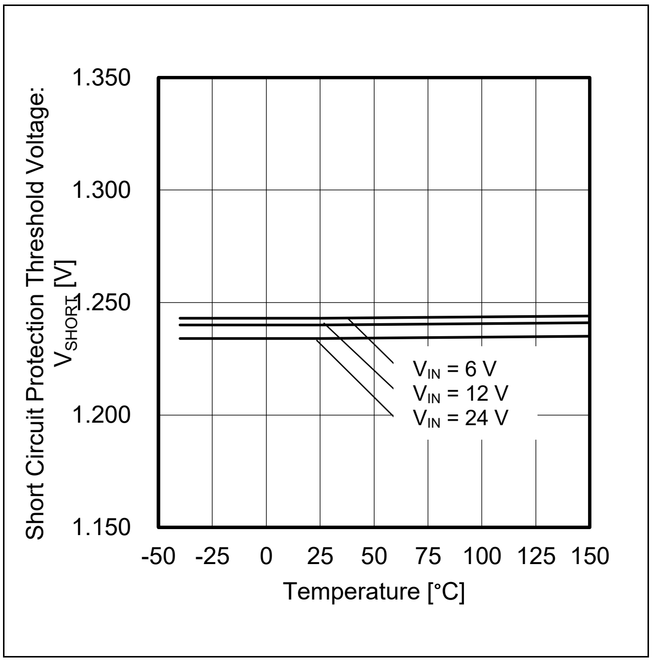
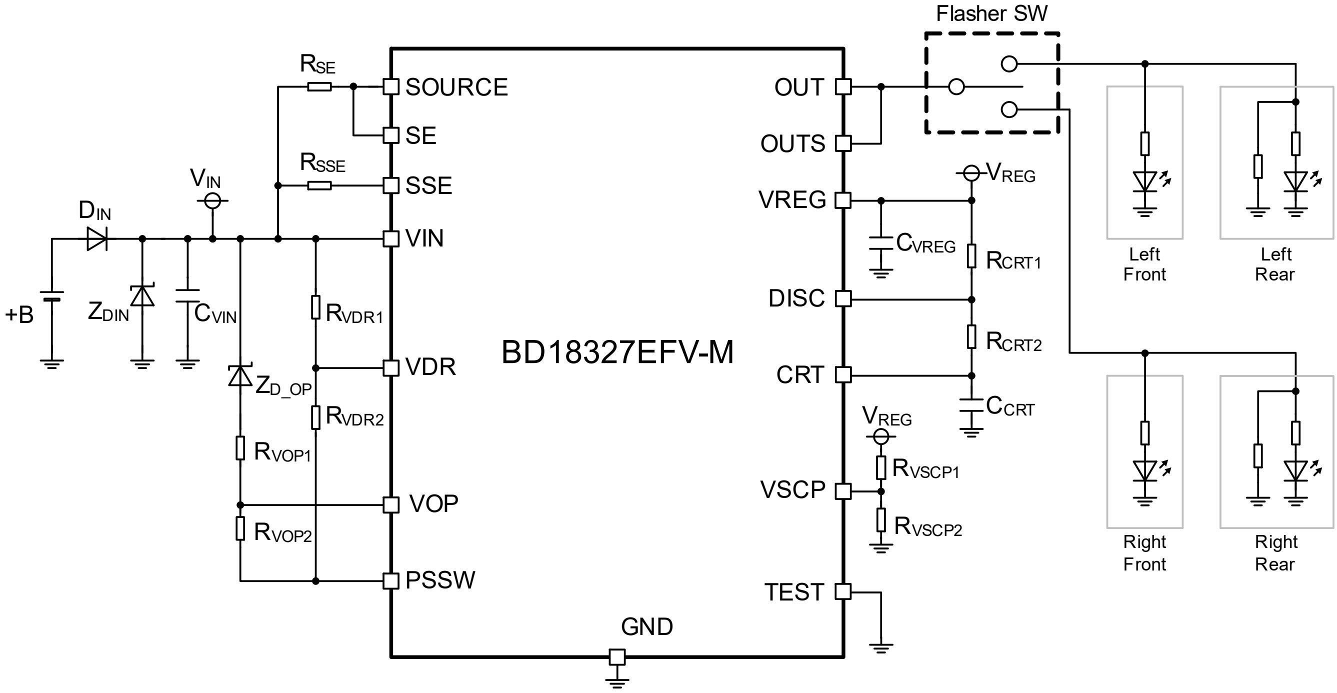


Figure 8. Short Circuit Protection Threshold Voltage at V_{SCP} = 2.5 V, V_{SHORT} = 1.250 V vs Temperature

Application Example

VIN = 13 V, CLK frequency 763 Hz (duty = 100 %), Blinking frequency: 1.49 Hz, I_{OUT} = 687 mA



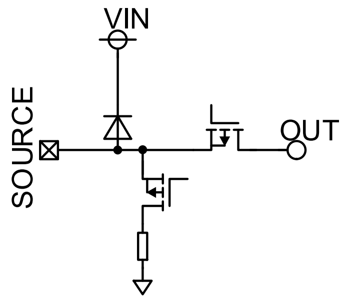
Recommended Parts List:

Parts	No	Parts Name	Value	UNIT	Product Maker
IC	U1	BD18327EFV-M	-	-	ROHM
Diode	D_{IN}	RFN2LAM6STFTR	-	-	ROHM
	Z_{DIN}	TND12H-220KB00AAA0	43	V	NIPPON CHEMICON
	Z_{D_OP}	EDZVFH3.6B	3.6	V	ROHM
Resistor	R_{SE}	LTR100JZPFLR510	0.51	Ω	ROHM
	R_{SSE}	MCR03EZPFX3600	360	Ω	ROHM
	R_{VDR1}	MCR03EZPFX6802	68	kΩ	ROHM
	R_{VDR2}	MCR03EZPFX5101	5.1	kΩ	ROHM
	R_{CRT1}	MCR03EZPFX4702	47	kΩ	ROHM
	R_{CRT2}	MCR03EZPFX3301	3.3	kΩ	ROHM
	R_{VSCP1}	MCR03EZPFX3002	30	kΩ	ROHM
	R_{VSCP2}	MCR03EZPFX1002	10	kΩ	ROHM
	R_{VOP1}	MCR03EZPFX2402	24	kΩ	ROHM
	R_{VOP2}	MCR03EZPFX1002	10	kΩ	ROHM
Capacitor	C_{VIN}	GCM31CC71H475KA03	4.7	µF	murata
	C_{VREG}	GCM188C71A225KE01	2.2	µF	murata
	C_{CRT}	GCM155R11A104KA01	0.1	µF	murata

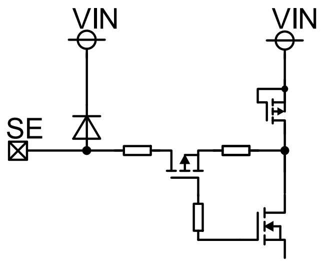
Precautions for board design
① Place C_{VIN}, C_{VREG} in the immediate vicinity of the IC pin. If necessary, connect a bypass capacitor (0.1 µF) close to the IC.
② Select the optimum one for D1 according to the output current.

I/O Equivalence Circuit

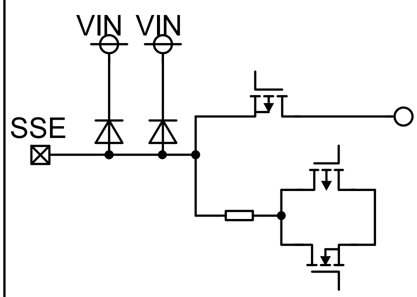
1. SOURCE



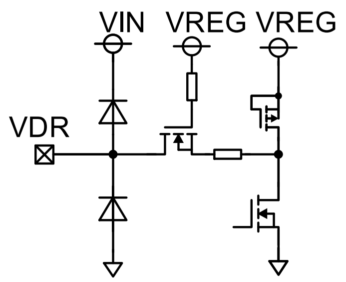
2 . SE



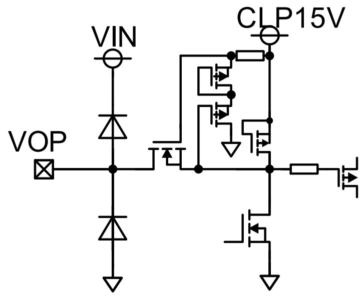
4 . SSE



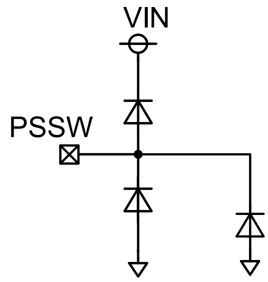
8. VDR



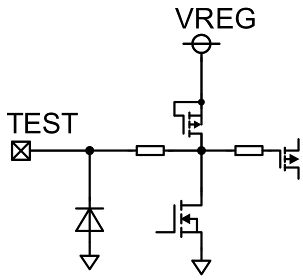
9. VOP



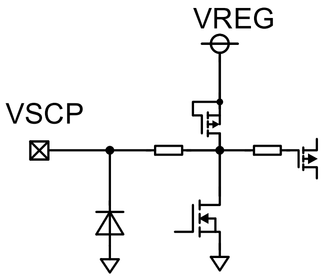
10. PSSW



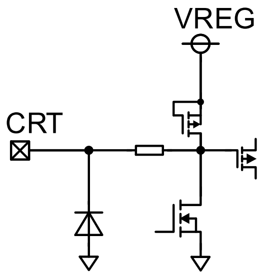
12. TEST



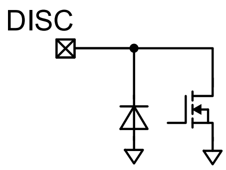
13 . VSCP



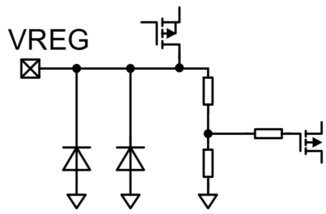
14 . CRT



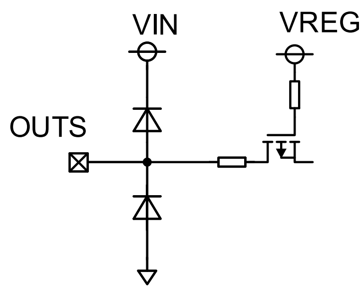
15. DISC



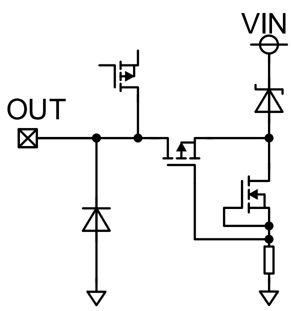
17. VREG



19. OUTS



20. OUT



Operational Notes

1. **Reverse Connection of Power Supply**
Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2. **Power Supply Lines**
Design the PCB layout pattern to provide low impedance supply lines. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Recommended Operating Conditions**
The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **Inrush Current**
When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

7. **Testing on Application Boards**
When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

8. **Inter-pin Short and Mounting Errors**
Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

9. **Unused Input Pins**
Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

Operational Notes – continued

10. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

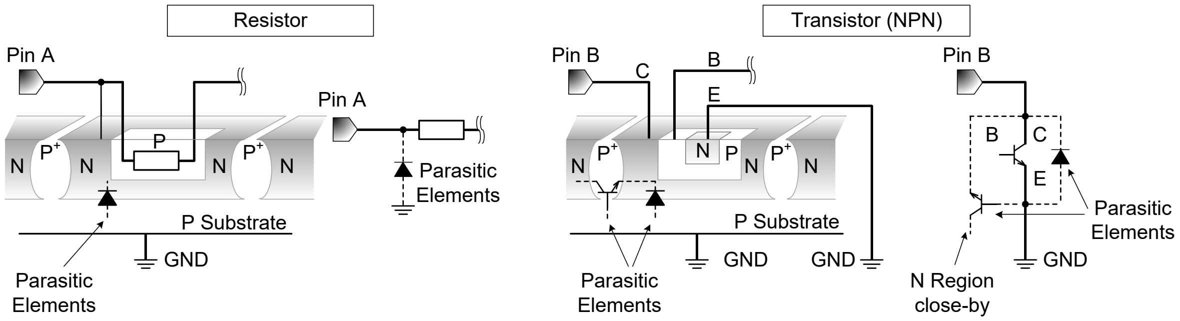


Figure 9. Example of Monolithic IC Structure

11. Ceramic Capacitor

When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

12. Thermal Shutdown Circuit (TSD)

This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF power output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.
Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

13. Functional Safety

"ISO 26262 Process Compliant to Support ASIL-*"
A product that has been developed based on an ISO 26262 design process compliant to the ASIL level described in the datasheet.

"Safety Mechanism is Implemented to Support Functional Safety (ASIL-*)"
A product that has implemented safety mechanism to meet ASIL level requirements described in the datasheet.

"Functional Safety Supportive Automotive Products"
A product that has been developed for automotive use and is capable of supporting safety analysis with regard to the functional safety.

Note: "ASIL-*" is stands for the ratings of "ASIL-A", "-B", "-C" or "-D" specified by each product's datasheet.

Ordering Information

B	D	1	8	3	2	7	E	F	V	-	M	E2

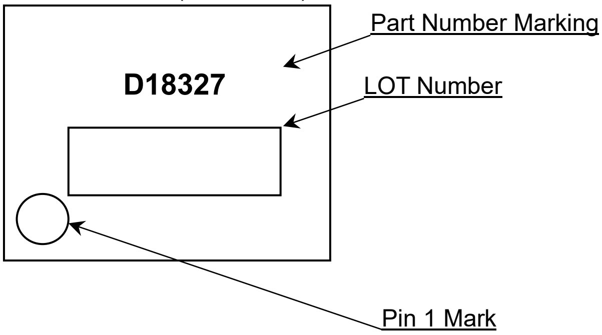
Part Number

Package
EFV: HTSSOP-B20

Packing and Forming Specification
M: For Automotive
E2: Embossed Tape and Reel

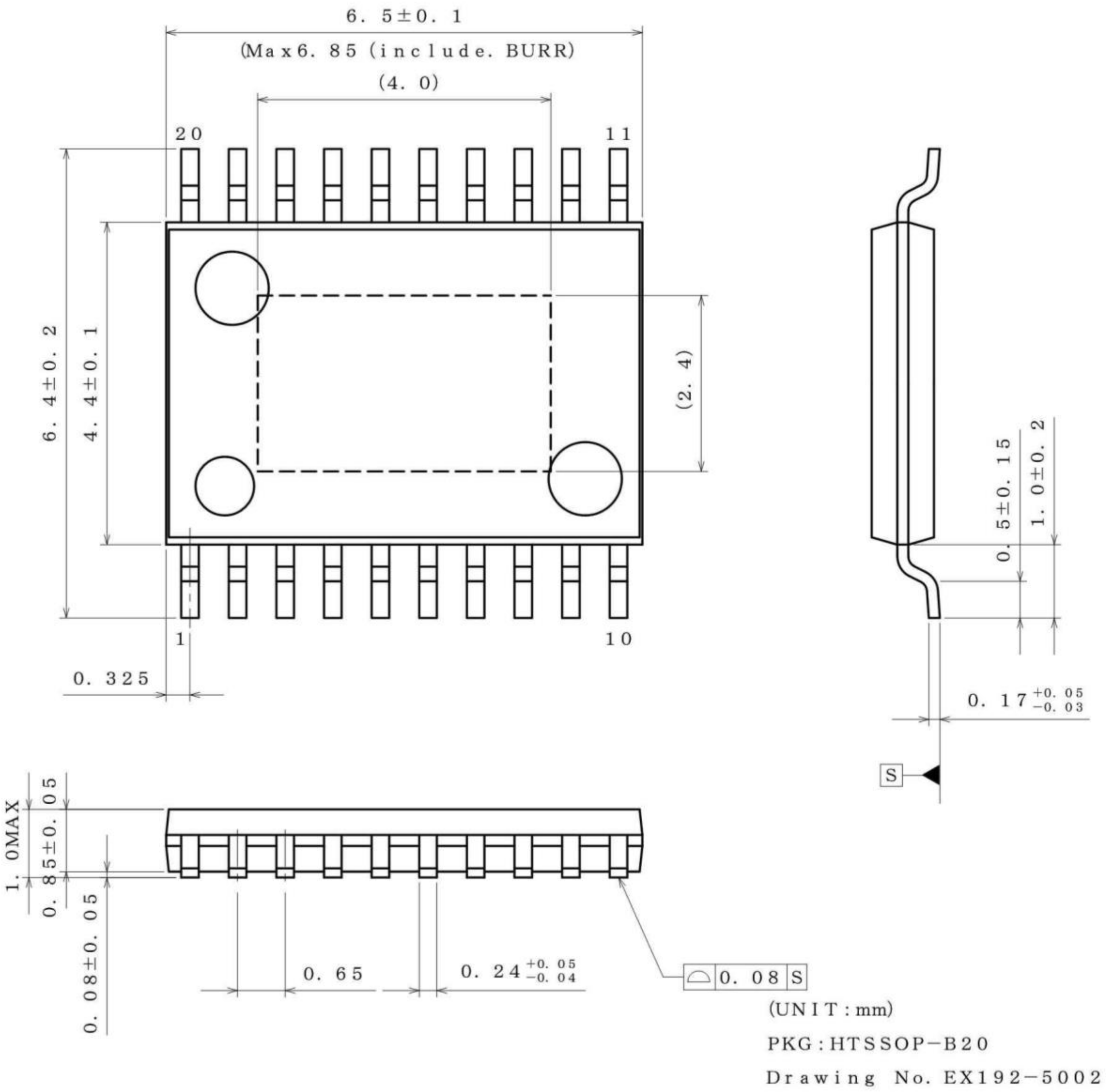
Marking Diagram

HTSSOP-B20 (TOP VIEW)



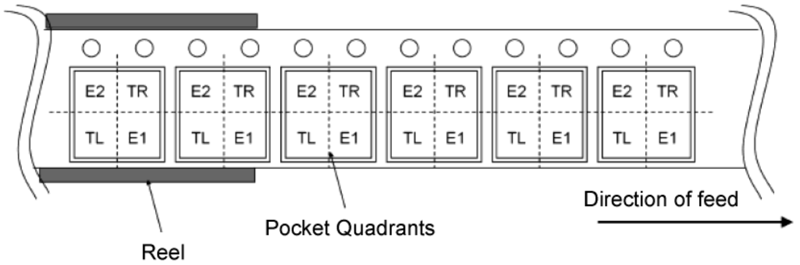
Physical Dimension and Packing Information

Package Name	HTSSOP-B20



< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 The direction is the pin 1 of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand



Revision History

Date	Version	Changes
26.Apr.2021	001	New Release
25.Nov.2021	002	Page.19 Short Circuit Protection Threshold Voltage Change limit: Min = VSCP/2 - 0.100 → VSCP/2 - 0.065 Max = VSCP/2 + 0.100 → VSCP/2 + 0.065

Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

<table>
<tr><th>JAPAN</th><th>USA</th><th>EU</th><th>CHINA</th></tr>
<tr><td>CLASSⅢ</td><td rowspan="2">CLASSⅢ</td><td>CLASSⅡb</td><td rowspan="2">CLASSⅢ</td></tr>
<tr><td>CLASSⅣ</td><td>CLASSⅢ</td></tr>
</table>

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
    [a] Installation of protection circuits or other protective devices to improve system safety
    [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
    [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
    [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
    [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
    [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
    [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
    [f] Sealing or coating our Products with resin or other coating materials
    [g] Use of our Products without cleaning residue of flux (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
    [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights

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2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).
3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

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