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MB39C604

ASSP

PSR LED Driver IC for LED Lighting

Data Sheet (Full Production)

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Publication Number MB39C604-DS405-00016 Revision 1.0 Issue Date March 6, 2014

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MB39C604

ASSP

PSR LED Driver IC for LED Lighting

Data Sheet (Full Production)

1. Description

MB39C604 is a PSR (Primary Side Regulation) 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. Using critical conduction mode, it is able to allow the use of small transformer. In addition, MB39C604 has a dimmable circuit built-in and can constitute the lighting system corresponding to the PWM dimming.
It is most suitable for the general lighting applications, for example replacement of commercial and residential incandescent lamp and so on.

2. Features

- PSR topology in an isolated flyback circuit
- High power factor (>0.9 : Not dimming) in Single Conversion
- High efficiency (>85% : Not dimming) and low EMI by detecting transformer zero energy
- PWM Dimmable LED lighting
- High-reliable protective function
  - Under voltage lock out (UVLO)
  - Output over voltage protection (OVP)
  - Transformer over current protection (OCP)
  - Output short circuit protection (SCP)
  - Over temperature protection (OTP)
- Switching frequency setting : 30kHz to 133kHz
- Input voltage range VDD : 9V to 20V
- Input voltage range for LED lighting applications : AC110VRMS, AC230VRMS
- Output power range for LED lighting applications : 5W to 50W
- Small Package : SOP-8 (3.9mm × 5.05mm × 1.75mm[Max])

3. Applications

- LED lighting
- PWM dimmable 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/

Publication Number MB39C604-DS405-00016 Revision 1.0 Issue Date March 6, 2014

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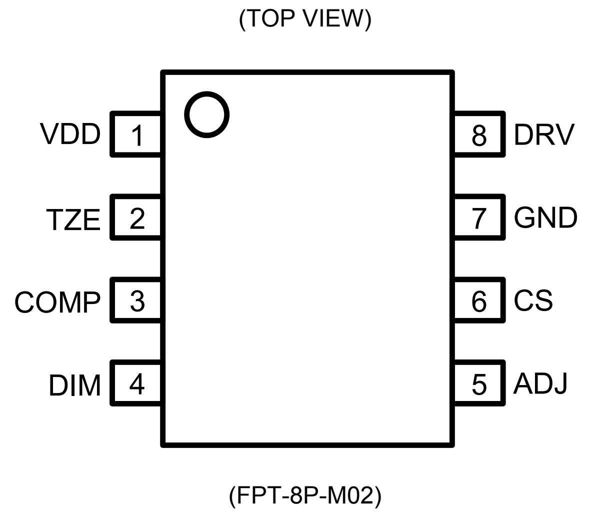
4. Pin Assignment

Figure 4-1 Pin Assignment



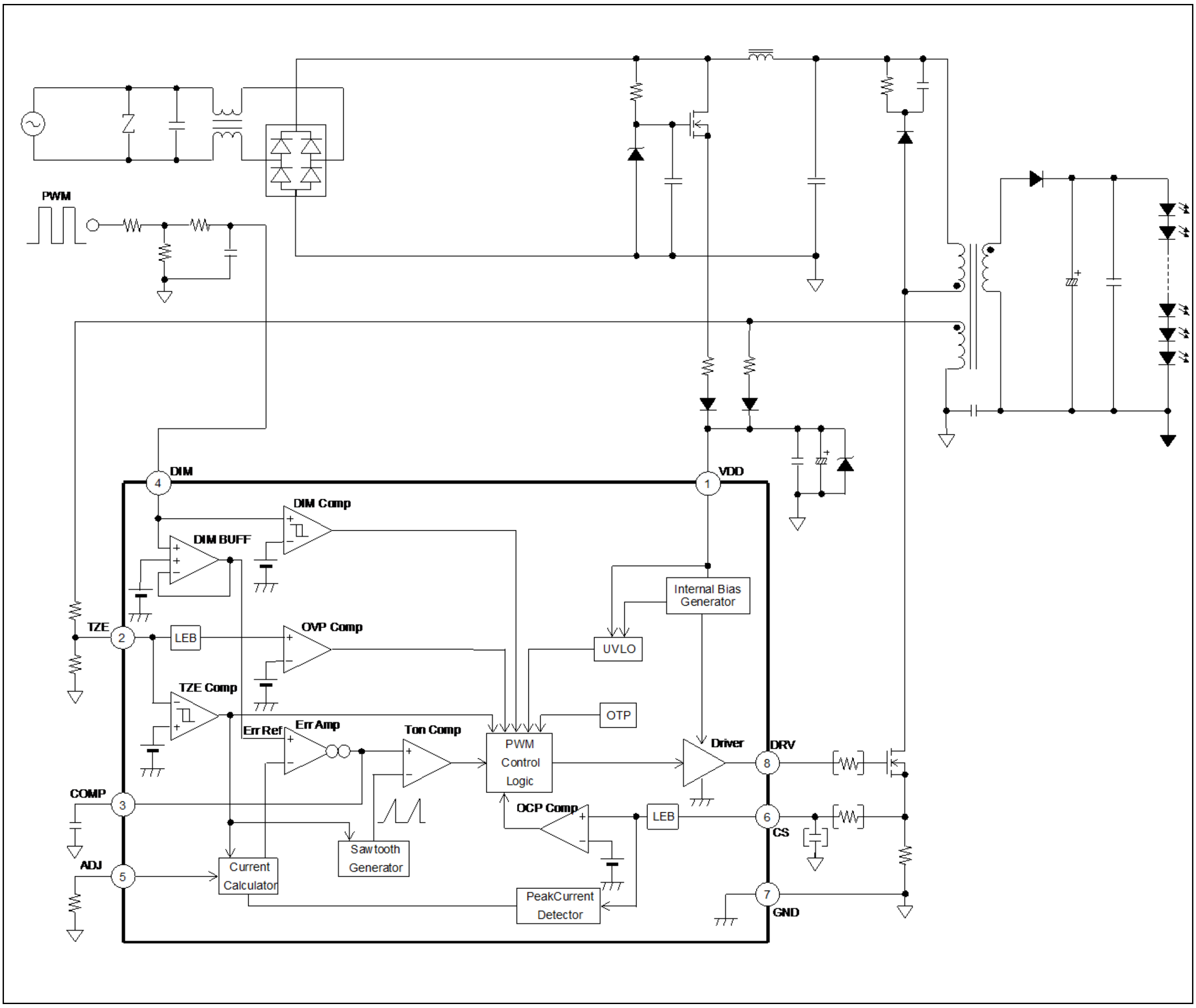
5. Pin Descriptions

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	DIM	I	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

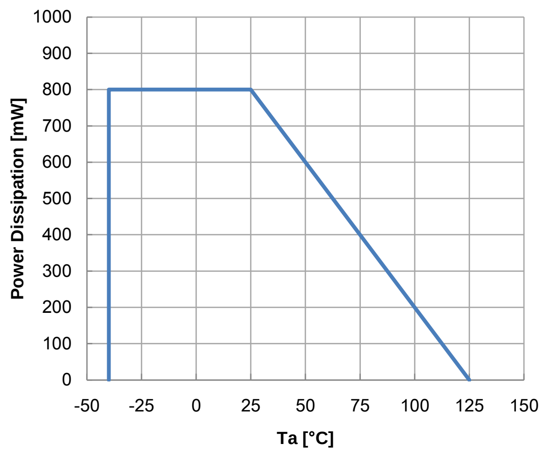
Table 7-1 Absolute Maximum Rating

Parameter	Symbol	Condition	Rating		Unit
			Min	Max	
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_{DIM}	DIM 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_{ESDM}	Machine Model	-200	+180	V
ESD Voltage 3	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
DIM pin Input Voltage	V_{DIM}	DIM pin After UVLO release	0	-	5	V
DIM pin Input Current	I_{DIM}	DIM 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	-	4.7	-	μF
VDD pin Capacitance	C_{BP}	Set between VDD pin and GND pin	-	100	-	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)

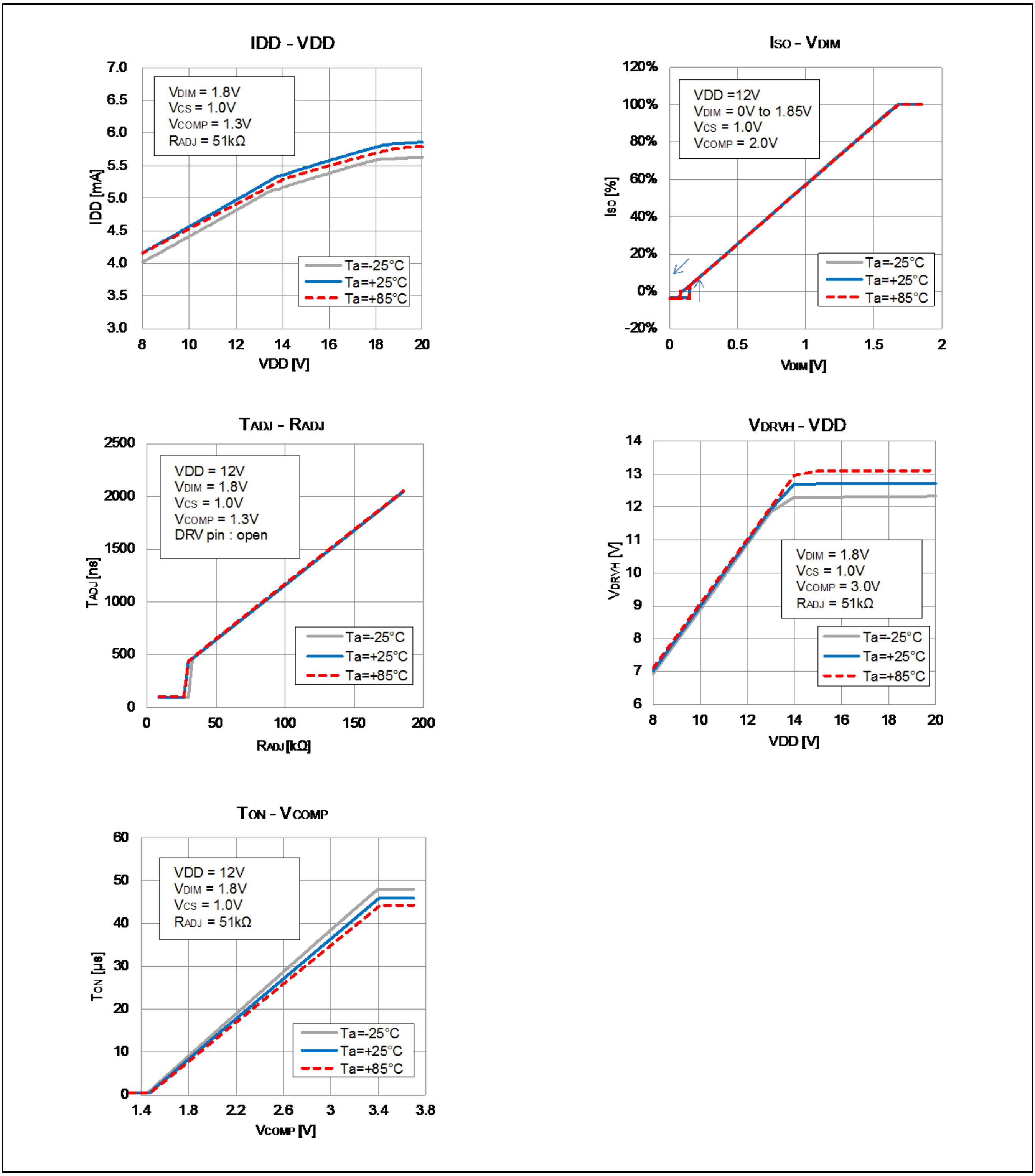
Parameter		Symbol	Pin	Condition	Value			Unit
					Min	Typ	Max	
UVLO	UVLO Turn-on threshold voltage	V_{TH}	VDD	-	12.25	13	13.75	V
	UVLO Turn-off threshold voltage	V_{TL}	VDD	-	7.55	7.9	8.5	V
	Startup current	I_{START}	VDD	V_{VDD} =7V	-	65	160	μA
TRANSFORMER ZERO ENERGY DETECTION	Zero energy threshold 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}=-10μA	-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_{DIM}=1.85V	-	27	-	μA
	Trans conductance	gm	COMP	V_{COMP}=2.5V, V_{CS}=1V	-	96	-	μA/V
ADJUSTMENT	ADJ voltage	V_{ADJ}	ADJ	-	1.81	1.85	1.89	V
	ADJ source current	I_{ADJ}	ADJ	V_{ADJ}=0V	250	450	650	μA
	ADJ time	T_{ADJ}	TZE DRV	T_{ADJ}(R_{ADJ}=51kΩ) T_{ADJ}(R_{ADJ}=9.1kΩ)	490	550	610	ns
	Minimum switching period	T_{SW}	TZE DRV	-	6.75	7.5	8.25	μs
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

(Ta = +25°C, V_{VDD} = 12V)

Parameter		Symbol	Pin	Condition	Value			Unit
					Min	Typ	Max	
DRV	DRV high voltage	V_{DRVH}	DRV	VDD=18V, I_{DRV}=-30mA	7.6	9.4	-	V
	DRV low voltage	V_{DRVL}	DRV	VDD=18V, I_{DRV}=30mA	-	130	260	mV
	Rise time	t_{RISE}	DRV	VDD=18V, CLOAD=1nF	-	94	-	ns
	Fall time	t_{FALL}	DRV	VDD=18V, CLOAD=1nF	-	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
DIMMING	DIM input current	I_{DIM}	DIM	V_{DIM}=5V	-0.1	-	+0.1	μA
	DIMCMP threshold voltage	$V_{DIMCMPVTH}$	DIM	-	135	150	165	mV
	DIMCMP hysteresis	$V_{DIMCMPHYS}$	DIM	-	-	70	-	mV
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=20nC, f_{SW}=133kHz	-	5.6	-	mA

10. Standard Characteristics

Figure 10-1 Standard Characteristics



11. Function Explanations

11.1 LED Current Control by PSR (Primary Side Regulation)

MB39C604 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. Figure 11-1 shows the operating waveform in a 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 expressed by the following calculation.

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

Using Primary Winding peak current (I_{P_PEAK}) and the turns ratio (N_P/N_S) with Primary Winding turns (N_P) and Secondary Winding turns (N_S), Secondary Winding peak current (I_{S_PEAK}) is expressed by the following calculation.

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

Therefore, I_{LED} is expressed by the following calculation.

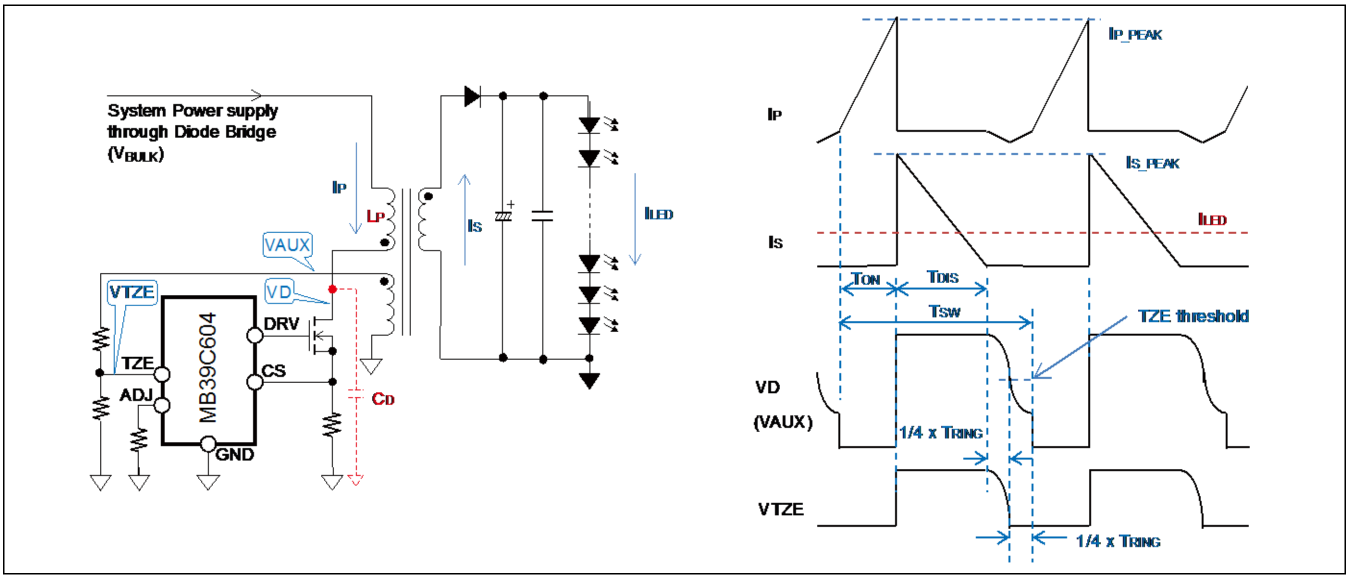
$$I_{LED} = \frac{1}{2} \times \frac{N_P}{N_S} \times I_{P\_PEAK} \times \frac{T_{DIS}}{T_{SW}}$$

MB39C604 regulates I_{LED}, by detecting T_{DIS} and T_{SW} by TZE pin and detecting I_{P_PEAK} by CS pin. In addition, using Primary Winding inductance of transformer (L_P) and switching on time (T_{ON}), I_{P_PEAK} is expressed by the following calculation.

$$I_{P\_PEAK} = \frac{V_{BULK}}{L_P} \times T_{ON}$$

Namely, MB39C604 regulates I_{P_PEAK} by controlling T_{ON} based on a detection result, and so regulates I_{LED}.

Figure 11-1 LED Current Control Waveform



11.2 PFC (Power Factor Correction) Function

T_{ON} in a steady state is generated by comparing the voltage of COMP pin with internal sawtooth waveform. (refer to Figure 6-1) The voltage of COMP pin is generated by the information of T_{DIS} and T_{SW} and I_{P_PEAK}. T_{ON} almost becomes the constant value, because the voltage of COMP pin gradually changes by capacitor connected to COMP pin between GND pin. Therefore, IP_PEAK almost is proportional to the voltage of AC Line (V_{BULK}). (reference 11.1) Therefore, it can bring the phase differences between the input voltage and the input current close to zero, and so high Power Factor can be realized. Please usually connect the capacitor of 4.7μF to COMP pin.

11.3 Dimming Function

MB39C604 has the dimmable circuit built-in and controls I_{LED} by changing a reference of ERRAMP of the PSR block based on the input voltage level of DIM pin and realized dimming. Figure 11-2 shows I_{LED} dimming ratio based on the input voltage level of DIM pin.

Figure 11-3 shows the input configuration of DIM pin in PWM dimming. It is possible to configurate PWM dimmable system by inputting the voltage that smoothed PWM signal into DIM pin.

Figure 11-2 Dimming Curve

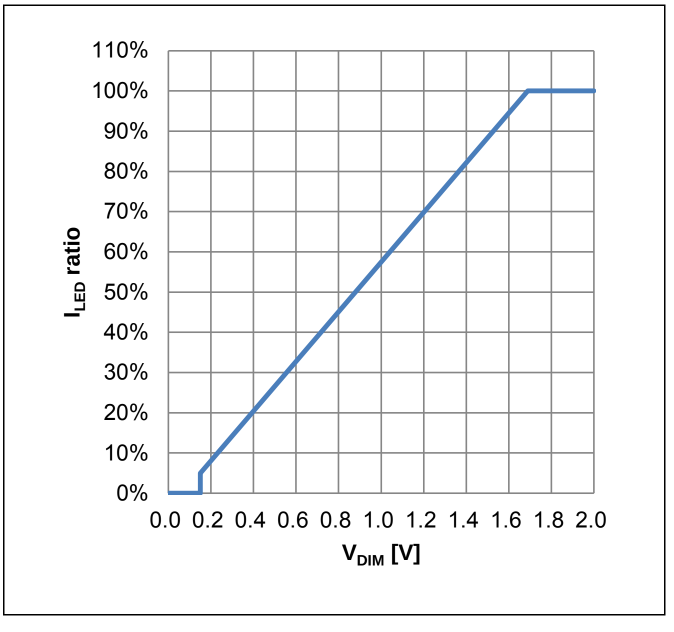
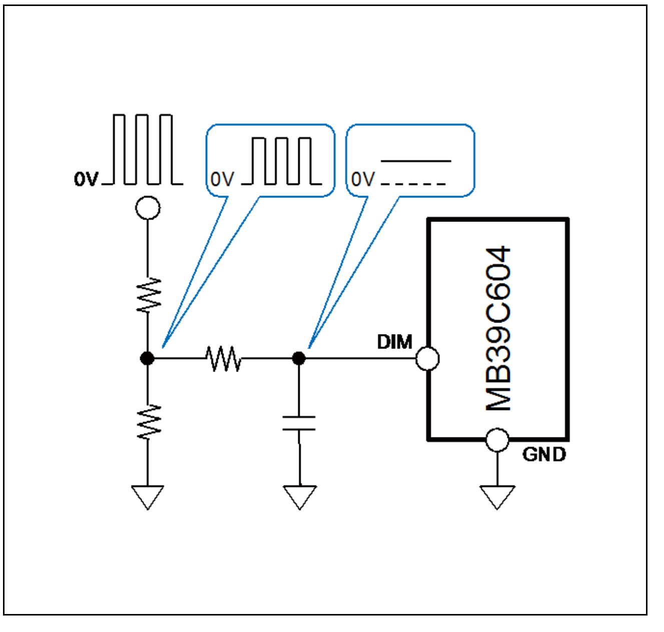


Figure 11-3 DIM Pin Input Circuit



11.4 Power-On Sequence

When the AC line voltage is supplied, the voltage is supplied to V_{BULK} through a diode bridge and supplies the current to VDD pin through source-follower of external BiasMOS. When VDD pin is charged and the voltage of VDD pin becomes more than the UVLO threshold voltage, the internal Bias circuit starts operating, and starts the dimming control. The hi-charging starts after UVLO release, and switching starts. In addition, MB39C604 becomes the forced switching mode at that time. (T_{ON}=1.5µs, T_{OFF}=78µs to 320µs) When the voltage of TZE pin becomes more than the threshold voltage (V_{TZETH}=0.7V) , MB39C604 becomes the normal operation mode.

After the switching begins, the voltage of VDD pin is supplied through the external diode from Auxiliary Winding. In addition, the voltage of Auxiliary Winding is decided by the turns ratio with Auxiliary Winding turns and Secondary Winding turns, and the voltage of Secondary Winding. Therefore, the voltage of VDD pin is not supplied from Auxiliary Winding, until the voltage of Auxiliary Winding becomes more than the voltage of VDD pin. In addition, the voltage of VDD pin is not supplied through BiasMOS, because V_{BULK} is low at the zero cross point of the AC line voltage. In this period, it is necessary to set the capacitor of the VDD pin to prevent the voltage of the VDD pin from falling below the threshold voltage of UVLO. The external diode between BiasMOS and VDD pin is used to prevent discharge from VDD pin to V_{BULK} at zero cross point of the AC line voltage.

Figure 11-4 VDD Supply Path at Power-On

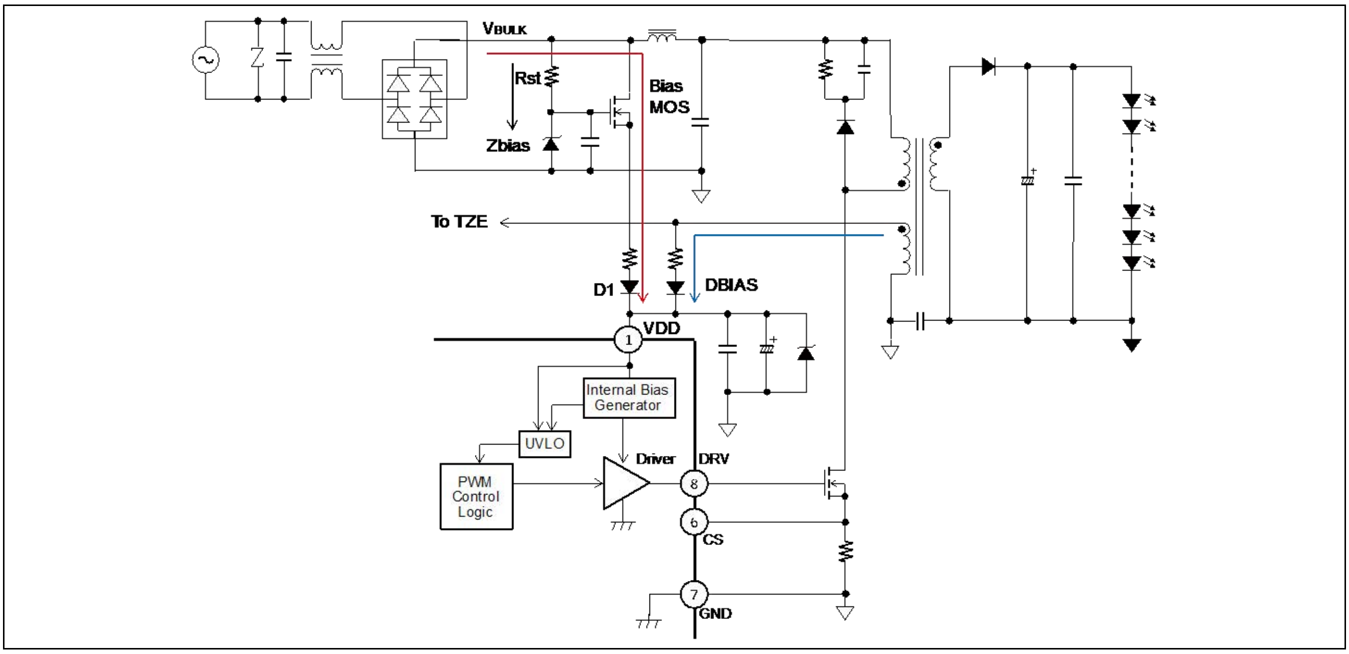
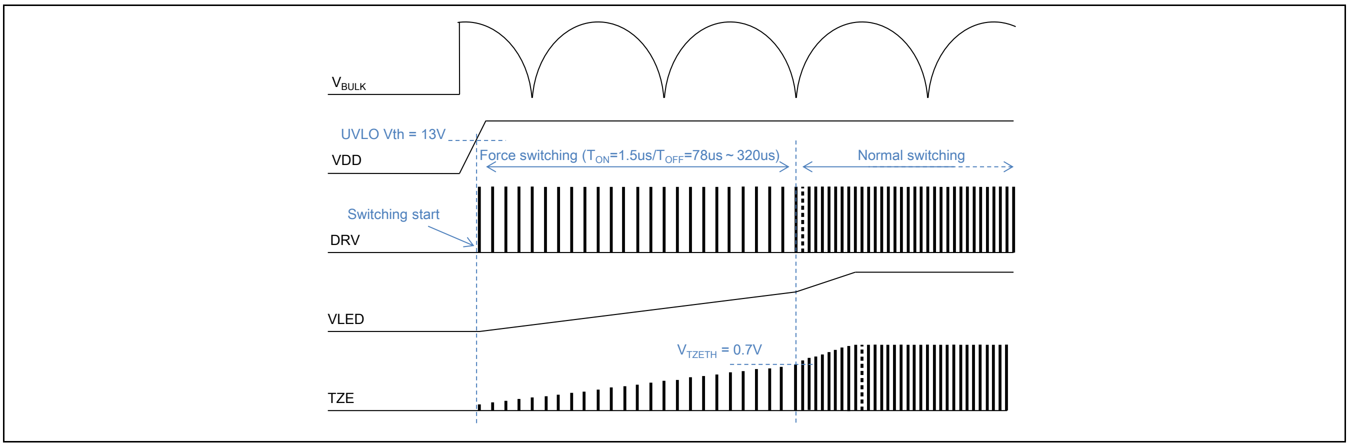


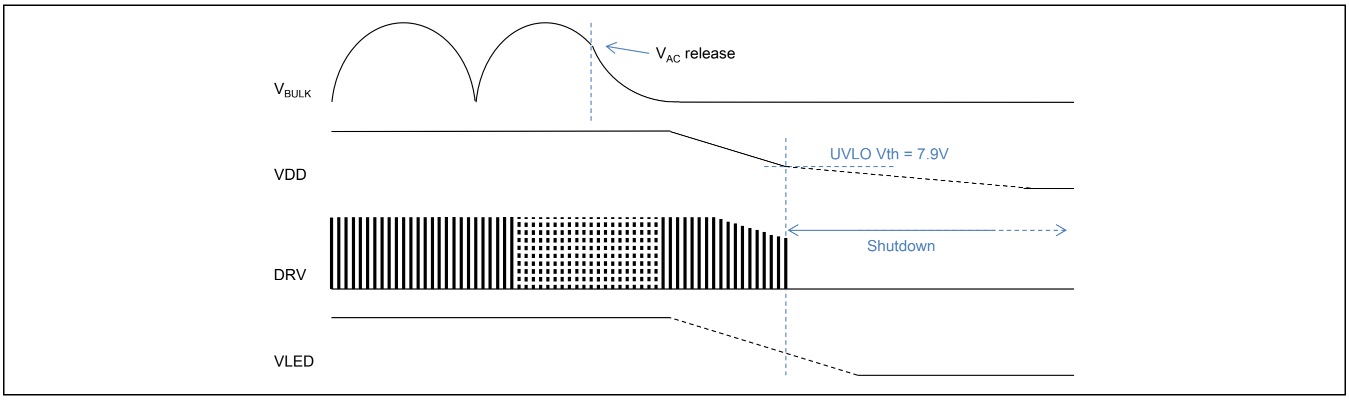
Figure 11-5 Power-On Waveform



11.5 Power-Off Sequence

When the AC line voltage is released, V_{BULK} is discharged by switching operation. At that time, I_{LED} is supplied from the output capacitor only and decreases gradually, because the current is not supplied to Secondary Winding. The voltage of VDD pin decreases, because the current supply to VDD pin becomes without Auxiliary Winding, both source-follower. When the voltage of VDD pin becomes less than the UVLO threshold voltage, MB39C604 becomes shutdown.

Figure 11-6 Power-Off Waveform



11.6 I_{P_PEAK} Detection Function

This function detects Primary Winding peak current (I_{P_PEAK}) of Transformer. I_{LED} is set by connecting resistance (Rcs) to CS pin between GND pin. Maximum I_{P_PEAK} ($I_{P\_PEAKMAX}$) at the time of the Over Current Protection (OCP) is set at the same time, too.
Using the turns ratio (N_P/N_S) with Primary Winding turns (N_P) and Secondary Winding turns (N_S), and I_{LED}, R_{CS} is expressed by the following calculation.

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

In addition, using the OCP threshold voltage (V_{OCPTH}) and the sense resistance (R_{CS}), $I_{P\_PEAKMAX}$ is expressed by the following calculation.

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

11.7 Zero Voltage Switching Function

MB39C604 has zero voltage switching function built-in to minimize a switching loss of the external switching MOSFET. The following functions are necessary to realize zero voltage switching.

(1) Detect that the energy of the transformer becomes zero
(2) Let a driver turn on at the lowest point of the energy ringing of transformer

(1) is possible to detect by TZE pin through resistance connected Auxiliary Winding of transformer.
(2) is possible to realize by adjustment on on-timing of switching MOSFET and adjustment on detection of the Secondary side current-releasing time. Adjustment time (t_{ADJ}) is set by connecting resistance (R_{ADJ}) to ADJ pin between GND pin. Using Primary Winding inductance (L_P), and the parasitic capacitor of switching MOSFET drain (C_D), t_{ADJ} is expressed by the following calculation.

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

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

$$R_{DLY}\,[k\Omega] = 0.092 \times t_{ADJ}\,[ns] - 3.85$$

11.8 Various Protection Functions

Under Voltage Lockout Protection (UVLO)

The under voltage lockout protection (UVLO) protects IC from malfunction and protects the system from destruction/deterioration during the transient state and momentary drop due to start up for the power supply pin voltage (VDD). The voltage decrease of the VDD pin is detected with comparator, and the voltage of DRV pin is turned to “L”, and the switching is stopped. The system automatically returns to the normal operation mode when the voltage of VDD pin becomes more than the UVLO threshold voltage.

Over Voltage Protection (OVP)

The over voltage protection (OVP) protects parts of Secondary side from an excessive stress voltage by the rising of the output voltage, when the LED dropout. The output overvoltage is detected by TZE pin. When current of Secondary side is supplied, output voltage appears to TZE pin that is the voltage division of Auxiliary Winding. When the voltage of TZE pin rise more than the threshold of the over voltage detecting circuit and the period passes more than three switching cycles, the voltage of DRV pin is turned to “L”, and the switching is stopped (latch off). A latch is removed, when the voltage of VDD pin becomes less than the UVLO threshold voltage.

Over Current Protection (OCP)

The over current protection (OCP) protects IC from the saturation of the inductor and the transformer. The drain current of the external switching MOSFET is limited by using OCP. When the voltage of CS pin becomes more than the OCP threshold voltage, the voltage of DRV pin is turned to “L”, and the switching is stopped. When TZE pin detects Zero energy again, DRV pin is turned to “H” and the next switching cycle begin.

Short Circuit Protection (SCP)

The short circuit protection (SCP) protects the transformer and the diode of Secondary side from an excessive current stress. When the Output voltage decreases by a short circuit of the LED and the voltage of TZE pin does not become more than the SCP threshold voltage, the voltage of COMP pin is discharged to 1.5V and the switching cycle shifts to a low frequency mode.(T_{ON}=1.5µs /T_{OFF}=78µs to 320µs)

Over Temperature Protection (OTP)

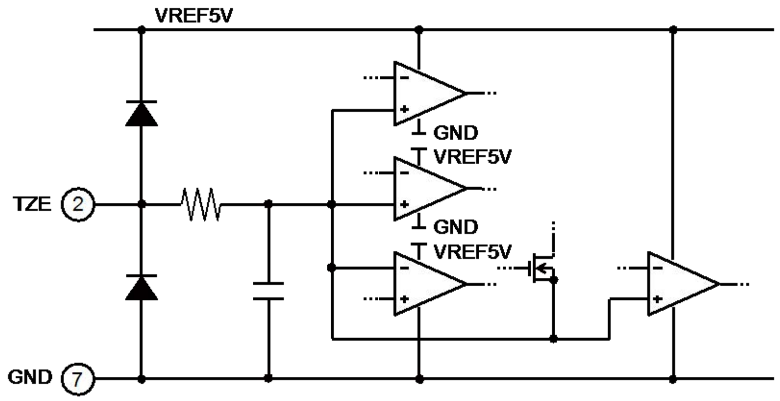
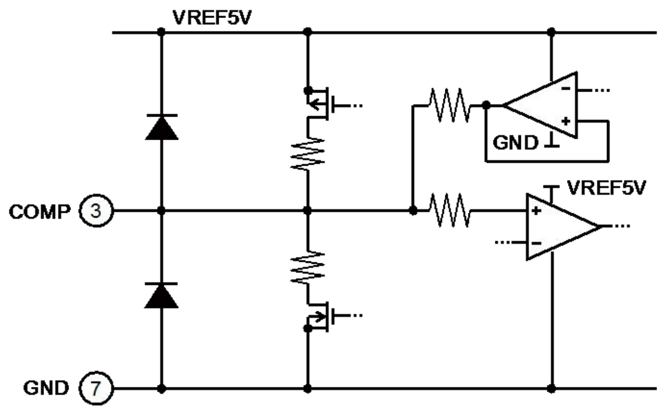
The over temperature protection (OTP) protects IC from the thermal destruction. When the junction temperature reaches +150°C, DRV pin voltage is turned to “L”, and the switching is stopped. It automatically returns to the normal operation mode when the junction temperature becomes below +125°C.

Table 11-1 Various Protection Functions Table

Function	DRV	COMP	ADJ	Detection Condition at Protected Operation	Return Condition	Remarks
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 fixation	Active	TZE > 4.2V	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 fixation	Active	TZE (peak) < 0.7V	TZE (peak) > 0.7V	Auto Restart
Over Temperature Protection (OTP)	L	1.5V fixation	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

<table>
<tr><th>Pin No.</th><th>Pin Name</th><th>Equivalent Circuit Diagram</th></tr>
<tr><td>2</td><td>TZE</td><td>
</td></tr>
<tr><td>3</td><td>COMP</td><td>
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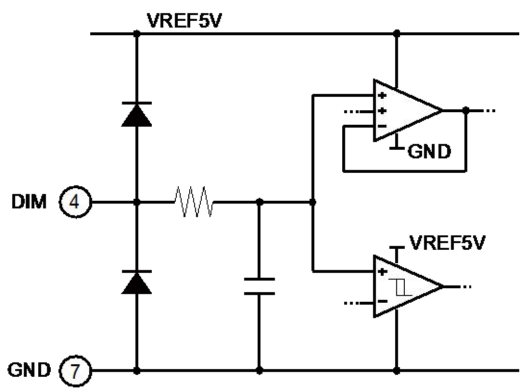
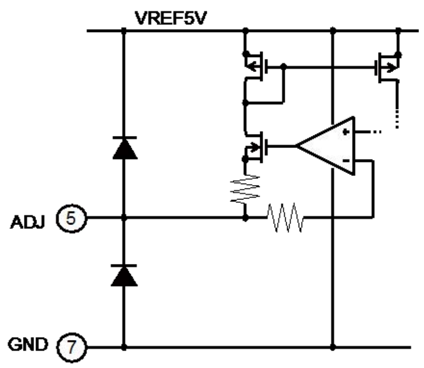
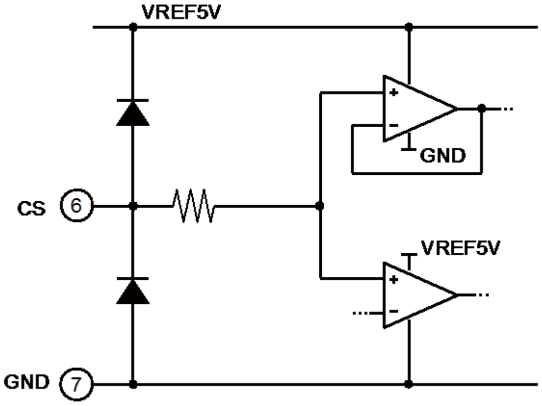
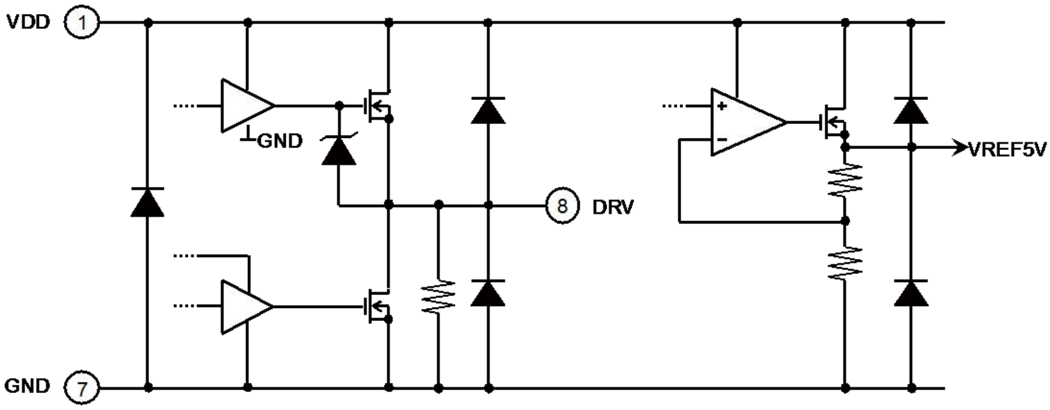
<tr><td>4</td><td>DIM</td><td>
</td></tr>
<tr><td>5</td><td>ADJ</td><td>
</td></tr>
</table>

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

13. Application Examples

13.1 50W Isolated and PWM Dimming Application

Input: AC85V$_{RMS}$ to 265V$_{RMS}$, Output: 1.5A/27V to 36V

Figure 13-1 50W EVB Schematic

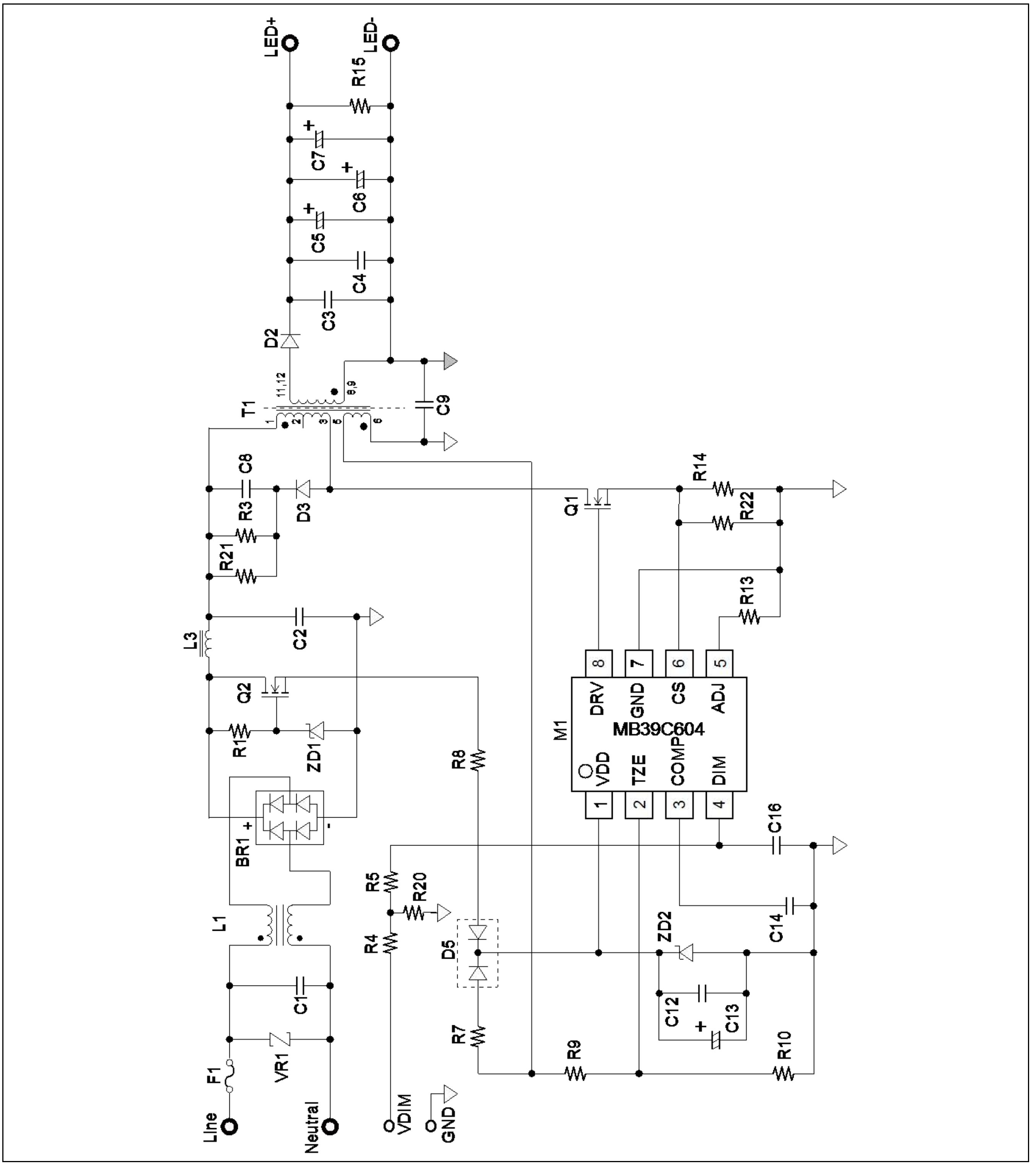
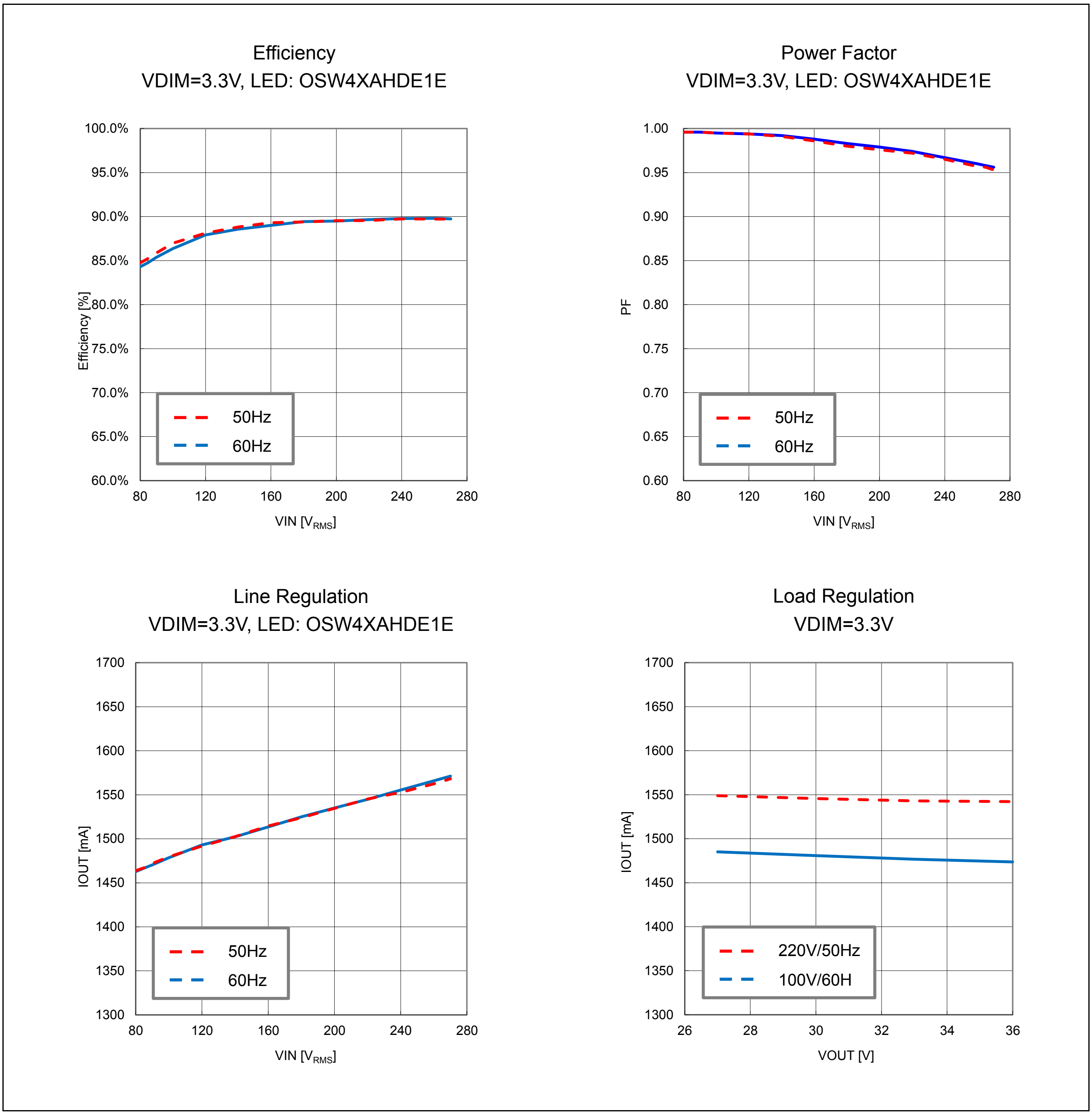


Table 13-1 50W BOM List

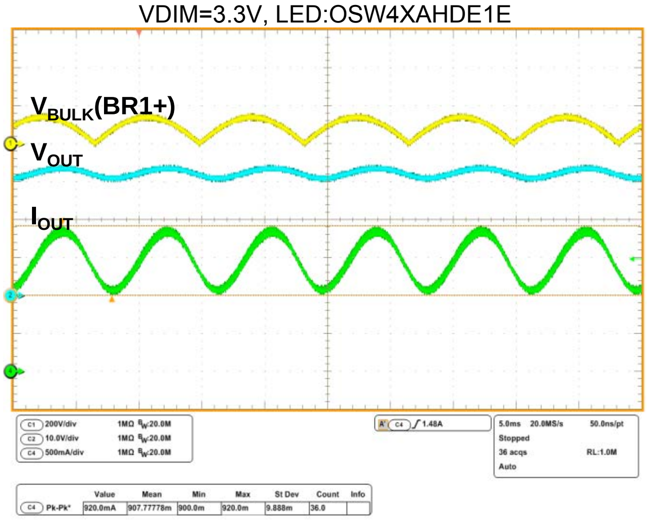
No	COMPONENT	DESCRIPTION	PART No.	VENDOR
1	M1	Driver IC for LED Lighting, SO-8	MB39C604	Spansion
2	Q1	MOSFET, N-channel, 800V, 5.5A, TO-220F	FQPF8N80C	Fairchild
3	Q2	MOSFET, N-channel, 600V, 2.8A, TO-251	FQU5N60C	Fairchild
4	BR1	Bridge rectifier, 3A, 600V, GBU-4L	GBU4J	Fairchild
5	D2	Diode, ultra fast rectifier, 10A, 200V, TO-220F	FFPF10UP20S	Fairchild
6	D3	Diode, fast rectifier, 1A, 800V, DO-41	UF4006	Fairchild
7	D5	Diode, 200mA, 200V, SOT-23	MMBD1404	Fairchild
8	ZD1	Diode, Zener, 20V, 500mW, SOD-123	MMSZ20T1G	ON Semiconductor
9	ZD2	Diode, Zener, 18V, 500mW, SOD-123	MMSZ18T1G	ON Semiconductor
10	T1	Transformer, 200μH, Np/Ns=3.5/1 Np/Na=7/1	PQ-2625	-
11	L1	Common mode choke, 47.0mH	LF2429NP-T473	Sumida
12	L3	Inductor, 1.0mH, 0.65A, 0.9Ω, 12.5ϕ × 16.0	RCH1216BNP-102K	Sumida
13	C1	Capacitor, X2, 305VAC, 0.1μF	B32921C3104M	EPCOS
14	C2	Capacitor, polyester film, 220nF, 400V, 18.5 × 5.9	ECQ-E4224KF	Panasonic
15	C3,C4	Capacitor, ceramic, 10μF, 50V, X7S, 1210	C3225X7S1H106K250AB	TDK
16	C5,C6,C7	Capacitor, aluminum electrolytic, 470μF 50V, 10.0ϕ × 20	EKMG500ELL471MJ20S	NIPPON-CHEMI-CON
17	C8	Capacitor, ceramic, 33nF, 250V, 1206	C3216X7R2E333K160AA	TDK
18	C9	Capacitor, ceramic, 2.2nF, X1/Y1 radial	DE1E3KX222M	muRata
19	C12,C16	Capacitor, ceramic, 0.1μF, 25V, 0603	-	-
20	C13	Capacitor, aluminum, 47μF, 25V	-	-
21	C14	Capacitor, ceramic, 4.7μF, 16V, 0805	-	-
22	R1	Resistor, chip, 1.00MΩ, 1/4W, 1206	-	-
23	R3,R21	Resistor, 100kΩ, 2W	-	-
24	R4	Resistor, chip, 68kΩ, 1/10W, 0603	-	-
25	R5	Resistor, chip, 1.0MΩ, 1/10W, 0603	-	-
26	R7	Resistor, chip, 10Ω, 1/8W, 0805	-	-
27	R8	Resistor, chip, 22Ω, 1/10W, 0603	-	-
28	R9	Resistor, chip, 91kΩ, 1/10W, 0603	-	-
29	R10	Resistor, chip, 24kΩ, 1/10W, 0603	-	-
30	R13	Resistor, chip, 27kΩ, 1/10W, 0603	-	-
31	R14,R22	Resistor, chip, 0.68Ω, 1/4W, 1206	-	-
32	R15	Resistor, chip, 30kΩ, 1/10W, 0603	-	-
33	R20	Resistor, chip, 100kΩ, 1/10W, 0603	-	-
34	VR1	Varistor, 275VAC, 7mm DISK	ERZ-V07D431	Panasonic
35	F1	Fuse, 2A, 300VAC	3691200000	Littelfuse

Spansion	:	Spansion, Inc
Fairchild	:	Fairchild Semiconductor International, Inc
On Semiconductor	:	ON Semiconductor
Sumida	:	SUMIDA CORPORATION
EPCOS	:	EPCOS AG
Panasonic	:	Panasonic Corporation
TDK	:	TDK Corporation
NIPPON-CHEMI-CON	:	Nippon Chemi-Con Corporation
muRata	:	Murata Manufacturing Co., Ltd.
Littelfuse	:	Littelfuse Inc

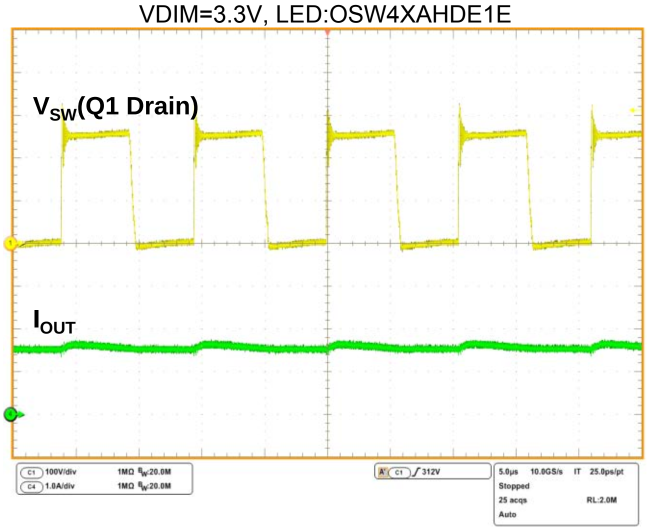
Figure 13-2 50W Reference Data



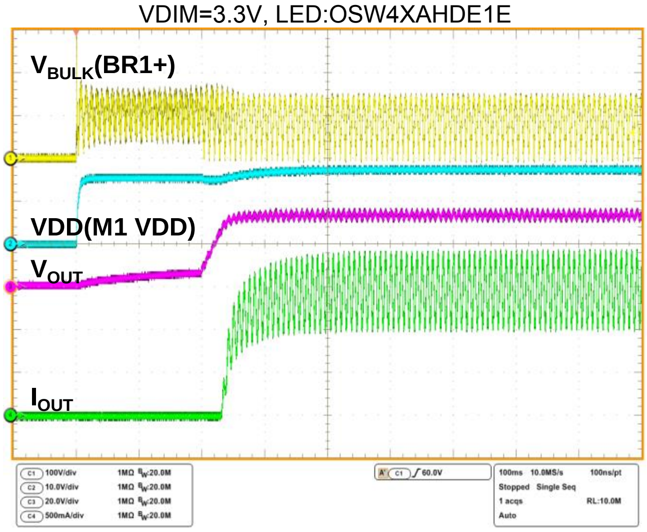
Output Ripple Waveform
V_{IN}=100V_{RMS} / 60Hz
VDIM=3.3V, LED:OSW4XAHDE1E



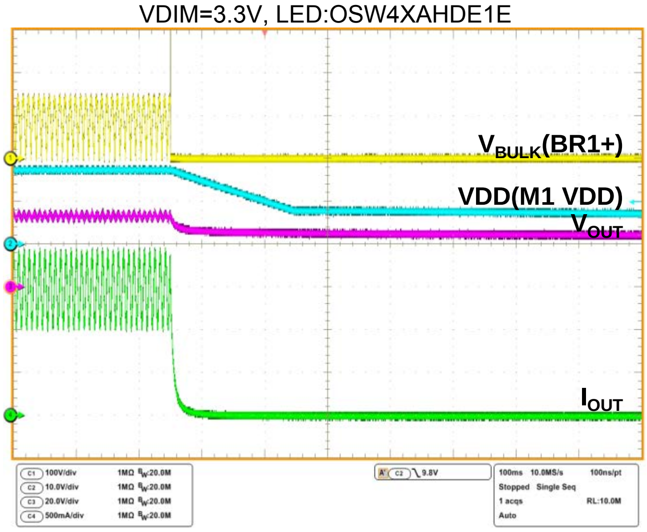
Switching Waveform
V_{IN}=100V_{RMS} / 60Hz
VDIM=3.3V, LED:OSW4XAHDE1E



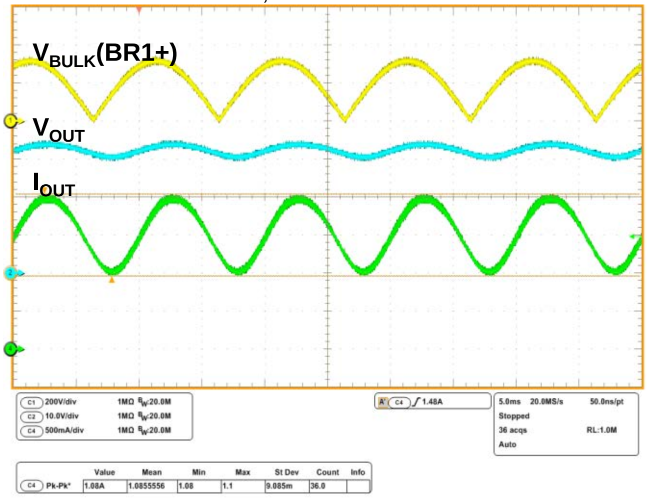
Turn-On Waveform
V_{IN}=100V_{RMS} / 60Hz
VDIM=3.3V, LED:OSW4XAHDE1E



Turn-Off Waveform
V_{IN}=100V_{RMS} / 60Hz
VDIM=3.3V, LED:OSW4XAHDE1E

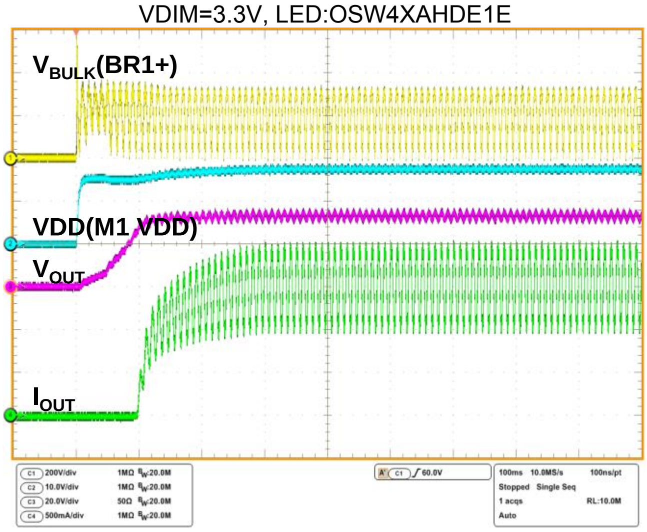


Output Ripple Waveform
V_{IN}=220V_{RMS} / 50Hz
VDIM=3.3V, LED:OSW4XAHDE1E

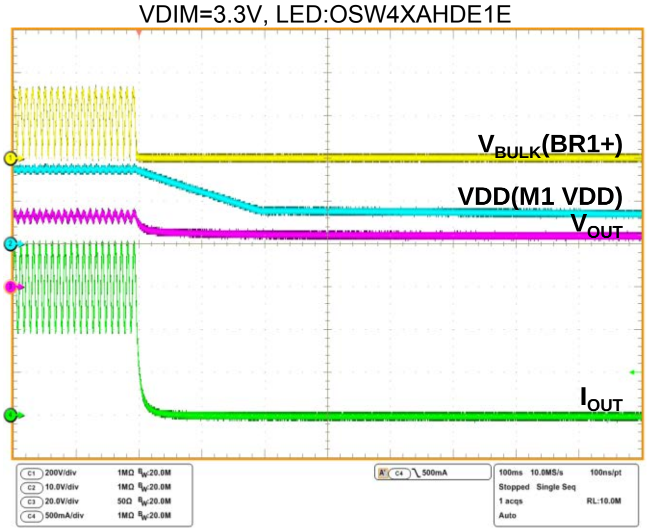


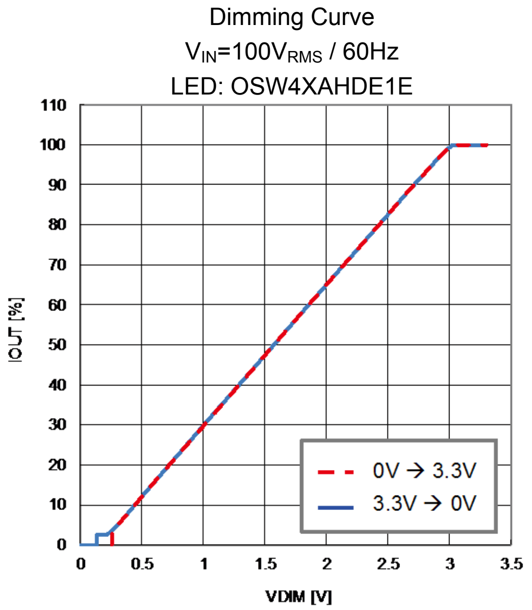
Switching Waveform
V_{IN}=220V_{RMS} / 50Hz
VDIM=3.3V, LED:OSW4XAHDE1E

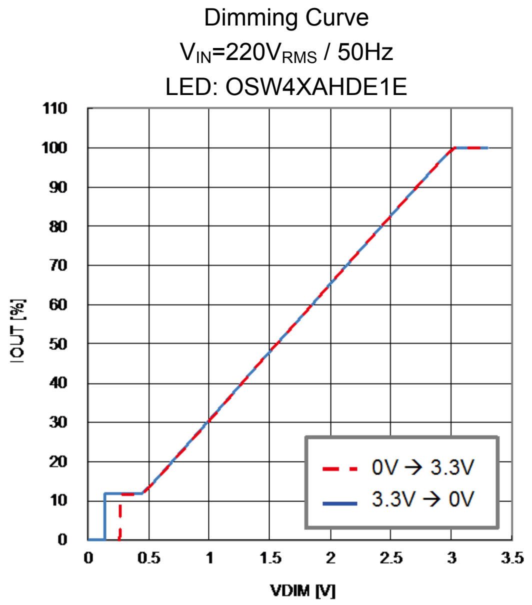
Turn-On Waveform
V_{IN}=220V_{RMS} / 50Hz
VDIM=3.3V, LED:OSW4XAHDE1E

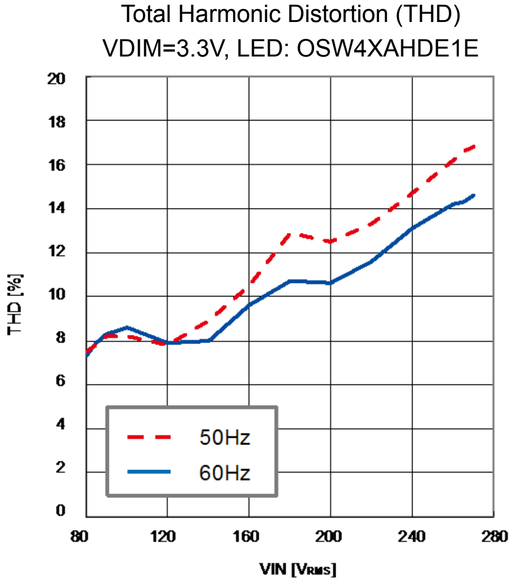


Turn-Off Waveform
V_{IN}=220V_{RMS} / 50Hz
VDIM=3.3V, LED:OSW4XAHDE1E




Dimming Curve
V_{IN}=100V_{RMS} / 60Hz
LED: OSW4XAHDE1E
IOUT [%]
VDIM [V]
0V → 3.3V
3.3V → 0V


Dimming Curve
V_{IN}=220V_{RMS} / 50Hz
LED: OSW4XAHDE1E
IOUT [%]
VDIM [V]
0V → 3.3V
3.3V → 0V


Total Harmonic Distortion (THD)
VDIM=3.3V, LED: OSW4XAHDE1E
THD [%]
VIN [VRMS]
50Hz
60Hz

13.2 5W Non-isolated and Non-Dimming Application

Input: AC85V$_{RMS}$ to 145V$_{RMS}$, Output: 70mA/67V to 82V

Figure 13-3 5W EVB Schematic

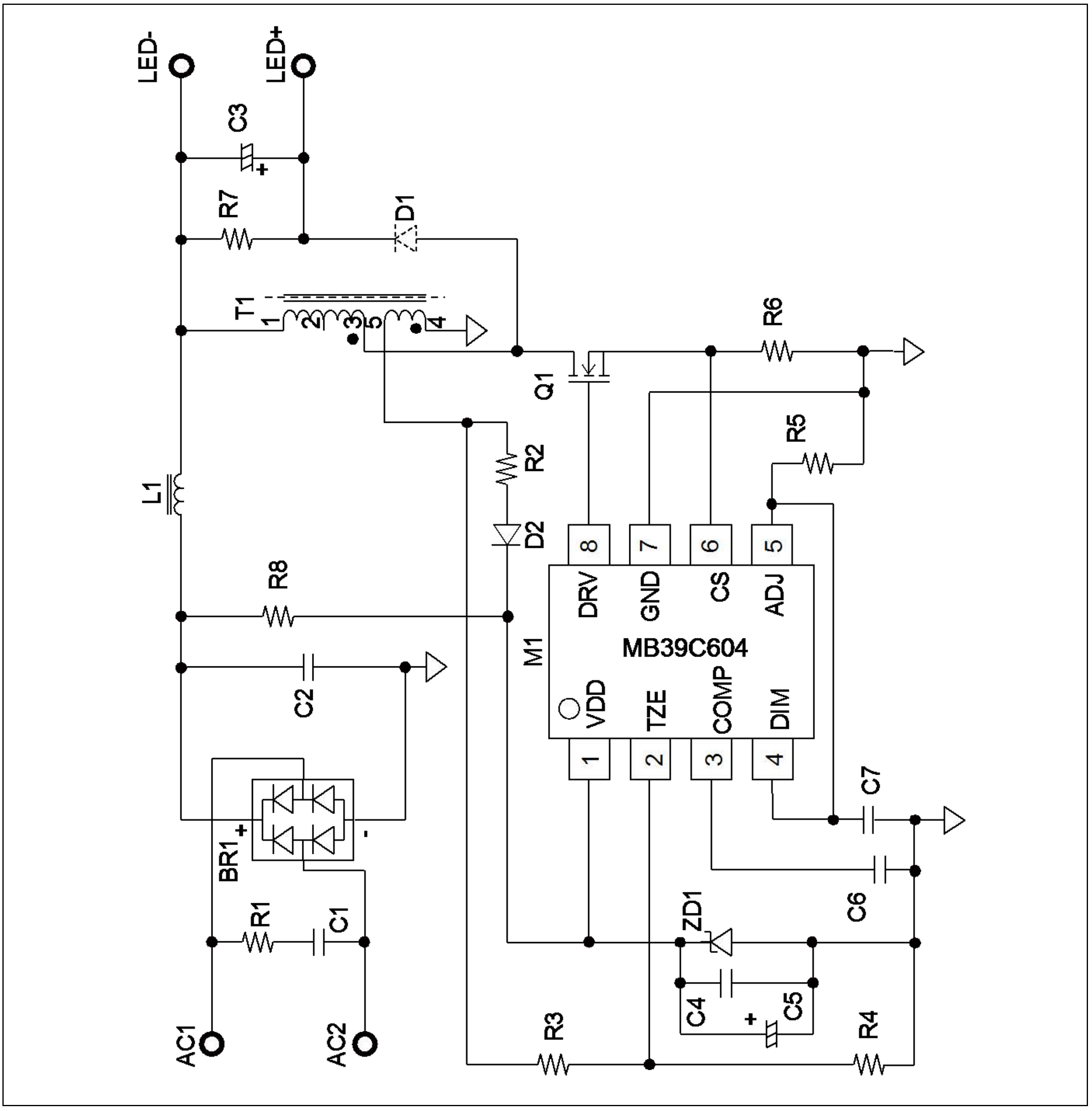
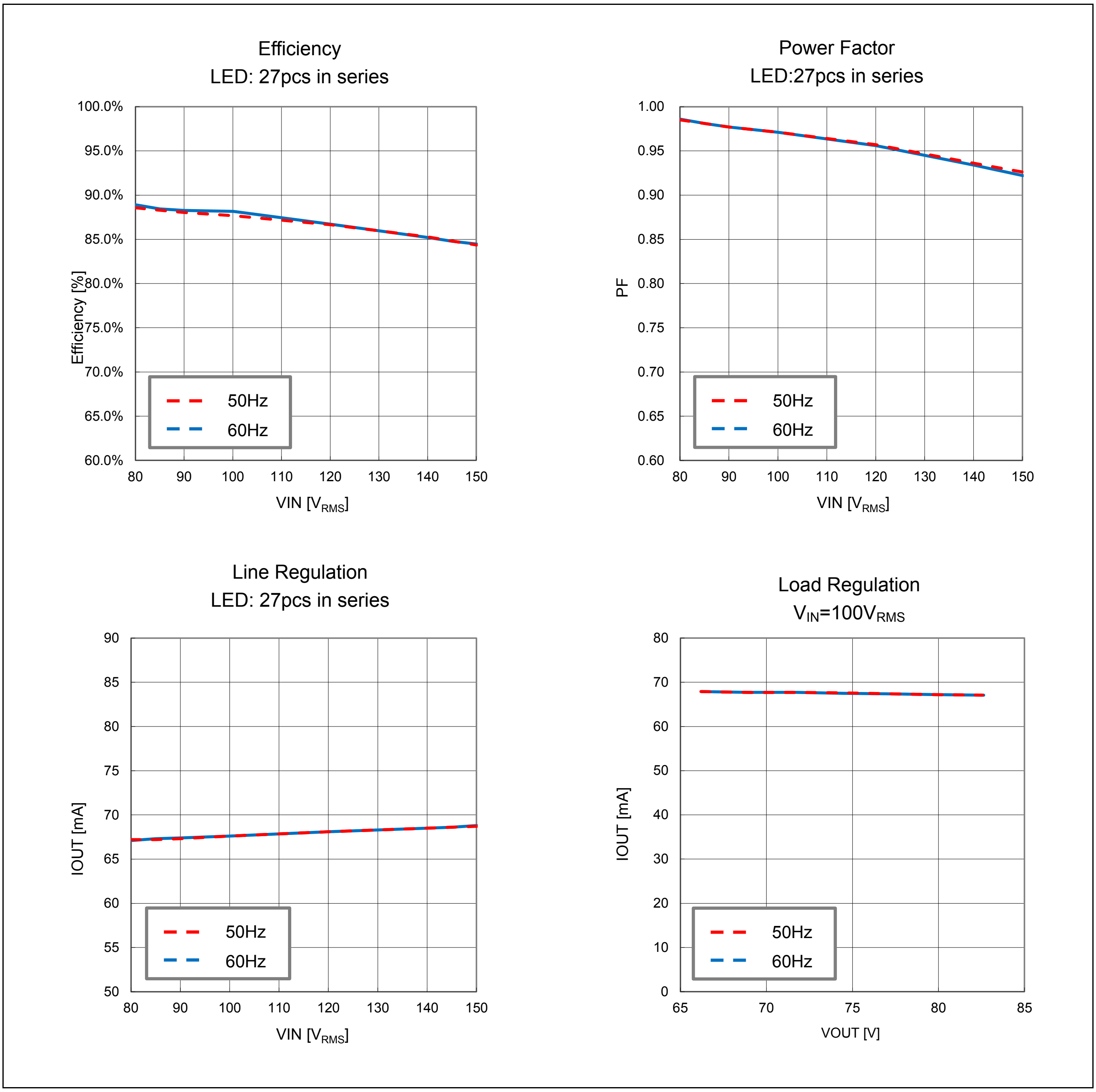


Table 13-2 5W BOM List

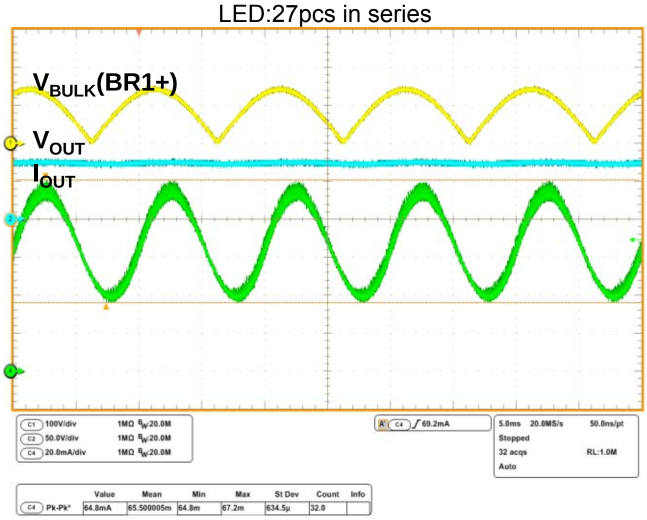
No	COMPONENT	DESCRIPTION	PART No.	VENDOR
1	M1	Driver IC for LED Lighting, SO-8	MB39C604	Spansion
2	Q1	MOSFET, N-channel, 600V, 2.8A, TO-251	FQU5N60C	Fairchild
3	BR1	Bridge rectifier, 1A, 600V, Micro-DIP	MDB6S	Fairchild
4	D1	Diode, ultra fast rectifier, 1A, 600V, SMA	ES1J	Fairchild
5	D2	Diode, 200mA, 200V, SOT-23	MMBD1404	Fairchild
6	ZD1	Diode, Zener, 18V, 500mW, SOD-123	MMSZ18T1G	ON Semiconductor
7	T1	Transformer, Lp= 430µH, Np/Na=5.33/1	EE808	-
8	L1	Inductor 470µH 0.31A ϕ7.2mm × 10.5mm	22R474C	muRata
9	C1	Capacitor, polyester film, 100nF, 630V, 18.5 × 6.3	ECQ-E6104KF	Panasonic
10	C2	Capacitor, polyester film, 100nF, 250V, 7.9 × 5.9	ECQE2104KB	Panasonic
11	C3	Capacitor, aluminum electrolytic, 100µF 100V, 10.0ϕ × 20	EKMG101ELL101MJ20S	NIPPON-CHEMI-CON
12	C4	Capacitor, ceramic, 0.1µF, 25V, 0603	-	-
13	C5	Capacitor, aluminum, 47µF, 25V	-	-
14	C6	Capacitor, ceramic, 4.7µF, 16V, 0805	-	-
15	C7	Capacitor, ceramic, 0.1µF, 25V, 0603	-	-
16	R1	Resistor, 510Ω, 1/2W	-	-
17	R2	Resistor, chip, 10Ω, 1/8W, 0805	-	-
18	R3	Resistor, chip, 110kΩ, 1/10W, 0603	-	-
19	R4	Resistor, chip, 30kΩ, 1/10W, 0603	-	-
20	R5	Resistor, chip, 22kΩ, 1/10W, 0603	-	-
21	R6	Resistor, 2Ω, 1W	-	-
22	R7	Resistor, chip, 100kΩ, 1/10W, 0603	-	-
23	R8	Resistor, 47kΩ, 2W	-	-

Spansion	:	Spansion,Inc
Fairchild	:	Fairchild Semiconductor International, Inc
On Semiconductor	:	ON Semiconductor
Panasonic	:	Panasonic Corporation
NIPPON-CHEMI-CON	:	Nippon Chemi-Con Corporation
muRata	:	Murata Manufacturing Co., Ltd.

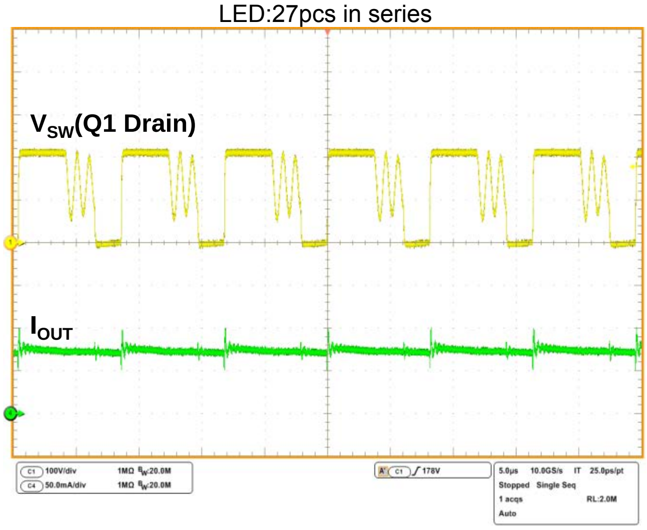
Figure 13-4 5W Reference Data



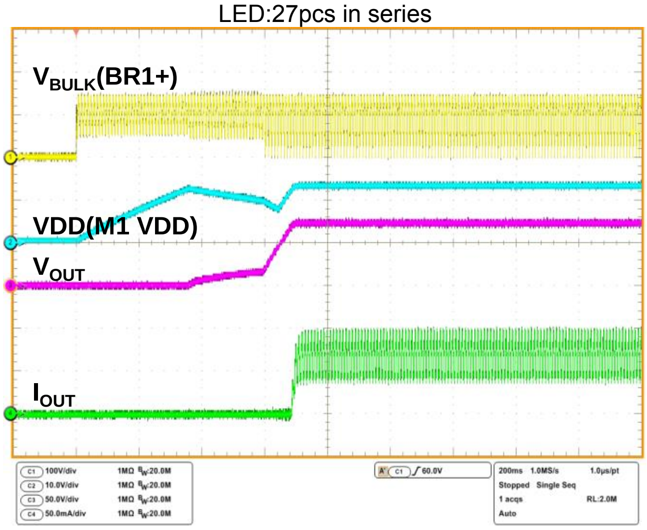
Output Ripple Waveform
V_{IN}=100V_{RMS} / 50Hz
LED:27pcs in series



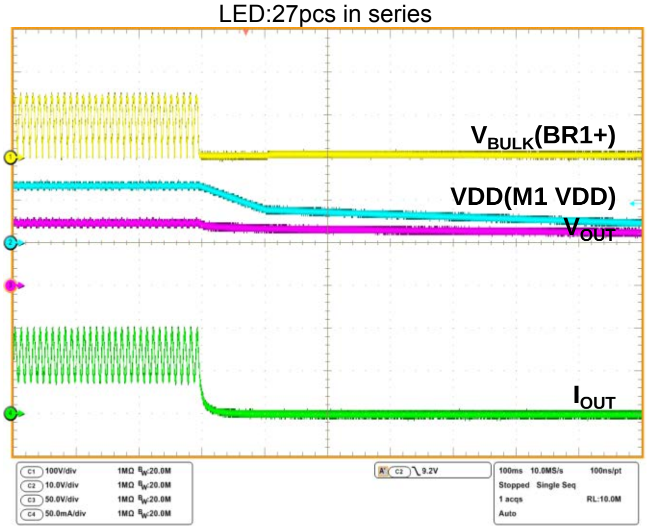
Switching Waveform
V_{IN}=100V_{RMS} / 50Hz
LED:27pcs in series

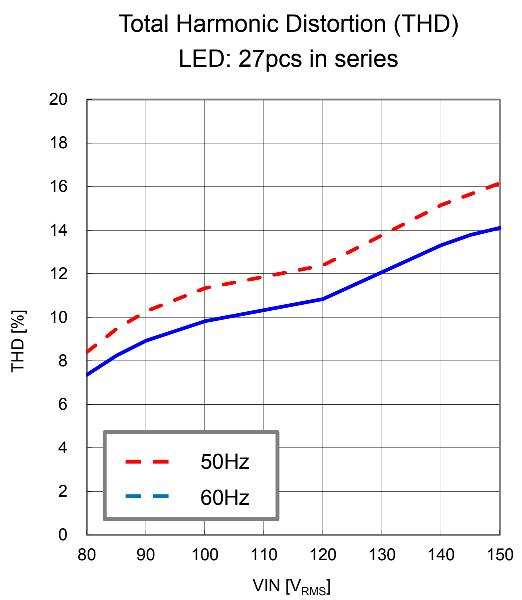


Turn-On Waveform
V_{IN}=100V_{RMS} / 50Hz
LED:27pcs in series



Turn-Off Waveform
V_{IN}=100V_{RMS} / 50Hz
LED:27pcs in series




Total Harmonic Distortion (THD)
LED: 27pcs in series
THD [%]
20
18
16
14
12
10
8
6
4
2
0
80
90
100
110
120
130
140
150
VIN [VRMS]
50Hz
60Hz

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.

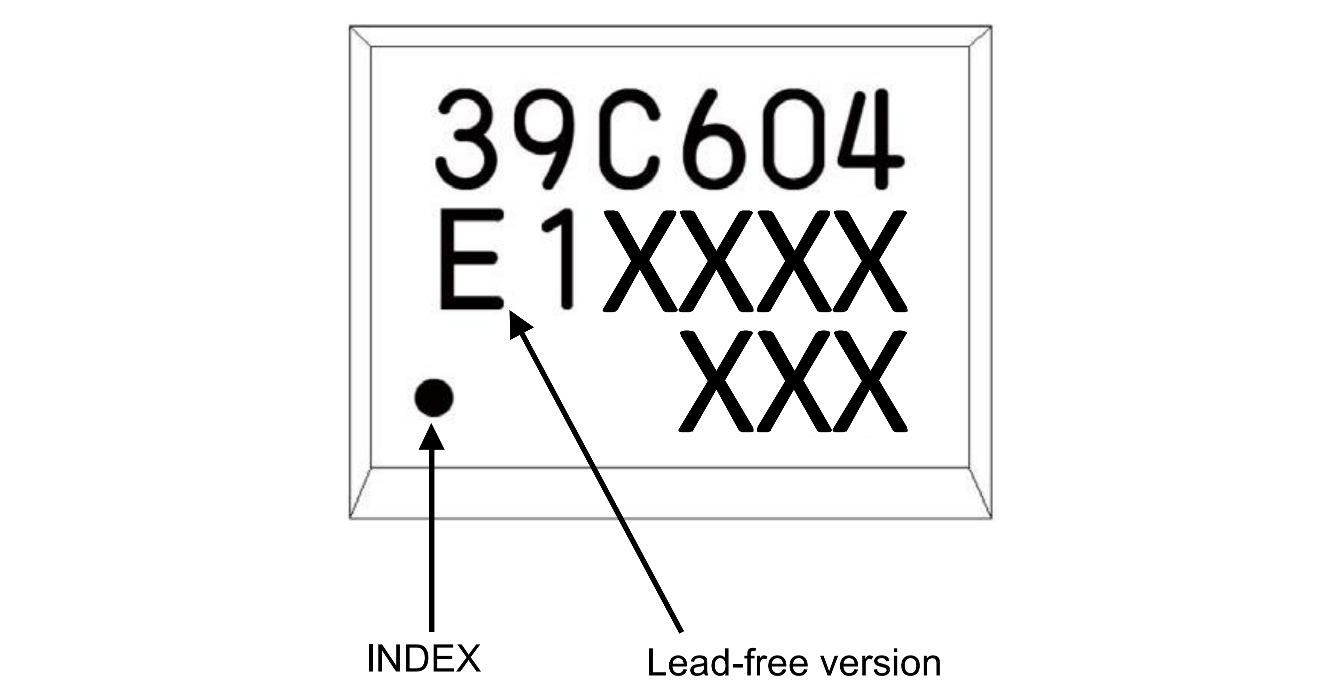
15. Ordering Information

Table 15-1 Ordering Information

Part Number	Package
MB39C604PNF	8-pin plastic SOP (FPT-8P-M02)

16. Marking Format

Figure 16-1 Marking Format



17. Labeling Sample

Figure 17-1 Labeling Sample

18. Recommended Conditions of Moisture Sensitivity Level

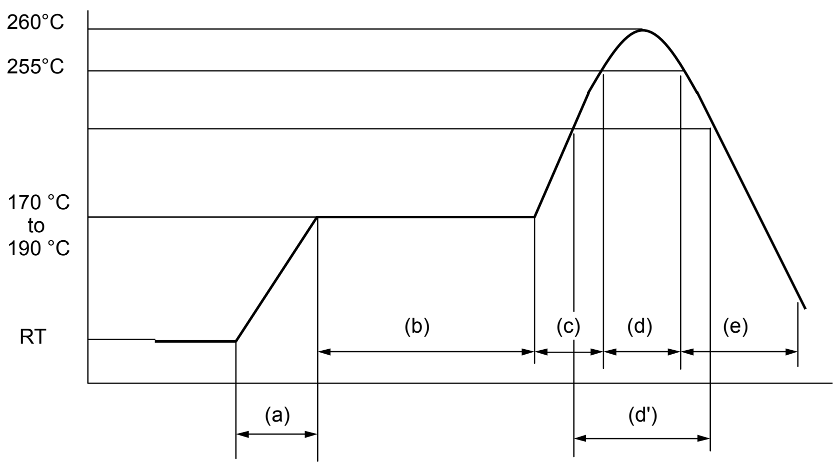
18.1 Recommended Reflow Condition

Table 18-1 Recommended Reflow Condition

Item	Condition	
Mounting Method	IR (infrared reflow), warm air reflow	
Mounting times	2 times	
Storage period	Before opening	Please use it within 2 years after manufacture.
	From opening to the 2nd reflow	Less than 8 days
	When the storage period after opening was exceeded	Please process within 8 days after baking (125°C±3°C, 24H+2H/-0H). Baking can be performed up to 2 times.
Storage conditions	5°C to 30°C, 70% RH or less (the lowest possible humidity)	

18.2 Reflow Profile

Figure 18-1 Reflow Profile



H rank : 260°C Max

(a)	Temperature Increase gradient	:	Average	1°C/s to 4°C/s
(b)	Preliminary Heating	:	Temperature	170°C to 190°C, 60s to 180s
(c)	Temperature Increase gradient	:	Average	1°C/s to 4°C/s
(d)	Peak Temperature	:	Temperature	260°C Max.
				255°C or more, 10s or less
(d')	Main Heating	:	Temperature	230°C or more, 40s or less
				or
			Temperature	225°C or more, 60s or less
				or
			Temperature	220°C or more, 80s or less
(e)	Cooling	:	Natural cooling or forced cooling	

Note : Temperature : the top of the package body

18.3 JEDEC Condition

Moisture Sensitivity Level3 (IPC/JEDEC J-STD-020D)

18.4 Recommended manual soldering (partial heating method)

Table 18-2 Recommended manual soldering

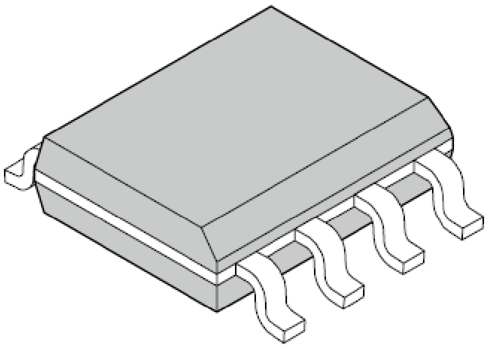
Item	Condition	
Storage period	Before opening	Within 2 years after manufacture
	Between opening and mounting	Within 2 years after manufacture (No need to control moisture during the storage period because of the partial heating method.)
Storage conditions	5°C to 30°C, 70%RH or less (the lowest possible humidity)	
Mounting conditions	Temperature at the tip of a soldering iron : 400°C Max. Time : 5 seconds or below per pin (*1)	

**1: Make sure that the tip of a soldering iron does not come in contact with the package body.*

19. Package Dimensions

Figure 19-1 Package Dimensions

8-pin plastic SOP

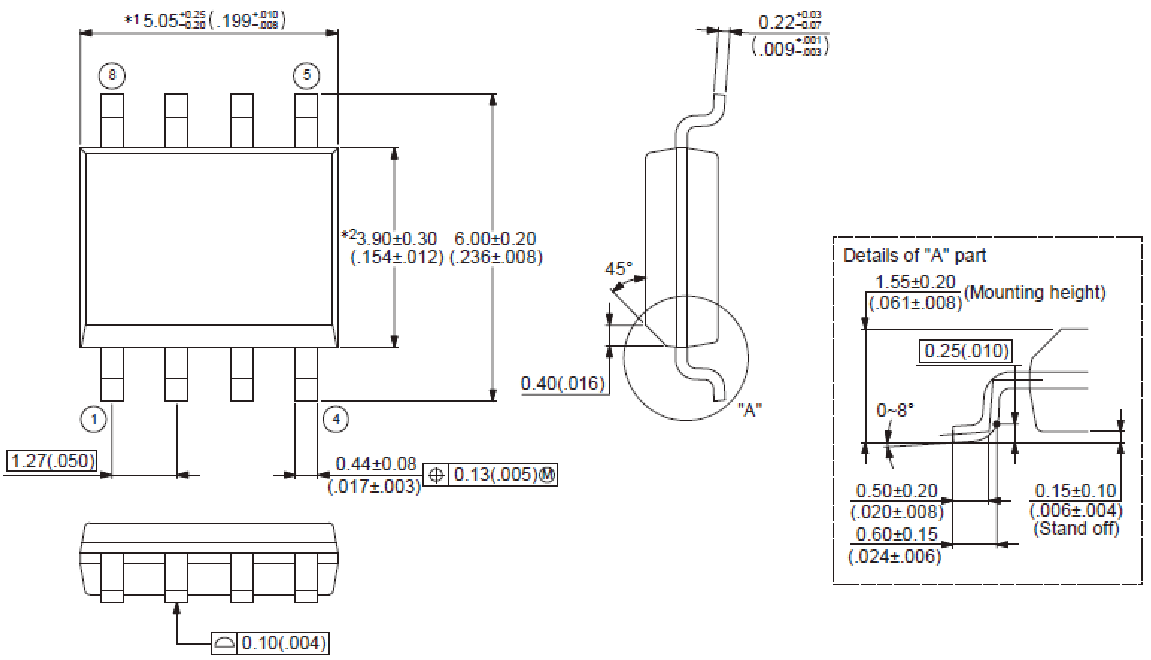


(FPT-8P-M02)

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.

Please check the latest package dimension at the following URL.
http://edevice.fujitsu.com/package/jp-search/

20. Major Changes

Page	Section	Change Results
Revision 1.0		
-	-	Initial release

Colophon

The products described in this document are designed, developed and manufactured as contemplated for general use, including without limitation, ordinary industrial use, general office use, personal use, and household use, but are not designed, developed and manufactured as contemplated (1) for any use that includes fatal risks or dangers that, unless extremely high safety is secured, could have a serious effect to the public, and could lead directly to death, personal injury, severe physical damage or other loss (i.e., nuclear reaction control in nuclear facility, aircraft flight control, air traffic control, mass transport control, medical life support system, missile launch control in weapon system), or (2) for any use where chance of failure is intolerable (i.e., submersible repeater and artificial satellite). Please note that Spansion will not be liable to you and/or any third party for any claims or damages arising in connection with above-mentioned uses of the products. Any semiconductor devices have an inherent chance of failure. You must protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over-current levels and other abnormal operating conditions. If any products described in this document represent goods or technologies subject to certain restrictions on export under the Foreign Exchange and Foreign Trade Law of Japan, the US Export Administration Regulations or the applicable laws of any other country, the prior authorization by the respective government entity will be required for export of those products.

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