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.
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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 MIP6T1BMTSCF

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	MIP6T1B

A. ABSOLUTE MAXIMUM RATINGS (Ta=25℃±3℃)

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

B. RECOMMENDED OPERATING CONDITIONS

No.	Item	Symbol	Conditions	Unit	Note
1	Junction Temperature (Control IC)	Tjcon	−40 ～ +125	℃	
2	Junction Temperature (Power MOSFET)	Tjmos	−40 ～ +150	℃	
3	VCC Operation Voltage	VCC	13 ～ 28	V	

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C. ELECTRICAL CHARACTERISTICS Measurement condition (Ta=25℃±3℃)

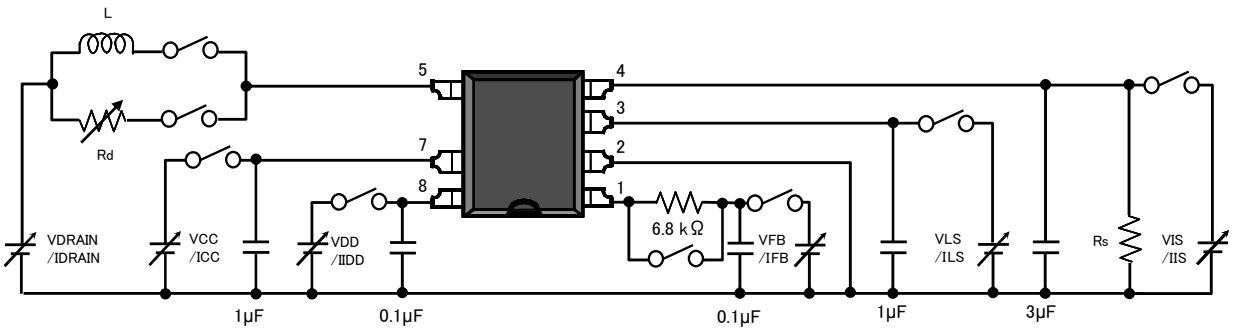
No.	Item	Symbol	Measurement Conditions (Refer to figure 1)	Typ.	Min.	Max.	Unit
【CONTROL FUNCTIONS】*Design Guarantee Item, **Reference Item							
1	VCC Start Voltage	VCC(ON)		18.5	16.5	20.5	V
2	VCC Stop Voltage	VCC(OFF)		10.8	9.8	11.8	V
3	VCC Start/Stop Hysteresis	D_VCC	VCC(ON) − VCC(OFF)	7.7	6.9	8.8	V
4	VDD Reference Voltage	VDDreg	VCC = 21 V	5.9	5.6	6.2	V
5	VCC Pin Current before Start-up	ICC(SB)	VCC = VCC(ON) − 0.8 V, FB = open	0.43	0.30	0.56	mA
**6	VCC Pin Current at Standby Mode	ICC(STB)	VCC = 15 V, IFB = IFB1 − 10 μA	0.54	−	−	mA
**7	VCC Pin Current at Light Load PWM	ICC(OP)L	VCC = 15 V, IFB = IFB1 + 5 μA, VDRAIN = 5 V	1.3	−	−	mA
**8	VCC Pin Current at Heavy Load PWM	ICC(OP)H	VCC = 15 V, IFB = −20 μA, VDRAIN = 5 V	2.20	−	2.62	mA
9	VCC Pin Current at Over Load Protection	ICC(OL)	VCC = 15 V VFB = VFB(OL) → open	0.43	0.30	0.56	mA
10	Switching Frequency at Light Load PWM	f(PWM)L	VCC = 21 V, IFB = IFB1 + 5 μA, VDRAIN = 5 V *Refer Figure 3	25	20	30	kHz
11	Switching Frequency at Heavy Load PWM	f(PWM)H	VCC = 21 V, IFB = −20 μA, VDRAIN = 5 V *Refer Figure 3	132	123	141	kHz
**12	Frequency Jitter Deviation at Light Load PWM	d_f(PWM)L	VCC = 21 V, IFB = IFB1 + 5 μA, VDRAIN = 5 V *Refer Figure 2	0.85	−	−	kHz
13	Frequency Jitter Deviation at Heavy Load PWM	d_f(PWM)H	VCC = 21 V, IFB = −20 μA, VDRAIN = 5 V *Refer Figure 2	4.5	2.7	6.3	kHz
**14	Frequency Jitter Modulation Rate	fM	VCC = 21 V, IFB = −20 μA, VDRAIN = 5 V *Refer Figure 2	450	−	−	Hz
15	Maximum Duty Cycle	MAXDC	VCC = 21 V, IFB = IFB3 + 3 μA, VDRAIN = 5 V	64	59	69	%
16	Feedback Current	IFB1	ON → OFF, VCC = 21 V, VDRAIN = 5V	−85	−110	−60	μA
**17	Feedback Current Hysteresis	IFBHYS	OFF → ON, VCC = 21 V, VDRAIN = 5V	2	−	−	μA
**18	Feedback Current at Light Load PWM	IFB2	VCC = 21 V, VDRAIN = 5V *Refer Figure 3	−60	−	−	μA
**19	Feedback Current at Heavy Load PWM	IFB3	VCC = 21 V, VDRAIN = 5V *Refer Figure 3	−43	−	−	μA
**20	Feedback Current at Maximum Output	IFB4	VCC = 21 V, VDRAIN = 5V *Refer Figure 3	−41	−	−	μA

No.	Item	Symbol	Measurement Conditions (Refer to figure 1)	Typ.	Min.	Max.	Unit
21	FB Pin Voltage at Light Load	VFB1	VCC = 21 V, IFB = IFB1	1.6	1.4	1.8	V
22	FB Pin Voltage at Heavy Load	VFB3	VCC = 21 V, IFB = IFB3	1.7	1.5	1.9	V
23	FB Pin Grounded Current	IFB0	VCC = 21 V, VFB = 0 V	−330	−450	−210	μA
24	FB Pin Pull-Down Resistance at Output Stop	RFB(OFF)	VCC = 40 V, VFB = VFB1	400	250	550	Ω
25	VCC Pin Charging Current	ICCH1	VCC = 0 V, FB = open, VLS = 2 V, VDRAIN = 50 V	−11.0	−15.4	−6.6	mA
		ICCH2	VCC = VCC(ON) − 0.5 V, FB = open, VLS = 2 V, VDRAIN = 50 V	−3.9	−5.6	−2.2	mA
*26	Soft Start Time	Tsoft	VDRAIN = 50 V, VFB = 3V	6.0	3.5	8.5	ms
【CIRCUIT PROTECTIONS】 *Design Guarantee Item, **Reference Item							
27	Over Current Detection Voltage	VLIMIT	VCC = 21 V, VFB = 3 V, Ton = 4 μs *Refer Figure 4	780	725	835	mV
28	Over Current Detection Voltage 2	VLIMIT2	VCC = 21 V, VFB = 3 V, Ton = 2 μs *Refer Figure 4	760	691	−	mV
29	Over Current Detection Reference Voltage During Blanking Delay	VLIM(BLK)	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	1.85	1.60	−	V
**30	Leading Edge Blanking Delay	Ton(BLK)	VCC = 21 V, IFB = IFB3 + 3 μA, VIS = 1.5 V, VDRAIN = 5 V	280	−	−	ns
**31	Over Current Detection Delay	Td(OCL)	VCC = 21 V, VFB = 3 V	270	−	−	ns
**32	Peak Current Detection Voltage at PFM	VIS(PFM)	VCC = 21 V, IFB = IFB2 + 5 μA, Ton = 4 μs	700	−	−	mV
**33	Peak Current Detection Reference Voltage at Intermittent Stop	VIS(OFF)	VCC = 21 V, IFB = IFB1, VDRAIN = 5 V	160	−	−	mV
**34	Peak Current Detection Reference Voltage at Intermittent Recovery	VIS(OFF)H	VCC = 21 V, IFB = IFB1 + IFBHYS, VDRAIN = 5 V	240	−	−	mV
**35	Peak Current Detection Voltage Jitter Deviation	D_VIS	VCC = 21 V, IFB = IFB2 + 5 μA, VDRAIN = 5 V	24	−	−	mV
*36	Slope Compensation Rate	VIS_SLP	VCC = 21 V, IFB = IFB2 + 5 μA, VDRAIN = 5 V	−37.0	−46.3	−28.0	mV/μs
37	Over Load Detection Voltage	VFB(OL)	VCC = 21 V, VDRAIN = 5 V	4.4	4.1	4.7	V
38	FB Pin Current at Over Load	IFB(OL)	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	−10.0	−13.0	−7.5	μA
**39	Over Load Detection Filter Time	Td(OL)	VCC = 21 V, VDRAIN = 5 V	20	−	−	μs
40	IS Pin Short Detection Reference Voltage	VIS(IST)	VCC = 21 V, IFB = IFB1 + 5 μA, VDRAIN = 5 V	50	−	100	mV

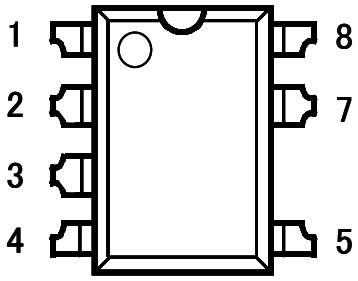
No.	Item	Symbol	Measurement Conditions (Refer to figure 1)	Typ.	Min.	Max.	Unit
**41	IS Pin Short Detection On Time	Ton(IST)	VCC = 21 V, IFB = IFB1 + 5 μA, VIS = 0V, VDRAIN = 5 V	3	–	–	μs
42	VCC Pin Over Voltage Detection Voltage	VCC(OV)	VFB = 3 V, VDRAIN = 5 V	31.5	28.5	34.5	V
**43	VCC Pin Over Voltage Detection Filter Time	Td(VCCOV)		150	–	–	μs
44	VCC Charge and Discharge Cycle at Timer Intermittent Operation	COUNT	VCC = VCC(ON) ⇔VCC(OFF) *Refer Figure 5	4			–
45	VDD Pin Latch Stop Detection Voltage	VDD(OV)	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	7.55	7.00	8.10	V
46	VDD Pin Latch Stop Detection Current	IDD(OV)	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	1.6	0.9	2.3	mA
47	VDD Pin Clamp Current	IDD(CLP)	VDD = 10 V	16.5	13.2	19.8	mA
**48	VDD Pin Latch Stop Detection Filter Time	Td(VDDOV)	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	150	–	–	μs
49	VDD Pin Reset Voltage	VDDreset		2.7	1.7	3.7	V
*50	Thermal Shutdown Temperature (Control IC)	TOTP		140	130	150	℃
**51	Thermal Shutdown Temperature Hysteresis (Control IC)	TOTPHYS		45	–	–	℃
52	LS Pin Over Voltage Detection Voltage	VLS(OV)	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	4.40	4.15	4.65	V
53	LS Pin Over Voltage Release Voltage	VLS(OV)L	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	4.18	3.93	4.43	V
**54	LS Pin Over Voltage Detection/ Release Voltage Hysteresis	D_VLSOV	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	0.22	–	–	V
55	DRAIN Pin Current at LS Pin Over Voltage Detection	ID(LSOV)	VCC = open, VFB = 3 V, VLS = 5 V, VDRAIN = 50 V	2.8	1.8	3.8	mA
**56	LS Pin Over Voltage Detection Filter Time	Td(LSOV)	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V	50	–	–	μs
57	LS Pin Under Voltage Detection Voltage	VLS(UV)	VCC = 21 V, VFB = VFB(OL) → 3V, VDRAIN = 5 V	0.73	0.66	0.80	V
58	LS Pin Under Voltage Release Voltage	VLS(UV)H	VCC = 21 V, VFB = VFB(OL) → 3V, VDRAIN = 5 V	0.81	0.73	0.89	V
**59	LS Pin Under Voltage Detection/ Release Voltage Hysteresis	D_VLSUV	VCC = 21 V, VFB = VFB(OL) → 3V, VDRAIN = 5 V	0.08	–	–	V
**60	LS Pin Under Voltage Detection Filter Time	Td(LSUV)	VCC = 21 V, VFB = VFB(OL) → 3V, VDRAIN = 5 V	50	–	–	μs
61	LS Pin Disable Detection Voltage	VLS(DIS)	VCC = 21 V, VFB = VFB(OL) → 3V, VDRAIN = 5 V	0.10	0.05	0.15	V

No.	Item	Symbol	Measurement Conditions (Refer to figure 1)	Typ.	Min.	Max.	Unit
【POWER MOSFET】 *Design Guarantee Item, **Reference Item							
62	Minimum DRAIN Pin Voltage	VD(MIN)	IFB = −20 μA, VLS = 2 V ※DRAIN voltage when oscillation start	25	20	29	V
63	DRAIN Pin Breakdown Voltage	VDSS	VCC = 40 V, IDRAIN = 250 μA,	−	700	−	V
64	DRAIN Pin Leakage Current	IDSS	VCC = 40 V, VDRAIN = 650 V	2	−	7	μA
65	ON−State Resistance	RDS(ON)	VCC = 21 V, VFB = 3 V, IDRAIN = 1 A	2.3	−	2.7	Ω
**66	Rise Time	tr	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V *Refer Figure 6	150	−	−	ns
**67	Fall Time	tf	VCC = 21 V, VFB = 3 V, VDRAIN = 5 V *Refer Figure 6	80	−	−	ns

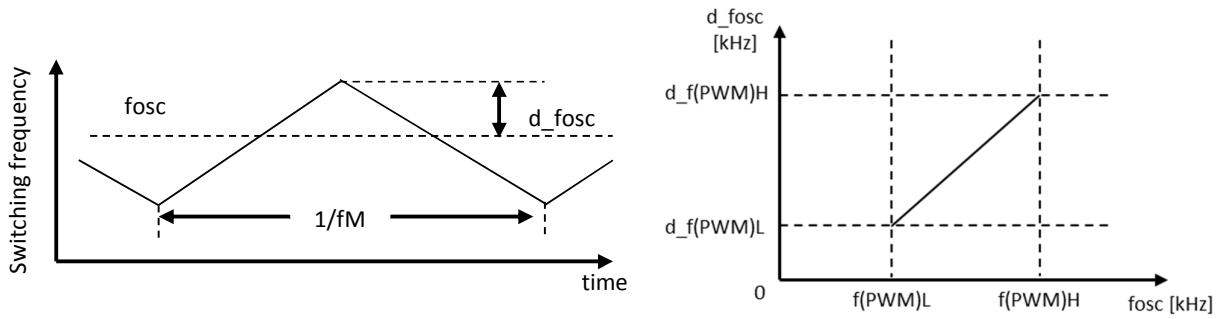
【Figure 1： Measurement circuit／Pin Layout】



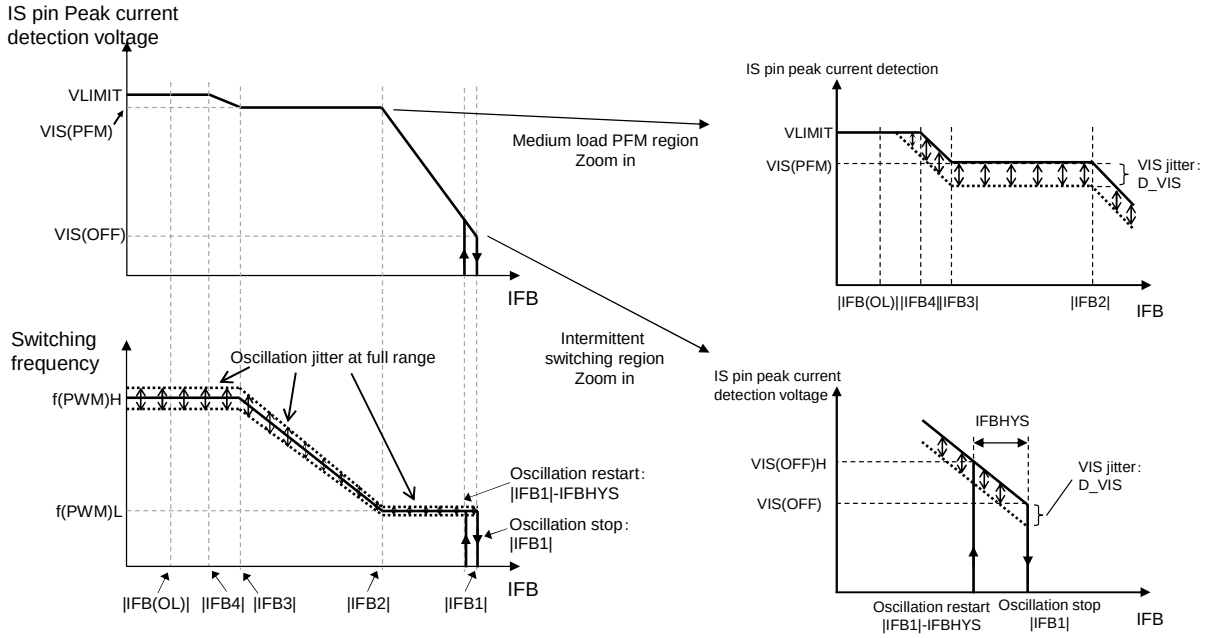
Pin No.	Pin Name	Function
1	FB	Feedback control, Over Load Detection
2	GND	Control Ground
3	LS	Input Over Voltage detection / Over load protection deactivation when input Under Voltage detection
4	IS	Power MOSFET Source / Over Current Detection
5	DRAIN	Power MOSFET Drain / Start-up current supply
6	–	–
7	VCC	Power supply from bias winding / Over Voltage Detection
8	VDD	Internal circuit power supply voltage / External Latch-Stop function



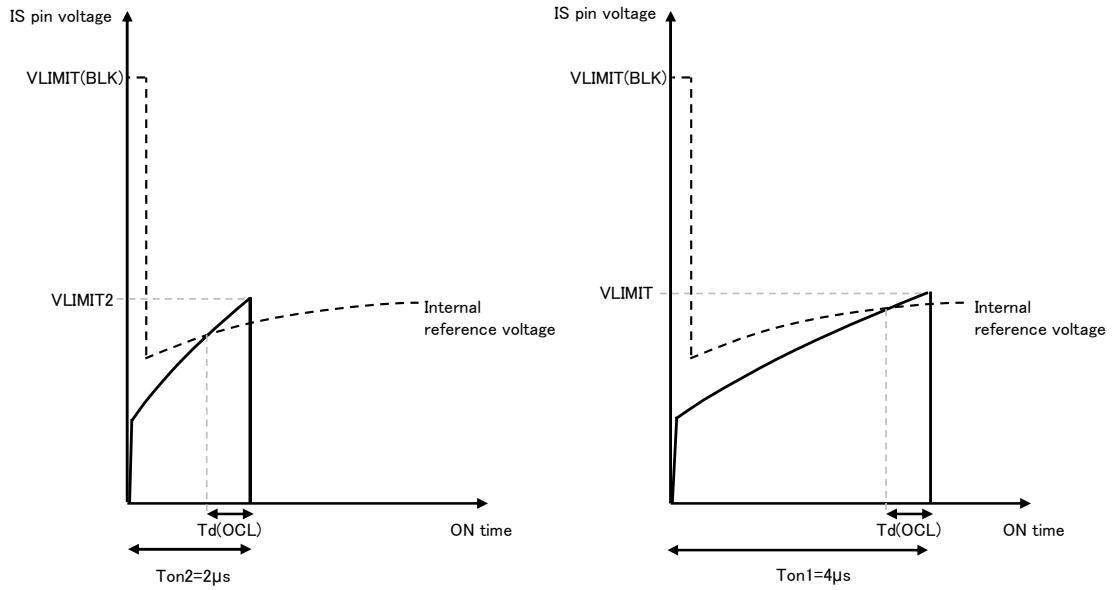
【Figure 2： Switching frequency & jitter deviation (fosc & d_fosc), frequency jitter modulation rate (fM) characteristics】



【Figure 3： IS pin detection voltage-IFB Characteristic、Switching frequency－IFB Characteristic】



【Figure 4： IS pin detection voltage – ON time dependency】



※Drain pin load for VLIMIT & VLIMIT2 measurement: L=100 μH, Rd=51 Ω

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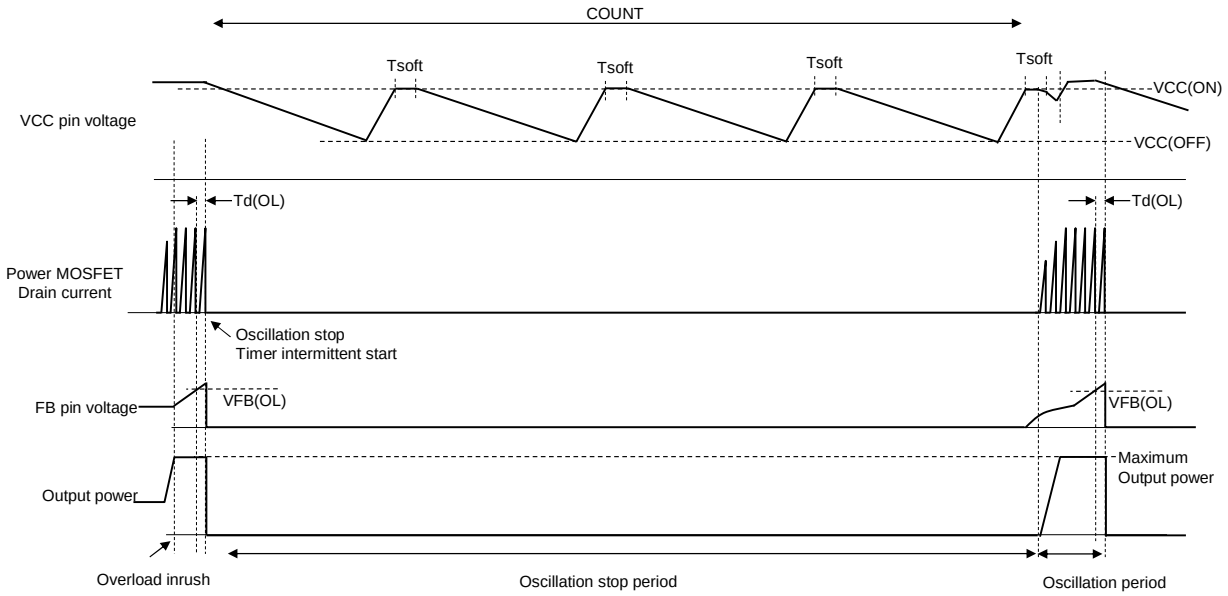
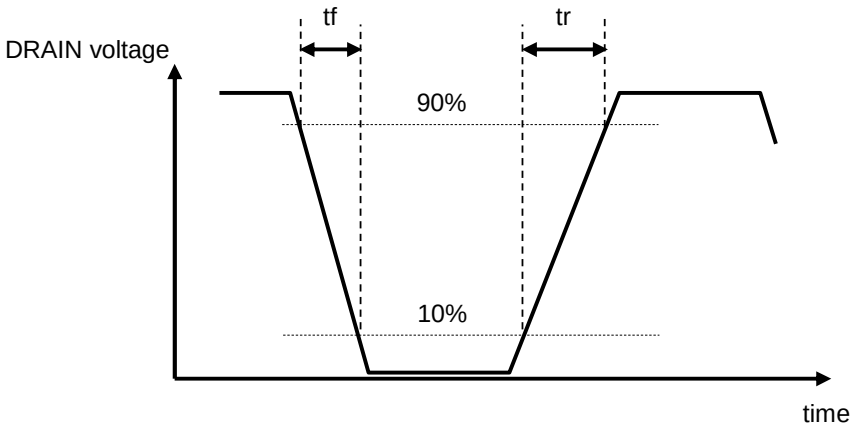
【Figure 5： Over Load Protection Characteristics】



【Figure 6： tr, tf measurement】



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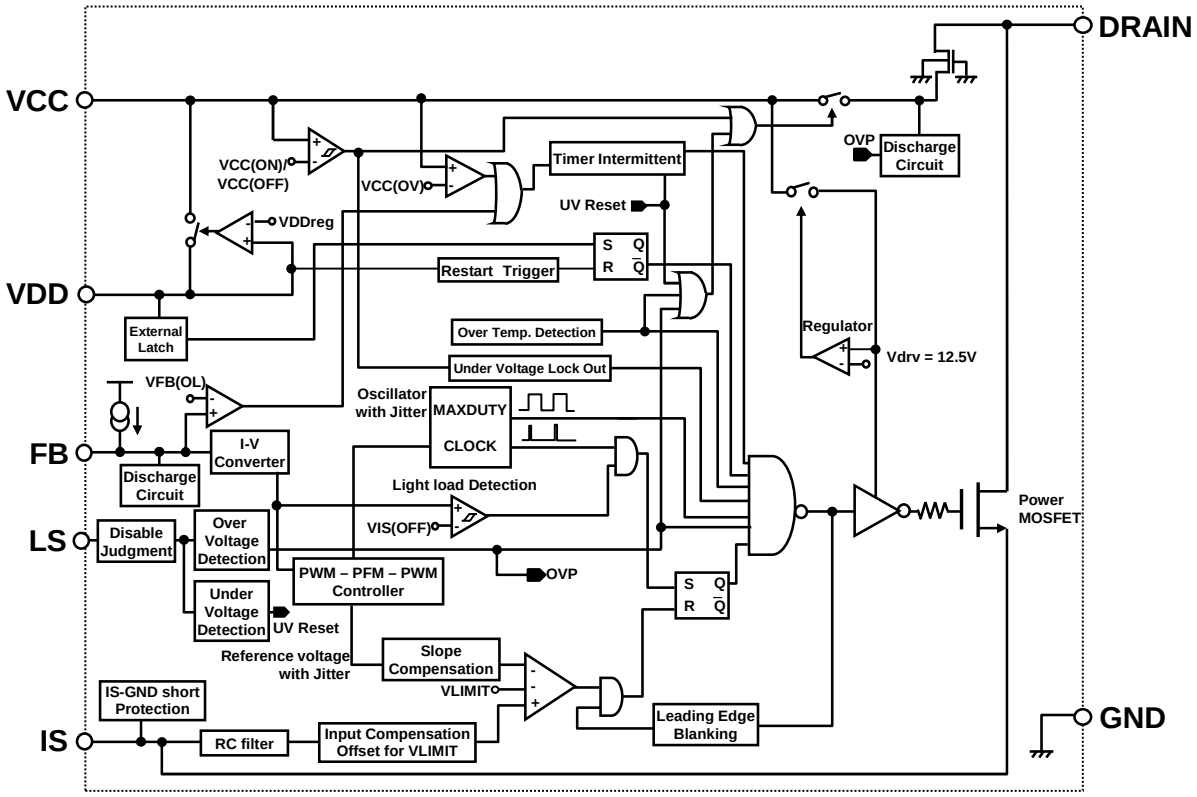
【Figure 7： Block Diagram】



【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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