


SANYO Semiconductors

DATA SHEET

LA5677M — Monolithic Linear IC Dual Switching Regulator Control IC

Overview

The LA5677M supports single-input control of the outputs of two converters of arbitrary types, including step up, step down and inverting. Since the LA5677M supports low voltage (3.6 to 18V) and high frequency (1 to 500kHz) operation, it is ideal for use in power supplies in battery powered portable equipment.

Functions

- Operates at low voltages (3.6 to 18V).
- Can be used with high frequency oscillators (1 to 500kHz).
- Built-in low input malfunction prevention circuit.
- Built-in timer-latch short circuit protection circuit

Specifications

Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC \text{ max}}$		20	V
Error amplifier input voltage	V_I		20	V
Collector output voltage	V_O		20	V
Collector output current	I_O		21	mA
Allowable power dissipation	$P_d \text{ max}$		330	mW
Operating temperature	T_{opr}		-20 to +85	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +125	$^\circ\text{C}$

■ Any and all SANYO Semiconductor Co.,Ltd. products described or contained herein are, with regard to "standard application", intended for the use as general electronics equipment (home appliances, AV equipment, communication device, office equipment, industrial equipment etc.). The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for applications outside the standard applications of our customer who is considering such use and/or outside the scope of our intended standard applications, please consult with us prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

LA5677M

Operating Conditions at $T_a = 25^{\circ}\text{C}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Recommended supply voltage	V_{CC}		3.6		18	V
Error amplifier input voltage	V_I		1.05		1.45	V
Collector output voltage	V_O		-0.3		+18	V
Collector output current	I_O				20	mA
Feedback pin current	I_{FT}				45	μA
Feedback resistance	R_{NF}		100			$\text{k}\Omega$
Timing capacitance	C_T		150		15000	pF
Timing resistance	R_T		5.1		100	$\text{k}\Omega$
Oscillator frequency	f_{OSC}		1		500	kHz

Electrical Characteristics at $T_a = 25^{\circ}\text{C}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Reference voltage block						
Output voltage	Vref	I _{OR} = 1mA	2.40	2.50	2.60	V
Line regulation	V _{line}	V _{CC} = 3.6 to 18V		2	10	mV
Load regulation	V _{load}	I _{OR} = 0.1 to 1mA		1	7.5	mV
Output voltage temperature variation				±0.2		%
Short circuit output current	I _{OSC}	Vref = 0V	3	10	30	mA
Low input malfunction prevention block						
High level threshold voltage	V _{tH}	I _{OR} = 0.1mA		2.70		V
Low level threshold Voltage	V _{tL}	I _{OR} = 0.1mA		2.58		V
Hysteresis	V _{hys}	I _{OR} = 0.1mA	80	120		mV
Reset voltage	V _r	I _{OR} = 0.1mA	1.5	1.9		V
Protection circuit block						
Input threshold voltage	V _{tpc}		1.02	1.16	1.30	V
Input standby voltage	V _{stby}	No pull-up		0.78		V
Input latch voltage	V _l	No pull-up		0.74		V
Input source current	I _{bpc}		12	18	27	μA
Comparator threshold voltage	V _{tc}			1.2		V
Oscillator block						
Oscillator frequency	f _{OSC}	C _T = 330pF, R _T = 10kΩ		200		kHz
f _{OSC} standard deviation	Δf _A	All values agree		10		%
Frequency variation 1 (V _{CC})	Δf _V			1		%
Frequency variation 2 (T _a)	Δf _t			±0.4		%
Idle period adjustment circuit block						
Input bias current	I _{bdt}				1	μA
Latch mode source current	I _{dt}			230		μA
Latch input voltage	V _{dt}	I _{dt} = 40μA	2.3			V
Input threshold voltage	V _{t0}	With a duty cycle of 0%		2.05	2.25	V
	V _{t100}	f _{OSC} = 10kHz, With a duty cycle of 100%	1.20	1.45		V
Error amplifier block						
Input offset voltage	V _{IO}	With V (pins 5, 12) = 1.25V	-6		+6	mV
Input offset current	I _{IO}	With V (pins 5, 12) = 1.25V	-100		+100	nA
Input bias current	I _B	With V (pins 5, 12) = 1.25V		160	500	nA
Common mode input voltage range	V _{ICR}	V _{CC} = 3.6 to 18V	1.05		1.45	V
Open loop gain	A _V	R _{NF} = 200kΩ		80		dB
Unity gain bandwidth	G _B			1.5		MHz
Common mode rejection ratio	CMMR			80		dB

Continued on next page.

LA5677M

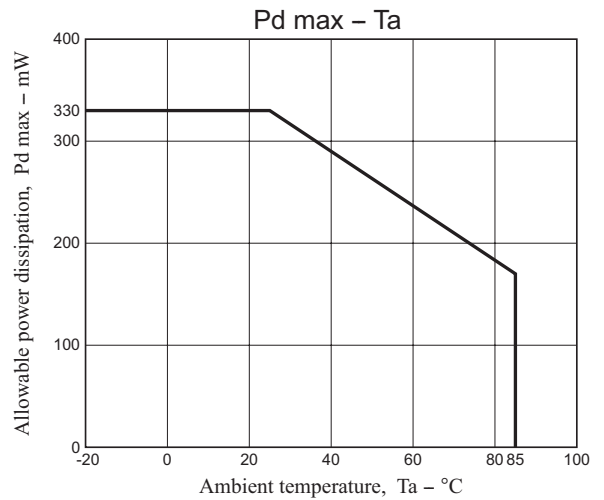
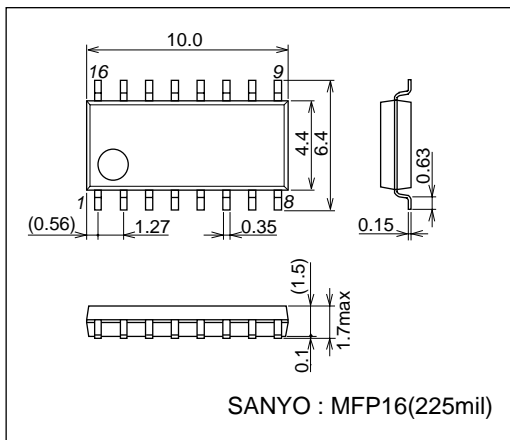
Continued from preceding page.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Maximum output voltage amplitude (1)	V_{O^+m}		$V_{ref}-0.1$			V
Maximum output voltage amplitude (2)	V_{O^-m}				1.0	V
Output sink current (pins 5, 12)	I_{O^+m}	$V_{ID} = -0.1V, V_O = 1.25V$		1.6		mA
Output source current (pins 5, 12)	I_{O^-m}	$V_{ID} = 0.1V, V_O = 1.25V$		-70		μA
Output block						
Output leakage current	I_{leak}	$V_O = 18V$			10	μA
Output saturation voltage	V_{sat}	$I_O = 10mA$		1.0	2	V
Short circuit output current	I_{OS}	$V_O = 6V$		60		mA
PWM comparator block						
Input threshold voltage	V_{t0}	With a duty cycle of 0%		2.05	2.25	V
	V_{t100}	$f_{OSC} = 10kHz$, With a duty cycle of 100%	1.20	1.45		V
Input sink current (pins 5, 12)	I_{IN^+m}	With V (pins 5, 12) = 1.25V		1.6		mA
Input source current (pins 5, 12)	I_{IN^-m}	With V (pins 5, 12) = 1.25V		-70		μA
Whole device						
Standby current	I_{CC1}	Output off state		1.6	2.2	mA
Average supply current	I_{CC2}	$R_T = 10k\Omega$		1.9	2.6	mA

Package Dimensions

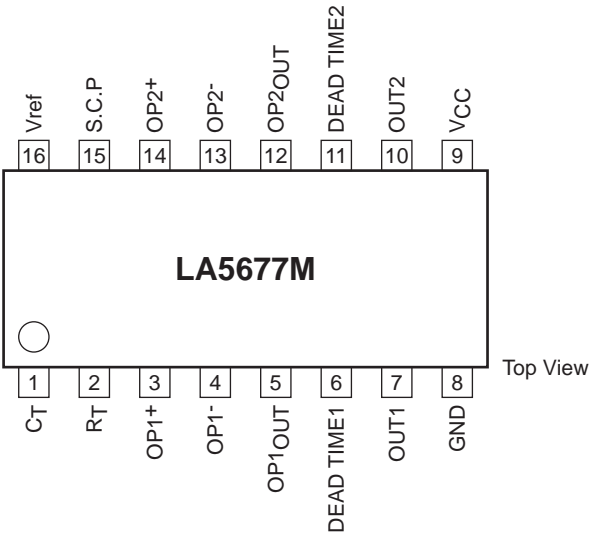
unit : mm (typ)

3035B



LA5677M

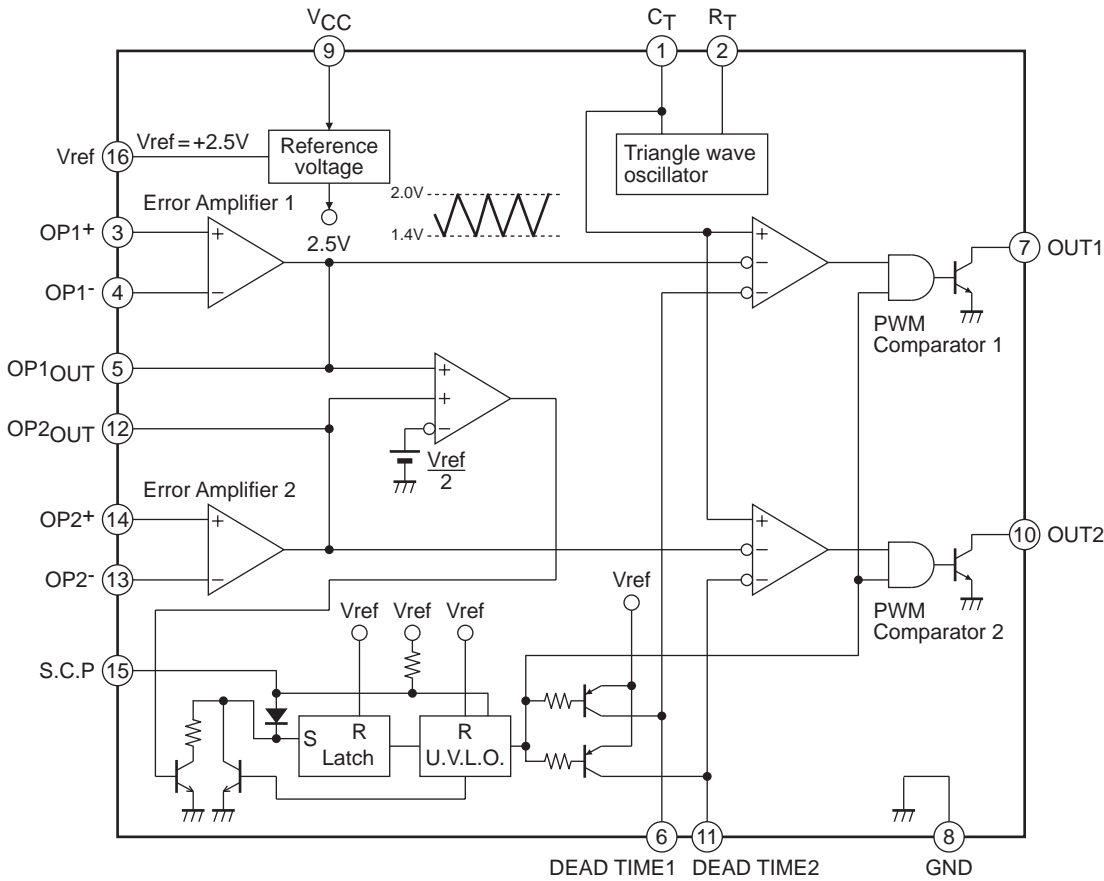
Pin Assignment



Pin Function

Pin No.	Pin name	Function	Pin No.	Pin name	Function
1	C_T	Triangle wave oscillator capacitor connection	9	V_{CC}	Power supply input
2	R_T	Triangle wave oscillator resistor connection	10	$OUT2$	Output 2
3	$OP1^+$	Error amplifier 1 + input	11	$DEAD TIME2$	Dead time 2 control
4	$OP1^-$	Error amplifier 1 - input	12	$OP2OUT$	Error amplifier 2 output
5	$OP1OUT$	Error amplifier 1 output	13	$OP2^-$	Error amplifier 1 - input
6	$DEAD TIME1$	Dead time 1 control	14	$OP2^+$	Error amplifier 1 + input
7	$OUT1$	Output 1	15	$S.C.P$	Short circuit protection circuit connection
8	GND	Ground connection	16	V_{ref}	Reference voltage (2.5V)

Block Diagram



Operation Overview

1. Reference Voltage Block

The reference voltage block uses a 2.5V reference voltage. This voltage is made available to external circuits from pin 16, and at the same time is used as the reference power supply by internal circuits.

2. Low Input Malfunction Prevention Circuit Block

The low input malfunction prevention circuit prevents incorrect operation when the power supply is brought up or during brief voltage drops. After power is applied and the reference voltage reaches V_{be} , the output transistors are held off until the power supply voltage becomes 2.72V (typical). The dead time control pin voltage is held at the high level (V_{ref}) and the short circuit protection pin is held low (the initial state). Since this circuit has a hysteresis of 120mV (typical) chattering due to power supply ripple can be prevented to a certain extent.

3. Timer-Latch Short Circuit Protection Circuit

During output overload, the timer-latch short circuit protection circuit's short circuit protection comparator turns off Q86 when the error amplifier inputs a low level signal (a voltage less than $V_{ref}/2$) to one or both of the short circuit protection comparator's two non-inverting inputs. At this time the pin 15 voltage increases from about 0.75V (steady state) towards V_{ref} as the external capacitor is charged from V_{ref} through resistor R41 (80k Ω). When the capacitor is charged to about 1.2V, the protection latch is set, the output transistors are turned off, and the idle time becomes 100%. This also turns on Q97 which resets the protection enable state. The latch circuit reset voltage is under 1.9V (typical).

$$V_{PE1} = V_{ref} \{1 - \exp(-t_1/R_{41} \times C_{PT})\}$$

$$V_{PE2} = V_{ref} \{1 - \exp(-t_2/R_{41} \times C_{PT})\}$$

$$0.75 = 2.5 \{1 - \exp(-t_1/80k \times C_{PT})\}$$

$$1.20 = 2.5 \{1 - \exp(-t_2/80k \times C_{PT})\}$$

$$t_1 = 28.56k \times C_{PT}$$

$$t_2 = 52.31k \times C_{PT}$$

$$t_{PT} = t_2 - t_1 = 23.75k \times C_{PT}$$

$$C_{PT} = 42.1 \times t_{PT} [\mu F]$$

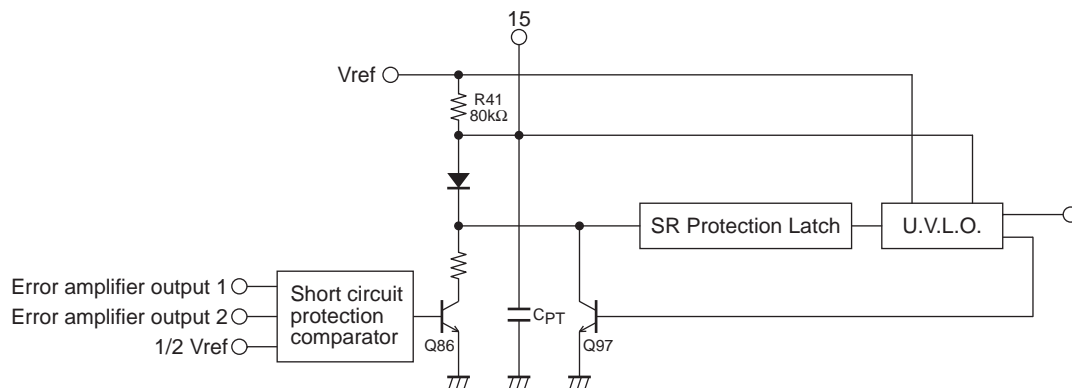


Figure 1 Timer-Latch Short Circuit Protection Circuit

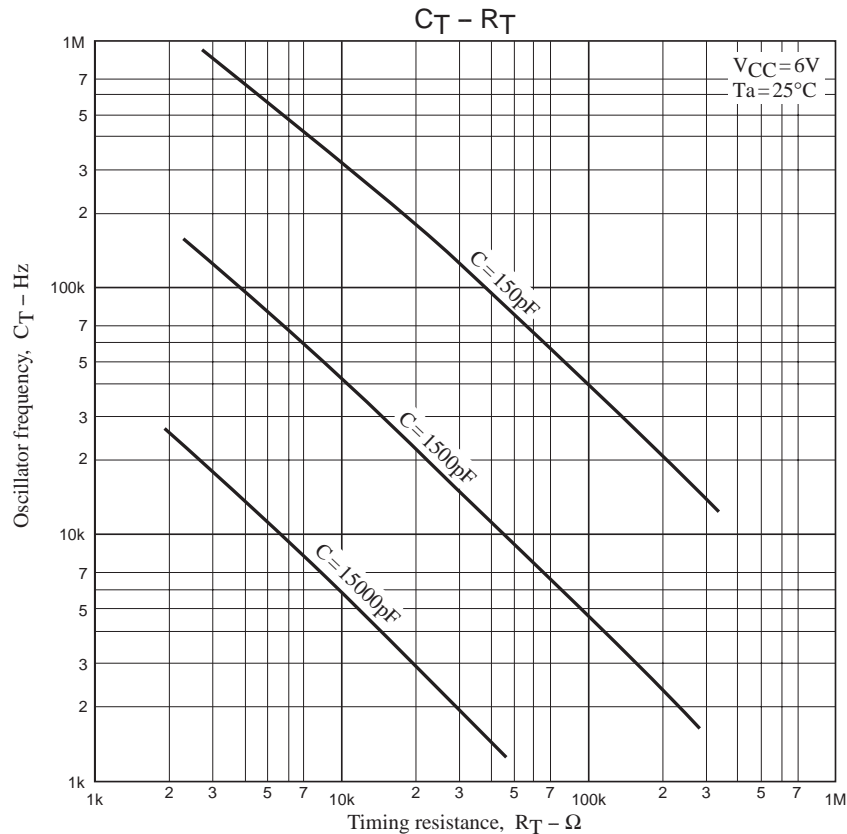


Figure 2 Timing Resistance/Oscillator Frequency Characteristics

4. Triangle Wave Oscillator Block

The triangle wave oscillator generates an essentially symmetric triangle wave using a timing capacitor and resistor attached to the C_T pin (pin 1) and the R_T pin (pin 2), respectively. The voltage amplitude is between 1.4 and 2.0V with pin 2 stabilized at 1V. The oscillator frequency is determined by the external capacitor and resistor.

5. Idle Period Adjustment Circuit Block

The idle period adjustment circuit consists of PWM comparators 1 and 2, each of which has one non-inverting and two inverting inputs. The output pulse width (on time) is controlled according to the input voltage. Pins 6 and 11 are dead time control pins, and are used to limit the maximum value of the pulse width. A pin voltage of 2.05V (Typical) or over results in the output being off for the whole period, and a pin voltage of 1.45V (Typical) or lower results in the output being on for the whole period.

6. Error Amplifier Block

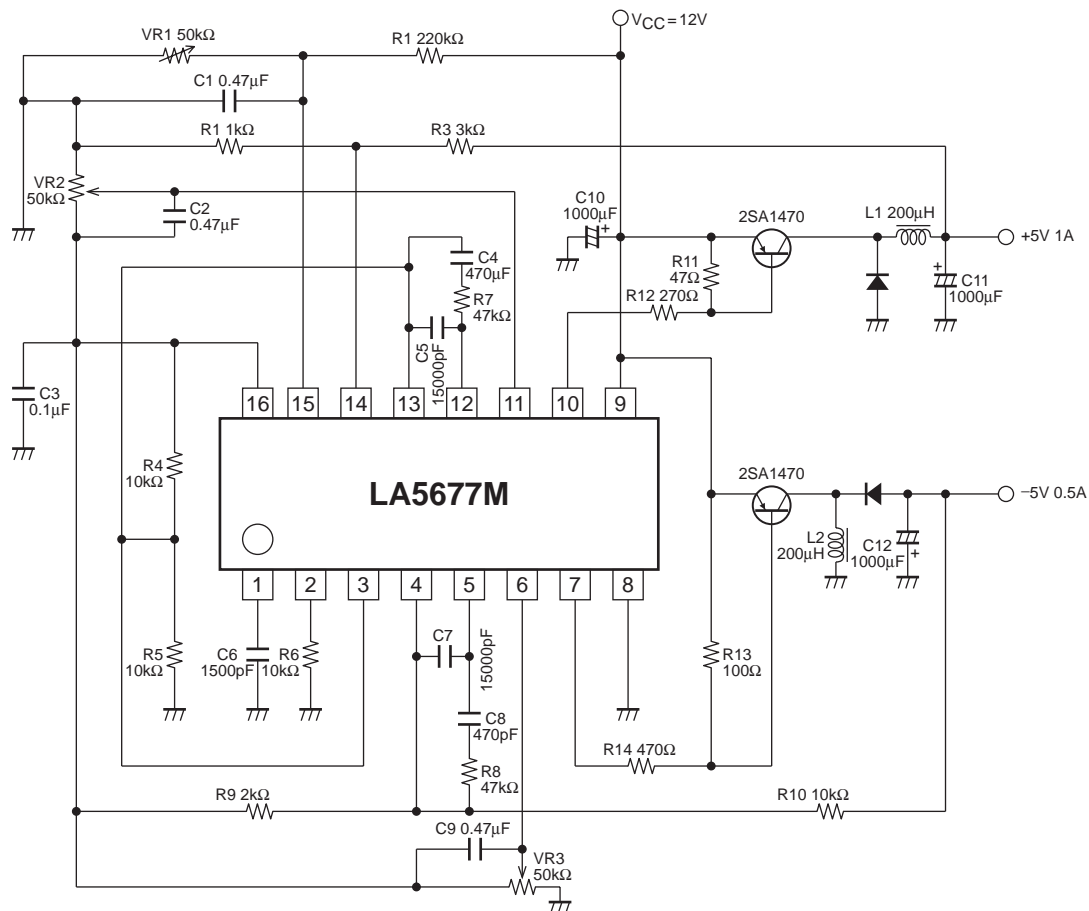
Error amplifiers 1 and 2 are amplifiers for detecting the output voltages, i.e., the LA5677M application system output voltages. Since the common mode input voltage range is 1.05 to 1.45V, we recommend setting their input voltages to $V_{ref}/2$. Pins 5 and 12 are the output pins, and the gain is set and the frequency characteristics adjusted with a resistor and a capacitor connected between the outputs and the non-inverting inputs of each amplifier. The outputs are also connected to the short circuit protection circuit detection circuit.

7. Output Block

The outputs are single end open collector outputs with an NPN Darlington pair structure.

Application Circuit Example

+5V, 1A step-down converter and -5V, 0.5A polarity inverting converter using a 12V input.



- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
- SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production.
- Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellectual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of September, 2008. Specifications and information herein are subject to change without notice.