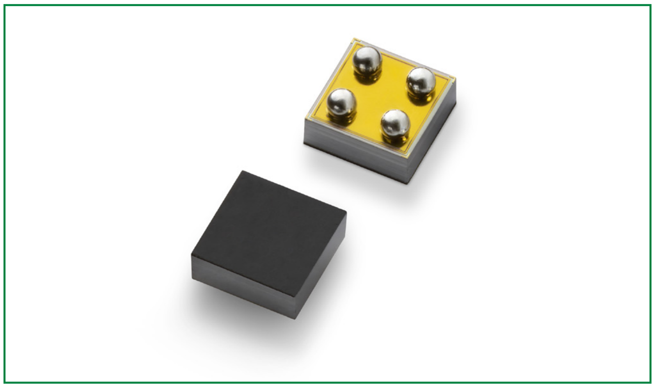
LQ05021RCS4

5 V, 2 A Ultra Low Consumption Load Switch With True Reverse Current Blocking

RoHS Pb



Description

The LQ05021RCS4 is an advanced technology fully integrated load switch device with true reverse current blocking (TRCB) technology and the slew rate control of the output voltage.

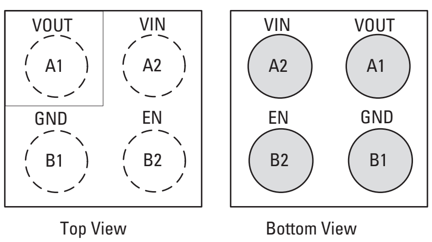
It offers industry leading true reverse current blocking (TRCB) performance, featuring an ultra-low threshold voltage. It minimizes reverse current flow in the event that the VOUT pin voltage exceeds the VIN voltage.

It has industry leading efficiency. It features a R_{ON} as low as 37 mΩ typical at 5.5 V, reducing power loss during conduction. The device also feature ultra-low shutdown current (I_{SD}) to reduce power loss and battery drain in the off state. When EN is pulled low, and the output is grounded, It can achieve an ISD as low as 20 nA typical at 5.5 V.

The LQ05021RCS4 load switch device supports an industry leading wide input voltage range and helps to improve operating life and system robustness. Furthermore, one device can be used in multiple voltage rail applications which helps to simplify inventory management and reduces operating cost.

The LQ05021RCS4 load switch device is small utilizing a chip scale package with 4 bumps in a 0.77 mm x 0.77 mm x 0.46 mm die size and a 0.4 mm pitch.

Pinout Designation



Pin Description

Pin #	Pin Name	Description
A1	V_{OUT}	Switch output
A2	V_{IN}	Switch input. Supply voltage for IC
B1	GND	Ground
B2	EN	Enable to control the switch

Features and Benefits

- Wide input range: 1.5 V to 5.5 V, 6 V_{abs} max
- True reverse current blocking
- Ultra-low I_Q: 0.45 µA Typ @ 5.5 V_{IN}
- Ultra-low I_{SD}: 20 nA Typ @ 5.5 V_{IN}
- Low R_{ON}: 37 mΩ Typ @ 5.5 V_{IN}
- I_{OUT} max: 2 A
- Controlled V_{OUT} rise time
- Internal EN pull-down resistor on EN pin
- Integrated output discharge switch

Applications

- Wearables
- Mobile Devices
- IoT Devices
- Low Power Subsystems

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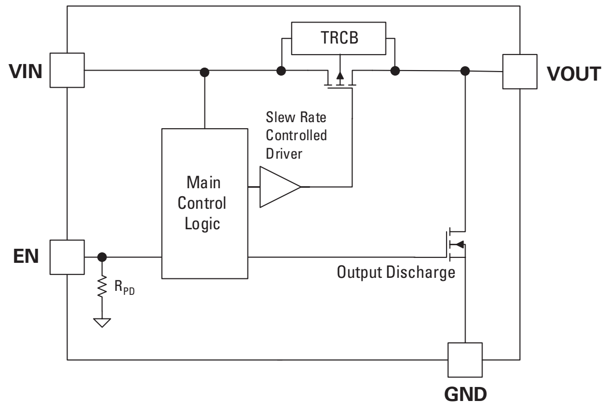
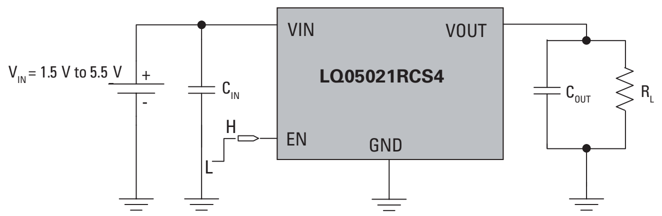
Functional Block Diagram



Typical Applications



Absolute Maximum Rating

Symbol	Parameter		Min	Max	Unit
V_{IN}, V_{OUT}, V_{EN}	Each Pin Voltage Range to GND		-0.3	6	V
I_{OUT}	Maximum Continuous Switch Current			2	A
P_D	Power Dissipation at T_A = 25 °C			1.2	W
T_{STG}	Storage Junction Temperature		-65	150	°C
T_J	Maximum Junction Temperature			150	°C
θ_{JA}	Thermal Resistance, Junction to Ambient (board dependent)			85	°C/W
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	4		kV
		Charged Device Model, JESD22-C101	2		kV

Note: Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions; extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Recommend Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Supply Voltage	1.5	5.5	V
T_A	Ambient Operating Temperature	-40	85	°C

Note: The device is not guaranteed to function outside of the recommended operating conditions.

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Electrical Characteristics (Values are at V_{IN} = 3.3 V and T_A = 25 °C unless otherwise noted.)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
Basic Operation							
I_Q	Quiescent Current	EN = Enable, I_{OUT} = 0 mA, V_{IN} = V_{EN} = 5.5 V			980		nA
		EN = Enable, I_{OUT} = 0 mA, V_{IN} = V_{EN} = 5.5 V[1]			450	1000	nA
		EN = Enable, I_{OUT} = 0 mA, V_{IN} = V_{EN} = 5.5 V, T_A = 85 °C[1]			500		nA
I_{SD}	Shutdown Current	EN = Disable, I_{OUT} = 0 mA, V_{IN} = 1.5 V			5		nA
		EN = Disable, I_{OUT} = 0 mA, V_{IN} = 3.3 V			9		nA
		EN = Disable, I_{OUT} = 0 mA, V_{IN} = 4.2 V			12		nA
		EN = Disable, I_{OUT} = 0 mA, V_{IN} = 5.5 V			20	100	nA
		EN = Disable, I_{OUT} = 0 mA, V_{IN} = 5.5 V, T_A = 85 °C			50		nA
R_{ON}	On-Resistance	V_{IN} = 5.5 V, I_{OUT} = 500 mA	T_A = 25 °C		37	42	mΩ
			T_A = 85 °C[4]		43		mΩ
		VI_{IN} = 3.3 V, I_{OUT} = 500 mA	T_A = 25 °C		47	52	mΩ
			T_A = 85 °C[4]		56		mΩ
		V_{IN} = 1.8 V, I_{OUT} = 300 mA	T_A = 25 °C[4]		80		mΩ
		V_{IN} = 1.5 V, I_{OUT} = 100 mA	T_A = 25 °C		100		mΩ
R_{DSC}	Output Discharge Resistance	EN = Low , I_{FORCE} = 10 mA			85		Ω
V_{IH}	EN Input Logic High Voltage	V_{IN} = 1.5 V - 5.5 V		1.2			V
V_{IL}	EN Input Logic Low Voltage	V_{IN} = 1.5 V - 5.5 V				0.45	V
R_{EN}	EN Internal resistance	Pull-down Resistance			10		mΩ
I_{EN}	EN Current	V_{EN} = V_{IN} or GND			0.5		µA
V_{RCB_TH}	RCB Protection Threshold Voltage	$V_{OUT} - V_{IN}$			25		mV
V_{RCB_RL}	RCB Protection Release Voltage	$V_{IN} - V_{OUT}$			30		mV
I_{RCB_TH}	RCB Protection Threshold Current	V_{IN} = 3.3 V, Enabled, $V_{OUT} > V_{IN}$			0.6		A
$t_{Trigger}$	RCB Trigger Time	V_{IN} = 3.3 V, Enabled, $V_{OUT} > V_{IN}$ + 25 mV			266.5		µs
Switching Characteristics[2]							
t_{dON}	Turn-On Delay	R_L = 150 Ω, C_{OUT} = 0.1 µF			430		µs
t_R	V_{OUT} Rise Time				570		µs
t_{dOFF}	Turn-Off Delay[3,4]	R_L = 150 Ω, C_{OUT} = 0.1 µF			17		µs
t_F	V_{OUT} Fall Time[3,4]				15		µs

Notes:

1. I_Q does not include enable pull down current through the pull-down resistor RPD.
2. $t_{ON} = td_{ON} + t_R$, $t_{OFF} = td_{OFF} + t_F$
3. Output discharge path is enabled during off.
4. By design; characterized, not production tested.

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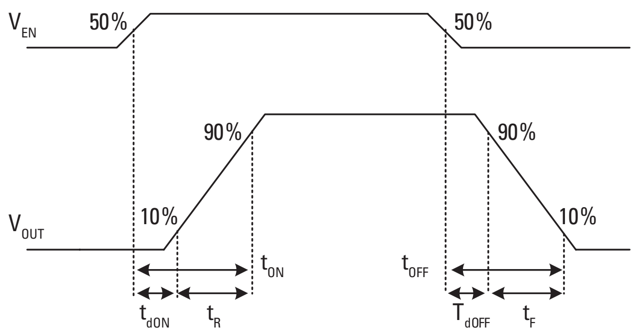
Timing Waveforms



Typical Performance Characteristics

Figure 1 - On-Resistance vs. Supply Voltage

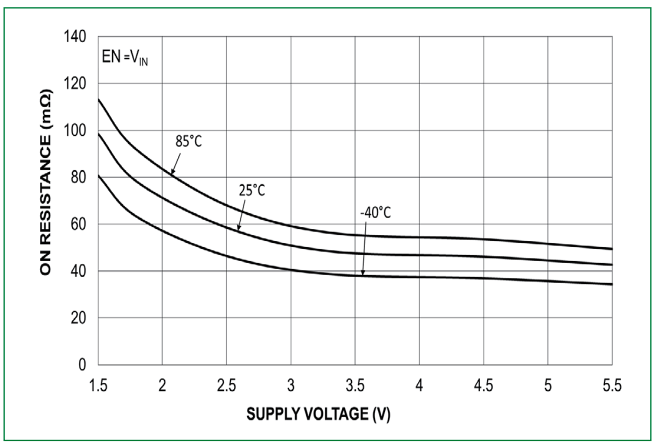


Figure 2 - On-Resistance vs. Temperature

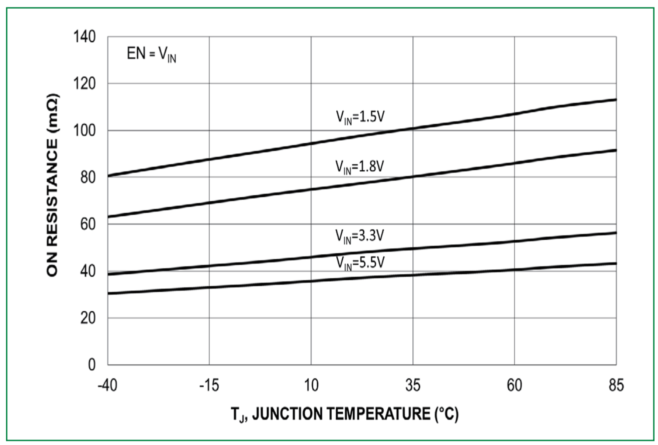


Figure 3 - Quiescent Current vs. Supply Voltage

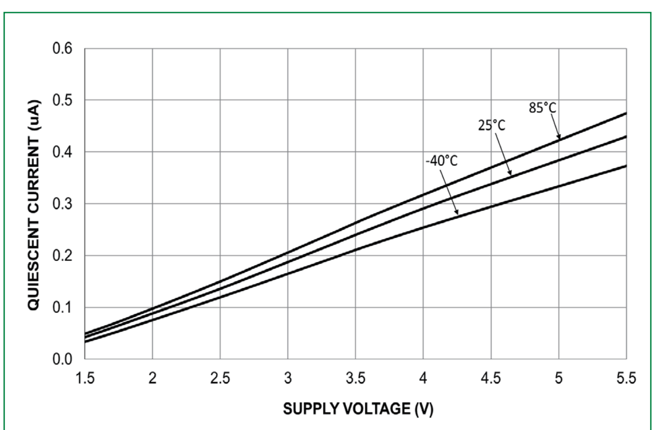


Figure 4 - Quiescent Current vs. Temperature

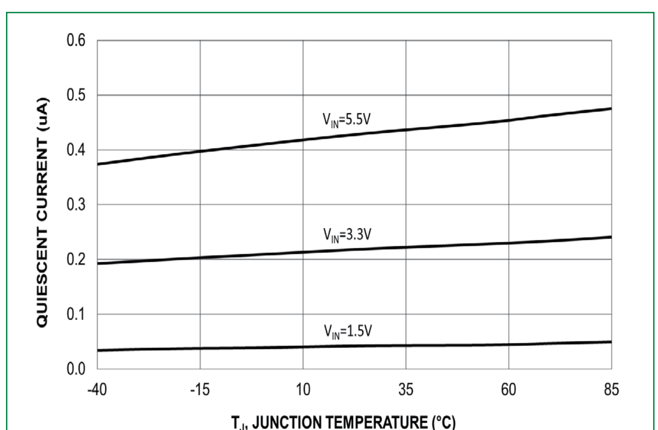


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Figure 5 - Shutdown Current vs. Supply Voltage

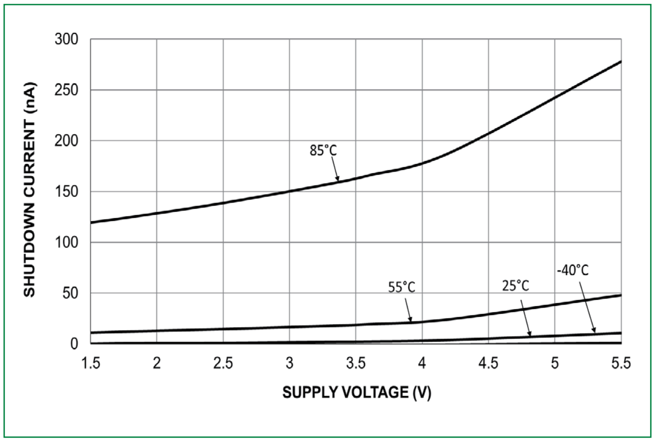

Figure 6 - Shutdown Current vs. Temperature

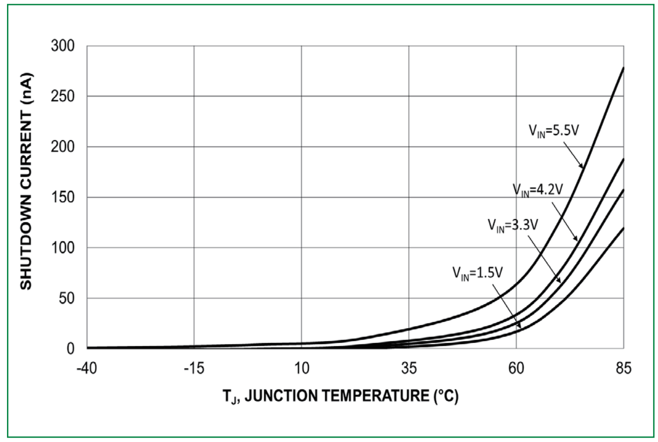

Figure 7 - EN Input Logic High Threshold

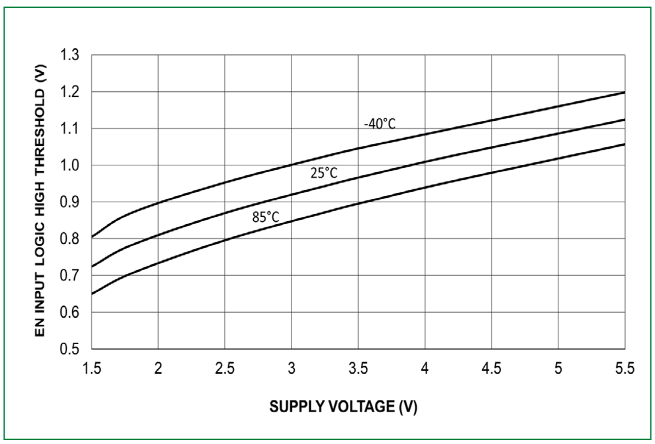

Figure 8 - EN Input Logic High Threshold Vs. Temperature

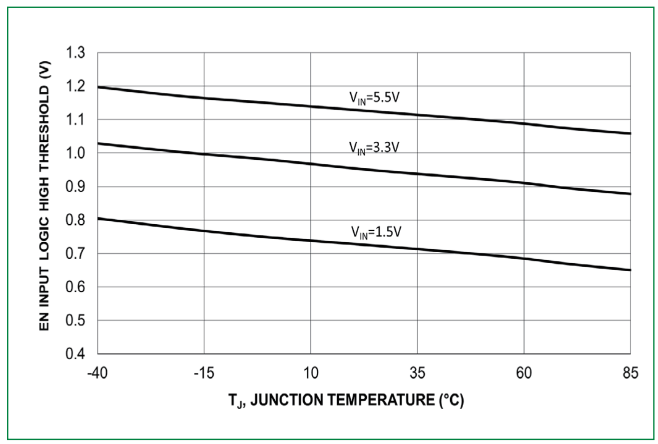

Figure 9 - EN Input Logic Low Threshold

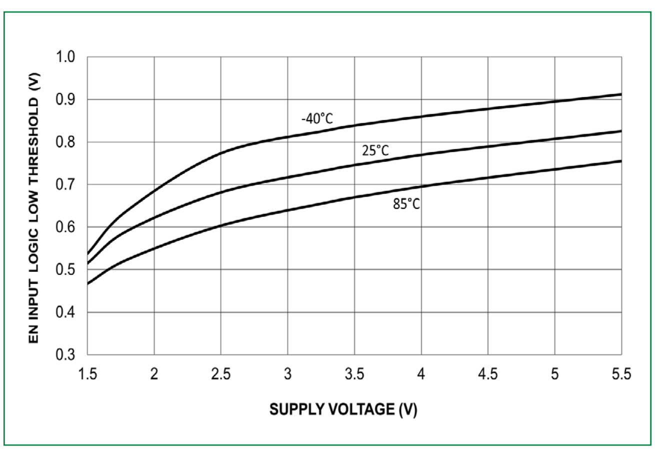

Figure 10 - EN Input Logic Low Threshold Vs. Temperature

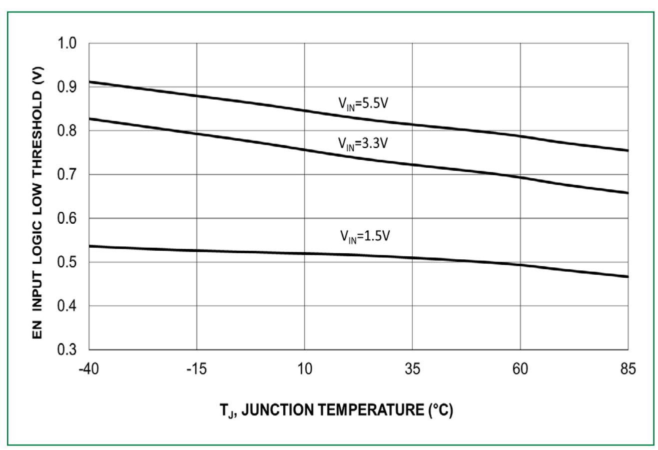

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Figure 11 - V_{OUT} Rise Time vs. Temperature

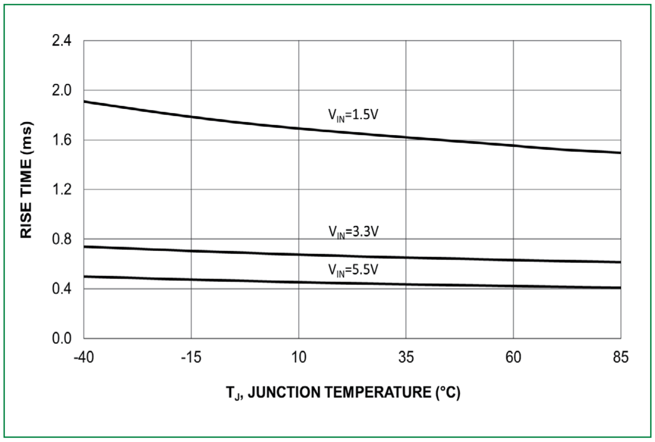


Figure 12 - Turn-On Delay Time vs. Temperature

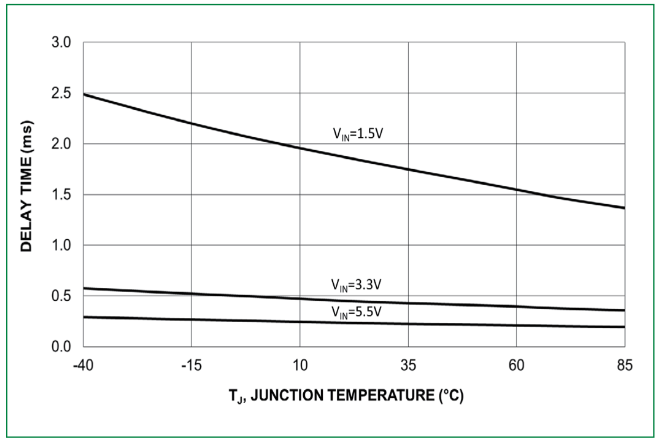


Figure 13 - RCB Threshold Voltage vs. Supply Voltage

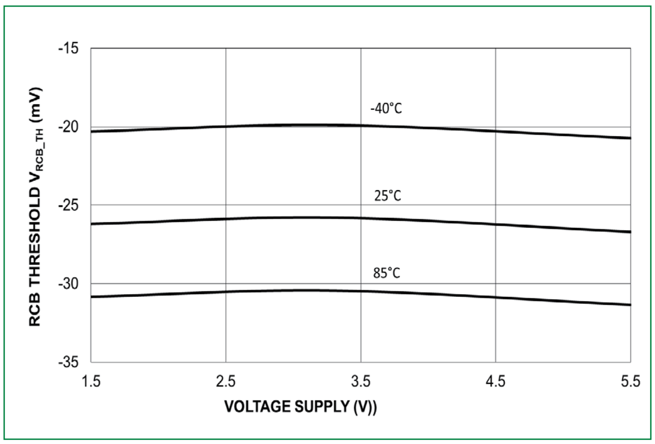


Figure 14 - RCB Threshold Voltage vs. Temperature

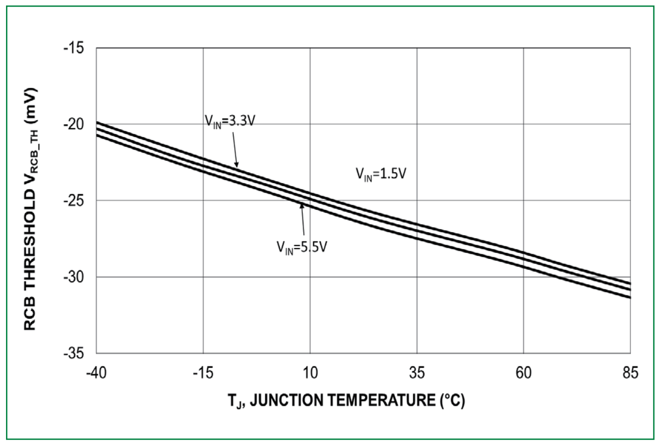


Figure 15 - RCB Release Voltage vs. Supply Voltage

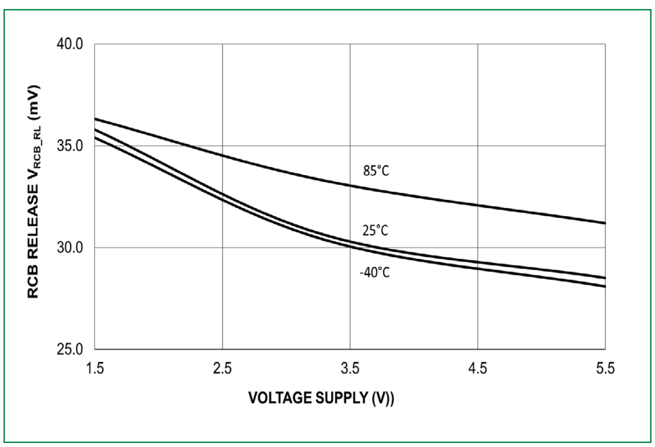


Figure 16 - RCB Release Voltage vs. Temperature

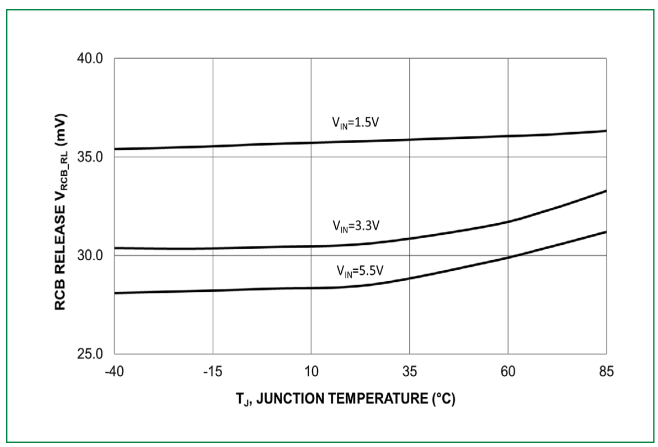


Figure 17 - Turn-On Response
V_{IN} = 3.3 V, C_{IN} = 0.1 µF, C_{OUT} = 0.1 µF, R_L = 150 Ω

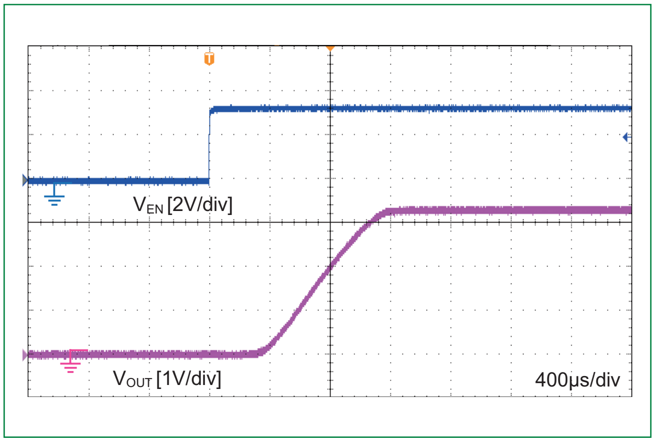


Figure 18 - Turn-Off Response
V_{IN} = 3.3 V, C_{IN} = 0.1 µF, C_{OUT} = 0.1 µF, R_L = 150 Ω

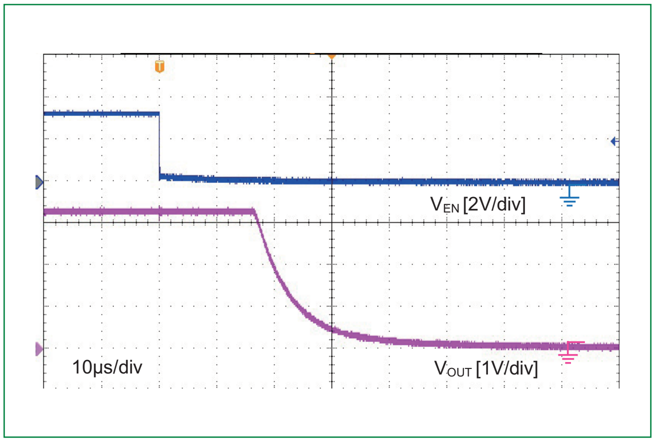


Figure 19 - RCB Release Voltage vs. Supply Voltage

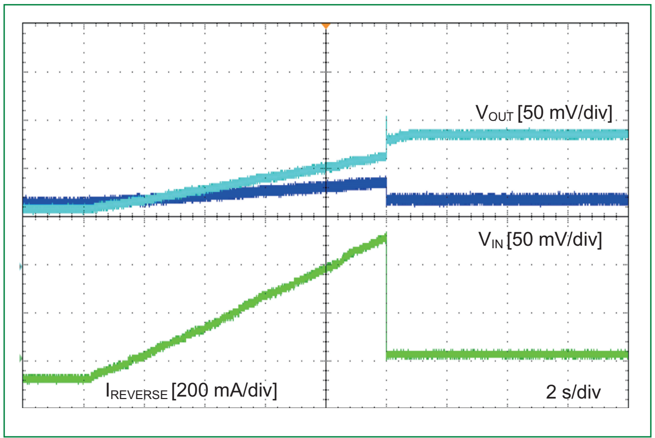
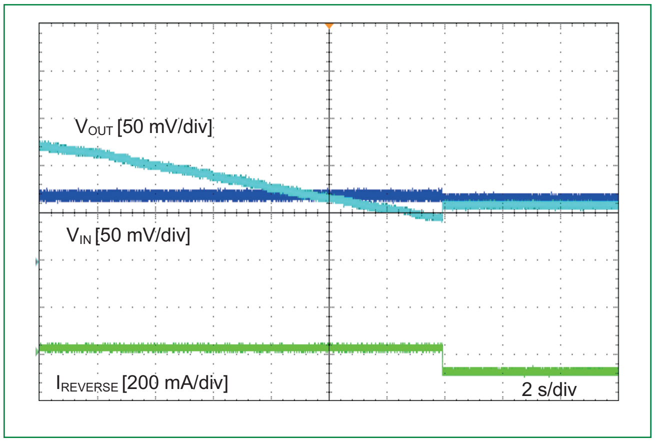


Figure 20 - RCB Release Voltage vs. Temperature



Application Information

The devices integrated 2 A, ultra-efficient load switch devices with a fixed slew rate control to limit the inrush current during turn on. Each device is capable of operating over a wide input range from 1.5 V to 5.5 V with very low on-resistance to reduce conduction loss. In the off state, these devices consume very low leakage current to avoid unwanted standby current and save limited input power. The package is a 0.77 mm x 0.77 mm x 0.46 mm wafer level chip scale package, saving space in compact applications. It is constructed using 4 bumps, with a 0.4 mm pitch for manufacturability.

Input Capacitor

The devices do not require an input capacitor. However, to reduce the voltage drop on the input power rail caused by transient inrush current at start-up, a 0.1 µF capacitor is recommended to be placed close to the VIN pin. A higher input capacitor value can be used to further attenuate the input voltage drop.

Output Capacitor

The devices do not require an output capacitor. However, use of an output capacitor is recommended to mitigate voltage undershoot on the output pin when the switch is turning off. Undershoot can be caused by parasitic inductance from board traces or intentional load inductances. If load inductances do exist, use of an output capacitor can improve output voltage stability and system reliability. The C_{OUT} capacitor should be spaced close to the VOUT and GND pins.

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EN pin

The devices can be activated by forcing EN pin high level. Note that the EN pin has an internal pull-down resistor to help pull the main switch to a known "off state" when no EN signal is applied from an external controller.

True Reverse Current Blocking

The devices have a built-in reverse current blocking protection which always monitors the output voltage level regardless of the status of EN pin to check if it is greater than the input voltage. When the output voltage goes beyond the input voltage by 25 mV, that is the reverse current blocking protection trip voltage, the reverse current blocking function block turns off the switch. Note that some reverse current can occur until the V_{RCB} is triggered. The main switch will resume normal operation when the output voltage drops below the input source by the RCB protection release voltage.

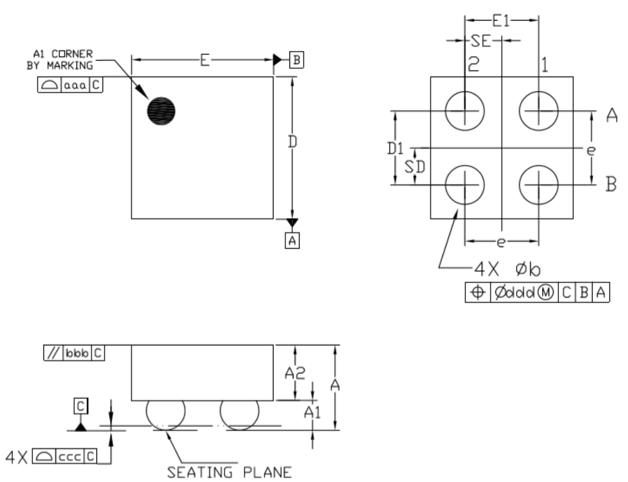
Output Discharge Function

The devices have an internal discharge N-channel FET switch on the VOUT pin. When EN signal turns the main power FET to an off state, the N-channel switch turns on to discharge an output capacitor quickly.

Board Layout

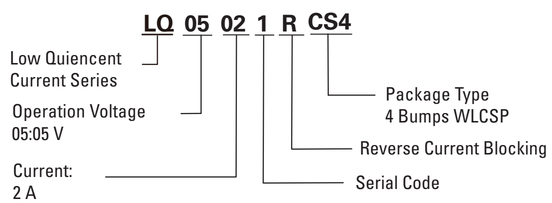
All traces should be as short as possible to minimize parasitic inductance effects. Wide traces for VIN, VOUT, and GND will help reduce signal degradation and parasitic effects during dynamic operation as well as improve the thermal performance at high load current.

Dimensions

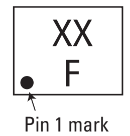


Dimension	Millimeters		
	Min	Nom	Max
A	0.410	0.460	0.510
A1	0.135	0.160	0.185
A2	0.275	0.300	0.325
D	0.755	0.770	0.785
E	0.755	0.770	0.785
D1	0.350	0.400	0.450
E1	0.350	0.400	0.450
b	0.170	0.210	0.250
e		0.400 BSC	
SD		0.200 BSC	
SE		0.200 BSC	
Tol. of Form & Position			
aaa		0.100	
bbb		0.100	
ccc		0.050	
ddd		0.050	

Part Numbering



Part Marking



F = Device Code
XX = Lot Run Code

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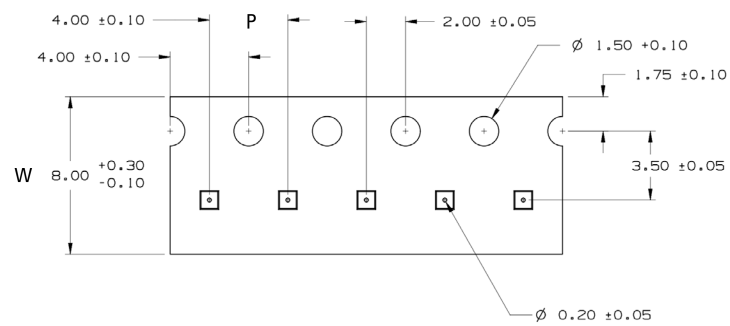
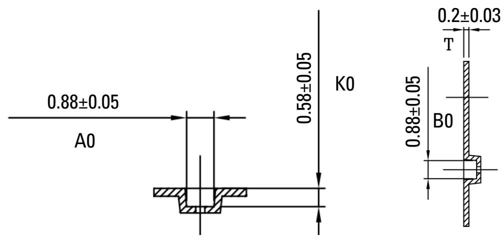
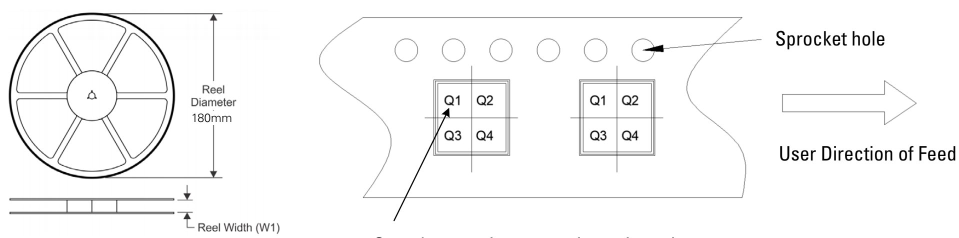
Carrier Tape & Reel Specification







Quandrant assignments pin 1 orientation
Dimensions are in millimeters

Device	Package	Pins	SPQ	Reel Diameter	Reel Width W1	A0	B0	K0	P	W	Pin1
LQ05021RCS4	4 Bumps WLCSP	4	4000	179	9	0.88	0.88	0.58	4	8	Q1