WD1305E20

18V, 2A, High-Efficiency, Synchronous Step-Down Converter

Http//:www.sh-willsemi.com

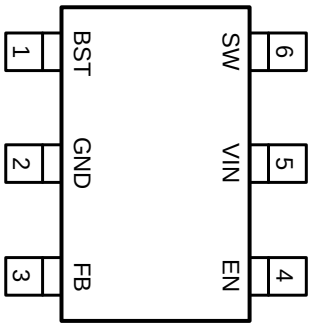
Descriptions

The WD1305E20 is a high efficiency, 500kHz switch frequency, synchronous step-down DC-DC converter with delivering 2A current capability. The WD1305E20 operates over a wide input voltage range from 4.5V to 18V and integrates main switch and synchronous switch with very low $R_{DS(ON)}$ to minimize the conduction loss.

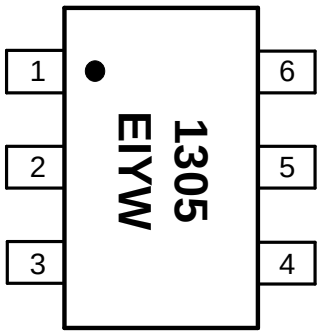
The WD1305E20 applies Constant-on-time (COT) control mode which provides very fast load transient response and easy loop design. The WD1305E20 integrates full protections features including short-circuit protection, over-current protection, under voltage protection and thermal shutdown to make the part operating safely.

The WD1305E20 is available in SOT-23-6L package. Standard product is Pb-free and Halogen-free.

SOT-23-6L



Pin configuration (Top view)



1305 = Device Code
EI = Special code
Y = Year code
W = Week code

Marking

Features

- Wide input voltage range of 4.5V to 18V
- Integrate 140mΩ (High Side) / 110mΩ (Low Side) Low $R_{DS(ON)}$ Power MOSFETs
- 70μA Low Quiescent Current
- High-efficiency synchronous-mode Operation
- Power save mode at light load
- Fast load transient response with COT control mode
- Over-current protection and Hiccup
- Output adjustable from 0.6V

Applications

- Set Top Box
- Access Point Router
- DSL Modem、Security Cameras
- Flat-Panel Televisions and Monitors

Order information

Device	Package	Shipping
WD1305E20-6/TR	SOT-23-6L	3000/Reel&Tape

Typical Applications

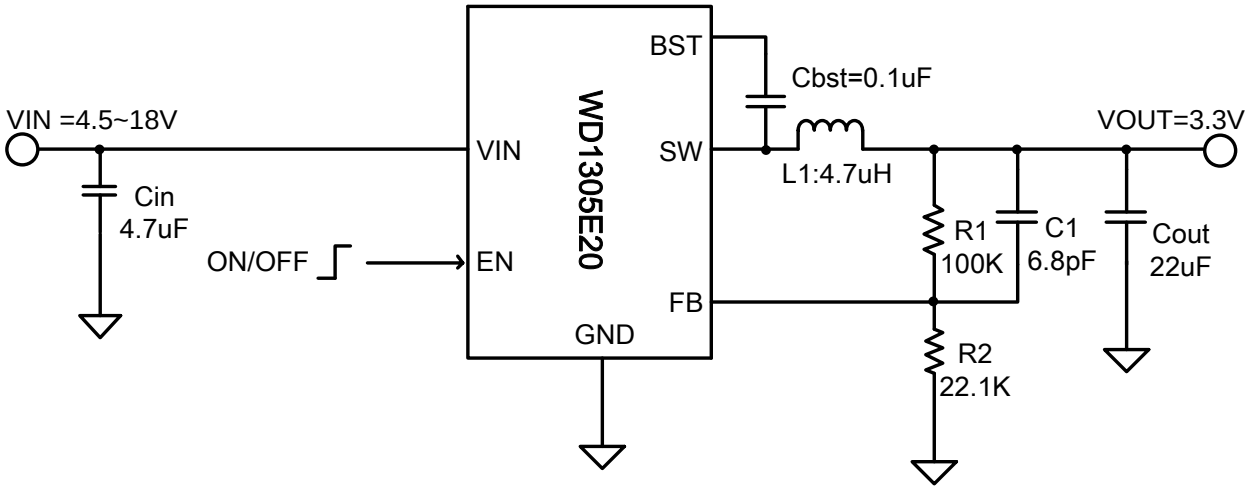
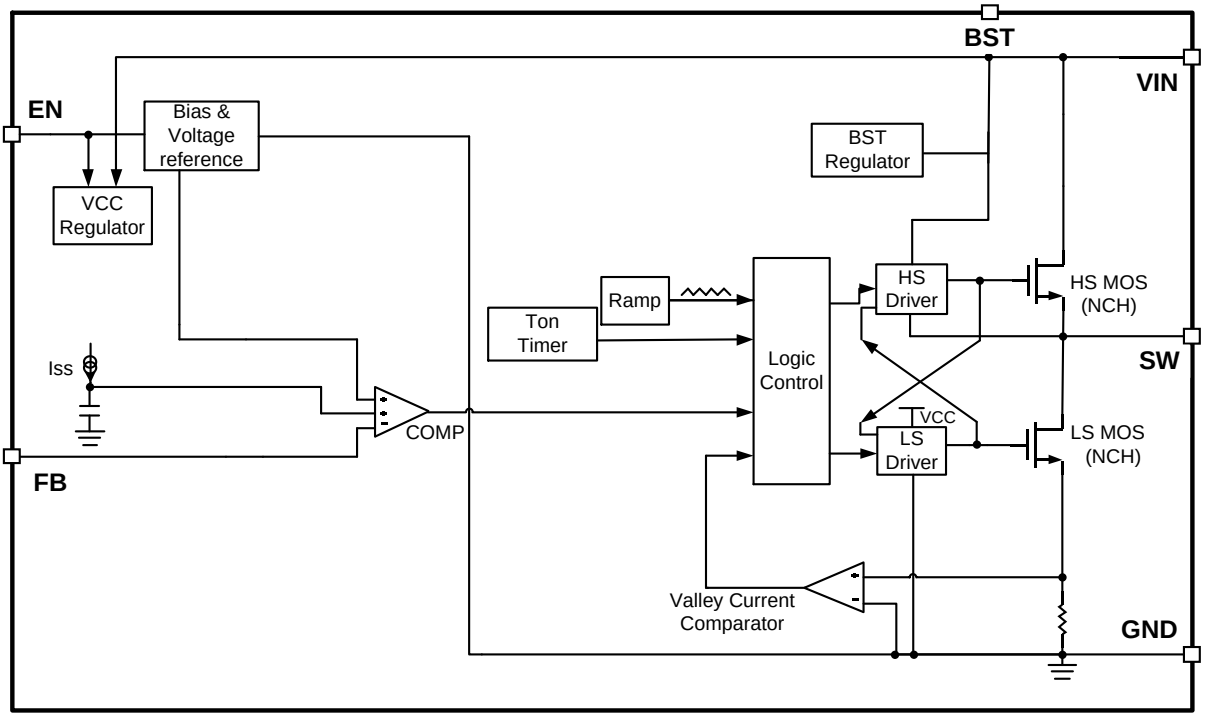


Fig1 Schematic Diagram

Pin Descriptions

No.	Symbol	Description
1	BST	Bootstrap pin. Connect a capacitor between SW and BST pins to form a floating supply across the high-side switch driver. Use a 0.1μF BST capacitor.
2	GND	System Ground pin. Reference ground of the regulated output voltage: requires extra care during PCB layout. Connect to GND with copper traces and vias.
3	FB	Converter feedback input. Connect to output voltage with feedback resistor divider.
4	EN	Enable input control pin. To active high for automatic start-up, EN can be connected to VIN directly or through a resistor.
5	VIN	Supply Voltage pin. Requires a cap to decouple the input rail. Connect using a wide PCB trace.
6	SW	Switch Output pin. Connect using a wide PCB trace.

Block Diagram



Absolute Maximum Ratings(1)

Parameter	Symbol	Value	Unit
VIN pin voltage range	V_{IN}	-0.3～+20	V
EN pin voltage range	-	-0.3～V_{IN}	V
SW pin voltage range (DC)	V_{SW}	-0.3～($V_{IN(Max)}$+0.3)	V
BST pin voltage range(DC)		(V_{SW} – 0.3) ~ (V_{SW} + 6)	V
All Other Pins Voltage	-	-0.3~ 6	V
Power Dissipation – SOT23-6L (Note 2)	P_D	0.5	W
Thermal Characteristics	$R_{\theta JA}$	250	°C/W
	$R_{\theta JC}$	110	°C/W
Maximum Junction Temperature	T_J	150	°C
Lead temperature(Soldering, 10s)	T_L	260	°C
Operating ambient temperature	Topr	-40 ~ 85	°C
Storage temperature	Tstg	-55 ~ 150	°C
ESD Classification	HBM	5500	V
	CDM	2000	V

Note (1): Exceeding these ratings may damage the device.

Note (2): The maximum allowable power dissipation is a function of the maximum junction temperature T_J(MAX), the junction-to-ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P_D(MAX) = (T_J(MAX)-T_A)/θ_{JA}. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage. θ_{JA} is tested based on EV5303-1.0 board.

Recommended Operation Conditions (3)

Symbol	Characteristics	Min	Typ	Max	Unit
V_{IN}	Supply Voltage	4.5	12	18	V
V_{OUT}	Output Voltage	V_{FB}		8	V
Operating Junction Temp. (T_J)	Operating temperature	-40	-	125	℃

Note (3): The device is not guaranteed to function outside of its operating conditions.

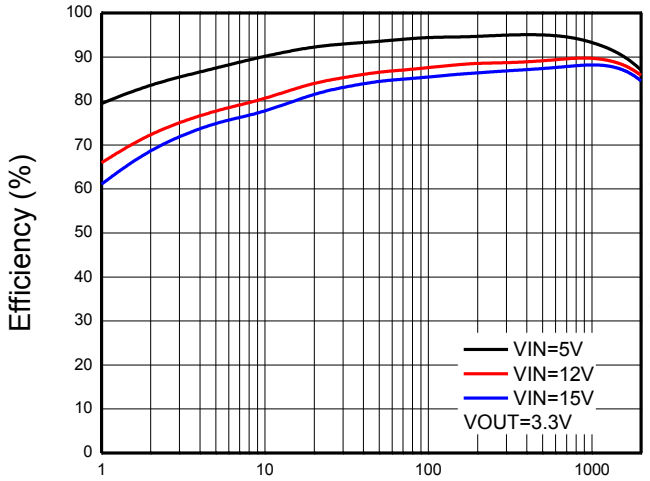
Electronics Characteristics (Ta=25°C, V_{IN}=12V, unless otherwise noted)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage Range	V_{IN}		4.5		18	V
V_{IN} Under Voltage Lockout Threshold	V_{UVLO}	Rising		4.15	4.45	V
		Falling		3.85		
Standby Supply Current	I_Q	V_{FB} = 105%, I_{OUT} = 0A		70	100	uA
Shutdown Supply Current	I_{SHDN}	V_{EN} = 0V, Vin=12V		2	5	uA
Feedback reference Voltage	V_{FB}		-2%	0.6	2%	V
Inductor valley Current Limit	I_{LIM}	V_{IN} = 12V, V_{OUT} = 5V		2.4		A
Oscillator Frequency	f_{OSC}	V_{FB} or V_{OUT} in regulation		500		kHz
$R_{DS(ON)}$ of HS FET	R_{PFET}	I_{SW} = 100mA		0.14		Ω
$R_{DS(ON)}$ of LS FET	R_{NFET}	I_{SW} = −100mA		0.11		Ω
Feedback Leakage Current	I_{FB}	VFB=0.85V			±30	nA
SW Leakage Current	I_{LSW}	V_{IN} = 12V, V_{SW} = 0V or 12V			±5	uA
EN Rising Threshold	V_{ENH}		1.4			V
EN falling Threshold	V_{ENL}				0.4	V
EN Leakage Current	I_{EN}	V_{IN} = 12V, V_{EN} = 0V			1	uA
		V_{IN} = 12V, V_{EN} = VIN		1	2	
Min On Time				50		nS
Min Off Time				100		nS
Soft Start Time				800		uS
Input OVP Shutdown	V_{OVP}	Rising		19		V
		Falling	18	18.5		V
Over Voltage Protection Blanking Time				15		uS
Over Temperature Protection	T_{OTP}			155		°C
OTP Hysteresis				25		°C

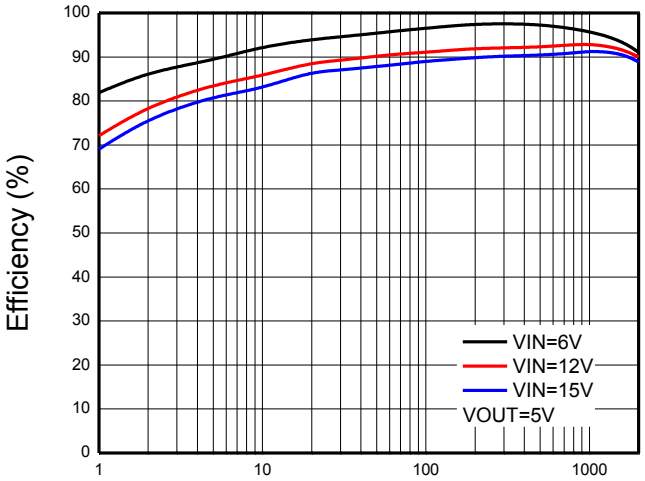
Note (4): Guaranteed by design and engineering sample characterization.

Typical Characteristics

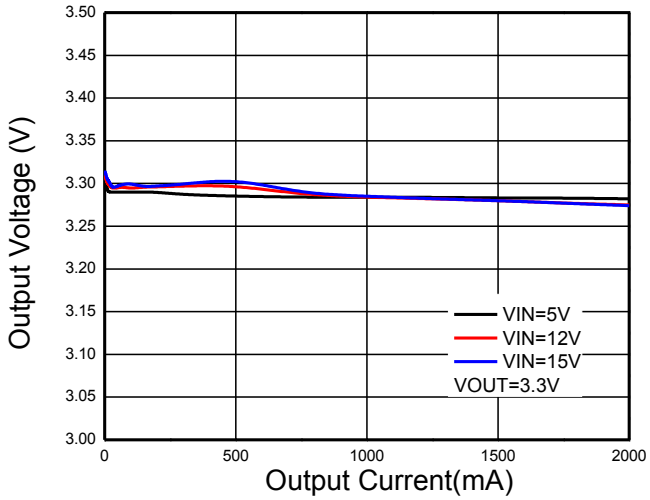
(Ta=25℃, VIN=12V，VEN=3V , VOUT =5V, L1=4.7uH, CIN=4.7uF, COUT=22μF, C1=6.8pF, unless otherwise noted)



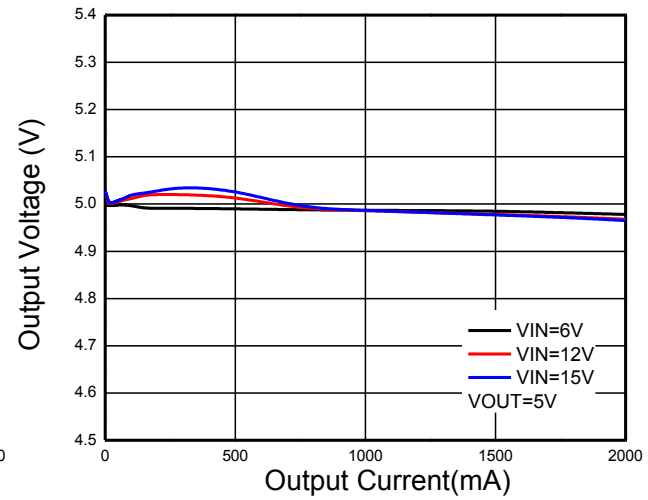
Efficieny VS.Load Current



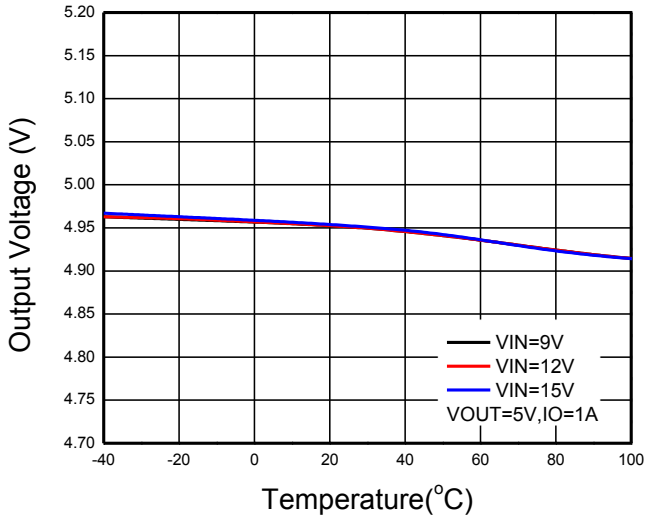
Efficieny VS.Load Current



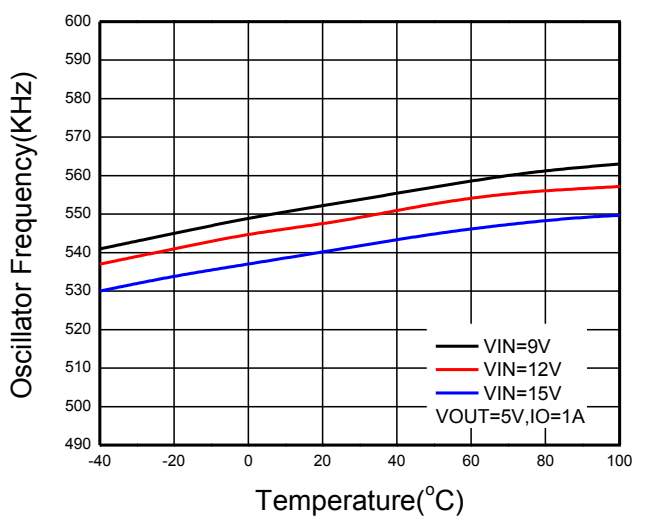
Output Voltage vs. Output Current



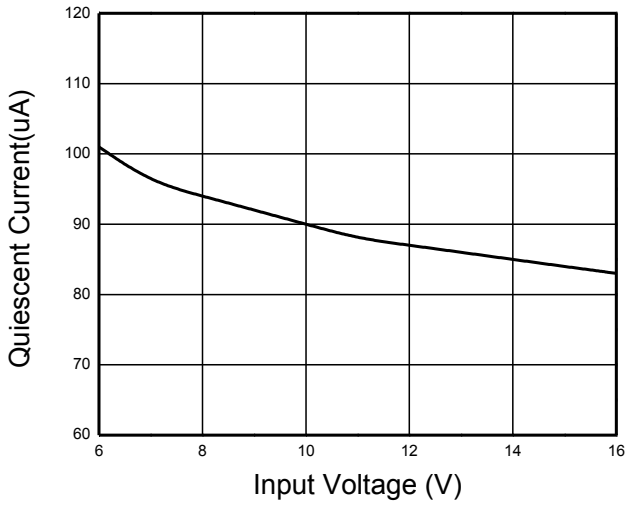
Output Voltage vs. Output Current



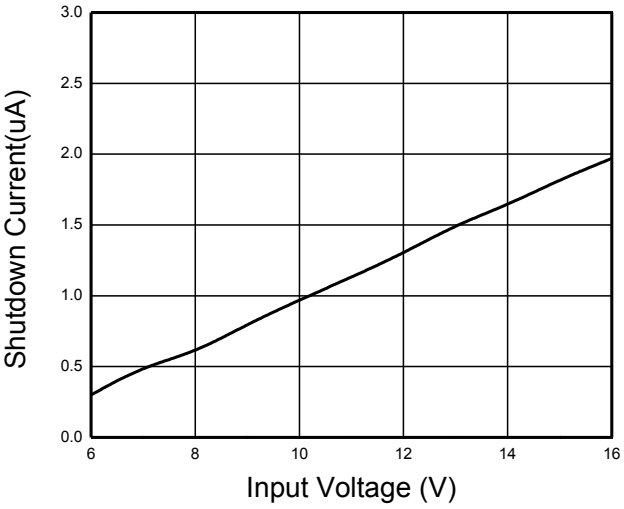
Output Voltage vs. Temperature



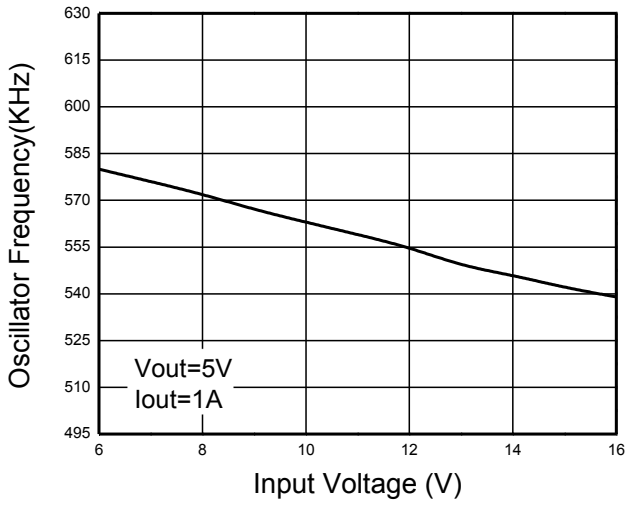
Oscillator Frequency vs. Temperature



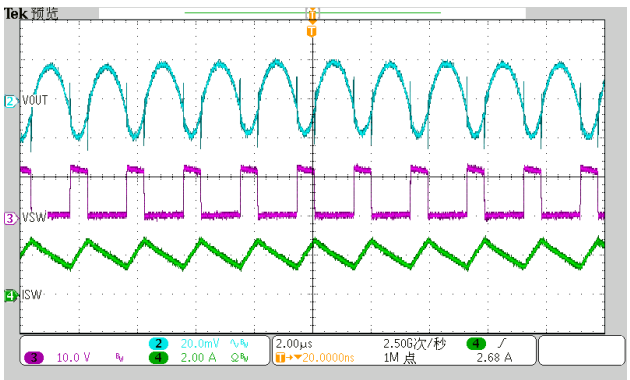
Quiescent Current vs. Input Voltage



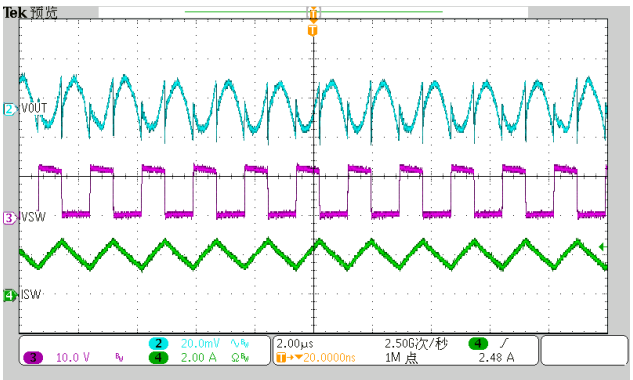
Shutdown Current vs. Input Voltage



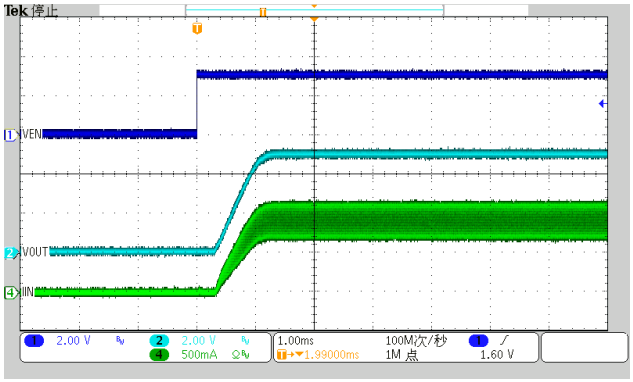
Oscillator Frequency VS. Input Voltage



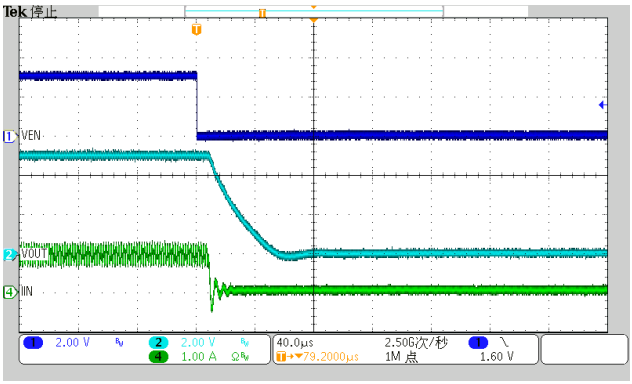
Ripple, VIN=12V, VO=3.3V,VEN=3.0V,IO=2A



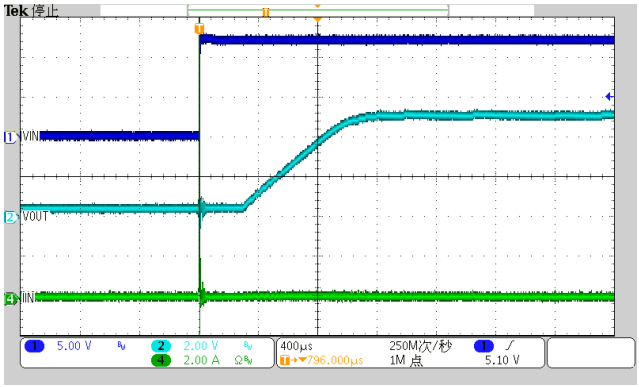
Ripple, VIN=12V, VO=5V,VEN=3.0V,IO=2A



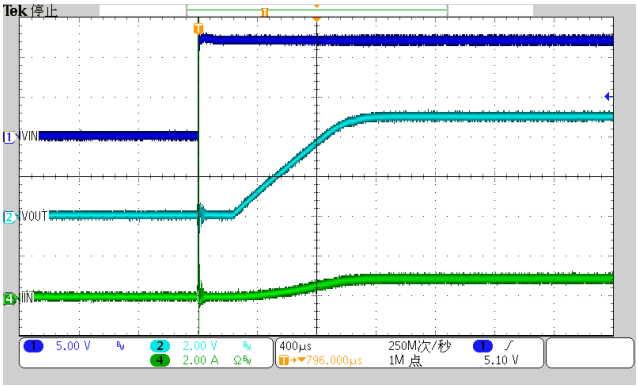
V_{IN}=12V, V_O=5V,V_{EN}=3.0V,I_O=2A, EN On



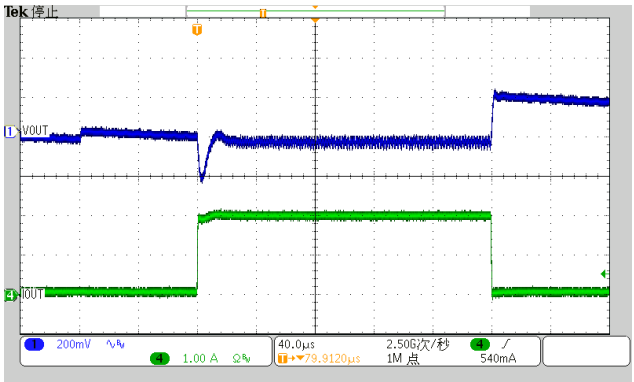
VIN=12V, VO=5V,VEN=3.0V,IO=2A, EN OFF



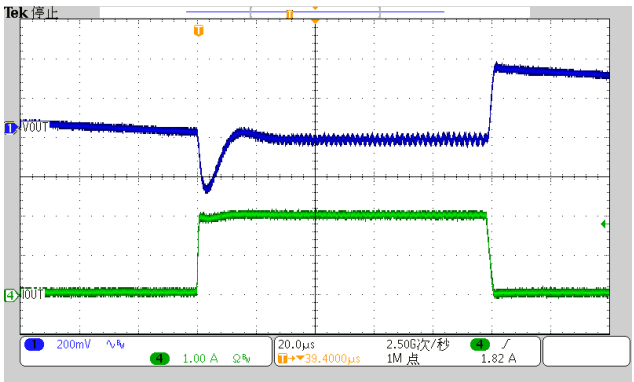
VIN= VEN=12V,VO=5V,IO=1mA,VIN ON



VIN= VEN=12V,VO=5V,IO=2A,VIN ON



VIN=12V,VO=3.3V,VEN=3.0V,IO=1mA-2A



VIN=12V,VO=5V,VEN=3.0V,IO=1mA-2A

Operation Informations

Control Mode

The WD1305E20 step-down converter operates with typically 500KHz constant on time at moderate to heavy load currents. Both the upper and lower synchronous N-channel MOSFET switches are internal. The converter uses a proprietary fast constant on time control (FCOT) scheme to achieve good line and load transient response. The FCOT™ mode control combines adaptive on-time control with an internal compensation circuit for pseudo-fixed frequency and low external component count configuration with both low ESR and ceramic output capacitors. It is stable even with virtually no ripple at the output.

At the beginning of each cycle, the high-side MOSFET is turned on. This MOSFET is turned off after internal one shot timer expires. This one shot duration is set proportional to the converter input voltage-V_{IN} and inversely proportional to the output voltage-V_O to maintain a pseudo-fixed frequency over the input voltage range. The one-shot timer is reset and the high-side MOSFET is turned on again when a internal pseudo ramp is fallen below the output of internal error amplifier.

Short-Circuit Protection

WD1305E20 provides cycle by cycle current limit, the inductor valley current need to drop below the current limit before the next pulse can be fired.

Dropout Operation

Once the input voltage comes close to the nominal output voltage, the upper switch is turned on for one or more cycles. Every 20-30us, low side FET is turned on briefly to refresh Cboot. Thus the voltage difference between BST and SW can be kept high enough to fully turn on the upper FET.

The output voltage will then be determined by the input voltage minus the voltage drop across the upper N-channel MOSFET and the inductor.

Shutdown Mode

Drive EN to GND to place the WD1305E20 in shutdown mode. In shutdown mode, the reference, control circuit, main switch, and synchronous switch turn off and the output becomes high impedance. Input current falls to 1.8μA (Typ.) during shutdown mode.

Over Temperature Protection (OTP)

As soon as the junction temperature (T_J) exceeds 155°C (Typ.), the device goes into thermal shutdown. In this mode, the high-side and low-side MOSFET are turned off.

Application Informations

External component selection for the application circuit depends on the load current requirements. Certain tradeoffs between different performance parameters can also be made.

Output Voltage Setting

The output voltage can be calculated as:

$$V_{OUT} = 0.6 \times \left(1 + \frac{R1}{R2}\right)$$

The external resistive divider is connected to the output. The sum of R1 and R2 should be between 10kΩ to 1 MΩ, to keep the network robust against noise. An external feed forward capacitor C1 is required for optimum load transient response. The value of C1 should be in the range between 6.8pF and 22pF. If Vout is 3.3V, R1=100k is chosen, then using the equation, R2 can be calculated to be 22.1k.

Route the FB line away from noise sources, such as the inductor or the SW line.

Inductor Selection

The WD1305E20 high switching frequency allows the use of a physically small inductor. The inductor ripple current is determined by

$$\Delta I_L = \frac{V_{OUT}}{(f)(L)}\left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

Where ΔI_L is the peak-to-peak inductor ripple current and f is the switching frequency. The inductor peak-to-peak current ripple is typically set to be 40% of the maximum dc load current. Using this guideline and solving for L,

$$L = \frac{V_{OUT}}{f(40\% I_{LOAD(MAX)})}\left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

It is important to ensure that the inductor is capable of handling the maximum peak inductor current, I_{LPK}, determined by

$$I_{LPK} = I_{LOAD(MAX)} + \frac{\Delta I_L}{2}$$

Inductor Core Selection

Different core materials and shapes will change the size/current and price/current relationship of an inductor. Toroid or shielded pot cores in ferrite or permalloy materials are small and don't radiate much energy, but generally cost more than powdered iron core inductors with similar electrical characteristics. The choice of which style inductor to use often depends more on the price vs. size requirements and any radiated field EMI requirements than on what the WD1305E20 requires to operate.

Input Capacitor Selection

Capacitor ESR is a major contributor to input ripple in high-frequency DC-DC converters. Ordinary aluminum electrolytic capacitors have high ESR and should be avoided. Low-ESR tantalum or polymer capacitors are better and provide a compact solution for space constrained surface mount designs. Ceramic capacitors have the lowest overall ESR. The input filter capacitor reduces peak currents and noise at the input voltage source. Connect a low ESR bulk capacitor (4.7μF to 10μF) to the input. Select this bulk capacitor to meet the input ripple requirements and voltage rating rather than capacitance value. Use the following equation to calculate the maximum RMS input current:

$$I_{RMS} = \frac{I_{OUT}}{V_{IN}}\sqrt{V_{OUT} \times (V_{IN} - V_{OUT})}$$

Output Capacitor Selection

Ceramic capacitors with low-ESR values have the lowest output voltage ripple and are recommended. At nominal load current, the device operates in PWM mode, and the RMS ripple current is calculated as:

$$I_{RMSCout} = V_{OUT} \times \frac{1 - \frac{V_{OUT}}{V_{IN}}}{L \times f} \times \frac{1}{2 \times \sqrt{3}}$$

At nominal load current, the device operates in

PWM mode, and the overall output voltage ripple is the sum of the voltage spike caused by the output capacitor ESR plus the voltage ripple caused by charging and discharging the output capacitor:

$$\Delta V = V_{OUT} \times \frac{1-\frac{V_{OUT}}{V_{IN}}}{L \times f} \times \left(\frac{1}{8 \times C_{OUT} \times f} + ESR \right)$$

At light load currents, the converter operates in pulse skipping mode, and the output voltage ripple is dependent on the capacitor and inductor values. Larger output capacitor and inductor values minimize the voltage ripple in PSM operation and tighten dc output accuracy in PSM operation.

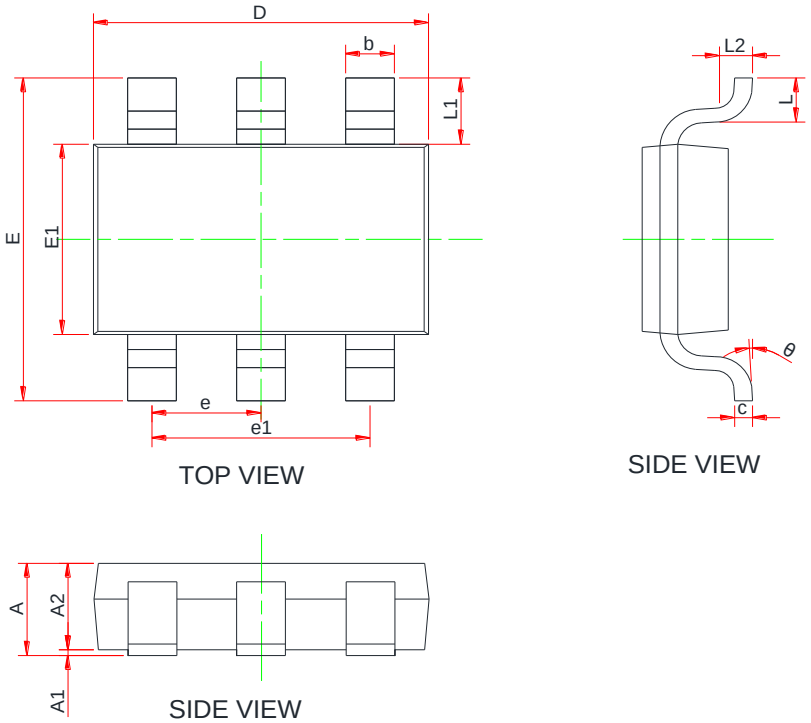
PC Board Layout Considerations

A good circuit board layout aids in extracting the most performance from the WD1305E20. Poor circuit layout degrades the output ripple and the electromagnetic interference (EMI) or electromagnetic compatibility (EMC) performance.
The evaluation board layout is optimized for the WD1305E20. Use this layout for best performance. If this layout needs changing, use the following guidelines:

1. Use separate analog and power ground planes. Connect the sensitive analog circuitry (such as voltage divider components) to analog ground; connect the power components (such as input and output bypass capacitors) to power ground. Connect the two ground planes together near the load to reduce the effects of voltage dropped on circuit board traces. Locate C_{IN} as close to the V_{IN} pin as possible, and use separate input bypass capacitors for the analog.
2. Route the high current path from C_{IN}, through L, to the SW and PGND pins as short as possible.
3. Keep high current traces as short and as wide as possible.
4. Place the feedback resistors as close as possible to the FB pin to prevent noise pickup.
5. Avoid routing high impedance traces, such as FB, near the high current traces and components or near the switch node (SW).
6. If high impedance traces are routed near high current and/or the SW node, place a ground plane shield between the traces.

PACKAGE OUTLINE DIMENSIONS

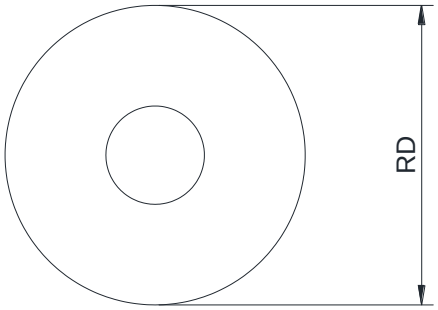
SOT-23-6L



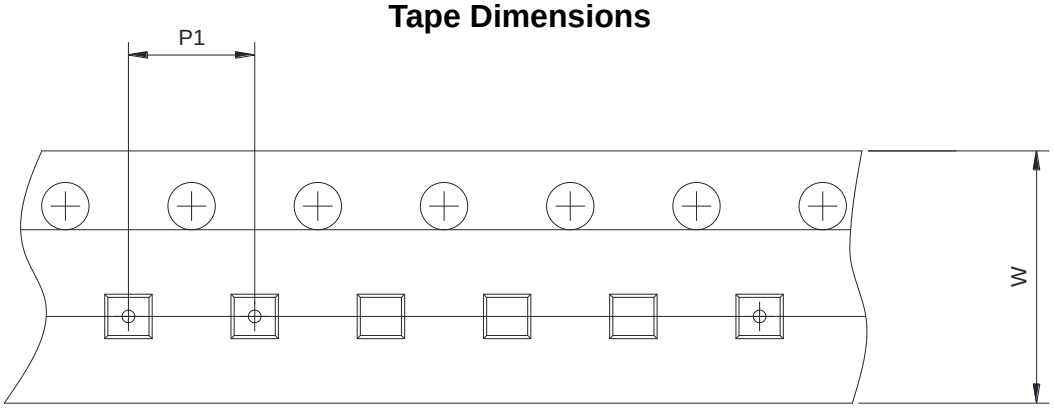
Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	-	-	1.45
A1	0	-	0.15
A2	0.90	1.10	1.30
b	0.30	0.40	0.50
c	0.10	-	0.21
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	0.85	0.95	1.05
e1	1.80	1.90	2.00
L	0.30	-	0.60
L1	0.59Ref		
L2	0.25Ref		
θ	0 °	-	8 °

TAPE AND REEL INFORMATION

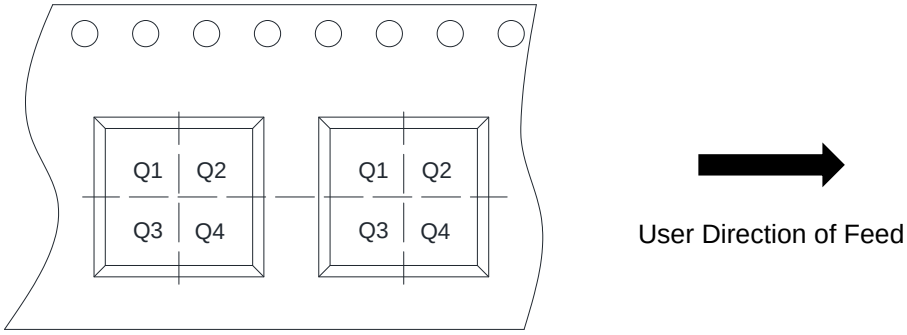
Reel Dimensions



Tape Dimensions



Quadrant Assignments For PIN1 Orientation In Tape



RD	Reel Dimension	☑ 7inch ☐ 13inch
W	Overall width of the carrier tape	☑ 8mm ☐ 12mm ☐ 16mm
P1	Pitch between successive cavity centers	☐ 2mm ☑ 4mm ☐ 8mm
Pin1	Pin1 Quadrant	☐ Q1 ☐ Q2 ☑ Q3 ☐ Q4

X-ON Electronics

Largest Supplier of Electrical and Electronic Components

Click to view similar products for Switching Controllers ***category:***

Click to view products by Will Semiconductor ***manufacturer:***

Other Similar products are found below :

NCP1218AD65R2G NCP1244BD065R2G NCP1336ADR2G NCP6153MNTWG NCP81101BMNTXG NCP81205MNTXG SJE6600 AZ7500BMTR-E1 SG3845DM NCP1250BP65G NCP4204MNTXG NCP6132AMNR2G NCP81102MNTXG NCP81206MNTXG NCP1240AD065R2G NCP1240FD065R2G NCP1361BABAYSNT1G NCP1230P100G NX2124CSTR SG2845M NCP1366BABAYDR2G NCP81101MNTXG NCP81174NMNTXG NCP4308DMTTWG NCP4308AMTTWG NCP1366AABAYDR2G NCP1251FSN65T1G NCP1246BLD065R2G MB39A136PFT-G-BND-ERE1 NCP1256BSN100T1G LV5768V-A-TLM-E NCP1365BABCYDR2G NCP1365AABCYDR2G NCP1246ALD065R2G AZ494AP-E1 CR1510-10 NCP4205MNTXG XRP6141ELTR-F RY8017 LP6260SQVF LP6298QVF ISL6121LIB ISL6225CA ISL6244HRZ ISL6268CAZ ISL6315IRZ ISL6420AIAZ-TK ISL6420AIRZ ISL6420IAZ ISL6421ERZ