## Notification about the transfer of the semiconductor business

The semiconductor business of Panasonic Corporation was transferred on September 1, 2020 to Nuvoton Technology Corporation (hereinafter referred to as "Nuvoton"). Accordingly, Panasonic Semiconductor Solutions Co., Ltd. became under the umbrella of the Nuvoton Group, with the new name of Nuvoton Technology Corporation Japan (hereinafter referred to as "NTCJ").

In accordance with this transfer, semiconductor products will be handled as NTCJ-made products after September 1, 2020. However, such products will be continuously sold through Panasonic Corporation.

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

Nuvoton Technology Corporation Japan

Panasonic MIP6S1AMTSCF

| | | | |
|---|---|---|---|
| Type | Silicon MOSFET type Integrated Circuit | | |
| Application | For Switching Power Supply Control | | |
| Structure | Bi-CMOS type | | |
| Equivalent Circuit | Figure 7 | | |
| Package | DIP7-A1-B | Marking | MIP6S1A |

## A. ABSOLUTE MAXIMUM RATINGS

| No. | Item | Symbol | Ratings | Unit | Note |
|---|---|---|---|---|---|
| 1 | Drain Voltage | DRAIN | −0.3 ～ 700 | V | Tc = 25°C |
| 2 | Drain Peak Current | IDP | 4 | A | Tc = 25°C |
| 3 | VCC Voltage | VCC | −0.3 ～ 45 | V | Tc = 25°C |
| 4 | VDD Voltage | VDD | −0.3 ～ 10 | V | Tc = 25°C |
| 5 | LS Voltage | VLS | −0.3 ～ 10 | V | Tc = 25°C |
| 6 | IS Voltage | VIS | −0.3 ～ 5 | V | Tc = 25°C |
| 7 | FB Voltage | VFB | −0.3 ～ 8 | V | Tc = 25°C |
| 8 | Junction Temperature | Tj | 150 | °C | Control IC& Power MOSFET |
| 9 | Storage Temperature | Tstg | −55 ～ +150 | °C | |

## B. RECOMMENDED OPERATING CONDITIONS

| No. | Item | Symbol | Conditions | Unit | Note |
|---|---|---|---|---|---|
| 1 | Junction Temperature (Control IC) | Tjcon | −40 ～ +100 | °C | |
| 2 | Junction Temperature (Power MOSFET) | Tjmos | −40 ～ +150 | °C | |
| 3 | VCC operation voltage range at Heavy Load | VCC | 13 ～ 28 | V | |



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**C. ELECTRICAL CHARACTERISTICS** Measurement conditions (Ta=25°C±3°C)

| NO. | Item | Symbol | Measurement Conditions | Typ. | Min. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| [CONTROL FUNCTIONS] *Design Guarantee Item, **Reference Item | | | | | | | |
| 1 | VCC Start Voltage | VCC(ON) | | 18.5 | 17.0 | 20.0 | V |
| 2 | VCC Stop Voltage | VCC(OFF) | | 10.8 | 9.8 | 11.8 | V |
| 3 | VCC Start/Stop Hysteresis | D_VCC | VCC(ON) - VCC(OFF) | 7.7 | 6.9 | 8.8 | V |
| 4 | VDD Reference Voltage | VDD | VCC = 21 V | 5.9 | 5.6 | 6.2 | V |
| 5 | Circuit Current before start | ICC (SB) | VCC = VCC(ON) - 0.8 V, FB : open | 0.58 | 0.48 | 0.68 | mA |
| 6 | Operating Circuit Current at light load | ICC (STB) | VCC = 15 V, IFB = IFB1 – 10 µA | 0.51 | 0.45 | 0.56 | mA |
| **7 | Operating Circuit Current | ICC(OP) | VCC = 21 V, IFB = -20µA, DRAIN = 5 V | 1.90 | - | - | mA |
| 8 | Operating Circuit Current at Over Load Protection | ICC(OL) | VCC = 15 V VFB = VFB(OL) → open | 0.85 | 0.70 | 1.00 | mA |
| 9 | Output Frequency | fosc | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 100 | 93 | 107 | kHz |
| 10 | Jitter Frequency Deviation | d_fosc | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 5.1 | 3.0 | 7.2 | kHz |
| **11 | Jitter Frequency Modulation Rate | fM | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 350 | - | - | Hz |
| 12 | Maximum Duty Cycle | MAXDC | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 66 | 60 | 72 | % |
| 13 | Feedback Threshold Current | IFB1 | ON → OFF, VCC = 21 V | -80 | -104 | -56 | µA |
| **14 | Feedback Current Hysteresis | IFBHYS | OFF → ON, VCC = 21 V | 1 | - | - | µA |
| 15 | FB Pin Voltage | VFB1 | VCC = 21 V, IFB = IFB1 | 1.6 | 1.4 | 1.8 | V |
| 16 | FB Pin Grounded Current | IFB0 | VCC = 21 V, VFB = 0 V | -330 | -410 | -250 | µA |
| 17 | FB Pin Pull-down resistance at Output Stop | RFB(OFF) | VCC = 40 V, VFB = VFB1 | 400 | 250 | 550 | Ω |



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| No. | Item | Symbol | Measure Conditions | Typ. | Min. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| 18 | VCC Pin Charging Current | ICCH1 | VCC = 0 V, FB : open, DRAIN = 50 V | -11.0 | -15.4 | -6.6 | mA |
| | | ICCH2 | VCC = VCC(ON) - 0.5 V, FB : open, DRAIN = 50 V | -3.0 | -5.0 | -2.0 | mA |
| *19 | Soft Start Time | Tsoft | DRAIN = 50 V | 6.0 | 3.5 | 8.5 | ms |
| [CIRCUIT PROTECTIONS] *Design Guarantee Item, **Reference Item | | | | | | | |
| 20 | Current Limit Detection Maximum Voltage | VLIMIT(MAX) | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 800 | 744 | 856 | mV |
| 21 | Current Limit Detection Maximum Voltage at Input Compensation Mode | VLIMIT_L | VCC = 21 V, VFB = 3 V, VLS = 0.75 V, DRAIN = 5 V | 710 | 660 | 760 | mV |
| 22 | Slope Compensation Rate | VLIM_SLP | VCC = 21 V, VFB = 3 V | -22.4 | -27.6 | -17.2 | mV/µs |
| *23 | Start Duty Cycle of Slope Compensation | D_SLP | VCC = 21 V, VFB = 3 V | 35 | 31.5 | 38.5 | % |
| *24 | Current Detection Minimum Voltage at light load | VIS(OFF)min | VCC = 21 V, IFB = IFB1, DRAIN = 5 V | 160 | 110 | 210 | mV |
| **25 | Jitter Deviation of Current Detection Voltage at light load | D_VIS(OFF) | VCC = 21 V, IFB = IFB1, DRAIN = 5 V | 40 | - | - | mV |
| 26 | LS Pin Voltage of Input Compensation Detect | VLS(CL) | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 520 | 468 | 572 | mV |
| 27 | LS Pin Voltage of Input Compensation Release | VLS(CL)L | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 470 | 423 | 517 | mV |
| 28 | LS Pin Hysteresis Voltage of Input Compensation | VLS(CL)HYS | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 60 | 45 | 75 | mV |
| 29 | LS Pin Voltage of Over Input Protection Detect | VLS(OV) | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 1.050 | 0.945 | 1.155 | V |
| 30 | LS Pin Voltage of Over Input Protection Return | VLS(OV)L | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 1.000 | 0.900 | 1.100 | V |
| 31 | LS Pin Hysteresis Voltage of Over Input Protection | VLS(OV)HYS | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 0.06 | 0.045 | 0.075 | V |
| 32 | VCC timer Count at Over Load Protection | OLP_CNT | VCC = VCC(ON) ⇔VCC(OFF) | | 4 | | - |
| **33 | Leading Edge Blanking Delay | Ton(BLK) | | 440 | - | - | ns |
| **34 | Current Limit Delay | Td(OCL) | | 150 | - | - | ns |
| 35 | FB Over Load Protection detect Voltage | VFB(OL) | VCC = 22 V, DRAIN = 5 V | 4.4 | 4.1 | 4.7 | V |
| 36 | FB Current at heavy load | IFB(OL) | VCC = 22 V, VFB = 3 V, DRAIN = 5 V | -10 | -13 | -7 | µA |



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| No. | Item | Symbol | Measure Conditions | Typ. | Min. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| 37 | VCC Over Voltage Protection | VCC(OV) | VFB = 3 V, DRAIN = 5 V | 31.5 | 28.5 | 34.5 | V |
| 38 | VDD Over Voltage Protection | VDD(OV) | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 7.5 | 7.0 | 8.1 | V |
| 39 | VDD current at VDD Over Voltage Protection | IDD(OV) | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 1.2 | 0.7 | 1.7 | mA |
| 40 | VDD Clamp Current | IDD(CLP) | VDD = 10 V | 16.5 | 13.2 | 19.8 | mA |
| **41 | Over Load Protection Filter Time | Td(OL) | VCC = 21 V | 20 | - | - | µs |
| **42 | Over Voltage Protection Latch Stop Filter Time | Td(LAT) | VCC = 21 V | 150 | - | - | µs |
| 43 | Latch Reset VDD Threshold Voltage | VDDreset | | 2.7 | 1.7 | 3.7 | V |
| *44 | Thermal Shutdown Temperature (Control IC) | TOTP | | 140 | 130. | 150 | °C |
| **45 | Thermal Shutdown Temperature Hysteresis (Control IC) | TOTPHYS | | 70 | - | - | °C |

[Power MOSFET] *Design Guarantee Item, **Reference Item

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 46 | Minimum Drain Supply Voltage | VD(MIN) | | 25.0 | 20.0 | 29.0 | V |
| 47 | Breakdown Voltage | VDSS | VCC = 40 V, IDRAIN = 250 µA, | - | 700 | - | V |
| 48 | OFF-State leakage Current | IDSS | VCC = 40 V DRAIN = 650 V | 2 | - | 7 | µA |
| 49 | ON-State Resistance | RDS(ON) | VCC = 21 V, VFB = 3 V, IDRAIN = 1 A, | 2.5 | - | 2.7 | Ω |
| **50 | Rise Time | tr | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 150 | - | - | ns |
| **51 | Fall Time | tf | VCC = 21 V, VFB = 3 V, DRAIN = 5 V | 80 | - | - | ns |



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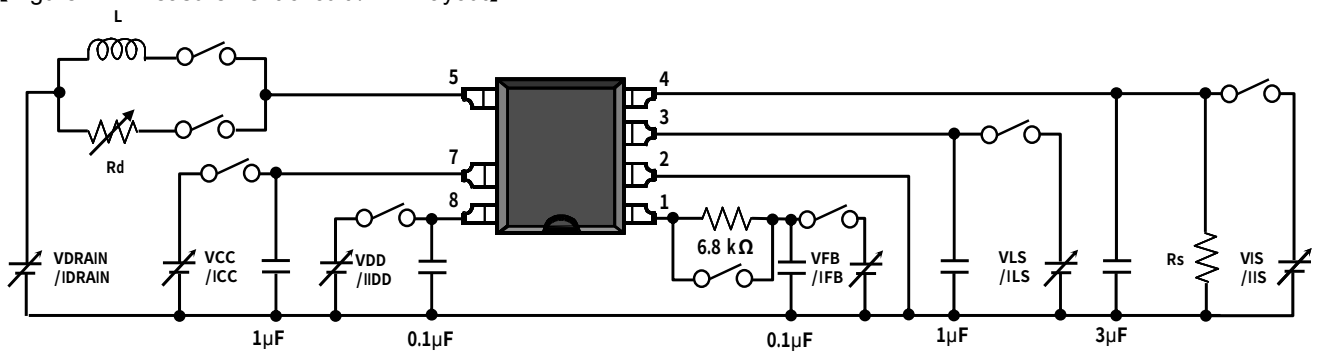
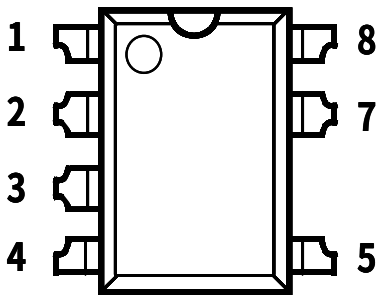
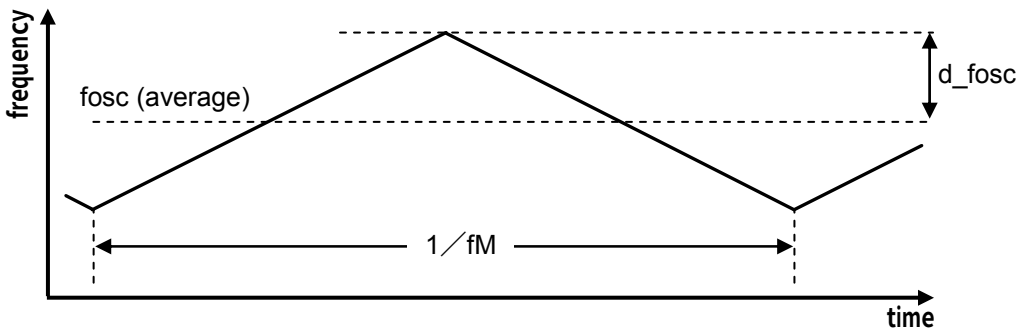
【Figure 1 : Measurement circuit / Pin Layout】




| Pin No. | Pin Name | Function |
|---|---|---|
| 1 | FB | Feedback control |
| 2 | GND | Ground |
| 3 | LS | Input Compensation /<br>Over Input Voltage Protection |
| 4 | IS | MOSFET Source / Current Detection |
| 5 | DRAIN | MOSFET Drain /<br>Power supply for start-up |
| 6 | | |
| 7 | VCC | Power supply from bias winding /<br>Over Voltage Protection |
| 8 | VDD | Reference Voltage for circuits /<br>External latch Protection |




【Figure 2： fosc, d_fosc, fM measurement】



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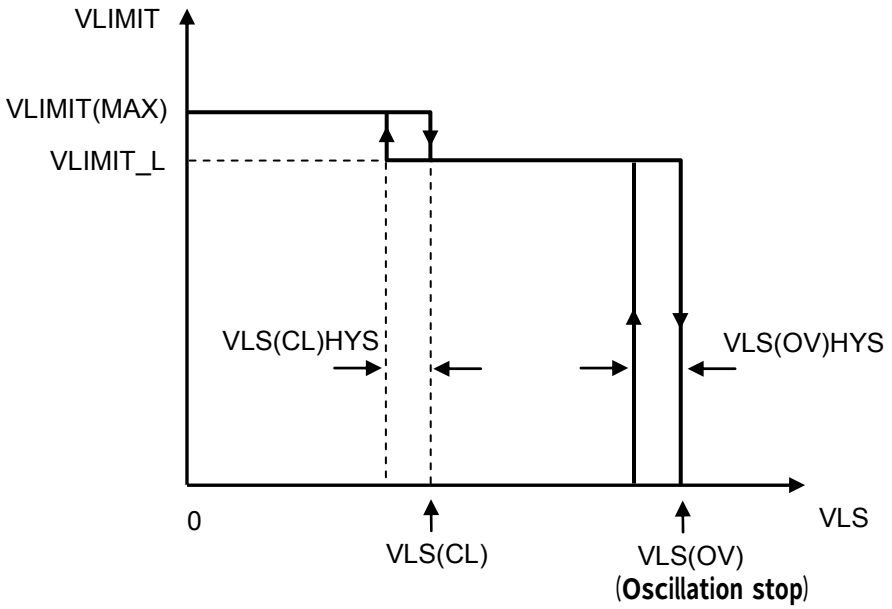
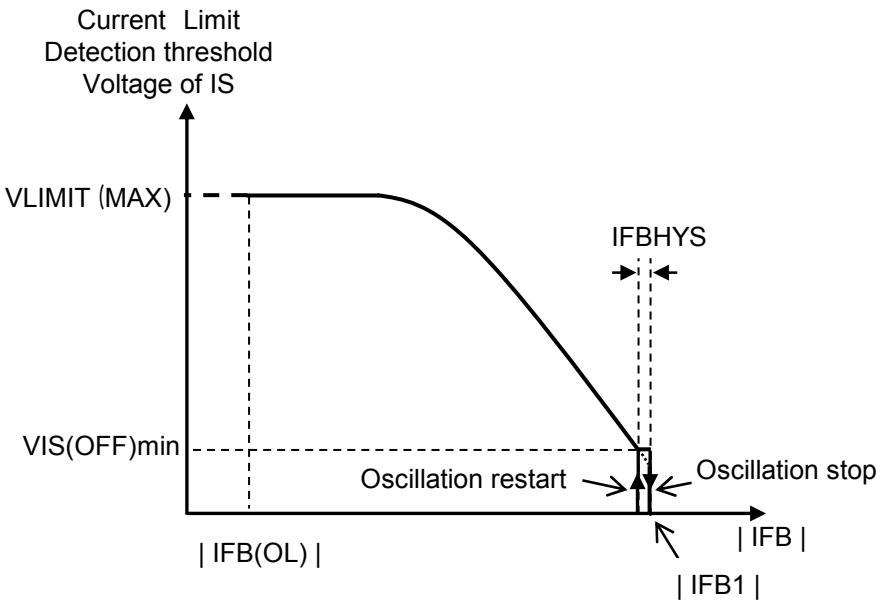
【Figure 3： VLS－VLIMIT Characteristics】




【Figure 4： IFB－VLIMIT Characteristics】



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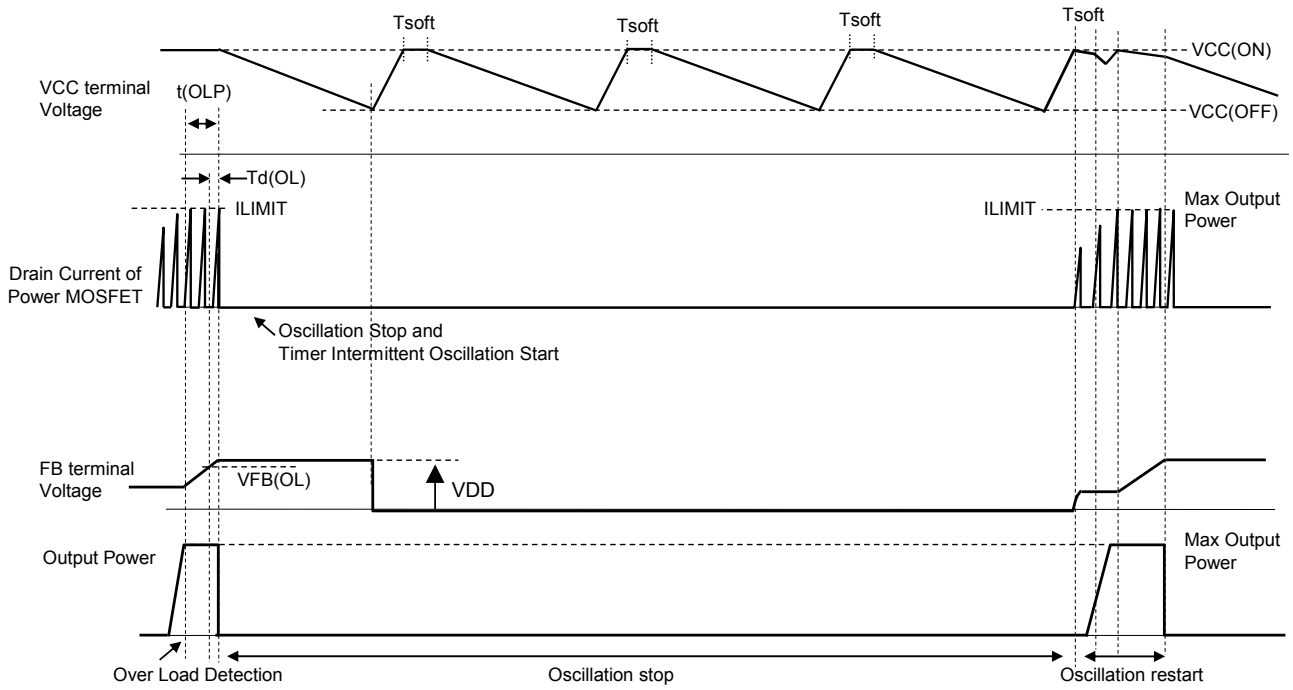
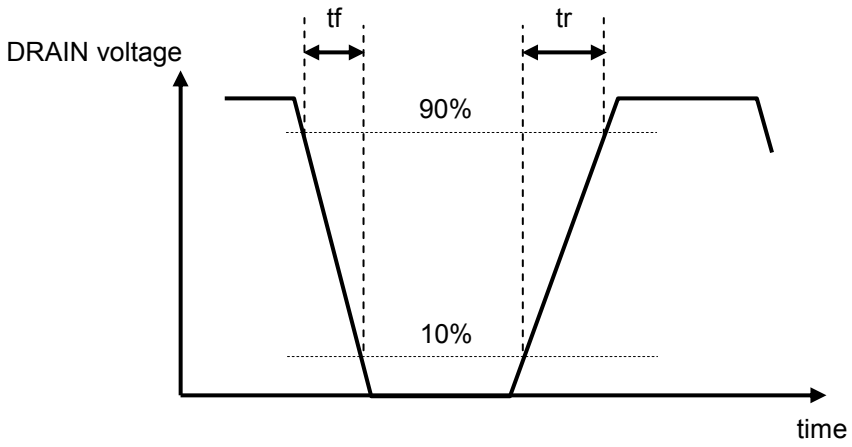
【Figure 5： Over Load Protection Characteristics】




【Figure 6： tr, tf measurement】



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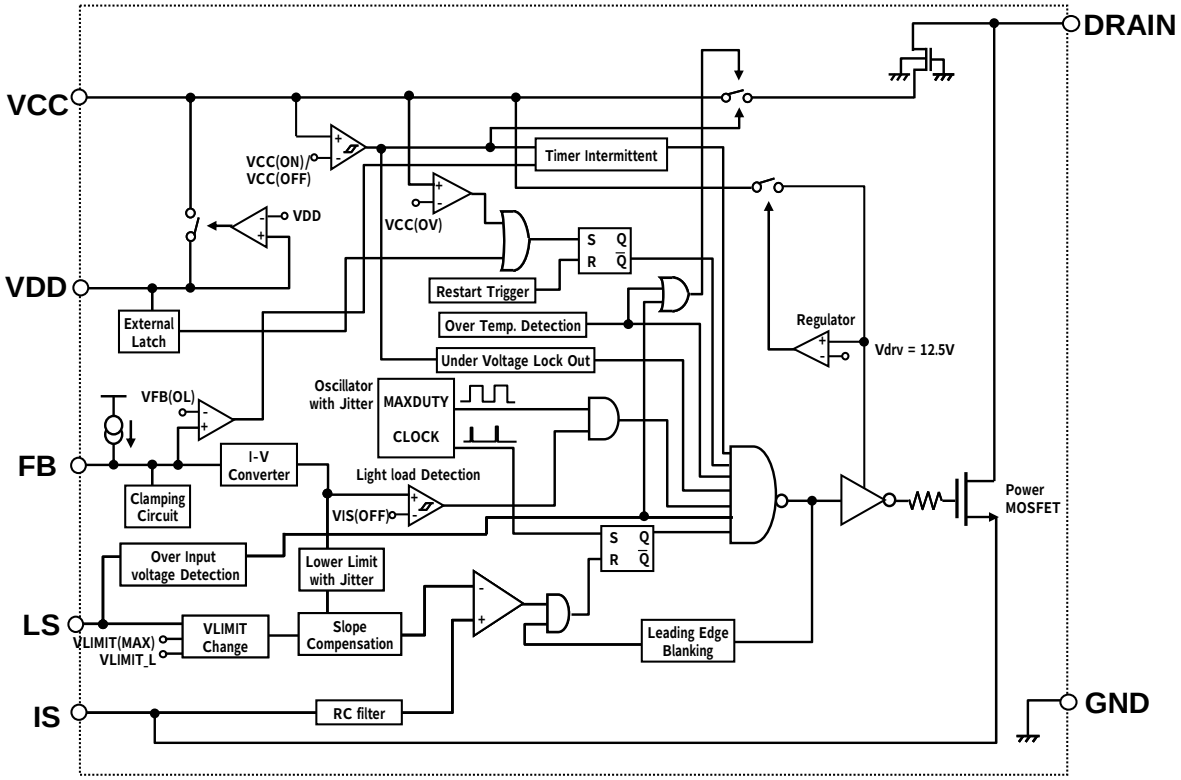
【Figure 7： Block Diagram】




[Precautions for Use 1]

Connect a ceramic capacitor with value ≧ 0.1 μF between VDD pin and GND

[Precautions for Use 2]

The product has risks for break-down or burst or giving off smoke in following conditions. Avoid the following use. Fuse should be added at the input side or connect Zener diode between control pin and GND, etc. as a countermeasure to pass regulatory Safety Standard. Concrete countermeasure could be provided individually. However, customer should make the final judgment.

(1) Reverse the Drain pin and FB pin connection to the power supply board.
(2) Connect to pins in which different Maximum ratings.



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