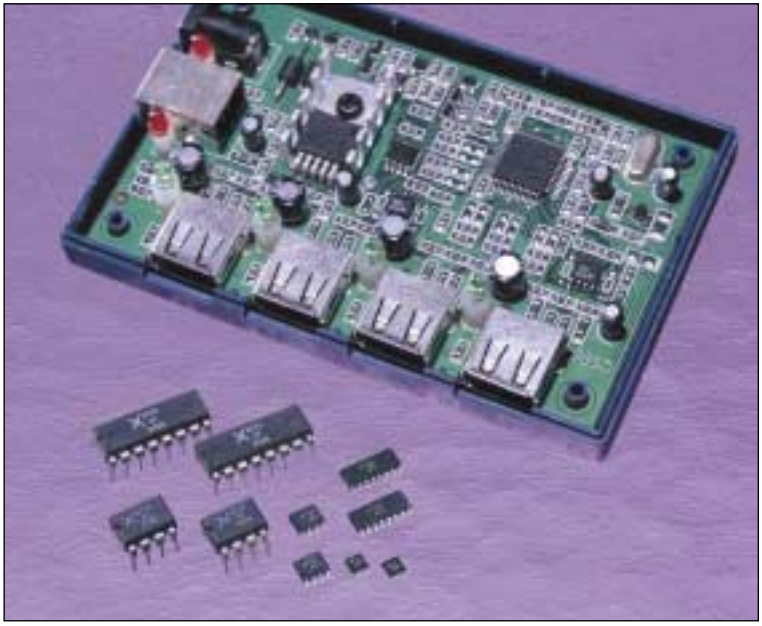
Protected Power Switch Devices

Raychem Circuit Protection offers silicon-based Protected Power Switch devices as well as the PolySwitch resettable devices for USB protection. USB bus-powered hubs and some USB host applications require power switching as well as over-current protection. Raychem Circuit Protection's protected power switch devices help meet both of these requirements as well as in-rush current control.



Benefits:
- Reduced nuisance tripping during hot-plug
- Reduced component count
- Device designed such that a fault on one port does not disable remaining ports

Features:
- Compliant to USB 1.1 and proposed USB 2.0 specifications
- UL recognized component
- Built-in hot-plug flag delay
- Low On-Resistance (90mΩ, typ)
- Independent OC and OT protection
- Resistance decreases as voltage decreases
- Optional imbedded resistors on EN pins

Application:
- USB Hosts
  Desktop PC
  Notebook PC
- USB Self-Powered Hubs
  Monitor
  Stand-Alone Hub
- USB Bus-Powered Hubs
  Keyboard
- USB Function
  CCD Camera
  Joystick

Step 1. Verify the circuit's operating parameters.

Confirm that the circuit's operating parameters are within the following device ratings.

• Input voltage (V_{IN})	+3 to +5.5V
• Output voltage (V_{OUT})	+3 to +5.5V
• Output current per port (I_{OUT})	0.6A
• Operating temperature range	-40 to +85°C

Step 2. Determine the package type and number of switches per package.

The RYC82xx series are available in a variety of package types and number of switches per package. Refer to Table P1 for the options available in package type and switches per package. Dimensions of each package type are available in Table P3 to confirm the device selected will fit in your space requirements.

Step 3. Determine the output parameters of the USB controller chip used in your circuit.

Some USB controller chips have enable logic that requires the power switch to be active low while others require the switch to be active high. This signal will be connected to the enable pin of the device selected. See Table P1 to select the correct enable logic voltage of the device selected in Step 2 above.

Step 4. Determine your preferred circuit implementation for the internal Enable (EN) pull-up/pull-down resistors.

The RYC82xx series devices have been designed with an option to minimize the number of external components to achieve functionality. Depending on the design of your circuit you may or may not require the enable resistor to maximize performance of your USB circuit. Devices with the EN resistor on board may eliminate the need for an external resistor, thereby reducing external components. See Table P1 to select the desired configuration for your USB circuit.

Step 5. Independently evaluate and test the suitability of and performance of the selected protected power switch.

Table P1. Product Series – Number of Switches, Package Type, Enable Logic and EN Resistor Options for Protected Power Switch Devices

Part Number	Number of Switches	Package Type*	Enable Logic	EN Resistor on Chip
RYC8210-1M	1	SO-8	Active high	Yes
RYC8210-1MM**	1	TSSOP-8	Active high	Yes
RYC8210-2M	1	SO-8	Active low	Yes
RYC8210-2MM**	1	TSSOP-8	Active low	Yes
RYC8210-3M	1	SO-8	Active high	No
RYC8210-4M	1	SO-8	Active low	No
RYC8220-1M	2	SO-8	Active high	Yes
RYC8220-2M	2	SO-8	Active low	Yes
RYC8220-3M	2	SO-8	Active high	No
RYC8220-4M	2	SO-8	Active low	No
RYC8240-1WM	4	SO-16	Active high	Yes
RYC8240-2WM	4	SO-16	Active low	Yes

Notes:
*Leaded packages are available. Please contact your Raychem Circuit Protection representative for more information.
**Please contact your Raychem Circuit Protection representative for availability.

Table P2. Electrical and Thermal Specifications for Protected Power Switch Devices

Thermal and Maximum Ratings 1, 2	Symbol	Value	Units
Max. supply voltage	V_{IN}	+8	V
Fault flag voltage	V_{FLG}	+8	V
Fault flag current	I_{FLG}	50	µA
Output voltage	V_{OUT}	+8	V
Output current	I_{OUT}	Internally limited	A
Control input	V_{EN}	-0.3 to +12.0	V
Storage temperature	T_S	-65 to +150	°C
Max. lead temperature during soldering (5 sec.)		260	°C
Operating Ratings, 3			
Supply voltage	V_{IN}	+3 to +5.5	V
Continuous output current	I_{OUT}	0.6	A
Ambient operating temperature	T_A	-40 to +85	°C
Thermal resistance (SO-8)	θJ_A	120	°C/W

Electrical Characteristics (V_{IN} = 5V, T_A = 25°C, unless noted.)

Power Switch	Condition	Min	Typ	Max	Units
Switch resistance	V_{IN} = 5V, I_{OUT} = 500mA, each switch	—	95	120	mΩ
	V_{IN} = 3.3V, I_{OUT} = 500mA, each switch	—	90	110	mΩ
Output turn-on time	R_L = 10 Ω each output, consists of delay+rise time	—	3.6	12	ms
Output turn-off time	R_L = 10 Ω each output, consists of delay+fall time	—	2	40	µs
Short-circuit current limit	Each output (enable into 0Ω load)	0.6	0.9	1.25	A
	Each output (3Ω load hot-plugged into EN device), V_{OUT} = 4.0V	0.6	0.9	1.25	A
Enable input threshhold	Low-to-high transition, 4	—	1.5	2.4	V
	High-to-low transition, 4	0.8	1.5	—	V
Enable input current	V_{EN} = 0V to 5.5V	—	0.01	1	µA
Enable input capacitance		—	—	5	pF
Supply current	Switch off, OUT = open	—	0.5	5	µA
	Switches on, OUT = open, 5	—	200	250	µA
Output leakage current	Each output (output disabled)	—	—	10	µA
Over Temperature, Under Voltage (UVLO) Lock Out (OVLO)					
Over temperature shutdown	T_J increasing	—	135	—	•C
Threshold	T_J decreasing	—	125	—	•C
UVLO threshold	V_{IN} = increasing	—	2.5	—	V
	V_{IN} = decreasing	—	2.3	—	V
OVLO threshold	V_{IN} = increasing	—	6.4	—	V
	V_{IN} = decreasing	—	6.1	—	V
Error Flag					
Error flag output resistance	V_{IN} =5V, I_L = 10mA, 6	—	50	100	Ω
	V_{IN} = 3.3V, I_L = 10mA, 6	—	80	100	Ω
Error flag output delay	Fault on overcurrent, 7	6	9	15	ms
Error flag off current	V_{FLAG} = 5V	—	0.01	1	µA

Notes:
1. Exceeding the maximum rating may damage the device.
2. Devices are ESD sensitive. Handling precautions recommended.
3. The device is not designed to function outside its operating rating.
4. Off is ≤0.8V and on is ≥2.4V for the RYC82x0-1 and RYC82x0-3. Off is ≥2.4V and on is ≤0.8V for the RYC82x0-2 and RYC82x0-4. The enable input has approximately 200mV of hysteresis. Pull-down/pull-up resistors are on chip for "-1" and "-2" configurations.
5. With internal enable pull up/down resistors.
6. Pull-up resistors are on chip.
7. No error flag output delay on UVLO, OVLO and thermal shut down.

Figures P1–P20. Typical Characteristics for Protected Power Switch Devices

Figure P1. Test Circuit and Timing Diagram

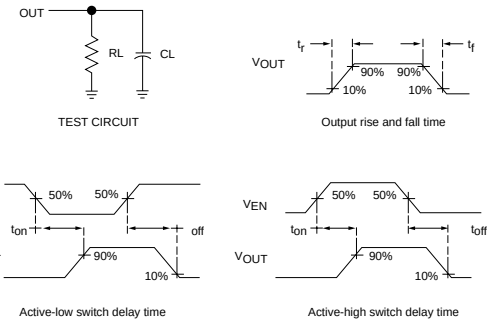


Figure P2. Turn-on Delay Time

(V_{IN} = 5V, R_L = 10Ω)

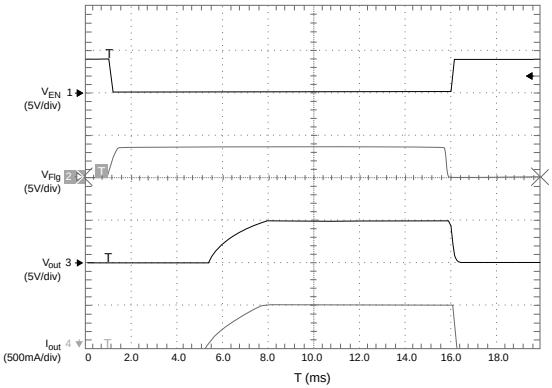


Figure P3. Enabled into Short Circuit

(V_{IN} = 5V, R_L = 0.1Ω)

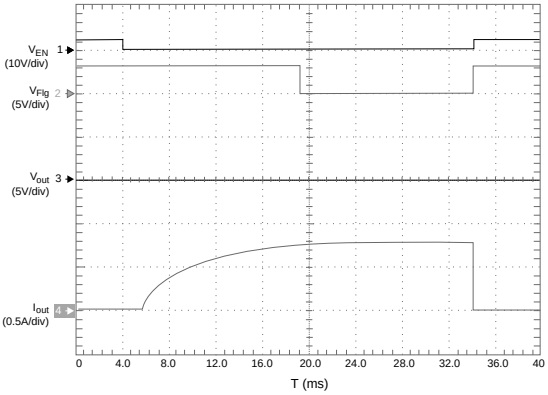


Figure P4. Enabled into Short Circuit (extended time with thermal cycling)

(V_{IN} = 5V, R_L = 0.1Ω)

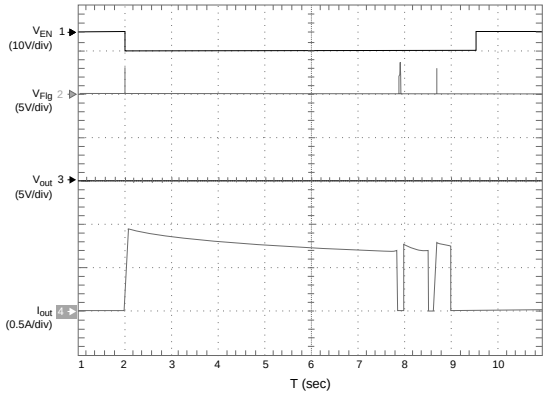


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Figure P5. Hot-Plugged Short Circuit

(T_A = 25˚C, V_{IN} = 5V, R_L = .05Ω)

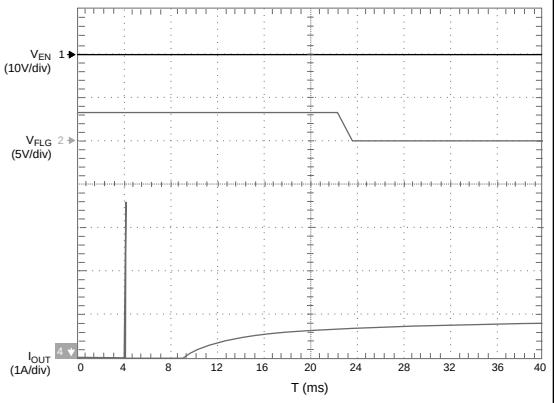


Figure P6. Hot-Plugged Short Circuit (extended time with thermal cycling)

(T_A = 25˚C, V_{IN} = 5V, R_L = .05Ω)

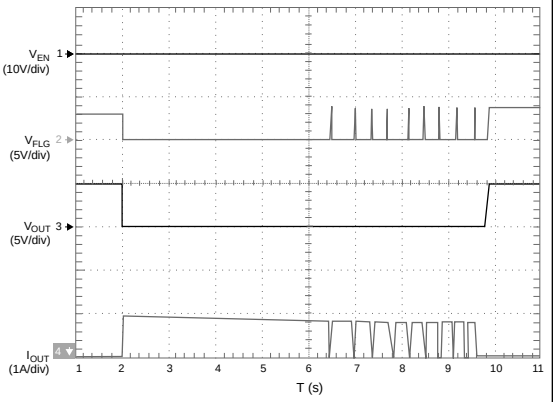


Figure P7. Nuisance Trip Elimination

(V_{IN} = 5V, R_L = 10Ω)

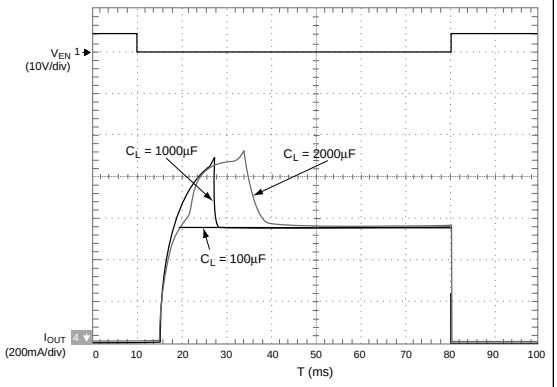
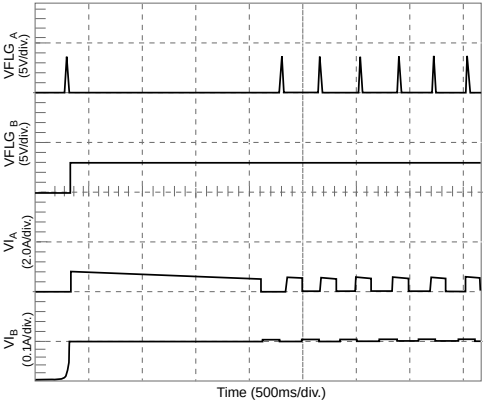


Figure P8. Independent OC/OT Coordination

(OC/OT protection in channel A, normal operation in channel B, V_{IN} = 5V, R_L = 0.1Ω)



Figures P1–P20. Typical Characteristics for Protected Power Switch Devices *continued*

Figure P9. On-Resistance vs. Input Voltage

(T_A = 25˚C, I_L = 500 mA)

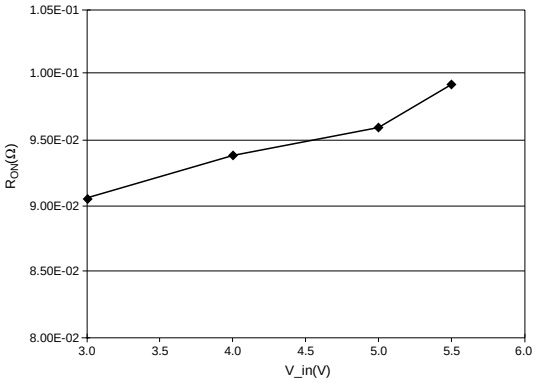


Figure P10. On-Resistance vs. Ambient Temperature

(V_{IN} = 5V, I_L = 500 mA)

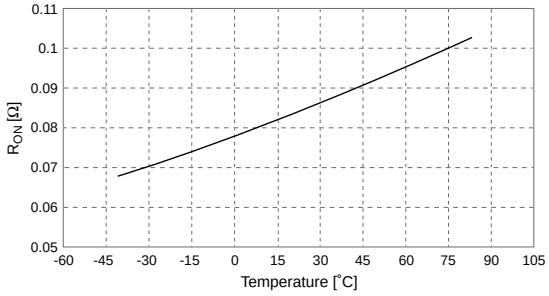


Figure P11. Enable Threshold vs. Supply Voltage

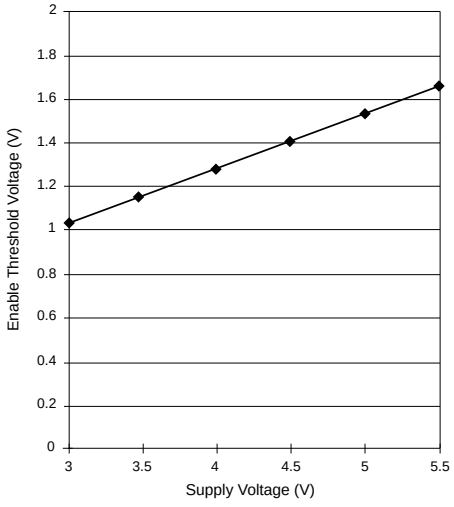


Figure P12. On-State Supply Current vs. Input Voltage

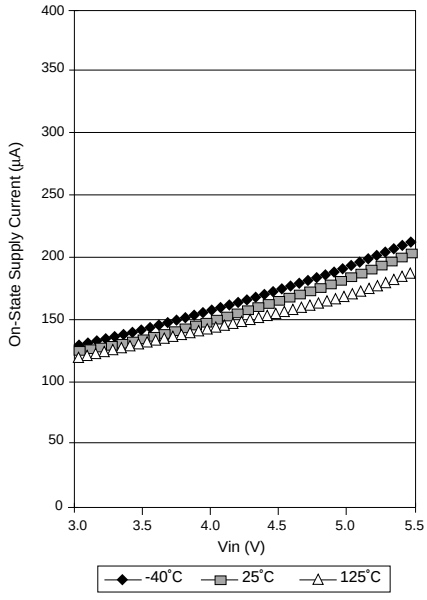


Figure P13. On-State Supply Current vs. Ambient Temperature

(V_{IN} = 5V)

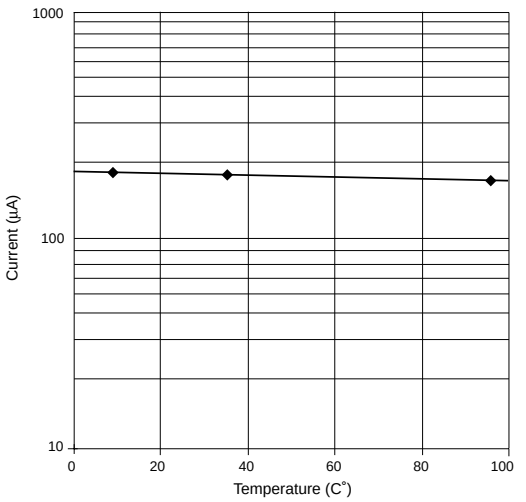


Figure P14. Off-State Supply Current vs. Input Voltage

(T_A = 25˚C)

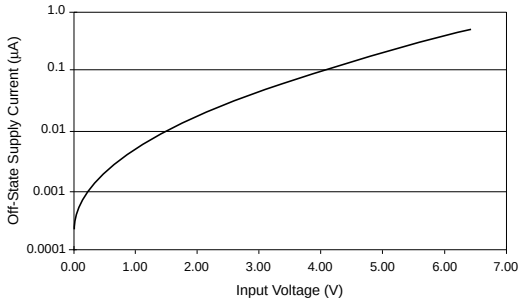


Figure P15. Off-State Supply Current vs. Ambient Temperature

(V_{IN} = 5V)

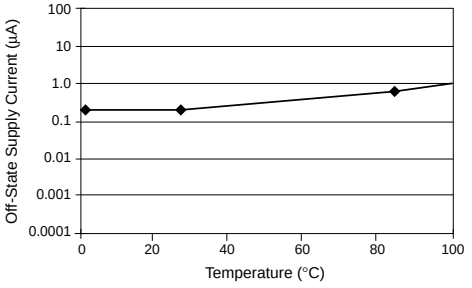
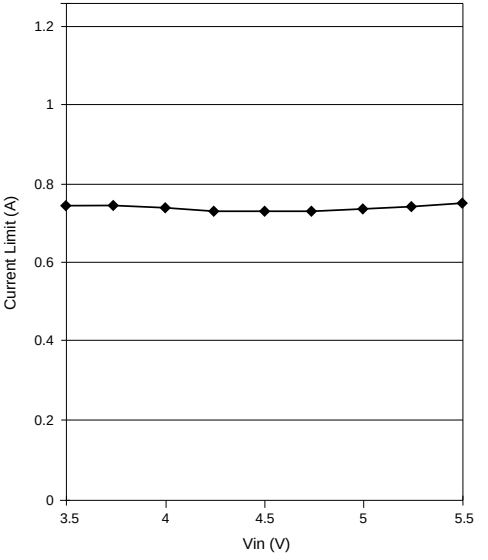


Figure P16. Current Limit vs. Input Voltage

(T_A = 25˚C)



Figures P1–P20. Typical Characteristics for Protected Power Switch Devices *continued*

Figure P17. Current Limit vs. Ambient Temperature

(V_{IN} = 5V)

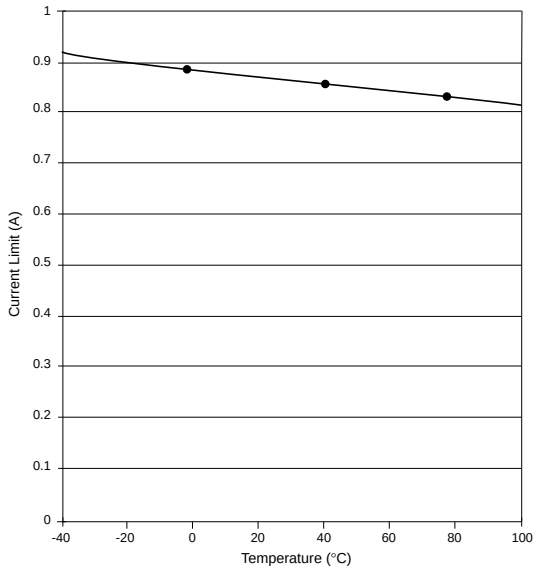


Figure P18. Hot-Plug Short Circuit Current vs. Supply Voltage

(T_A = 25˚C)

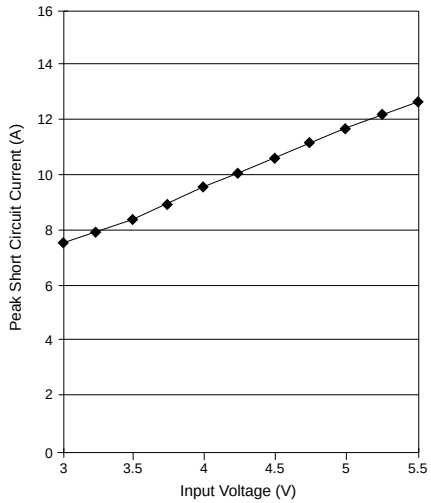


Figure P19. Hot-Plug Short Circuit vs. Ambient Temperature

(V_{IN} = 5V)

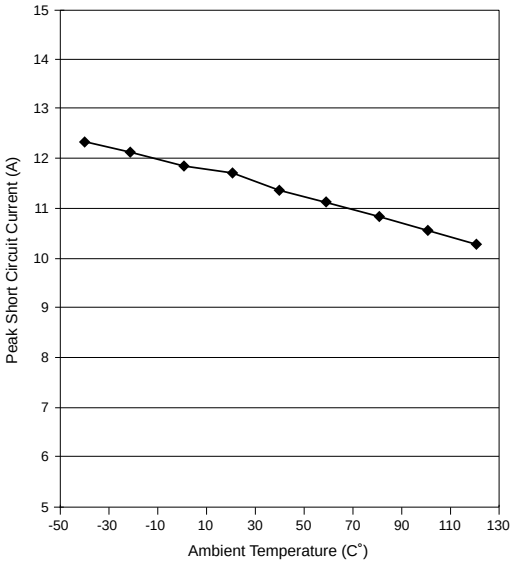
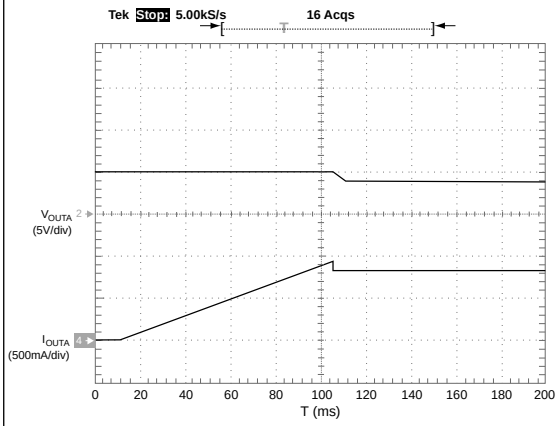


Figure P20. Enable Voltage vs. Ambient Temperature

(V_{IN} = 5V)



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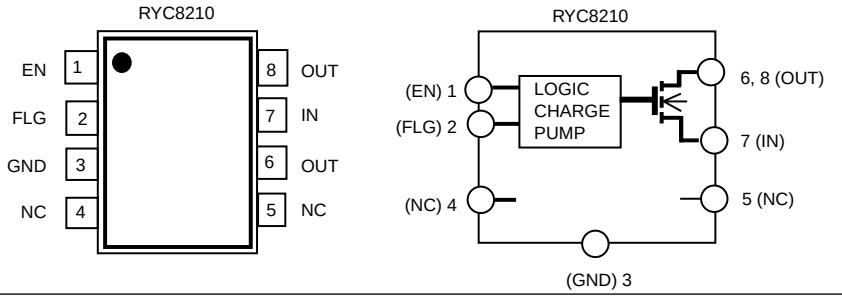
RYC8210 & RYC8220 Pin Configurations for Protected Power Switch Devices

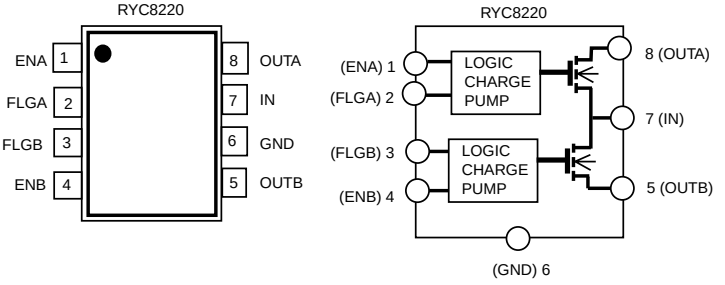
Figure P21. Pin Configuration for RYC8210 Series



Pin Descriptions

Pin Name	Pin Number	Pin Function
EN	1	Enable (Input): Logic-compatible enable input. High input > 2.4V. Low input < 0.8V (-1 active high, -2 active low). Do not float.
FLG	2	Fault Flag (Output): Active-low open-drain output. Indicates overcurrent, UVLO, OVLO and thermal shutdown.
GND	3	Ground: Supply return
IN	7	Supply Input: Output MOSFET drain. Also supplies IC's internal circuitry. Connect to positive supply.
OUT	6 and 8	Switch Output: Output MOSFET source. Typically connect to switched side of load.
NC	4 and 5	No connections

Figure P22. Pin Configuration for RYC8220 Series

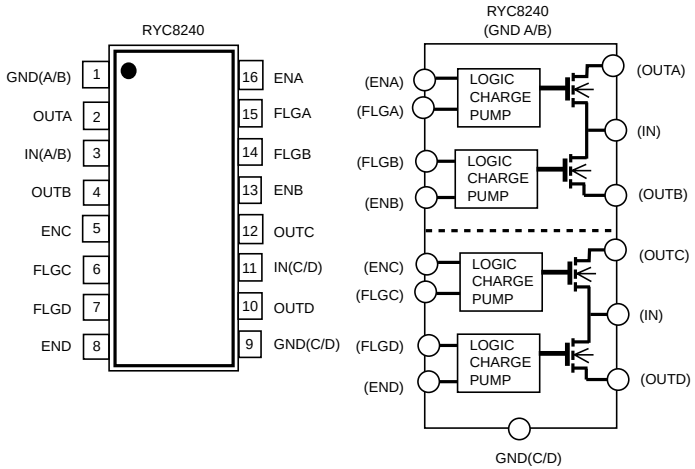


Pin Descriptions

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

RYC8240 Pin Configurations for Protected Power Switch Devices

Figure P23. Pin Configuration for RYC8240 Series



Pin Descriptions

Pin Number	Pin Name	Pin Function
ENA ENB ENC END	16 13 5 8	Enable (Input): Logic-compatible enable input. High input > 2.4V Low input < 0.8V (-1 active high, -2 active low).
FLGA FLGB FLGC FLGD	15 14 6 7	Fault Flag (Output): Active-low open-drain output. Indicates overcurrent, UVLO, OVLO and thermal shutdown.
OUTA OUTB OUTC OUTD	2 4 12 10	Switch Output: Output MOSFET source. Typically connect to switched side of load.
GND(A/B) GND(C/D)	1 9	Ground: Supply return
IN(A/B) IN(C/D)	3 11	Supply Input: Output MOSFET drain. Also supplies IC's internal circuitry. Connect to positive supply.

Figure P24-P26 Physical Descriptions for Dimensions of Protected Power Switch Devices

Figure P24. TSSOP-8 Device Dimensions

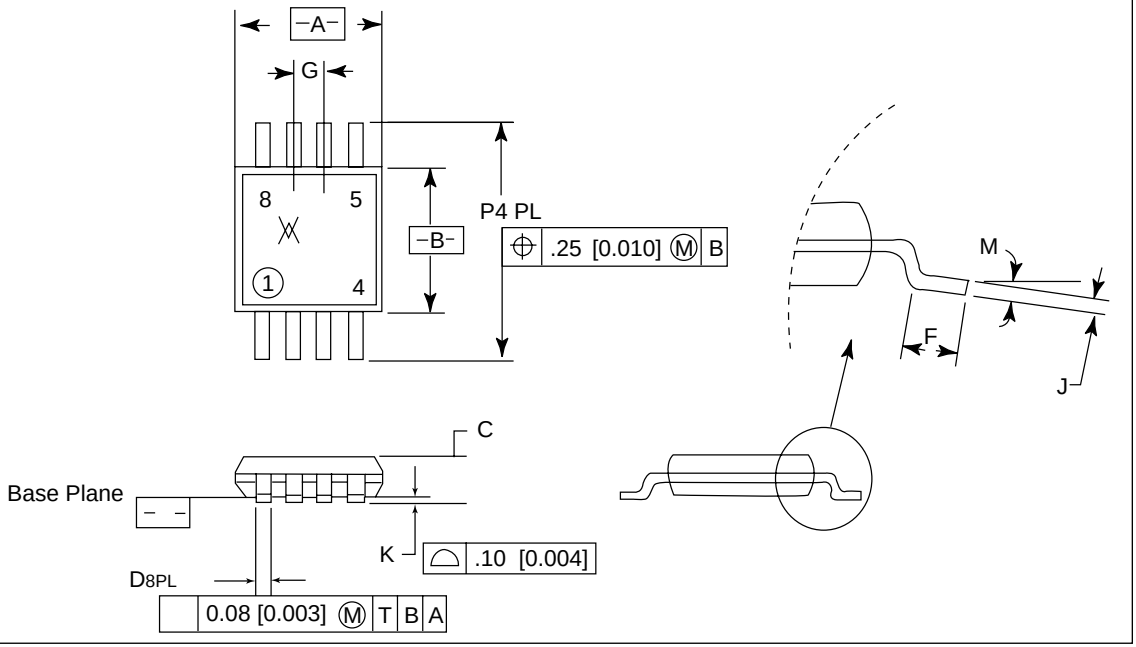


Figure P25. SO-8 Device Dimensions

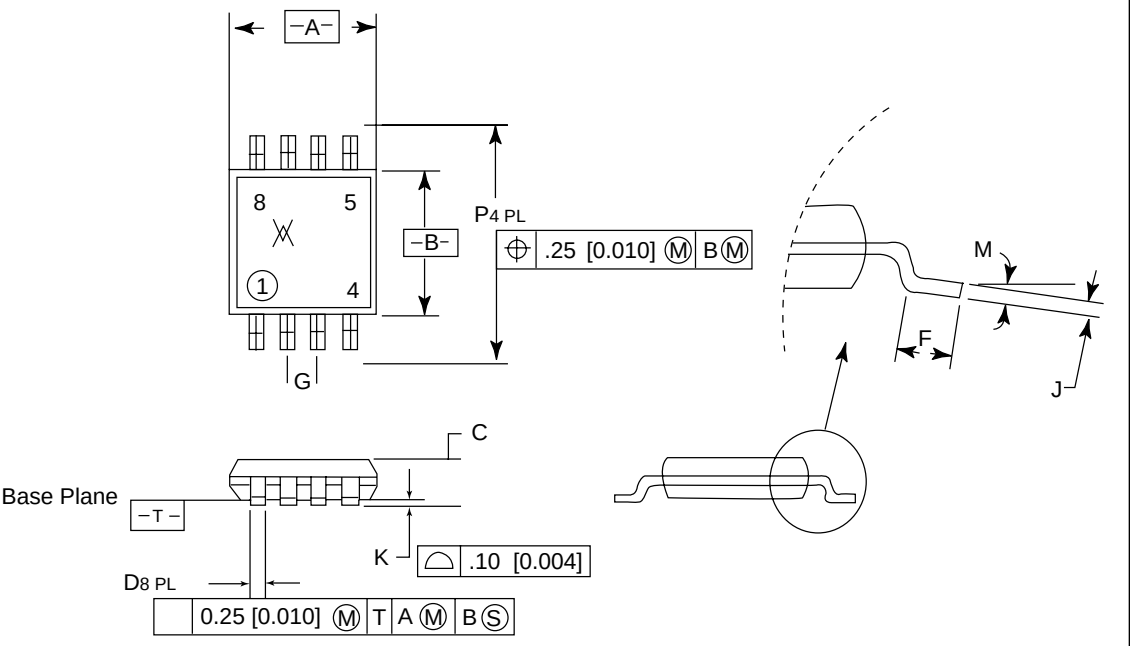


Figure P24-P26 Physical Descriptions for Dimensions of Protected Power Switch Devices *continued*

Figure P26. SO-16 Device Dimensions

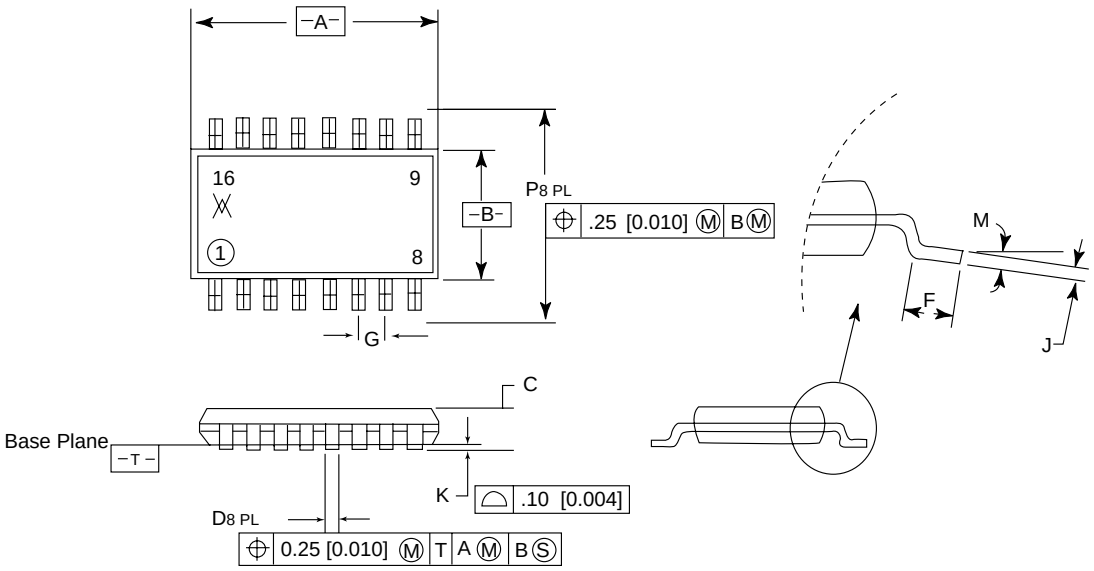


Table P3. Dimensions of Protected Power Switch Devices in Millimeters (Inches)

Figure / Package Type	Figure P24 TSSOP-8		Figure P25 SO-8		Figure P26 SO-16	
Dimension	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
A	2.90 (0.114)	3.10 (0.122)	4.80 (0.190)	5.00 (0.197)	9.80 (0.386)	10.00 (0.393)
B	2.90 (0.114)	3.10 (0.122)	3.80 (0.150)	4.00 (0.157)	3.80 (0.150)	4.00 (0.157)
C	0.80 (0.032)	1.10 (0.043)	1.35 (0.054)	1.75 (0.068)	1.35 (0.054)	1.75 (0.068)
D	0.25 (0.110)	0.40 (0.016)	0.35 (0.013)	0.49 (0.020)	0.35 (0.013)	0.49 (0.020)
F	0.40 (0.016)	0.70 (0.027)	0.40 (0.016)	1.27 (0.050)	0.40 (0.016)	1.27 (0.050)
G	0.65 BSC (0.026) BSC		1.27 BSC (0.05) BSC		1.27 BSC (0.05) BSC	
J	0.13 (0.005)	0.23 (0.009)	0.18 (0.0075)	0.25 (0.010)	0.18 (0.0075)	0.25 (0.010)
K	0.05 (0.002)	0.15 (0.006)	0.10 (0.004)	0.25 (0.010)	0.10 (0.004)	0.25 (0.101)
M	0°	6°	0°	8°	0°	8°
P	4.80 (0.189)	5.00 (0.197)	5.80 (0.228)	6.20 (0.244)	5.80 (0.228)	6.20 (0.244)

Note: Dimensions and tolerancing per ANSI Y14.5M-1982.
Dimensions A and B are datums and T is a datum surface.
Dimensions A and C do not include mold flash. Mold flash shall not exceed 0.15 mm (0.006 in.) per side.
Dimension D does not include interlead flash. Interlead flash shall not exceed 0.25 mm (0.010 in.)

Table P4. Environmental Specifications and Reliability Tests for Protected Power Switch Devices

Test	Conditions	Pass Criteria
Flammability	IEC 695-2-2 (Needle flame test)	20 sec. Flame application
Solderability	ANSI/J-STD-002, Category 3	> 95% coverage
Solder heat withstand	IEC 68-2-2, 260°C for 10 sec.	no damage
Solvent resistance	MIL-STD 202 Method 215	no mechanical damage
Temperature humidity bias	per JESD26, Test Method A101-B	1000 hrs @ 85°C/85% RH
High temperature storage life	per JESD26, Test Method A103-A	1000 hrs @ 150°C
High temperature operating life	per JESD26, Test Method A108-A	1000 hrs @ rated current, 120°C
Thermal shock	per JESD26, Test Method A104-A	1000 cycles @ –55°C to 125°C
Autoclave (PTH)	per JESD26, Test Method A102-B	96 hrs @ 121°C, 100% RH, 15 psi

Recommended Reflow Profile for Protected Power Switch Devices

Power switches are compatible with standard reflow soldering techniques. The following guidelines will assist in the proper installation of the device:

- Recommended reflow methods: IR, vapor phase oven, hot air oven.
- Always preheat the device to prevent excessive thermal shock and stress.
- Recommended maximum paste thickness of 0.25 mm (0.010 in.)
- Profile may vary among different soldering systems, depending on board density and types of components used.
- Devices may be cleaned using standard industry methods and solvents.
- Due to potential damage, it is recommended that reworked boards should use a new device.

Figure P27. Recommended Reflow Profile

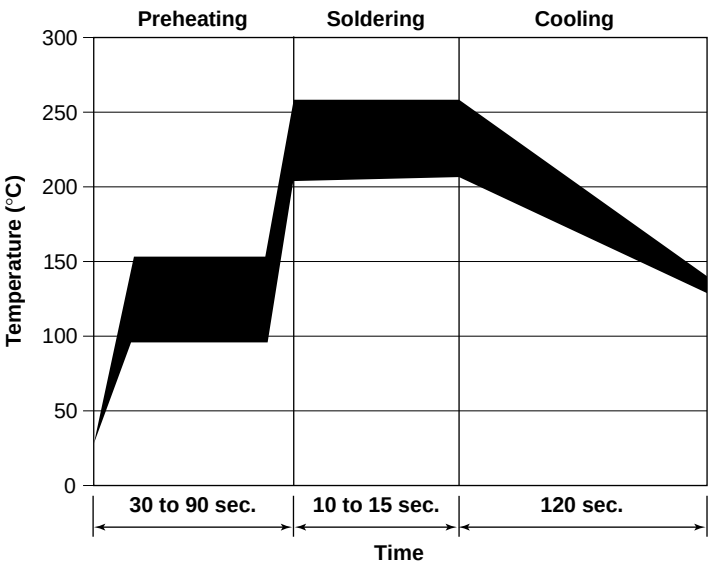


Table P5. Packaging and Marking Information for Protected Power Switch Devices

Part Number	Tape & Reel Quantity	Standard Package Quantity	Part Marking	Agency Recognition
RYC8210-1M	2,500	10,000	8210-1M	UL
RYC8210-1MM	2,500	10,000	8210-1MM	UL
RYC8210-2M	2,500	10,000	8210-2M	UL
RYC8210-2MM	2,500	10,000	8210-2MM	UL
RYC8210-3M	2,500	10,000	8210-3M	UL
RYC8210-4M	2,500	10,000	8210-4M	UL
RYC8220-1M	2,500	10,000	8220-1M	UL
RYC8220-2M	2,500	10,000	8220-2M	UL
RYC8220-3M	2,500	10,000	8220-3M	UL
RYC8220-4M	2,500	10,000	8220-4M	UL
RYC8240-1WM	2,500	10,000	8240-1WM	UL
RYC8240-2WM	2,500	10,000	8240-2WM	UL

Agency Recognition for Protected Power Switch Devices

UL	File # E211484

Part Numbering System for Protected Power Switch Devices

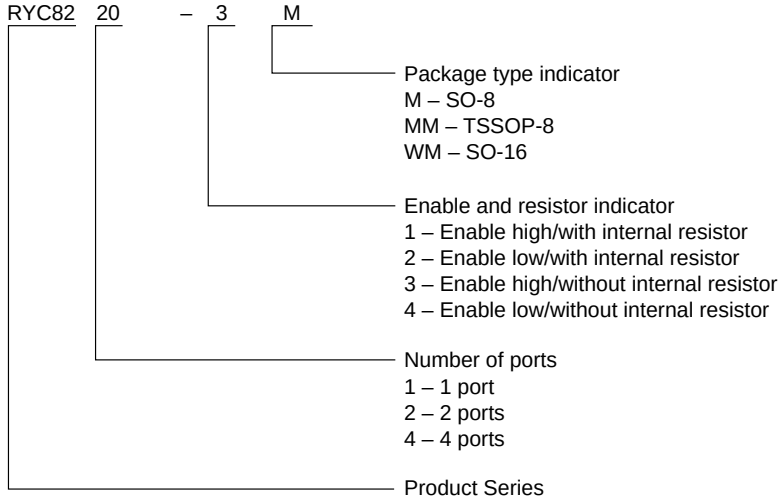


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Table P6. Tape and Reel Specifications for Protected Power Switch Devices

Protected power switch devices are supplied on tape and reel per EIA481-2 standards. See Figures P28 and P29 on the next page for details.

Dimension Description	SO-8		SO-16	
	Dimension (mm)	Tolerance	Dimension (mm)	Tolerance
W	12	±0.3	16	±0.3
P_0	4.0	±0.10	4.0	±0.10
P_1	8.0	±0.10	8.0	±0.10
P_2	2.0	±0.10	2.0	±0.10
A_0	6.40	±0.10	6.55	±0.10
B_0	5.2	±0.10	10.38	±0.10
B_1 max.	6.0	—	11.18	—
D_0	1.55	±0.05	1.55	±0.05
F	7.5	±0.10	7.5	±0.10
E_1	1.75	±0.10	1.75	±0.10
E_2 min.	10.25	—	14.25	—
T max.	0.3	±0.05	0.3	±0.05
T_1 max	0.1	—	0.1	—
K_0	2.10	±0.1	2.10	±0.1
Leader min.	390	—	390	—
Trailer min.	160	—	160	—
Reel Dimensions				
A max	340	—	340	—
N min.	50	—	50	—
W_1	12.4	+2.0,-0	12.4	+2.0,-0
W_2 max.	16.4	—	16.4	—

Figure P28. EIA Taped Component Dimensions

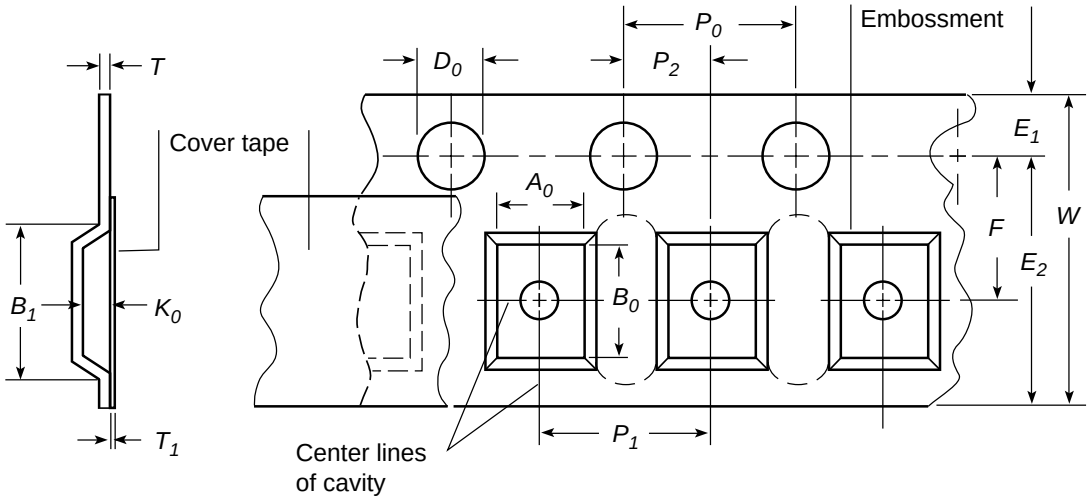
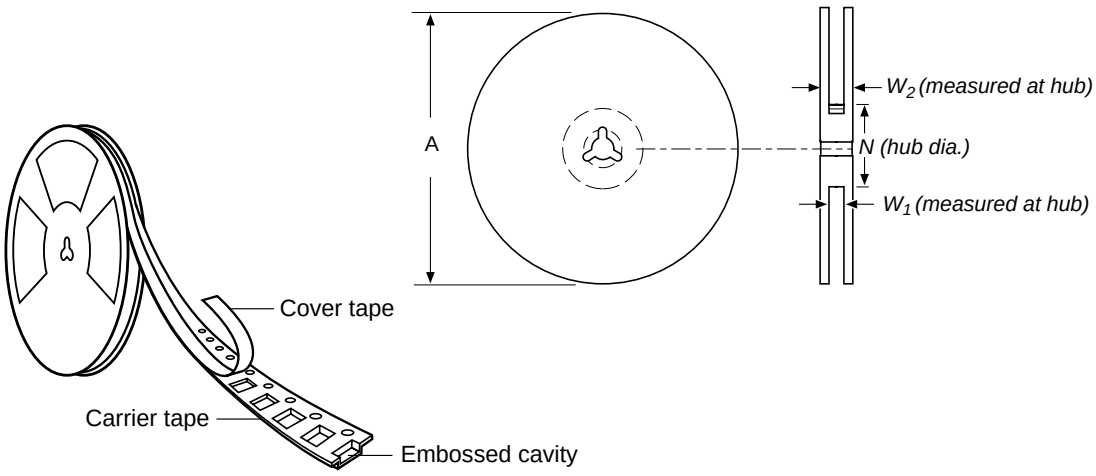


Figure P29. EIA Reel Dimensions



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WARNING:

- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overcurrent fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.