Charge Controller for Dual Batteries

FEATURES

Quick and easy testing for production.
Sequential charging control of two NiMH/NiCd Battery Packs.
Reliable sequential fast charge control of dual NiMH and/or NiCd Battery Packs, even with a fluctuating charging current.
Fast charge termination by: ΔTΔt, -ΔV, 0ΔV, safety timer, maximum temperature, or maximum voltage.
Linearly adjustable safety timer and ΔTΔt detection slope line.
Selectable battery voltage protection range.
Selectable battery temperature protection mode.
Protection against battery voltage and battery temperature faults.
Selectable LED display mode for battery status.
Five pulsed trickle charge modes.
Discharge-before-charge function available to eliminate memory effect.
Choice of 20-pin DIP or 20-pin SOP packages.

APPLICATIONS

Dual-Battery Fast Chargers for:

- Mobile Phones.
- Notebook and Laptop Personal Computers.
- Portable Power Tools and Toys.
- Portable Communication Equipments.
- Portable Video & Stereo Equipments.

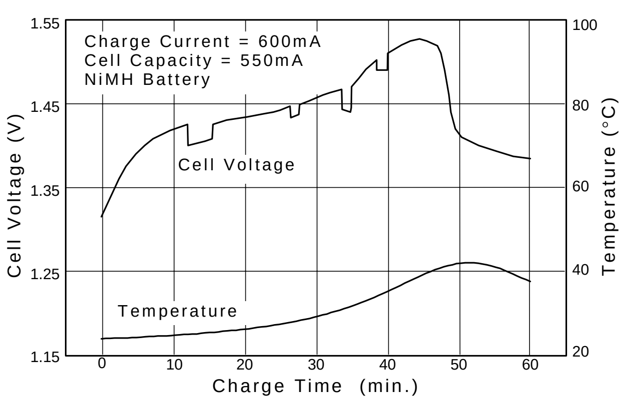


Fig. 1 Battery charging characteristics from an SS6782G-controlled charger with a fluctuating charging current.

DESCRIPTION

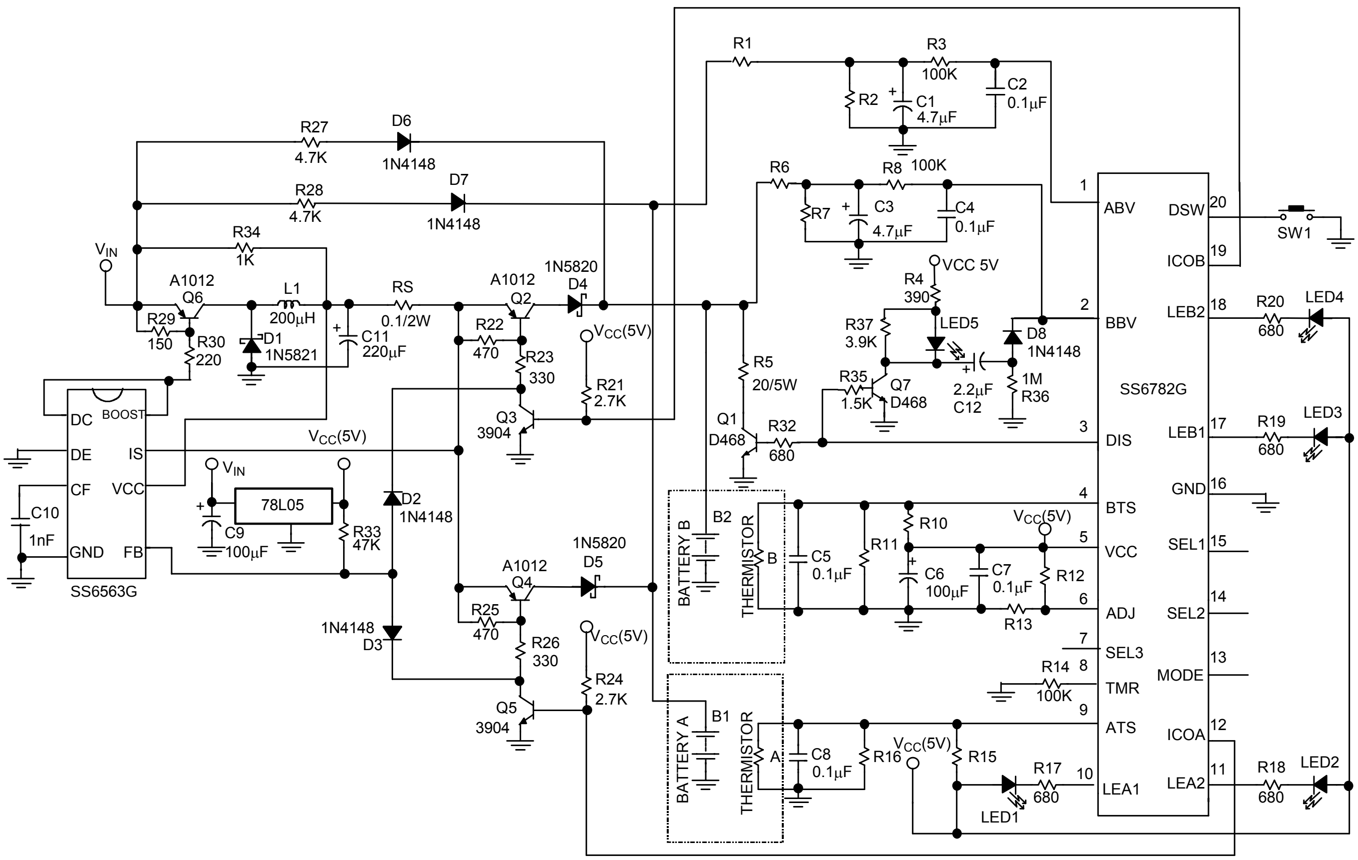
The SS6782G fast-charge controller is designed for intelligent sequential charging of dual NiMH and NiCd batteries without the risk of malfunction. After powering on, the SS6782G charging sequence gives priority to battery pack A, represented by input signals at the ATS and ABV pins, over battery pack B, represented by BTS and BBV pin signals. The SS6782G automatically switches to charging the standby battery pack after the battery pack being charged finishes charging or encounters a fault condition.

-ΔV (-0.25%) detection, 0ΔV (peak voltage timer) detection, and ΔTΔt detection are the primary methods employed by the SS6782G to terminate fast charge. The fast charge can also be cut off by maximum battery voltage and maximum battery temperature detection along with the safety timer to prevent charging under fault conditions of the charging system or the battery itself.

Both ΔTΔt and -ΔV detection methods have been proved powerful in terminating fast charging for NiMH and NiCd batteries. The SS6782G utilizes the combination of these two methods to make a reliable decision for ending fast charge and to avoid issues caused by using -ΔV detection alone under certain conditions. Fig. 1 shows an example of a charging curve of a battery charged by a fluctuating current from a NiMH battery charger which uses the SS6782G controller IC to achieve optimal charging. The ΔTΔt or -ΔV detection circuitry may be disabled independently for different applications, such as system-integrated chargers, chargers with varying charge current, or battery packs lacking a temperature-sensing thermistor.

The safety timer period, the mode of battery temperature protection, battery voltage protection range, the pulsed trickle charge duty cycle, and the LED display mode are all adjustable or selectable. A discharge-before-charge function is included to reduce the memory effect of NiCd batteries without the risk of overdischarging. A test mode is provided for charger manufacturers to dramatically reduce the production test time.

TYPICAL APPLICATION CIRCUIT



Battery charger for Dual NiMH and NiCd Batteries

ORDERING INFORMATION

SS6782GXXX

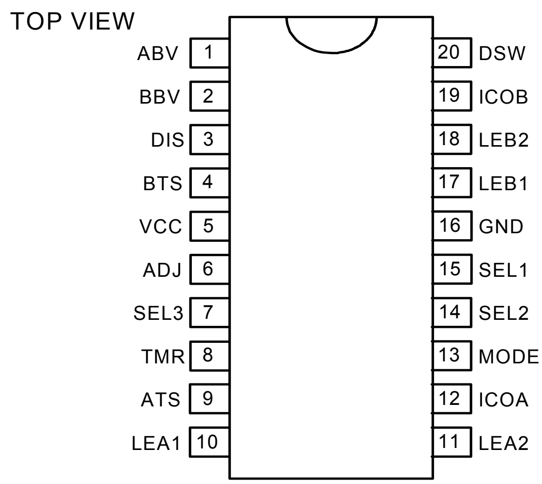
Packing options
TR: tape and reel (not for PDIP)
TB: tube (only option for PDIP)

Package type
GN: RoHS-compliant PDIP-20
GS: RoHS-compliant SO-20

Example: SS6782GSTR
in RoHS-compliant SO-20, shipped
on tape and reel

PIN CONFIGURATION

PIN CONFIGURATION

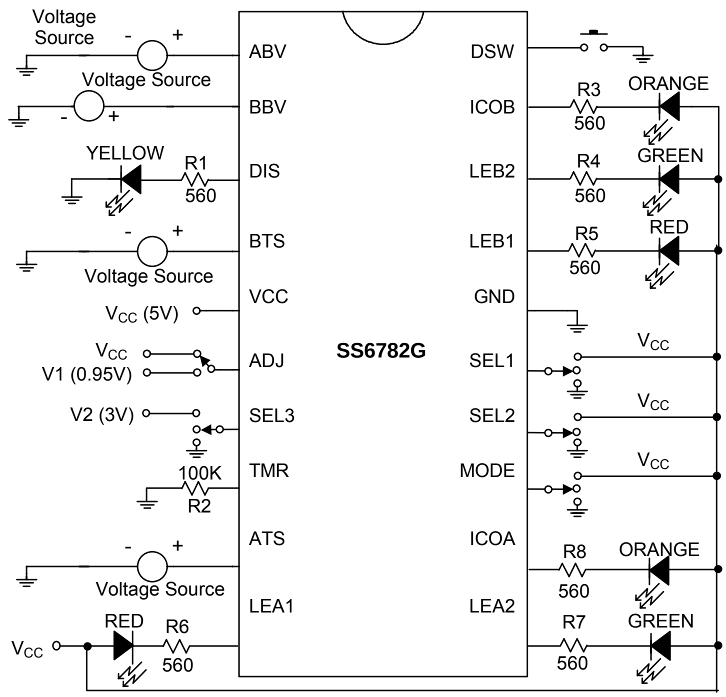


ABSOLUTE MAXIMUM RATINGS

Supply voltage	5.5V
DC voltage applied on any pin	5.5V
Sink current of ICOA pin, LEA1 and LEA2 pins	20mA
Sink current of ICOB pin, LEB1 and LEB2 pins	20mA
Operating temperature range	-40°C ~ +85°C
Maximum junction temperature	125°C
Storage temperature range	-65°C~ 150°C
Lead temperature (soldering 10 sec.)	260°C

Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

TEST CIRCUIT



ELECTRICAL CHARACTERISTICS

(T_A=25°C, V_{CC}=5V, unless otherwise specified) (Note1)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage		V_{CC}	4.5	5	5.5	V
Supply Current		I_{CC}		1.1		mA
Voltage Protection Limit	Battery Low	V_{ABV} V_{BBV}				V
	Before Initial Timer		0.11	0.16	0.21	
	After Initial Timer					
	(SEL3>3V)		0.63	0.69	0.75	
	(SEL3<2V)		1.1	1.2	1.3	
	Battery High					
	(SEL3>3V)		2.6	2.7	2.8	
	(SEL3<2V)		1.9	2.0	2.1	
Temperature Sense Limit	Temperature High	V_{ATS} V_{BTS}	1.35	1.45	1.55	V
	Temperature Low		3.5	3.6	3.7	

ELECTRICAL CHARACTERISTICS (Continued)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Output Impedance of DIS pin		Z_{DIS}		140	250	Ω
Output Impedance	LEA1, LEA2, LEB1, LEB2, ICOA, ICOB pins					
	ON			25	50	Ω
	OFF		1			MΩ
Source Current Capability	SEL3 pin	I_{SEL3}		5.5		µA
	DSW pin	I_{DSW}		16		µA
Input Impedance	MODE, SEL1, SEL2 pins			300		kΩ
	ABV, BBV, ATS, BTS, ADJ pins		1			MΩ
Recommended External Resistor on TMR pin		R_{TMR}	2	100	1000	kΩ
−ΔV detection level relative to peak value				-0.25		%

Note 1: Specifications are production-tested at T_A=25°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

TYPICAL PERFORMANCE CHARACTERISTICS

(T_A=25°C, R2=100kΩ , V_{CC}=5V, refer to the test circuit, page 4)

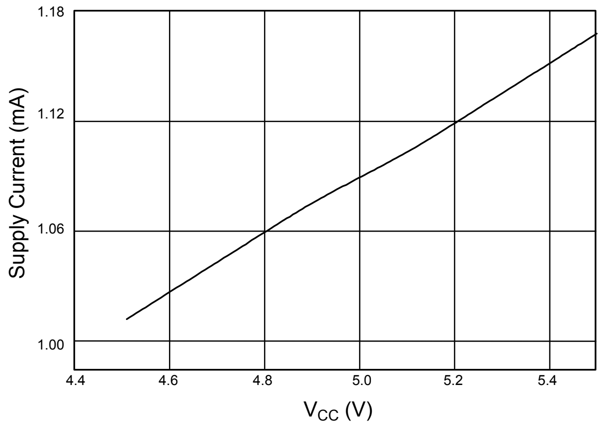


Fig. 2 Supply Current vs. Supply Voltage

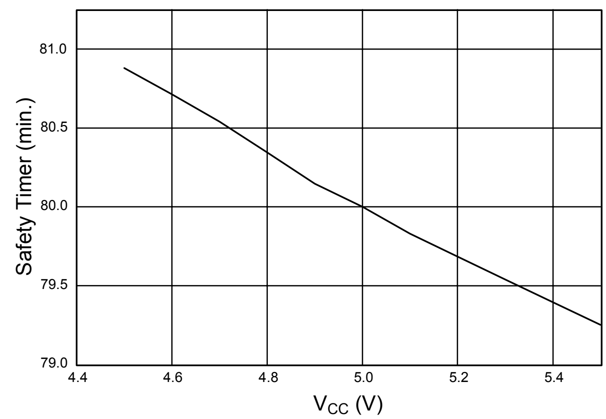


Fig. 3 Safety Timer vs. Supply Voltage

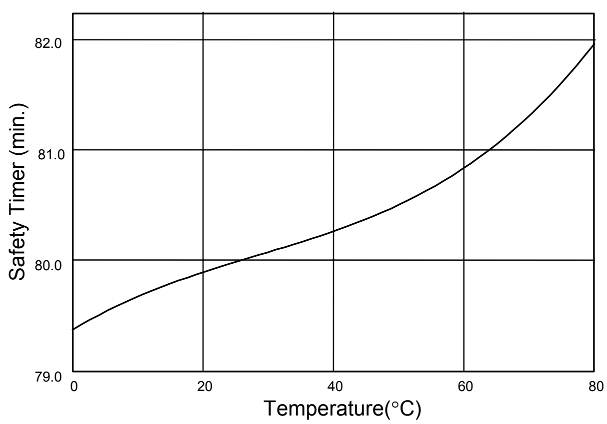


Fig. 4 Safety Timer vs. Temperature

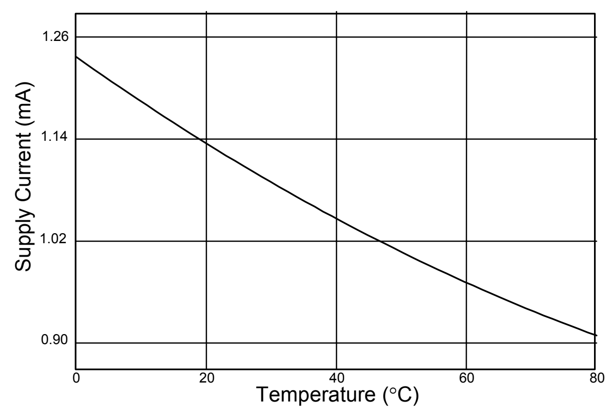


Fig. 5 Supply Current vs. Temperature

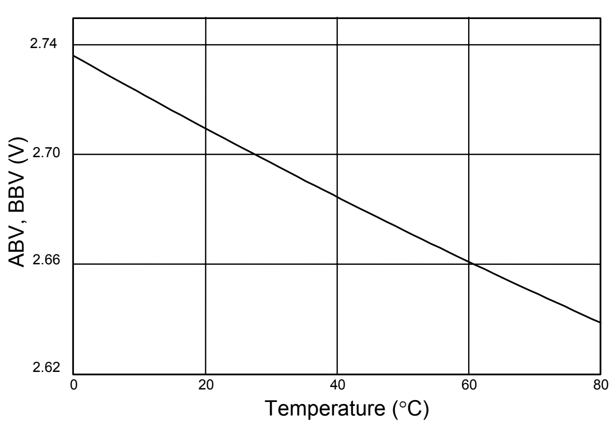


Fig. 6 ABV and BBV (High) Limit vs. Temperature (SEL3>3V)

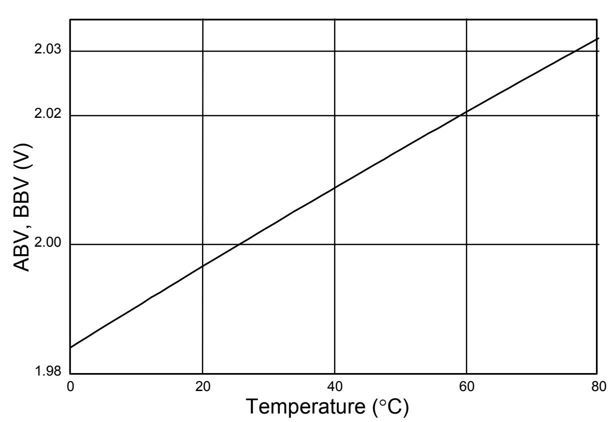


Fig. 7 ABV and BBV (High) Limit vs. Temperature (SEL3<2V)

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

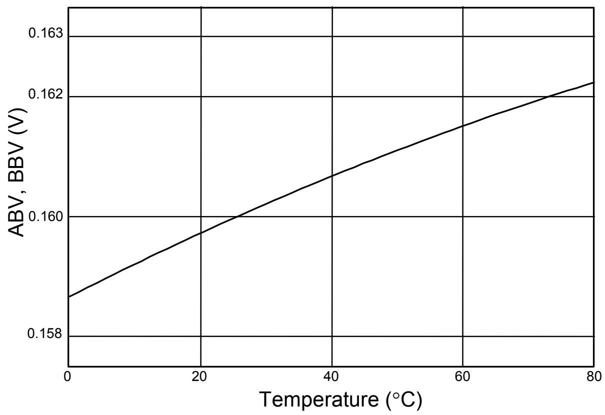


Fig. 8 ABV and BBV (Low) Limit vs. Temperature (Before Initial Timer)

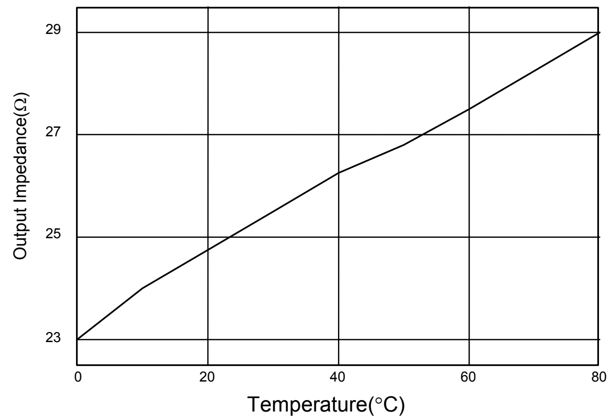


Fig. 9 Output Impedance vs. Temperature (LEA's, LEB's, ICO's pins)

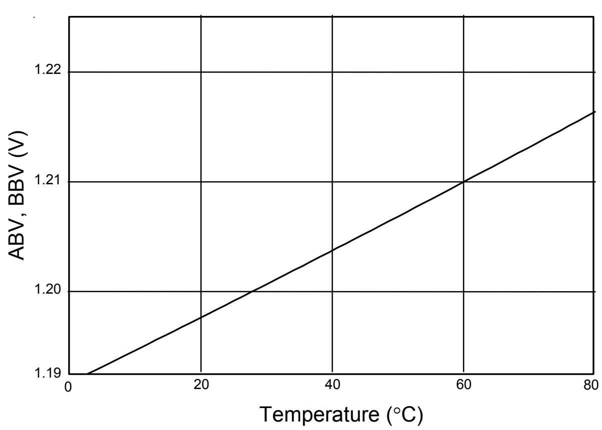


Fig. 10 ABV and BBV (Low) limits vs. Temperature (SEL3<2V, After Initial Timer)

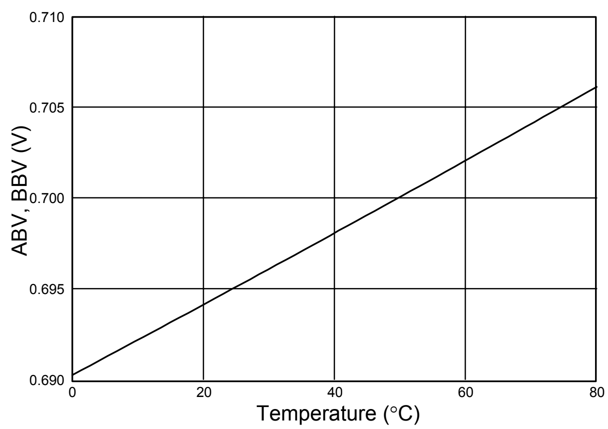


Fig. 11 ABV and BBV (Low) limits vs. Temperature (SEL3>3V, After Initial Timer)

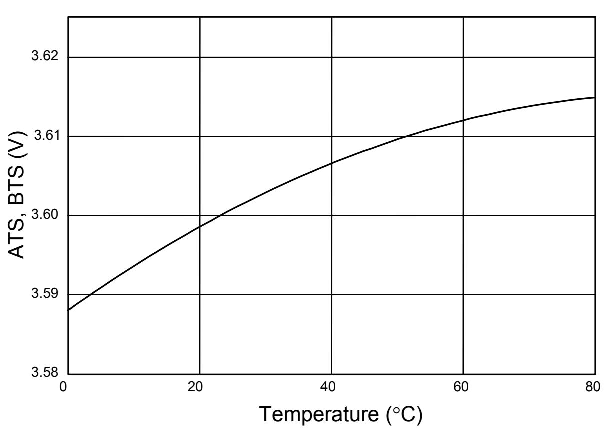


Fig. 12 ATS and BTS (High) Limit vs. Temperature

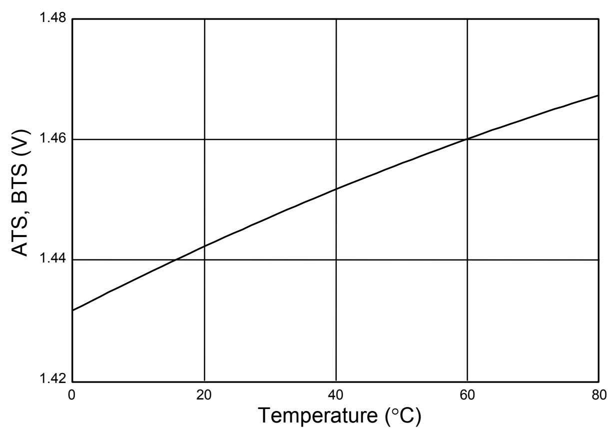
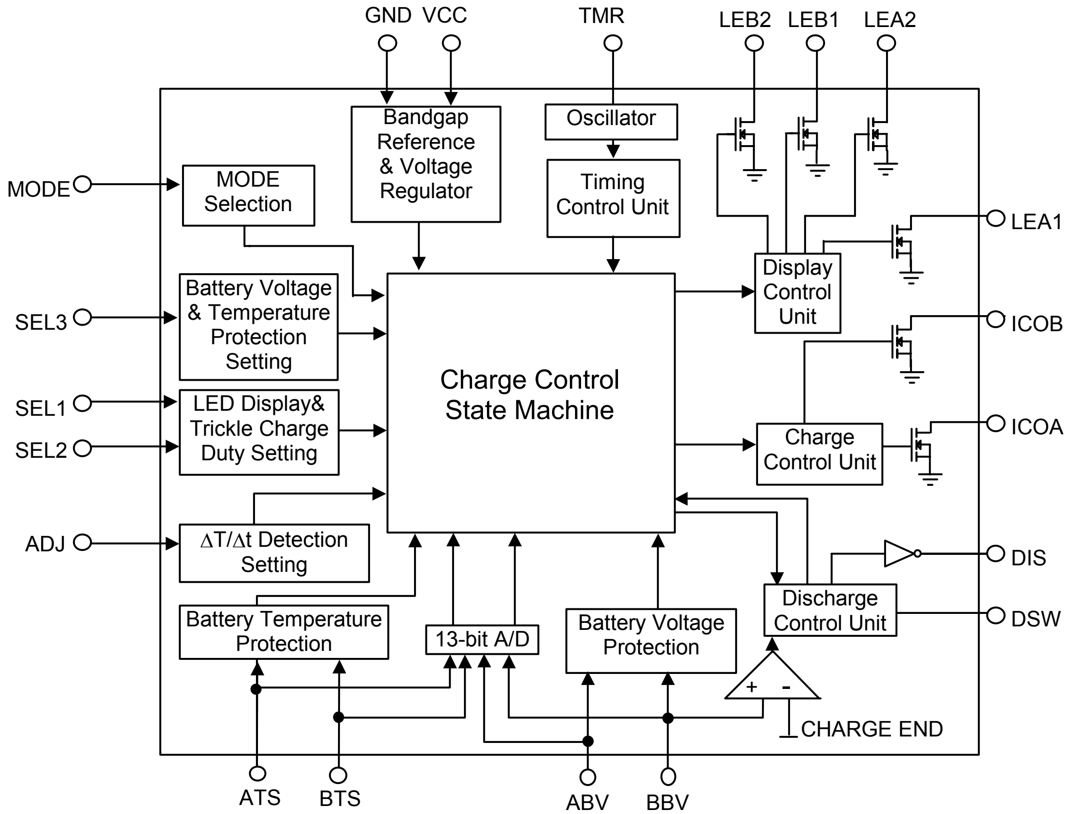


Fig. 13 ATS and BTS (Low) Limit vs. Temperature

BLOCK DIAGRAM



PIN DESCRIPTIONS

PIN 1: ABV - Battery voltage input to sense the voltage of battery pack A.

PIN 2: BBV - Battery voltage input to sense the voltage of battery pack B.

PIN 3: DIS - Push-pull output, used to control an external transistor to discharge the battery pack B. DIS is active high when the discharge function is enabled.

PIN 4: BTS - The battery cell temperature of pack B is represented as a voltage input to the SS6782G on this pin. The acceptable voltage range of the BTS pin is 0.29Vcc to 0.72Vcc.

PIN 5: VCC - Power supply input at 5V±10%.

PIN 6: ADJ - For adjusting the slope of ΔT/Δt. Acceptable voltage range for this pin is approximately 0.28V to 3.8V. If the voltage is higher than (VCC - 0.3V), then ΔT/Δt detection is disabled.

PIN 7: SEL3 - Determines the acceptable voltage range of ABV and BBV pins and the mode of the temperature protection function.

PIN 8: TMR - Determines the period of the safety timer with an external resistor connected to GND.

PIN 9: ATS - The battery cell temperature of pack A is represented as a voltage input to the SS6782G on this pin. The acceptable voltage range of the ATS pin is 0.29Vcc to 0.72Vcc.

PIN 10: LEA1 - Open-draind outputs used to indicate the charging status of the battery pack A.

PIN 11: LEA2 - The same as pin 10.

PIN 12: ICOA - Open-drain output, used to control the charging current of the battery pack A.

PIN 13: MODE - Determines the operating mode of the SS6782G.

PIN 14: SEL2 - Tri-level inputs, which jointly control the LED display mode and the duty of trickle charge after the completion of fast charge.

PIN 15: SEL1 - The same as pin 14.

PIN 16: GND - Power ground.

PIN 17: LEB1 - Open-drain outputs used to indicate the charging status of battery pack B

PIN 18: LEB2 - The same as pin 17.

PIN 19: ICOB - Open-drain output, used to control the charging current of the battery pack B.

PIN 20: DSW - Controls the function of discharge-before-charge of the battery pack B. (See discharge-before-charge subsection in the application information section).

APPLICATION INFORMATION

OPERATION

Power-on and Battery Pre-qualification

The SS6782G is a sequential charger, initiating charging on either battery pack A or B.
When power is first applied to the SS6782G, all internal digital circuits of the SS6782G are reset by the internal power-on-reset circuitry, and the output of LED‘s (depending on the setting of SEL1 and SEL2 pins) flash 3 times to indicate the initiation of power-on. If both battery pack A and B are present when V_{CC} is applied to the SS6782G, the charging action begins with battery pack A if conditions are acceptable.

The condition of battery pack A is examined through the ATS and ABV pins, while battery pack B is examined through the BTS and BBV pins. The acceptable limits of ABV and BBV are determined by the input voltage of SEL3 pin and the acceptable temperature sense voltage window for ATS and BTS of 0.29Vcc to 0.72Vcc.

The SS6782G controls initiation of the charging action and checks for acceptable battery voltage and temperature prior to fast charging. If the voltage of ABV or BBV does not fall within the predetermined acceptable limits, the corresponding battery pack enters a charging-suspended mode. If the voltage of ATS or BTS is outside the $0.29V_{CC}$ to $0.72V_{CC}$ window, the action to be taken is determined by the input voltage of SEL3 pin.

Discharge-Before-Charge

The SS6782G provides the function of discharge-before-charge to precondition NiCd batteries, which can suffer from a memory effect. This function can only be activated for pack B after the prequalification of battery voltage and temperature, but before the charge completion is registered for a fast charge cycle of pack B.

To trigger this function, DSW pin has to be biased to GND over 0.18 second. After discharge begins, LEB1 and LEB2 pins are both OFF, ICOB pin is ON, and DIS pin goes high to activate an external circuit to discharge the battery pack B until the voltage of BBV pin fall below 0.9V (or 0.69V, depending on the input voltage of SEL3 pin) or DSW pin is biased to GND for over 0.18 second again. The application circuit is included in the TYPICAL APPLICATION CIRCUIT shown on page 2.

Fast Charge

After the battery passes fault checks, charging begins on either of the batteries, and the other battery remains in a waiting state until the first battery terminates fast charging. The SS6782G automatically switches to fast charge the second battery. The battery pack A has the priority over battery pack B only when power is first applied to the SS6782G. When fast charging begins, the initial and safety timer of the SS6782G start counting. The -ΔV detection, peak voltage timer, $\Delta T / \Delta t$ detection, and maximum battery voltage functions are, however, disabled temporarily until the initial timer period in the initial stage of the charging cycle elapses. The initial timer period is equal to 1/80 of safety timer.

Since the low limit of acceptable ABV or BBV voltages are only about 0.16V during the initial timer period, even deeply discharged batteries can easily qualify to be fast charged subsequently.

In the course of fast charge, the SS6782G constantly monitors the battery voltage and temperature through ABV (or BBV) and ATS (or BTS) pins. The fast charge process is registered complete when any one of the following situations is encountered, which are explained below:

- Negative delta voltage (-ΔV).
- Peak voltage timer (0ΔV).
- Delta temperature/ delta time ($\Delta T / \Delta t$).
- Maximum charge time.
- Maximum battery voltage.
- Maximum battery temperature.

-ΔV Cutoff

The SS6782G makes a voltage sampling at ABV (or BBV) pin every 4 seconds when the safety timer period is set equal to 80 minutes. If a negative delta voltage of 0.25% compared to its peak value is detected at ABV (or BBV) pin, the fast charge cycle is terminated.

0ΔV Cutoff

If the battery voltage stays at its peak value or decreases very slowly for the duration determined by the peak voltage timer, which is in turn equal to 3.7% of the safety timer, the fast charging action is terminated.

ΔT/Δt Cutoff

The $\Delta T / \Delta t$ detection of the SS6782G is performed by sensing the decrease of ATS (or BTS) pin voltage in a specific timer interval dictated by the safety timer. The fast charging terminates when the decrease of ATS (or BTS) pin voltage in 56 seconds exceeds the predetermined value set by ADJ pin input. This time interval of 56 seconds is based on the assumption that the voltage of ATS (or BTS) pin is sampled once every 8 seconds, which is also determined by the safety timer.

The -ΔV detection and peak voltage timer (0ΔV) functions can be disabled if the MODE pin is biased to GND. The ΔT/Δt function can be disabled if the voltage of the ADJ pin is higher than (Vcc-0.3V).

Maximum Safety Timer Cutoff

The maximum fast charge period is determined by the safety timer, which is set by a resistor connected from TMR pin to GND. Safety timer, -ΔV sampling rate, and ΔT / Δt sampling rate will be longer if the resistor value is larger. When the value of the resistor is 100kΩ, the safety timer period equals 80 minutes. This can be verified by biasing the MODE pin to V_{CC} and the measured frequency on DSW pin should be around 32.8 KHz. After the safety timer period is finished, the fast charge action is terminated.

Maximum Voltage and Temperature Cutoff

The SS6782G guards against the maximum limits for battery voltage and temperature during fast charging. If either of these limits is exceeded, fast charge action is terminated.

Trickle Charge

There are five different selectable duty cycles for trickle charging after fast charging to prevent the loss of charge due to battery self-discharging. The setting of SEL1 and SEL2 pins controls the duty cycle. This function can only be activated in the following three situations:

- Battery pack A is fully charged and battery pack B is abnormal.
- Battery pack B is fully charged and battery pack A is abnormal.
- Battery pack A and B are both fully charged.

DESIGN GUIDE

ABV/BBV Range and Temperature Protection

The acceptable battery voltage range of ABV and BBV pins and the mode of temperature protection function is determined by the voltage of the SEL3 pin, shown as the following:

(a) SEL3 > V_{CC} - 0.3V

Acceptable ABV/BBV Range:

Before initial timer: 0.16V~2.7V

After initial timer: 0.69V~2.7V

Temperature Protection Mode:

Enters charging-suspended mode when temperature is either too low or too high, same as abnormal battery voltage. Latch for charge-suspending function is provided for high temperature protection, but not for low temperature protection.

(b) VCC - 1.4V> SEL3 > $\frac{V_{CC}}{2}$ - 0.4V

Acceptable ABV/BBV Range:

Before initial timer: 0.16V~2.7V

After initial timer: 0.69V~2.7V

Temperature Protection Mode:

If temperature is too high, battery charging is regarded as completed. If temperature is too low, function of ΔT / Δt detection is disabled, just as if the thermistor did not exist.

(c) **$\frac{V_{CC}}{2}$ - 0.4V>SEL3 >1.4V**

Acceptable ABV/BBV Range:

Before initial timer: 0.16V~2 V

After initial timer: 1.2V~2V

Temperature Protection Mode:

Enters the charging-suspended mode when temperature is too low or too high, same as abnormal battery voltage. Latch for charging-suspended function is provided for high temperature protection, but not for low temperature protection.

(d) 0.3V> SEL3

Acceptable ABV/BBV Range:

Before initial timer: 0.16V~2 V

After initial timer:1.2V~2V

Temperature Protection Mode:

If temperature is too high, battery charging is regarded as complete. If temperature is too low, the Δt/Δt detection function is disabled, just as if the thermistor did not exist.

Battery Voltage Measurement

The SS6782G measures the battery voltage through ABV and BBV pins, which are connected to the battery positive terminals through a resistor-divider network, as shown in Fig. 14. The acceptable limit of divided battery voltage is determined by the input voltage of SEL3 pin.

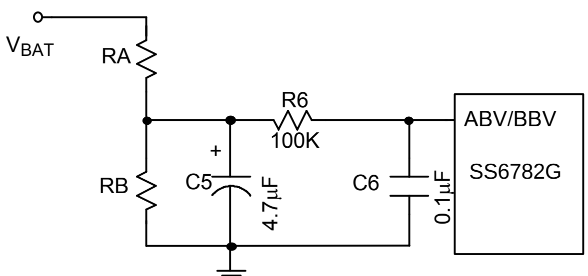


Fig. 14 Battery Voltage Divider

For SEL3 > ((VCC/2) + 0.4V), the suggested divider resistances of RA and RB for the corresponding number of battery cells are as below:

TABLE 1

BATTERY CELLS	RA/RB	RA kΩ	RB kΩ
2~4	2	240	120
3~6	3.3	300	91
4~8	4.9	300	62
5~10	6.4	300	47
6~12	7.8	310	39
8~16	10.8	390	36

For SEL3 < ((V_{CC}/2) -0.4V), the suggested divider resistances of RA and RB for the corresponding number of battery cells are shown below:

TABLE 2

BATTERY CELLS	RA/RB	RA (kΩ)	RB (kΩ)
2	1	240	240
3	2	240	120
4	3	240	80
5	4	300	75
6	5	300	60
8	7	360	51
10	9	360	40
12	11	390	36
16	15	410	27

Battery Temperature Measurement

The SS6782G employs a negative temperature coefficient (NTC) thermistor to measure the battery's temperature. The thermistor is inherently nonlinear with respect to temperature. To reduce the effect of nonlinearity, a resistor-divider network in parallel with the thermistor is recommended. A typical application circuit is shown in Fig. 15.

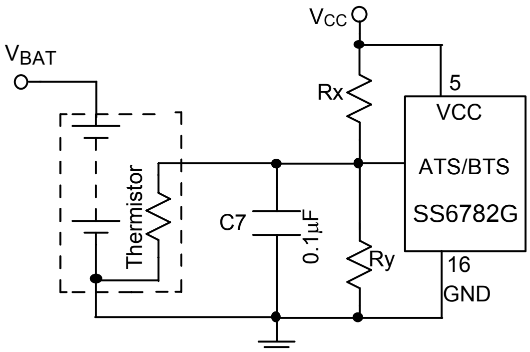


Fig. 15 Battery Temperature Sense Circuit with a Negative Temperature-Coefficient (NTC) Thermistor

The calculation for Rx and Ry in the circuit is as follows:

$$0.29\ Vcc = \frac{Ry//R_{TH}}{Rx + (Ry//R_{TH})} \times Vcc$$

R_{TH}= The resistance of thermistor at upper limit of temperature protection.

$$0.72\ Vcc = \frac{Ry//R_{TH}}{Rx + (Ry//R_{TL})} \times Vcc$$

R_{TL}= The resistance of thermistor at lower limit of temperature protection.

Substitution and rearranging the equations yields

$$Rx = 2.061 \times \frac{R_{TL} \times R_{TH}}{R_{TL} - R_{TH}}$$

$$Ry = \frac{5.3 \times R_{TL} \times R_{TH}}{R_{TL} - 6.3R_{TH}}$$

If the temperature characteristic of the thermistor is like that of the SEMITEC 103AT-2, the resistance of Rx and Ry is tabulated below for different values of TL and TH:

(note: TL is the lower temperature limit and TH is the upper temperature limit.)

TABLE 3 Values of Rx and Ry at TL = 0°C

TH (°C)	Rx(kΩ)	Ry (kΩ)
50	10.1	551.1
51	9.7	300.7
52	9.4	204.8
53	9.0	153.9
54	8.7	122.8
55	8.4	101.8
56	8.1	86.5
57	7.8	75.0
58	7.5	66.0
59	7.2	58.7
60	7.0	52.8
61	6.8	47.8
62	6.5	43.6
63	6.3	39.9
64	6.1	36.8
65	5.9	34.0
66	5.7	31.6
67	5.5	29.5
68	5.3	27.5
69	5.2	25.8
70	5.0	24.3

TABLE 4 Values of Rx and Ry at TL = -10°C

TH (°C)	Rx (kΩ)	Ry (kΩ)
45	11.4	95.6
46	11.0	85.0
47	10.6	76.2
48	10.2	68.9
49	9.8	62.8
50	9.5	57.5
51	9.1	52.9
52	8.8	48.8
53	8.5	45.3
54	8.2	42.1
55	7.9	39.4
56	7.6	36.8
57	7.4	34.6
58	7.1	32.5
59	6.9	30.7
60	6.7	29.0
61	6.4	27.4
62	6.2	26.0
63	6.0	24.6
64	5.8	23.4
65	5.6	22.2

Setting the ADJ Pin Voltage

The slope of $\Delta T / \Delta t$ detection is determined by the ADJ pin voltage of the SS6782G.

The calculation of ADJ pin voltage is shown in the following procedure followed by an example.

Procedure

(a) First, determine the temperature protection limits TH and TL. Then, substitute TH & TL into the following equation:

$$\frac{\Delta V_{TS}}{\Delta T_{BASE}} = \frac{0.72V_{CC} - 0.29V_{CC}}{TH - TL} = \frac{0.43V_{CC}}{TH - TL}$$

(b) Determine the safety timer to obtain the value of Δt_{BASE} .

$$\Delta t_{BASE}(sec.) = \frac{56(sec.)}{80(min.)} \times \text{Safety Timer}(min.)$$

(c) Determine the expected slope of $\Delta T / \Delta t$ at which temperature rises y°C in x seconds and fast charge is subsequently cut off.

$$\frac{\Delta T}{\Delta t} = \frac{y}{x}$$

(d) Calculate the value of V_{ADJ}

$$V_{ADJ} = 25 \times \frac{\Delta V_{TS}}{\Delta T_{BASE}} \times \frac{\Delta T}{\Delta t} \times \Delta t_{BASE}$$

Example

(a) Let TH=50°C, TL=0°C, V_{CC} =5V. We have

$$\frac{\Delta V_{TS}}{\Delta T_{BASE}} = \frac{0.43 \times 5}{50 - 0} = 0.043V/°C$$

which means that V_{TS} decreases 43mV as temperature rises 1°C.

(b) If safety timer is equal to 80 minutes, Δt_{BASE} is then 56 seconds.

(c) If fast charging should be terminated when temperature rises 1°C in 60 seconds, then

$$\Delta T / \Delta t = \frac{1}{60} = 0.0166$$

(d) V_{ADJ} =25 x 0.043 x 0.0166 x 56 = 1(V)

If the temperature range is from 0°C to 50°C, the voltage of V_{ADJ} under different setting conditions should be set as tabulated below.

TABLE 5 ADJ Pin Voltage (TL=0°C, TH=50°C)

S.T. \ ΔT / Δt	0.75 (°C/min.)	1.0 (°C/min.)	1.25 (°C/min.)
40 min. (2C)	0.37	0.5	0.63
80 min. (1C)	0.75	1.0	1.25
120 min. (0.67C)	1.12	1.5	1.87
160 min. (0.5C)	1.5	2.0	2.5
200 min. (0.4C)	1.87	2.5	3.12
240 min. (0.33C)	2.25	3.0	3.75

A similar table for temperature range from 0°C to 60°C is shown below.

TABLE 6 ADJ Pin Voltage (TL=0°C, TH=60°C)

S.T. \ ΔT / Δt	0.75 (°C/min.)	1.0 (°C/min.)	1.25 (°C/min.)
40 min. (2C)	0.31	0.42	0.52
80 min. (1C)	0.62	0.84	1.05
120 min. (0.67C)	0.94	1.25	1.56
160 min. (0.5C)	1.25	1.67	2.08
200 min. (0.4C)	1.56	2.08	2.60
240 min. (0.33C)	1.87	2.5	3.12

Setting the Period of Safety Timer

The SS6782G provides a method for linearly adjusting the period of safety timer with an external resistor connected from TMR pin to GND. The relation between safety timer length and the external resistor (R_{TMR}) is shown in Fig. 16. The table following shows the resistor values.

for some of the commonly chosen safety timer periods. Also shown in the table is their corresponding oscillator frequencies.

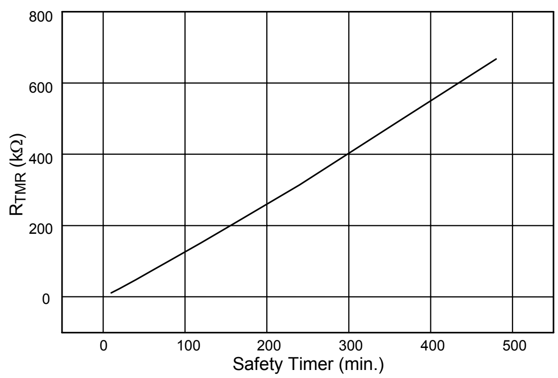


Fig. 16 Safety Timer vs RTMR

TABLE 7

R_{TMR} (kΩ)	Osc.Freq. (kHz)	Safety timer (min.)
11	262.4	10
23	131.2	20
48	65.6	40
74	43.7	60
100	32.8	80
152	21.9	120
206	16.4	160
314	10.9	240
491	7.3	360
667	5.5	480

Selecting Mode of Operation

The SS6782G provides three modes of operation: normal, test, and AC mode, determined by the setting of the MODE pin according to TABLE 8. The SS6782G will operate normally when the MODE pin is left floating (a 0.1μF capacitor is recommended to be tied to the MODE pin if the charging circuit works in a noisy environment). When the MODE pin is biased to GND, the function of –ΔV detection is disabled. When the MODE pin is biased to V_{CC}, the SS6782G enters the test mode. The test mode can be used to significantly reduce production test time. For relevant information, please contact SSC directly.

TABLE 8 The Operating Mode of SS6782G

MODE pin	Mode	Function
V_{CC}	Test	Safety timer period scaled down to 1/32.... etc.
Floating	Normal	Normal operation
GND	AC	-ΔV detection disabled

The LED Display and Trickle Charge Modes

The SS6782G provides two LED display modes and five pulsed trickle charge modes. The modes of LED display and trickle charge are determined by the tri-level inputs, SEL1 and SEL2 pins, as in the TABLE 9.

TABLE 9 Mode of LED Display and Trickle Charge

SEL1	SEL2	Trickle Charge Duty	LED Display Mode
V_{CC}	V_{CC}	N/A	Type 1
	Floating	1/32	Type 1
	GND	1/64	Type 1
Floating	V_{CC}	1/128	Type 1
	Floating	1/256	Type 1
	GND	N/A	Type 2
GND	V_{CC}	1/32	Type 2
	Floating	1/64	Type 2
	GND	1/128	Type 2

Displaying the Battery Charging Status

The SS6782G provides four open-drain outputs, in which LEA1 and LEA2 are used to indicate the battery charging status of pack A, and LEB1 and LEB2 are used to indicate battery charging status of pack B. Refering to the table of LED display modes (TABLE 6), depending on the setting of SEL1 and SEL2 pins, the outputs of LEA1, LEA2, LEB1, and LEB2 pins are shown in the following table:

TYPE 1

	Power On	Wait	Charge	Full	Abnormal
LEA1/ LEB1	1HZ	ON	ON	OFF	OFF
LEA2/ LEB2	OFF	ON	OFF	ON	OFF

TYPE 2

	Power On	Wait	Charge	Full	Abnormal
LEA1/ LEB1	1HZ	1HZ	ON	OFF	4HZ
LEA2/ LEB2	1HZ	1HZ	4HZ	ON	OFF

Charging Current Control

As shown in the typical application circuit, the SS6782G offers two open-drain output pins, ICOA and ICOB pins, to control the charging current of battery pack A and pack B. When fast charging is completed, the SS6782G enters the trickle charge mode. In trickle charge mode, the ICOA or ICOB output pins switch with predetermined duty cycle. Refering to the table of trickle charge mode (TABLE 6), the duty cycle is determined by the setting of SEL1 and SEL2 pins. The following table summarizes how ICOA and ICOB pins correspond to various charging states.

	Power ON	Wait ON	Fast Charging	Charge Completed	Fault Conditions
ICOA/ ICOB	ON	ON	OFF	See pin 14 & 15	ON

Test Mode

Fig. 17 shows the timing diagram for externally controlled ADJ, ABV, BBV, ATS, BTS, SEL1 and SEL2 pin voltages in a recommended SS6782G test scheme, utilizing TEST mode function. Output waveforms of LEA1, LEA2, LEB1, LEB2, ICOA and ICOB from a properly functioning SS6782G are also shown in the figure. For detailed information please consult with SSC staff directly.

TIMING DIAGRAM

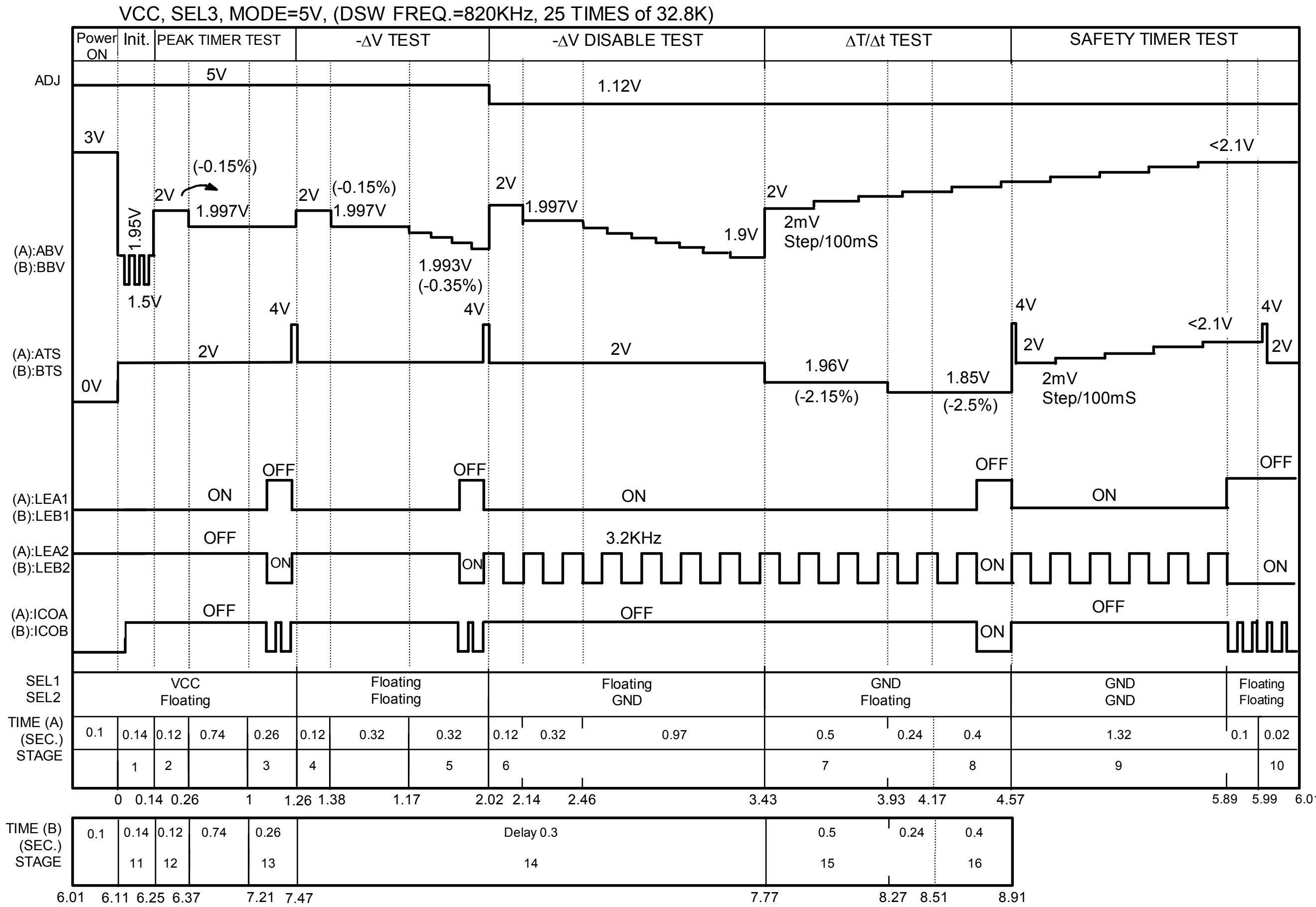
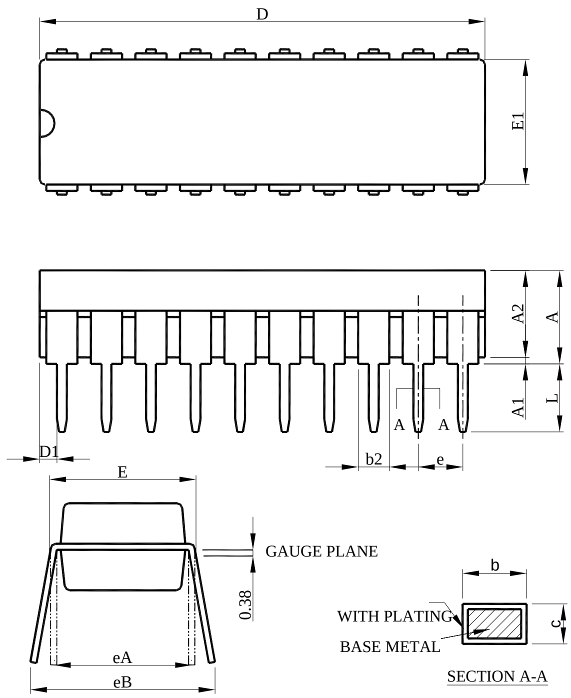


Fig. 17 Timing Diagram of SS6782G in Test Mode

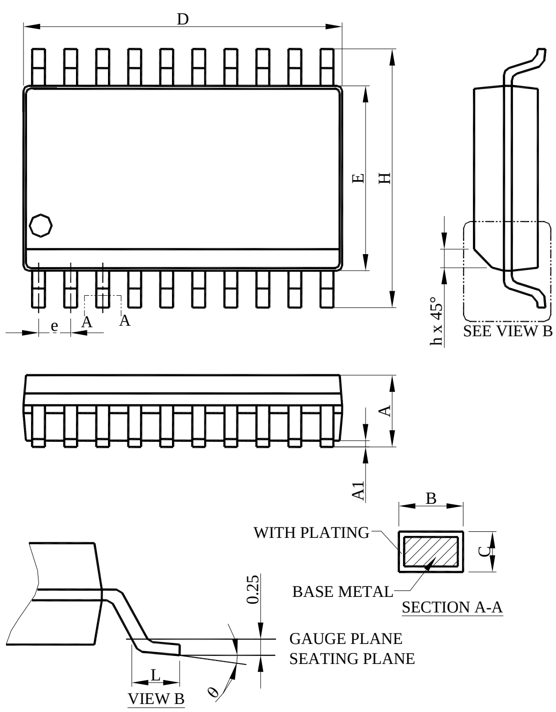
PHYSICAL DIMENSIONS (unit: mm)

DIP-20



SYMBOL	DIP-20	
	MILLIMETERS	
	MIN.	MAX.
A		5.33
A1	0.38	
A2	2.92	4.95
b	0.36	0.56
b2	1.14	1.78
c	0.20	0.35
D	24.89	26.92
D1	0.13	
E	7.62	8.26
E1	6.10	7.11
e	2.54 BSC	
eA	7.62 BSC	
eB		10.92
L	2.92	3.81

SOP-20 (300 mil)



SYMBOL	SOP-20	
	MILLIMETERS	
	MIN.	MAX.
A	2.35	2.65
A1	0.10	0.30
B	0.33	0.51
C	0.23	0.32
D	12.60	13.00
E	7.40	7.60
e	1.27 BSC	
H	10.00	10.65
h	0.25	0.50
L	0.40	1.27
θ	0°	8°