

# Data Sheet

# BIT3713

## High Performance PWM Controller

Preliminary  
Version: 0.00

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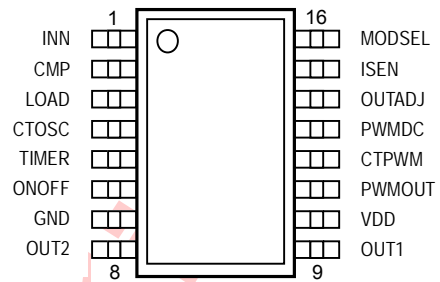
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**Features:**

- Near Zero Stand By Current
- Low Power CMOS Process
- 4.5V ~ 8.0V operation
- Fixed High Frequency, Voltage Mode PWM Control Topology
- Latched Off Protection
- Build-In 2<sup>nd</sup> Low Frequency PWM Generator
- Build-In UVLO
- Totem Pole Output
- 16 Pin Package

**Pin Layout:**



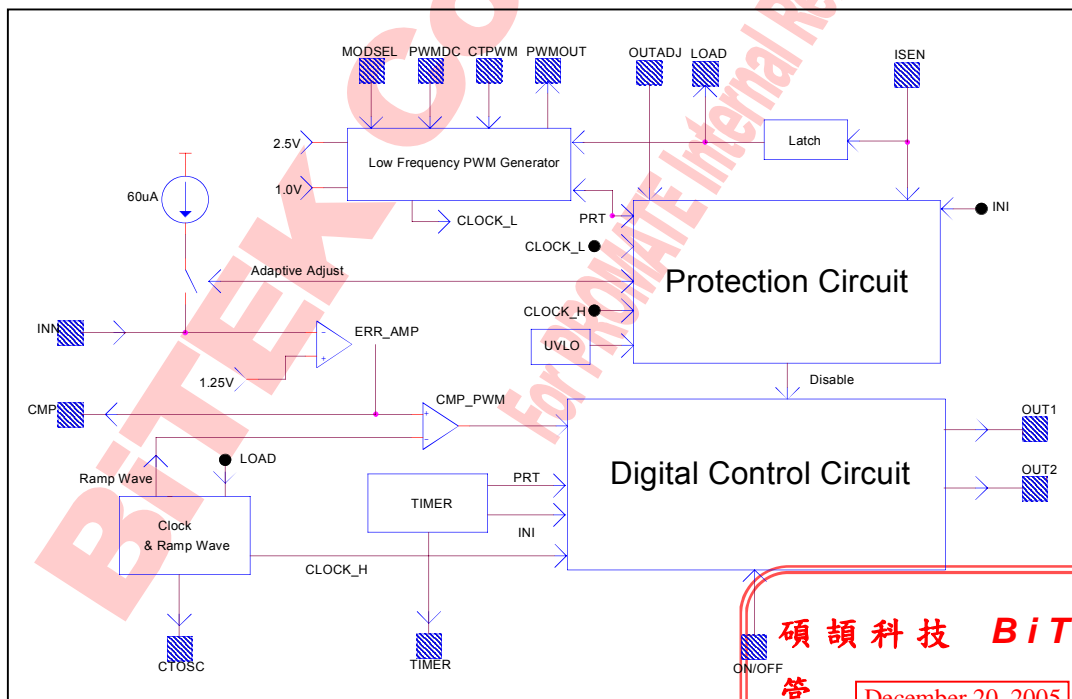
**General Description:**

BIT3713 integrated circuit provides the essential PWM features for DC/DC conversion purpose in a small low cost 16-pin package. Another built-in low frequency PWM generator provides user more flexible applications. BIT3713 provides latched off protection feature may make the system more reliable. CMOS process makes BIT3713 consumes less power while compare to conventional bipolar products.

**Recommended Operating Condition:**

Supply Voltage.....4.5 ~ 8.0V  
 Operating Ambient Temperature.....-20 ~ 85 °C  
 Operating Frequency.....50K ~ 400K Hz

**Functional Block Diagram:**



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**Pin Description:**

Table 1

Pin No.	Symbol	I/O	Descriptions
1	INN	I	The inverting input of the error amplifier.
2	CMP	O	Output of the error amplifier.
3	LOAD	I/O	A switch that connected to the high frequency triangle wave generator. This switch is closed while the voltage level of ISEN pin is lower than 1.3V. Once the ISEN pin has become > 1.3V, the switch keeps open no matter the status of ISEN pin. An external resistor connected here may change the operation frequency of CTOSC during this switch is open.
4	CTOSC	I/O	An external capacitor connected here decides the frequency of high frequency PWM controller.
5	TIMER	I/O	With internal reference current and an external capacitor connected here, it decides the required period of starting and the timing of initialization. The controller is forced to the reset mode while the voltage level of TIMER is lower than 0.3V. During reset mode, the current about 60uA will flow into the INN pin to reduce the output level of the error amplifier CMP to turn off the controller. The protection function will be enabled after this node is charged to exceed 2.5V. The output current of this pin is 20uA when the level of TIMER is lower than 0.3V. The output current becomes 1uA when the level of TIMER is higher than 0.3V
6	ONOFF	I	The control pin of turning on or off the IC. 1V threshold with an internal 80K±15% ohm pull-low resistor.
7	GND	I/O	The ground pin of the device.
8	OUT1	O	The active high output driver.
9	OUT2	O	The active high output driver.
10	VDD	I	The power supply pin of the device.
11	PWMOUT	O	The output pin of the 2 <sup>nd</sup> low frequency PWM generator. A 2.5V or floating two state output is provided through this pin. The internal circuit limits the max. Duty-cycle to about 92%.
12	CTPWM	I/O	With the internal reference current and an external capacitor connected here can set the operation frequency of the 2 <sup>nd</sup> low frequency PWM generator with 1.0V ~ 2.5V triangle wave output.
13	PWMDC	I	The 2 <sup>nd</sup> Low frequency PWM controlling input. A PWM output comes out by comparing this DC input and the 1.0 ~ 2.5V triangle wave that is generated by CTPWM.
14	OUTADJ	I	Output adjustment. If a > 2.0 V voltage is detected. A ~ 60uA current will flow into the INN pin to adjust the output of the error amplifier pin CMP to regulate the output voltage.
15	ISEN	I	Load detection pin, the abnormal load situation is detected if a less than 1.3V voltage is continuously kept for 32 cycles of the 2 <sup>nd</sup> low frequency PWM on this pin.
16	MODSEL	O	To set the output polarity of the 2 <sup>nd</sup> low frequency PWM generator.

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**Functional Description:**

**The Power On Initialization:** BIT3713 is in an "initial state" when TIMER pin voltage is less than 0.3V. An internal current source charges the external capacitor connected on TIMER pin determines the operation timing of BIT3713. This current provides about 20uA when TIMER pin voltage is less than 0.3V, or about 1uA when TIMER pin voltage is large than 0.3V. Table 2 lists the states of each key features during TIMER pin voltage is less than 0.3V.

Table 2 BIT3713 initial states

Pin Number	Pin Name	Status
4	CTOSC	Normally run
8	OUT1	Forced to GND level
9	OUT2	Forced to VDD level
11	PWMOUT	Floating
12	CTPWM	Normally run

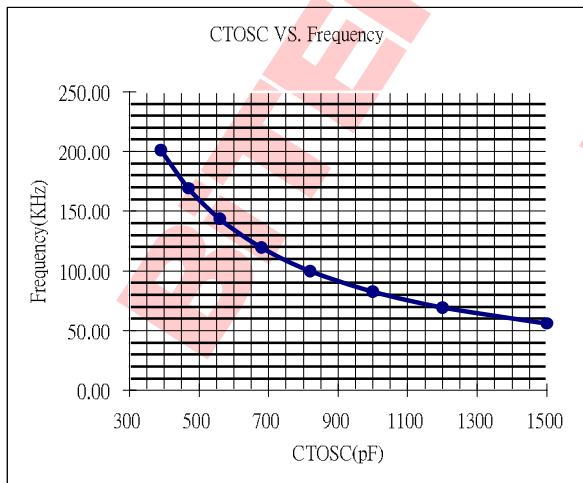
**To Set the Operation Frequency of the 1<sup>st</sup> High**

**Frequency PWM Controller:** An external capacitor C<sub>CTOSC</sub> pin CTOSC determines the frequency as equation (1)

The frequency of the 1<sup>st</sup> high frequency PWM controller is:

$$F_{HFPWM} = \frac{K_{HF}}{C_{CTOSC}}, K_{HF} = 8.2e - 5 \dots\dots\dots(1)$$

Or a 100KHz operation PWM control system if an 820pF capacitor is connected to pin CTOSC. Equation (1) is valid only when VDD=6V, temperature=30°C and frequency ≈ (80K ~ 120K)Hz. Fig. 1 shows the relationship between the frequency of the high frequency PWM and CTOSC capacitance.



**The 1<sup>st</sup> Latched Off Protection:** The ISEN pin may be used for detecting if the operation is controlled stably during normal operation. For most of the applications, to define a "staring period" in which period no power deliver to the load side, are necessary. BIT3713 disable the latched off function when TIMER pin voltage < 2.5V. If "TIMER >2.5V and ISEN < 1.3V" for 32 cycles of the 2<sup>nd</sup> low frequency PWM, BIT3713 will shut down the output pins, OUT1 and OUT2 until the system is powered on again. The detail is as bellow:

During TIMER > 2.5V, the system operates normally when the ISEN > or < than 1.3V. The latched off function performs when ISEN has continuously been kept < 1.3V for 32 cycles of the 2<sup>nd</sup> low frequency PWM.

**The Output Adjustment and 2<sup>nd</sup> Latched Off Protection:**

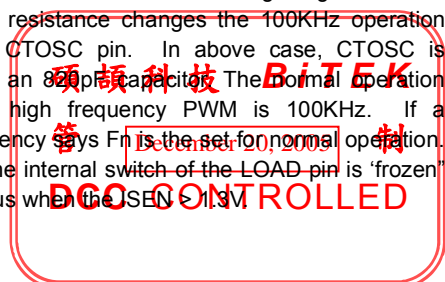
The OUTADJ pin may be used for detecting if the PWM control system operates normally. An about 60uA current source will charge the INN pin to adjust the output of CMP while OUTADJ > 2.0V. The latched off abnormal protection performs while TIMER > 2.5V. If "TIMER > 2.5V and OUTADJ > 2.0V" for 32 cycles of the 1<sup>st</sup> high frequency PWM, BIT3713 will shut down the output pins, OUT1 and OUT2, until the system is powered on again. The detail is as bellow:

During TIMER > 2.5V, the system operates normally when the OUTADJ > or < than 2.0V. The latched off function performs when OUTADJ has continuously been kept > 2.0V for 32 cycles of the 1<sup>st</sup> high frequency PWM.

Or, a pulse signal on OUTADJ pin with > 50KHz which may > 2.0V or < 2.0V. BIT3713 performs latched off function when TIMER > 2.5V and the pulse signal has continuously present on OUTADJ pin for 32 cycles of the 1<sup>st</sup> high frequency PWM.

**To Set The Frequency Deviation of High Frequency PWM During Different Loading Condition:**

A connected between GND and LOAD resistor may increase the operation frequency of CTOSC. An internal switch of the LOAD pin is closed may be used to change the frequency of CTOSC before ISEN had been triggered to larger than 1.3V. In many cases, the resonance frequency of the load is varied while the load is changed. For obtaining the better performance, the operation frequency of the PWM controller must fit to the resonance frequency of the load. The following diagram shows how the load resistance changes the 100KHz operation frequency of CTOSC pin. In above case, CTOSC is connected by an 820pF capacitor. The normal operation frequency of high frequency PWM is 100KHz. If a different frequency says F<sub>n</sub> is the set for normal operation. In BIT3713, the internal switch of the LOAD pin is "frozen" to "open" status when the ISEN > 1.3V.



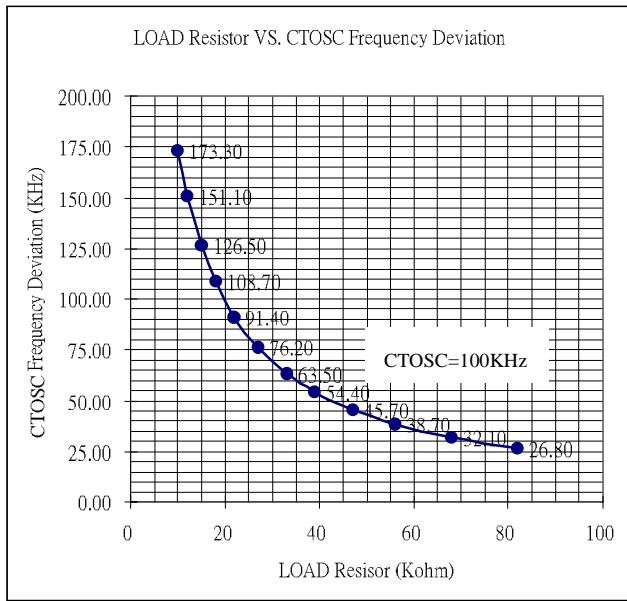


Fig.2

Then the frequency deviation can be calculated as Equation (2)

$$\Delta F_n = \frac{\Delta F_{100\text{KHz}} \times F_n}{100\text{KHz}} \dots\dots\dots(2)$$

**Setting the Frequency of the 2<sup>nd</sup> Low Frequency PWM Generator:**

A 2<sup>nd</sup> internal trimmed low frequency oscillator generates a ± 3% accurate frequency on CTPWM pin with external capacitors. The capacitor values versus operation frequencies are as below:

$$F_{LFPWM} = \frac{4512}{[C_{CTPWM} + 0.005]nF} \dots\dots\dots(3)$$

Note: Above equation (3) is valid only when operating frequency is between 150Hz ~ 1.5KHz

The logic high output of pin PWMOUT is made by a 2.5V DC voltage and the floating state makes the logic low portion. MODSEL pin provides the polarity selection of LF\_PWM generator. If MODSEL pin is 0V, a 0% duty cycle is obtained when PWMDC < 1.0V. If this pin is pulled to IC VDD level, 0% duty cycle is obtained while PWMDC > 2.5V.

Note: BIT3713 limits the maximum duty cycle to about 92%. PWMOUT sends the pulses when ISEN > 1.3V or TIMER > 2.5V.

**UVLO:** The under-voltage-lockout circuit turns the output driver off when supply voltage drops too low. Whole system includes the protection and timing circuits are reset (pin TIMER =0) in low VDD state.

**DC/AC Characteristics:**

**Absolute Ratings:**

Table 3

Parameter	Symbol	Ratings	Unit	Remarks
Supply Voltage	VDD	-0.3~+ 8.8	V	Ta=25°C
Ground	GND	±0.3	V	
Input pin Voltage		-0.3~ VDD+0.3	V	
Operating Ambient Temperature	Ta	-20 ~ +85	°C	
Operating Junction Temperature		+150	°C	
Storage Temperature		-55~+150	°C	

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## DC/AC Characteristics

Table 4

Parameter	Test Conditions	Min.	Typ.	Max.	Unit
<b>Supply Voltages</b>					
Pin VDD input		4.0		8.0	V
Chip Consumed Current	8V Supply Voltage Ta=25°C		4		mA
<b>Error Amplifier Reference Voltage</b>					
Non-inverting input of the error amplifier	Measure INN	1.2125	1.25	1.2875	V
Line regulation	VDD=4.0~8.0 V		2	20	mV
<b>Under Voltage Look Out</b>					
Positive Going Threshold	Ta=25°C	3.8	4.0	4.2	V
Hysteresis	Note3	0.1	0.2	0.3	V
<b>The 1<sup>st</sup> High Frequency Ramp Wave Generator</b>					
Operating Frequency		50		400	KHz
Output peak(CTOSC)	Note1		2.25		V
Output valley(CTOSC)			0.5		V
<b>Error Amplifier</b>					
Input voltage		0.1		3	V
Open loop gain	Note2	60	80		dB
Unit gain band width		1	1.5		MHz
<b>Power On Initialization and Latched Off Protection Enable</b>					
Pin TIMER Output current Case1. TIMER <0.3V			20		uA
Pin TIMER Output current Case1. TIMER > 0.3V	VDD=6V, Ta=25°C		1		uA
Power On Reset/Initialization threshold on pin TIMER	Note 3		0.3		V
Latched Off Protection enable threshold on pin TIMER			2.5		V
<b>Load Detection</b>					
Pin ISEN detection lower threshold	VDD=6V, Ta=25°C		1.3		V
Hysteresis			20		mV
<b>Output Detection and Adaptive Adjusting</b>					
Pin OUTADJ detection lower threshold	VDD=6V, Ta=25°C		2.0		V
Hysteresis			20		mV
INN pin pull-up current source			60		uA
<b>The 2<sup>nd</sup> Low Frequency PWM Generator</b>					
Ramp Wave Peak(CTPWM)			2.5		V
Ramp Wave Valley(CTPWM)			1.0		V
PWM Frequency		10		100K	Hz
Control voltage of 0 % Duty cycle on pin PWMDC Case 1. MODSEL = 0V			1.0		V
Control voltage of 0 % Duty cycle on pin PWMDC Case 1. MODSEL = ICVDD	VDD=6V, Ta=25°C		2.5		V
Output voltage of Pin PWMOUT for making the logic "high".			2.5		V
Pin PWMOUT output for making the logic "low"			Floating		
Maximum Duty Cycle			92		%
<b>Output of the 1<sup>st</sup> PWM (OUT1, OUT2)</b>					
CMOS output impedance	(Note2, Note3)		50		ohm
Rising Time	VDD=6V,		110		nS
Falling Time	2000pF(Note2, Note3)		100		nS
Delay Time			600		nS



- Note 1. The output driver frequency is the half of the ramp wave frequency.
- Note 2. Only verified by simulation. Not 100% tested.
- Note 3. The voltages of the output drivers are pulled to GND in each off states.

**Timing Diagram**

The timing of the 2<sup>nd</sup> low frequency PWM generator, ISEN and LOAD pin are as bellow: A 51Kohm pulled-low resistor is connected on PWMOUT pin in this example.

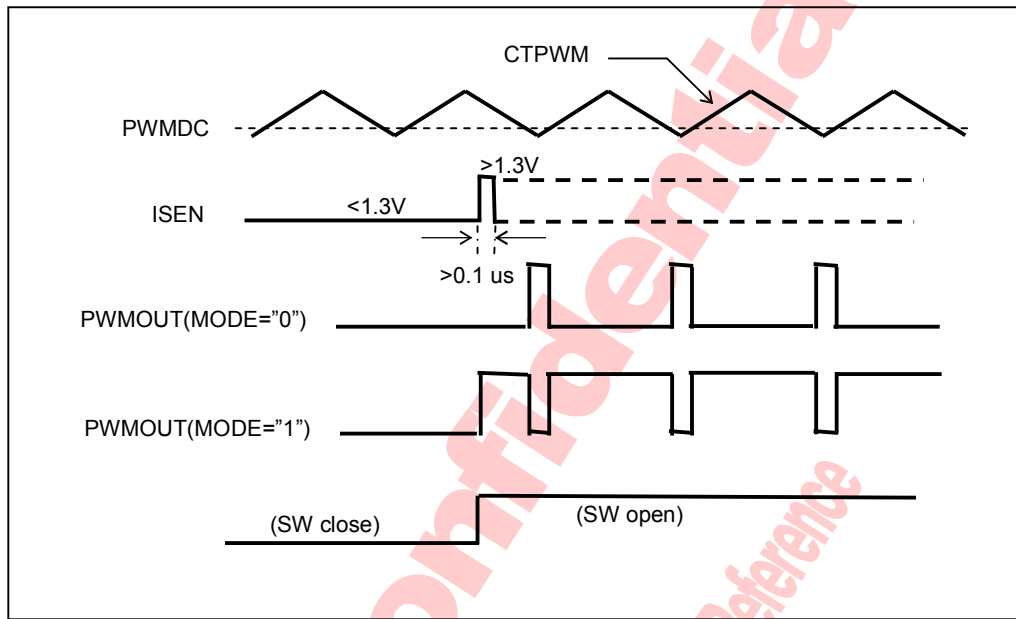


Fig. 3

BIT3713 uses fixed frequency driving methodology. The power switch is driven by fixed frequency PWM controlled signal. The detail timing relationship is shown as below: The maximum duty cycle of OUT1 and OUT2 are smaller than 50% with 180° phase difference.

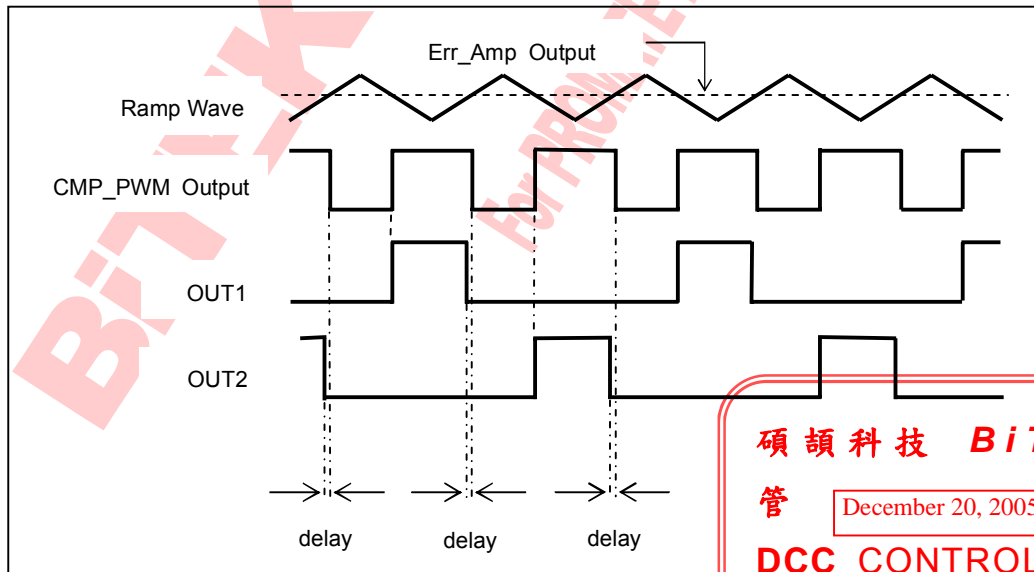


Fig. 4

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**Order Information:****BIT3713-SO****SO:** SOP    **SS:** SSOP

Part number

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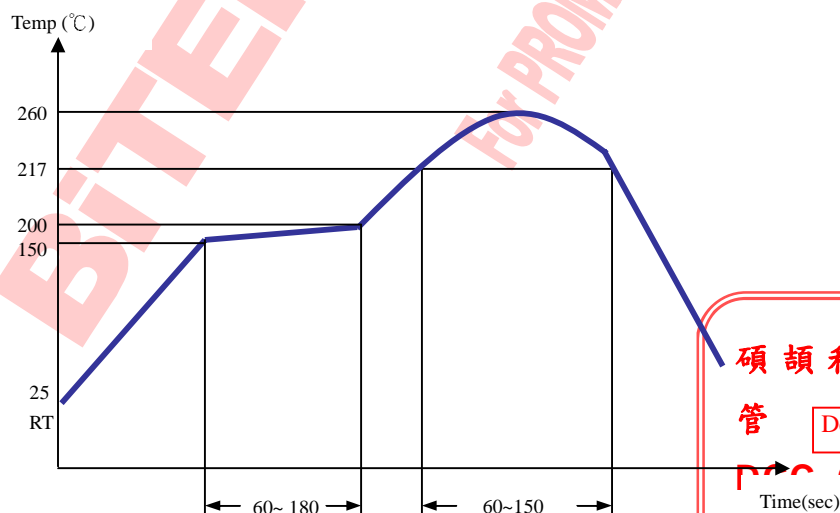
**Soldering Information****Reflow Soldering:**

The choice of heating method may be influenced by plastic QFP package). If infrared or vapor phase heating is used and the package is not absolutely dry (less than 0.1% moisture content by weight), vaporization of the small amount of moisture in them can cause cracking of the plastic body. Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stenciling or pressure-syringe dispensing before package placement. Several methods exist for reflowing; for example, convection or convection/infrared heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 270 °C depending on solder paste material. The top-surface temperature of the packages should preferably be kept below 245 °C for thick/large packages (packages with a thickness  $\geq 2.5$  mm or with a volume  $\geq 350$  mm<sup>3</sup> so called thick/large packages). The top-surface temperature of the packages should preferably be kept below 260 °C for thin/small packages (packages with a thickness < 2.5 mm and a volume < 350 mm<sup>3</sup> so called thin/small packages).

Stage	Condition	Duration
1'st Ram Up Rate	max3.0+/-2°C/sec	-
Preheat	150°C~200°C	60~180 sec
2'nd Ram Up	max3.0+/-2°C/sec	-
Solder Joint	217°C above	60~150 sec
Peak Temp	260 +0/-5°C	20~40 sec
Ram Down rate	6°C/sec max	-



**Wave Soldering:**

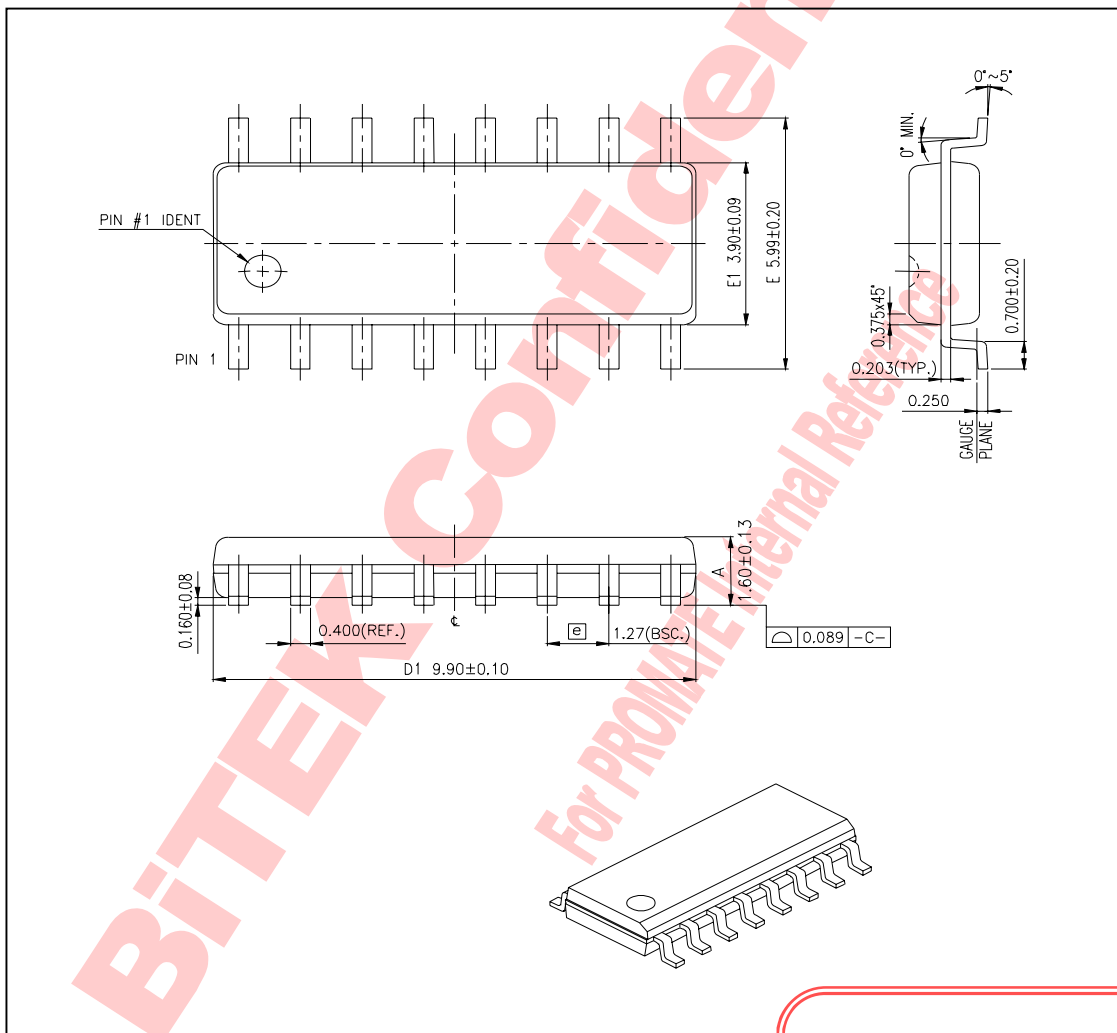
Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

**Manual Soldering:**

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

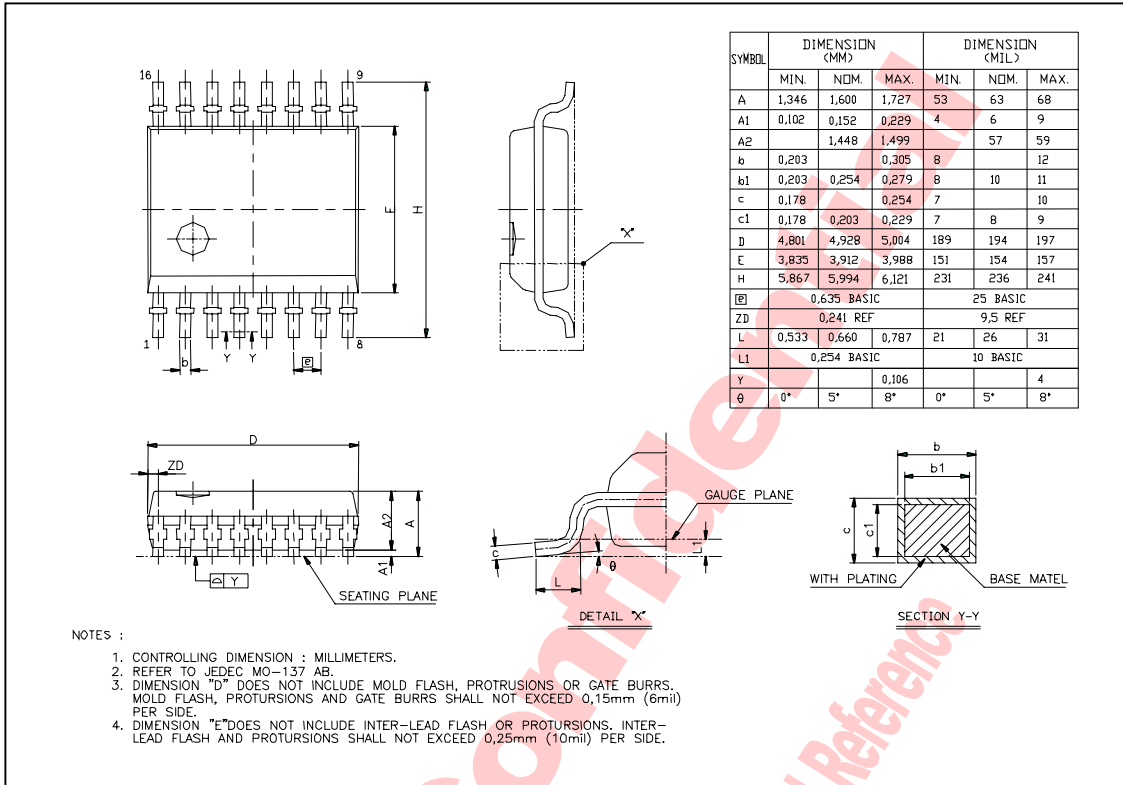
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SOP type :



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