

RoHS

Free

LED Drivers series for LCD Backlights PWM pulse Generator for LCD Panels



General Description

BD9478F is PWM pulse generator for LCD panel. This IC compares triangle waveform which is generated inside IC and external DC signal, and generates a PWM pulse. This PWM pulse is provided to LED driver and controls LED grayscale. PWM pulse frequency can be synchronized to external signal frequency inputted to SYNC terminal. Even if this frequency gets out of range, it works in the setting frequency, is protected and it always provides stable PWM pulse to LED driver.

Key Specification

- Operating power supply voltage range: 4.5V to 5.5V
- Free Run frequency: 150Hz (CT=0.01µF)
- Operating Current: 2mA (typ.)
- Operating temperature range: -40°C to +85°C

Applications

LED backlight of monitor, TV, NOTE PC, etc.

Typical Application Circuit



The signal that the frequency synchronizes with the VSYNC signal is output to PWMOUT.

■The PWM pulse is generated with the DC signal of a triangular wave and PDIM generated with the LCT capacitor.

■ When the VSYNC frequency exceeds the stipulated range, it fixes by a set frequency.

(fSYNC<fPLLtyp*0.35 -> fPLL=0.36*fPLLtyp , fSYNC> fPLLtyp*2.75 -> fPLL=2.75*fPLLtyp)

When VSYNC is a no signal input, the self-oscillation is operated by set frequency decided on the CT capacitance.When the pulse signal is input to the terminal EXTPWM,

it shifts automatically to external PWM mode.

Package SOP-8: Pin Pitch: W(Typ.) D(Typ.) H(Max.) 5.00mm x 6.20mm x 1.71mm 1.27mm



Figure 2. Typical Application Circuit



Figure 1. SOP-8

OProduct structure : Silicon monolithic integrated circuit OThis product is not designed protection against radioactive rays

●Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Ratings	Unit
Power supply voltage	VCC	7	V
Operating Temperature Range	Ta(opr)	-40 ~ +85	°C
Storage Temperature Range	Tstg	-55 ~ +150	°C
Junction Temperature	Tjmax	150	°C
Power Dissipation	Pd	689 %1	mW

^{*1} Decreases 5.5mW/°C at Ta=25°C or higher (When mounting a one-layer 70.0mmx70.0mmx1.6mm board)

•Operating Ratings (Ta = 25°C)

Parameter	Symbol	Range	Unit
Power supply voltage	VCC	4.5 ~ 5.5	V
VSYNC input frequency range	F_VSYNC	0.040 ~ 0.8	kHz
EXTPWM input PWM signal frequency range	F_EXTPWM	FCT ~ 30	kHz

The operating conditions written above are constants of the IC unit. Be careful enough when setting the constant in the actual set.

FCT is dimming frequency that oscillates itself when VSYNC terminal is input no signal

External Components Recommended Range

Item	Symbol	Setting Range	Unit
VCC capacitance	CVCC	0.1 ~ 10	μF
PLL Burst OSC oscillation frequency setting capacitance	СТ	0.040 ~ 0.8	uF

The operating conditions written above are constants of the IC unit. Be careful enough when setting the constant in the actual set.

●Pin Configuration



SOP-8

Figure 3. Pin Configuration

Marking diagram and physical dimension





● Electrical Characteristics (Unless otherwise specified, Ta=25°C, VCC=5V)

Demonster	Symbol	Limit				A 11/1	
Parameter		Min.	Тур.	Max.	Unit	Condition	
[Whole Device]							
Circuit Current during Operation	ICC	—	2	4	mA	PDIM=3V,CT=0.01uF VSYNC=EXTPWM=open	
[UVLO Block]							
Release voltage	VUVLO	3.5	3.8	4.1	V	VCC=SWEEP UP	
Hysteresis voltage	VUHYS	150	300	600	mV	VCC=SWEEP DOWN	
[PLL Block]							
Oscillation frequency when VSYNC is input no signal	fCTNS	142	150	158	Hz	CT=0.01µF,LPF=0V	
Triangle wave maximum voltage	VCTH	2.70	3.00	3.30	V	fCT=150Hz	
Triangle wave minimum voltage	VCTL	0.40	0.50	0.60	V	fCT=150Hz	
Synchronous signal abnormal judgment	CT_SYNC						
voltage, (at High frequency input)	_DET1	2.612	2.750	2.888	V	LPF=2.0V→3.0V	
Synchronous signal normal judgment	CT_SYNC						
voltage, (at High frequency input)	_ОКН	2.517	2.650	2.783	V	LPF=3.0V→2.0V	
Internal RT voltage at Synchronous							
signal, abnormal judgment when High	VOTELL		0.750				
Surphysical charges indemont		-	2.750	-	V	LPF=3V	
Synchronous signal abnormal judgment		0 224	0.250	0.200	V		
Synchronous signal permatindement		0.331	0.350	0.369	V	$LPF=1.0V \rightarrow 0.1V$	
Synchronous signal normal judgment		0 4 1 4	0.450	0 4 8 6	V		
Internal PT voltage at Synchronous		0.414	0.450	0.400	v	$LFF=0.1V \rightarrow 1.0V$	
signal abnormal judgment when High							
frequency input	VRTEI	_	0 360	_	V	L PE=0.25V	
Switch voltage to internal fixed	VICITE		0.000		v	211-0.201	
frequency	VINTE	0.10	0.15	0.20	V	LPF=1.0V→0.1V	
Internal RT voltage at switched to							
internal fixed, frequency	VRTFI	-	0.900	-	V	LPF=0V	
【Input pin (EXTPWM,PDIM,VSYNC)】							
Input High level	VIH	2.0	-	20	V		
Input Low level	VIL	-0.3	-	0.8	V		
Pull down resistance	RIPD	0.5	1.0	2.0	MΩ		
[Output pin (PWMOUT)]							
Output High level	VOH	4.3	4.85	-	V	lo=-1mA	
Output Low level	VOL	-	0.1	0.5	V	lo=1mA	

Pin Descriptions

Pin No	Pin Name	In/Out	Function	Rating [V]
1	VCC	-	Power supply	-0.3~7
2	EXTPWM	In	External PWM signal input	-0.3~20
3	PDIM	In	DC signal input for Internal PWM	-0.3~20
4	VSYNC	In	Synchronous signal input	-0.3~20
5	СТ	Out	Capacitance pin for VCO	-0.3~7
6	LPF	In/Out	LPF output for PLL	-0.3~7
7	GND	-	Ground	-
8	PWMOUT	Out	PWM dimming signal output	-0.3~7

Pin ESD Type



Figure 5. Pin ESD Type

Block Diagram



Figure 6. Block Diagram

Typical Performance Curve



Figure 11. Start up waveform (Free Run mode)



Figure 12. EXTPWM mode waveform



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Pin Function

OPin 1: VCC

Power supply pin of the IC. Input range is from 4.5V to 5.5V Operation starts at VCC=3.8V(TYP.) or higher and shuts down at VCC=3.5V(TYP.) or lower.

OPin 2: EXTPWM

External PWM signal input terminal.

In case of the following equation, the signal input to EXTPWM is output directly to PWMOUT.

The equation ; f(PLL) < 2 * f(EXTPWM) f(EXTPWM) ; frequency of signal input to EXTPWM

f(PLL); frequency of signal that synchronizes with VSYNC signal

OPin 3: PDIM

DC signal input terminal to generate internal PWM signal. The PWM signal is generated with compare it with a triangular waveform in IC. If PDIM input DC level is changed, PWM Duty can be changed. PDIM input DC voltage range is from 0.5V to 3.0V. (PWM Duty is changed from 0% to 100%)

OPin 4: VSYNC

Synchronous signal input terminal.

The signal that synchronizes with the frequency of the signal input to VSYNC is generated with PLL. A triangular wave is generated based on the frequency of this synchronized signal, and the PWM pulse is generated with compare it with the PDIM signal

OPin 5: CT

Capacitor connection terminal that decides the oscillation frequency of VCO.. Please adjust the capacity of CT by the following equation so that the voltage of the terminal LPF may become 0.9V when the frequency of the signal that synchronizes is input.

$$CT = \frac{1.5}{f_{PLLtyp}[Hz]} \quad [uF]$$

OPin 6: LPF

Low pass filter connection pin.

The pulse signal output from Phase Comparator is smoothed by Low path filter, and it inputs to Voltage. Controlled Oscillator (VCO).

OPin 7: GND

Ground pin of this IC.

OPin 8: PWMOUT

PWM signal output pin. The PWM signal generated in IC is output.

About Dimming Function

Burst Frequency Free Run Function

Because PLL is incorporated, Free Run operation is possible for burst frequency.

PLL circuit will operate like it synchronizes with the frequency of signal input to VSYNC pin.

Then, the voltage that is in proportion to the frequency will be generated in LPF pin.

When LPF pin voltage becomes 0.35V or lower, it will judge the external burst frequency is abnormal and clumps with the frequency of fPLLmin. Then, PLL frequency is changed to Free Run frequency. (note1)

When the burst frequency becomes normal and LPF pin becomes over 0.9V, it will return to the state that synchronizes with the burst frequency.(note2)

In the same way, when LPF pin becomes 2.75V or more, it will clump with the frequency of fPLLmax.

When the burst frequency becomes normal and LPF2 pin becomes 2.65V or lower, it will return to the state that synchronizes with the burst frequency.

When LPF pin becomes 0.15V or lower, it will judge the external burst frequency is not inputted and switches to the frequency of fPLLtyp.(Free Run mode)



Note1

If fVSYNC is less than fPLLmin, the input of VCO is fixed to 0.36V inside IC, and PWM frequency is fixed to fPLLmin. However, since it is fVSYNC<fPLLmin, a LPF terminal approaches 0V. Then, it is set to LPF<0.15V, and it shifts to Free Run mode and PWM frequency is set to fPLLtyp.

Note2

In order to shift to PLL mode, it is necessary to input bigger frequency than Free Run frequency into VSYNC.



(Free Run Operation Explanation)

For example, if you set CT=0.01uF (At this time, fPLLtyp is adjusted to 150 Hz.) and f(VSYNC)=180Hz,

the LPF pin voltage becomes 1.2V.

The built-in VCO is proportional to the LPF pin voltage.

If VSYNC is inputted to low frequency and it becomes LPF<0.35V (at this time, f<58Hz), it will clump at fPLLmin=58Hz. However, since it is fVSYNC<fPLLmin, a LPF terminal approaches 0V.

Then, it is set to LPF<0.15V, and it shifts to Free Run mode and PWM frequency is set to fPLLtyp.

(at this time, f=150Hz). If fSYNC is larger than fPLLtyp, PWM frequency will return to the frequency that synchronizes with f(VSYNC).

If VSYNC is inputted high frequency and it becomes LPF>2.75V (at this time, f>343Hz), it will clump at fPLLmax=343Hz. When synchronous signal is not inputted to VSYNC terminal, LPF voltage decreases and then it becomes LPF<0.15V (at this time, f<19Hz), it oscillates typical frequency (at this time, f=150Hz).

Note: Please set f(VSYNC) frequency to satisfy the following equations when you start up PLL mode. And then, please change f(VSYNC) frequency. f(VSYNC) > fPLLtyp , fPLLtyp = 1.5/(CT[uF]) [Hz]

Dimming Signal Automatic Selection Function

In this IC, even if either PWM dimming signal or DC dimming signal is inputted into the DUTY pin, it is automatically distinguished as DC or PWM in the IC.

By detecting 4 cycles of the PWM signal within the 8 cycles of the burst frequency in the IC, it will switch automatically to PWM dimming.

Therefore, set the burst frequency in the IC as follows:

(Burst Frequency in the IC(same fSYNC)) < 2 X (Externally inputted PWM signal (fEXTPWM))Also, if you do not detect 4 cycles of the PWM signal within the 8 cycles of the burst frequency after switching to PWM dimming, it will automatically switch to DC dimming.

(a) When (Burst Frequency in the IC) < 2 X (Externally inputted PWM signal)



(b) When (Burst Frequency in the IC) \geq 2 X (Externally inputted PWM signal)



Operational Notes

- Although the quality of this product has been tightly controlled, deterioration or even destruction may occur if the absolute maximum ratings, such as for applied pressure and operational temperature range, are exceeded. Furthermore, we are unable to assume short or open mode destruction conditions. If special modes which exceed the absolute maximum ratings are expected, physical safely precautions such as fuses should be considered.
- 2.) The IC can destruct from reverse connection of the power supply connector. Precautions, such as inserting a diode between t he external power supply and IC power terminal, should be taken as protection against reverse connection destruction.
- 3.) When attaching to the printed substrate, pay special attention to the direction and proper placement of the IC. If the IC is att ached incorrectly, it may be destroyed. Destruction can also occur when there is a short, which can be caused by foreign objects entering between outputs or an output and the
- power GND.4.) Because there is a return of current regenerated by back EMF of the external coil, the capacity value should be determined af ter confirming that there are no problems with characteristics such as capacity loss at low temperatures with electrolysis conde
- nsers, for example by placing a condenser between the power supply and GND as a route for the regenerated current.
- 5.) The potential of the GND pin should be at the minimum potential during all operation status
- 6.) Heat design should consider power dissipation (Pd) during actual use and margins should be set with plenty of room.
- 7.) Exercise caution when operating in strong magnet fields, as errors can occur.
- 8.) When using this IC, it should be configured so that the output Tr should not exceed absolute maximum ratings and ASO. Wit h CMOS ICs and ICs which have multiple power sources, there is a chance of rush current flowing momentarily, so exercise c aution with power supply coupling capacity, power supply and width of GND pattern wiring and its layout.
- 9.) This IC has a built-in Temperature Protection Circuit (TSD circuit). The temperature protection circuit (TSD circuit) is only to cut off the IC from thermal runaway, and has not been designed to protect or guarantee the IC. Therefore, the user should not plan to activate this circuit with continued operation in mind.
- 10.) If a condenser is connected to a pin with low impedance when inspecting the set substrate, stress may be placed on the IC, so there should be a discharge after each process. Furthermore, when connecting a jig for the inspection process, the power must first be turned OFF before connection and inspection, and turned OFF again before removal.
- 11.) This IC is a monolithic IC, and between each element there is a P+ isolation and P substrate for element separation. There is a P-N junction formed between this P-layer and each element's N-layer, which makes up various parasitic elements.
 - For example, when resistance and transistor are connected with a terminal as in figure 15:
 - OWhen GND>(terminal A) at the resistance, or GND>(terminal B) at the transistor (NPN), the P-N junction operates as a parasitic diode.
 - OAlso, when GND>(terminal B) at the transistor, a parasitic NPN transistor operates by the N-layer of other elements close to the aforementioned parasitic diode.

With the IC's configuration, the production of parasitic elements by the relationships of the electrical potentials is inevitable. The operation of the parasitic elements can also interfere with the circuit operation, leading to malfunction and even destruction. Therefore, uses which cause the parasitic elements to operate, such as applying voltage to the input terminal which is lower than the GND (P-substrate), should be avoided.



Figure 17. Example of Simple Structure of Monolithic IC

Status of this document

The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.

If there are any differences in translation version of this document formal version takes priority

Ordering Information



Physical Dimension Tape and Reel Information

SOP8



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 - [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 (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
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- 4. The Products are not subject to radiation-proof design.
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