TAIWAN SEMICONDUCTOR

RoHS COMPLIANCE

Preliminary

TS9020

200mA Dual Channel CMOS LDO with Enable Function

SOT-26



Pin Definition:

1. V_{OUT} 1
2. V_{IN}
3. V_{OUT} 2
4. Enable 2
5. Ground
6. Enable 1

General Description

The TS9020 is a high accurately, low noise, high ripple rejection ratio, low dropout, dual CMOS LDO voltage regulators with enable function. The EN function allows the output of each regulator to be turned off independently, resulting in greatly reduced power consumption. The TS9020 has the soft start function to suppress the inrush current. The current limit is over 250mA per channel and also operates as a short protection for the output current limiter. The output voltage for each regulator is set independently by metal trimming.

The TS9020 is fully compatible with low ESR ceramic capacitors, reducing cost and improving output stability. This high level output stability is maintained even during frequent load fluctuations, due to the excellent transient response performance and high PSRR achieved across a broad range of frequency.

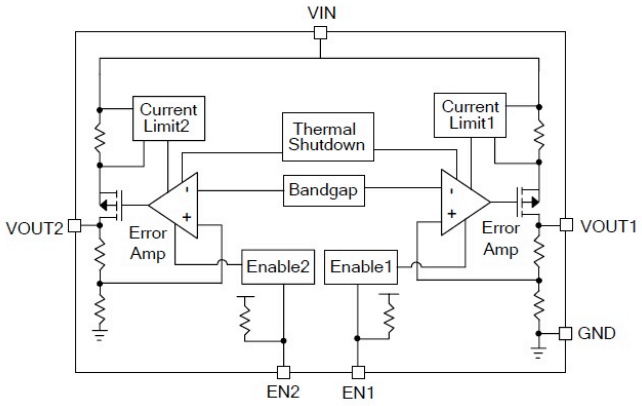
Features

- Input voltage range: 2.5V~6V
- V_{DROP} typically 150mV@Io=100mA (Vout≥2.8V)
- Varied fixed output voltage combinations
- Output current: 200mA/channel (typ.)
- Internal current limit and Short circuit protection
- Thermal shutdown
- Standby current: 1uA (typ)
- Power saving shutdown mode
- Fast transient response
- Low ESR capacitor compatible

Applications

- Instrumentation
- Wireless device
- Battery powered equipment
- Portable Devices

Block Diagram



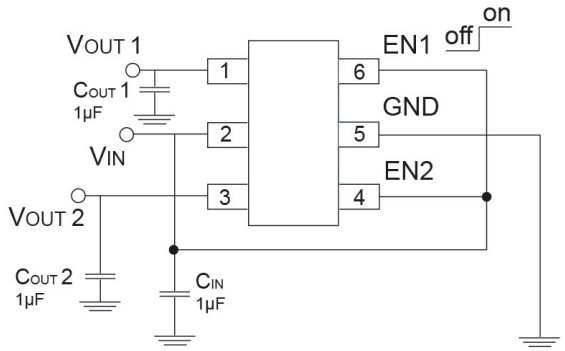
Ordering Information

Part No.	Package	Packing
TS9020**xx**CX6 RF	SOT-25	3Kpcs / 7" Reel

Note: Where **xx** denotes voltage option. Available are:
1= 1.2V, **A**= 1.5V, **D**= 1.8V, **K**= 2.5V, **N**= 2.8V,
P= 3.0V, **S**= 3.3V
Contact factory for additional voltage options.

* 1st **x** denote for V_{OUT} 1 voltage code
* 2nd **x** denote for V_{OUT} 2 voltage code

Typical Application Circuit



Name	Description
VIN	Power Input
GND	Ground
EN1	V_{OUT}1 Enable control pin
EN2	V_{OUT}2 Enable control pin
V_{OUT}1	Output Voltage 1
V_{OUT}2	Output Voltage 2

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Absolute Maximum Rating

Parameter	Symbol	Limit	Unit
Input Supply Voltage	V_{IN}	GND -0.3 ~ +6.5	V
Output Voltage	$V_{OUT}1$ / $V_{OUT}2$	GND -0.3 ~ V_{IN} +0.3	V
Enable Input Voltage	EN1 / EN2	GND -0.3 ~ V_{IN} +0.3	V
Output Current	$I_{OUT}1$+ $I_{OUT}2$	700	mA
Power Dissipation	P_D	250	mW
Thermal Resistance – Junction to Case	Θ_{JC}	180	°C/W
Thermal Resistance – Junction to Ambient	Θ_{JA}	250	°C/W
Operating Temperature Range	T_{OPR}	-40 ~ +85	°C
Junction Temperature Range	T_J	-40 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

Notes: Θ_{JA} is measured with the PCB copper area of approximately 1 in^2(multi-layer). That need connect to GND pin.

Electrical Characteristics (Ta = 25°C, unless otherwise noted)

Parameter	Symbol	Test Condition		Min	Typ	Max	Units
Input Voltage	V_{IN}	(Note 1)		2.5	--	6	V
Output Voltage Accuracy	ΔV_{OUT}	I_{OUT} =1mA, V_{IN}= 5V, V_{OUT}>2V		-2	--	+2	%
		I_{OUT} =1mA, V_{IN}= 5V, V_{OUT}≤2V		-0.04	--	0.04	V
Dropout Voltage	V_{DROP}	I_O =200mA V_O =$V_{O(NOM)}$ -2%	V_{OUT}=1.5V	--	1000	1200	mV
			V_{OUT}=1.8V	--	700	900	
			V_{OUT}>2.5V	--	300	400	
Quiescent Current	I_{CC}	I_{OUT} 1,2=0mA, V_{IN}= 5V		--	60	--	uA
Current Limit	I_{LIM}	(Note 2)		250	--	--	mA
Short Circuit Current	I_{SHORT}	V_{OUT} <1V, each channel		--	150	--	mA
Line Regulation	REG_{LINE}	I_{OUT} =1mA , V_{IN}= V_{OUT} +1V to 6V		--	0.2	0.3	%/V
Load Regulation	REG_{LOAD}	I_{OUT} =1~100mA, V_{IN}= V_{OUT} +1V		--	0.01	0.03	%/mA
Power Supply Rejection	PSRR	f=120Hz, I_{OUT} =30mA		--	60	--	dB
Over Temp. Shutdown	OTS			--	150	--	°C
Over Temp. Hysterisis	OTH			--	40	--	°C
Shutdown Current	I_{SD}	I_{OUT} 1,2=0mA, V_{IN}= 5V, V_{EN}1,2= 0V		--	1	2	uA
EN Input Threshold	V_{EH}			2	--	--	V
	V_{EL}			--	--	0.8	V
Output Voltage Temperature Coefficient		I_{OUT} =30mA (Note 4)		--	±100	--	PPM/ºC

Note1: $V_{IN(MIN)}$=V_{OUT}+$V_{DROPOUT}$
Note2: Current limit is measured at constant junction temperature by using pulsed testing with a low ON time.
Note3: Regulation is measured at constant junction temperature by using pulsed testing with a low ON time.
Note4: Guaranteed by design.

Function Description

The TS9020 is a highly accurate, dual, low noised, CMOS LDO voltage regulators with enable function. The output voltage for each regulator is set independently by fuse trimming. As illustrated in function block diagram, it consists of a reference, error amplifier, a P-channel pass transistor, an ON/OFF control logic and an internal feedback voltage divider. The band gap reference is connected to the error amplifier, which compares the reference with the feedback voltage and amplifies the voltage difference. If the feedback voltage is lower than the reference voltage, the pass-transistor gate is pulled lower, which allows more current to pass to the V_{OUT} pin and increases the output voltage. If the feedback voltage is too high, the pass transistor gate is pulled up to decrease the output voltage. The output voltage is feed back through an internal resistive divider connected to V_{OUT} pin. Additional blocks include an output current limiter, thermal sensor, and shutdown logic.

Enable

EN1 and EN2 pin start and stop the corresponding outputs independently. When the EN pin is switched to the power off level, the operation of all internal circuit stops, the build-in P-channel MOSFET output transistor between pins V_{IN} and V_{OUT} is switched off, allowing current consumption to be drastically reduced.

Dropout Voltage

A regulator's minimum input-output voltage differential, or dropout voltage, determines the lowest usable supply voltage. The TS9020 use a P- channel MOSFET pass transistor, its dropout voltage is function of drain-to-source on-resistance $R_{DS(ON)}$ multiplied by the load current

$$\mathbf{V_{DROP} = V_{IN}-V_{OUT} = R_{DSON} * I_{OUT}}$$

Current Limit

Each channel of TS9020 includes a fold back current limiter. It monitors and controls the pass transistor's gate voltage, estimates the output current, and limits the output current within 250mA.

Thermal Shutdown Protection

Thermal Shutdown protection limits total power dissipation of TS9020. When the junction temperature exceeds T_J= +150°C, a thermal sensor turns off the pass transistor, allowing the IC to cool down. The thermal sensor turns the pass transistor on again after the junction temperature cools down by 40°C, resulting in a pulsed output during continuous thermal shutdown conditions. Thermal shutdown protection is designed to protect the TS9020 in the event of fault conditions. For continuous operation, the absolute maximum operating junction temperature rating of T_J=+125°C should not be exceeded.

Application Information

Like any low-dropout regulator, the TS9020 requires input and output decoupling capacitors. The device is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance (see Capacitor Characteristics Section). Please note that linear regulators with a low dropout voltage have high internal loop gains which require care in guarding against oscillation caused by insufficient decoupling capacitance.

Input Capacitor

The TS9020 is designed specifically to work with very small ceramic output capacitors. A ceramic capacitor (temperature characteristics X7R, X5R) in 1μF is suitable for the TS9020 application. The recommended minimum capacitance for the device is 1μF, X5R or X7R dielectric ceramic, between VOUT and GND for stability, but it may be increased without limit. Higher capacitance values help to improve transient. The output capacitor's ESR is critical because if forms a zero to provide phase lead which is required for loop stability.

Application Information (continue)

Input Capacitor

An input capacitance of 1μF is required between input pin and ground directly (the amount of the capacitance may be increased without limit). The input capacitor must be located less than 1cm from the device to assure input stability. A lower ESR capacitor allows the use of less capacitance, while higher ESR type (like aluminum electrolytic) requires more capacitance. Capacitor types (aluminum, ceramic and tantalum) can be mixed in parallel, but the total equivalent input capacitance/ ESR must be defined as above to stable operation. There are no requirements for the ESR on the input capacitor, but tolerance and temperature coefficient must be considered when selecting the capacitor to ensure the capacitance will be 1μF over the entire operating temperature range.

Thermal Considerations

The TS9020 series can deliver a current of up to 200mA/channel over the full operating junction temperature range. However, the maximum output current must be debated at higher ambient temperature to ensure the junction temperature does not exceed 125°C. With all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

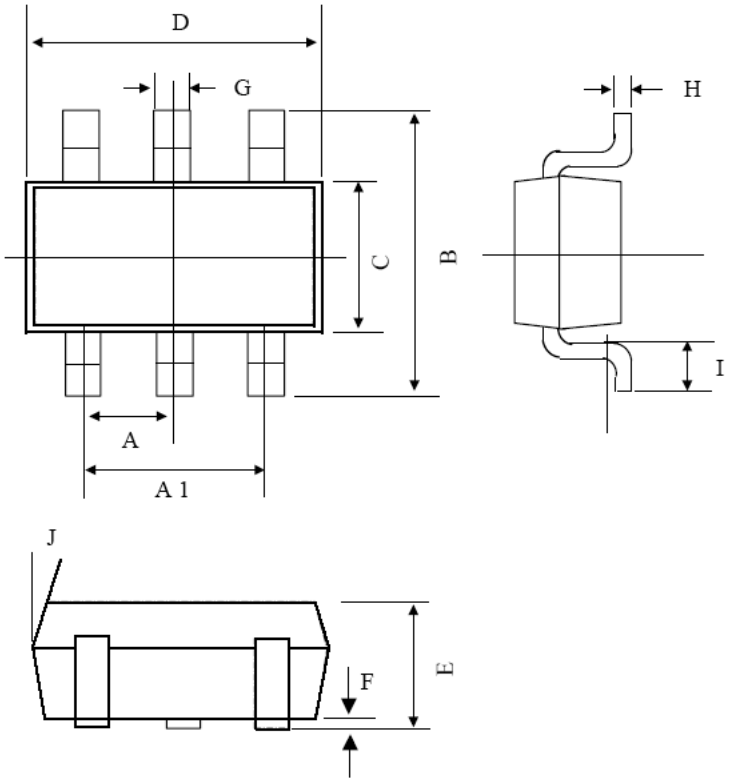
$$P_D = (V_{IN} - V_{OUT})\, I_{OUT} + V_{IN}\, I_{GND}$$

The final operating junction temperature for any set of conditions can be estimated by the following thermal equation:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$

Where $T_{J(MAX)}$ is the maximum junction temperature of the die (125°C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA}) SOT-26 package at recommended minimum footprint is 250°C/W. Visit our website in which “Recommended Footprints for Soldering Surface Mount Package” for detail.

SOT-26 Mechanical Drawing



SOT-26 DIMENSION						
DIM	MILLIMETERS			INCHES		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.95 BSC			0.0374 BSC		
A1	1.9 BSC			0.0748 BSC		
B	2.60	2.80	3.00	0.1024	0.1102	0.1181
C	1.40	1.50	1.70	0.0551	0.0591	0.0669
D	2.80	2.90	3.10	0.1101	0.1142	0.1220
E	1.00	1.10	1.20	0.0394	0.0433	0.0472
F	0.00	--	0.10	0.00		0.0039
G	0.35	0.40	0.50	0.0138	0.0157	0.0197
H	0.10	0.15	0.20	0.0039	0.0059	0.0079
I	0.30	--	0.60	0.0118	--	0.0236
J	5°	--	10°	5°	--	10°

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