

RYC8620/21/30

Protected Power Switch

Document: SCD 25389
Status: Released
Rev. E
Date: September 3, 2004

GENERAL DESCRIPTION

RYC8620/21/630 is a series of dual channel protected power switches designed for USB and other 3.3V to 5V high-side power switched applications. Each channel can be separately enabled and has a deglitched fault flag to minimize nuisance tripping when high inrush current devices are plugged into the port. The output MOSFET typically has a low on resistance of 100mΩ. The RYC8620/21/30 series of power switches provides channel independent current limiting and overtemperature protection. In an overcurrent event the offending channel is turned off allowing normal operation on the other channel. The RYC8620/21/30 features undervoltage lockout, soft start and reverse current blocking when disabled.

RYC8620/21/30 devices are available with multiple current limits. Custom current limit levels may be available on request.

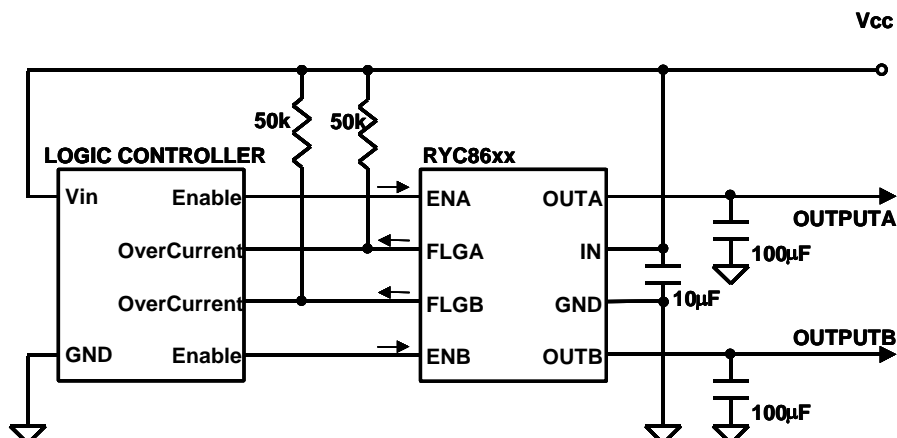
FEATURES

- Designed for USB applications
- Low Rds on, typical 100mΩ
- Fast overcurrent shut down minimizes peak inrush current
- Built-in flag deglitch to minimize nuisance tripping
- Independent OC and OT protection
- Soft start
- Reverse current blocking when disabled.
- Undervoltage lockout (UVLO)
- 8 pin SOIC package
- UL Recognized
- Typical Current Limit
 - RYC8620: 1.0A
 - RYC8621: 1.2A
 - RYC8630: 1.5A

APPLICATIONS

- USB peripherals
- Notebook PCs
- PDAs
- PC card hot swap
- General purpose power switches

TYPICAL APPLICATION SCHEMATIC



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ORDERING INFORMATION

| Part Description | Part Number | Enable | Continuous Current (A) | Package | Tape and Reel Quantity |
|------------------|-------------|-------------|------------------------|-------------|------------------------|
| RYC8620-1M | D17540-000 | Active High | 0.6 | 8-lead SOIC | 2,500 pcs |
| RYC8620-2M | A05322-000 | Active Low | 0.6 | 8-lead SOIC | 2,500 pcs |
| RYC8621-1M | A22854-000 | Active High | 0.7 | 8-lead SOIC | 2,500 pcs |
| RYC8621-2M | E04678-000 | Active Low | 0.7 | 8-lead SOIC | 2,500 pcs |
| RYC8630-1M | C36814-000 | Active High | 1.1 | 8-lead SOIC | 2,500 pcs |
| RYC8630-2M | A22843-000 | Active Low | 1.1 | 8-lead SOIC | 2,500 pcs |

Note: Other current may be available, please contact factory.

MATERIALS INFORMATION

ROHS Compliant

Directive 2002/95/EC
Compliant

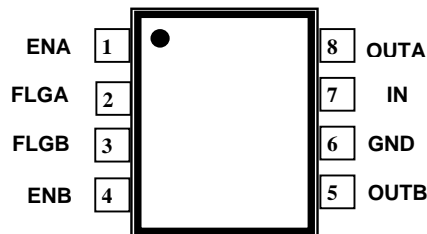
ELV Compliant

Directive 2000/53/EC
Compliant

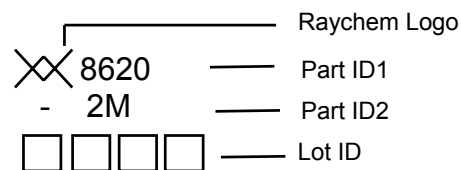
Pb-Free



PIN CONFIGURATION



DEVICE MARKING



PIN DESCRIPTION

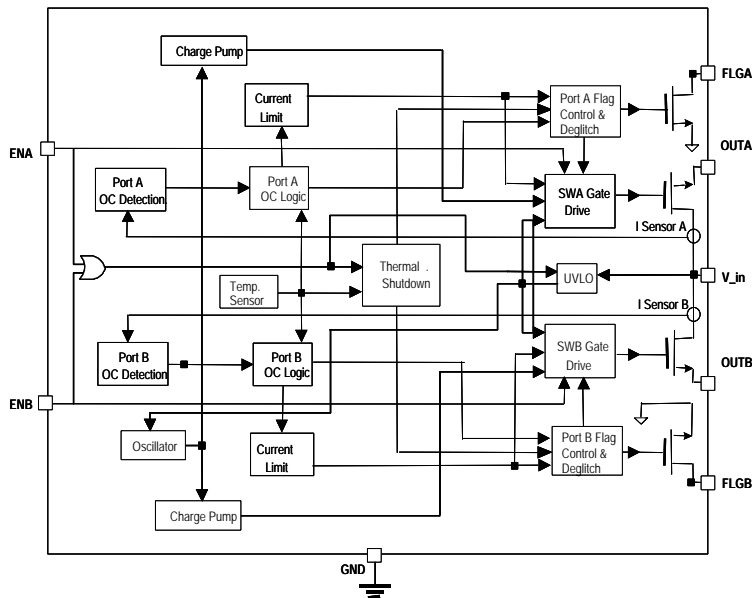
| Pin Number | Pin Name | Pin Function |
|------------|----------|--|
| 1, 4 | EN(A/B) | Enable (Input): Logic-compatible enable input. High input > 2.4V. Low input <0.8V (-1 active high, -2 active low). Do not float. |
| 2, 3 | FLG(A/B) | Fault Flag (Output): Active-low open-drain output. Indicates overcurrent, UVLO and thermal shutdown. |
| 5, 8 | OUT(A/B) | Switch Output: Output MOSFET source. Typically connects to switched side of load. |
| 6 | GND | Ground: Supply return. |
| 7 | IN | Supply Input: Output MOSFET drain. Also supplies IC's internal circuitry. Connect to positive supply. |

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FUNCTIONAL DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Notes 1, 2)

| Parameter | Symbol | Value | Units |
|--|-----------|--------------------|-------|
| Max main supply voltage | V_{IN} | -0.3 to +6 | V |
| Max voltage, all I/O pins | V_{IN} | -0.3 to +6 | V |
| Output voltage | V_{OUT} | +6 | V |
| Output current | I_{OUT} | Internally limited | A |
| Control input | V_{EN} | - 0.3 to 5.5 | V |
| Storage temperature | T_S | - 65 to +150 | °C |
| Fault flag current | I_{FLG} | 25 | mA |
| Max lead temperature during soldering (5 sec.) | | 260 | °C |

Note 1. Operation beyond absolute maximum rating or improper use may result in permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods or to conditions beyond absolute maximum rating conditions may adversely affect device reliability. Functional operation under absolute maximum rating conditions is not implied.

Note 2. Devices are ESD sensitive. Handling precautions recommended.

OPERATING RATINGS (Note 3)

| Parameter | Symbol | Value | Units |
|---|---------------|--------------|-------|
| Supply voltage, Note 4 | V_{IN} | +3.0 to +5.5 | V |
| Continuous Output Current | I_{OUT} | RYC8620 | 0.6 A |
| | | RYC8621 | 0.7 A |
| | | RYC8630 | 1.1 A |
| Ambient operating temperature | T_A | -40 to +85 | °C |
| Thermal resistance (8 pin SOIC), Note 5 | θ_{JA} | 120 | °C/W |

Note 3. The device is not designed to function outside its operating rating.

Note 4. UL recognized at 3.3 – 5Vdc

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ELECTRICAL CHARACTERISTICS ($V_{IN} = +5V$; $T_A = 25^\circ C$; unless noted.)

| Power Switch | Condition | Min | Typ | Max | Units |
|-----------------------|--|-----|-----|-----|-----------|
| Pin to Pin Resistance | $V_{IN} = 5V$, $I_{OUT} = 500mA$, Note 6 | | 100 | 140 | $m\Omega$ |
| | $V_{IN} = 3.3V$, $I_{OUT} = 500mA$, Note 6 | | 100 | 140 | $m\Omega$ |
| Output Turn-On Time | $R_L = 50 \Omega$, $C_L = 1\mu F$, each output, sum of delay+ rise time. | 0.2 | 0.5 | 1.0 | ms |
| Output Turn-Off Time | $R_L = 50 \Omega$, $C_L = 1\mu F$, each output, sum of delay+ fall time | 10 | 150 | 300 | μs |

| Current Limit | Condition | Min | Typ | Max | Units |
|-----------------------------|---|-----|-----|------|---------|
| Short-circuit Current Limit | RYC8620 Short circuit applied to the output pin of EN device with 1Ω load | 0.6 | 1.0 | 1.25 | A |
| | RYC8621 Short circuit applied to the output pin of EN device with 1Ω load | 0.7 | 1.2 | 1.35 | A |
| | RYC8630 Short circuit applied to the output pin of EN device with 1Ω load | 1.1 | 1.5 | 2.2 | A |
| Short-circuit Response Time | Short-circuit applied to the output port of EN device ('Hot-plugged short') $V_{OUT} = 5.0V$, $R_L = 0.5 \Omega$, Note 5 | | 1 | | μs |

| Enable Input | Condition | Min | Typ | Max | Units |
|--------------------------|--------------------------------|------|-----|-----|---------|
| Enable Input Threshold | Low-to-high transition, Note 7 | | 1.8 | 2.4 | V |
| | High-to-low transition, Note 7 | 0.8 | 1.7 | | V |
| Enable Input Current | $V_{EN} = 0V$ to $5.5V$ | 0.01 | | 1 | μA |
| Enable Input Capacitance | Note 5 | | | 5 | pF |

| Leakage Current | Condition | Min | Typ | Max | Units |
|------------------------|-------------------------------|------|-----|-----|---------|
| Supply Current | Switch off, $OUT = open$ | | 6 | 15 | μA |
| | All switches on, $OUT = open$ | | 100 | 200 | μA |
| Output Leakage Current | Each output, output disabled | 0.01 | 1 | 20 | μA |

| Overtemperature and UVLO | Condition | Min | Typ | Max | Units |
|------------------------------------|--------------------------|-----|-----|-----|------------|
| Overtemperature Shutdown Threshold | T_J increasing, Note 5 | | 130 | | $^\circ C$ |
| | T_J decreasing, Note 5 | | 120 | | $^\circ C$ |
| UVLO Threshold | $V_{IN} = increasing$ | | 2.3 | | V |
| | $V_{IN} = decreasing$ | | 2.0 | | V |

| Error Flag | Condition | Min | Typ | Max | Units |
|------------------------------|---|------|-----|-----|----------|
| Error Flag Output Resistance | $V_{IN} = 5V$, $I_L = 10mA$, open drain | | 10 | 100 | Ω |
| Error Flag Off Current | $V_{FLAG} = 5V$ | 0.01 | | 1 | μA |
| Error flag output deglitch | Fault on overcurrent, UVLO and thermal shutdown, Note 8 | | 12 | 20 | ms |

Note 5. Validated by design, but not production tested.

Note 6. Pin to Pin total resistance includes lead frame, silicon die metalization, bond wire and FET R_{dson} resistances. Please be aware that some manufacturers only specify the R_{dson} value, which can be significantly less than the total pin to pin resistance.

Note 7. V_{IN} should be within the operating range before the device is enabled.

Note 8. No error flag out deglitch on UVLO and thermal shutdown.

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TYPICAL CHARACTERISTICS

Figure 1. Test Circuit and Timing Diagram

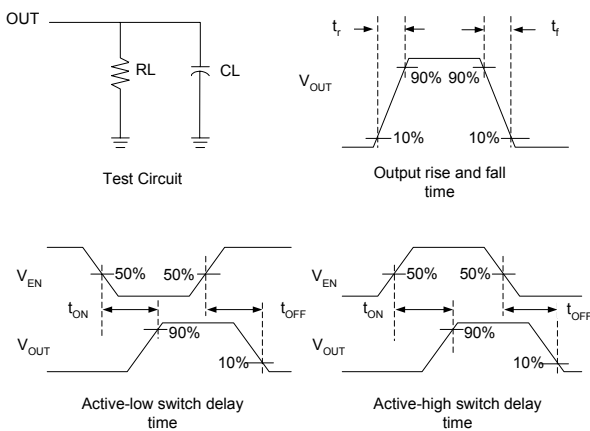


Figure 2. Turn-on Delay Time
 $V_{IN} = 5V, R_L = 10 \Omega$

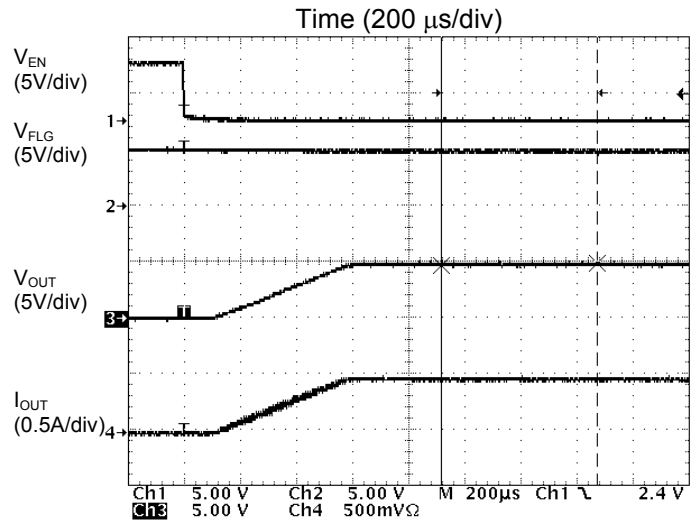


Figure 3. Enable into Short Circuit
(note the 13 ms flag delay)
 $V_{IN} = 5V, R_L = 0.1 \Omega$
Time (2 ms/div)

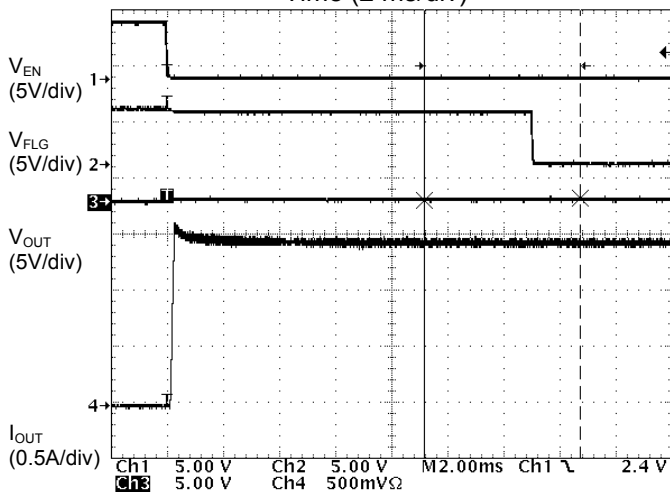
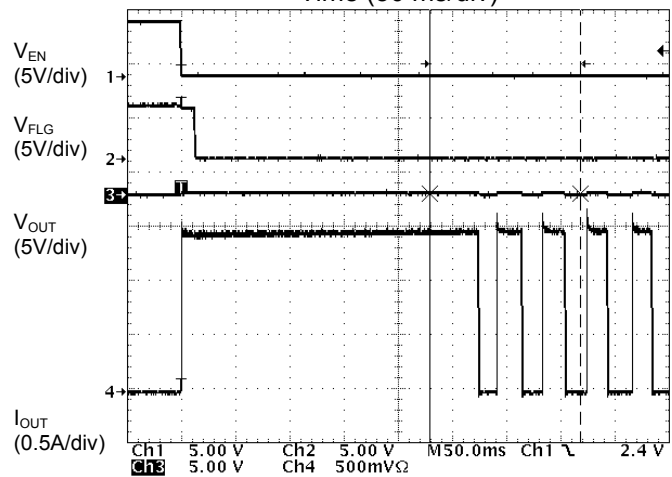


Figure 4. Enable into Short Circuit
(extended time with thermal cycling)
 $V_{IN} = 5V, R_L = 0.1 \Omega$
Time (50 ms/div)



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Figure 5. Hot-plugged Short Circuit
 $V_{IN} = 5V$, $R_L = 0.1 \Omega$

Time (200 μ s/div)

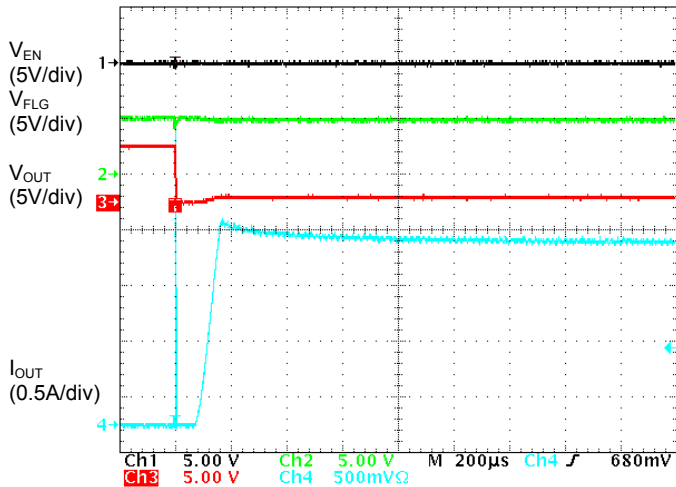


Figure 6. Hot-plugged Short Circuit
(extended time with thermal cycling)
 $V_{IN} = 5V$, $R_L = 0.05 \Omega$

Time (50 ms/div)

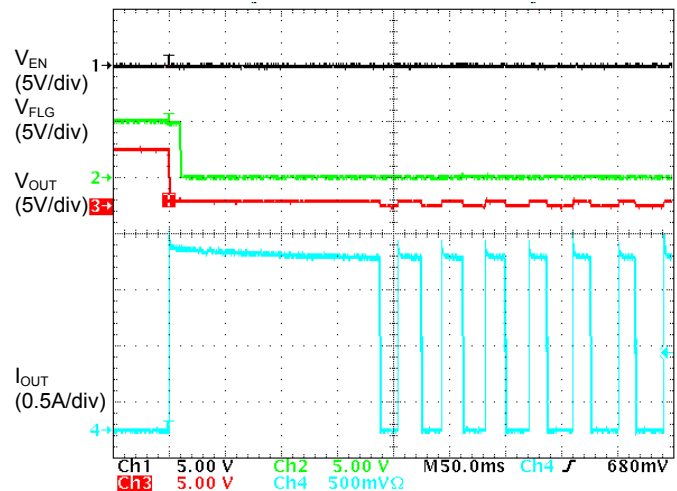


Figure 7. Nuisance Trip Elimination
Hot plugged into a capacitive load
 $V_{IN} = 5V$, $R_L = 10 \Omega$, $C_L = 1880 \mu$ F

Time (10 ms/div)

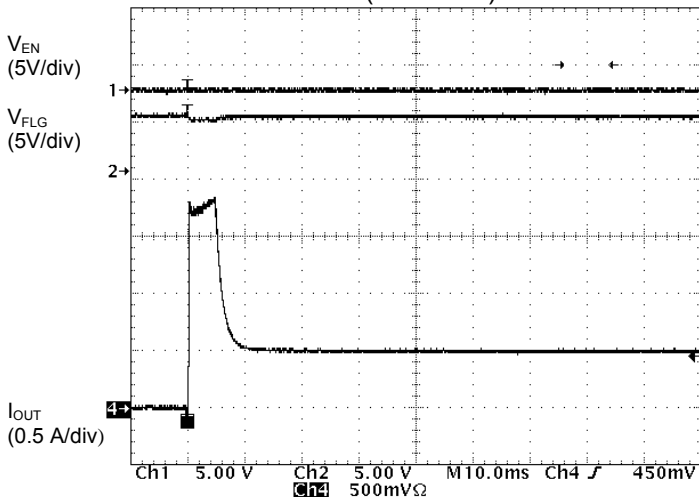
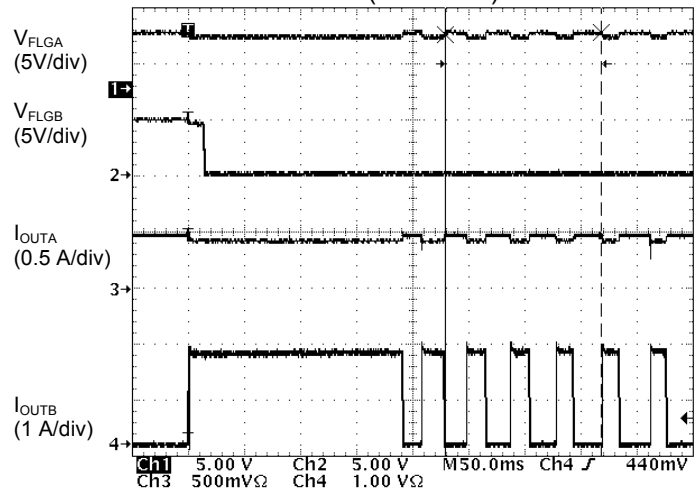


Figure 8. Independent OC/OT Coordination
 $V_{IN} = 5V$, $R_{LA} = 10 \Omega$, $R_{LB} = 0.1 \Omega$

Time (50 ms/div)



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FUNCTIONAL DESCRIPTION

The RYC86xx is a series of dual channel protected power switches designed for USB, SD Memory, and other 3.3V to 5V high-side power switched applications. Each channel can be separately enabled and has a deglitched fault flag to minimize nuisance tripping when high inrush current devices are plugged into the port. The output MOSFET typically has a low on resistance of 100m Ω . The RYC86xx provides channel independent current limiting and overtemperature protection. In an overcurrent event, the offending channel is turned off allowing normal operation on the other channel. The RYC86xx features undervoltage lockout, soft start and reverse current blocking when disabled.

Current Limit and Overtemperature

The RYC86xx is designed to support two power ports. The current limit is 0.6A minimum and 1.25A maximum for the RYC8620, 0.7A minimum and 1.35A maximum for RYC8621 and 1.1A minimum and 2.2A maximum for the RYC8630. When the current limit is exceeded, the device will first limit the current and then, if necessary, will go into thermal shutdown when the die temperature reaches approximately 130°C. When the temperature falls 10°C below the thermal shutdown temperature, the device will restart. If the fault has not been removed, the device will continue to cycle on and off. The frequency of the cycle is dependent on the impedance of the fault and the thermal environment. Each channel operates independently and in a fault event will be protected while allowing the other channel to operate normally.

Enable Pull Up/Down

The EN input is logic level compatible. The enable pin should not be allowed to float; a pull-up/pull-down resistor (depending on the polarity of the enable) should be used to tie the pin high/low.

Fault Flag

The fault flag signal is asserted low when an overcurrent, overtemperature or undervoltage event occurs. In the event of an overcurrent, the fault flag is deglitched for approximately 10 ms to minimize nuisance tripping. The FLAG pin is an open drain design and will require a pull-up resistor.

Undervoltage lockout (UVLO)

If the supply voltage (V_{aux}) drops below approximately 2.0V the RYC86xx will turn off. The undervoltage limit protects the hub from operating at voltages too low to assure reliable logic operation.

Soft Start

When the device is first enabled into a load, the device is turned on slowly and requires typically 0.5 ms to reach 90% of the operating voltage.

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APPLICATION INFORMATION

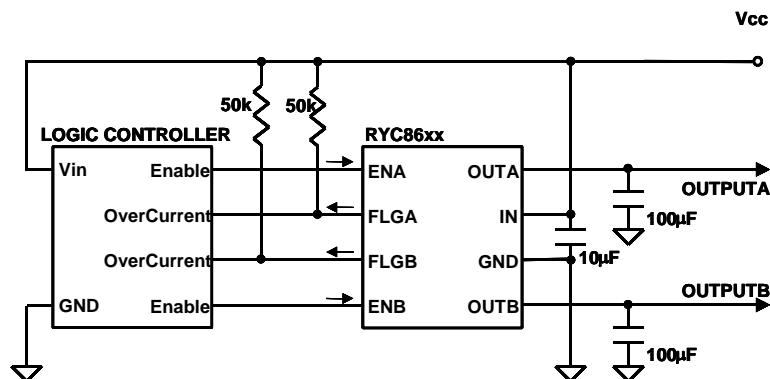
Input Capacitor

Decoupling input capacitors (0.1 μF) should be used to tie the V_{IN} pin to ground to minimize voltage transients.

Input transients which exceed the absolute maximum rating may cause damage to the device.

Output Capacitors

Decoupling capacitors (0.1 μF) between the output and ground are also recommended to reduce the impact of other voltage transients such as ESD. Output capacitors will help minimize negative voltage spikes due to parasitic inductance. USB specifications require 120 μF of low ESR output capacitance per hub.

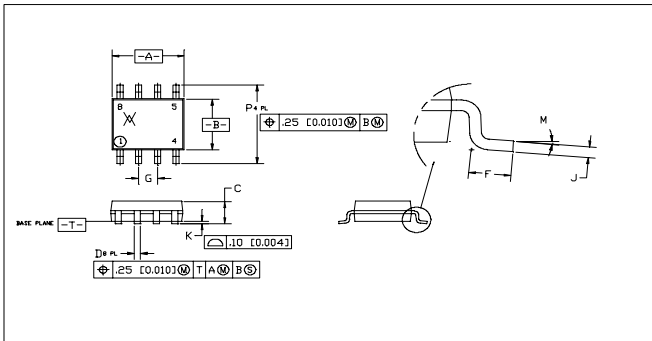


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PACKAGE INFORMATION



| | MIN | MAX | MIN | MAX |
|-----------|----------|------|-----------|-------|
| DIMENSION | mm | mm | inch | inch |
| A | 4.80 | 5.00 | 0.190 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.013 | 0.020 |
| F | 0.40 | 1.27 | 0.016 | 0.050 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.18 | 0.25 | 0.0075 | 0.010 |
| K | 0.10 | 0.25 | 0.004 | 0.010 |
| M | 0° | 8° | 0° | 8° |
| P | 5.80 | 6.20 | 0.228 | 0.244 |

8-lead SOIC PACKAGE NOTES:

1. Dimensions and tolerance per ANSI Y14.5M-1982.
2. Dimensions A and B are datums and T is a datum surface.
3. Controlling dimensions: Millimeters
4. Dimension A and B do not include mold flash. Mold flash shall not exceed 0.15mm [0.006] per side.
5. Dimension D does not include interlead flash. Interlead flash shall not exceed 0.25 mm [0.010].

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