

## **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**

<h1>Product Standards</h1>	<b>MIP5540MTSCF</b>	
	Total pages	Page
	8	2

Type	Silicon MOSFET type Integrated Circuit		
Application	For LED Driver		
Structure	CMOS type		
Equivalent Circuit	Figure 6		
Out Line	DIP7-A1-B	Marking	MIP554

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

NO.	Item	Symbol	Ratings	Unit	Note
1	DRAIN	VD-S	-0.3 ~ 400	V	※1 IDP is guaranteed at the pulse width narrower than MIN(PW).
2	VIN Voltage	VIN-S	-0.3 ~ 400	V	
3	VDD Voltage	VDD-S	-0.3 ~ 8.0	V	
4	EX Voltage	VEX-S	-0.3 ~ 7.2	V	
5	CL Voltage	VCL-S	-0.3 ~ 7.2	V	
6	Output Peak Current	IDP	3.0(※1)	A	
7	Channel Temperature	Tch	150	°C	
8	Storage Temperature	Tstg	-55 ~ +150	°C	

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

No.	Item	Symbol	Measure Condition (Figure 1)	Typ	Min	Max	Unit
-----	------	--------	------------------------------	-----	-----	-----	------

**[CONTROL FUNCTIONS]**

1	Constant OFF Time	Toff	VDD=VDD(ON)+0.1 V, VD=5 V, VIN=30 V IEX=0 μA, ICL=ICLmax+50 μA	15	13.65	16.35	μs
2	Maximum ON Time	MAXon	VDD=VDD(ON)+0.1 V, VD=5 V, VIN=30 V IEX=0 μA, ICL=ICLmax+50 μA	58	49.3	66.7	μs
3	VDD Start Voltage	VDD(ON)	VD=5 V IEX=0 μA, ICL=ICLmax+50 μA	6.60	6.10	7.10	V
4	VDD Stop Voltage	VDD(UV)	VD=5 V, IEX=0 μA, ICL=ICLmax+50 μA	5.55	5.05	6.05	V
5	Circuit Current before start	IS1	VDD=VDD(ON)-0.2 V, VD=5 V IEX=0 μA, ICL=ICLmax+50 μA	0.95	0.56	1.34	mA
6	Circuit Current under switching	IS2	VDD=VDD(ON)+0.1 V, VD=5 V IEX=0 μA, ICL=ICLmax+50 μA	1.00	0.59	1.41	mA

--	--	--

<h1>Product Standards</h1>		<b>MIP5540MTSCF</b>	
		Total pages	Page
		8	3

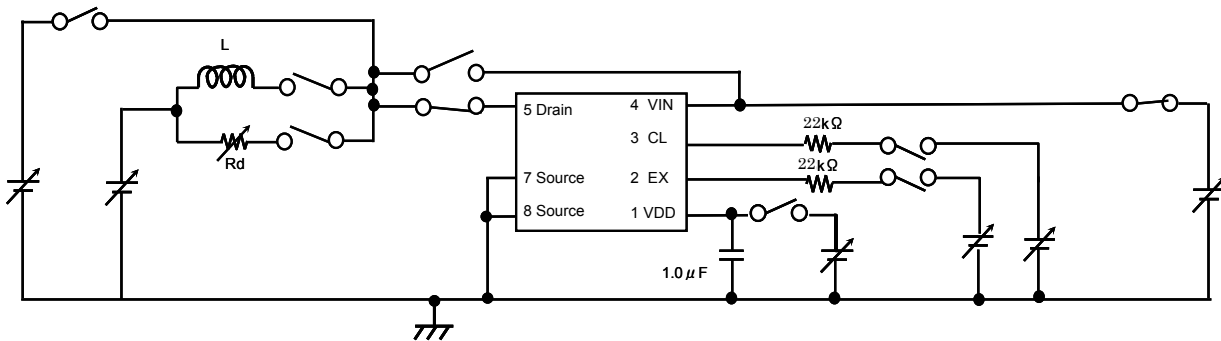
No.	Item	Symbol	Measure Condition (Figure 1)	Typ	Min	Max	Unit
<b>【CONTROL FUNCTIONS】</b>							
*	7	EX Pin Current for setting ILIMITmin	IEXH VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A ILIMIT=ILIMITmin ※Figure 3	244			$\mu$ A
	8	EX Pin Current at oscillation stop	IEXoff VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A ※Figure 3	385	280	510	$\mu$ A
	9	EX Pin Current Hysteresis at oscillation restart	IEXhys VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A ※Figure 3	45			$\mu$ A
	10	Difference of IEXoff and IEXH	Delta_IEX Delta_IEX=IEXoff-IEXH ※Figure 3	141	30	250	$\mu$ A
	11	EX Pin Voltage	VEXM VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=150 $\mu$ A	2.80	2.13	3.47	V
			VEXH VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=IEXH	2.90	2.23	3.57	V
			VEXoff VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=IEXoff	3.10	2.35	3.85	V
	12	EX Pin Short Current	IEXSVDD VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A VEX=VDD	1.1	0.615	1.585	mA
			IEX0 VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A VEX=0 V	0			$\mu$ A
	13	CL Pin Current for setting ILIMITmax	ICLmax VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A ILIMIT=ILIMITmax ※Figure4	400	360	440	$\mu$ A
*	14	CL Pin Current at minimum ILIMIT	ICLL VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A ※Figure4	160			$\mu$ A
	15	CL Pin Current at oscillation stop	ICLoff VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A ※Figure4	25	4	50	$\mu$ A
	16	CL Pin Current Hysteresis at oscillation restart	ICLhys VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A ※Figure4	15			$\mu$ A
	17	CL Pin Voltage	VCLmax VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A ICL=ICLmax	3.15	2.42	3.88	V
			VCLoff VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A ICL=ICLoff	2.5	1.92	3.08	V
	18	CL Pin Short Current	ICLSVDD VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A VCL=VDD	1.1	0.615	1.585	mA
			ICL0 VDD=VDD(ON)+0.1 V, IEX=0 $\mu$ A VCL=0 V	0			$\mu$ A
<b>【PROTECT FUNCTION: * Design guaranteed item】</b>							
	19	Maximum Peak Current Limit	ILIMITmax VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=0 $\mu$ A ※Figure2, 3, 4	1.0	0.915	1.085	A
	20	ILIMIT at IEX150	ILIMITexm VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=150 $\mu$ A ※Figure2, 3	0.6	0.54	0.66	A
	21	Minimum Clamp ILIMIT	ILIMITmin VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=IEXH+20 $\mu$ A ※Figure2, 3	0.33	0.19	0.42	A
	22	ILIMIT at ICL300	ILIMCL300 VDD=VDD(ON)+0.1 V, ICL=300 $\mu$ A IEX=0 $\mu$ A ※Figure2, 4	0.592	0.533	0.651	A
	23	ILIMIT at ICL350	ILIMCL350 VDD=VDD(ON)+0.1 V, ICL=350 $\mu$ A IEX=0 $\mu$ A ※Figure2, 4	0.796	0.716	0.876	A
*	24	Leading Edge Blanking Delay	ton(BLK) VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=0 $\mu$ A	200	150	250	ns


		Product Standards		MIP5540MTSCF	
				Total pages	Page
		8	4		

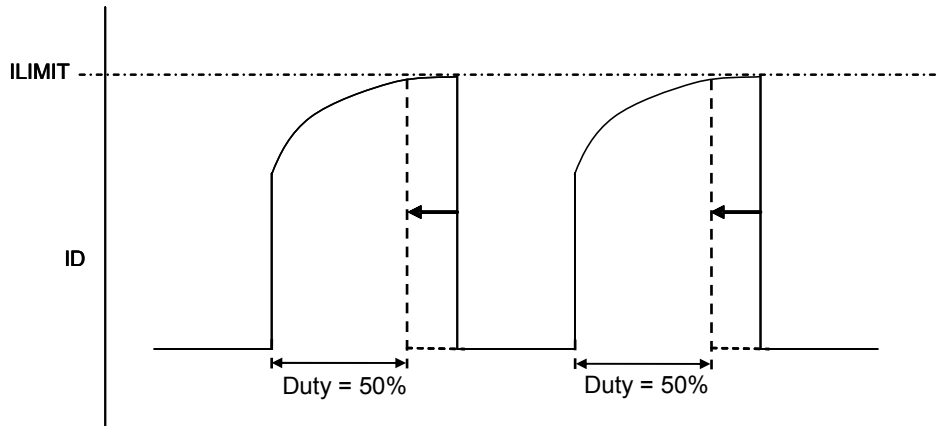
No.	Item	Symbol	Measure Condition (Figure 1)	Typ	Min	Max	Unit
<b>【PROTECT FUNCTION: * Design guaranteed item】</b>							
* 25	Peak Current Limit Delay	td(OCL)	VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=0 $\mu$ A	200			ns
26	Minimum On-pulse Width	MIN(PW)	VIN=30 V, VD=35 V, IEX=0 $\mu$ A ICL=ICLmax+50 $\mu$ A	400		510	ns
* 27	Thermal Shutdown Junction Temperature	TOTPJ		140	130	150	$^{\circ}$ C
* 28	Thermal Shutdown Hysteresis	TOTPJ(hys)		70			$^{\circ}$ C
<b>【OUTPUT】</b>							
29	ON-State Resistance	RDS(ON)	VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=0 $\mu$ A, IDS=300 mA	3.7		4.5	$\Omega$
30	OFF-State leakage Current of DRAIN Pin	IDSS	VDD=VDD(ON)+0.1 V, VEX=VCL=0 V VD=400 V	5.0		20	$\mu$ A
31	Breakdown Voltage of DRAIN Pin	VDSS	VDD=VDD(ON)+0.1 V, VEX=VCL=0 V ID=100 $\mu$ A		400		V
32	Rise Time	tr	VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=0 $\mu$ A, VD=5 V ※Figure5	100			ns
33	Fall Time	tf	VDD=VDD(ON)+0.1 V, ICL=ICLmax+50 $\mu$ A IEX=0 $\mu$ A, VD=5 V ※Figure5	50			ns
<b>【HIGH VOLTAGE INPUT】</b>							
34	OFF-State leakage Current of VIN Pin	IIN(LEAK)	VDD=VDD(ON)+0.1 V, VEX=VCL=0 V VIN=400 V	22		50	$\mu$ A
35	Breakdown Voltage of VIN Pin	BVVIN	VDD=VDD(ON)+0.1 V, VEX=VCL=0 V IIN=100 $\mu$ A		400		V
36	VDD Charging Current	CHRG10	VIN=40 V, VDD=0 V, EX, CL: open	-10	-14.6	-5.4	mA
		CHRG15	VIN=40 V, VDD=5.5 V, EX, CL: open	-6.15	-9.2	-3.1	mA
37	VIN Supply Voltage	VIN(MIN)	VDD: open, VD=5 V IEX=0 $\mu$ A, ICL=ICLmax+50 $\mu$ A	13		20	V


<h1>Product Standards</h1>		<b>MIP5540MTSCF</b>	
		Total pages	Page
		8	5

【Figure1: Measure circuit】

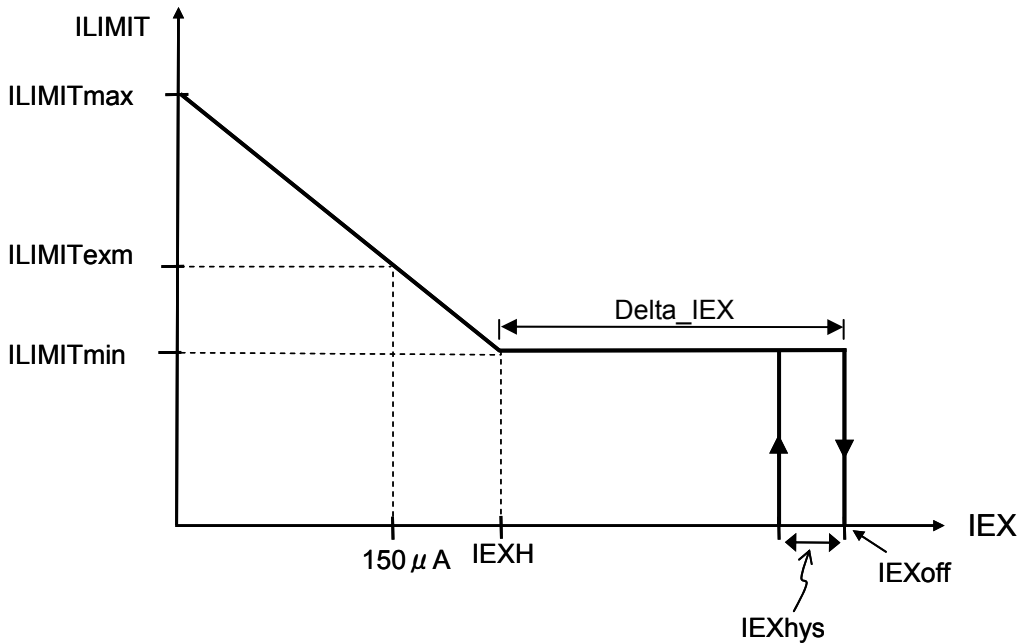


【 Figure2: ILIMIT measurement】



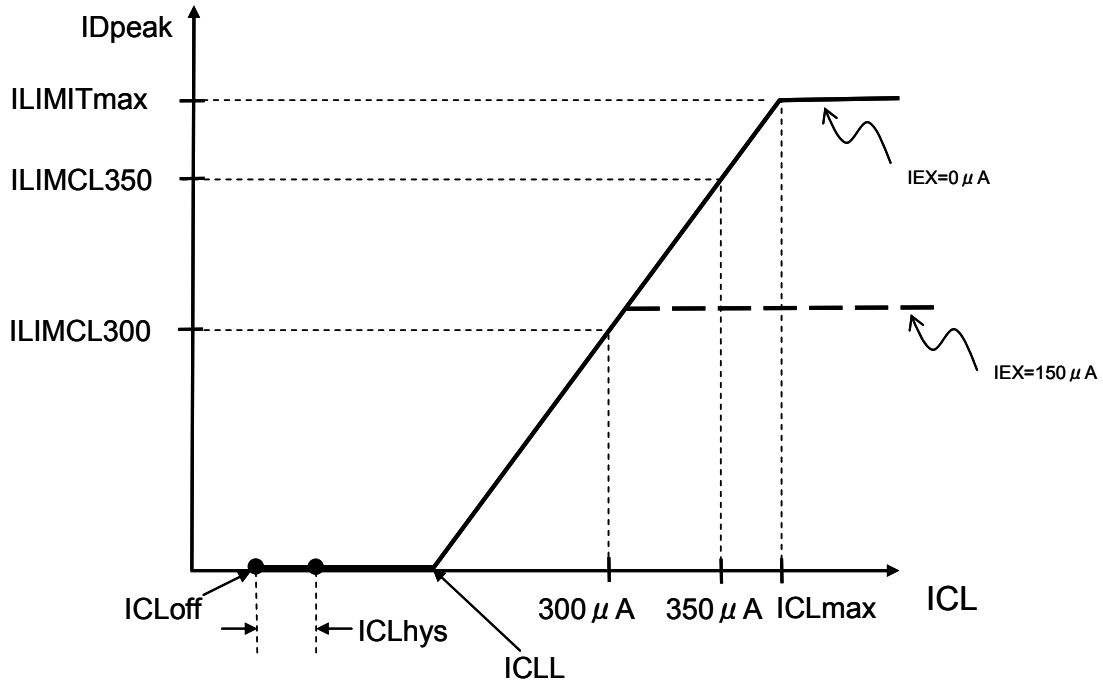
\* The load condition of ILIMIT measurement is L=100 μ H, Rd=130 Ω.

【Figure3: IEX-ILIMIT characteristic】

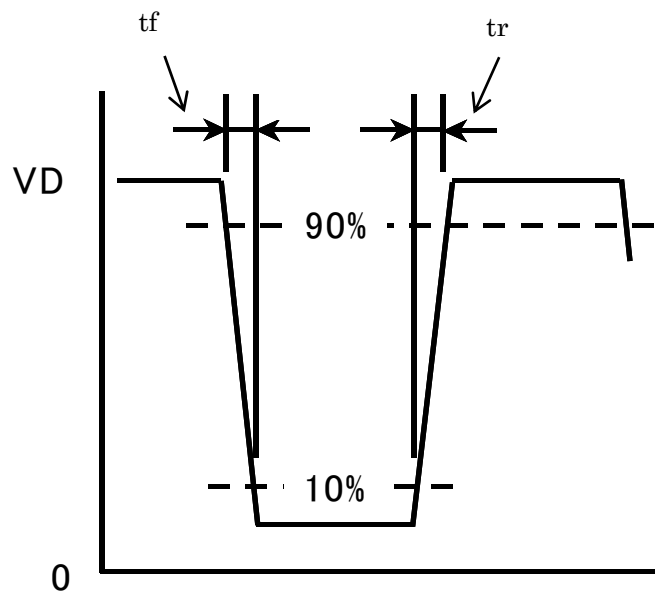



	Product Standards	MIP5540MTSCF	
		Total pages	Page
		8	6

【Figure4:ICL-ILIMIT characteristic】

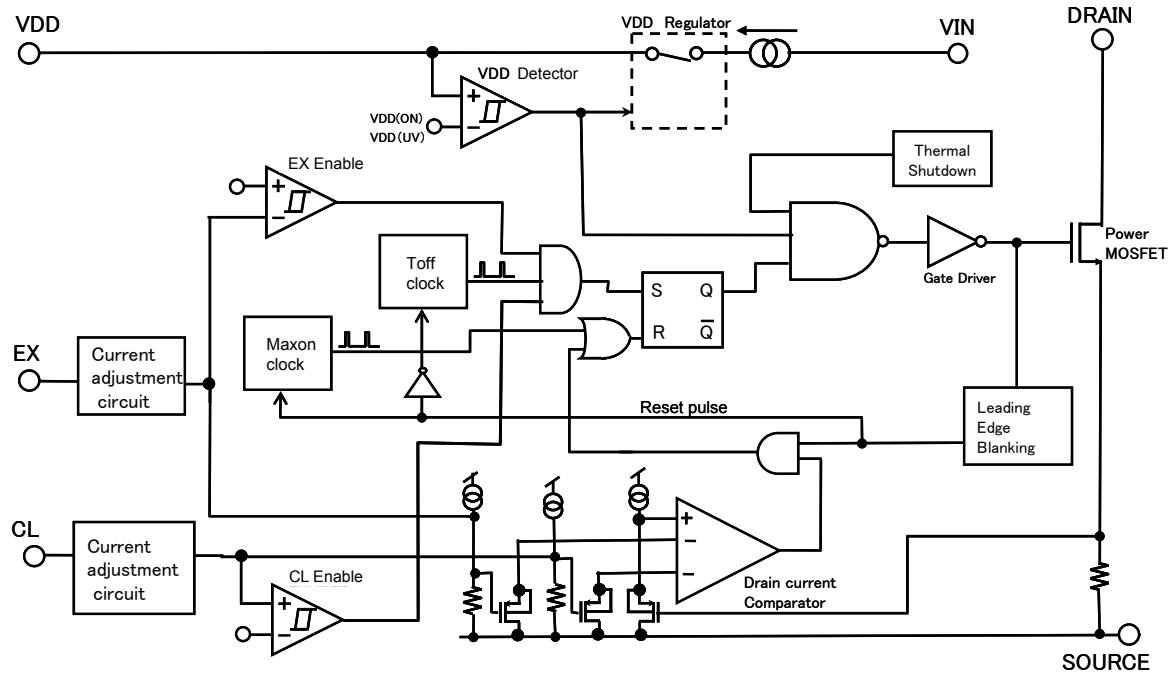


【Figure5:tr, tf characteristic】

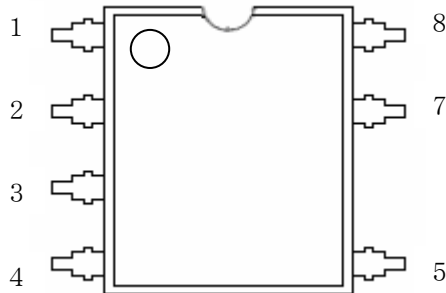



<h1>Product Standards</h1>		<b>MIP5540MTSCF</b>	
		Total pages	Page
		8	7

【Figure6:Block Diagram】



【Figure7:Pin Layout】



Pin No.	Terminal Name
1	VDD
2	EX
3	CL
4	VIN
5	DRAIN
6	—
7	SOURCE
8	SOURCE


	Product Standards	MIP5540MTSCF	
		Total pages	Page
		8	8

**【Precautions for Use 1】**

Connect a ceramic capacitor with value  $>1.0 \mu F$  between VDD pin and GND.

**【Precautions for Use 2】**

The IPD 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 VDD pin connection to the power supply board.
- (2) DRAIN pin short to low voltage pin (VDD, EX, CL).
- (3) VIN pin short to low voltage pin (VDD, EX, CL).
- (4) VIN pin short to DRAIN pin under switching.
- (5) DRAIN pin short to SOURCE pin.




## 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, Nuvoton Technology Corporation Japan 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 de-scribed 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.  
Please consult with our sales staff in advance for information on the following applications, moreover please exchange documents separately on terms of use etc.: Special applications (such as for in-vehicle equipment, airplanes, aerospace, automotive equipment, traffic signaling equipment, combustion equipment, medical equipment 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.  
Unless exchanging documents on terms of use etc. in advance, 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.
- (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. We do not guarantee quality for disassembled products or the product re-mounted after removing from the mounting board.  
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.
- (7) When reselling products described in this book to other companies without our permission and receiving any claim of request from the resale destination, please understand that customers will bear the burden.
- (8) This book may be not reprinted or reproduced whether wholly or partially, without the prior written permission of our company.