Ordering number : EN3660B

Monolithic Linear IC

LA5677M

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 18 V) and high frequency (1 to 500 kHz) operation, it is ideal for use in power supplies in battery powered portable equipment.

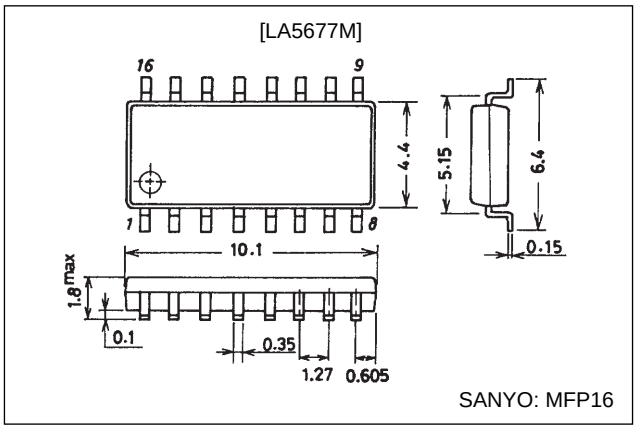
Features

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

Package Dimensions

unit: mm

3035A-MFP16



Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} 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	Pd max		330	mW
Operating temperature	Topr		–20 to +85	°C
Storage temperature	Tstg		–40 to +125	°C

Operating Conditions at Ta = 25°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			kΩ
Timing capacitance	C_T		150		15000	pF
Timing resistance	R_T		5.1		100	kΩ
Oscillator frequency	f_{OSC}		1		500	kHz

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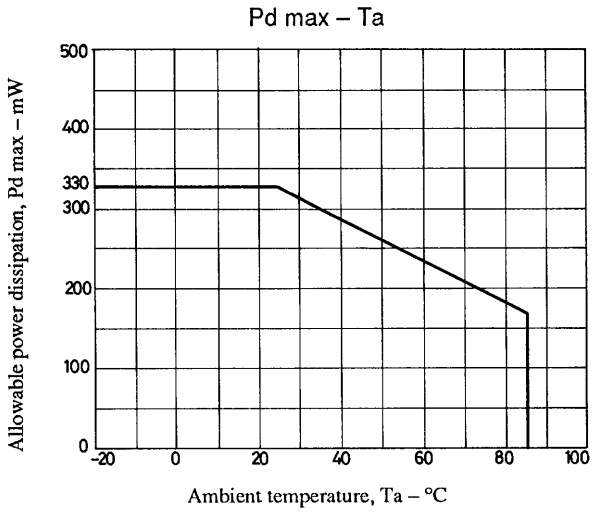

Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Reference voltage block	Output voltage	Vref	I_{OR} = 1 mA	2.40	2.50	2.60	V
	Line regulation	V_{line}	V_{CC} = 3.6 to 18 V		2	10	mV
	Load regulation	V_{load}	I_{OR} = 0.1 to 1 mA		1	7.5	mV
	Output voltage temperature variation				±0.2		%
	Short circuit output current	I_{OSC}	Vref = 0 V	3	10	30	mA
Low input malfunction prevention block	High level threshold voltage	V_{tH}	I_{OR} = 0.1 mA		2.70		V
	Low level threshold voltage	V_{tL}	I_{OR} = 0.1 mA		2.58		V
	Hysteresis	Vhys	I_{OR} = 0.1 mA	80	120		mV
	Reset voltage	Vr	I_{OR} = 0.1 mA	1.5	1.9		V
Protection circuit block	Input threshold voltage	Vtpc		1.02	1.16	1.30	V
	Input standby voltage	Vstby	No pull-up		0.78		V
	Input latch voltage	V_1	No pull-up		0.74		V
	Input source current	Ibpc	When VS.C.P is 1.0 V	12	18	27	µA
	Comparator threshold voltage	Vtc	Pins 5, 12		1.2		V
Oscillator block	Oscillator frequency	fosc	Ct = 330 pF, Rt = 10 kΩ		200		kHz
	fosc standard deviation	Δf_A	All values agree		10		%
	Frequency variation 1 (V_{CC})	Δf_V	V_{CC} = 3.6 to 18 V		1		%
	Frequency variation 2 (Ta)	Δft			±0.4		%
Idle period adjustment circuit block	Input bias current	Ibdt				1	µA
	Latch mode source current	Idt			230		µA
	Latch input voltage	Vdt	Iodt = 40 µA	2.3			V
	Input threshold voltage	Vt0	With a duty cycle of 0%		2.05	2.25	V
		Vt100	fosc = 10 kHz, With a duty cycle of 100%	1.20	1.45		V

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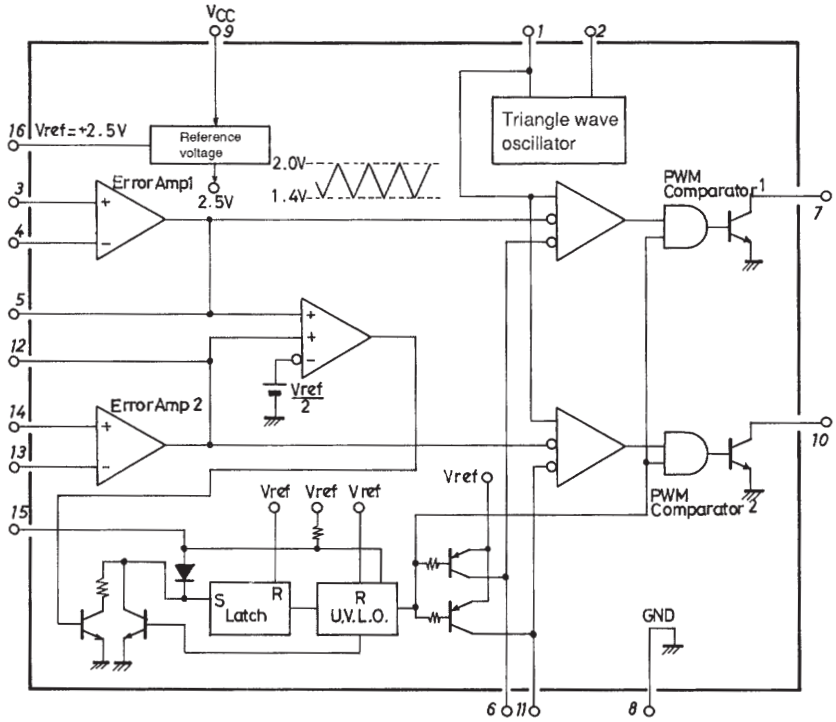
Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Error amplifier block	Input offset voltage	V_{IO}	With V (pins 5, 12) = 1.25 V	–6		+6	mV
	Input offset current	I_{IO}	With V (pins 5, 12) = 1.25 V	–100		+100	nA
	Input bias current	I_B	With V (pins 5, 12) = 1.25 V		160	500	nA
	Common mode input voltage range	V_{ICR}	V_{CC} = 3.6 to 18 V	1.05		1.45	V
	Open loop gain	A_V	R_{NF} = 200 kΩ		80		dB
	Unity gain bandwidth	G_B			1.5		MHz
	Common mode rejection ratio	CMRR			80		dB
	Maximum output voltage amplitude (1)	V_O + m		Vref – 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} = –0.1 V, V_O = 1.25 V		1.6		mA
	Output source current (pins 5, 12)	I_O – m	V_{ID} = 0.1 V, V_O = 1.25 V		–70		µA
Output block	Output leakage current	I_{leak}	V_O = 18 V			10	µA
	Output saturation voltage	Vsat	I_O = 10 mA		1.0	2	V
	Short circuit output current	I_{OS}	V_O = 6 V		60		mA
PWM comparator block	Input threshold voltage	Vt0	With a duty cycle of 0%		2.05	2.25	V
		Vt100	fosc = 10 kHz, With a duty cycle of 100%	1.20	1.45		V
	Input sink current (pins 5, 12)		With V (pins 5, 12) = 1.25 V		1.6		mA
	Input source current (pins 5, 12)		With V (pins 5, 12) = 1.25 V		–70		µA
Whole device	Standby current	$I_{CC}1$	Output off state		1.6	2.2	mA
	Average supply current	$I_{CC}2$	R_T = 10 kΩ		1.9	2.6	mA

Pin Functions

No.	Pin	Function	No.	Pin	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	$OP2_{OUT}$	Error amplifier 2 output
5	$OP1_{OUT}$	Error amplifier 1 output	13	OP2–	Error amplifier 2 – input
6	DEAD TIME1	Dead time 1 control	14	OP2+	Error amplifier 2 + input
7	OUT1	Output 1	15	S. C. P	Short circuit protection circuit connection
8	GND	Ground connection	16	Vref	Reference voltage (2.5 V)

Equivalent Circuit Block Diagram



Operation Overview

1. Reference Voltage Block

   The reference voltage block uses a 2.5 V 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 Vbe, the output transistors are held off until the power supply voltage becomes 2.72 V (typical). The dead time control pin voltage is held at the high level (Vref) and the short circuit protection pin is held low (the initial state). Since this circuit has a hysteresis of 120 mV (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 Vref/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 0.75 V (steady state) towards Vref as the external capacitor is charged from Vref through resistor R41 (80 kΩ). When the capacitor is charged to about 1.2 V, 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 1.9 V (typical).

$$V_{PE}1 = Vref \{1 - \exp(-t1/R41 \cdot C_{PT})\}$$
$$V_{PE}2 = Vref \{1 - \exp(-t2/R41 \cdot C_{PT})\}$$
$$0.75 = 2.5 \{1 - \exp(-t1/80\ k \cdot C_{PT})\}$$
$$1.20 = 2.5 \{1 - \exp(-t2/80\ k \cdot C_{PT})\}$$
$$t1 = 28.56\ k \cdot C_{PT}$$
$$t2 = 52.31\ k \cdot C_{PT}$$
$$t_{PT} = t2 - t1 = 23.75\ k \cdot C_{PT}$$
$$C_{PT} = 42.1 \times t_{PT}\ [\mu F]$$

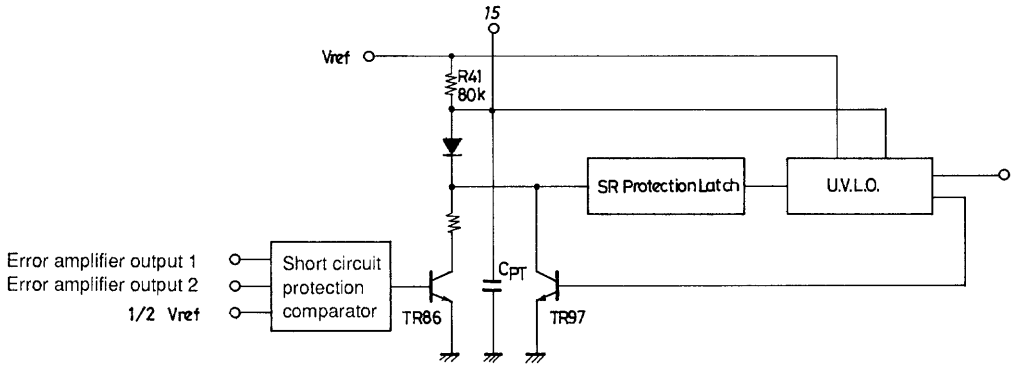


Figure 1 Timer-Latch Short Circuit Protection Circuit

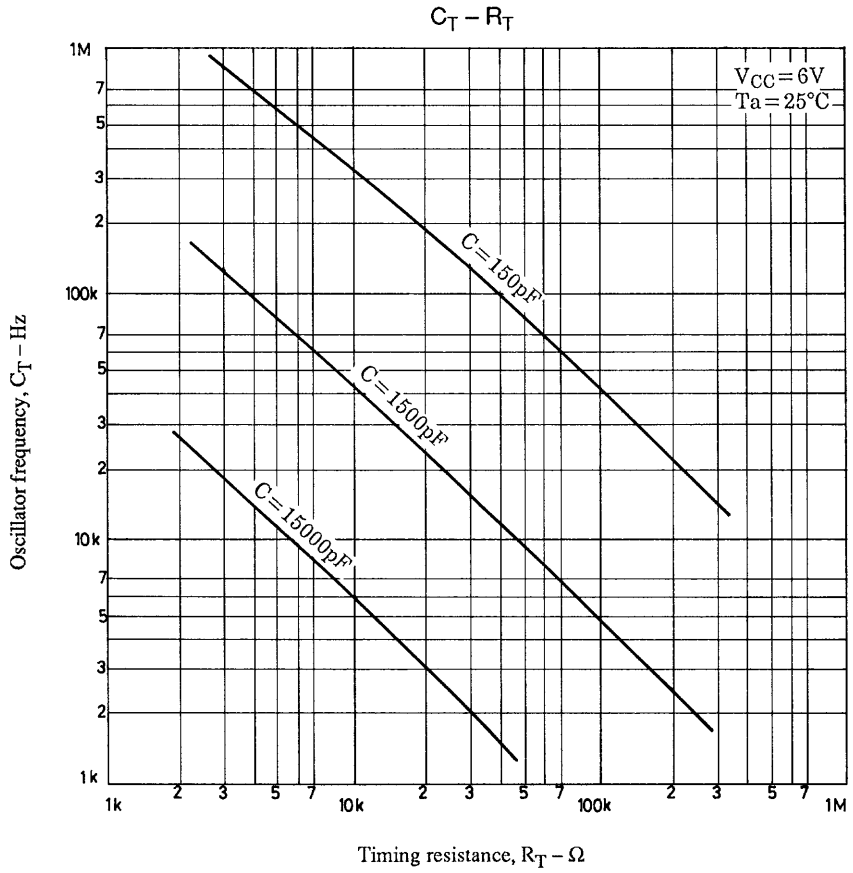


Figure 2 Timing Resistance/Oscillator Frequency Characteristics

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 2.0 V with pin 2 stabilized at 1 V. 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 2.05 V (Typical) or over results in the output being off for the whole period, and a pin voltage of 1.45 V (Typical) or lower results in the output being on for the whole period.

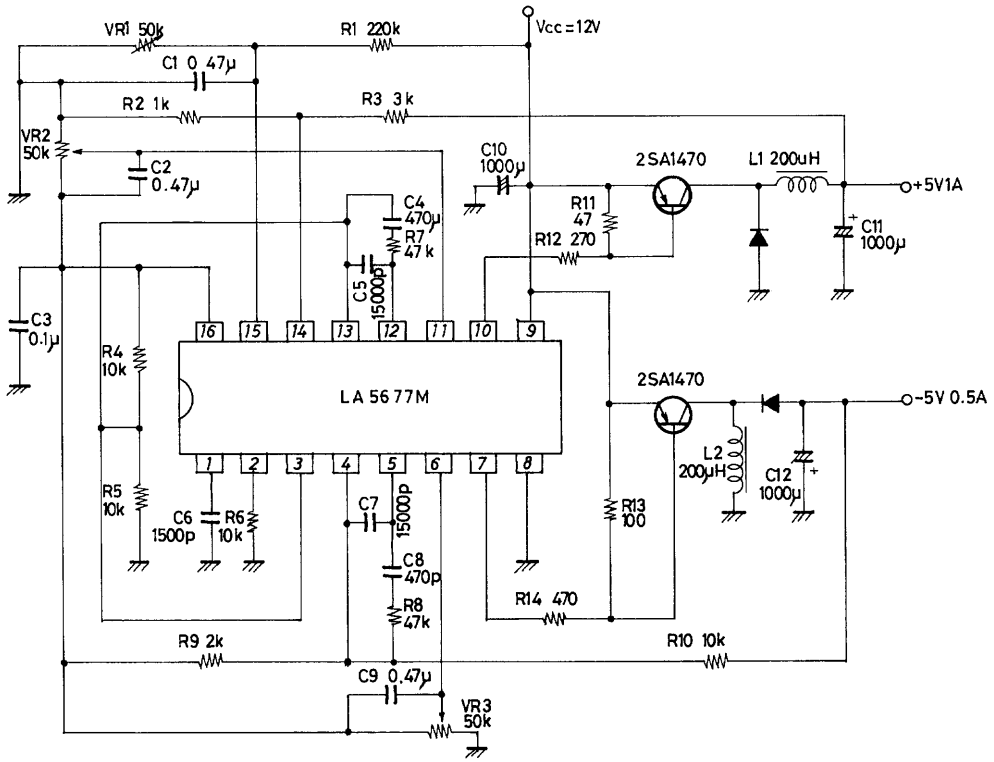
6. Error Amplifier Block

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 1.45 V, we recommend setting their input voltages to Vref/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.

Sample Application Circuit: +5 V, 1 A step-down converter and –5 V, 0.5 A polarity inverting converter using a 12 V input



Unit (resistance: Ω, capacitance: F)