Advanced Dual PWM and Dual Linear Power Controller

Features

- Provides 4 Regulated Voltages
  - Microprocessor Core , I/O , Clock Chip and GTL Bus
- Simple Single-Loop Control Design
  - Voltage-Mode PWM Control
- Fast Transient Response
  - High-Bandwidth Error Amplifier
  - Full 0% to 100% Duty Ratio
- Excellent Output Voltage Regulation
  - Core PWM Output : ±1% Over Temperature
  - I/O PWM Output : ±2% Over Temperature
  - Other Output : ±2.5% Over Temperature
- Power-Good Output Voltage Monitor
- Microprocessor Core Voltage Protection Against Shorted MOSFET
- Over-Voltage and Over-Current Fault Monitors
- Small Converter Size
  - Constant Frequency Operation
  - 200kHz Free-Running Oscillator ;

  Programmagle from 50kHz to 800kHz

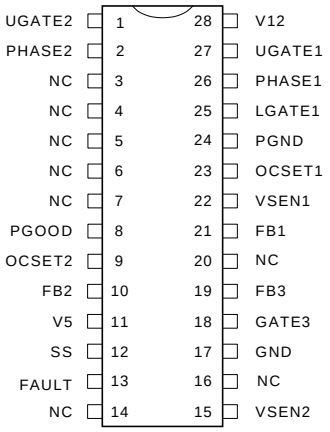
Applications

- Motherboard Power Regulation for Computers
- Low-Voltage Distributed Power Supplies
- VGA Card Power Regulation
- Termination Voltage

General Description

The APW3007 provides the power control and protection for four output voltage in high-performance microprocessor and computer applications.
The APW3007 is designed to provide termination voltage VTT(1.25V) with ±1% accuracy.
It integrates two PWM controllers , a linear regulator and a liear controller as well as the monitoring and protection function into a single package. One PWM controller regulates the microprocessor core voltage with a synchronous-rectified buck converter , while the second PWM controller supplies the I/O 3.3V power with a standard buck converter. The linear controller regulates power for GTL bus and the intermal 200mA regulator for clock driver circuits.
The APW3007 can provide in excess of 14A of output current for an on-board DC/DC converter via internal reference voltage. It can monitor all the output voltage , and a single Power Good signal is issued when the core is within 10% of the internal reference voltage and the other levels are above their undervoltage levels. Additional built-in over-voltage protection for the core output uses the lower MOSFET to prevent output voltage above 115% of the reference voltage. The PWM controller's over-current function monitor the output current by sensing the voltage drop across the upper MOSFET's $R_{DS(ON)}$, eliminating the need for a current sensing resistor.

Pin Description



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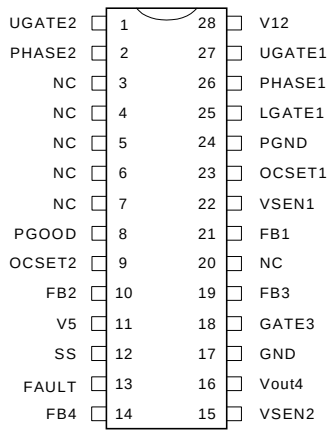
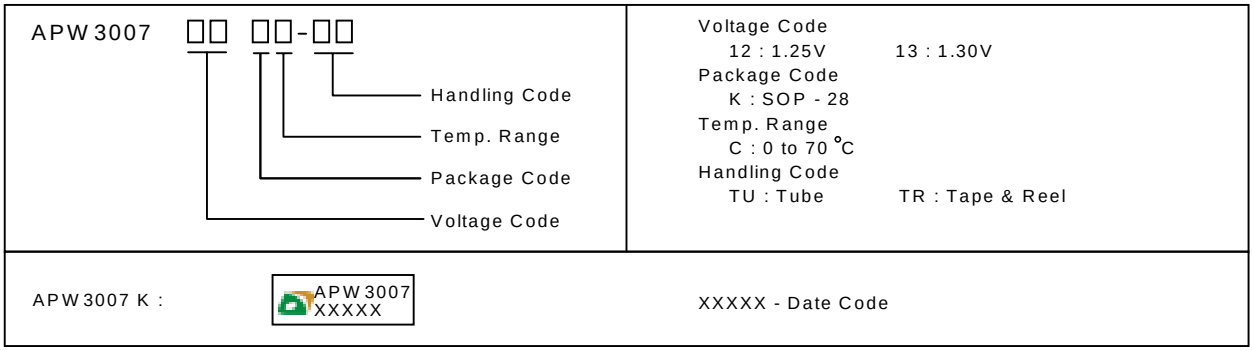


APW3007-13

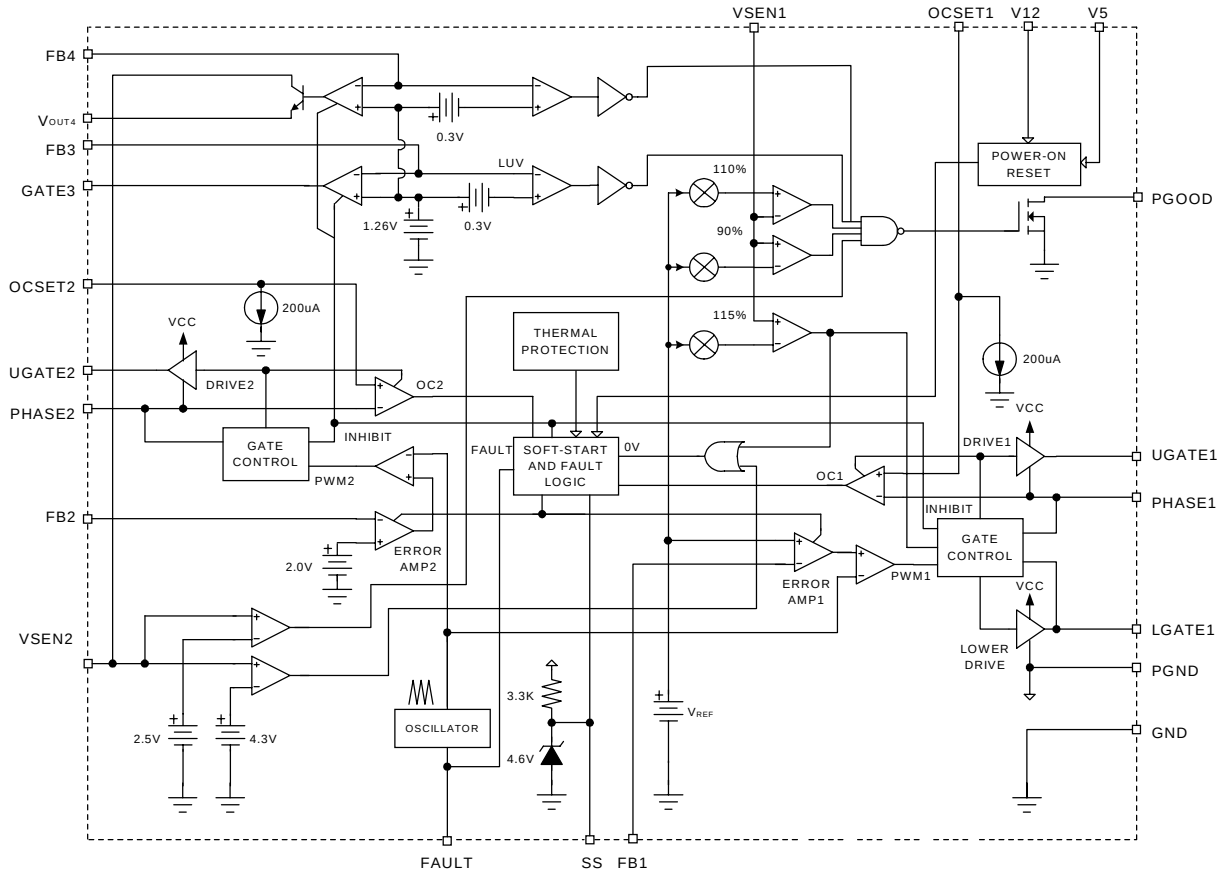
Ordering and Marking Information



Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V12	Supply Voltage	15	V
V_I , V_O	Input , Output or I/O Voltage	GND -0.3 V to V12 +0.3	V
T_A	Operating Ambient Temperature Range	0 to 70	℃
T_J	Junction Temperature Range	0 to 125	℃
T_{STG}	Storage Temperature Range	-65 to +150	℃
T_S	Soldering Temperature	300 ,10 seconds	℃

Block Diagram



Thermal Characteristics

Symbol	Parameter	Value	Unit
$R_{\theta JA}$	Thermal Resistance in Free Air SOIC SOIC (with 3in^2 of Copper)	 75 65	°C/W

Electrical Characteristics

(Recommended operating conditions , Unless otherwise noted) Refer to Block and Simplified Power System Diagrams , and Typical Application Schematic.

Symbol	Parameter	Test Conditions	APW3007			Unit
			Min	Typ	Max	
Supply UVLO Section						
	UVLO Threshold-12V	Supply ramping up		9.5		V
	UVLO Hysterises-12V			0.5		V
	UVLO Threshold-5V	Supply ramping up		4.3		V
	UVLO Hysterises-5V			0.3		V
Supply Current						
I_{12}	Nominal Supply Current	V12		6		mA
I_5		V5		2		
Oscillator						
F_{OCS}	Free Running Frequency	RT= Open	185	200	215	kHz
ΔV_{OSC}	Ramp Amplitude	RT= Open		1.9		V_{P-P}
Switching Controller Reference Voltage						
V_{REF}	Reference Voltage APW3007-12			1.25		V
	APW3007-13			1.30		
	Reference Voltage accuracy		–1.0		+1.0	%
	VFB2 Output Voltage			2		V
	VFB2 Voltage Accuracy		-2		+2	%
2.5V Regulator (Vout4)						
Vo4	Reference Voltage	T_A=25 , Vout4=FB4		1.26		V
	Dropout Voltage	Io=200mA		0.6		V
	Load Regulation	1mA<Io<200mA		0.5		%
	Line Regulation	3.1V<VIO<4V , Vo=2.5V		0.2		%
	Input bias Current				2	µA
	Output Current		200			mA
	Current Limit		300	420		mA
	Thermal Shutdown			150		°C
1.5V Regulator (Vout3)						
Vo3	Reference Voltage	T_A=25 , GATE=FB3		1.26		V
	Reference Voltage Accaracy		-2.5		+2.5	%
	Input bias current				2	µA
	Output Drive Current		50			mA

Electrical Characteristics Cont.

Symbol	Parameter	Test Conditions	APW3007			Unit
			Min	Typ	Max	
Synchronous PWM Controller Error Amplifier						
	DC Gain			88		dB
GBWP	Gain-Bandwidth Product			15		MHz
SR	Slew Rate	COMP1 = 10pF		6		V/µS
PWM Controller Gate Drive						
I_{UGATE}	UGATE Source	V12 = 12V , V_{UGATE} = 6V		1		A
R_{UGATE}	UGATE Sink	$V_{UGATE-PHASE}$ =1V			3.5	Ω
I_{LGATE}	LGATE Source	V12 = 12V , V_{LGATE} = 1V		1		A
R_{LGATE}	LGATE Sink	V_{LGATE} = 1V			3	Ω
Protection						
	VSEN1 O.V. Upper trip point	VSEN1 ramping up		117		%
	VSEN1 O.V. lower trip point	VSEN1 ramping down		115		%
I_{OVP}	FAULT Souring Current	$V_{FAULT/RT}$=2.0V		8.5		mA
I_{OCSET}	OCSET Current Source	V_{OCSET}=4.5V_{DC}	170	200	230	µA
R_{SS}	Pull up resistor to 5V	OCSET=0V , Phase=5V		23		KΩ
Power Good						
	VSEN1 Upper Threshold	VSEN1 Rising		110		%
	VSEN1 Under Voltage	VSEN1 Rising		94		%
	VSEN1 Hysteresis	Upper /Lower Threshold		2		%
$V_{PGOOD-L}$	PGOOD Voltage Low	RL = 3mA		0.4		V
$V_{PGOOD-H}$	PGOOD Voltage High	RL = 5kΩ Pull up to 5V		4.8		V

Functional Pin Description

UGATE2 (Pin1)

Connect this pin to the gate of an external MOSFET. This pin provides the drive for the regulator's pass transistor .

PHASE1 , PHASE2 (Pin26 and 2)

Connect the PHASE pins to the respective PWM converter's upper MOSFET source. These pins are used to monitor the voltage drop across the upper MOSFETs for over-current protection .

NC (Pin 3,4,5,6,7,20)

No connection.

PGOOD (Pin8)

PGOOD is an open collector output used to indicate the status of the output voltages. This pin is pulled low when the synchronous regulator output is not within ±10% of the DACOUT reference voltage or when any of the other outputs are below their under-voltage thresholds .

OCSET1 , OCSET2 (Pin23 and Pin9)

Connect a resistor (R_{OCSET}) from this pin to the drain of the respective upper MOSFET. R_{OCSET} , an internal 200μA current source (I_{OCSET}) , and the upper MOSFET's on-resistance ($r_{DS(ON)}$) set the converter over-current (OC) trip point according to the following equation :

$$I_{PEAK} = \frac{I_{OCSET} \times R_{OCSET}}{r_{DS(ON)}}$$

FB2 (Pin10)

This pin provides the feedback for the non-synchronous switching regulator. A resistor driver is connected from this pin to vout2 and GND that sets the output voltage. The value of the resistor connected from Vout2 to FB2 must be less than 100Ω .

V5 (Pin11)

5V supply voltage. A high frequency capacitor (0.1 to 1uF) must be placed close to this pin and connected from this pin to the GND plane for noise free operation.

SS (Pin12)

This pin provides the soft start for the 2 switching regulators. An internal resistor charges an external capacitor that is connected from 5V supply to this pin which ramps up the outputs of the switching regulators , preventing the outputs from overshooting as well as limiting the input current. The second function of the Soft Start cap is to provides long off time for the synchronoud MOSFET during current limiting .

FAULT (Pin13)

This pin has dual function. It acts as an output of the OVP cicuitry or it can be used to program the frequency using an extermal resistor. When used as a fault detector , if any of the switcher outputs exceed the OVP trip point , the FAULT pin switches to 12V and the soft start cap is discharged. If the FAULT pin is to be connected to any external circuity , it needs to be buffered as shown in the application circuit .

FB4 (Pin14)
APW3007-12 : NC

This pin provides the feedback for the internal LDO regular that its ourpur is Vout4.

VSEN2 (Pin15)

This pin is connected to the output of the I/O switching regulator. It is an input that provides sensing for the Under/Over voltage circuitry for the I/O supply as well as the power for the internal LDO regulator .

VOUT4 (Pin16)
APW3007-12 : NC

This pin is the output of the internal LDO regulator.

Functional Pin Description (Cont.)

GND (Pin 17)

Signal ground for the IC. All voltage levels are measured with respect to this pin.

GATE3 (Pin 18)

Connect this pin to the gate of an external MOSFET. This pin provides the drive for the 1.5V regulator's pass transistor.

FB3 (Pin 19)

Connect this pin to the output of the 1.5V linear regulator. This pin is monitored for under-voltage events.

FB1 (Pin21)

This pin provides the feedback for the synchronous switching regulator . Typically this pin can be connected directly to the output of the switching regulator . However , a resistor driver is recommended to be connected from this pin to vout1 and GND to adjust the output voltage for any drop in the output voltage that is caused by the trace resistance . The value of the resistor connected from Vou1 to FB1 must be less than 100Ω .

VSEN1 (Pin 22).

This pin is connected to the PWM converter's output voltage . The PGOOD and OVP comparator circuits use this signal to report output voltage status and for over-voltage protection .

PGND (Pin 24)

This is the power ground connection . Tie the synchronous PWM converter's lower MOSFET source to this pin .

LGATE (Pin 25)

Connect LGATE to the PWM converter's lower MOSFET gate . This pin provides the gate drive for the lower MOSFET .

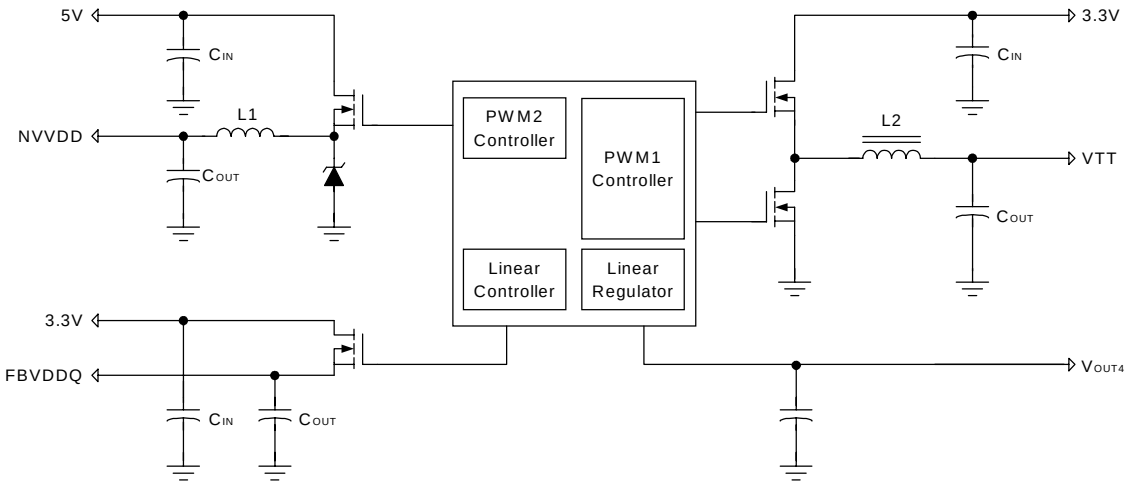
UGATE (Pin 27)

Connect UGATE pin to the PWM converter's upper MOSFET gate . This pin provides the gate drive for the upper MOSFET .

V12 (Pin28)

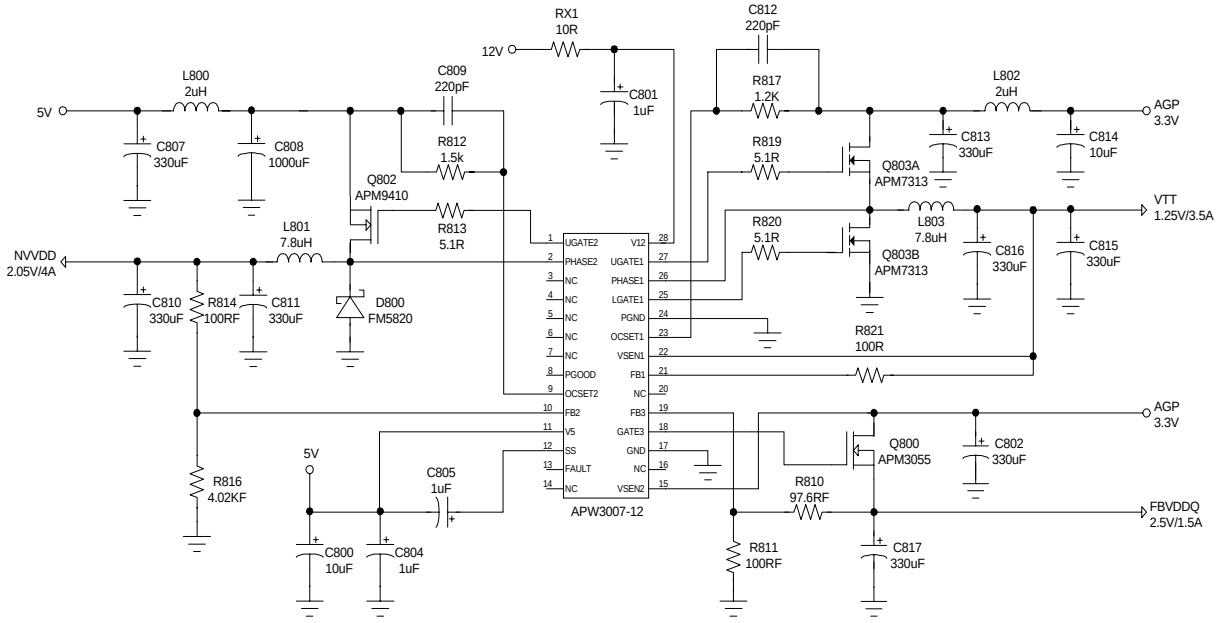
Provide a 12V bias supply for the IC to this pin . This pin also provides the gate bias charge for all the MOSFETs controlled by the IC . The voltage at this pin is monitored for Power-On Reset purposes .

Simplified Power System Diagram



Typical Application Circuit

APW3007-12



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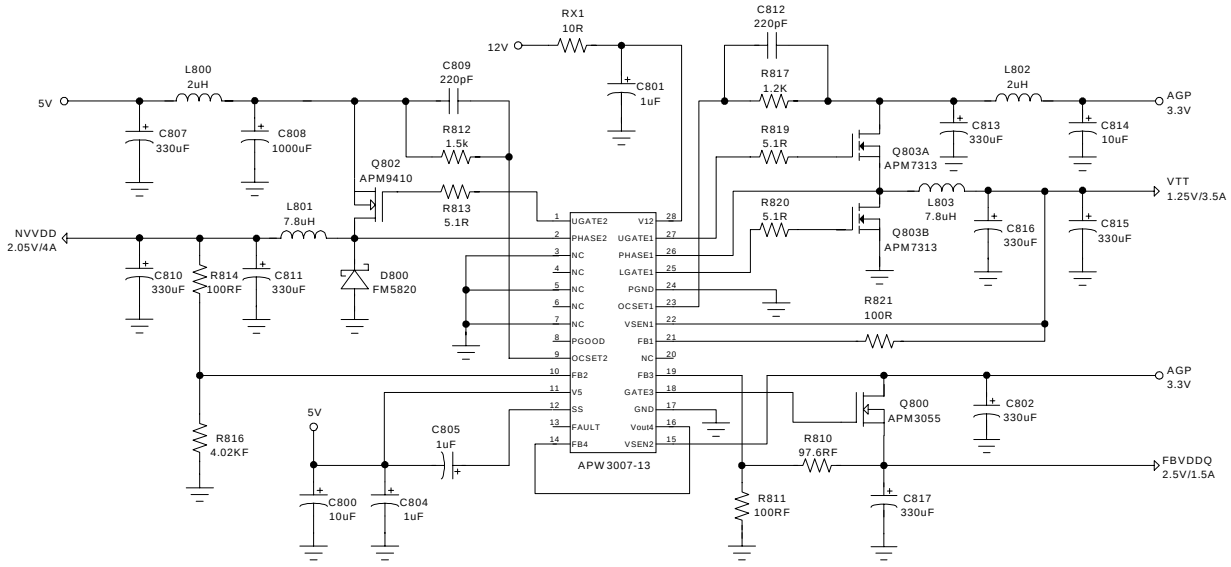
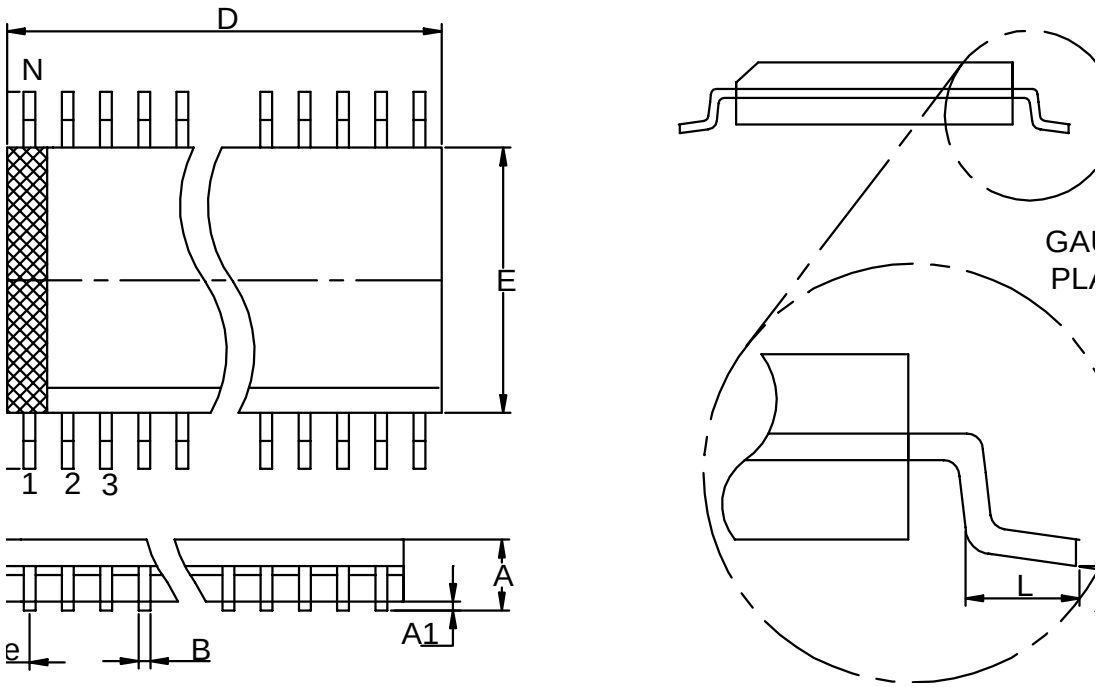


Package Information

SO – 300mil (Reference JEDEC Registration MS-013)



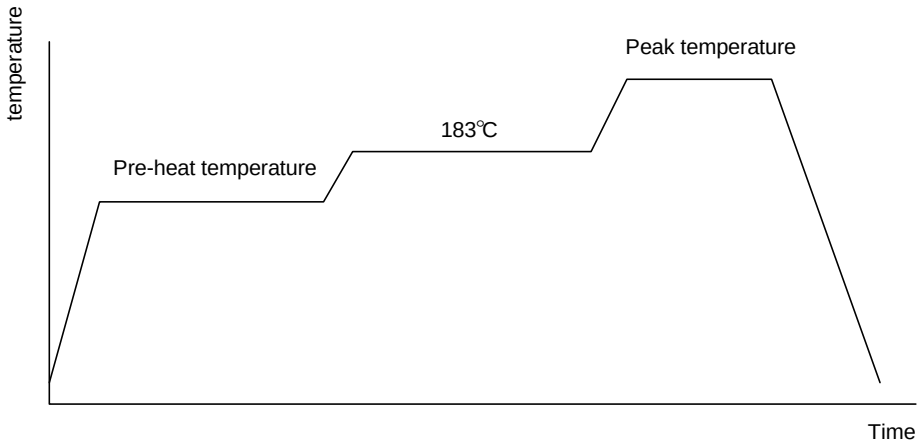
Dim	Millimeters		Variations- D			Dim	Inches		Variations- D		
	Min.	Max.	Variations	Min.	Max.		Min.	Max.	Variations	Min.	Max.
A	2.35	2.65	SO-16	10.10	10.50	A	0.093	0.1043	SO-16	0.398	0.413
A1	0.10	0.30	SO-18	11.35	11.76	A1	0.004	0.0120	SO-18	0.447	0.463
B	0.33	0.51	SO-20	12.60	13	B	0.013	0.020	SO-20	0.496	0.512
D	See variations		SO-24	15.20	15.60	D	See variations		SO-24	0.599	0.614
E	7.40	7.60	SO-28	17.70	18.11	E	0.2914	0.2992	SO-28	0.697	0.713
e	1.27BSC		SO-14	8.80	9.20	e	0.050BSC		SO-14	0.347	0.362
H	10	10.65				H	0.394	0.419			
L	0.40	1.27				L	0.016	0.050			
N	See variations					N	See variations				
ϕ 1	0°	8°				ϕ 1	0°	8°			

Physical Specifications

Terminal Material	Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb)
Lead Solderability	Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3.
Packaging	1000 devices per reel

Refolw Condition (IR/ Convection or VPR Reflow)

Reference JEDEC Standard J-STD-020A APRIL 1999



Classification Reflow Profiles

	Convection or IR/ Convection	VPR
Average ramp-up rate(183°C to Peak)	3°C/second max.	10 °C /second max.
Preheat temperature 125 ± 25°C)	120 seconds max.	
Temperature maintained above 183°C	60 ~ 150 seconds	
Time within 5°C of actual peak temperature	10 ~ 20 seconds	60 seconds
Peak temperature range	220 +5/-0°C or 235 +5/-0°C	215~ 219°C or 235 +5/-0°C
Ramp-down rate	6 °C /second max.	10 °C /second max.
Time 25°C to peak temperature	6 minutes max.	

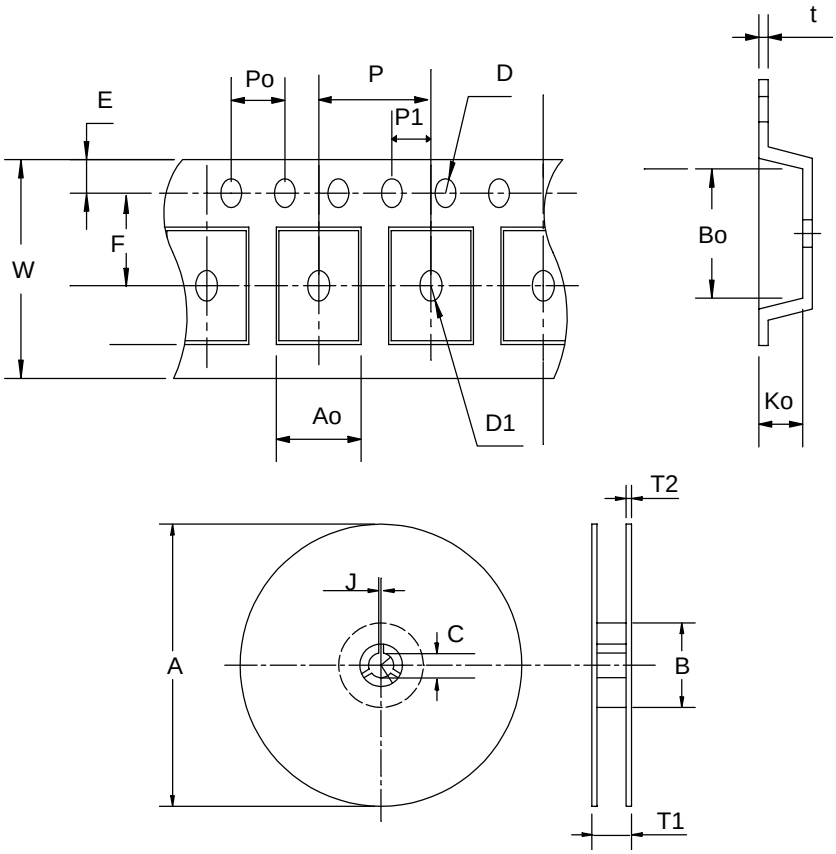
Package Reflow Conditions

pkg. thickness ≥ 2.5mm and all bags	**pkg. thickness < 2.5mm and pkg. volume ≥ 350 mm³**	**pkg. thickness < 2.5mm and pkg. volume < 350mm³**
Convection 220 +5/-0 °C		Convection 235 +5/-0 °C
VPR 215-219 °C		VPR 235 +5/-0 °C
IR/Convection 220 +5/-0 °C		IR/Convection 235 +5/-0 °C

Reliability test program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C , 5 SEC
HOLT	MIL-STD-883D-1005.7	1000 Hrs Bias @ 125 °C
PCT	JESD-22-B, A102	168 Hrs, 100 % RH , 121°C
TST	MIL-STD-883D-1011.9	-65°C ~ 150°C, 200 Cycles
ESD	MIL-STD-883D-3015.7	VHBM > 2KV, VMM > 200V
Latch-Up	JESD 78	10ms , I_{tr} > 100mA

Tape & Reel Dimensions



Application	A	B	C	J	T1	T2	W	P	E
SOP- 28	330±1	62 ±1.5	12.75 ± 0.5	2 ± 0.6	24.4 ± 0.2	2± 0.2	24 ± 0.3	12 ± 0.1	1.75± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	11.5 ± 0.1	1.5 +0.1	1.5+ 0.25	4.0 ± 0.1	2.0 ± 0.1	10.85 ± 0.1	18.34± 0.1	2.97± 0.1	0.35±0.01

Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP- 28	24	21.3	1000

Customer Service

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