DATA SHEET
(Tentative)

Part No.	AN37010A
Package Code No.	HSOP042-P-0400D

Contents

AN37010A (Tentative)

4-channel LED driver, including a built-in DC/DC converter, for LCD TV backlight

■ Overview

AN37010A is a 4-channel LED driver IC, which has a built-in step-up DC/DC converter, for LCD TV backlight. It is possible to drive series-connected LEDs by the voltage of less than 185 V applied to each channel. It is possible to input PWM duty pulses to each channel from outside. Moreover, since the maximum LED current value of each 4-channel can be adjusted by external applied voltage, either normal mode or backlight scan mode can be used by selecting the maximum LED current value.

■ Features

- LED driver IC with 4-channel constant current output
- Integrated 185 V, 2 Ω (typ.) MOSFETs for LED Driver Stages
- LED drive current range of each channel : 10 mA to 200 mA
- Individual dimming control can be set by PWM input
- The maximum current value of each channel can be set by an external resistor and external applied voltage.
- Built-in various protection functions
  - Thermal shutdown protection
  - Over-voltage protection
  - Over-current protection
  - LED abnormal detection etc.
- Built-in 5 V regulator for internal circuits of IC
- The switching frequency of DC/DC converter is synchronized with an external signal

■ Applications

- LED backlight for LCD TV, LCD monitor

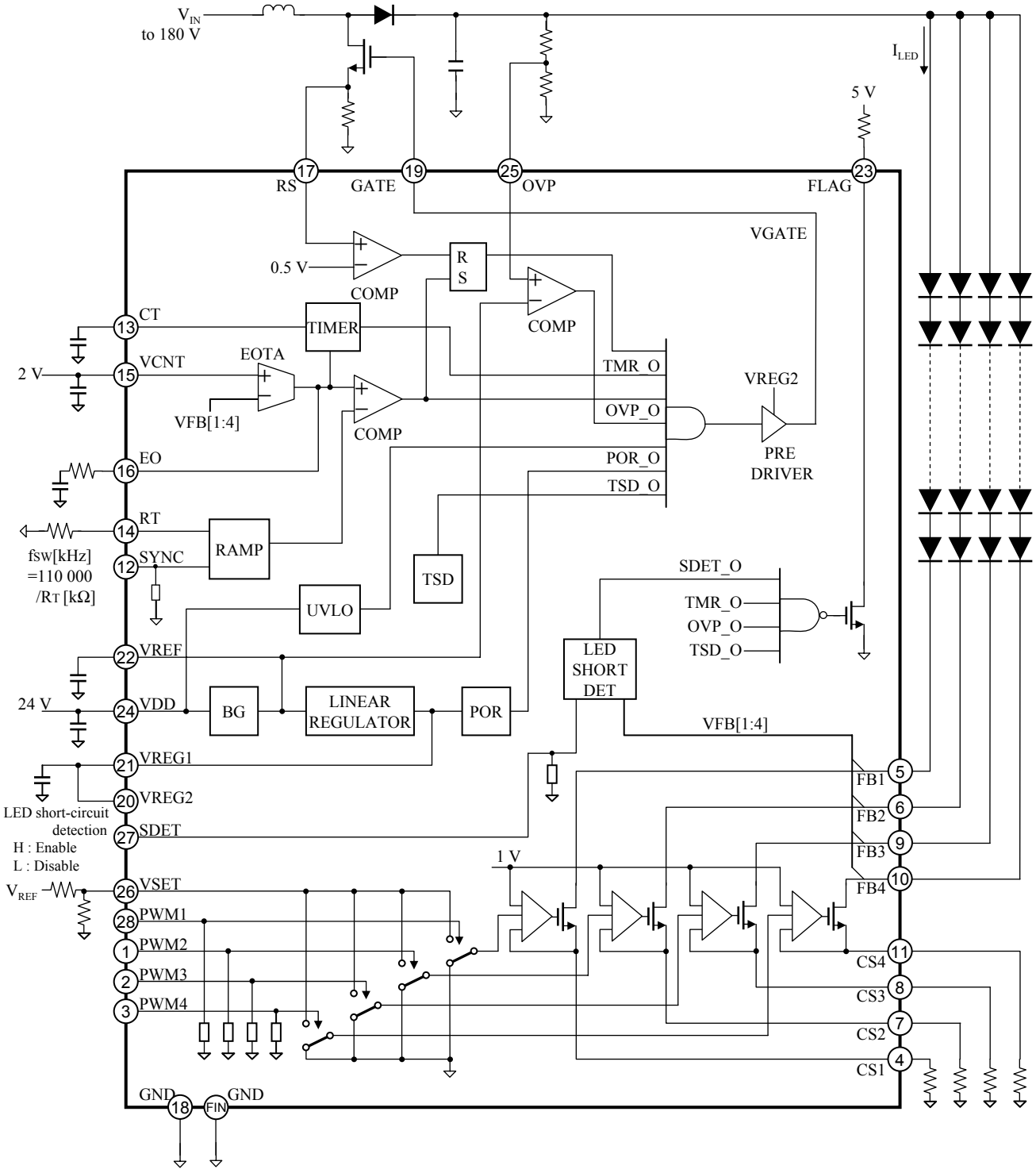
■ Package

- 28 pin Plastic Small Outline Package With Heat Sink (SOP Type)

■ Type

- Silicon Monolithic Bipolar IC

■ Application Circuit Example (Block Diagram)



Notes) • This application circuit is an example. The operation of mass production set is not guaranteed. Perform enough evaluation and verification on the design of mass production set.

• This block diagram is for explaining functions. Part of the block diagram may be omitted, or it may be simplified.

■ Pin Descriptions

Pin No.	Pin name	Type	Description
1	PWM2	Input	Dimming pulse input 2 (LED current , High : Enable, Low : Disable)
2	PWM3	Input	Dimming pulse input 3 (LED current , High : Enable, Low : Disable)
3	PWM4	Input	Dimming pulse input 4 (LED current , High : Enable, Low : Disable)
4	CS1	Input	External resistor connection 1 for LED current peak value setup
5	FB1	Output	LED cathode drive output 1
6	FB2	Output	LED cathode drive output 2
7	CS2	Input	External resistor connection 2 for LED current peak value setup
8	CS3	Input	External resistor connection 3 for LED current peak value setup
9	FB3	Output	LED cathode drive output 3
10	FB4	Output	LED cathode drive output 4
11	CS4	Input	External resistor connection 4 for LED current peak value setup
12	SYNC	Input	Switching frequency synchronization pulse input (The operation of internal oscillator is synchronized with the rising edge)
13	CT	—	Timer capacitor connection for startup and protection operation
14	RT	—	Resistor connection for the switching frequency setup
15	VCNT	Input	Reference voltage input for DCDC control
16	EO	—	DCDC control error amplifier output
17	RS	Input	Switching NMOSFET current detection resistor connection
18	GND	Ground	Ground for pre-driver operating external switching NMOSFET
19	GATE	Output	Output pin to drive the gate of external switching NMOSFET
20	VREG2	Input	Power supply input for pre-driver driving external switching NMOSFET (Connect with VREG1 pin externally.)
21	VREG1	Output	Internal 5 V supply voltage output
22	VREF	Output	Reference voltage output
23	FLAG	Output	Abnormal state output
24	VDD	Power supply	Power supply for control circuit
25	OVP	Input	Over-voltage detection
26	VSET	Input	LED current peak value setup
27	SDET	Input	LED short detection enable (High : Enable, Low : Disable)
28	PWM1	Input	Dimming pulse input 1 (LED current , High : Enable, Low : Disable)
FIN	FIN	Ground	Main ground and die pad ground

■ Absolute Maximum Ratings

Note) Absolute maximum ratings are limit values which do not result in damages to this IC, and IC operation is not guaranteed at these limit values.

A No.	Parameter	Symbol	Rating	Unit	Notes
1	Supply voltage	V_{DD}	60	V	*1
2	Supply current	I_{DD}	—	A	—
3	Power dissipation	P_D	582	mW	*2
4	Operating ambient temperature	T_{opr}	–20 to +85	°C	*3
5	Storage temperature	T_{stg}	–55 to +150	°C	*3
6	FB pin current	I_{FB1ABS} to I_{FB4ABS}	300	mA	*3
7	Junctions temperature	T_j	+150	°C	—

Notes) *1 : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

*2 : The power dissipation shown is the value at T_a = 85°C for the independent (unmounted) IC package without a heat sink. When using this IC, refer to the P_D-T_a diagram of the package standard and design the heat radiation with sufficient margin so that the allowable value might not be exceeded based on the conditions of power supply voltage, load, and ambient temperature.

*3 : Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for T_a = 25°C.

*4 : Refer to ■ Allowable Current and Voltage Range in page 7 for the allowable voltage and current of each pin.

■ Operating Supply Voltage Range

Parameter	Symbol	Range	Unit	Notes
Supply voltage range	V_{DD}	10.8 to 55	V	*1

Note) *1 : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

■ Recommended Use Conditions

Parameter	Symbol	Range	Unit	Notes
PWM dimming pulse frequency	f_{PWM1} to f_{PWM4}	0 to 1000	Hz	*2
Step-up DCDC switching frequency	f_{SW}	300 to 800	kHz	*2
SYNC pin input frequency	f_{SYNC}	300 to 800	kHz	*2

Note) *2 : Use this IC under the condition not exceeding the above ratings, referring to the reference values for an application manual. Especially pay attention to the power dissipation in case of step-up operation.

■ Allowable Current and Voltage Range

Notes) • Allowable current and voltage ranges are limit ranges which do not result in damages to this IC, and IC operation is not guaranteed within these limit ranges.
• Voltage values, unless otherwise specified, are with respect to GND.
• Do not apply external currents or voltages to any pin not specifically mentioned.
• For the circuit currents, "+" denotes current flowing into the IC, and "−" denotes current flowing out of the IC.

Pin No.	Pin name	Rating	Unit	Notes
5	FB1	–0.3 to 185	V	—
6	FB2	–0.3 to 185	V	—
9	FB3	–0.3 to 185	V	—
10	FB4	–0.3 to 185	V	—
28	PWM1	–0.3 to V_{REG}	V	*1
1	PWM2	–0.3 to V_{REG}	V	*1
2	PWM3	–0.3 to V_{REG}	V	*1
3	PWM4	–0.3 to V_{REG}	V	*1
4	CS1	–0.3 to V_{REG}	V	*1
7	CS2	–0.3 to V_{REG}	V	*1
8	CS3	–0.3 to V_{REG}	V	*1
11	CS4	–0.3 to V_{REG}	V	*1
12	SYNC	–0.3 to V_{REG}	V	*1
13	CT	–0.3 to V_{REG}	V	*1
14	RT	–0.3 to V_{REG}	V	*1
15	VCNT	–0.3 to V_{REG}	V	*1
17	RS	–0.3 to V_{REG}	V	*1
25	OVP	–0.3 to V_{REG}	V	*1
26	VSET	–0.3 to V_{REG}	V	*1
27	SDET	–0.3 to V_{REG}	V	*1
23	FLAG	–0.3 to V_{DD}	V	*2

Pin No.	Pin name	Rating	Unit	Notes
5	FB1	0 to 300	mA	—
6	FB2	0 to 300	mA	—
9	FB3	0 to 300	mA	—
10	FB4	0 to 300	mA	—
4	CS1	–300 to 0	mA	—
7	CS2	–300 to 0	mA	—
8	CS3	–300 to 0	mA	—
11	CS4	–300 to 0	mA	—

Notes) *1 : V_{REG} must not exceed 6 V.
*2 : Do not apply external voltages. This pin voltage must not exceed the rated value transiently.

■ Electrical Characteristics at V_{DD} = 24 V

Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
Regulator block								
1	VDD pin current at LED operation	I_{DDOP}	PWM1 to 4 = High fsw = 500 kHz	1.8	2.6	3.4	mA	—
2	VDD pin current at LED stop	I_{DDHT}	PWM1 to 4 = Low fsw = 500 kHz	1.5	2.3	3.1	mA	—
3	VDD under-voltage protection cancel voltage	V_{DDUL}	VDD rising	8.6	9.5	10.4	V	—
4	VDD under-voltage protection hysteresis	V_{DDULHY}	VDD falling	0.25	0.45	0.65	V	—
5	VREF voltage	V_{REF}	C = 0.1 µF, V_{DD} = 24 V, PWM1 to 4 = Low, I_{REF} = 0	2.328	2.4	2.427	V	—
6	VREF load regulation	ΔV_{REFL}	C = 0.1 µF, V_{DD} = 24 V, PWM1 to 4 = Low, I_{REF} = 100 µA	0	—	20	mV	—
7	VREG voltage	V_{REG}	C = 1 µF, V_{DD} = 24 V, PWM1 to 4 = Low, I_{REG} = 0	4.75	5.0	5.25	V	—
8	VREG line regulation	ΔV_{REGV}	C = 1 µF, V_{DD} = 10.8 V to 55 V, PWM1 to 4 = Low, I_{REG} = 0	0	—	20	mV	—
9	VREG load regulation	ΔV_{REGL}	C = 1 µF, V_{DD} = 24 V, PWM1 to 4 = Low, I_{REG} = 4 mA	0	—	20	mV	—
LED drive								
10	FB pin current range	I_{FB}	PWM1 to 4 = High	10	—	200	mA	—
11	FB pin ON resistance	R_{FBON}	IFB1 to 4 = 0.2 A	1	2	3	Ω	—
12	FB pin leak current	R_{FBLK}	V_{FB} = 45 V to 180 V	—	—	1	µA	—
13	CS pin output offset voltage	V_{CSOS}	V_{SET} = 0.5 V	–10	—	10	mV	—
14	CS pin output maximum voltage	V_{CSUL}	V_{SET} = 1.5 V	0.97	1.00	1.03	V	—
15	PWM pin input High voltage	V_{PWMIH}	—	1.8	—	V_{REG}	V	—
16	PWM pin input Low voltage	V_{PWMIL}	—	0	—	0.3	V	—
17	PWM pin pull-down resistance	R_{PWM}	V_{PWM} = 5 V	60	100	140	kΩ	—

■ Electrical Characteristics (continued) at V_{DD} = 24 V

Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
Step-up DCDC								
18	RT pin voltage	V_{RT}	RT = 110 kΩ	2.32	2.4	2.48	V	—
19	DC/DC switching frequency	f_{SW}	RT = 110 kΩ	442	520	598	kHz	—
20	Maximum duty ratio	D_{MAX}	RT = 110 kΩ	80	90	99	%	—
21	GATE pin source resistance	R_{GTSRC}	I_{GATE} = –50 mA	—	3	6	Ω	—
22	GATE pin sink resistance	R_{GTSNK}	I_{GATE} = 50 mA	—	2.5	5	Ω	—
23	VCNT voltage range	V_{CNT}	$V_{CNT} > V_{SET} + 3 \times I_{FB} + 0.2$	1	—	2	V	—
24	Error amp. trans conductance	gm	V_{CNT} = 1.5 V	260	400	540	µA/V	—
25	EO source current	I_{EOSRC}	V_{EO} = 1.75 V, V_{CNT} = 1.5 V, V_{FB} = 1 V	–90	–65	–40	µA	—
26	EO sink current	I_{EOSNK}	V_{EO} = 1.75 V, V_{CNT} = 1.5 V, V_{FB} = 2 V	40	65	90	µA	—
27	SYNC pin High-level threshold	V_{SYNCIH}	—	1.8	—	V_{REG}	V	—
28	SYNC pin Low-level threshold	V_{SYNCIL}	—	0	—	0.3	V	—
29	SYNC pin pull-down resistance	R_{SYNC}	V_{SYNC} = 5 V	60	100	140	kΩ	—
FLAG pin								
30	FLAG pin output High voltage	V_{FLAGH}	Pull-up to 5 V via 100 kΩ	4.9	—	5.1	V	—
31	FLAG pin output Low voltage	V_{FLAGL}	Pull-up to 5 V via 100 kΩ	—	50	100	mV	—
32	FLAG pin Off leak current	I_{FLAGLK}	Pull-up to 45 V via 100 kΩ	—	—	1	µA	—
Over-voltage protection (Step-up DCDC output)								
33	OVP pin over-voltage protection operation threshold	V_{OVP}	—	2.32	2.4	2.48	V	—
Timer (Overload)								
34	CT pin current	I_{CT}	CT = 0 V	–4.1	–3.1	–2.1	µA	—
35	CT pun protection operation threshold voltage	V_{CTSHDN}	—	2.3	2.4	2.5	V	—
Over-current protection (Step-up DCDC switching transistor current)								
36	RS pin limit threshold	V_{RS}	—	0.45	0.50	0.55	V	—
LED short detection								
37	LED short detection threshold	V_{LEDSC}	$V_{FB} - V_{SET}$, V_{SET} = 0.5 V	6.0	6.4	6.8	V	—
38	SDET timer	t_{SDET}	V_{SET} = 0.5 V, V_{FB1} = 7.5 V, FLAG = High → Low	10	23	40	µs	—
39	SDET pin High-level threshold	V_{SDETIH}	—	V_{REG} – 0.7	—	V_{REG}	V	—
40	SDET pin Low-level threshold	V_{SDETIL}	—	0	—	0.7	V	—

■ Electrical Characteristics (Reference values for design) at V_{DD} = 24 V

Notes) T_a = 25°C±2°C unless otherwise specified.
The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Conditions	Reference values			Unit	Notes
				Min	Typ	Max		
Over-voltage protection (Step-up DCDC output)								
41	OVP timer	t_{OVP}	V_{OVP} = 5 V, FLAG = High → Low	10	23	40	µs	—
LED drive								
42	FB current rising delay time	I_{FBRD}	V_{SET} = 0.5 V, R_{CS} = 5 Ω	—	—	2.0	µs	—
43	FB current falling delay time	I_{FBFD}	V_{SET} = 0.5 V, R_{CS} = 5 Ω	—	—	1.0	µs	—
Thermal shutdown protection								
44	Thermal shutdown protection operation temperature	T_{TSD}	At the time the temperature of chip rises	150	160	170	°C	—
45	Thermal shutdown protection cancel temperature	T_{TRCV}	Temp falling	110	120	130	°C	—
VSET-voltage								
46	VSET voltage range	V_{SET}	—	0.1	—	V_{REF}	V	—

■ Technical Data

- Various protection function composition

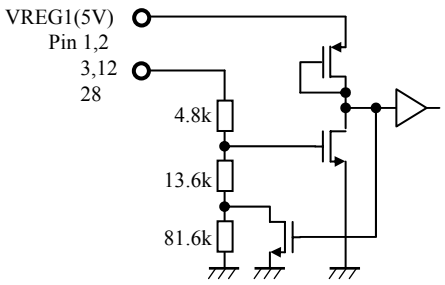
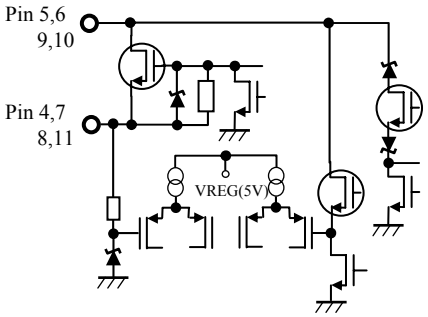
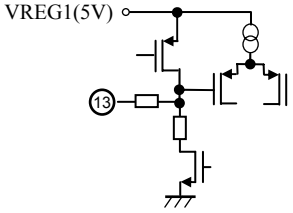
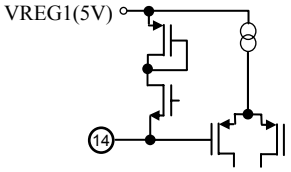
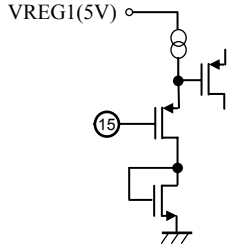
Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Protection function	Setting			Protection method		
	Detection pin	Threshold (Hysteresis width)	Timer time	DC/DC converter switching operation	LED current source operation	FLAG pin detection
Chip temperature	—	> 160°C (40°C)	—	The IC operation stops only at the time TSD operates	The IC operation stops only at the time TSD operates	Low (not hold)
VDD pin under-voltage	VDD	< 9.5 V (0.45 V)	—	OFF (The IC operation recovers at the time when VDD is applied again)	OFF (The IC operation recovers at the time when VDD is applied again)	—
RS pin over-current	RS	0.5 V (—)	—	OFF (Pulse-by-pulse over current limit)	—	—
LED open / Over-load	EO	> 2.64 V (—)	0.8 × CT[pF] µs	OFF (The IC operation recovers at the time when VDD is applied again)	OFF (The IC operation recovers at the time when VDD is applied again)	Low (hold)
LED short	FB1, FB2, FB3, FB4	> V_{SET} + 6.4 V (—)	23 µs	—	—	Low (hold)
Step-up DCDC over-voltage	OVP	> 2.4 V (—)	23 µs	OFF (The IC operation recovers at the time when VDD is applied again)	OFF (The IC operation recovers at the time when VDD is applied again)	Low (hold)

■ Technical Data (continued)

• I/O block circuit diagrams and pin function descriptions

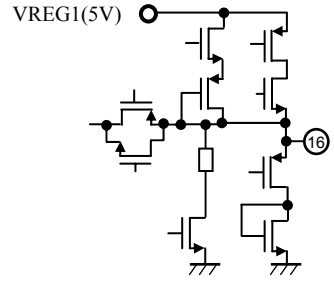
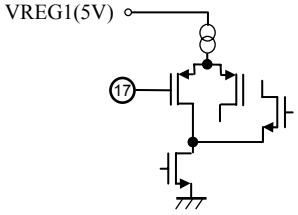
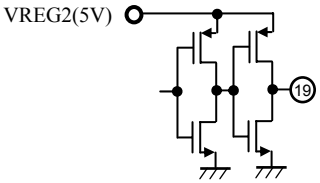
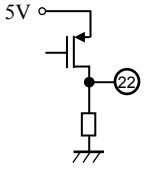
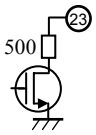
Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
1, 2, 3, 12, 28	AC or DC		Z : 100 kΩ (High voltage input) Z : 18.4 kΩ (Low voltage input)	Pin 1, 2, 3, 28 : Dimming pulse input Pin 12 : Switching frequency syncronizing pulse input (Input range : 0 V to V_{REG} (5 V typ))
4, 7, 8, 11	DC (Same voltage as Pin 26) ※1 V max		Z : —	External resister connection pin for setting LED current (Current setting range : 10 mA to 200 mA)
5, 6, 9, 10	DC (Same voltage as Pin 15)		Z : —	LED cathode drive output (Allowable voltage range : 180 V max)
13	AC (Depends on other pin condition)		Z : 2.27 kΩ	External capacitor connection pin for start up and protection function
14	DC 2.4 V		Z : —	External resister connection pin for setting DC/DC switching frequency
15	DC		Z : —	Reference voltage input for DC/DC control (Allowable voltage range : $V_{CNT} > V_{SET} + 3 \times I_{FB} + 0.2$ and $1\ V < V_{CNT} < 2\ V$)

■ Technical Data (continued)

• I/O block circuit diagrams and pin function descriptions (continued)

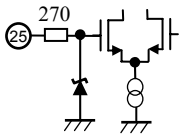
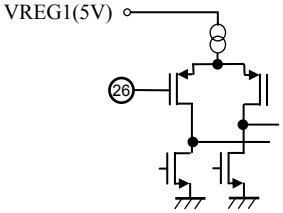
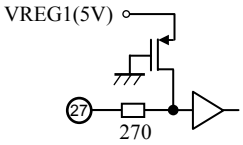
Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
16	DC (0 to 2.64 V)		Z : —	External component connection pin for DC/DC phase compensation
17	AC (0.5 V peak_Max)		Z : —	Current detection pin for external NMOSFET
18	DC (GND : 0 V)	—	Z : Low	GND pin of pre-driver circuit for external NMOSFET
19	AC		Z : —	External NMOSFET gate control
20	DC 5 V		Z : —	Power supply input of pre-driver circuit for external NMOSFET
21	DC 5 V	—	Z : Low	External capacitor connection pin for internal stabilized power supply (5 V)
22	DC 2.4 V		Z : Low	B/G voltage output (2.4 V)
23	AC or DC		Z : —	Abnormal condition detection output
24	DC	—	Z : —	Power supply input (Allowable voltage range : 10.8 V to 55 V)

■ Technical Data (continued)

• I/O block circuit diagrams and pin function descriptions (continued)

Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
25	DC (0 to V_{REF})		Z : High	Over voltage protection input
26	DC		Z : —	Reference voltage input for setting LED current (Allowable voltage range : 1 V max)
27	DC (0 V or V_{REG1})		Z : —	Enable pin for LED short detection ※High(V_{REG1}) : Available Low(GND) : Unavailable
Fin	DC 0 V	—	Z : Low	Main GND

■ Usage Notes

• Special attention and precaution in using

1. This IC is intended to be used for general electronic equipment [Backlight LED driver for LCD TV].
   Consult our sales staff in advance for information on the following applications:
   - Special applications in which exceptional quality and reliability are required, or if the failure or malfunction of this IC may directly jeopardize life or harm the human body.
   - Any applications other than the standard applications intended.
     (1) Space appliance (such as artificial satellite, and rocket)
     (2) Traffic control equipment (such as for automobile, airplane, train, and ship)
     (3) Medical equipment for life support
     (4) Submarine transponder
     (5) Control equipment for power plant
     (6) Disaster prevention and security device
     (7) Weapon
     (8) Others : Applications of which reliability equivalent to (1) to (7) is required

   It is to be understood that our company shall not be held responsible for any damage incurred as a result of or in connection with your using the IC described in this book for any special application, unless our company agrees to your using the IC in this book for any special application.
2. Pay attention to the direction of LSI. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might smoke or ignite.
3. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
4. Perform a visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as a solder-bridge between the pins of the semiconductor device. Also, perform a full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the LSI during transportation.
5. Take notice in the use of this product that it might break or occasionally smoke when an abnormal state occurs such as output pin-V_{DD} or V_{IN} short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short) .
   And, safety measures such as an installation of fuses are recommended because the extent of the above-mentioned damage and smoke emission will depend on the current capability of the power supply.
6. When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.
   Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.
7. When using the LSI for new models, verify the safety including the long-term reliability for each product.
8. When the application system is designed by using this LSI, be sure to confirm notes in this book.
   Be sure to read the notes to descriptions and the usage notes in the book.
9. Connect the metallic plate (fin) on the side of the IC with the GND potential. The thermal resistance and the electrical characteristics are guaranteed only when the metallic plate (fin) is connected with the GND potential.
10. Power-on sequence : Apply VDD after the voltage is applied to VIN.
    Power-off sequence : Lower VIN after VDD power-off.
11. Use the external components of DC/DC converter block corresponding to input voltage, output voltage and output current. Use this IC under the condition that over-voltage and over-current don't occur on the actual use condition, taking enough margin against the absolute maximum ratings. Please refer to the recommended constant and the method of calculation in an application manual.
12. Raise VIN voltage in 3 ms or more.
    Then, confirm carefully that the over-current more than specified value doesn't flow into external components and this IC.
13. Input a signal to PWM pin and SYNC pin on the conditions that VS pin, VIN voltage and VDD pin have been raised.
14. The PWM1-4 pin signals of all channels should be Low-level in order to change the input signal to VSET pin.

■ Usage Notes (continued)

- Notes of Power LSI

1. The protection circuit is for maintaining safety against abnormal operation. Therefore, the protection circuit should not work during normal operation.
   Especially for the thermal protection circuit, if the area of safe operation or the absolute maximum rating is momentarily exceeded due to output pin to V_{DD} or V_{IN} short (Power supply fault), or output pin to GND short (Ground fault), the LSI might be damaged before the thermal protection circuit could operate.

2. Unless specified in the product specifications, make sure that negative voltage or excessive voltage are not applied to the pins because the device might be damaged, which could happen due to negative voltage or excessive voltage generated during the ON and OFF timing when the inductive load of a motor coil or actuator coils of optical pick-up is being driven.

3. The product which has specified ASO (Area of Safe Operation) should be operated in ASO.

4. Verify the risks which might be caused by the malfunctions of external components.

Request for your special attention and precautions in using the technical information and semiconductors described in this book

(1) If any of the products or technical information described in this book is to be exported or provided to non-residents, the laws and regulations of the exporting country, especially, those with regard to security export control, must be observed.

(2) The technical information described in this book is intended only to show the main characteristics and application circuit examples of the products. No license is granted in and to any intellectual property right or other right owned by Panasonic Corporation or any other company. Therefore, no responsibility is assumed by our company as to the infringement upon any such right owned by any other company which may arise as a result of the use of technical information described in this book.

(3) The products described in this book are intended to be used for general applications (such as office equipment, communications equipment, measuring instruments and household appliances), or for specific applications as expressly stated in this book.
Consult our sales staff in advance for information on the following applications:
- Special applications (such as for airplanes, aerospace, automotive equipment, traffic signaling equipment, combustion equipment, life support systems and safety devices) in which exceptional quality and reliability are required, or if the failure or malfunction of the products may directly jeopardize life or harm the human body.

It is to be understood that our company shall not be held responsible for any damage incurred as a result of or in connection with your using the products described in this book for any special application, unless our company agrees to your using the products in this book for any special application.

(4) The products and product specifications described in this book are subject to change without notice for modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.

(5) When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.
Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.

(6) Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.

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