Power Supply ICs for TFT-LCD Panels

# Multi-channel System Power Supply IC for Small to Middle PANEL

**BD8184MUV**

No.11035EBT19



## ●Description

The BD8184MUV is a system power supply for the TFT-LCD panels used for liquid crystal Monitors and Note Display. Incorporates high-power FET with low on resistance for large currents that employ high-power packages, thus driving large current loads while suppressing the generation of heat. A charge pump controller is incorporated as well, thus greatly reducing the number of application components. Also Gate Shading Function is included.

## ●Features

1) Boost DC/DC converter; 18 V / 2.5 A switch current. (Target specification is ±1% accurate.)
2) Switching frequency: 1.2 MHz
3) Operational Amplifier (short current 200mA)
4) Incorporates Positive / Negative Charge-pump Controllers.
5) Gate Shading Function
6) VQFN024V4040 Package (4.0 mm x 4.0 mm)
7) Protection circuits: Under Voltage Lockout Protection Circuit
   Thermal Shutdown Circuit (Latch Mode)
   Over Current Protection Circuit (AVDD)
   Timer Latch Mode Short Circuit Protection (AVDD SRC VGL)
   Over / Under Voltage Protection Circuit for Boost DC/DC Output
   No SCP time included (160ms from UVLO-off)

## ●Applications

Power supply for the TFT-LCD panels used for LCD Monitors and Note Display

●**Absolute Maximum Ratings** ($T_A$ = 25℃)

| Parameter | Symbol | LIMIT | Unit |
|---|---|---|---|
| Supply Voltage 1 | VIN | +7 | V |
| Supply Voltage 2 | AVDD | +20 | V |
| Supply Voltage 3 | SRC | +36 | V |
| Switching Voltage | SW, DRP, DRN | +20 | V |
| Input Voltage 1 | RSTIN, DLY, CTL, FB, FBP, FBN | VIN+0.3 | V |
| Input Voltage 2 | INN, INP | +20 | V |
| Output Voltage 1 | RST, COMP, VREF | +7 | V |
| Output Voltage 2 | VCOM | +20 | V |
| Output Voltage 3_1 | GSOUT | +36 | V |
| Output Voltage 3_2 | SRC - GSOUT | +40 | V |
| Junction Temperature | Tama | 150 | ℃ |
| Power Dissipation | Pd | 3560*1 | mW |
| Operating Temperature Range | Topr | -40～85 | ℃ |
| Storage Temperature Range | Tstg | -55～150 | ℃ |

*1 Derating in done 28.5mW/℃ for operating above Ta≧25℃(On 4-layer 74.2mm×74.2mm×1.6mm board)

●**Operating Range** (Ta=-40℃～85℃)

| Parameter | Symbol | MIN | MAX | Unit |
|---|---|---|---|---|
| Supply Voltage 1 | VIN | 2.0 | 5.5 | V |
| Supply Voltage 2 | AVDD | 6 | 18 | V |
| Supply Voltage 3 | SRC | 12 | 34 | V |

●**Electrical characteristics** (unless otherwise specified VIN = 3.3V, AVDD = 10V and TA=25℃)

| Parameter | Symbol | Limits | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| GENERAL | | | | | | |
| Circuit Current | $I_{VIN}$ | - | 1.2 | 3 | mA | No Switching |
| Under Voltage Lockout Threshold | $V_{UVLO}$ | 1.75 | 1.85 | 1.95 | V | VIN rising |
| Internal Reference Output Voltage | VREF | 1.238 | 1.250 | 1.262 | V | No load |
| Thermal Shutdown (rising) | TSD | - | 160 | - | ℃ | Junction Temp |
| Duration to Trigger Fault Condition | $T_{SCP}$ | - | 55 | - | ms | FB , FBP or FBN below threshold |
| BOOST CONVERTER (AVDD) | | | | | | |
| FB Regulation Voltage | $V_{FB}$ | 1.238 | 1.250 | 1.262 | V | Voltage rising |
| FB Fault Trip Level | $V_{TL\_FB}$ | 0.95 | 1.0 | 1.05 | V | VFB falling |
| FB Input Bias Current | $I_{FB}$ | - | 0.1 | 1 | µA | VFB= 1.5V |
| SW Leakage Current | $I_{SW\_L}$ | - | 0 | 10 | µA | VSW=20V |
| Maximum switching Duty Cycle | $M_{DUTY}$ | 85 | 90 | 95 | % | VFB= 1.0V |
| SW ON-Resistance | $R_{SW}$ | - | 200 | - | mΩ | ISW= 200mA |
| SW Current Limit | $I_{SWLIM}$ | 2.5 | - | - | A | |
| Over Voltage Protection | $V_{OVP}$ | - | 20 | - | V | AVDD rising |
| Under Voltage Protection | $V_{UVP}$ | 1.3 | 1.6 | 1.9 | V | AVDD falling |
| BOOST Soft Start Time | $T_{SS\_FB}$ | - | 13.6 | - | ms | |
| Oscillator frequency | $F_{SW}$ | 1.0 | 1.2 | 1.4 | MHz | |
| RESET | | | | | | |
| RST Output Low Voltage | $V_{RST}$ | - | 0.05 | 0.2 | V | IRST =1.2mA |
| RSTIN Threshold Voltage | $V_{TH\_L}$ | 1.18 | 1.25 | 1.32 | V | RSTIN falling |
| RSTIN Input Current | $I_{RSTIN}$ | - | 0 | - | µA | VRSTIN=0 to VIN-0.3 |
| RST Blanking Time | $T_{NO\_SCP}$ | 146 | 163 | 180 | ms | No SCP Zone |
| Operational Amp rifer | | | | | | |
| Input Range | $V_{RANGE}$ | 0 | - | AVDD | V | |
| Offset Voltage | $V_{OS}$ | - | 2 | 15 | mV | VINP= 5.0V |
| Input Current | $I_{INP}$ | - | 0 | - | µA | VINP= 5.0V |
| Output Swing Voltage (VINP= 5.0V) | $V_{OH}$ | - | 5.03 | 5.06 | V | ICOM = +50mA |
| | $V_{OL}$ | 4.94 | 4.97 | - | V | ICOM = -50mA |
| Short Circuit Current | $I_{SHT\_VCOM}$ | - | 200 | - | mA | |
| Slew Rate | SR | - | 40 | - | V/us | |

●**Electrical characteristics** (unless otherwise specified VIN = 3.3V, AVDD = 10V and $T_A$=25℃) (Continued)

| Parameter | Symbol | Limits | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Negative Charge pump driver (VGL) | | | | | | |
| FBN Regulation Voltage | $V_{FBN}$ | 241 | 265 | 289 | mV | |
| FBN Fault Trip Level | $V_{TL\_FBN}$ | 400 | 450 | 500 | mV | $V_{FBN}$ rising |
| FBN Input Bias Current | $I_{FBN}$ | - | 0.1 | 1 | µA | $V_{FBN}$= 0.1V |
| Oscillator frequency | $F_{CPN}$ | 500 | 600 | 700 | kHz | |
| DRN Leakage Current | $I_{DRN\_L}$ | - | 0 | 10 | µA | $V_{FBN}$=1.0V |
| Positive Charge pump driver (SRC) | | | | | | |
| FBP Regulation Voltage | $V_{FBP}$ | 1.23 | 1.25 | 1.27 | V | |
| FBP Fault Trip Level | $V_{TL\_FBP}$ | 0.95 | 1.0 | 1.05 | V | $V_{FBP}$ falling |
| FBP Input Bias Current | $I_{FBP}$ | - | 0.1 | 1 | µA | $V_{FBP}$= 1.5V |
| Oscillator frequency | $F_{CPP}$ | 500 | 600 | 700 | kHz | |
| DRP Leakage Current | $I_{DRP\_L}$ | - | 0 | 10 | µA | $V_{FBP}$= 1.5V |
| Soft-Start Time | $T_{SSP}$ | - | 3.4 | - | ms | |
| Gate Shading Function (GSOUT) | | | | | | |
| DLY Source Current | $I_{DLY}$ | 4 | 5 | 6 | µA | |
| DLY Threshold Voltage | $V_{TL\_DLY}$ | 1.22 | 1.25 | 1.28 | V | $V_{DLY}$ falling |
| CTL Input Voltage High | $V_{IN\_H}$ | 2.0 | - | - | V | |
| CTL Input Voltage Low | $V_{IN\_L}$ | - | - | 0.5 | V | |
| CTL Input Bias Current | $I_{CTL}$ | - | 0 | - | µA | VRSTIN=0 to VIN-0.3 |
| Propagation delay time (Rising) | $T_{GS\_R}$ | - | 100 | - | ns | $V_{SRC}$= 25V |
| Propagation delay time (Falling) | $T_{GS\_F}$ | - | 100 | - | ns | $V_{SRC}$= 25V |
| SRC -GSOUT ON Resistance | $R_{GS\_H}$ | - | 15 | - | Ω | $V_{DLY}$ = 1.5V |
| GSOUT-RE ON Resistance | $R_{GS\_M}$ | - | 30 | - | Ω | $V_{DLY}$ = 1.5V |
| GSOUT-GND ON Resistance | $R_{GS\_L}$ | - | 2.5 | - | kΩ | $V_{DLY}$ = 1.0V |

○This product is not designed for protection against radio active rays.

●**Electrical characteristic curves (Reference data)**
(Unless otherwise specified VIN = 3.3V, AVDD = 10V and $T_A$=25℃)

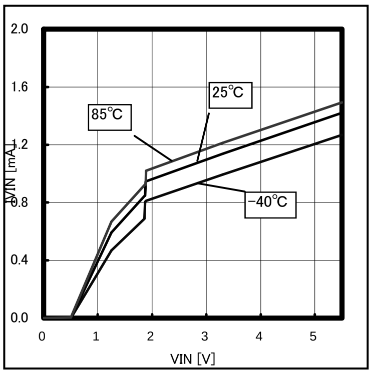



Fig.1 Circuit Current
(No switching)

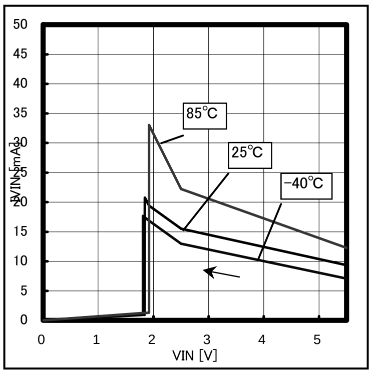



Fig.2 Circuit Current
(Switching)

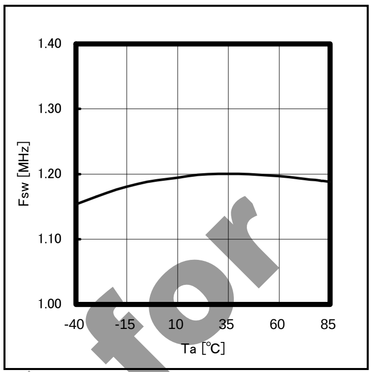



Fig.3 Dependent on Temperature
Frequency

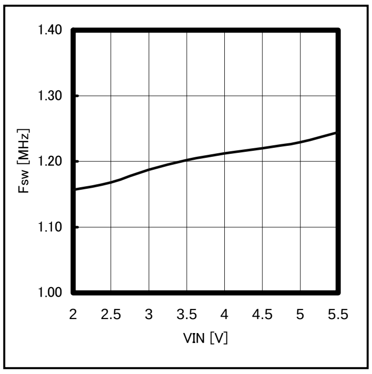



Fig.4 Dependent on Input
Voltage Frequency

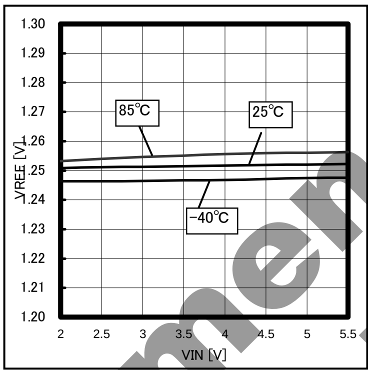



Fig.5 VREF Line Regulation

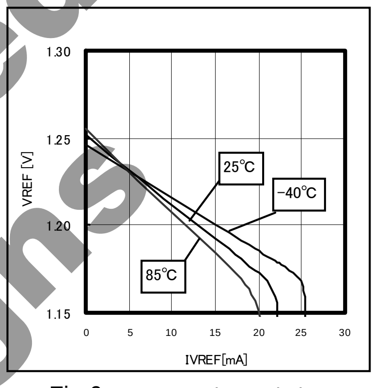



Fig.6 VREF Load Regulation

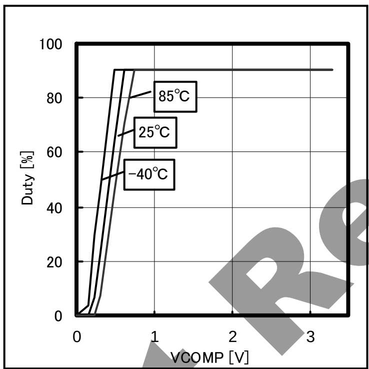



Fig.7 COMP V.S.CDUTY

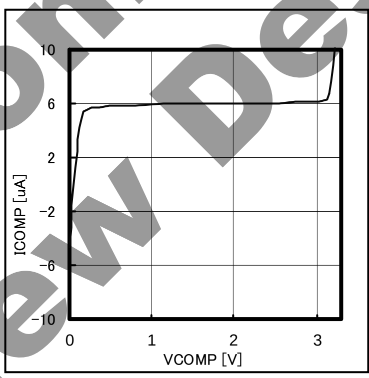



Fig.8 COMP Sink Current

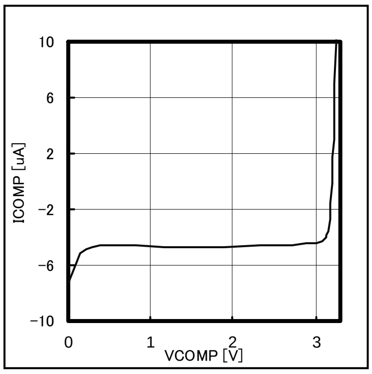



Fig.9 COMP Source Current

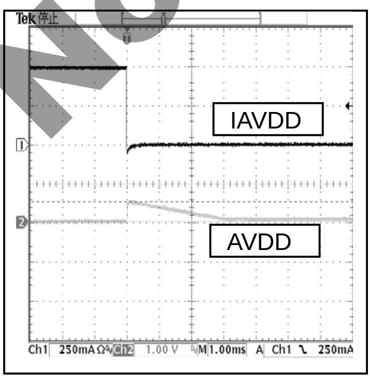



Fig.10 Load Transient Response
Falling

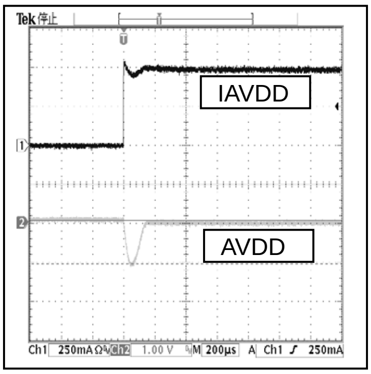



Fig.11 Load Transient Response
Rising

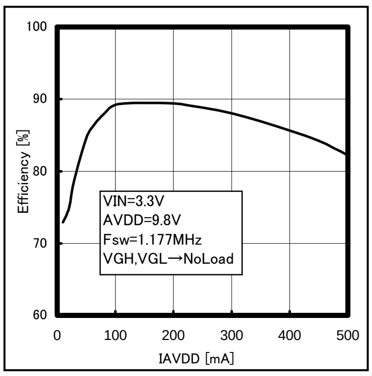



Fig.12 Boost Converter
Efficiency

**●Electrical characteristic curves (Reference data) – Continued**

(Unless otherwise specified VIN = 3.3V, AVDD = 10V and $T_A$=25℃)

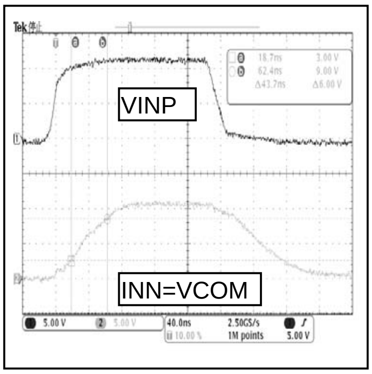



Fig.13 VCOM Slew Rate (Rising)

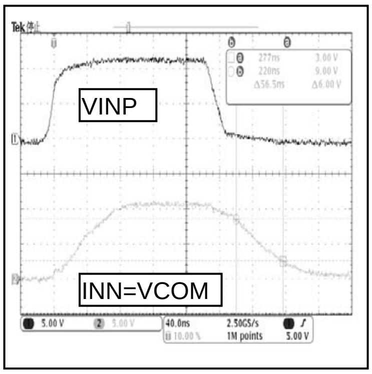



Fig.14 VCOM Slew Rate (falling)

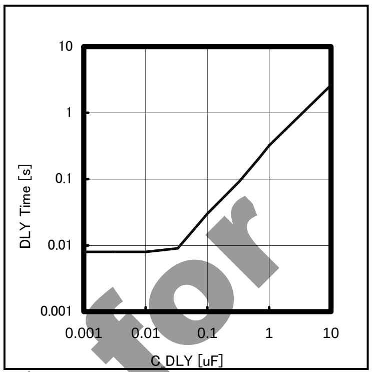



Fig.15 C_DLY vs. delay time

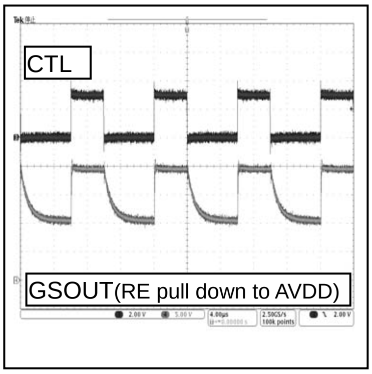



Fig. 16 Gate Shading Wave form1

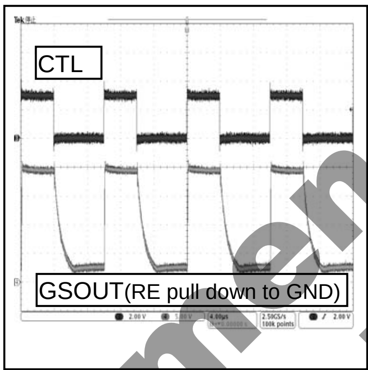



Fig.17 Gate Shading Wave form2

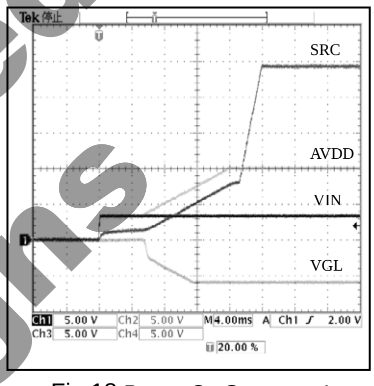



Fig.18 Power On Sequence1 (Main Output)

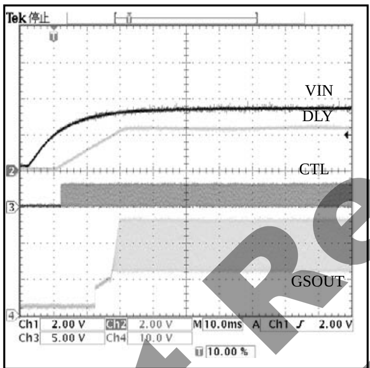



Fig.19 Power On Sequence2 (CTL=signal, RE pull down to AVDD)

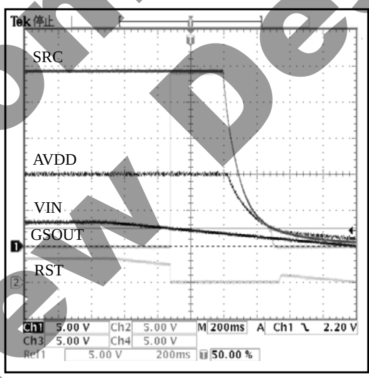



Fig.20 Power Off Sequence1 (R_RST_U=10k,R_RST_D=10k)

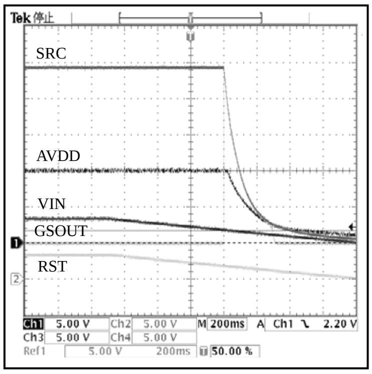



Fig.21 Power Off Sequence2 (R_RST_U=10k,R_RST_D=OPEN)

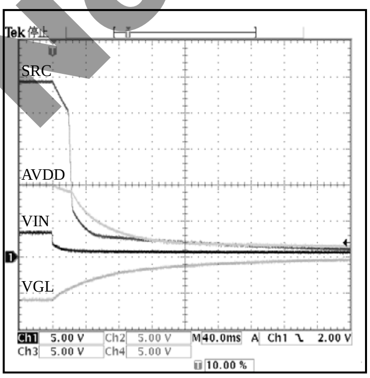



Fig.22 Power On Sequence3 (Main Output)

## ●Block Diagram

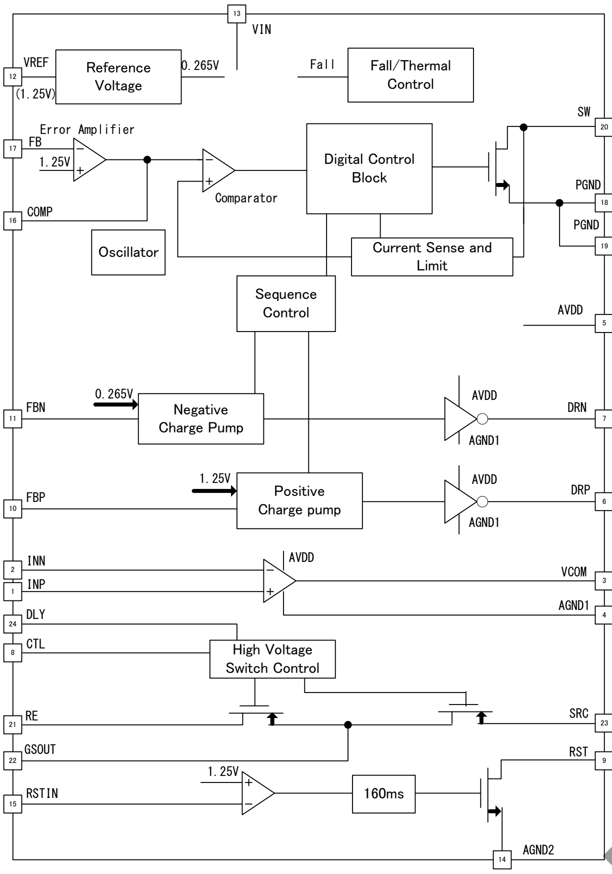



Fig.23 Block Diagram

## ●Pin Configuration

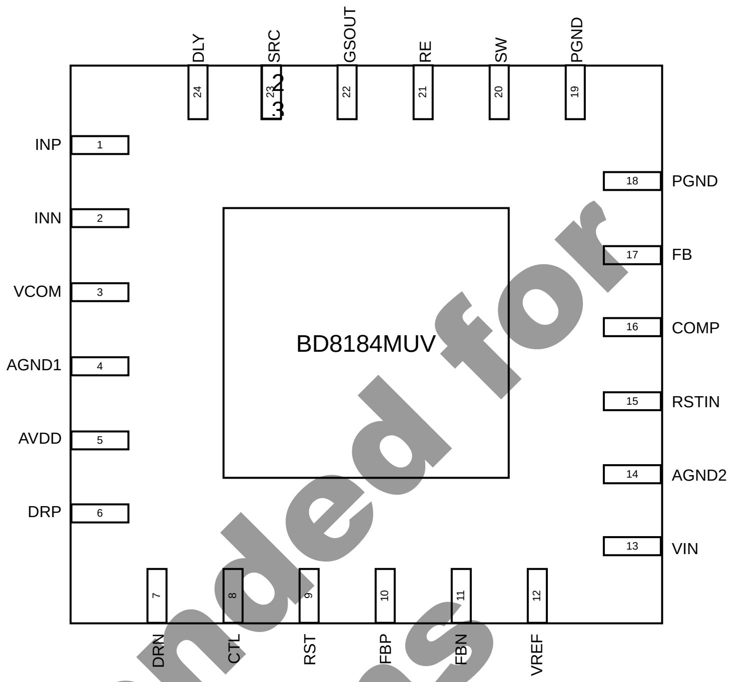



Fig.24 Pin Configuration



## ●Package Dimension

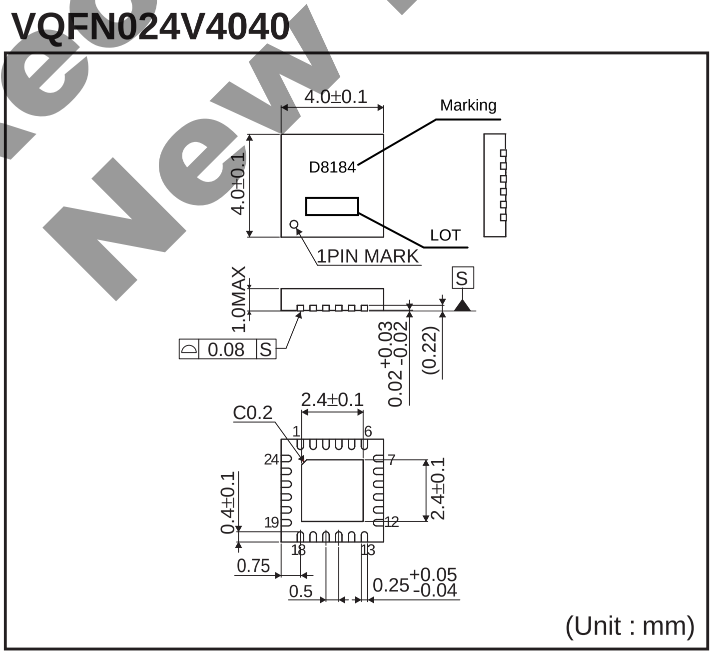



Fig.25 Package Dimension (UNIT : mm)

●**Pin Assignments**

| PINNO. | Pin name | Function |
|---|---|---|
| 1 | INP | COM Amplifier input + |
| 2 | INN | COM Amplifier input - |
| 3 | VCOM | COM Amplifier output |
| 4 | AGND1 | Ground |
| 5 | AVDD | Supply voltage input for com, charge pump |
| 6 | DRP | Drive pin of the positive charge pump |
| 7 | DRN | Drive pin of the negative charge pump |
| 8 | CTL | High voltage switch control pin |
| 9 | RST | Open drain reset output |
| 10 | FBP | Positive charge pump feed back |
| 11 | FBN | Negative charge pump feed back |
| 12 | VREF | Internal Reference voltage output |
| 13 | VIN | Supply voltage input for PWM |
| 14 | AGND2 | Ground |
| 15 | RSTIN | Reset comparator input |
| 16 | COMP | BOOST amplifier output |
| 17 | FB | BOOST amplifier input |
| 18 | PGND1 | BOOST FET ground |
| 19 | PGND2 | BOOST FET ground |
| 20 | SW | BOOST FET Drain |
| 21 | RE | Gate High voltage Fall set pin |
| 22 | GSOUT | Gate High voltage output set pin |
| 23 | SRC | Gate High voltage input set pin |
| 24 | DLY | GSOUT Delay Adjust pin |

## ●Main Block Function

・Boost Converter
A controller circuit for DC/DC boosting.
The switching duty is controlled so that the feedback voltage FB is set to 1.25 V (typ.).
A soft start operates at the time of starting.

・Positive Charge Pump
A controller circuit for the positive-side charge pump.
The switching amplitude is controlled so that the feedback voltage FBP will be set to 1.25 V (typ.).

・Negative Charge Pump
A controller circuit for the negative-side charge pump.
The switching amplitude is controlled so that the feedback voltage FBN will be set to 0.265 V (Typ.).

・Gate Shading Controller
A controller circuit for P-MOS FET Switch
The GSOUT switching synchronize with CTL input.
When VIN drops below UVLO threshold or RST=Low(=RSTIN<1.25V), GSOUT is pulled High(=SRC).

・VCOM
A 1-channel operational amplifier block.

・Reset
A open-drain output(RST) refer from RSTIN voltage(up to threshold voltage 1.25V)
RST is keep High(need a pull-up resistor connected to VIN) dulling to 163ms from start-up.

・VREF
A block that generates internal reference voltage of 1.25V (Typ.).
VREF is keep High when the thermal/short-current-protection shutdown circuit.

・TSD/UVLO/OVP/UVP
The thermal shutdown circuit is shut down at an IC internal temperature of 160℃.
The under-voltage lockout protection circuit shuts down the IC when the VIN is 1.85 V (Typ.) or below.
The over-voltage protection circuit when the SW is 19 V (Typ.) or over.
The under-voltage protection circuit when the SW is 1.3 V (Typ.) or under

・Start-up Controller
A control circuit for the starting sequence.
Controls to start in order of $V_{CC} \rightarrow V_{GL} \rightarrow V_{DD} \rightarrow S_{RC}$
(Please refer to Fig.4 of next page for details.)

### ●Power Sequence

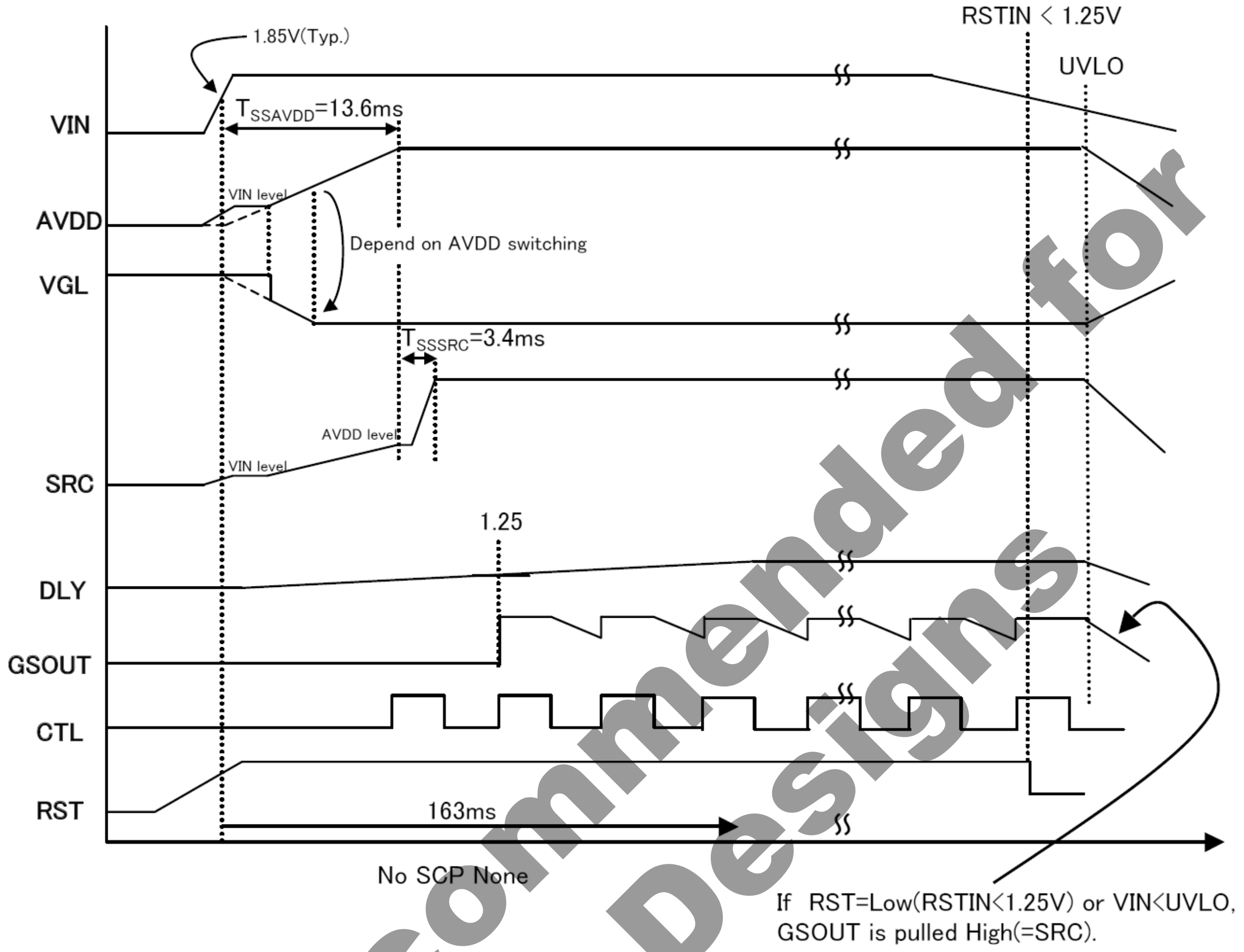



Fig.26 **Power Sequence**

**●How to select parts of application**

(1-1) Setting the Output L Constant (Boost Converter)

The coil to use for output is decided by the rating current $I_{LR}$ and input current maximum value $I_{INMAX}$ of the coil.

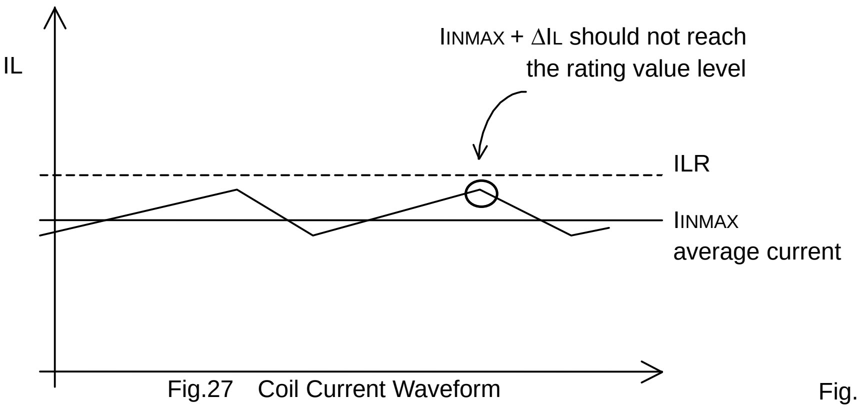



Fig.27 Coil Current Waveform

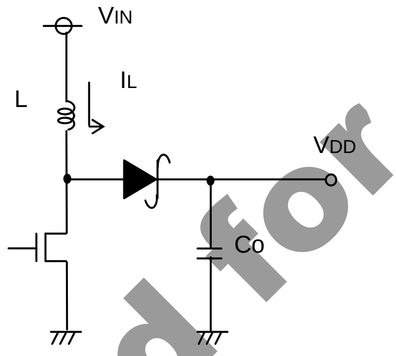



Fig. 28 Output Application Circuit Diagram

Adjust so that $I_{INMAX}$ +$\Delta I_L$ does not reach the rating current value $I_{LR}$. At this time, $\Delta I_L$ can be obtained by the following equation.

$$\Delta I_L = \frac{1}{L} V_{IN} \times \frac{V_{DD}-V_{IN}}{V_{DD}} \times \frac{1}{f} \quad [A]$$

Here, f is the switching frequency.

Set with sufficient margin because the coil value may have the dispersion of ±30%. If the coil current exceeds the rating current $I_{LR}$ of the coil, it may damage the IC internal element.

BD8164MUV uses the current mode DC/DC converter control and has the optimized design at the coil value. A coil inductance (L) of 4.7 uH to 15 uH is recommended from viewpoints of electric power efficiency, response, and stability.

(2) Output Capacity Settings

For the capacitor to use for the output, select the capacitor which has the larger value in the ripple voltage $V_{PP}$ allowance value and the drop voltage allowance value at the time of sudden load change. Output ripple voltage is decided by the following equation.

Here, f is the switching frequency.

$$\Delta V_{PP} = I_{LMAX} \times R_{ESR} + \frac{1}{fCo} \times \frac{V_{IN}}{V_{DD}} \times \left(I_{LMAX} - \frac{\Delta I_L}{2}\right) \quad [V]$$

Perform setting so that the voltage is within the allowable ripple voltage range.

For the drop voltage during sudden load change; $V_{DR}$, please perform the rough calculation by the following equation.

$$V_{DR} = \frac{\Delta I}{Co} \times 10\,us \quad [V]$$

However, 10 μs is the rough calculation value of the DC/DC response speed. Please set the capacitance considering the sufficient margin so that these two values are within the standard value range.

(3) Selecting the Input Capacitor

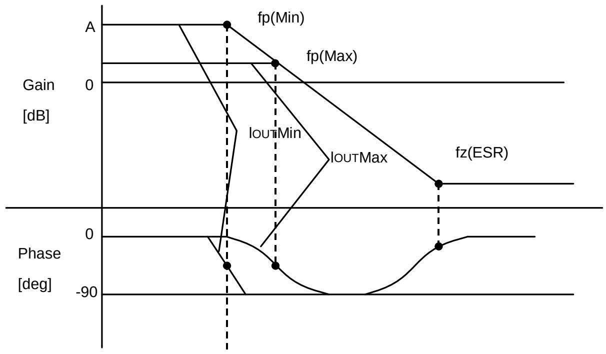
Since the peak current flows between the input and output at the DC/DC converter, a capacitor is required to install at the input side. For the reason, the low ESR capacitor is recommended as an input capacitor which has the value more than 10 μF and less than 100 mΩ. If a capacitor out of this range is selected, the excessive ripple voltage is superposed on the input voltage, accordingly it may cause the malfunction of IC.

However these conditions may vary according to the load current, input voltage, output voltage, inductance and switching frequency. Be sure to perform the margin check using the actual product.

(4) Setting Rc, Cc of the Phase Compensation Circuit

In the current mode control, since the coil current is controlled, a pole (phase lag) made by the CR filter composed of the output capacitor and load resistor will be created in the low frequency range, and a zero (phase lead) by the output capacitor and ESR of capacitor will be created in the high frequency range. In this case, to cancel the pole of the power amplifier, it is easy to compensate by adding the zero point with Cc and Rc to the output from the error amp as shown in the illustration.

**Open loop gain characteristics**




**Error amp phase compensation characteristics**

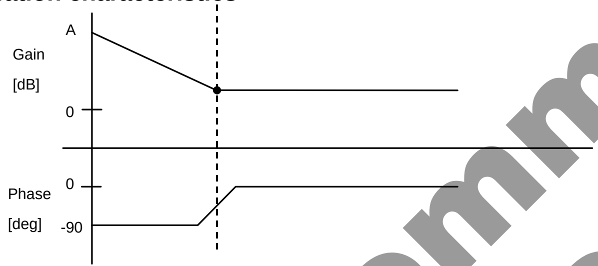



Fig. 29 Gain vs Phase

$$Fp = \frac{1}{2\pi \times R_O \times C_O} \text{ [Hz]}$$

$$fz(ESR) = \frac{1}{2\pi \times ESR \times C_O} \text{ [Hz]}$$

Pole at the power amplification stage

When the output current reduces, the load resistance $R_O$ increases and the pole frequency lowers.

$$fp(Min) = \frac{1}{2\pi \times R_{OMax} \times C_O} \text{ [Hz]} \leftarrow \text{at light load}$$

$$fz(Max) = \frac{1}{2\pi \times R_{OMin} \times C_O} \text{ [Hz]} \leftarrow \text{at heavy load}$$

Zero at the power amplification stage

When the output capacitor is set larger, the pole frequency lowers but the zero frequency will not change. (This is because the capacitor ESR becomes 1/2 when the capacitor becomes 2 times.)

$$fp(Amp.) = \frac{1}{2\pi \times R_C \times C_C} \text{ [Hz]}$$

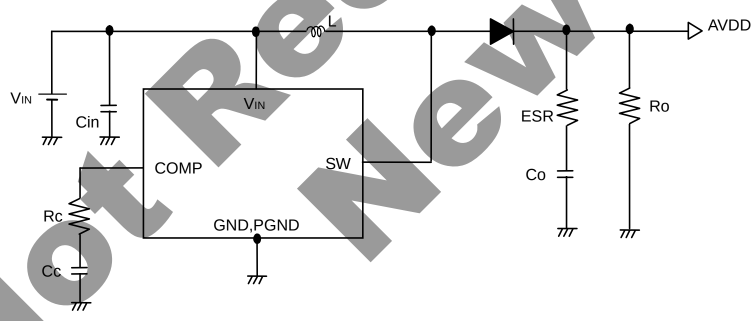



Fig. 30 Application Circuit Diagram

It is possible to realize the stable feedback loop by canceling the pole fp(Min.), which is created by the output capacitor and load resistor, with CR zero compensation of the error amp as shown below.

fz(Amp.) = fp(Min.)

$$\longrightarrow \frac{1}{2\pi \times Rc \times Cc} = \frac{1}{2\pi \times Romax \times Co} \text{ [Hz]}$$

(5) Design of the Feedback Resistor Constant

Refer to the following equation to set the feedback resistor. As the setting range, 6.8 kΩ to 330 kΩ is recommended. If the resistor is set lower than a 6.8 kΩ, it causes the reduction of power efficiency. If it is set more than 330 kΩ, the offset voltage becomes larger by the input bias current 0.1 μA(Typ.) in the internal error amplifier.

$$AVDD = \frac{R1 + R2}{R2} \times FB \quad [V]$$

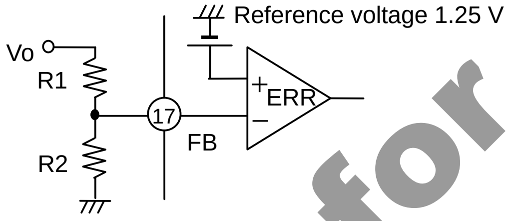



Fig. 31 Application Circuit Diagram

(6) Positive-side Charge Pump Settings

The IC incorporates a charge pump controller, thus making it possible to generate stable gate voltage. The output voltage is determined by the following formula. As the setting range, 6.8 kΩ to 330 kΩ is recommended. If the resistor is set lower than a 6.8kΩ, it causes the reduction of power efficiency. If it is set more than 330 kΩ, the offset voltage becomes larger by the input bias current 0.1 μA (Typ.) in the internal error amp.

$$SRC = \frac{R3 + R4}{R4} \times FBP \quad [V]$$

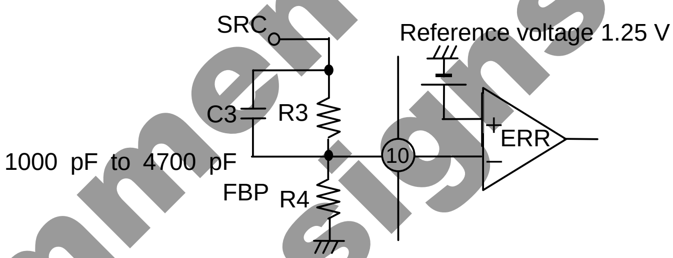



Fig. 32 Application Circuit Diagram

In order to prevent output voltage overshooting, add capacitor C3 in parallel with R3. The recommended capacitance is 1000 pF to 4700 pF. If a capacitor outside this range is inserted, the output voltage may oscillate.

(7) Negative-side Charge Pump Settings

This IC incorporates a charge pump controller for negative voltage, thus making it possible to generate stable gate voltage.

The output voltage is determined by the following formula. As the setting range, 6.8 kΩ to 330 kΩ is recommended. If the resistor is set lower than a 6.8 kΩ, it causes the reduction of power efficiency. If it is set more than 330 kΩ, the offset voltage becomes larger by the input bias current 0.1 μA (Typ.) in the internal error amp.

$$V_{GL} = (FBN - VREF)\frac{R5}{R6} + FBN \quad [V]$$

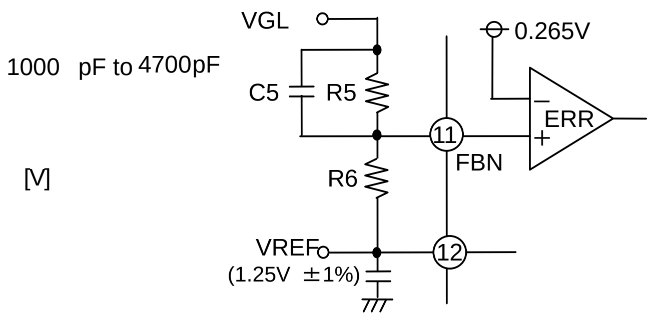



Fig. 33 Application Circuit Diagram

In order to prevent output voltage overshooting, insert capacitor C5 in parallel with R5. The recommended capacitance is 1000 pF to 4700 pF. If a capacitor outside this range is inserted, the output voltage may oscillate.

### ●Application Circuit

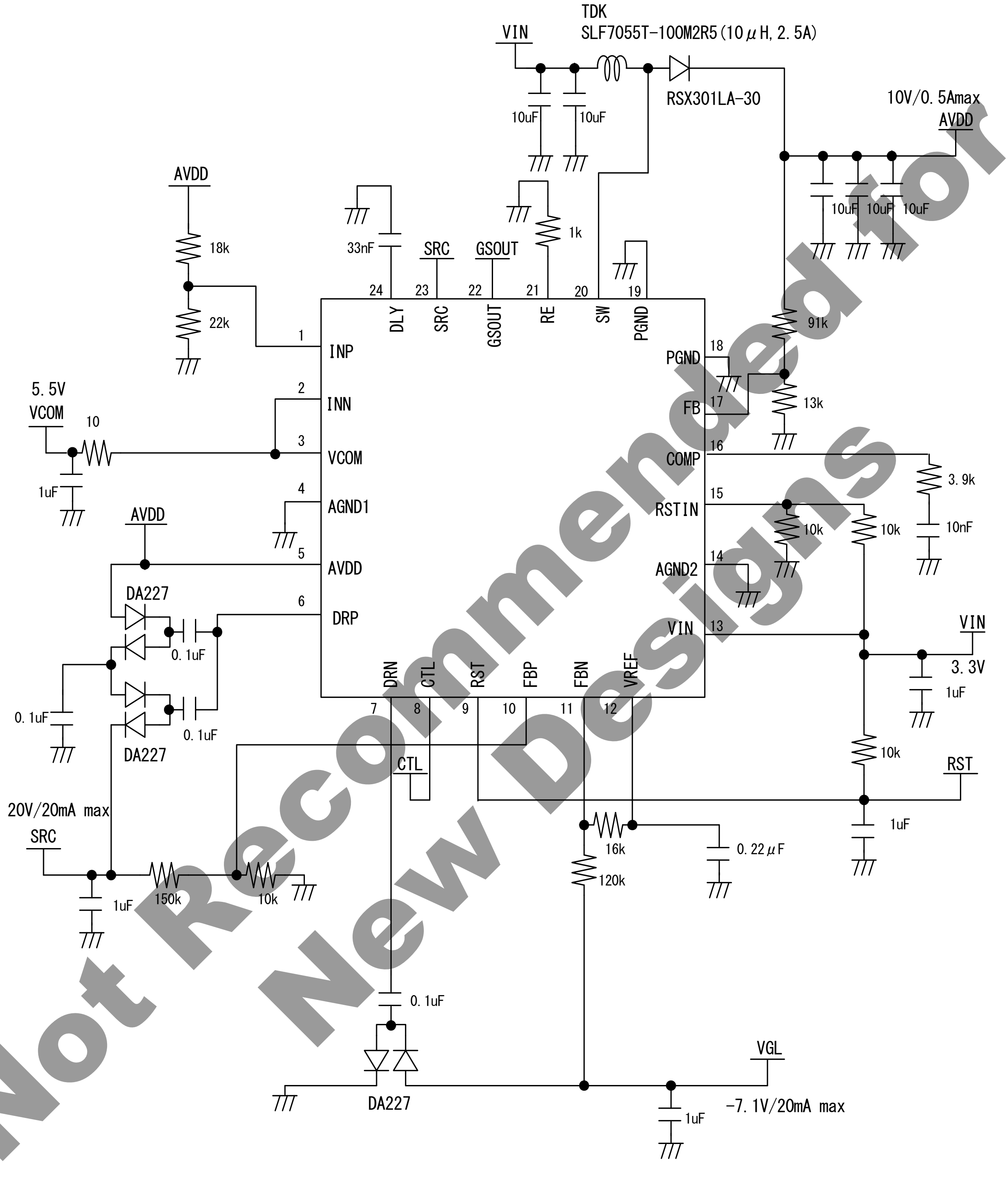
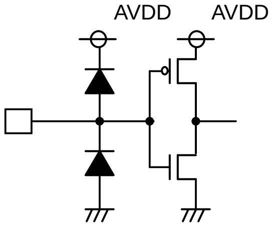
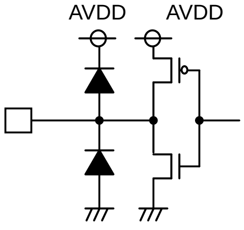
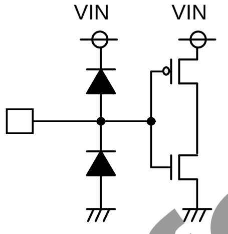
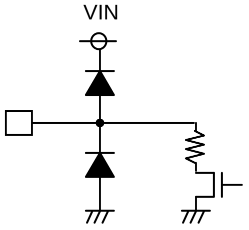
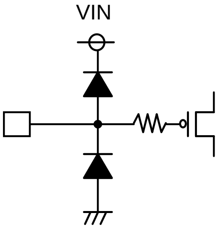
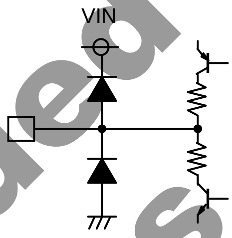
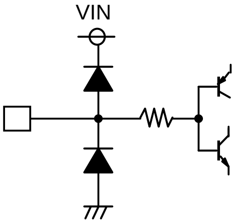
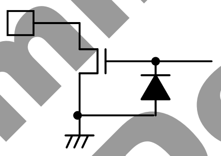
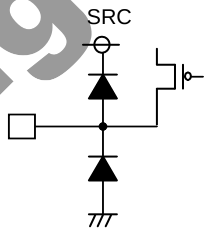
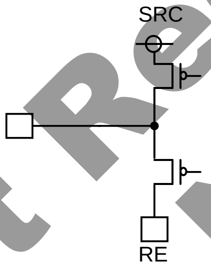
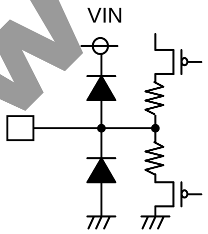



Fig. 34 Application Circuit

## ●I/O Equivalent Circuit Diagrams

(Except for 4.AGND1, 5.AVDD, 13.VIN, 14.AGND2, 18･19.PGND, 23.SRC)

| 1.INP 2.INN | 3.VCOM 6.DRP 7.DRN | 8.CTL |
|---|---|---|
|  |  |  |
| 9.RST | 10.FBP 11.FBN 15.RSTIN | 16.COMP |
|  |  |  |
| 17.FB | 18.SW | 21.RE |
|  |  |  |
| 22.GSOUT | 24.DLY | |
|  |  | |

**●Operation Notes**

1. Absolute maximum range
   This product are produced with strict quality control, but might be destroyed in using beyond absolute maximum ratings. Open IC destroyed a failure mode cannot be defined (like Short mode, or Open mode).
   Therefore physical security countermeasure, like fuse, is to be given when a specified mode to be beyond absolute maximum ratings is considered.

2. About Rush Current
   Rush current might flow momentarily by the order of turning on the power supply and rise time in IC with two or more power supplies. Therefore, please note drawing the width of the power supply and the GND pattern wiring, the output capacity, and the pattern and the current abilities.

3. Setting of heat
   Use a setting of heat that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

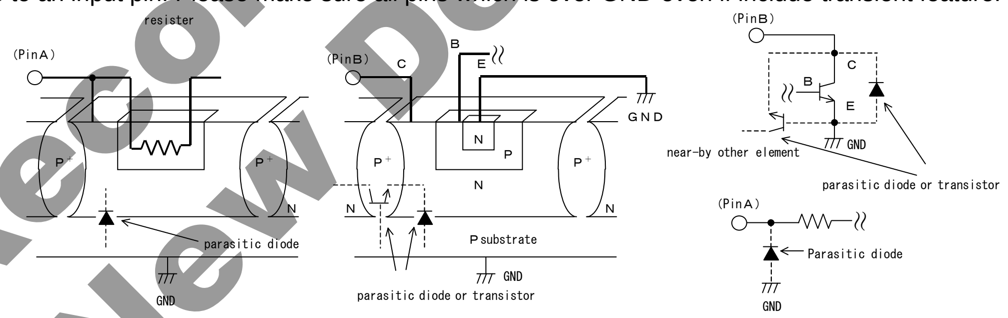
4. Short Circuit between Terminal and Soldering
   Don’t short-circuit between Output pin and VIN pin, Output pin and GND pin, or VIN pin and GND pin.
   When soldering the IC on circuit board, please be unusually cautious about the orientation and the position of the IC. When the orientation is mistaken the IC may be destroyed.

5. Electromagnetic Field
   Mal-function may happen when the device is used in the strong electromagnetic field.

6. Ground wiring patterns
   When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the application's reference point so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage.
   Be careful not to change the GND wiring patterns of any external components.

7. This IC is a monolithic IC which has P+ isolation in the P substrate and between the various pins.
   A P-N junction is formed from this P layer and the N layer of each pin. For example, when a resistor and a transistor is connected to a pin. Parasitic diodes can occur inevitably in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits as well as operation faults and physical damage. Accordingly, you must not use methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND.
   (P substrate) voltage to an input pin. Please make sure all pins which is over GND even if include transient feature.

SIMPLIFIED STRUCTURE OF BI-POLAR IC




8. Over current protection circuit
   The over-current protection circuits are built in at output, according to their respective current outputs and prevent the IC from being damaged when the load is short-circuited or over-current. But, these protection circuits are effective for preventing destruction by unexpected accident. When it’s in continuous protection circuit moving period don’t use please. And for ability, because this chip has minus characteristic, be careful for heat plan.

9. Built-in thermal circuit
   A temperature control circuit is built in the IC to prevent the damage due to overheat.
   Therefore, all the outputs are turned off when the thermal circuit works and are turned on when the temperature goes down to the specified level.

10. Testing on application boards
    When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Ground the IC during assembly steps as an antistatic measure, and use similar caution when transporting or storing the IC. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process.

● **Ordering part number**

| B | D | | 8 | 1 | 8 | 4 | | M | U | V | - | E | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

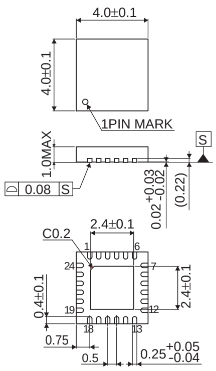
Part No. — BD

Part No. — 8184

Package
MUV:VQFN024V4040

Packaging and forming specification
E2: Embossed tape and reel

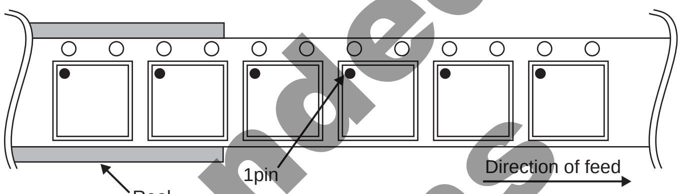
**VQFN024V4040**




(Unit : mm)

<Tape and Reel information>

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




※Order quantity needs to be multiple of the minimum quantity.

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1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

| JAPAN | USA | EU | CHINA |
|---|---|---|---|
| CLASSⅢ | CLASSⅢ | CLASSⅡb | CLASSⅢ |
| CLASSⅣ | | CLASSⅢ | |

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

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   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (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
   [h] Use of the Products in places subject to dew condensation

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

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

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

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

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

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

## Precaution for Mounting / Circuit board design

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

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

### Precautions Regarding Application Examples and External Circuits

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

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

### Precaution for Electrostatic

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

### Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

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

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

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

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

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