OPTIMIZE YOUR INPUT POWER PROTECTION WITH TPS1641 eFUSE

New Product Update

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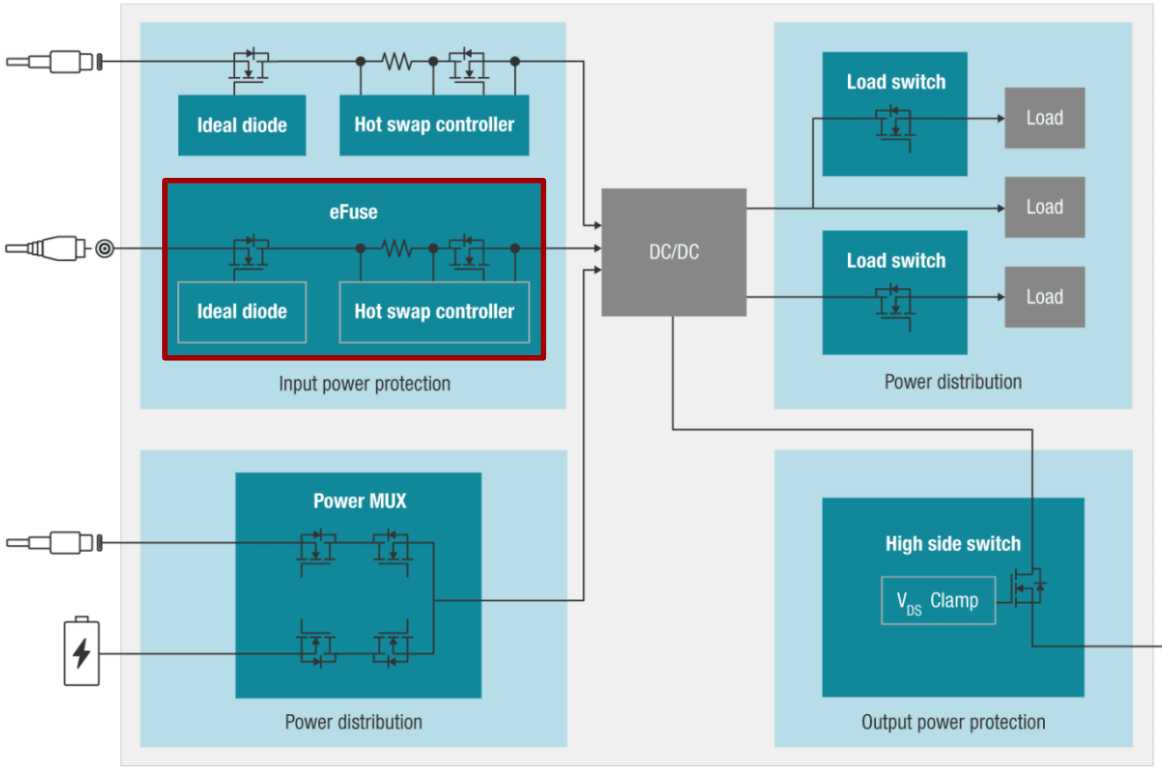
Agenda

- Power switches overview
- TPS1641 overview
  - Power limiting
  - Current limiting
  - Protection against single point failures
- Industrial applications for power limiting
  - Home appliances
  - Medical
  - Building Automation
- Backplane power protection for factory automation

Power switches | Use cases



Common Design Challenges

Input Power Protection

- Reverse current blocking
- Current limiting
- Overvoltage protection
- Inrush current control
- Surge immunity
- Reverse Polarity Protection

Power Distribution

- Power Sequencing
- Inrush current control
- Power Muxing/Power Oring

Output Power Protection

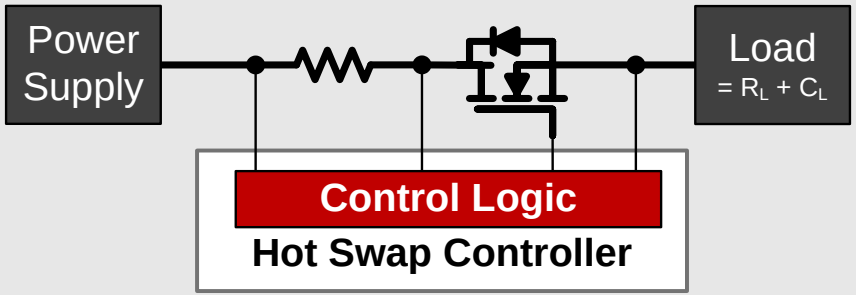
- Current limiting
- Inductive load driving

additional power switch products

- High-side Controllers
- Isolated Switches
- Low-side switches

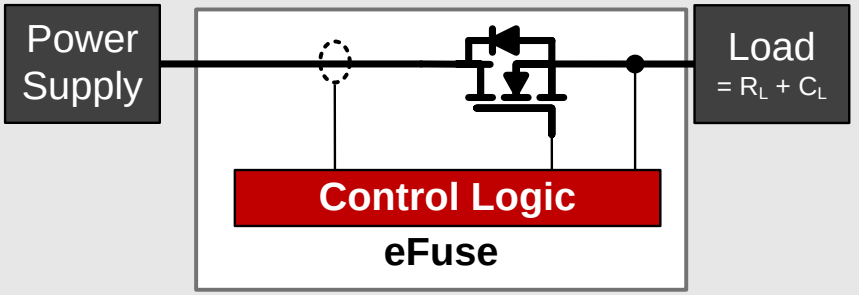
Hot swap controller vs. eFuse | Comparison

Hot swap controller



- Flexible R_{DSON} (Designers Choice)
- More feature options
  - No limit on current limit
  - Generally more accurate
- More external parts
  - R_{SENSE}, FET
  - Rs, Cs for configuration

eFuse



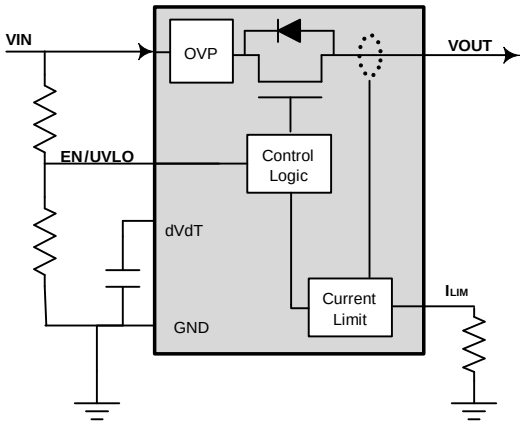
- Highly integrated
  - Few external parts
  - Internal FET, Current Sense
  - Fast and accurate monitoring
  - Matched FET & protection
  - OCP, SCP, OVP, OTP, UV, RPP, RCB
  - EN, PG, FAULT, IMON
  - Inrush current control, UL/IEC certified

eFuse Topologies

Basic Topologies

- eFuses utilize a charge pump to drive internal NMOS FET(s) to act as protection switches
- eFuses are available in two different topologies
  - Single FET
  - Back-to Back FET (B2B)

Single FET Topology



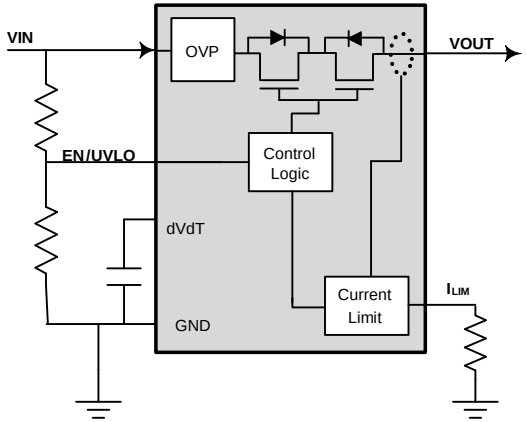
Consists of a single hot-swap FET to enable:

- ✓ Overvoltage protection
- ✓ Current limiting
- ✓ Slew rate control

Features NOT included:

- × Reverse current blocking
- × Reverse polarity protection

Back-to-back FET (B2B) Topology



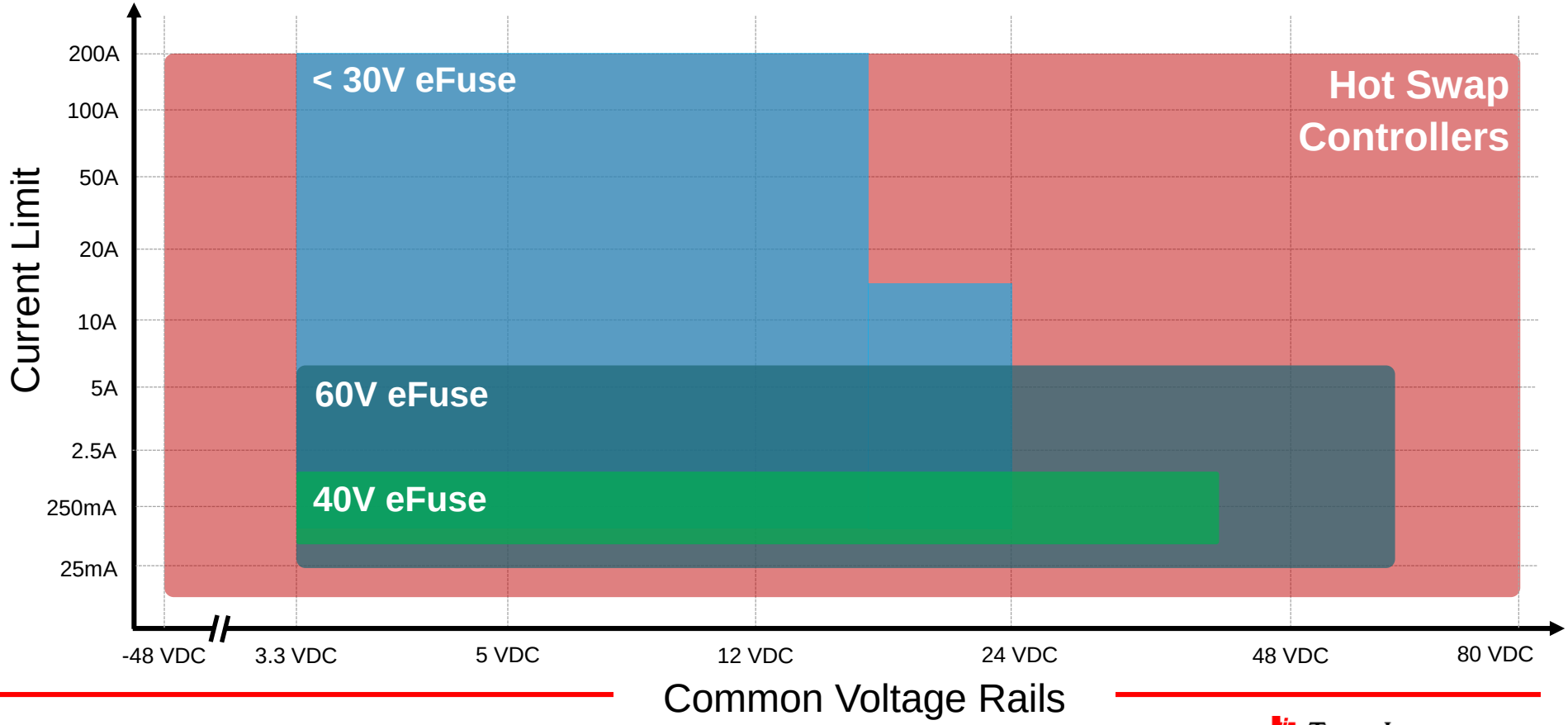
Consists of two back-to-back FETs to enable the same features and more:

- ✓ Overvoltage protection
- ✓ Current limiting
- ✓ Slew rate control

Features included:

- ✓ Reverse current blocking
- ✓ Reverse polarity protection

eFuse & hot-swap controller portfolio | Today



TPS1641 | 40V, 1.8A Power limit / Current limiting eFuse

Features

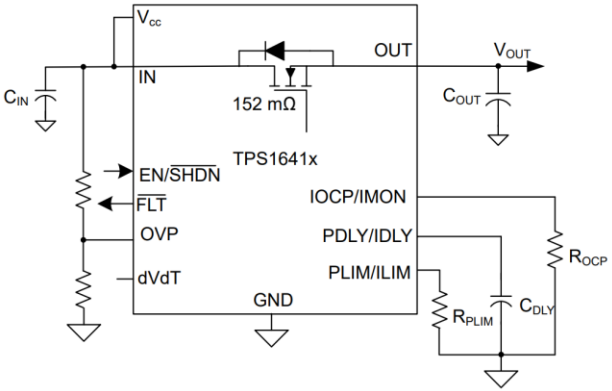
Parameter	TPS16410/1	TPS16412/3	TPS16414/5	TPS16416/7
V_{IN} Range	4.5 – 40V	2.7 – 40V	2.7 – 40V	2.7 – 40V
I_{OUT} Max	1.8A			
Limiting Type	Adj. power limiting	Adj. current limiting	Adj. power limiting	Adj. current limiting
I_{LIM} / P_{LIM} Range	2 – 64W	0.03 – 1.8A	2 – 64W	0.03 – 1.8A
I_{LIM} / P_{LIM} Blanking Time	Adjustable			
Fault Response	Auto retry	Latch-off	Auto retry	Latch-off
In-out short detection	Yes		No	
Overvoltage protection	Adjustable			
Soft-start	Adjustable			
Package type & size	VSON | 10, 3mm x 3mm			

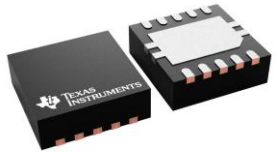
Applications

- **Low power circuit** for **Appliances** as per IEC60335 and UL60730
  - Refrigerators, dish washer, washers, dryers, ovens, residential AC units
- Medical Equipment
- Building Automation Actuators
- Back-plane power protection in PLC Modules

Benefits

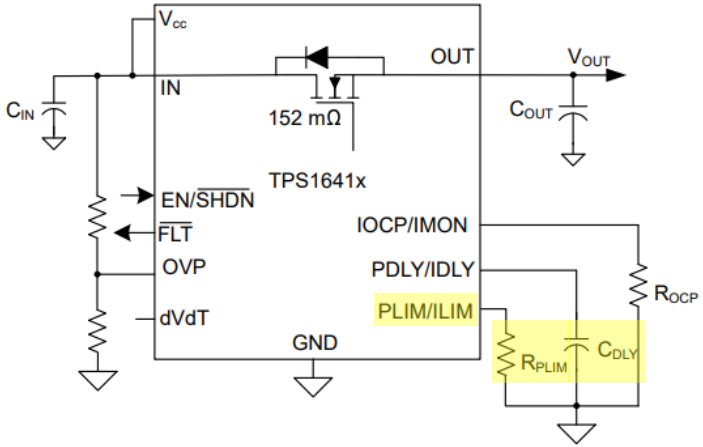
- Integrated and small size solution for power limiting and/or current limiting
- Shortens qualification for **IEC60335 and UL60730 Standards** and reduces system cost
- Adjustable blanking time allows transients to pass such as stall currents before power limiting or current limiting
- Inrush current control for startup with capacitive load
- Fault output for Diagnosis
- Load protection from over-voltage events



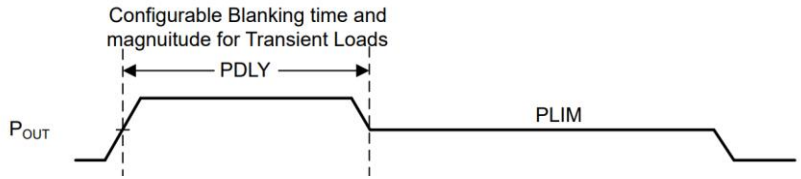


3mm x 3mm VSON | 10 pin
0.5mm pitch

TPS1641 | Power limiting

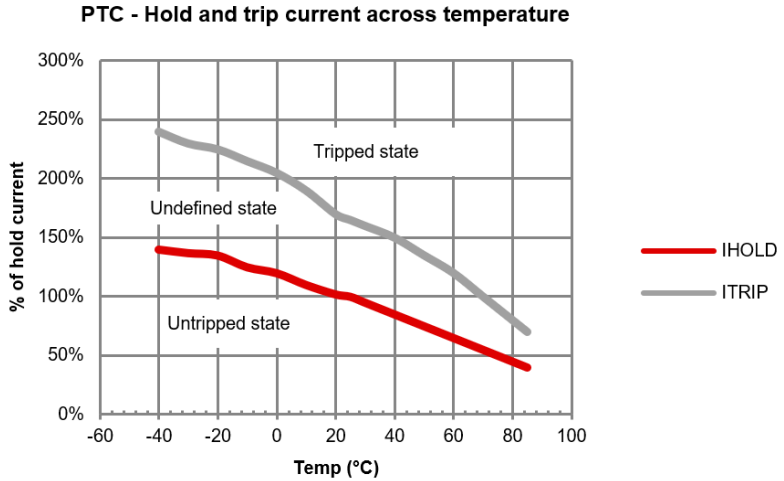


- TPS16410/11/14/15 orderables of the device offer adjustable power limiting
- The power limiting is ***adjustable*** from ***2W*** to ***64W*** via an external resistor on the PLIM pin
- The device also offers configurable blanking time for the power limit and overcurrent protection to allow transients to pass, such as a motor or a solenoid which may require high stall current when being enabled
- The blanking time for the power limit can be set to zero or to a larger time corresponding to the C_{DLY} capacitor that is placed



TPS1641 | Power limiting vs. PTC

PTC Hold and trip current across temperature



TPS1641 Power limiting accuracy across temperature

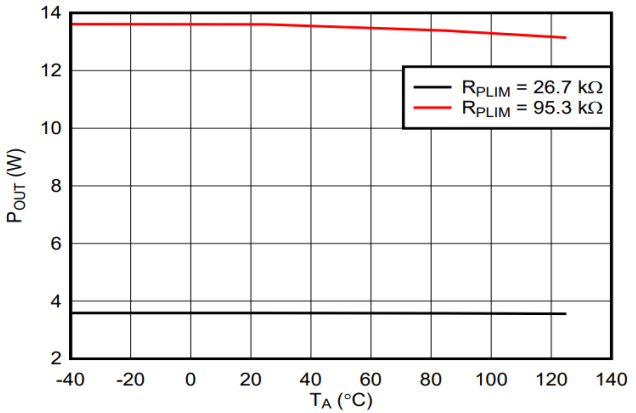
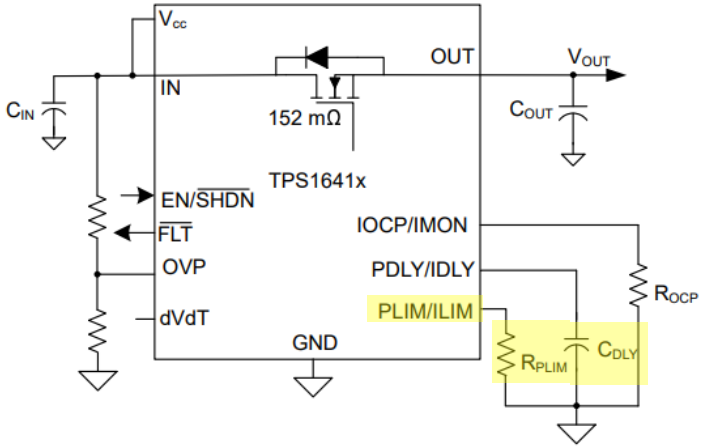


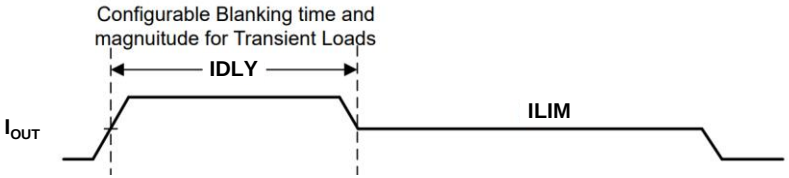
Figure 7-11. Output Power Limit vs Temperature for TPS16410 and TPS16411 with V_{IN} = 12 V

Problem with PTC: Power available for load at the output is greatly reduced with the PTC approach
Advantage of TPS1641: Power available at output maximized due to accurate power limit (+/-5%) of TPS1641

TPS1641 | Current limiting

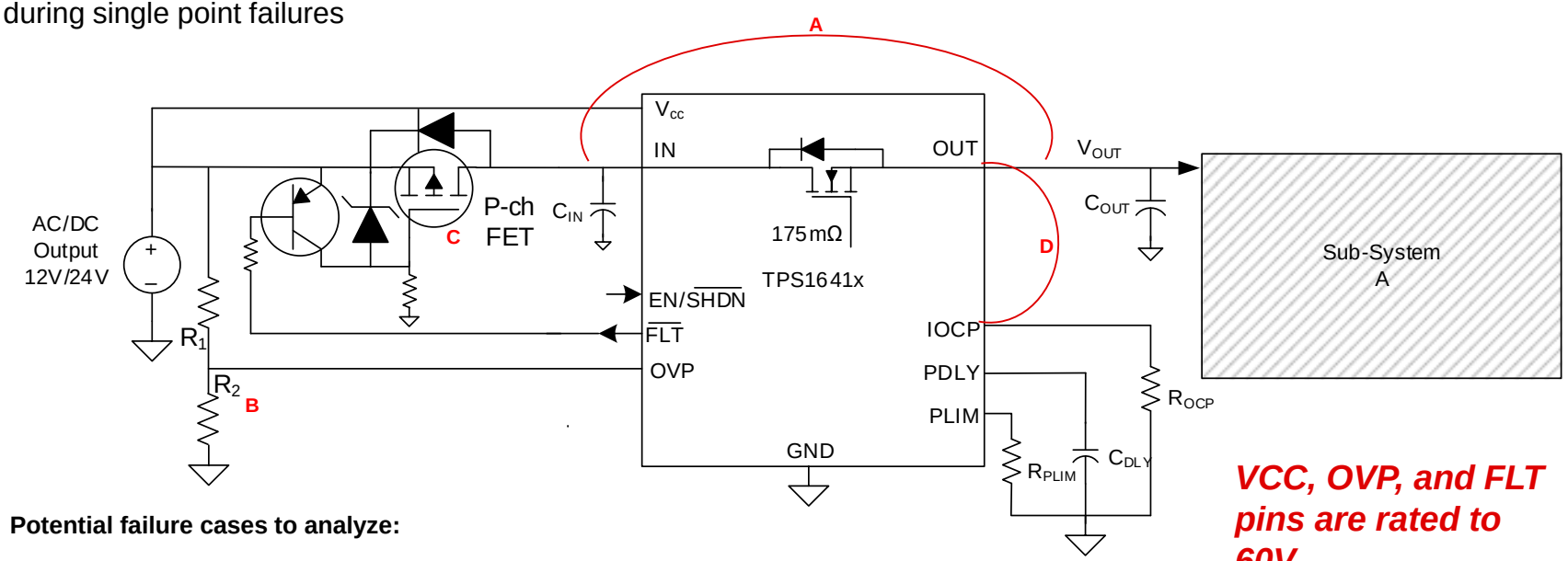


- TPS16412/13/16/17 orderables of the device offer adjustable current limiting
- The current limiting is ***adjustable*** from ***0.03A*** to ***1.8A*** via an external resistor on the ILIM pin
- The device also offers configurable blanking time for the current limit and overcurrent protection to allow transients to pass, such as a motor or a solenoid which may require high stall current when being enabled
- The blanking time for the power limit can be set to zero or to a larger time corresponding to the C_{DLY} capacitor that is placed



TPS1641x | Added protection against single point failures (optional)

Some systems require protection against single point failures, TPS1641 add a number of features which enable it to be safe during single point failures



VCC, OVP, and FLT pins are rated to 60V

Potential failure cases to analyze:

A. In case of IN to OUT short, TPS1641x asserts the FLT pin and turns off external PFET
B. OVP set to 36V or lower voltage with R1 and R2
C. TPS1641x turns off external PFET when Input voltage goes above OVP set-point.
D. Protection from Adjacent Pin short

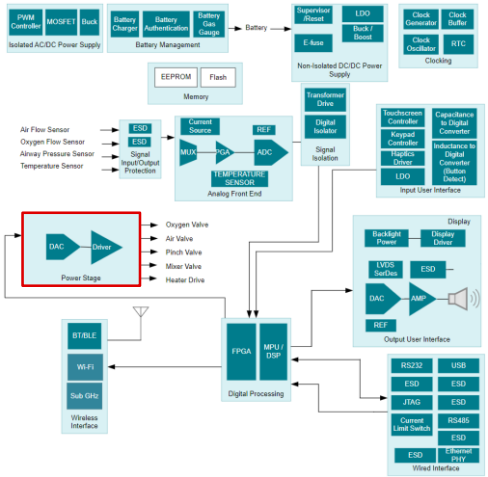
Power limiting application | Industrial

Home Appliances

- Reduce system cost and development cost for appliances which need to undergo IEC60335-1 and UL60730 certification by enabling 15W low power circuits

Medical

- To prevent fire, medical equipment with high concentration of O2 gas needs to be limited to 10VA according to **IEC60601 Section 11.2**



Building Automation

- Reduce system cost and development cost for HVAC systems such as actuators which need to undergo IEC60335-1 and UL60730 certification by enabling 15W low power circuits

TPS16410/1 | 15W Power limiting in appliances

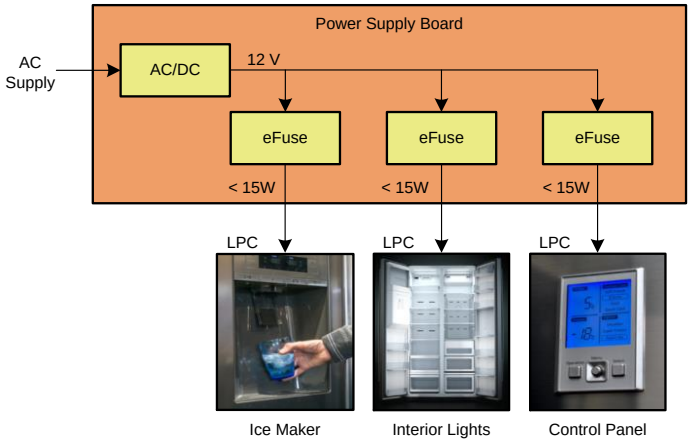
As per IEC60335-1 and UL60730, ***Low Power Circuit (LPC)*** is defined as a circuit consuming < 15W of power

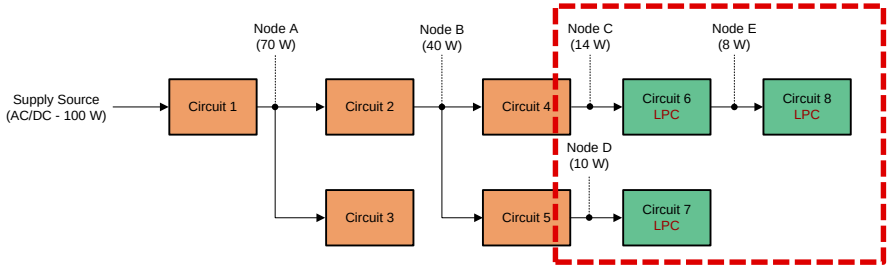
Benefits of Low Power Circuit:

- Below tests can be exempted:
  - Glow Wire Test for appliances
  - Needle Flame Test (NFT) on printed circuit boards
- Reduced system cost
  - ***Reduced flame retardant rating of the plastic enclosures and wiring for UL94 [Standard for Tests for Flammability of Plastic Materials] reduces system cost***

Benefits of TPS1641x for Low Power Circuit:

- TPS1641 offers accurate current limiting of +/-5% accuracy at 15W which helps to maximize the power to the output vs. discrete fuses



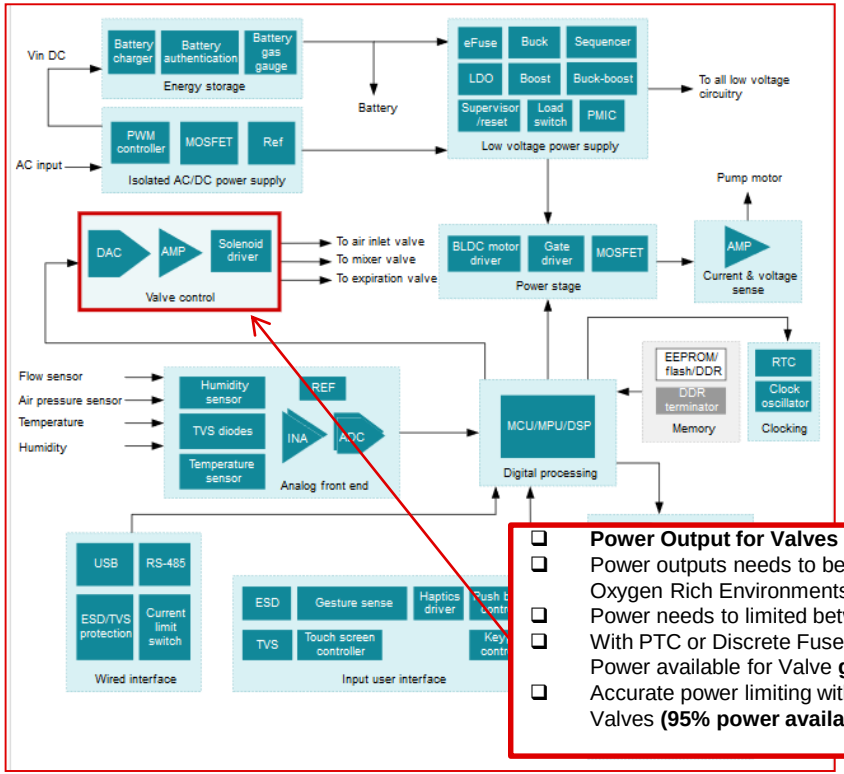


- Beyond Node B there is no other point in the circuit which consumes power greater than 15 W
- Node C and Node D are points closest to the supply source where the maximum power consumed does not exceed15

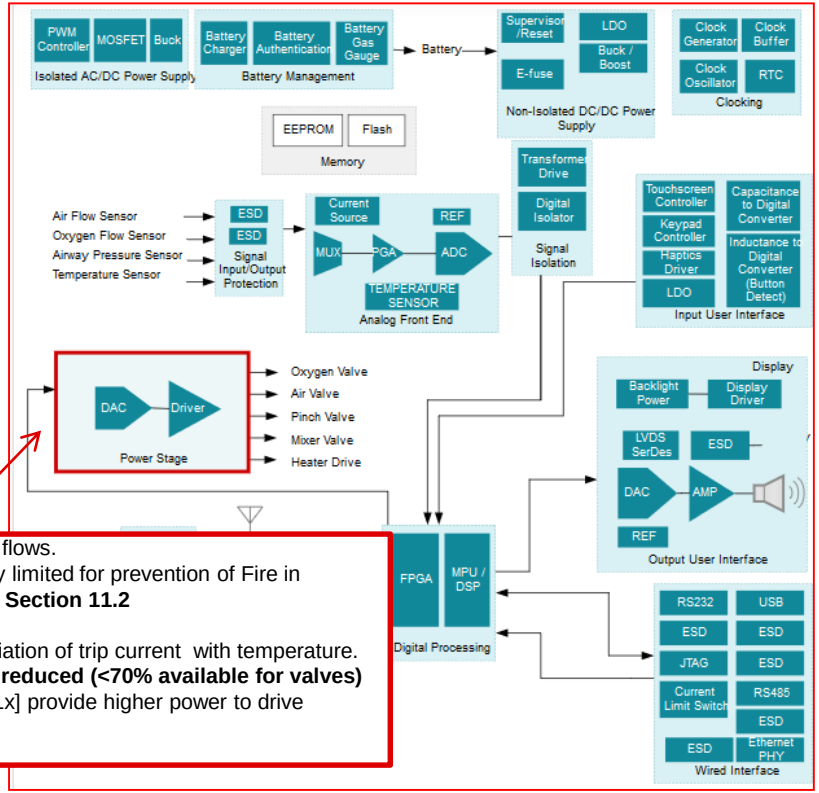
App Note: Designing Low-Power Circuits (LPCs) using an eFuse for Household and Similar Appliances

TPS16410/1 | Power limiting in medical applications

Ventilators



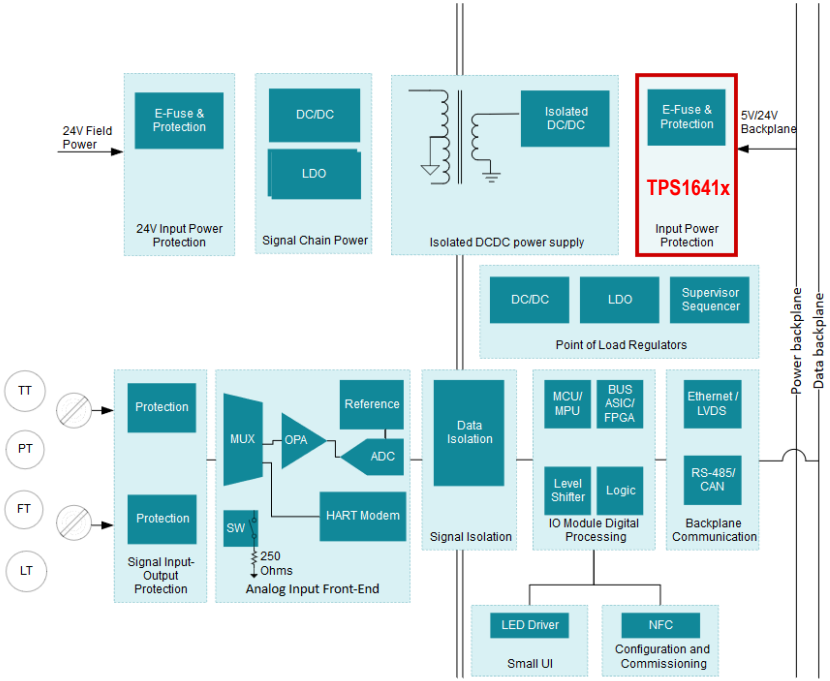
Anesthesia delivery systems



- **Power Output for Valves** for controlling gas flows.
- Power outputs needs to be power and energy limited for prevention of Fire in Oxygen Rich Environments as per **IEC60601 Section 11.2**
- Power needs to limited between **12 to 20W**
- With PTC or Discrete Fuse, there is large variation of trip current with temperature. Power available for Valve **gets significantly reduced (<70% available for valves)**
- Accurate power limiting with eFuse [TPS1641x] provide higher power to drive Valves **(95% power available for valves)**

TPS1641
Backplane power protection

TPS16412/3 | Backplane power protection in PLC



Background:

- Backplanes are used to distribute both power and data to PLC modules
- Generally, backplanes have few components in them to increase lifetime of the product
- A backplane should remain active even if a plug-in module fails due to a short-circuit
- To achieve localized protection in each plug-in module is required
- TPS16412/3 can be used to provide both overvoltage protection from surges on the backplane and overcurrent protection for the backplane in the case of a module failure

TPS16412/3 Benefits:

- Provides ***overvoltage protection*** for the plug-in module from surges on the backplane
- Provides ***overcurrent protection*** for the backplane in the case of a module failure
- Available in a small 3mm x 3mm package

Summary

- TPS1641 is a flexible 40V, 1.8A eFuse with many different variants as listed below

5 Device Comparison Table

Part Number	Power or Current Limit	Fault Behavior	IN-OUT Short Detection
TPS16410	Power limit	Auto-retry	Y
TPS16411	Power limit	Latch-off	Y
TPS16412	Current limit	Auto-retry	Y
TPS16413	Current limit	Latch-off	Y
TPS16414	Power limit	Auto-retry	N
TPS16415	Power limit	Latch-off	N
TPS16416	Current limit	Auto-retry	N
TPS16417	Current limit	Latch-off	N

- The device can be used to limit power in industrial applications to save cost in such applications as:
  - Home appliances with IEC60335 and UL60730 certification
  - Medical equipment adhering to **IEC60601 Section 11.2**
  - Building automation applications with IEC60335 and UL60730 certification
- The device is also optimized to provide backplane power protection PLC systems
- For more information
  - Go to the product folder on ti.com here
  - To start evaluating the device, order the EVM here

Getting started

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product folder	TPS1641 - 2.7-V to 40-V 152-mΩ 1.8-A eFuse with output power limiting	Link
Application Report	Designing Low-Power Circuits (LPCs) using an eFuse for Household and Similar Appliances	Link
Selection and design tools and models	TPS1641 design calculator	Link
Development tool or evaluation kit	TPS1641 evaluation module for 40-V 1.8-A eFuse	Link

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