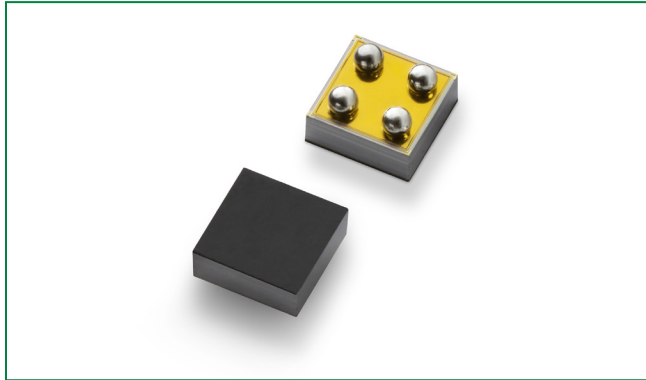


# LQ05022QCS4

## 5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control



### Description

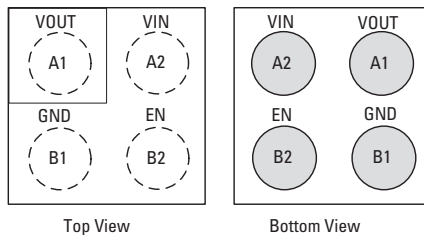
The LQ05022QCS4 is an ultimated efficient, 2 A rated integrated load switch with slew rate control. Its outstanding performance in efficiency makes this an ideal solution for applications like IoT, mobile and wearable.

This remarkable device incorporates cutting-edge technology that achieves industry-leading performance in terms of the lowest quiescent current ( $I_Q$ ), and shutdown current ( $I_{SD}$ ). The low  $I_Q$  and  $I_{SD}$  solutions empower designers to curtail parasitic leakage current, enhance system efficiency, and extend battery lifespan.

The integration of slew rate control within the LQ05022QCS4 serves as a critical enhancement to system reliability, effectively mitigating voltage swings on the bus during switching events. In situations where uncontrolled switches might otherwise generate substantial inrush currents, leading to voltage droop and potential bus reset events, the slew rate control functions to confine inrush current during activation, thereby minimizing the voltage droop.

The LQ05022QCS4 load switch device is designed in a chip scale package of 0.97 mm x 0.97 mm x 0.55 mm with 4 bumps and 0.5 mm pitch and support an extensive input voltage range, enhancing both the operational lifespan and the resilience of the system. Additionally, this single device can serve in various voltage rail applications, streamlining inventory management and lowering operational expenses.

### 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

- Ultra-low  $I_Q$ : 7 nA Typ @ 5.5  $V_{IN}$
- Ultra-low  $I_{SD}$ : 28 nA Typ @ 5.5  $V_{IN}$
- Low  $R_{ON}$  = 31 m $\Omega$  Typ @ 5.5  $V_{IN}$
- $I_{OUT}$  max = 2.0 A
- Wide input range: 1.1 V to 5.5 V, 6 Vabs max
- Controlled rise time: 335  $\mu$ s at 3.3  $V_{IN}$
- Internal EN pull-down resistor
- Integrated output discharge switch
- Ultra-small: 4 bumps in a 0.97 mm x 0.97 mm x 0.55 mm WLCSP

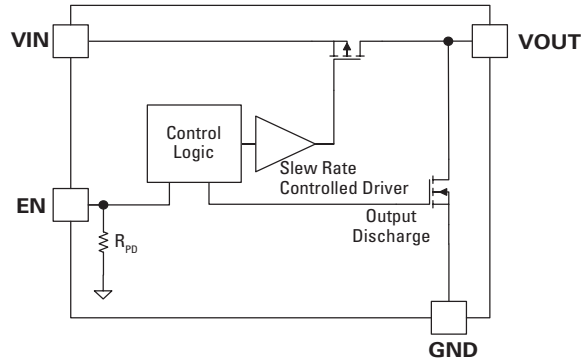
### Applications

- Mobile devices
- Data storage, SSD
- IoT devices
- Wearables
- Low power subsystems

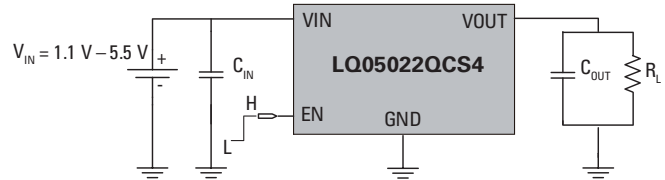
# LQ05022QCS4

## 5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control

### Functional Block Diagram



### Typical Applications



### Absolute Maximum Rating

| Symbol                                               | Parameter                                   |                                   | Min  | Max | Unit |
|------------------------------------------------------|---------------------------------------------|-----------------------------------|------|-----|------|
| V <sub>IN</sub> , V <sub>OUT</sub> , V <sub>EN</sub> | Each Pin Voltage Range to GND               |                                   | -0.3 | 6   | V    |
| I <sub>OUT</sub>                                     | Maximum Continuous Switch Current           |                                   |      | 2   | A    |
| P <sub>D</sub>                                       | Power Dissipation at T <sub>A</sub> = 25 °C |                                   |      | 1.2 | W    |
| T <sub>STG</sub>                                     | Storage Junction Temperature                |                                   | -65  | 150 | °C   |
| T <sub>J</sub>                                       | Maximum Junction Temperature                |                                   |      | 150 | °C   |
| θ <sub>JA</sub>                                      | Thermal Resistance, Junction to Ambient     |                                   |      | 85  | °C/W |
| ESD                                                  | Electrostatic Discharge Capability          | Human Body Model, JESD22-A114     | 6    |     | 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 <sub>IN</sub> | Supply Voltage                | 1.1 | 5.5 | V    |
| T <sub>A</sub>  | Ambient Operating Temperature | -40 | 85  | °C   |

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

**LQ05022QCS4****5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control****Electrical Characteristics** (Values are at  $V_{IN} = 3.3\text{ V}$  and  $T_A = 25\text{ °C}$  unless otherwise noted.)

| Symbol                                                          | Parameter                                   | Test Conditions                                                                                           |               | Min                                                | Typ                    | Max | Unit |
|-----------------------------------------------------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------|------------------------|-----|------|
| Basic Operation                                                 |                                             |                                                                                                           |               |                                                    |                        |     |      |
| V <sub>IN</sub>                                                 | Supply Voltage                              |                                                                                                           |               | 1.1                                                |                        | 5.5 | V    |
| I <sub>Q</sub>                                                  | Quiescent Current                           | V <sub>IN</sub> = V <sub>EN</sub> = 5.5 V, I <sub>OUT</sub> = 0 mA                                        |               |                                                    | 570                    |     | nA   |
|                                                                 |                                             | V <sub>IN</sub> = V <sub>EN</sub> = 5.5 V, I <sub>OUT</sub> = 0 mA <sup>1</sup>                           |               |                                                    | 7                      | 70  | nA   |
|                                                                 |                                             | V <sub>IN</sub> = V <sub>EN</sub> = 5.5 V, I <sub>OUT</sub> = 0 mA, T <sub>A</sub> = 85 °C <sup>1,5</sup> |               |                                                    | 12                     |     | nA   |
| I <sub>SD</sub>                                                 |                                             | EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 1.1 V                                            |               |                                                    | 5                      |     | nA   |
|                                                                 |                                             | EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 1.8 V                                            |               |                                                    | 6                      |     | nA   |
|                                                                 |                                             | EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 3.3 V                                            |               |                                                    | 9                      | 35  | nA   |
|                                                                 |                                             | EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 4.5 V                                            |               |                                                    | 13                     |     | nA   |
|                                                                 |                                             | EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.5 V                                            |               |                                                    | 28                     | 100 | nA   |
|                                                                 |                                             | EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.5 V, T <sub>A</sub> = 55 °C <sup>5</sup>       |               |                                                    | 200                    |     | nA   |
|                                                                 |                                             | EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.5 V, T <sub>A</sub> = 85 °C <sup>5</sup>       |               |                                                    | 1                      |     | μA   |
|                                                                 |                                             | R <sub>ON</sub>                                                                                           | On-Resistance | V <sub>IN</sub> = 5.5 V, I <sub>OUT</sub> = 500 mA | T <sub>A</sub> = 25 °C |     | 31   |
| T <sub>A</sub> = 85 °C                                          |                                             |                                                                                                           |               |                                                    | 36                     |     | mΩ   |
| V <sub>I</sub> <sub>IN</sub> = 3.3 V, I <sub>OUT</sub> = 500 mA | T <sub>A</sub> = 25 °C                      |                                                                                                           |               |                                                    | 36                     | 41  | mΩ   |
|                                                                 | T <sub>A</sub> = 85 °C <sup>5</sup>         |                                                                                                           |               |                                                    | 43                     |     | mΩ   |
| V <sub>IN</sub> = 1.8 V, I <sub>OUT</sub> = 300 mA              | T <sub>A</sub> = 25 °C                      |                                                                                                           |               |                                                    | 52                     | 60  | mΩ   |
| V <sub>IN</sub> = 1.1 V, I <sub>OUT</sub> = 100 mA              | T <sub>A</sub> = 25 °C                      |                                                                                                           |               |                                                    | 95                     | 120 | mΩ   |
| R <sub>DSC</sub>                                                | Output Discharge Resistance                 | E <sub>N</sub> = Low , I <sub>FORCE</sub> = 10 mA                                                         |               | 70                                                 | 85                     | 100 | Ω    |
| V <sub>IH</sub>                                                 | EN Input Logic High Voltage                 | V <sub>IN</sub> = 1.1 V - 1.8 V                                                                           |               | 0.9                                                |                        |     | V    |
|                                                                 |                                             | V <sub>IN</sub> = 1.8 V - 5.5 V                                                                           |               | 1.2                                                |                        |     | V    |
| V <sub>IL</sub>                                                 | EN Input Logic Low Voltage                  | V <sub>IN</sub> = 1.1 V - 1.8 V                                                                           |               |                                                    |                        | 0.3 | V    |
|                                                                 |                                             | V <sub>IN</sub> = 1.8 V - 5.5 V                                                                           |               |                                                    |                        | 0.4 | V    |
| R <sub>EN</sub>                                                 | EN Internal resistance                      | Internal Pull-down Resistance                                                                             |               |                                                    | 9.5                    |     | MΩ   |
| I <sub>EN</sub>                                                 | EN Current                                  | E <sub>N</sub> = 5.5 V                                                                                    |               |                                                    |                        | 1   | μA   |
| Switching Characteristics                                       |                                             |                                                                                                           |               |                                                    |                        |     |      |
| t <sub>dON</sub>                                                | Turn-On Delay <sup>2</sup>                  | R <sub>L</sub> = 150 Ω, C <sub>OUT</sub> = 0.1 μF                                                         |               |                                                    | 210                    |     | μs   |
| t <sub>R</sub>                                                  | V <sub>OUT</sub> Rise Time <sup>2</sup>     |                                                                                                           |               |                                                    | 335                    |     | μs   |
| t <sub>dON</sub>                                                | Turn-On Delay <sup>2,5</sup>                | R <sub>L</sub> = 500 Ω, C <sub>OUT</sub> = 0.1 μF                                                         |               |                                                    | 220                    |     | μs   |
| t <sub>R</sub>                                                  | V <sub>OUT</sub> Rise Time <sup>2,5</sup>   |                                                                                                           |               |                                                    | 330                    |     | μs   |
| t <sub>dOFF</sub>                                               | Turn-Off Delay <sup>3,4,5</sup>             | R <sub>L</sub> = 10 Ω, C <sub>OUT</sub> = 0.1 μF                                                          |               |                                                    | 0.38                   |     | μs   |
| t <sub>F</sub>                                                  | V <sub>OUT</sub> Fall Time <sup>3,5</sup>   |                                                                                                           |               |                                                    | 1.30                   |     | μs   |
| t <sub>dOFF</sub>                                               | Turn-Off Delay <sup>3,4,5</sup>             | R <sub>L</sub> = 500 Ω, C <sub>OUT</sub> = 0.1 μF                                                         |               |                                                    | 0.9                    |     | μs   |
| t <sub>F</sub>                                                  | V <sub>OUT</sub> Fall Time <sup>3,4,5</sup> |                                                                                                           |               |                                                    | 16                     |     | μs   |

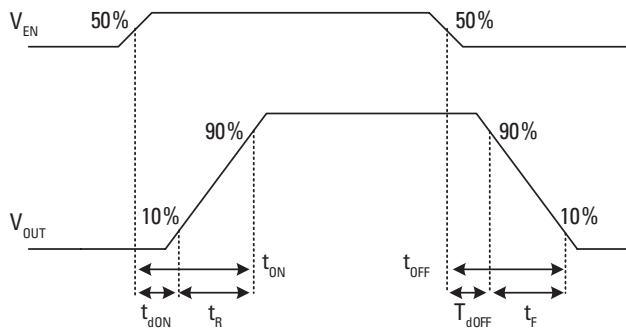
**Notes:**

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

# LQ05022QCS4

## 5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control

### Timing Waveforms



### Typical Performance Characteristics

Figure 1 - On-Resistance vs. Supply Voltage

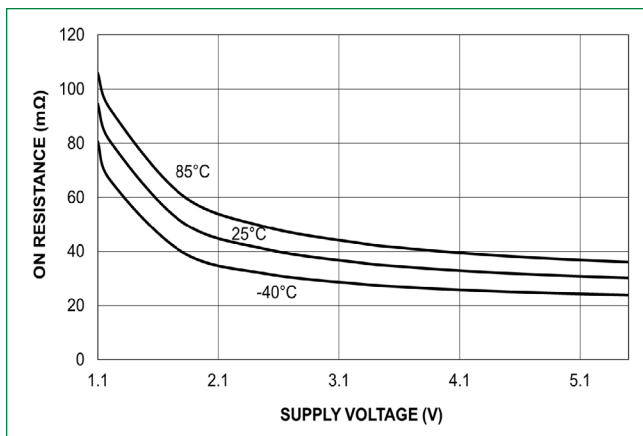


Figure 2 - On-Resistance vs. Temperature

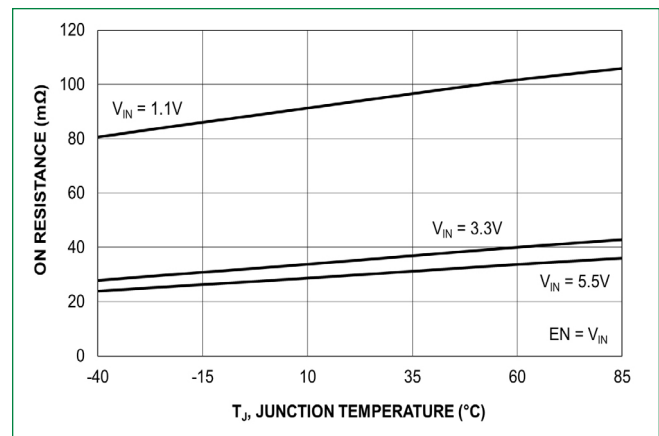


Figure 3 - Quiescent Current vs. Supply Voltage

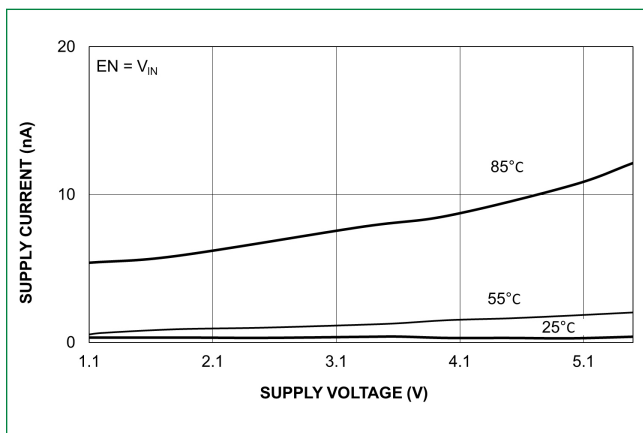
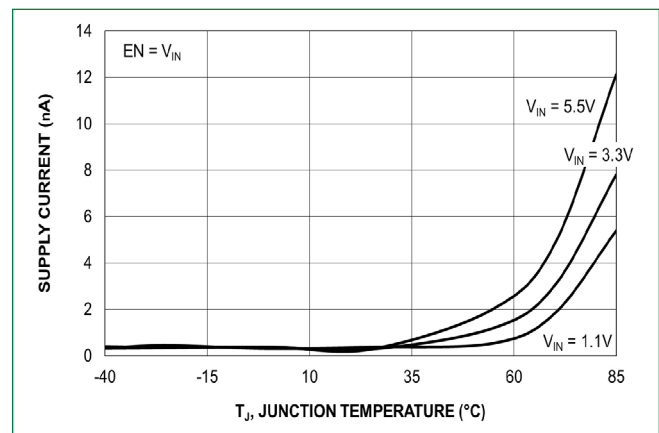
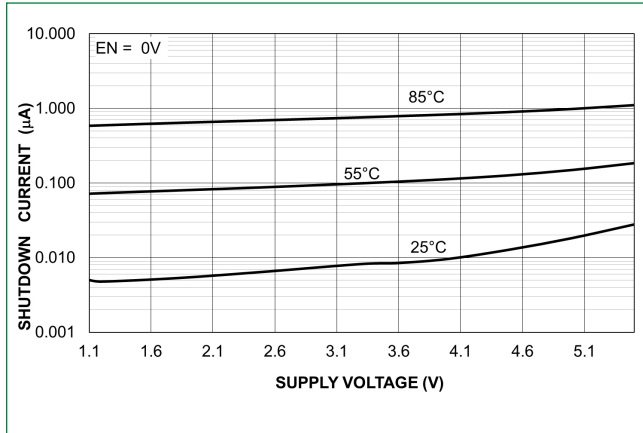
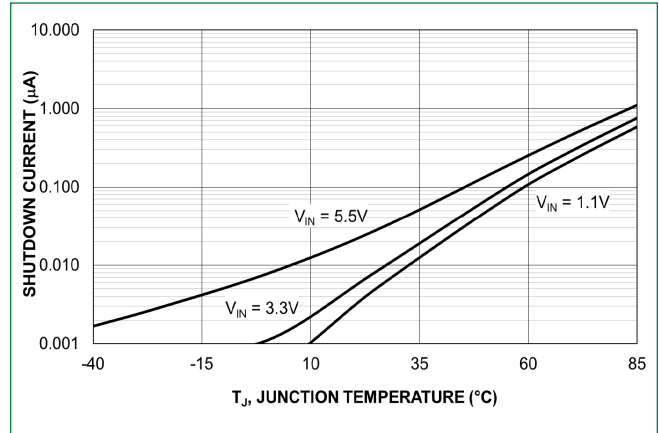
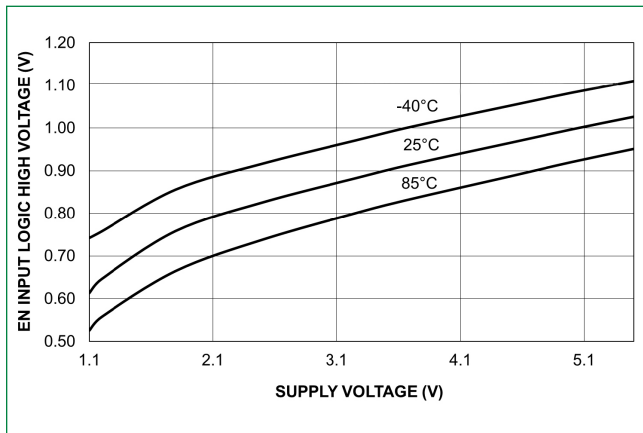
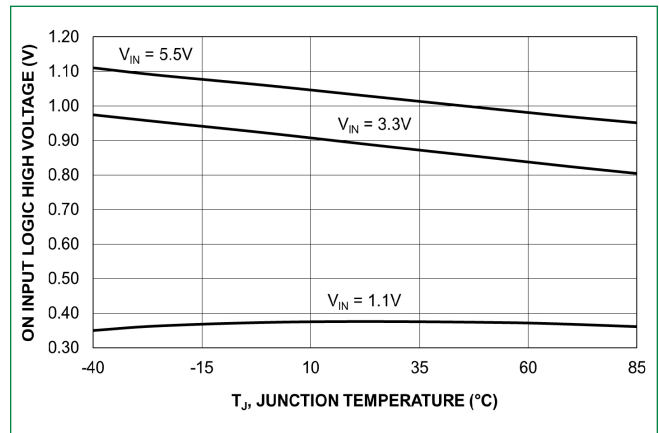
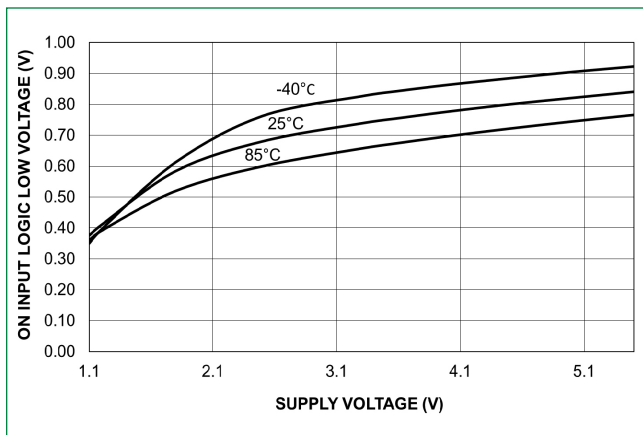
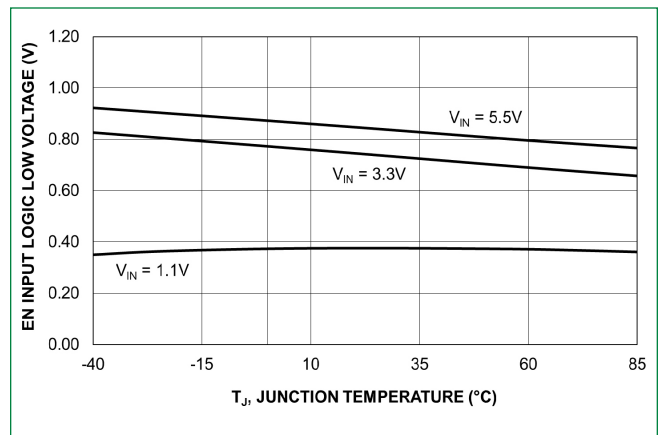


Figure 4 - Quiescent Current vs. Temperature



# LQ05022QCS4

## 5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control

**Figure 5 - Shut Down Current vs. Input 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**

# LQ05022QCS4

## 5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control

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

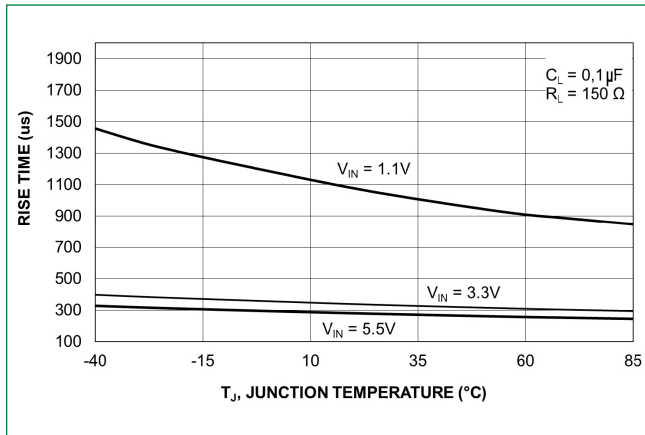


Figure 12 - Turn-On Delay Time vs. Temperature

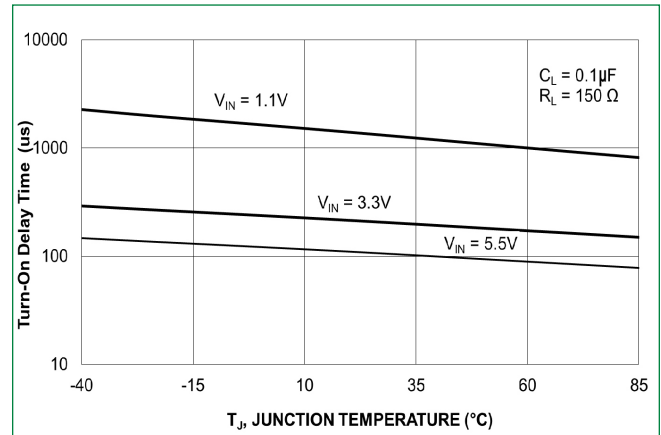


Figure 13 - Turn-On Response  
 $V_{IN} = 3.3V$ ,  $C_{IN} = 1.0\mu F$ ,  $C_{OUT} = 0.1\mu F$ ,  $R_L = 10\Omega$

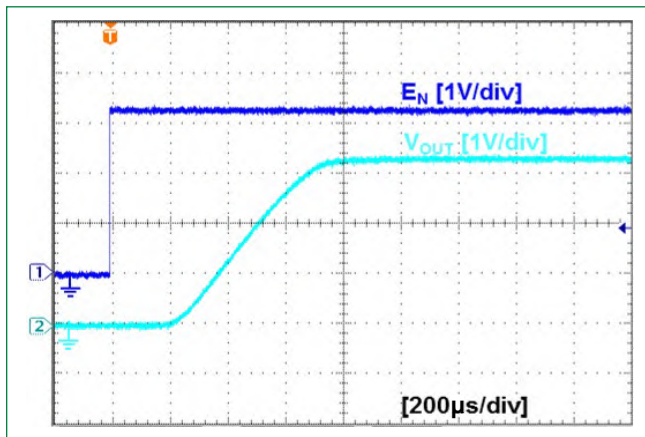


Figure 14 - Turn-On Response  
 $V_{IN} = 3.3V$ ,  $C_{IN} = 1.0\mu F$ ,  $C_{OUT} = 0.1\mu F$ ,  $R_L = 500\Omega$

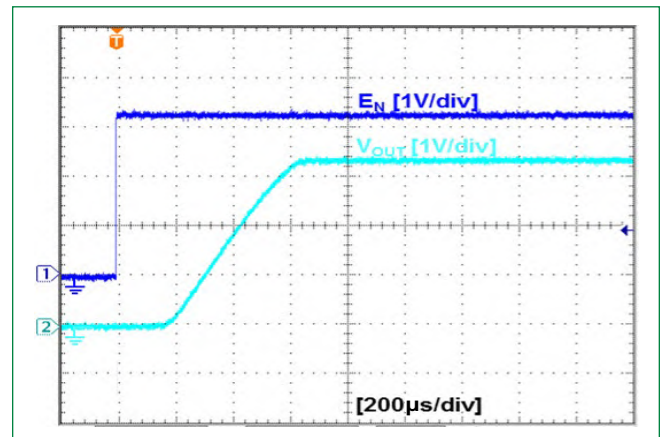


Figure 15 - Turn-Off Response, Output Discharge  
 $V_{IN} = 3.3V$ ,  $C_{IN} = 1.0\mu F$ ,  $C_{OUT} = 0.1\mu F$ ,  $R_L = 10\Omega$

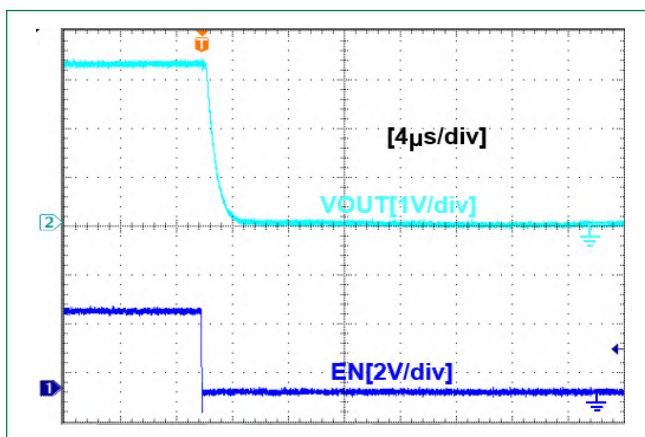
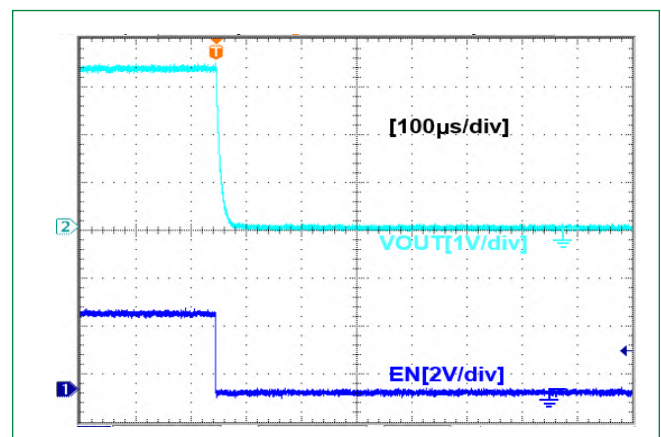


Figure 16 - Turn-Off Response, Output Discharge  
 $V_{IN} = 3.3V$ ,  $C_{IN} = 1.0\mu F$ ,  $C_{OUT} = 0.1\mu F$ ,  $R_L = 500\Omega$



# LQ05022QCS4

## 5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control

### Application Information

The LQ05022QCS4 is a highly efficient integrated load switch with a 2 A capacity. It allows a fixed slew rate control to limit inrush current when activated. This device works with a wide input voltage range, from 1.1 V to 5.5 V, and has minimal on-resistance to reduce power loss. When it is off, it has very low leakage current, saving power resources. It is in a chip scale size package at 0.97 mm x 0.97 mm x 0.55 mm with 4 bumps at a 0.5 mm pitch make it ideal for efficient manufacturing in the space-saving required applications.

#### Input Capacitor

Although this is not required to have an input capacitor. Suggest to use a 0.1  $\mu$ F capacitor positioned near the VIN pin to address voltage fluctuations on the input power rail that may occur as a result of transient inrush current during startup. To reduce the extent of the input voltage drop, suggest to use a higher input capacitor value.

#### Output Capacitor

An output capacitor is not mandatory for the LQ05022QCS4. Nevertheless, it is advisable to employ an output capacitor to minimize voltage undershoot on the output pin during switch-off.

Voltage undershoot may arise due to parasitic inductance from board traces or deliberate load inductances. In the presence of load inductances, utilizing an output capacitor can enhance output voltage stability and overall system reliability. Position the  $C_{OUT}$  capacitor in close proximity to the  $V_{OUT}$  and GND pins.

#### EN pin

The LQ05022QCS4 can be turned on by setting the EN pin to a high level. Be aware that there is an internal pull-down resistor in EN pin which can pull the primary switch to “off state” as long as no EN signal from an external controller is applied.

#### Output Discharge Function

The device incorporates an internal discharge N-channel FET switch located at the VOUT pin. When the EN signal switches the primary power FET to an off state, the N-channel switch activates to rapidly discharge the output capacitor.

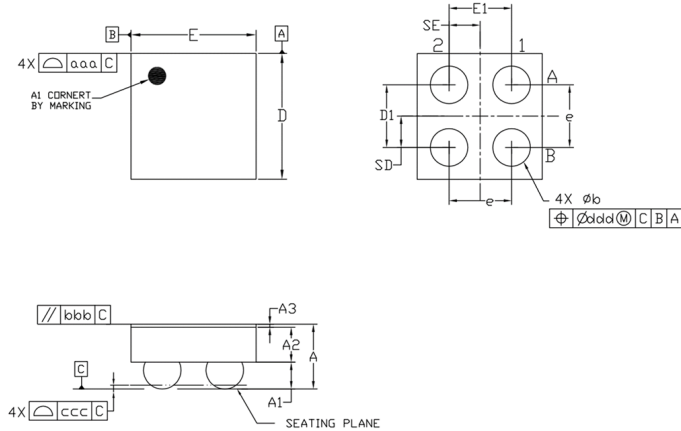
#### Board Layout

To minimize the impact of parasitic inductance, it is advisable to keep all traces as short as possible. Using wider traces for  $V_{IN}$ ,  $V_{OUT}$ , and GND is recommended to mitigate parasitic effects during dynamic operations and enhance thermal efficiency under high load currents.

# LQ05022QCS4

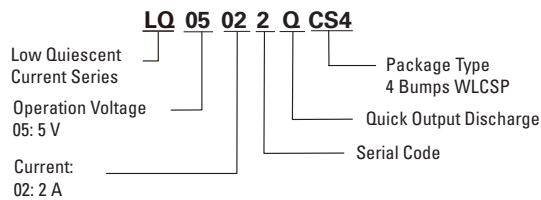
## 5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control

### Dimensions

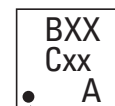


| Dimension               | Millimeters |       |       |
|-------------------------|-------------|-------|-------|
|                         | Min         | Nom   | Max   |
| A                       | 0.500       | 0.550 | 0.600 |
| A1                      | 0.225       | 0.250 | 0.275 |
| A2                      | 0.225       | 0.275 | 0.300 |
| A3                      | 0.020       | 0.025 | 0.030 |
| D                       | 0.960       | 0.970 | 0.985 |
| E                       | 0.960       | 0.970 | 0.985 |
| D1                      | 0.450       | 0.500 | 0.550 |
| E1                      | 0.450       | 0.500 | 0.550 |
| b                       | 0.260       | 0.310 | 0.360 |
| e                       | 0.500 BSC   |       |       |
| SD                      | 0.250 BSC   |       |       |
| SE                      | 0.250 BSC   |       |       |
| Tol. of Form & Position |             |       |       |
| aaa                     | 0.100       |       |       |
| bbb                     | 0.100       |       |       |
| ccc                     | 0.050       |       |       |
| ddd                     | 0.050       |       |       |

### Part Numbering

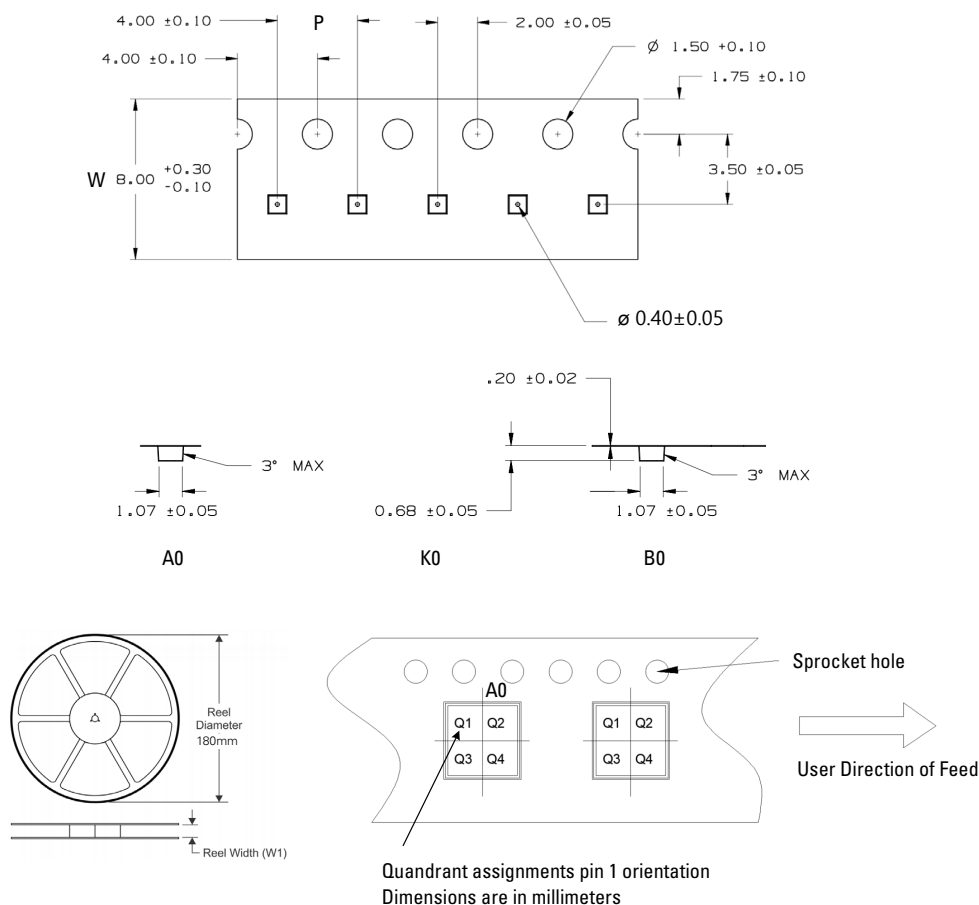


### Part Marking



Pin 1 mark

BC = Device Code  
 XX = Wafer Lot Run Code  
 xx = Assembly Lot Run Code  
 A = Assembly Code

**LQ05022QCS4****5 V, 2 A Ultra Low Consumption Load Switch With Slew Rate Control****Carrier Tape & Reel Specification**

| Device      | Package       | Pins | SPQ  | Reel Diameter | Reel Width W1 | A0   | B0   | K0   | P | W | Pin1 |
|-------------|---------------|------|------|---------------|---------------|------|------|------|---|---|------|
| LQ05022QCS4 | 4 Bumps WLCSP | 4    | 3000 | 180           | 9             | 1.07 | 1.07 | 0.68 | 4 | 8 | Q1   |

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