## 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.

Publisher of this Document is NTCJ.
If you would find description “Panasonic” or “Panasonic semiconductor solutions”, please replace it with NTCJ.

※ Except below description page
“Request for your special attention and precautions in using the technical information and semiconductors described in this book”

Nuvoton Technology Corporation Japan

MIP0060MXL

Panasonic

| | | | |
|---|---|---|---|
| Type | Silicon MOSFET type Integrated Circuit | | |
| Application | For Switching Power Supply Control | | |
| Structure | CMOS type | | |
| Equivalent Circuit | Figure 7 | | |
| Package | SSOP016-P-0300XZ | Marking | MIP006 |

**A. ABSOLUTE MAXIMUM RATINGS (Ta=25°C±3°C)**

| NO. | Item | Symbol | Ratings | Unit | Note |
|---|---|---|---|---|---|
| 1 | VIN Voltage | VIN | −0.3 ～ 550 | V | |
| 2 | VCC Voltage | VCC | −0.3 ～ 45 | V | |
| 3 | VDD1 Voltage | VDD1 | −0.3 ～ 10 | V | |
| 4 | VDD2 Voltage | VDD2 | −0.3 ～ 10 | V | |
| 5 | VGD Voltage | VGD | −0.3 ～ 15 | V | |
| 6 | OUT Voltage | VOUT | −0.3 ～ 15 | V | |
| 7 | IS Voltage | VIS | −0.3 ～ 5 | V | |
| 8 | FB Voltage | VFB | −0.3 ～ 8 | V | |
| 9 | OFF Voltage | VOFF | −0.3 ～ 10 | V | |
| 10 | CL Voltage | VCL | −0.3 ～ 10 | V | |
| 11 | LS Voltage | VLS | −0.3 ～ 10 | V | |
| 12 | SO Voltage | VSO | −0.3 ～ 10 | V | |
| 13 | SO Current | ISO | −1.3 | mA | |
| 14 | Junction Temperature | Tj | 150 | °C | |
| 15 | Storage Temperature | Tstg | −55 ～ +150 | °C | |

**B. RECOMMENDED OPERATING CONDITIONS**

| NO. | Item | Symbol | Conditions | Unit | Note |
|---|---|---|---|---|---|
| 1 | Junction Temperature | Tj | −40 ～ +125 | °C | |



Established : 2013-08-01
Revised : 2015-10-07

**C. ELECTRICAL CHARACTERISTICS** Measure condition (TC=25°C±3°C)

| No. | Item | Symbol | Measure Conditions | Typ. | Min. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| [CONTROL FUNCTIONS] *Design Guarantee Item, **Reference Item | | | | | | | |
| 1 | VCC Start Voltage | VCC(ON) | | 20 | 18 | 22 | V |
| 2 | VCC Stop Voltage | VCC(OFF) | | 10.3 | 9.3 | 11.3 | V |
| 3 | VCC Start/Stop Hysteresis | D_VCC | VCC(ON) - VCC(OFF) | 9.7 | 8.7 | 10.7 | V |
| 4 | VDD1 Reference Voltage | VDD1 | VCC = 22 V | 6.0 | 5.5 | 6.5 | V |
| 5 | VDD2 Reference Voltage | VDD2 | VCC = 22 V, VDD1 : open | 5.2 | 4.7 | 5.7 | V |
| 6 | VDD2 Charge Start Voltage | VDD2(OFF) | VIN = 50 V | 4.5 | 4.0 | 5.0 | V |
| 7 | Reset Voltage of Power-OFF Mode | VDD2reset | | 2.1 | 1.4 | 2.8 | V |
| 8 | Voltage Deference for keeping Power-OFF Mode | D_VDD2 | VDD2(OFF) - VDD2reset | 2.4 | 1.4 | 3.4 | V |
| 9 | VCC Pin Current at Start-up | ICC (SB) | VCC = VCC(ON) - 0.5 V, CL : open, FB : open, SO : open | 0.55 | 0.40 | 0.70 | mA |
| 10 | VCC Pin Current at Low Load | ICC (STB) | VCC = 15 V, CL : open, IFB = IFB1 – 5uA, SO : open | 0.73 | 0.63 | 0.83 | mA |
| 11 | VCC Pin Current at Operating | ICC(OP) | VCC = 22 V, CL : open, COUT = 1 nF, IFB = -50 µA, SO : open | 1.7 | 1.4 | 2.0 | mA |
| 12 | VCC Pin current in Power-OFF Mode | ICC(OFF) | Power-OFF Mode, VIN = 50 V, VCC = 22 V | 40 | 20 | 60 | µA |
| 13 | Output Frequency | fosc | VCC = 22 V, CL : open, COUT = 1 nF, VFB = 3 V | 66 | 61 | 71 | kHz |
| 14 | Jitter Frequency Deviation | d_fosc | VCC = 22 V, CL : open, COUT = 1 nF, VFB = 3 V | 3 | 1.8 | 4.2 | kHz |
| **15 | Jitter Frequency Modulation Rate | fM | VCC = 22 V, CL : open, COUT = 1 nF, VFB = 3 V | 430 | - | - | Hz |
| 16 | Maximum Duty Cycle | MAXDC | VCC = 22 V, CL : open, COUT = 1 nF, VFB = 3 V | 66 | 60 | 72 | % |
| 17 | Feedback Threshold Current | IFB1 | ON → OFF, VCC = 22 V, CL : open | -100 | -140 | -60 | µA |
| **18 | Feedback Current Hysteresis | IFBHYS | OFF → ON VCC = 22 V, CL : open | 1 | - | - | µA |
| 19 | FB Pin Voltage | VFB1 | VCC = 22 V, IFB = IFB1 | 1.6 | 1.2 | 2.0 | V |
| 20 | FB Pin Grounded Current | IFB0 | VCC = 22 V, VFB = 0 V | -330 | -410 | -250 | µA |
| 21 | FB Pin Pull-down resistance at Output Stop | RFB(OFF) | VCC = 22 V, VFB = VFB1, ICL < ICL1 | 370 | 220 | 520 | Ω |



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| No. | Item | Symbol | Measure Conditions | Typ. | Min. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| 22 | VCC Pin Charging Current | ICCH1 | VCC = 0 V, CL : open,<br>FB : open, , SO : open, VIN = 50 V | -11.0 | -15.4 | -6.6 | mA |
| | | ICCH2 | VCC = VCC(ON) - 0.5 V, CL : open,<br>FB : open, , SO : open, VIN = 50 V | -3.6 | -5.1 | -2.1 | mA |
| 23 | VDD2 Pin Charging Current | IDD2CH | Power-OFF Mode, Detection of AC input cutoff,<br>VDD2 = VDD2(OFF) – 0.5 V,<br>VSO = 0 V, VIN = 50 V | -8.0 | - | -4.0 | mA |
| 24 | LS Pin Detect Voltage | VLSH | VCC = 22 V, VFB = 3 V | 1.27 | 1.11 | 1.43 | V |
| 25 | LS Pin Detect Voltage Hysteresis | VLSHYS | VCC = 22 V, VFB = 3 V | 0.37 | 0.27 | 0.47 | V |
| 26 | LS Pin Leakage Current | ILS(LEAK) | VCC = 22 V, VLS = 10 V | 0 | - | 0.1 | µA |
| 27 | LS Pin Detect Filter Time | Td(LS)1 | VCC = 22 V | 36 | 23 | 55 | ms |
| | | Td(LS)2 | Power-OFF Mode,<br>VIN = 50 V | 32 | 22 | 48 | ms |
| 28 | VIN Current in LS Undetected State | IIN(ACCUT)1 | Detection of AC input cutoff,<br>VCC = 22 V, SO : open, VIN = 30 V | 2.4 | 1.4 | 3.4 | mA |
| | | IIN(ACCUT)2 | Power-OFF Mode, Detection of AC input cutoff,<br>VCC = 22 V, SO : open, VIN = 30 V | 2.2 | 1.2 | 3.2 | mA |
| 29 | OFF Pin Detect Voltage | VTH(OFF) | VIN = 50 V | 1.27 | 1.04 | 1.50 | V |
| *30 | Power-OFF Mode Detect Filter Time | Td(OFF) | VOFF = 0 V → VTH(OFF) + 0.2 V<br>VIN = 50 V | 1.2 | 0.7 | 1.7 | ms |
| 31 | SO Pin Output Voltage | VSO1 | Detection of AC input cutoff,<br>VCC = 22 V, ISO = 0 µA, VIN = 50 V | 3.7 | 2.7 | 4.7 | V |
| | | VSO2 | Power-OFF Mode, Detection of AC input cutoff,<br>ISO = 0 µA, VIN = 50 V | 2.9 | 1.9 | 3.9 | V |
| 32 | SO Pin Output Current | ISO | Detection of AC input cutoff,<br>VCC = 22 V, VSO = 1 V, VIN = 50 V | -0.75 | -1.2 | -0.3 | mA |
| 33 | SO Pin Disable Threshold | VTH(SO) | | VDD2-1.0 | VDD2-1.5 | VDD2-0.5 | V |
| *34 | Soft Start Time | Tsoft | VCC = VCC(OFF) → VCC(ON),<br>CL : open, VFB = 3 V, SO : open | 5 | 2.5 | 7.5 | ms |
| [CIRCUIT PROTECTIONS] *Design Guarantee Item, **Reference Item | | | | | | | |
| 35 | Current Limit Detection Maximum Voltage | VLIMIT(MAX) | VCC = 22 V, CL : open ,<br>VFB = 3 V | 775 | 720 | 830 | mV |
| 36 | Current Limit Detection Voltage at ICL = -150 µA | VLIMIT150 | VCC = 22 V, ICL = -150 µA ,<br>VFB = 3 V | 390 | 350 | 430 | mV |
| 37 | Remote ON/OFF Threshold Current | ICL1 | ON → OFF,<br>VCC = 22 V, VFB = 3 V | -300 | -390 | -210 | µA |



Established : 2013-08-01
Revised : 2015-10-07

| No. | Item | Symbol | Measure Conditions | Typ. | Min. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **38 | Remote ON/OFF Threshold Current Hysteresis | ICLHYS | OFF → ON, VCC = 22 V, VFB = 3 V | 10 | - | - | µA |
| 39 | CL Pin Voltage at ICL = 0 µA | VCL | VCC = 22 V, ICL = 0 µA , VFB = 3 V | 1.30 | 0.90 | 1.70 | V |
| 40 | CL Pin Voltage at ICL = 150 µA | VCL150 | VCC = 22 V, ICL = -150 µA , VFB = 3 V | 1.15 | 0.80 | 1.50 | V |
| 41 | CL Pin Voltage at ICL = ICL1 | VCL1 | VCC = 22 V, ICL = ICL1, VFB = 3 V | 1.00 | 0.65 | 1.35 | V |
| 42 | CL Pin Grounded Current | ICL0 | VCC = 22 V, VCL = 0 V, VFB = 3 V | -380 | -560 | -200 | µA |
| 43 | CL Pin Current Difference | D_ICL | ICL1 - ICL0 | 80 | 30 | 130 | µA |
| *44 | Current Detection Minimum Voltage at IFB = IFB1 | VIS(OFF)min | VCC = 22 V, ICL : open, IFB = IFB1 | 200 | 150 | 250 | mV |
| **45 | Jitter Deviation of Current Detection Voltage at IFB = IFB1 | D_VIS(OFF) | VCC = 22 V, ICL : open, IFB = IFB1 | 40 | - | - | mV |
| 46 | Sense Offset Current at Heavy Load | IIS1 | VCC = 22 V , VFB = 3 V, VIS = 0 V | 0 | -2 | 2 | µA |
| **47 | Sense Offset Minimum Current at IFB = IFB1 | IIS2 | VCC = 22 V , IFB = IFB1, VIS = 0 V | -90 | - | - | µA |
| 48 | Minimum On Time | Ton(MIN) | VCC = 20 V, COUT = 1 nF | 800 | 500 | 1100 | ns |
| **49 | Leading Edge Blanking Delay | Ton(BLK) | VCC = 22 V, CL : open, COUT = 1 nF, VFB = 3 V | 650 | - | - | ns |
| **50 | Current Limit Delay | Td(OCL) | VCC = 22 V, CL : open, COUT = 1 nF, VFB = 3 V | 150 | - | - | ns |
| 51 | FB Pin Over Load Protection Voltage | VFB(OL) | VCC = 22 V | 4.4 | 3.9 | 4.9 | V |
| 52 | FB Pin Charging Current at Over Load | IFB(OL) | VCC = 22 V, VFB = 3 V | -10 | -13 | -7 | µA |
| 53 | VDD1 Latch Stop Threshold Voltage | VDD1(OV) | VCC = 22 V, VFB = 3 V | 7.7 | 7.0 | 8.4 | V |
| 54 | VDD1 Latch Stop Threshold Current | IDD1(OV) | VCC = 22 V, VFB = 3 V | 1.4 | 0.8 | 2.0 | mA |
| 55 | VDD1clamp Current | IDD1(CLP) | VCC = 22 V, VDD1 = 10 V | 9.3 | 7.5 | 11.1 | mA |
| **56 | VDD1 Latch Reset Threshold Voltage | Td(LAT) | VCC = 22 V | 125 | - | - | µs |
| 57 | VDD1 Latch reset Voltage | VDD1reset | | 2.7 | 1.7 | 3.7 | V |
| *58 | Thermal Shutdown Temperature | TOTP | | 140 | 130 | 150 | °C |
| **59 | Thermal Shutdown Temperature Hysteresis | TOTPHYS | | 70 | - | - | °C |



Established : 2013-08-01
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| No. | Item | Symbol | Measure Conditions | Typ. | Min. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| [OUTPUT] **Reference Item | | | | | | | |
| 60 | VGD Reference Voltage | VGDref | VCC = 22 V | 12 | 11 | 13 | V |
| 61 | VGD Minimum Voltage | VGD(MIN) | VCC = VCC(OFF) | 9.4 | 8.4 | 10.4 | V |
| **62 | Output Sink Current | IOUTL | VCC = 22 V, VGD = VGDref + 0.2 V, VOUT = 12 V | 1.2 | - | - | A |
| **63 | Output Source Current | IOUTH | VCC = 22 V, VGD = VGDref + 0.2 V, VOUT = 0 V | -0.6 | - | - | A |
| 64 | Low Level Output Voltage | VOUTL | VCC = 22 V, VGD = VGDref + 0.2 V, IOUT = 10 mA | 0.05 | - | 0.2 | V |
| 65 | High Level Output Voltage | VOUTH | VCC = 22 V, VGD = VGDref + 0.2 V, IOUT = -10 mA | VGD-0.1 | VGD-0.3 | - | V |
| **66 | Rise Time | tr | VCC = 22 V, COUT = 1 nF VGD = VGDref + 0.2 V | 40 | - | - | ns |
| **67 | Fall Time | tf | VCC = 22 V, COUT = 1 nF VGD = VGDref + 0.2 V | 20 | - | - | ns |
| [HIGH VOLTAGE INPUT] | | | | | | | |
| 68 | VIN Pin Leakage Current | IIN(LEAK) | VIN = 500 V, VCC > VCC(ON), | 2.5 | - | 10 | µA |
| 69 | VIN Pin Current in Power-OFF Mode | IIN(OFF) | Power-OFF Mode, VIN = 500 V, VCC : open | 12.5 | - | 30 | µA |
| 70 | VIN Pin Breakdown Voltage | BVVIN | IIN = 100 µA, VCC > VCC(ON) | - | 550 | - | V |
| 71 | Minimum VIN Supply Voltage | VIN(MIN) | | 26 | 21 | 31 | V |



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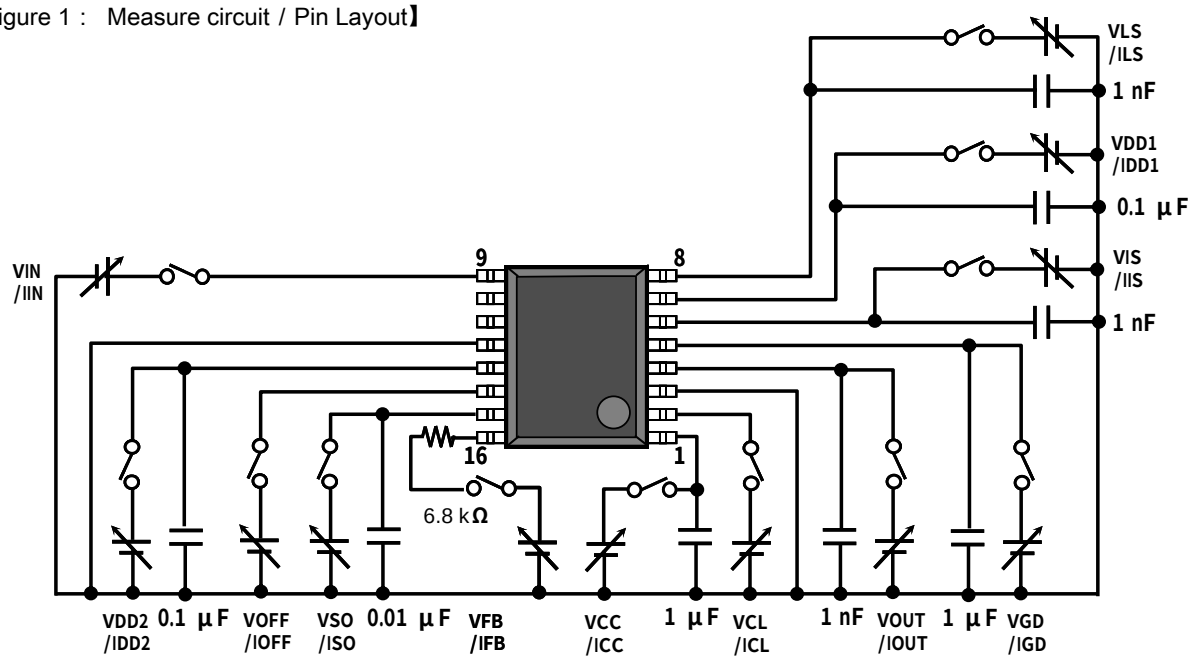
Revised : 2015-10-07

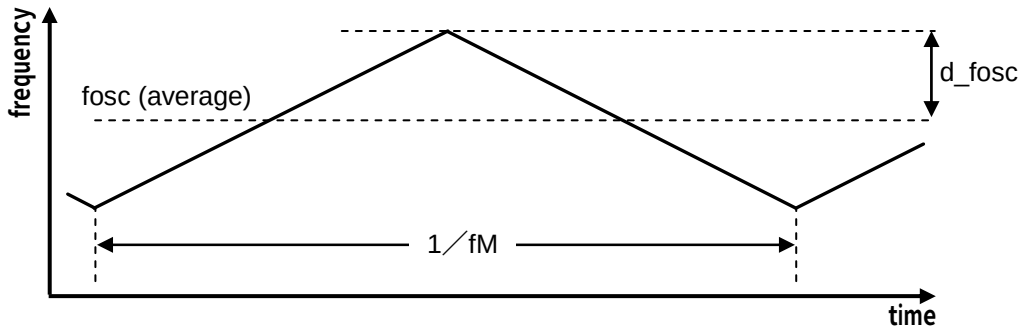
【Figure 1 : Measure circuit / Pin Layout】



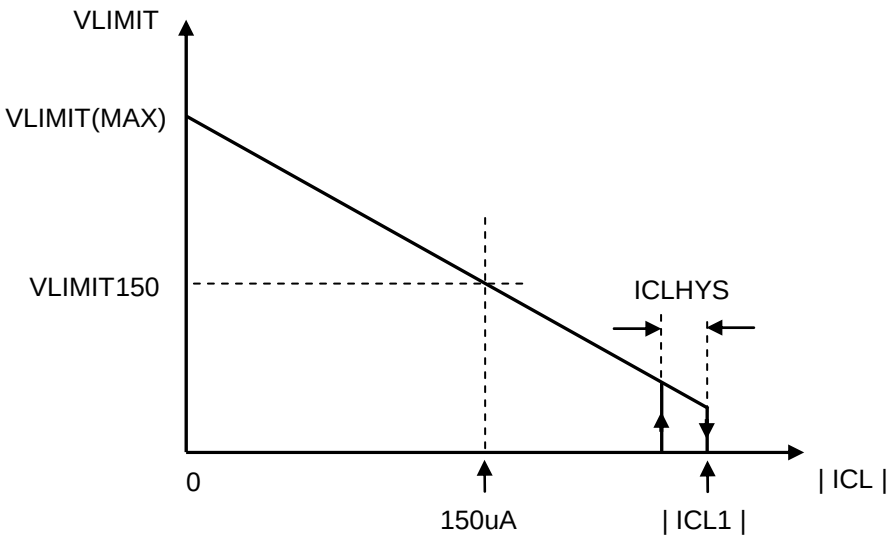

| Pin No. | Pin Name | Function |
|---|---|---|
| 1 | VCC | Power supply from bias winding |
| 2 | CL | VLIMIT adjustment（Input correction） |
| 3 | GND1 | Ground (※) |
| 4 | OUT | Output for gate drive |
| 5 | VGD | Power supply for gate drive |
| 6 | IS | Current detection |
| 7 | VDD1 | Power Supply Voltage for circuits, External latch |
| 8 | LS | AC input cutoff detection |
| 9 | VIN | Power supply for start-up |
| 10 | NC | — |
| 11 | NC | — |
| 12 | GND2 | Ground (※) |
| 13 | VDD2 | Power Supply Voltage for power off mode |
| 14 | OFF | Power-off mode control |
| 15 | SO | AC input signal detection signal output |
| 16 | FB | Feedback control |

※GND1 and GND2 should be shorted on this power supply board.

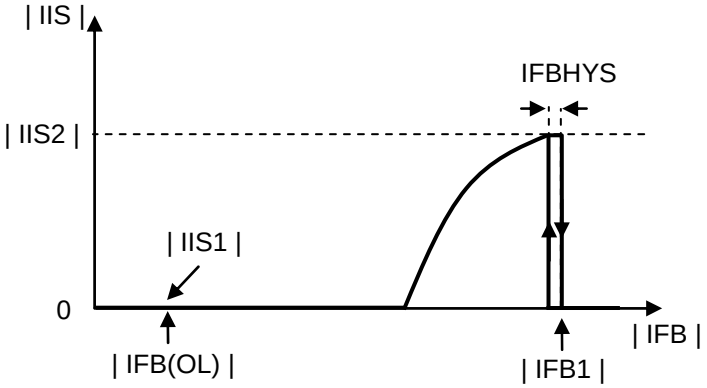
【Figure 2： fosc, d_fosc, fM measurement】




【Figure 3： ICL－VLIMIT Characteristics】




【Figure 4： IFB－IIS Characteristics】



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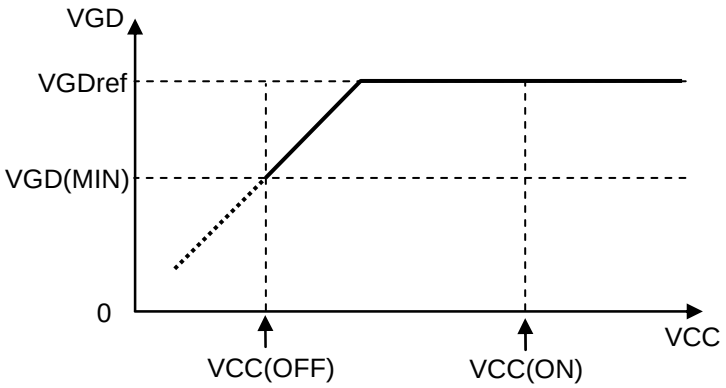
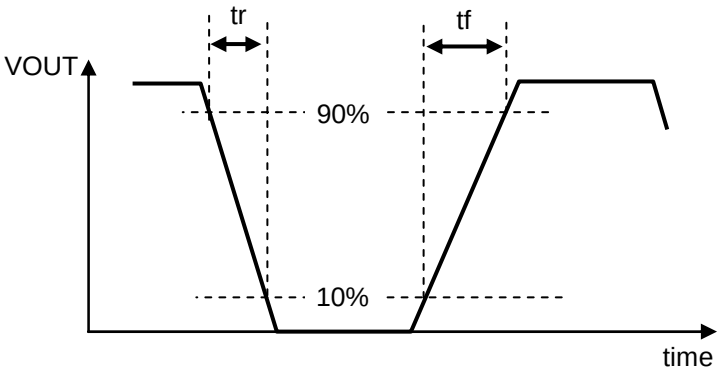
Revised : 2015-10-07

【Figure 5： VCC－VGD Characteristics】




【Figure 6： tr, tf measurement】



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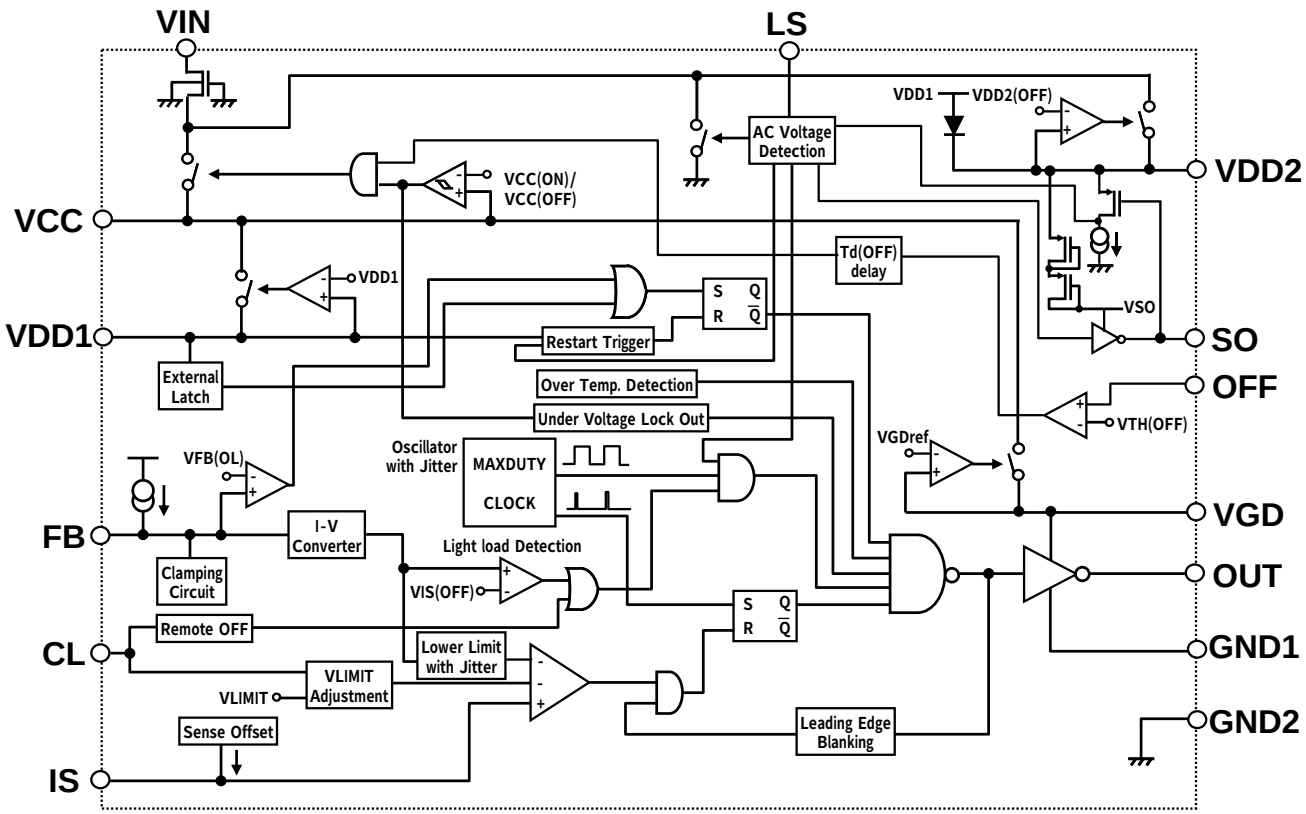
【Figure 7： Block Diagram】




[Precautions for Use 1]
Connect GND1 and GND2 on the power supply board.

[Precautions for Use 2]
Connect a ceramic capacitor with value ≧ 0.1μF between VDD1 pin and GND, and between VDD2 pin and GND.

[Precautions for Use 3]
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 VIN pin and VCC pin connection to the power supply board.
(2) Connect to pins in which different Maximum ratings.

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