MIP3530MS

Silicon MOS FET type integrated circuit

■ Features

- Expanding the range of input / output
- High-efficiency and the reduction of coil sound
- Lower the average noise
- Protecting function (overload protection, over voltage protection, overheat protection)

■ Applications

- IH rice cooker, air conditioners, air purification system, dehumidifier, washing machines and fan motor (for refrigerators)

■ Package

- Code
  DIP7-A1
- Pin Name

1. f	5. DRAIN
2. VDD	6. —
3. CL	7. SOURCE
4. FB	8. SOURCE

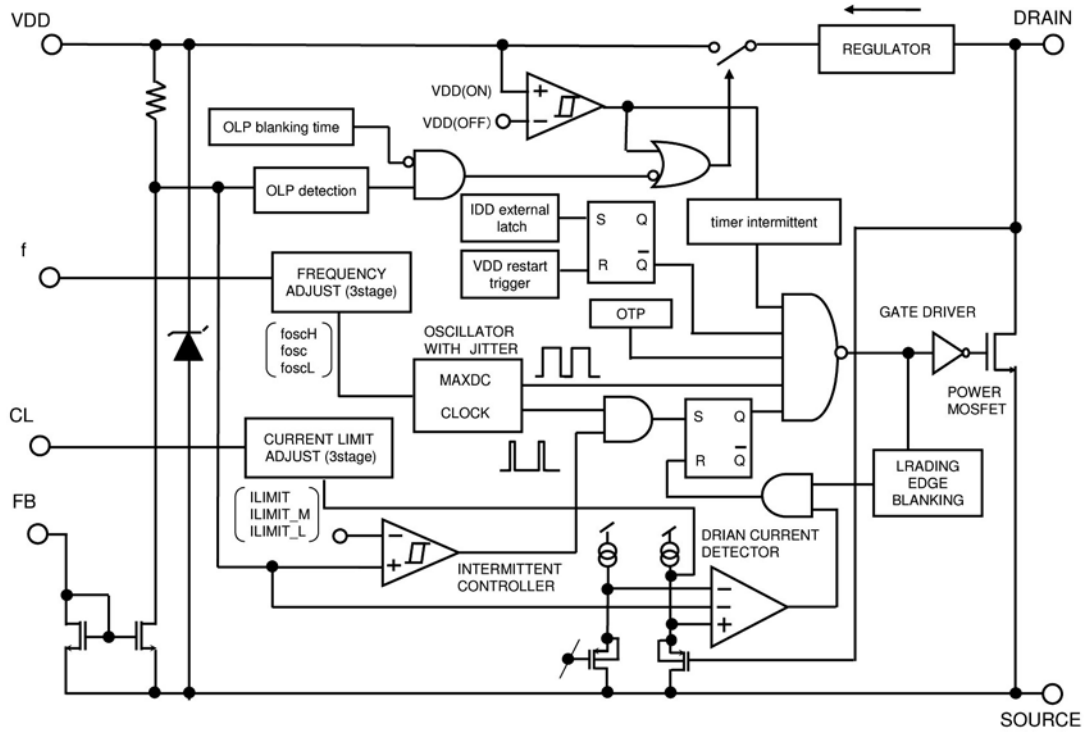
■ Marking Symbol: MIP353

■ Absolute Maximum Ratings $T_a = 25°C \pm 3°C$

Parameter	Symbol	Rating	Unit
DRAIN voltage	VD	– 0.3 to +700	V
VDD voltage	VDD	– 0.3 to +8	V
FB pin voltage	VFB	– 0.3 to +6	V
FB pin current	IFB	500	μA
f pin voltage	Vf	– 0.3 to +8	V
CL pin voltage	VCL	– 0.3 to +8	V
Output peak current *	IDP	1.3	A
Channel temperature	Tch	150	°C
Storage temperature	Tstg	–55 to +150	°C

Note) *: The guarantee within the following pulse width.
Leading edgε blanking delay + Current limit delay ton(BLK) + td(OCL)

■ Block Diagram



■ Electrical Characteristics T_C = 25°C±3°C

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Control functions						
Output frequency *2	fosc	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 µA, Vf = VDD, VCL = 0 V, after dis_OLP	39	43.5	48	kHz
Jitter frequency deviation *2	Δf	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 µA, Vf = VDD, VCL = 0 V, after dis_OLP	1.2	3	4.8	kHz
Jitter frequency modulation rate *1, 2	fM	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 µA, Vf = VDD, VCL = 0 V, after dis_OLP		150		Hz
Maximum duty cycle	MAXDC	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 µA, Vf = VDD, VCL = 0 V, after dis_OLP	65	70	75	%
VDD start voltage	VDD(ON)	VD = 5 V, IFB = 30 µA, Vf = VDD, VCL = 0 V	5.4	5.9	6.4	V
VDD stop voltage	VDD(OFF)	VD = 5 V, IFB = 30 µA, Vf = VDD, VCL = 0 V	4.4	4.9	5.4	V
VDD start / stop hysteresis	VDD(HYS)	VDD(ON) – VDD(OFF)	0.5	1.0	1.5	V
VDD clamp voltage	VDD(CLP)	IDD = 10 mA	6.9	7.4	8.9	V
FB threshold current	IFB1	ON → OFF, VD = 5 V, VDD = VDD(ON) + 0.1 V, Vf = VDD, VCL = 0 V	57	97	137	µA
FB hysteresis current	IFB(HYS)	VD = 5 V, VDD = VDD(ON) + 0.1 V, Vf = VDD, VCL = 0 V		2.5		µA
FB pin voltage	VFB1	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = IFB1, Vf = VDD, VCL = 0 V	1.6	1.9	2.2	V
	VFB	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 80 µA, Vf = VDD, VCL = 0 V	1.5	1.8	2.1	V
Supply current before start-up	IDD(SB)	VD = 5 V, VDD = VDD(ON) – 0.3 V, Vf = VDD, VCL = 0 V, FB: OPEN	170	350	530	µA
Supply current	IDD	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 µA, Vf = VDD, VCL = 0 V	250	510	750	µA
Supply current at light load	IDD(OFF)	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB =IFB1 + 5 µA, Vf = VDD, VCL = 0 V	300	550	800	µA
VDD charging current	Ich1	VDD = 0 V, VD = 40 V, FB, CL, f: OPEN	–13.6	–8.5	–4.1	mA
	Ich2	VDD = 5 V, VD = 40 V, FB, CL, f: OPEN	–8.5	–5.3	–2.1	mA
f pin threshold voltage	Vf1	VDD = VDD(ON) + 0.1 V, fosc: foscL → foscH	0.65	1.25	1.85	V
f pin current before start-up	If1	VDD = VDD(ON) – 0.1 V, Vf = 0 V	–70	–50	–30	µA
f pin threshold current	If2	VDD = VDD(ON), VD = 5 V, IFB = 30 µA, fosc: fosc → foscH	–44	–29	–14	µA
f pin voktage foscH change	Vf2	VDD = VDD(ON) + 0.1 V, If = If2	2	2.3	2.6	V
f pin short current	If_GND	VDD = VDD(ON) + 0.1 V, Vf = 0 V	–37	–22	–7	µA
f pin voltage	Vf	VD = 5V, VDD = VDD(ON) + 0.1 V If = –50 µA	1.55	2.25	2.85	V

■ Electrical Characteristics (continued) T_C = 25°C±3°C

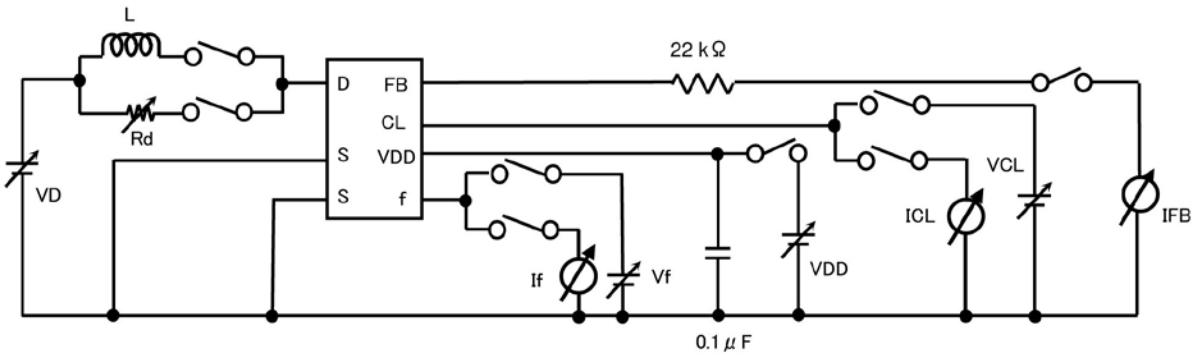
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
CL pin threshold voltage	VCL1	VDD = VDD(ON) + 0.1 V, ILIMIT: ILIMIT → ILIMIT_M	0.75	1.35	1.95	V
CL pin current before start-up	ICL1	VDD = VDD(ON) – 0.4 V, VCL = 0 V	–70	–50	–30	μA
CL pin threshold current	ICL2	VDD = VDD(ON) + 0.1V, ILIMIT: ILIMIT_L → ILIMIT_M	–44	–29	–14	μA
CL pin voltage for ILIMIT_M change	VCL2	VDD = VDD(ON) + 0.1 V, ICL = ICL2	1.75	2.35	2.95	V
CL pin short current	ICL_GND	VDD = VDD(ON) + 0.1 V, VCL = 0 V	–37	–22	–7	μA
CL pin voltage	VCL	VDD = VDD(ON) + 0.1 V, ICL = –50 μA	1.6	2.3	2.9	V
Output frequency High	foscH	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, If = –50 μA, VCL = 0 V, after dis_OLP	57.5	64	70.5	kHz
Jitter frequency deviation at foscH	ΔfH	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, If = –50 μA, VCL = 0 V, after dis_OLP	1.6	4	6.4	kHz
Jitter frequency modulation rate at foscH *1	fMH	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, If = –50 μA, VCL = 0 V, after dis_OLP		250		Hz
Output frequency Low	foscL	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, Vf = 0 V, VCL = 0 V, after dis_OLP	22	24	26	kHz
Jitter frequency deviation at foscL	ΔfL	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, Vf = 0 V, VCL = 0 V, after dis_OLP	0.6	1.5	2.4	kHz
Jitter frequency modulation rate at foscL *1	fML	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, Vf = 0 V, VCL = 0 V, after dis_OLP		100		Hz
Circuit protections						
Self protection current limit *6	ILIMIT	VDD = VDD(ON) + 0.1 V, Vf = VDD, VCL = 0 V, FB: OPEN, Duty = 30%	0.46	0.5	0.54	A
Drain current at light load *1, 3	ID(OFF)	VDD = VDD(ON) + 0.1 V, IFB = IFB1 – IFBHYS, Vf = VDD, VCL = 0 V, Duty = 30%	40	100	160	mA
OLP detection blanking time *1	dis_OLP	VD = 40 V, Vf = VDD, VCL = 0 V, VDD, VB: OPEN	8	16	25	ms
Self protection current ILIMIT_M *3	ILIMIT_M	VDD = VDD(ON) + 0.1 V, Vf = VDD, ICL = –50 μA, FB: OPEN, Duty = 30%	0.362	0.4	0.438	A
Drain current at light load of ILIMIT_M *1, 3	ID(OFF)_M	VDD = VDD(ON) + 0.1 V, IFB = IFB1 – IFBHYS, Vf = VDD, ICL = –50 μA, Duty = 30%	28	73	118	mA
Self protection current ILIMIT_L *3	ILIMIT_L	VDD = VDD(ON) + 0.1 V, Vf = VDD, VCL = VDD, FB: OPEN, Duty = 30%	0.263	0.29	0.318	A
Drain current at light load of ILIMIT_L *3	ID(OFF)_L	VDD = VDD(ON) + 0.1 V, IFB = IFB1 – IFBHYS, Vf = VDD, VCL = VDD, Duty = 30%	20	50	80	mA
VDD current at latch stop	IDD(OV)	VD = 5 V, IFB = 30 μA, VCL = 0 V, Vf = 0 V	22	32	42	mA

■ Electrical Characteristics (continued) T_C = 25°C±3°C

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
FB current at detecting OLP	IFB(OLP)	VD = 20 V, VCL = 0 V, Vf = VDD, VDD: OPEN	6	11.5	17	μA
Timer intermittent function *4	TIMER	VDD(ON) ↔ VDD(OFF), VD = 45 V, IFB < IFB(OLP)	8			—
Timer intermittent function disabled at MAXDC *5	TIMER2	VDD(ON) ↔ VDD(OFF), IFB < IFB(OLP) Duty = MAXDC	1			—
Power-up reset threshold voltage	VDDreset		1.8	2.6	3.5	V
Over temperature protection *1	OTP		130	140	150	°C
Over temperature protection hysteresis *1	ΔOTP			70		°C
Output						
Leading edge blanking delay *1	ton(BLK)	VDD = VDD(ON) + 0.1 V, IFB = 30 μA, Vf = VDD, VCL = 0 V	240	300	360	ns
Current limit delay *1	td(OCL)		20	70	120	ns
ON state resistance	RDS(ON)	IDS = 100 mA		9.2	11.6	Ω
Breakdown voltage	VDSS	VDD = 7.9 V, ID = 100 μA, VFB = 0 V, Vf = VDD, VCL = 0 V	700			V
Off state current	IDSS	VDD = 7.9 V, VDS = 650 V, VFB = 0 V, Vf = VDD, VCL = 0 V		8	25	μA
Rise time *7	tr	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, Vf = VDD, VCL = 0 V		75		ns
Fall time *7	tf	VD = 5 V, VDD = VDD(ON) + 0.1 V, IFB = 30 μA, Vf = VDD, VCL = 0 V		40		ns
Supply voltage characteristics						
Drain supply voltage	VD(MIN)	IFB = 30 μA, Vf = VDD, VCL = 0 V, VDD: OPEN		10	35	V
Control functions during VDD = VDD(CLP)						
Output frequency at CLAMP	fosscC	VD = 5 V, VDD = VDD(CLP) – 0.1 V, IFB = 30 μA, Vf = VDD, VCL = 0 V	42	48	54	kHz
Jitter frequency deviation at CLAMP	ΔfC	VD = 5 V, VDD = VDD(CLP) – 0.1 V, IFB = 30 μA, Vf = VDD, VCL = 0 V	2	5	8	kHz
Jitter frequency modulation rate at CLAMP *1	fMC	VD = 5 V, VDD = VDD(CLP) – 0.1 V, IFB = 30 μA, Vf = VDD, VCL = 0 V		100		Hz
Circuit protections during VDD = VDD(CLP)						
Self proteciton current limit at CLAMP	ILIMIT_C	VDD = VDD(CLP) – 0.1 V, Vf = VDD, VCL = 0 V, FB: OPEN, Duty = 30%	0.495	0.55	0.605	A
Output during VDD = VDD(CLP)						
Leading edge blanking delay at CLAMP *1	ton(BLK)_C	VDD = VDD(CLP) – 0.1 V, IFB = 30 μA, Vf = VDD, VCL = 0 V		240		ns

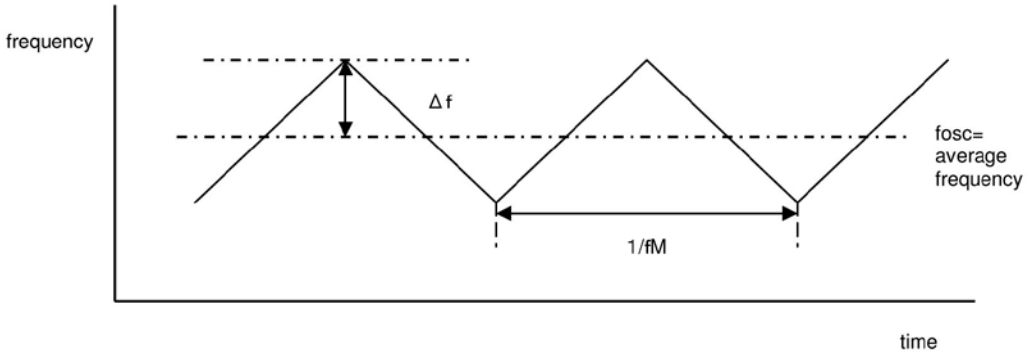
■ Electrical Characteristics (continued) T_C = 25°C±3°C

1. Measurement circuit

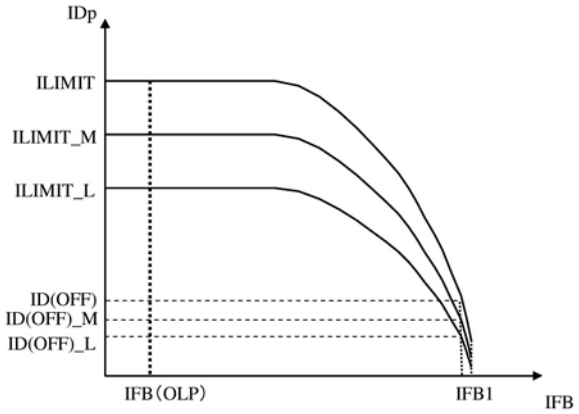


2. *1 : Design guarantee item

*2 : fosc, Δf, fM measurement

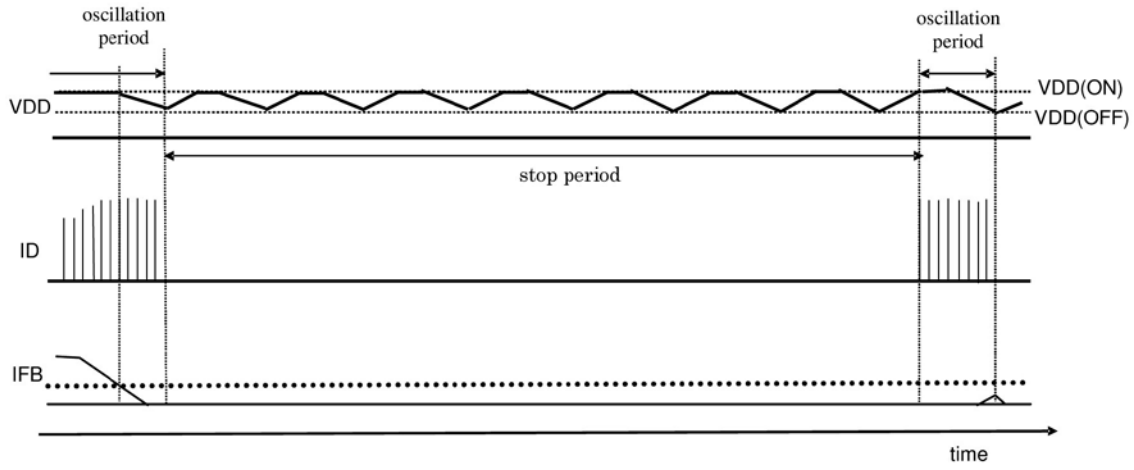


*3 : FB current IFB vs drain peak current IDP characteristic

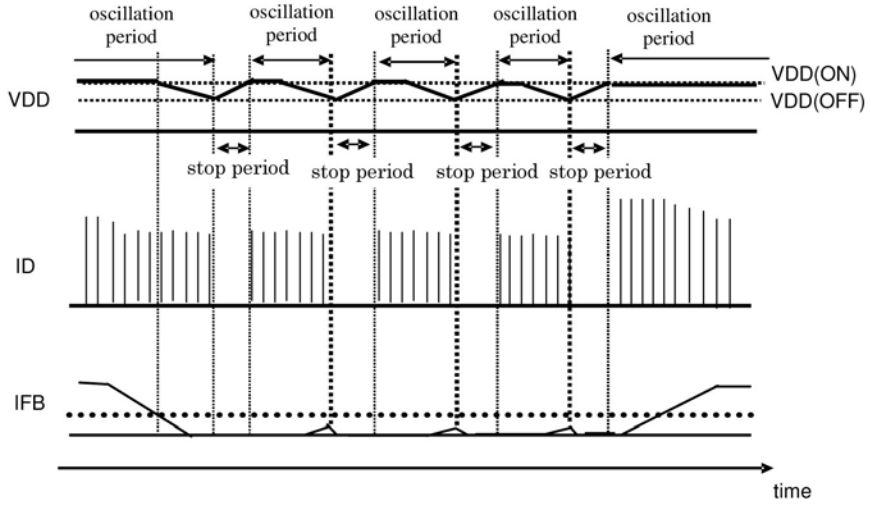


■ Electrical Characteristics (continued) T_C = 25°C±3°C

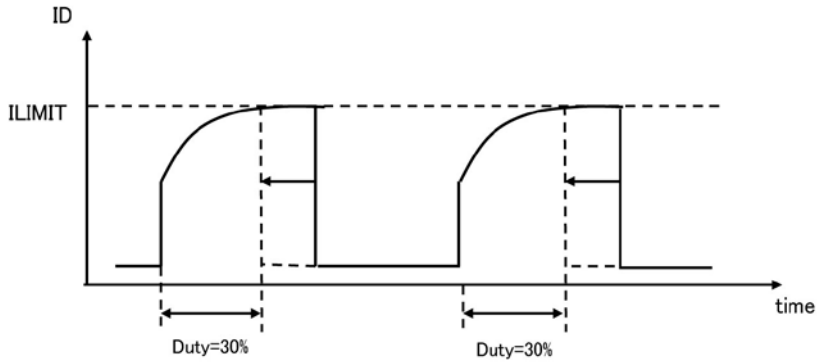
2. *4 : Terminal waveforms during timer intermittent operation due to the overload protection



*5 : Terminal waveforms when MAXDC is detected which makes timer intermittent operation becomes invalid
Though FB current is below IFB(OLP) which indicates the detection of overload state, if the ON duty of the drain current is operating at MAXDC, drain oscillation will occur in every rise and fall cycle of the VDD terminal.



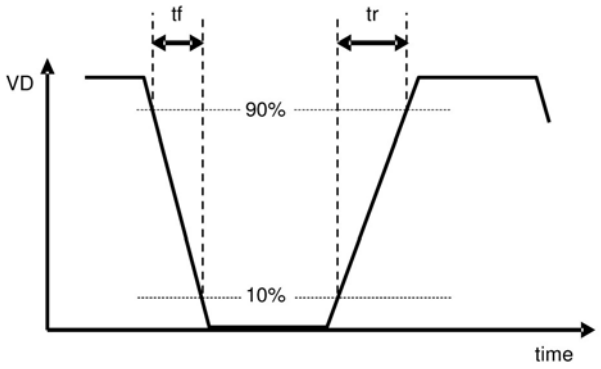
*6 : ILIMIT measurement



* Load L, R during the ILIMIT measurement are: L=100uH, Rd=130Ω

■ Electrical Characteristics (continued) T_C = 25°C±3°C

2. *7 : tr, tf measurement



3. fosc, ILIMIT setting method through f, CL terminals

Depending upon selection at f terminal and CL terminal according to description below 1) to 3), would outputt frequency (fosc) or over-current protection detection (ILIMIT) based on the setting in the below-mwntioned table.

1) Connection to S terminal
2) Resistor (47 kΩ) connected between S terminal *
3) Connection to VDD terminal

*: 2) please use resistor of 47 kΩ (tolerance: within ±5%)

	f	fpsc (kHz)
1)	S	foscL
2)	resistor (47 kΩ)	foscH
3)	VDD	fosc

	CL	ILIMIT (A)
1)	S	ILIMIT
2)	resistor (47 kΩ)	ILIMIT_M
3)	VDD	ILIMIT_L

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.

Precautions on the Sales of IPDs

1) The sale and/or the export of IPD products to customers located in certain countries is restricted by the Agreement made and executed by and between Power Integrations, Inc. and Panasonic Corporation. For details, refer to the following Attached table "IPD availability by customer."
2) IPD products purchased from our company, or its authorized agents, hereinafter referred to as our company, shall be used only for production purposes by those parties who have duly purchased IPD products. Those who have purchased IPD products shall not use such IPD products in unmodified form for re-sale, loan, or sample shipment for evaluation purposes to any other parties.
3) If a party who has duly purchased IPD products subcontracts its production to any other parties, including its subsidiaries or any other third parties inside and/or out of Japan, and the IPD products are consigned to such subcontracting parties thereat, such party is obligated to monitor and control the quantity of IPD products to prevent any of the aforementioned re-sale, loan or sample shipments from taking place.
4) In the event that any actual or threatened breach or violation of any of the above mentioned 2) or 3) has occurred or is about to occur, our company will hold all shipments of IPD products and may request the customer to disclose necessary documentation describing the status of our end-users and/or distribution channels.
Note) The products of MIP50**, MIP51**, and MIP7** are excluded from above-mentioned precautions, 1) to 3).

Attached table "IPD availability by customer"

Parts No.			Companies/areas to which products can be sold	Companies/areas to which products cannot be sold	Application
MIP01** MIP2** MIP9A**	MIP02** MIP3** MIP9L**	MIP1** MIP4**	· Japanese companies in Japan · Japanese companies in Asia (50% or more owned)	· Companies in European and American countries · Asian companies in Asia · Other local companies	· For power supply · For DC-DC converter
MIP00** MIP55** MIP816/826	MIP52** MIP56** MIP9E**	MIP53** MIP803/804	· Japanese companies in Japan · Japanese companies in Asia (50% or more owned) · Asian companies in Asia	· Companies in European and American countries · Other local companies	· For power supply · For EL driver · For LED lighting driver
MIP50**	MIP51**	MIP7**	· No restrictions in terms of contract	· No restrictions in terms of contract	· For lamp driver/ car electronics accessories

Note) For details, contact our sales division.