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MB39C605

ASSP

Phase Dimmable PSR LED Driver IC for LED Lighting

Data Sheet (Full Production)

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Publication Number MB39C605-DS405-00017 Revision 3.0 Issue Date February 20, 2015

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MB39C605

ASSP

Phase Dimmable PSR LED Driver IC for LED Lighting

Data Sheet (Full Production)

1. Description

MB39C605 is a Primary Side Regulation (PSR) LED driver IC for LED lighting. Using the information of the primary peak current and the transformer-energy-zero time, it is able to deliver a well regulated current to the secondary side without using an opto-coupler in an isolated flyback topology. Operating in critical conduction mode, a smaller transformer is required. In addition, MB39C605 has a built-in phase dimmable circuit and can constitute the lighting system for phase dimming.
It is most suitable for the general lighting applications, for example replacement of commercial and residential incandescent lamps.

2. Features

- PSR topology in an isolated flyback circuit
- High efficiency (>80% : without dimmer) and low EMI by detecting transformer zero energy
- TRAIC Dimmable LED lighting
- Highly reliable protection functions
  - Under voltage lock out (UVLO)
  - Over voltage protection (OVP)
  - Over current protection (OCP)
  - Short circuit protection (SCP)
  - Over temperature protection (OTP)
- Switching frequency setting : 30 kHz to 133 kHz
- Input voltage range VDD : 9V to 20V
- Input voltage for LED lighting applications : $AC110V_{RMS}$, $AC230V_{RMS}$
- Output power range for LED lighting applications : 5W to 10W
- Small Package : SOP-8 (3.9 mm × 5.05 mm × 1.75 mm[Max])

3. Applications

- Phase dimmable (Leading/Trailing) LED lighting
- LED lighting

Online Design Simulation
Easy DesignSim

This product supports the web-based design simulation tool.
It can easily select external components and can display useful information.
Please access from the following URL.
http://www.spansion.com/easydesignsim/

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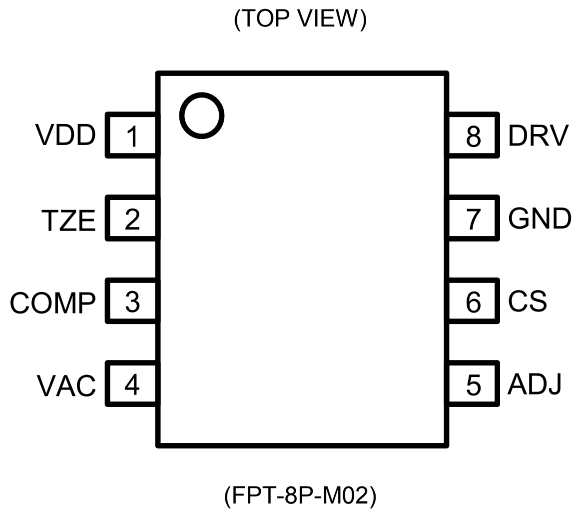
4. Pin Assignment

Figure 4-1 Pin Assignment



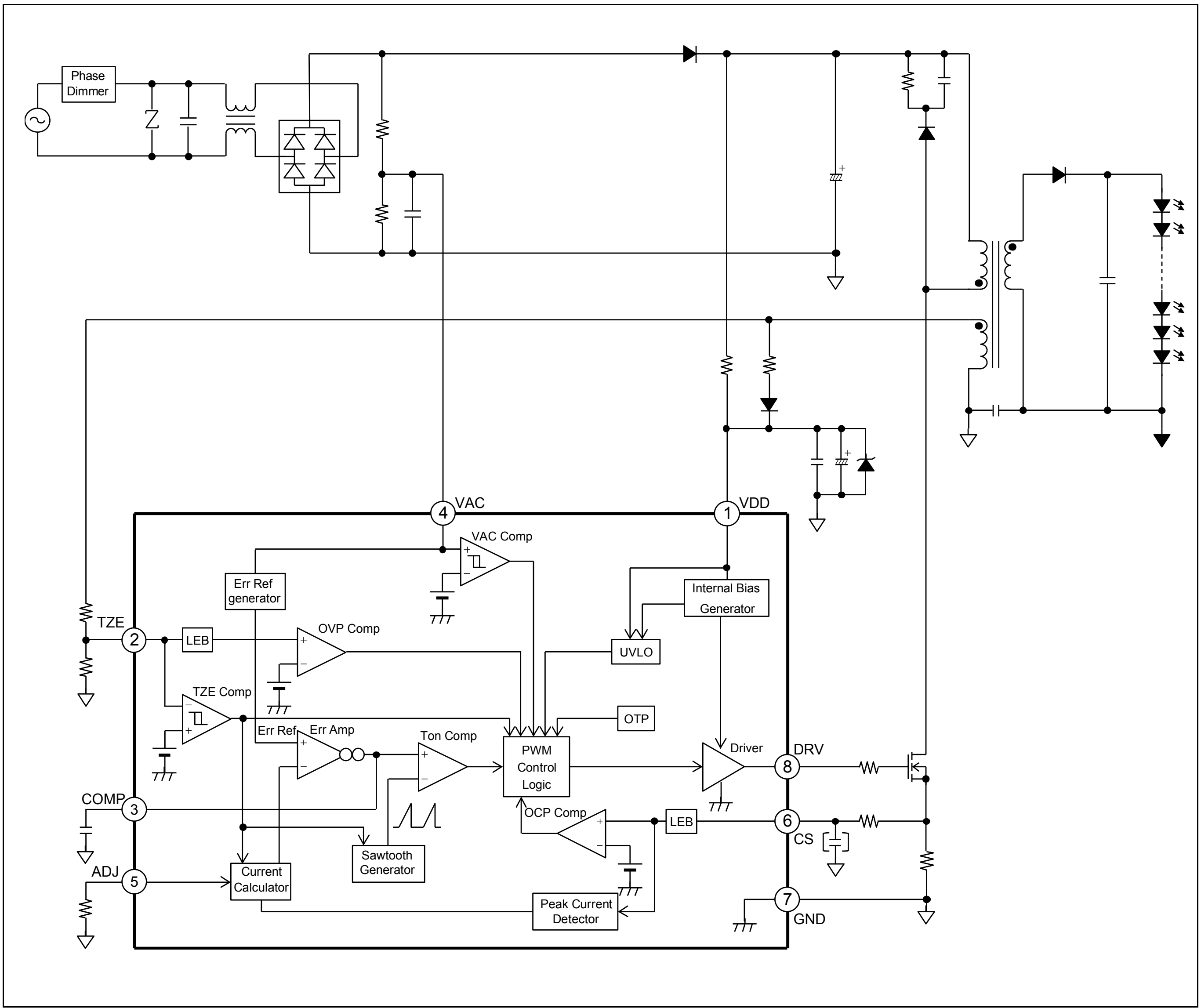
5. Pin Descriptions

Table 5-1 Pin Descriptions

Pin No.	Pin Name	I/O	Description
1	VDD	-	Power supply pin.
2	TZE	I	Transformer Zero Energy detecting pin.
3	COMP	O	External Capacitor connection pin for the compensation.
4	VAC	I	Phase dimming control pin.
5	ADJ	O	Pin for adjusting the switch-on timing.
6	CS	I	Pin for detecting peak current of transformer primary winding.
7	GND	-	Ground pin.
8	DRV	O	External MOSFET gate connection pin.

6. Block Diagram

Figure 6-1 Block Diagram (Isolated Flyback Application)



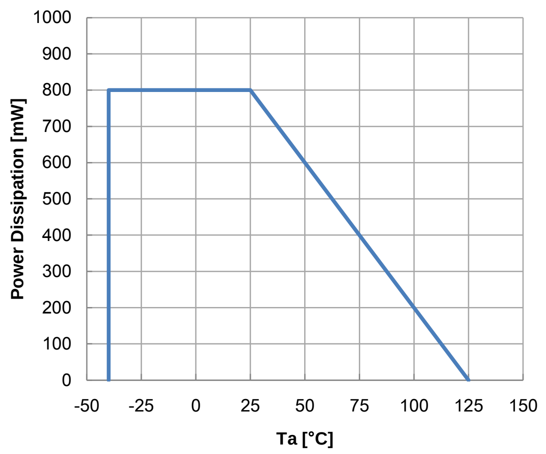
7. Absolute Maximum Ratings

Table 7-1 Absolute Maximum Rating

Parameter	Symbol	Condition	Rating Min	Rating Max	Unit
Power Supply Voltage	V_{VDD}	VDD pin	-0.3	+25	V
Input Voltage	V_{CS}	CS pin	-0.3	+6.0	V
	V_{TZE}	TZE pin	-0.3	+6.0	V
	V_{VAC}	VAC pin	-0.3	+6.0	V
Output Voltage	V_{DRV}	DRV pin	-0.3	+25	V
Output Current	I_{ADJ}	ADJ pin	-1	-	mA
	I_{DRV}	DRV pin DC level	-50	+50	mA
Power Dissipation	P_D	Ta ≤ +25°C	-	800 (*1)	mW
Storage temperature	T_{STG}	-	-55	+125	°C
ESD Voltage 1	V_{ESDH}	Human Body Model	-2000	+2000	V
ESD Voltage 2	V_{ESDC}	Charged Device Model	-1000	+1000	V

*1: The value when using two layers PCB.
Reference: θja (wind speed 0m/s): +125°C/W

Figure 7-1 Power Dissipation



WARNING:

1. *Semiconductor devices may be permanently damaged by application of stress (including, without limitation, voltage, current or temperature) in excess of absolute maximum ratings. Do not exceed any of these ratings.*

8. Recommended Operating Conditions

Table 8-1 Recommended Operating Conditions

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
VDD pin Input Voltage	VDD	VDD pin	9	-	20	V
VAC pin Input Voltage	V_{VAC}	VAC pin After UVLO release	0	-	5	V
VAC pin Input Current	I_{VAC}	VAC pin Before UVLO release	0	-	2.5	μA
TZE pin Resistance	R_{TZE}	TZE pin	50	-	200	kΩ
ADJ pin Resistance	R_{ADJ}	ADJ pin	9.3	-	185.5	kΩ
COMP pin Capacitance	C_{COMP}	COMP pin	-	0.01	-	μF
VDD pin Capacitance	C_{BP}	Set between VDD pin and GND pin	-	4.7	-	μF
Operating Junction Temperature	Tj	-	-40	-	+125	°C

WARNING:

1. *The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated under these conditions.*
2. *Any use of semiconductor devices will be under their recommended operating condition.*
3. *Operation under any conditions other than these conditions may adversely affect reliability of device and could result in device failure.*
4. *No warranty is made with respect to any use, operating conditions or combinations not represented on this data sheet. If you are considering application under any conditions other than listed herein, please contact sales representatives beforehand.*

9. Electrical Characteristics

Table 9-1 Electrical Characteristics

(Ta = +25°C, V_{VDD} = 12V)

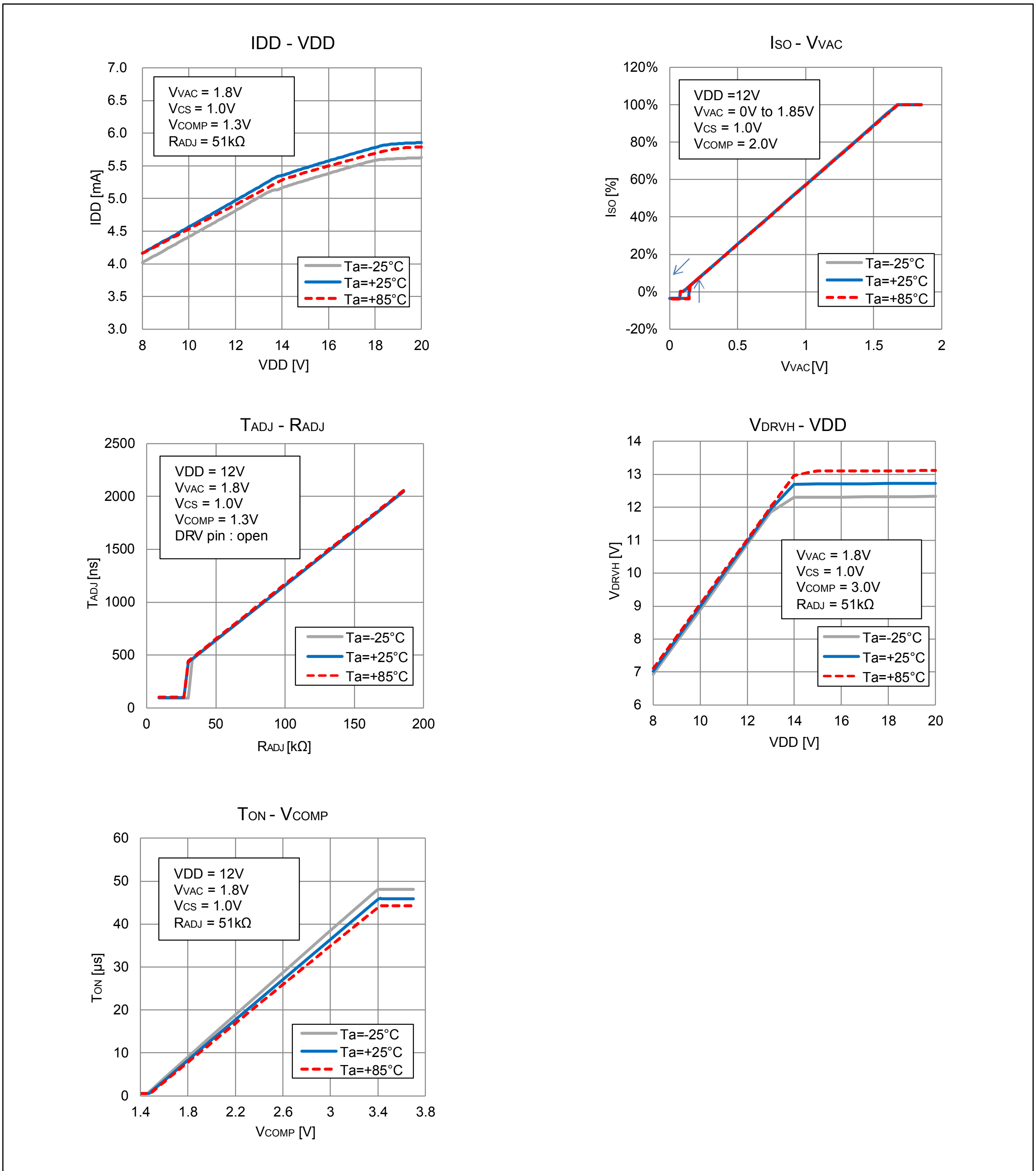
Parameter		Symbol	Pin	Condition	Value			Unit
					Min	Typ	Max	
POWER SUPPLY CURRENT	Power supply current	$I_{VDD(STATIC)}$	VDD	V_{VDD} = 20V, V_{TZE} = 1V	-	3	3.6	mA
		$I_{VDD(OPERATING)}$	VDD	V_{VDD} = 20V, Qg = 20 nC, f_{SW} = 133 kHz	-	5.6	-	mA
UVLO	UVLO Turn-on threshold voltage	V_{TH}	VDD	-	12.25	13	13.75	V
	UVLO Turn-off threshold voltage	V_{TL}	VDD	-	7.55	7.9	8.5	V
	Startup current	I_{START}	VDD	V_{VDD} = 7V	-	65	160	µA
TRANSFORMER ZERO ENERGY DETECTION	Zero energy threshold voltage	V_{TZETL}	TZE	TZE = "H" to "L"	-	20	-	mV
	Zero energy threshold voltage	V_{TZETH}	TZE	TZE = "L" to "H"	0.6	0.7	0.8	V
	TZE clamp voltage	$V_{TZECLAMP}$	TZE	I_{TZE} = -10 µA	-200	-160	-100	mV
	OVP threshold voltage	V_{TZEOVP}	TZE	-	4.15	4.3	4.45	V
	OVP blanking time	$t_{OVPBLANK}$	TZE	-	0.6	1	1.7	µs
	TZE input current	I_{TZE}	TZE	V_{TZE} = 5V	-1	-	+1	µA
COMPENSATION	Source current	I_{SO}	COMP	V_{COMP} = 2V, V_{CS} = 0V, V_{VAC} = 1.85V	-	-27	-	µA
	Trans conductance	gm	COMP	V_{COMP} = 2.5V, V_{CS} = 1V	-	96	-	µA/V
DIMMING	VAC input current	I_{VAC}	VAC	V_{VAC} = 5V	-0.1	-	+0.1	µA
	VACCMP threshold voltage	$V_{VACCMPVTH}$	VAC	-	135	150	165	mV
	VACCMP hysteresis	$V_{VACCMPHYS}$	VAC	-	-	70	-	mV
ADJUSTMENT	ADJ voltage	V_{ADJ}	ADJ	-	1.81	1.85	1.89	V
	ADJ source current	I_{ADJ}	ADJ	V_{ADJ} = 0V	-650	-450	-250	µA
	ADJ time	T_{ADJ}	TZE DRV	T_{ADJ} (R_{ADJ} = 51 kΩ) - T_{ADJ} (R_{ADJ} = 9.1 kΩ)	490	550	610	ns
	Minimum switching period	T_{SW}	TZE DRV	-	6.75	7.5	8.25	µs

(Ta = +25°C, V_{VDD} = 12V)

Parameter		Symbol	Pin	Condition	Value			Unit
					Min	Typ	Max	
CURRENT SENSE	OCP threshold voltage	V_{OCPTH}	CS	-	1.9	2	2.1	V
	OCP delay time	t_{OCPDLY}	CS	-	-	400	500	ns
	CS input current	I_{CS}	CS	V_{CS} = 5V	-1	-	+1	µA
DRV	DRV high voltage	V_{DRVH}	DRV	VDD = 18V, I_{DRV} = -30 mA	7.6	9.4	-	V
	DRV low voltage	V_{DRVL}	DRV	VDD = 18V, I_{DRV} = 30 mA	-	130	260	mV
	Rise time	t_{RISE}	DRV	VDD = 18V, CLOAD = 1 nF	-	94	-	ns
	Fall time	t_{FALL}	DRV	VDD = 18V, CLOAD = 1 nF	-	16	-	ns
	Minimum on time	t_{ONMIN}	DRV	TZE trigger	300	500	700	ns
	Maximum on time	t_{ONMAX}	DRV	-	27	44	60	µs
	Minimum off time	t_{OFFMIN}	DRV	-	1	1.5	1.93	µs
	Maximum off time	t_{OFFMAX}	DRV	TZE = GND	270	320	370	µs
OTP	OTP threshold	T_{OTP}	-	Tj, temperature rising	-	+150	-	°C
	OTP hysteresis	T_{OTPHYS}	-	Tj, temperature falling, degrees below T_{OTP}	-	+25	-	°C

10. Standard Characteristics

Figure 10-1 Standard Characteristics



11. Function Explanations

11.1 LED Current Control by PSR (Primary Side Regulation)

MB39C605 regulates the average LED current (I_{LED}) by feeding back the information based on Primary Winding peak current (I_{P_PEAK}) and Secondary Winding energy discharge time (T_{DIS}) and switching period (T_{SW}). Figure 11-1 shows the operating waveform in steady state. I_P is Primary Winding current and I_S is Secondary Winding current. I_{LED} as an average current of the Secondary Winding is described by the following equation.

$$I_{LED} = \frac{1}{2} \times I_{S\_PEAK} \times \frac{T_{DIS}}{T_{SW}}$$

Using I_{P_PEAK} and the transformer Secondary to Primary turns ratio (N_P/N_S), Secondary Winding peak current (I_{S_PEAK}) is described by the following equation.

$$I_{S\_PEAK} = \frac{N_P}{N_S} \times I_{P\_PEAK}$$

Therefore,

$$I_{LED} = \frac{1}{2} \times \frac{N_P}{N_S} \times I_{P\_PEAK} \times \frac{T_{DIS}}{T_{SW}}$$

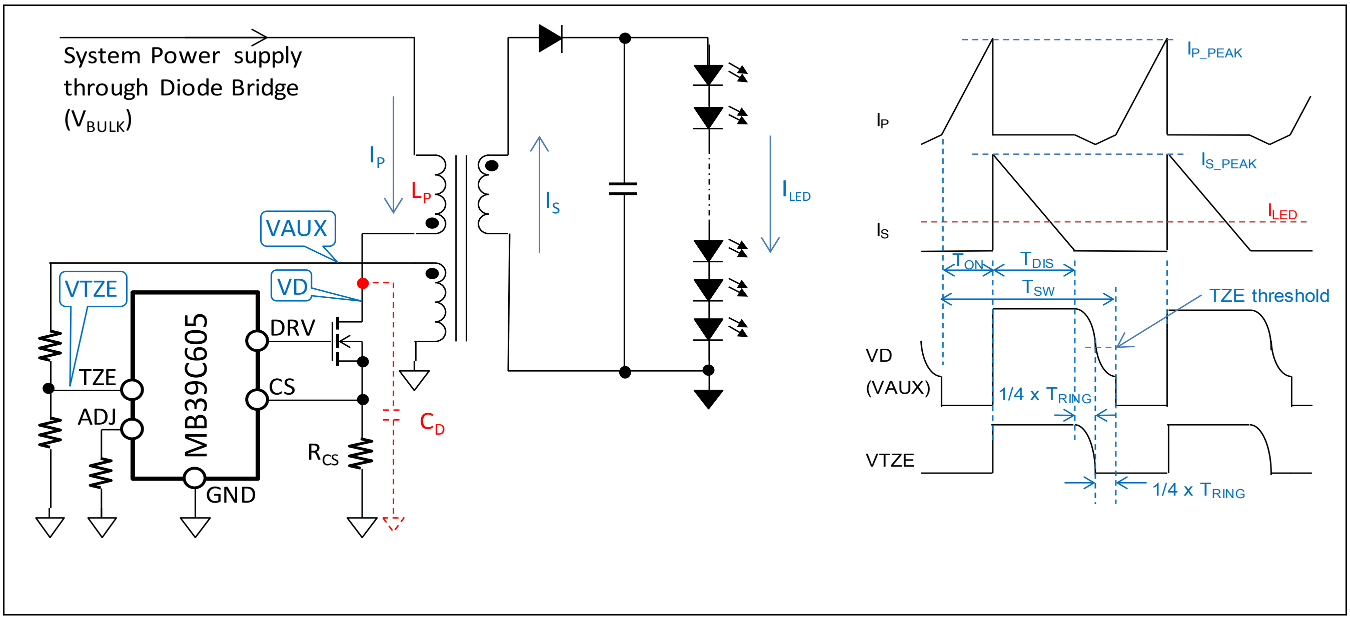
MB39C605 detects T_{DIS} by monitoring TZE pin and I_{P_PEAK} by monitoring CS pin. An internal Err Amp sinks gm current proportional to I_{P_PEAK} from COMP pin during T_{DIS} period. In steady state, since the average of the gm current is equal to internal reference current (I_{SO}), the voltage on COMP pin (V_{COMP}) is nearly constant.

$$I_{P\_PEAK} \times R_{CS} \times gm \times T_{DIS} = I_{SO} \times T_{SW}$$

In above equation, gm is transconductance of the Err Amp and R_{CS} is a sense resistance.
Eventually, I_{LED} can be calculated by the following equation.

$$I_{LED} = \frac{1}{2} \times \frac{N_P}{N_S} \times \frac{I_{SO}}{gm} \times \frac{1}{R_{CS}}$$

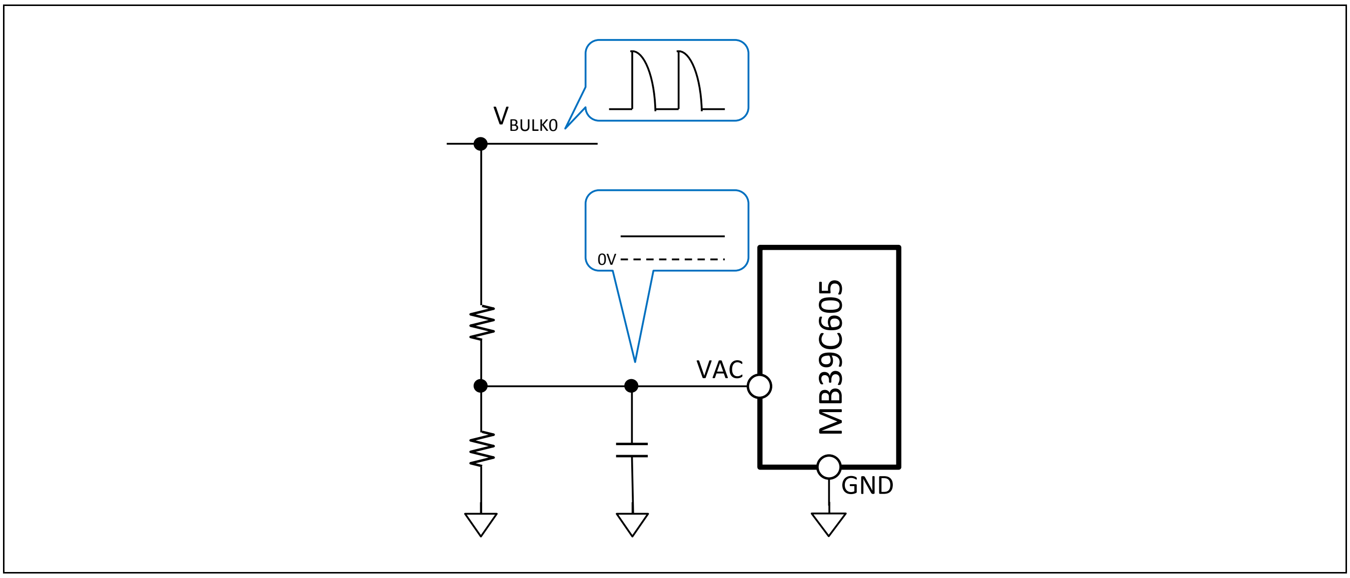
Figure 11-1 LED Current Control Waveform



11.2 Dimming Function

MB39C605 has the built-in Phase dimmable circuit to control I_{LED} by changing a reference of Err Amp based on the input dimming control level on the VAC pin and realizes dimming. Figure 11-2 shows the input circuit to the VAC pin for phase dimming. V_{BULK0} is divided and filtered into an analog voltage with RC network. It is possible to configurate phase dimmable system by inputting the voltage to the VAC pin.

Figure 11-2 VAC Pin Input Circuit



11.3 Power-On Sequence

When the AC line voltage is supplied, V_{BULK} is powered from the AC line through a diode bridge and a diode (D1) with charging a capacitor (C_{BULK}), and the VDD pin is charged from V_{BULK} through a start-up resistance (Rst). (Figure 11-3 red path)

When the VDD pin is charged up and the voltage on the VDD pin (V_{VDD}) rises above the UVLO threshold voltage, an internal Bias circuit starts operating, and MB39C605 starts the dimming control. After the UVLO is released, this device enables switching and is operating in a forced switching mode (T_{ON}=1.5µs, T_{OFF}=78µs to 320µs). When the voltage on the TZE pin reaches the Zero energy threshold voltage (V_{TZETH}=0.7V), MB39C605 enters normal operation mode. After the switching begins, the VDD pin is also charged from Auxiliary Winding through an external diode (DBIAS). (Figure 11-3 blue path)

During start-up period V_{VDD} is not supplied from Auxiliary Winding, because the LED voltage is low. V_{VDD} decreases gradually until the LED voltage rises above enough high that the Auxiliary Winding voltage can exceed V_{VDD}. In this period, if V_{VDD} falls below the UVLO threshold voltage, the switching stops. When the VDD pin is charged up again and V_{VDD} rises above the UVLO threshold voltage, MB39C605 restarts the switching. This device repeats above operation until the LED voltage rises above enough high. V_{VDD} becomes stable after that.

Figure 11-3 VDD Supply Path at Power-On

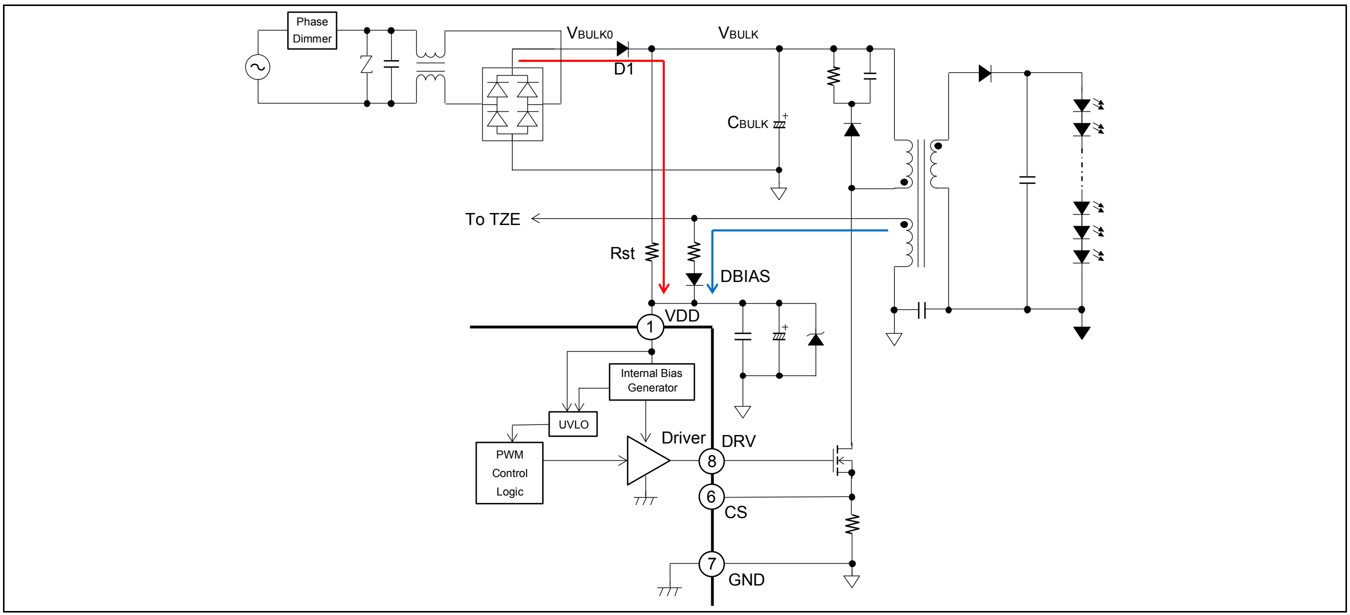
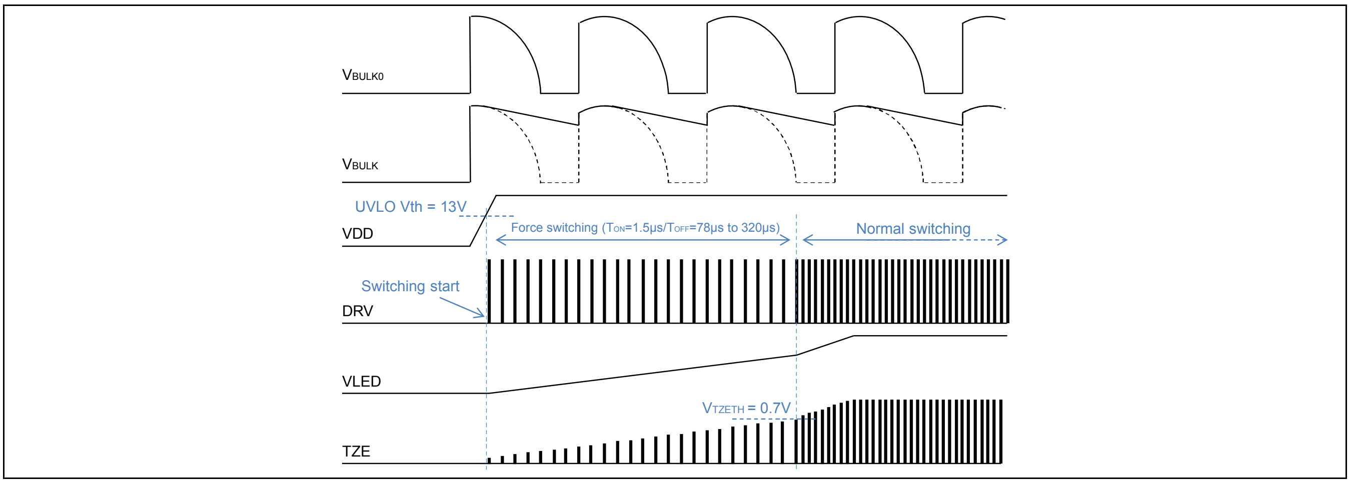


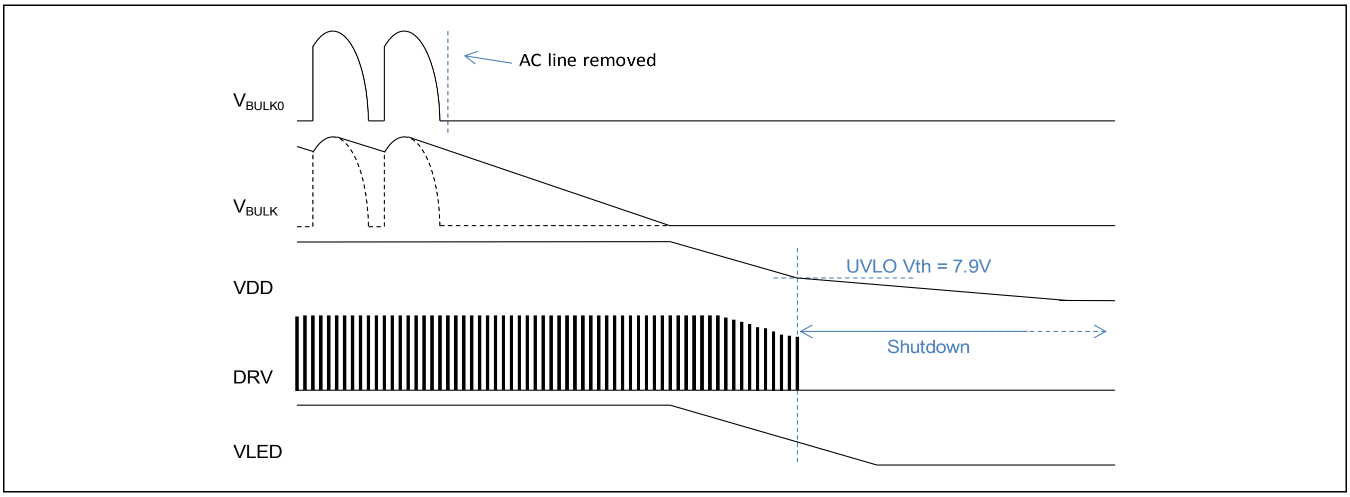
Figure 11-4 Power-On Waveform



11.4 Power-Off Sequence

After the AC line voltage is removed, V_{BULK} is discharged by switching operation. Since any Secondary Winding current does not flow, I_{LED} is supplied only from output capacitors and decreases gradually. V_{VDD} also decreases because there is no current supply from both Auxiliary Winding and V_{BULK}. When V_{VDD} falls below the UVLO threshold voltage, MB39C605 shuts down.

Figure 11-5 Power-Off Waveform



11.5 I_{P_PEAK} Detection Function

MB39C605 detects Primary Winding peak current (I_{P_PEAK}) of Transformer. I_{LED} is set by connecting a sense resistance (Rcs) between CS pin and GND pin. Maximum I_{P_PEAK} ($I_{P\_PEAKMAX}$) limited by Over Current Protection (OCP) can also be set with the resistance.
Using the Secondary to Primary turns ratio (N_P/N_S) and I_{LED}, R_{CS} is set as the following equation (refer to 11.1)

$$R_{CS} = \frac{N_P}{N_S} \times \frac{0.14}{I_{LED}}$$

In addition, using the OCP threshold voltage (V_{OCPTH}) and R_{CS}, $I_{P\_PEAKMAX}$ is calculated with the following equation.

$$I_{P\_PEAKMAX} = \frac{V_{OCPTH}}{R_{CS}}$$

11.6 Zero Voltage Switching Function

MB39C605 has built-in zero voltage switching function to minimize switching loss of the external switching MOSFET. This device detects a zero crossing point through a resistor divider connected from TZE pin to Auxiliary Winding. A zero energy detection circuit detects a negative crossing point of the voltage on TZE pin to Zero energy threshold voltage (V_{TZETL}). On-timing of switching MOSFET is decided with waiting an adjustment time (t_{ADJ}) after the negative crossing occurs.

t_{ADJ} is set by connecting an external resistance (R_{ADJ}) between ADJ pin and GND pin. Using Primary Winding inductance (L_P) and the parasitic drain capacitor of switching MOSFET (C_D), t_{ADJ} is calculated with the following equation.

$$t_{ADJ} = \frac{\pi\sqrt{L_P \times C_D}}{2}$$

Using t_{ADJ}, R_{ADJ} is expressed by the following calculation.

$$R_{ADJ}\,[k\Omega] = 0.0927 \times t_{ADJ}\,[ns]$$

11.7 Protection Functions

Under Voltage Lockout Protection (UVLO)

The under voltage lockout protection (UVLO) prevents IC from a malfunction in the transient state during V_{VDD} startup and a malfunction caused by a momentary drop of V_{VDD}, and protects the system from destruction/deterioration. An UVLO comparator detects the voltage decrease below the UVLO threshold voltage on VDD pin, and then DRV pin is turned to “L” and the switching stops. MB39C605 automatically returns to normal operation mode when V_{VDD} increases above the UVLO threshold voltage.

Over Voltage Protection (OVP)

The over voltage protection (OVP) protects Secondary side components from an excessive voltage stress. If the LED is disconnected, the output voltage of Secondary Winding rises up. The output overvoltage can be detected by monitoring TZE pin. During Secondary Winding energy discharge time, V_{TZE} is proportional to V_{AUX} and the voltage of Secondary Winding (refer to 11.1). When V_{TZE} rises higher than the OVP threshold voltage for 3 continues switching cycles, DRV pin is turned to “L”, and the switching stops (latch off). When V_{VDD} drops below the UVLO threshold voltage, the latch is removed.

Over Current Protection (OCP)

The over current protection (OCP) prevents inductor or transformer from saturation. The drain current of the external switching MOSFET is limited by OCP. When the voltage on CS pin reaches the OCP threshold voltage, DRV pin is turned to “L” and the switching cycle ends. After zero crossing is detected on TZE pin again, DRV pin is turned to “H” and the next switching cycle begins.

Short Circuit Protection (SCP)

The short circuit protection (SCP) protects the transformer and the Secondary side diode from an excessive current stress. When the short circuit between LED terminals occurs, output voltage decreases. If the voltage on TZE pin falls below SCP threshold voltage, V_{COMP} is discharged and fixed at 1.5V and then the switching enters a low frequency mode.(T_{ON}=1.5μs /T_{OFF}=78μs to 320μs)

Over Temperature Protection (OTP)

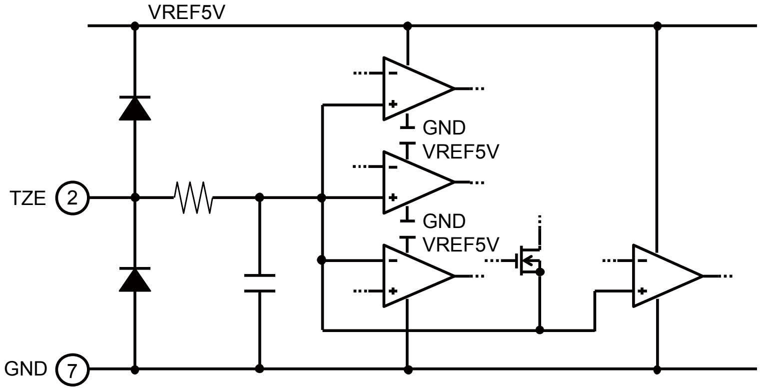
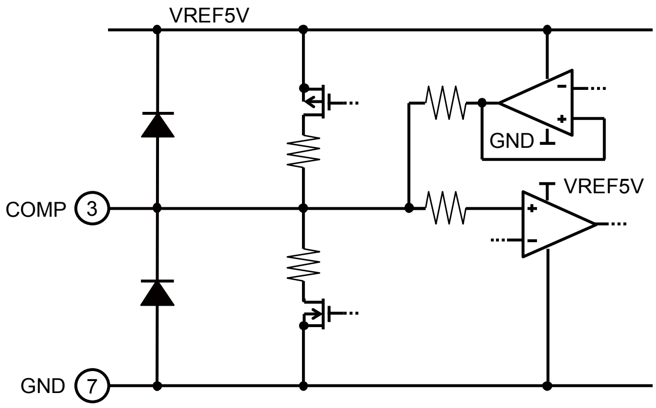
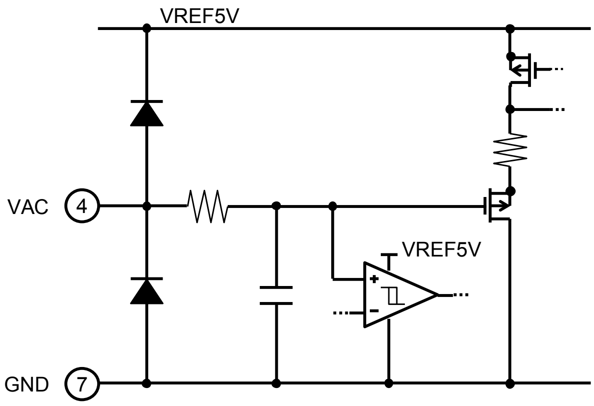
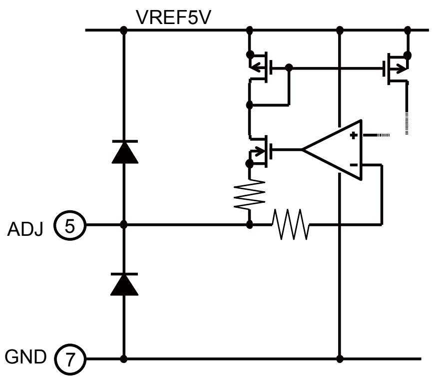
The over temperature protection (OTP) protects IC from thermal destruction. When the junction temperature reaches +150°C, DRV pin is turned to “L”, and the switching stops. It automatically returns to normal operation mode if the junction temperature falls back below +125°C.

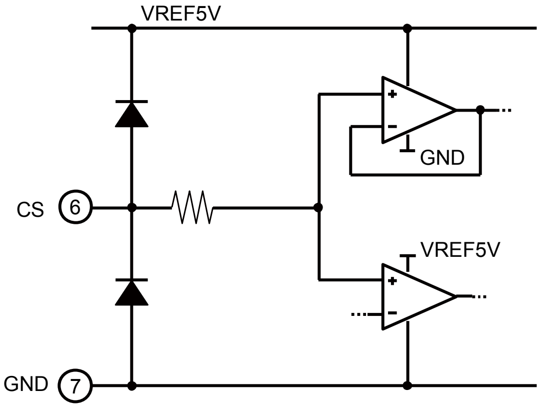
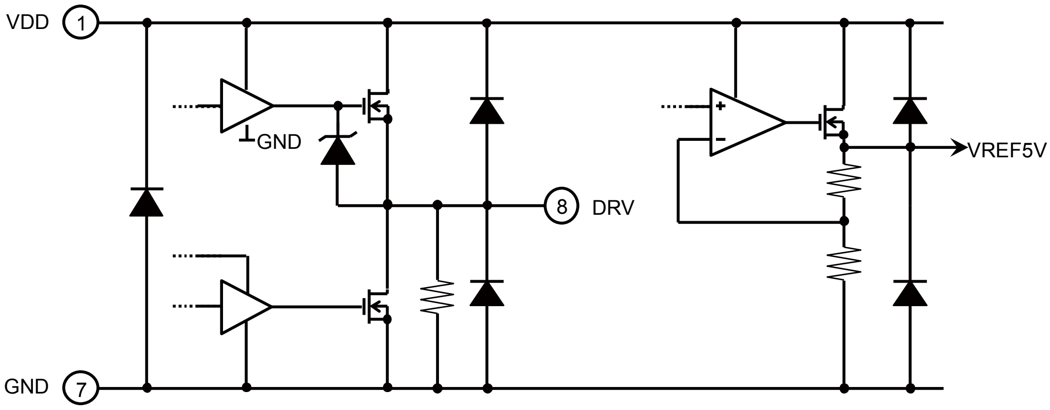
Table 11-1 Protection Functions Table

Function	PIN Operation			Detection Condition	Return Condition	Remarks
	DRV	COMP	ADJ			
Normal Operation	Active	Active	Active	-	-	-
Under Voltage Lockout Protection (UVLO)	L	L	L	VDD < 7.9V	VDD > 13V	Auto Restart
Over Voltage Protection (OVP)	L	1.5V fixed	Active	TZE > 4.3V	VDD < 7.9V → VDD > 13V	Latch off
Over Current Protection (OCP)	L	Active	Active	CS > 2V	Cycle by cycle	Auto Restart
Short Circuit Protection (SCP)	Active	1.5V fixed	Active	TZE (peak) < 0.7V	TZE (peak) > 0.7V	Auto Restart
Over Temperature Protection (OTP)	L	1.5V fixed	Active	Tj > +150°C	Tj < +125°C	Auto Restart

12. I/O Pin Equivalent Circuit Diagram

Figure 12-1 I/O Pin Equivalent Circuit Diagram

Pin No.	Pin Name	Equivalent Circuit Diagram
2	TZE	
3	COMP	
4	VAC	
5	ADJ	

Pin No.	Pin Name	Equivalent Circuit Diagram
6	CS	
8	DRV	

13. Application Examples

5W Non-isolated Dimming Application

Input: AC90V_{RMS}~110V_{RMS}, Output: 70mA/70V~76V, Ta = +25°C

Figure 13-1 5W EVB Schematic

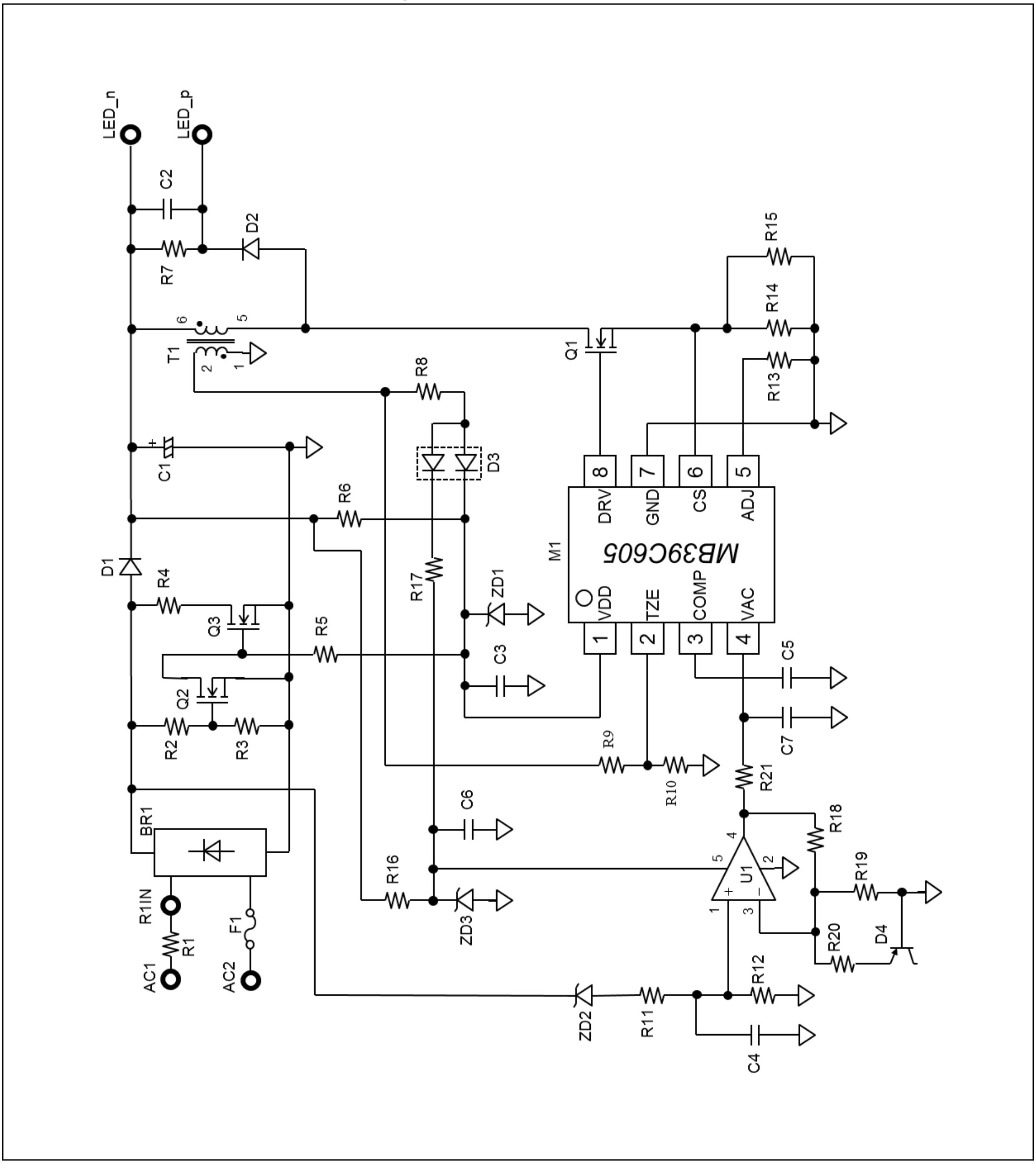
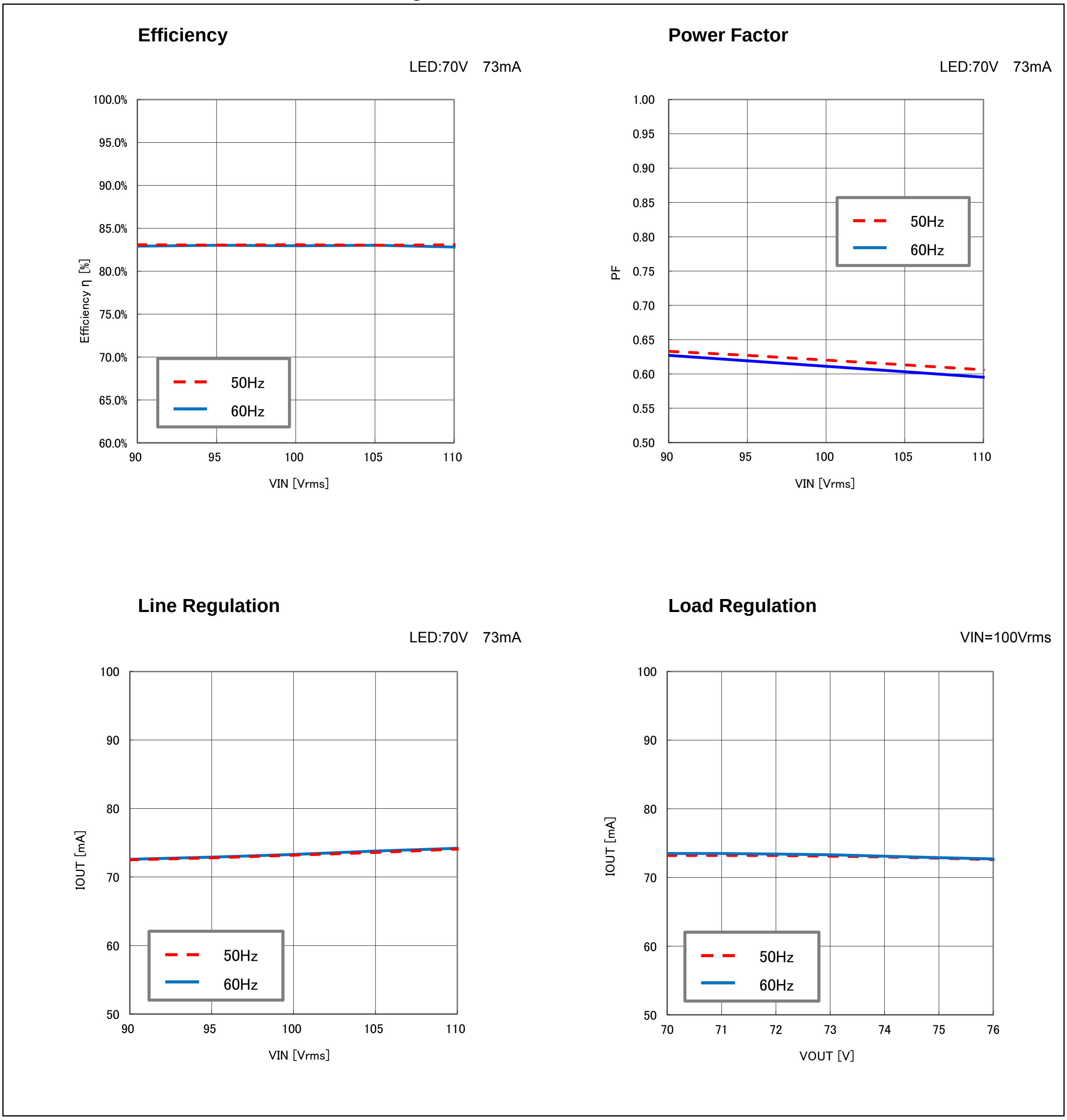


Table 13-1 5W BOM List

No.	Component	Description	Part No.	Vendor
1	M1	LED driver IC SOP-8	MB39C605	Spansion
2	U1	Op-Amp, Low voltage Rail-to-Rail, 130μA, SOT-23-5	LMV321	TI
3	T1	Transformer, Lp=550μH Np/Na=150/35	EE808	-
4	Q1	MosFET N-CH 600V 2.8A I-PAK	FQU5N60C	Fairchild
5	Q2	MosFET N-CH 60V 115mA SOT-23	2N7002	Fairchild
6	Q3	MosFET N-CH 600V 0.3A TO-92	FQN1N60C	Fairchild
7	BR1	Bridge Rectifiers, 0.5A, 600V, SOIC-4	MB6S	Fairchild
8	ZD1, ZD2	Diode, Zener, 18V, 500mW, SOD-123	MMSZ5248B	Fairchild
9	ZD3	Diode, Zener, 5.1V, 500mW, SOD-123	MMSZ4689	Fairchild
10	D1, D2	Diode, fast rectifier, 1A, 400V, SMA	ES1G	Fairchild
11	D3	Diode, 200mA, 200V, SOT-23	MMBD1405	Fairchild
12	D4	PNP Bipolar Transistor 12V 3A CPH3	CPH3106	On semiconductor
13	F1	Fuse, chip, 2A, AC/DC125V, 1206	3410.0035.01	Schurter Inc
14	C1	Capacitor, aluminum electrolytic, 8.2μF 200V ϕ8.0 × 11.0	200LLE8R2MEFC8X9	Rubycon
15	C2	Capacitor Ceramic 2.2μF 100V 1206	GRM31CR72A225KA73L	murata
16	C3	Capacitor Ceramic 4.7μF 35V 0603	-	-
17	C4, C7	Capacitor Ceramic 10μF 25V 0603	-	-
18	C5	Capacitor Ceramic 0.01μF 50V 0603	-	-
19	C6	Capacitor Ceramic 0.1μF 50V 0603	-	-
20	R1	Resistor, winding 10Ω 3W ±5%	-	-
21	R2, R11	Resistor, chip, 240kΩ, 1/10W, 0603	-	-
22	R3	Resistor, chip, 10kΩ, 1/10W, 0603	-	-
23	R4	Resistor, chip, 2kΩ, 1/4W, 1206	-	-
24	R5	Resistor, chip, 470kΩ, 1/10W, 0603	-	-
25	R6	Resistorr, chip, 200kΩ 1/4W, 1206	-	-
26	R7	Resistor, chip, 100kΩ, 1/10W, 0603	-	-
27	R8	Resistor, chip, 10Ω, 1/10W, 0603	-	-
28	R9	Resistor, chip, 110kΩ, 1/10W, 0603	-	-
29	R10	Resistor, chip, 30kΩ, 1/10W, 0603	-	-
30	R12	Resistor, chip, 3.0kΩ, 1/10W, 0603	-	-
31	R13	Resistor, chip, 24kΩ, 1/10W, 0603	-	-
32	R14	Resistor, chip, 3.3Ω, 1/10W, 0603	-	-
33	R15	Resistor, chip, 4.7Ω, 1/10W, 0603	-	-
34	R16	Resistorr, chip, 150kΩ 1/4W, 1206	-	-
35	R17	Resistor, chip, 5.1kΩ, 1/10W, 0603	-	-
36	R18	Resistor, chip, 36kΩ, 1/10W, 0603	-	-
37	R19	Resistor, chip, 150kΩ, 1/10W, 0603	-	-
38	R20	Resistor, chip, 3.3kΩ, 1/10W, 0603	-	-
39	R21	Resistor, chip, 1kΩ, 1/10W, 0603	-	-

Spansion	:	Spansion Inc.
TI	:	Texas Instruments Incorporated
Fairchild	:	Fairchild Semiconductor International, Inc.
On Semiconductor	:	ON Semiconductor
Schurter Inc	:	Schurter Holding AG
Rubycon	:	Rubycon Corporation
muRata	:	Murata Manufacturing Co., Ltd.

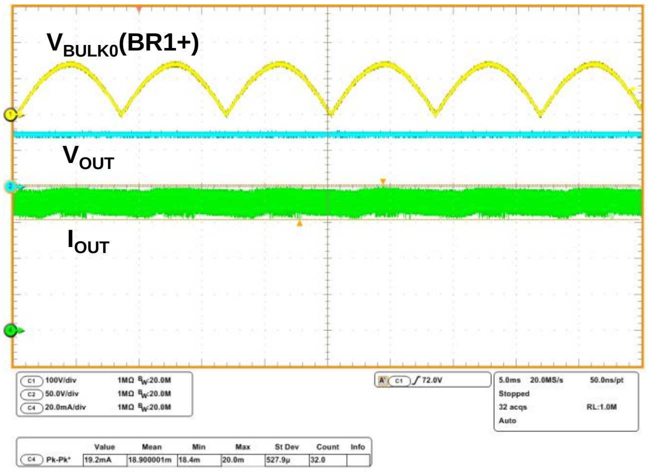
Figure 13-2 5W Reference Data



Output Ripple Waveform

V_{IN}=100V_{RMS} / 60Hz

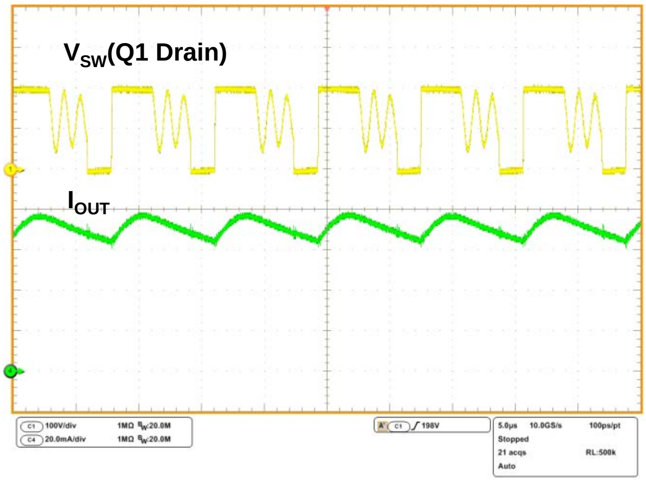
LED:70V   73mA



Switching Waveform

V_{IN}=100V_{RMS} / 60Hz

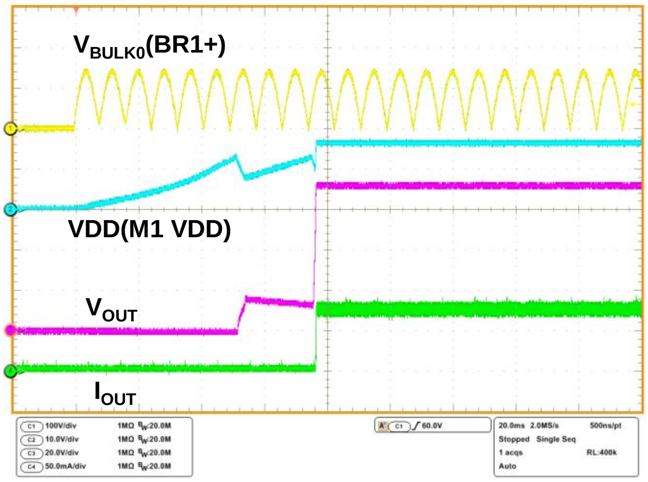
LED:70V   73mA



Turn-On Waveform

V_{IN}=100V_{RMS} / 60Hz

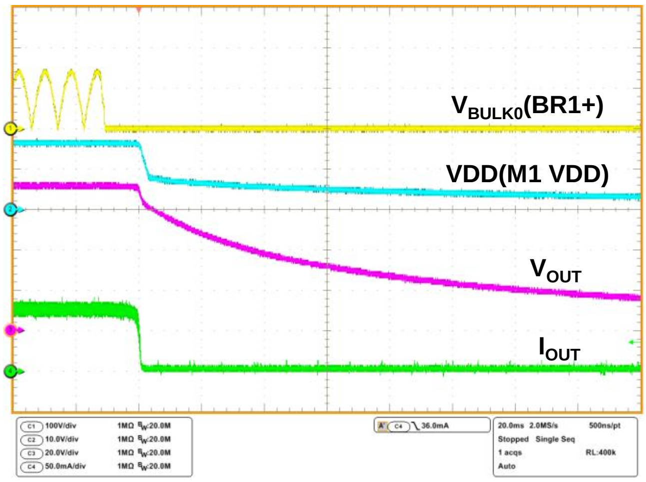
LED:70V   73mA



Turn-Off Waveform

V_{IN}=100V_{RMS} / 60Hz

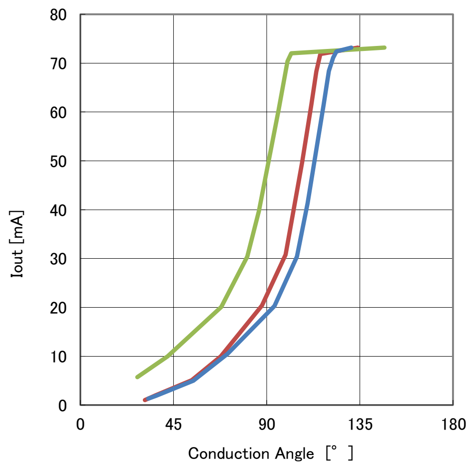
LED:70V   73mA



Dimming Curve

V_{IN}=100V_{RMS} / 50Hz

LED:70V 73mA

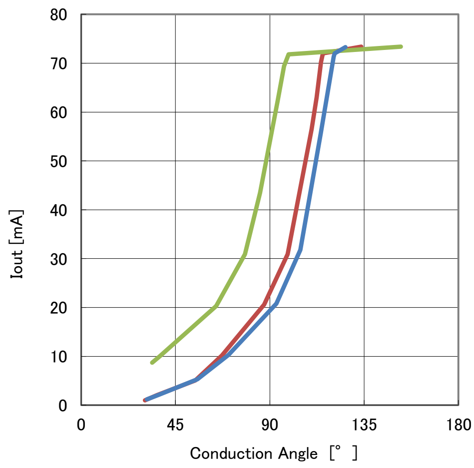


: DVCL-123P-JA
: WTC 57521
: WDG9001

Dimming Curve

V_{IN}=100V_{RMS} / 60Hz

LED:70V 73mA

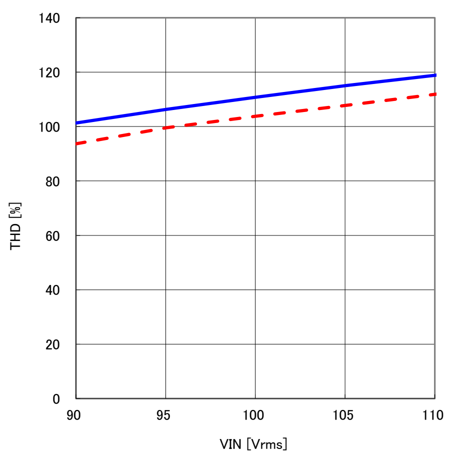


: DVCL-123P-JA
: WTC 57521
: WDG9001

Dimmer		Input Condition	Type	Minimum Angle (°)	Minimum I_{OUT} (mA)	Maximum Angle (°)	Maximum I_{OUT} (mA)
Vendor	Parts Name						
LUTRON	DVCL-123P-JA	VIN=100Vrms 50Hz (Japan Dimmer)	Leading Edge	32.8	1.3	130.9	73.2
Panasonic	WTC 57521		Leading Edge	31.1	1.0	134.1	73.2
TOSHIBA	WDG9001		Trailing Edge	27.5	5.7	146.9	73.2
LUTRON	DVCL-123P-JA	VIN=100Vrms 60Hz (Japan Dimmer)	Leading Edge	31.3	1.2	126.1	73.3
Panasonic	WTC 57521		Leading Edge	30.5	1.0	133.7	73.4
TOSHIBA	WDG9001		Trailing Edge	33.9	8.7	152.5	73.4

Total Harmonic Distortion(THD)

LED:70V 73mA



14. Usage Precautions

Do not configure the IC over the maximum ratings.

If the IC is used over the maximum ratings, the LSI may be permanently damaged.

It is preferable for the device to normally operate within the recommended usage conditions. Usage outside of these conditions can have an adverse effect on the reliability of the LSI.

Use the device within the recommended operating conditions.

The recommended values guarantee the normal LSI operation under the recommended operating conditions.

The electrical ratings are guaranteed when the device is used within the recommended operating conditions and under the conditions stated for each item.

Printed circuit board ground lines should be set up with consideration for common impedance.

Take appropriate measures against static electricity.

- Containers for semiconductor materials should have anti-static protection or be made of conductive material.
- After mounting, printed circuit boards should be stored and shipped in conductive bags or containers.
- Work platforms, tools, and instruments should be properly grounded.
- Working personnel should be grounded with resistance of 250 kΩ to 1 MΩ in serial between body and ground.

Do not apply negative voltages.

The use of negative voltages below - 0.3 V may make the parasitic transistor activated to the LSI, and can cause malfunctions.

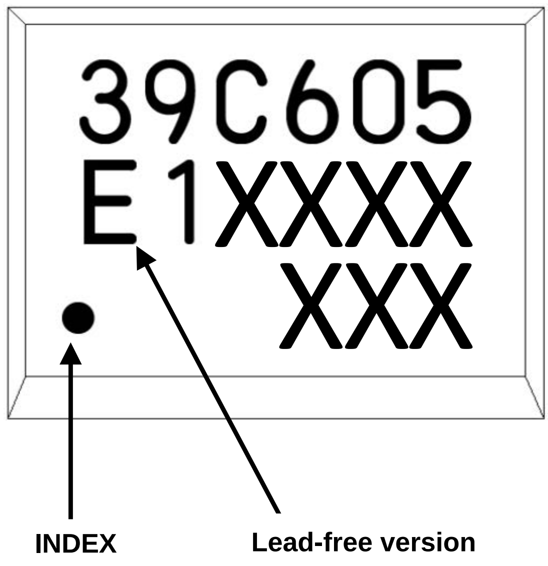
15. Ordering Information

Table 15-1 Ordering Information

Part Number	Package	Shipping Form
MB39C605PNF-G-JNEFE1	8-pin plastic SOP (FPT-8P-M02)	Emboss
MB39C605PNF-G-JNE1		Tube

16. Marking Format

Figure 16-1 Marking Format



17. Recommended Mounting Condition [JEDEC Level3] Lead Free

17.1 Recommended Reflow Condition

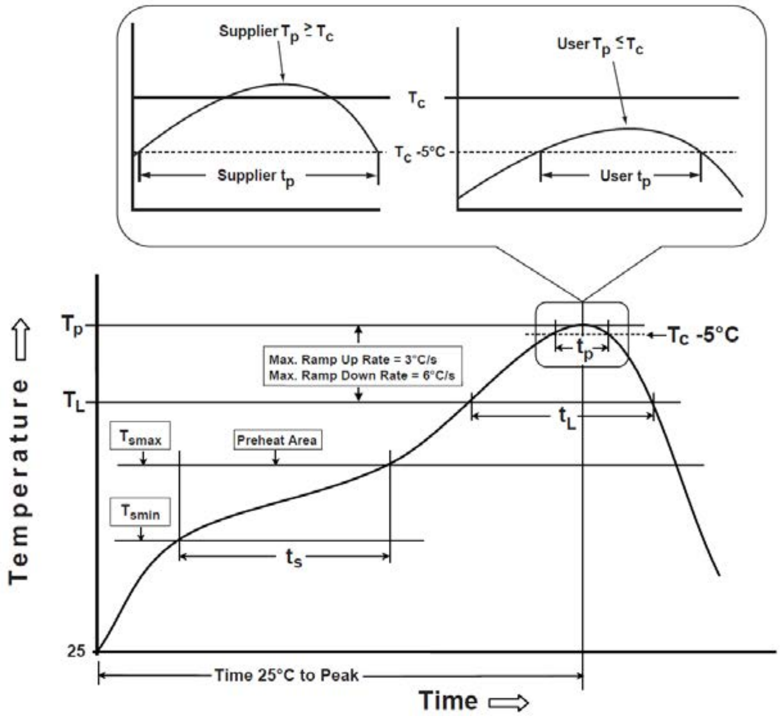
Table 17-1 Recommended Reflow Condition

Items	Contents	
Method	IR(Infrared Reflow) / Convection	
Times	3 times in succession	
Floor life	Before unpacking	Please use within 2 years after production.
	From unpacking to reflow	Within 7 days
	In case over period of floor life(*1)	Baking with 125°C+/-3°C for 24hrs+2hrs/-0hrs is required. Then please use within 7 days. (Please remember baking is up to 2 times)
Floor life condition	Between 5°C and 30°C and also below 60%RH required. (It is preferred lower humidity in the required temp range.)	

*1: Concerning the Tape & Reel product, please transfer product to heatproof tray and so on when you perform baking.
Also please prevent lead deforming and ESD damage during baking process.

17.2 Reflow Profile

Figure 17-1 Reflow Profile

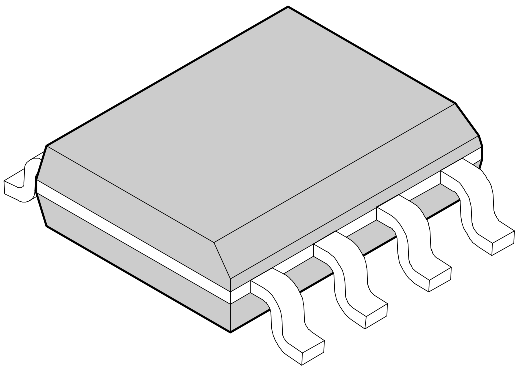


260°C Max. (J-STD-020D)	
T_L to T_P : Ramp Up Rate	3°C/s Max.
T_S : Preheat & Soak	150 to 200°C, 60 to 120s
T_P - t_P : Peak Temperature	260°C Down, within 30s
T_L - t_L : Liquidous Temperature	217°C, 60 to 150s
T_P to T_L : Ramp Down Rate	6°C/s Max.
Time 25°C to Peak	8min Max.

Temperature on the top of the package body is measured.

18. Package Dimensions

8-pin plastic SOP

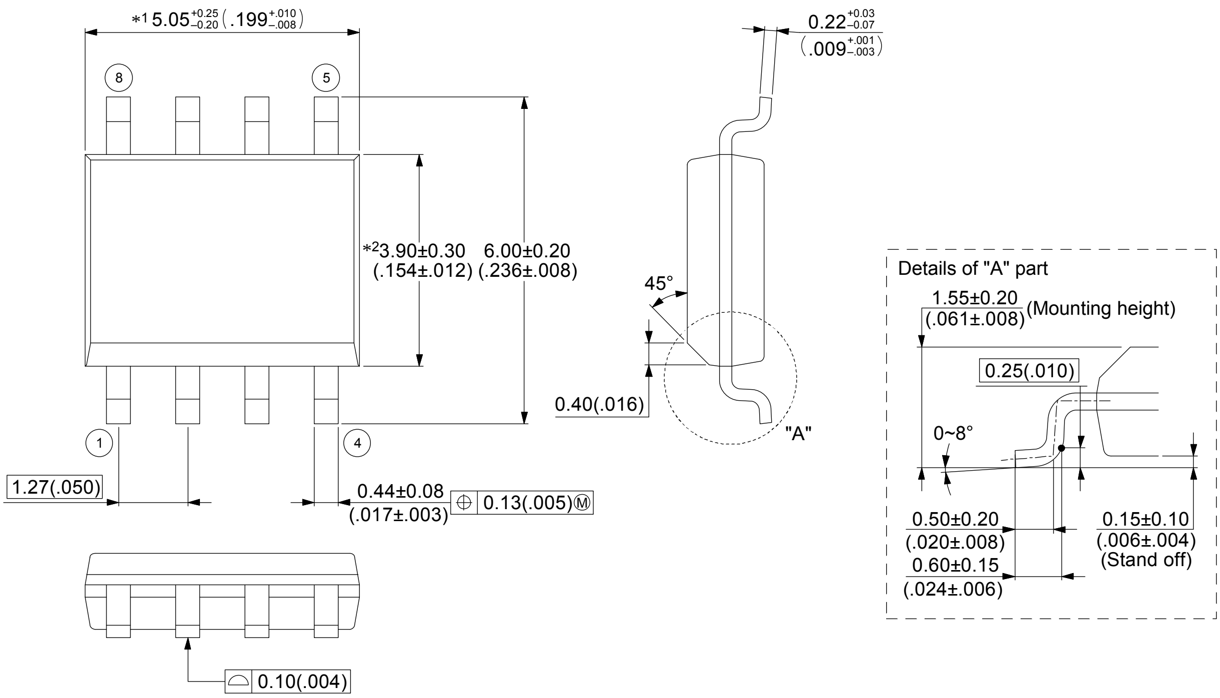


(FPT-8P-M02)

Lead pitch	1.27 mm
Package width× package length	3.9 mm × 5.05 mm
Lead shape	Gullwing
Sealing method	Plastic mold
Mounting height	1.75 mm MAX
Weight	0.06 g

8-pin plastic SOP
(FPT-8P-M02)

Note 1) *1 : These dimensions include resin protrusion.
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.



Dimensions in mm (inches).
Note: The values in parentheses are reference values.

19. Major Changes

Page	Section	Descriptions
Revision 1.0		
-	-	Initial release
Revision 2.0		
16	11.6 Zero Voltage Switching Function	Corrected the R_{ADJ} formula
20	13. Application Examples	Added Application Examples
26	15. Ordering Information	Added Shipping in Table 15-1
-	-	Rewrote entire document for improving the ease of understanding (the original intentions are remained unchanged).
Revision 3.0		
8	7. Absolute Maximum Ratings	Removed ESD Voltage (Machine Model) from Table 7-1
-	Labeling Sample	Removed section of Labeling Sample
28	17. Recommended mounting condition [JEDEC Level3] Lead Free	Changed Recommended Condition from three conditions to one condition "JEDEC LEVEL3"

Colophon

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