



# JP148 Functional Safety over EtherCAT Controlled Safety Drive System

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# Functional Safety Over EtherCAT Controlled Safety Drive System

## • Overview

This reference design features a safety motor drive with a safety industrial network control. The safety network, Functional Safety over EtherCAT (FSoE), is one of the most well-known safety protocols in industrial systems. The design includes two independent RX72N 32-bit microcontrollers (MCUs), so if the system hits an unwanted state system, control is maintained, and it can safely cut power to the motor.

The safety data, such as the emergency stops, comes from the safety sensor or safety programmable logic controller (PLC) through the EtherCAT communication block. This safety data is checked by both RX72N MCUs individually and if either shows an “emergency situation,” either one (or both) RX72N MCUs can cut off the motor power to avoid dangerous situations.

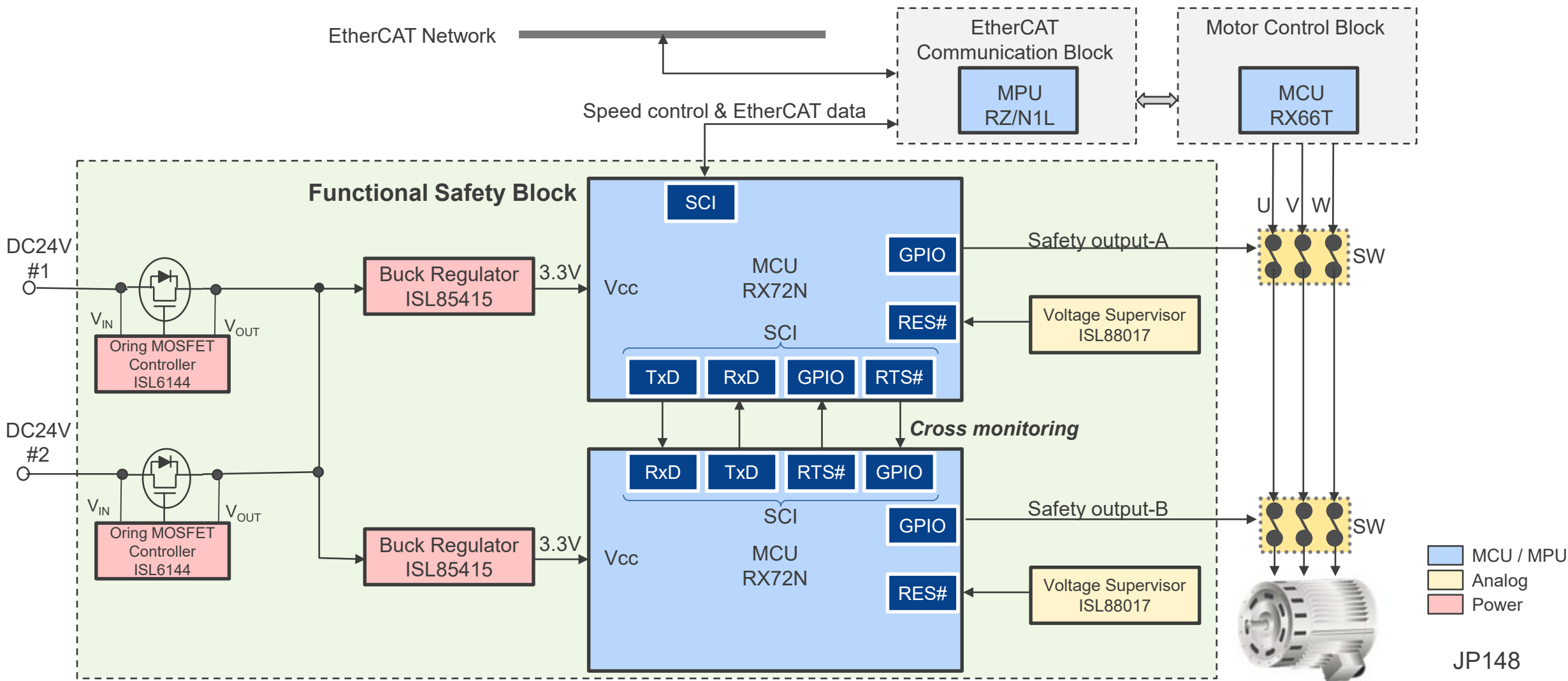
The safety control block consists of two RX72N MCUs, which manage motor emergency, stop control, and safety protocol data processing. According to the safety international standards (IEC 61508, ISO 13849-1), it is required to have redundancy in the system, which we achieve by having dual RX72N MCUs. Each RX72N MCU operates the same process and are able to check each other through the cross monitoring interface.

## • System Benefits

- Renesas supports required software for the safety control block, such as self-test software and control software system (self-test software kit and SIL3 system software kit). By using these safety solutions, customers can shorten their development and certification time and reduce the costs.
- By separating the safety functional block from the non-safety block (network device or motor control device), customers can easily design their applications
- Customers can select the best MCU for this safety system from our wide RX Family portfolio

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Device Category	Orderable P/N	Key Features
MCU/MPU	RZ/N1L	RZ/N1L industrial Ethernet MPU with Arm® Cortex®-M3 core
	RX66T	160MHz RXv3 MCU with advanced motor control. Optimal for motor control in industrial, home appliances, and robotics applications.
	RX72N	RX flagship MCU with the highest performance. RXv3 core, high performance, operates at 240MHz.
Power	ISL85415	0.5A regulator with integrated high side FET. Supports 3V-36V input voltage range for buck output.
	ISL6144	High voltage ORing MOSFET controller
Analog	ISL88017	-6 lead voltage supervisor -Pin selectable voltage trip points

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# RZ/N1L Industrial Ethernet MPU

Arm® Cortex®-M3

## R-IN Engine 125 MHz Cortex®-M3 MPU

- Proven R-IN engine as HW accelerator for Industrial Ethernet communication
- Internal oscillator for 40MHz crystal, i.e. no external clock required

## Up to 3 Ethernet Ports

## 6MB Internal RAM + External Storage Interface

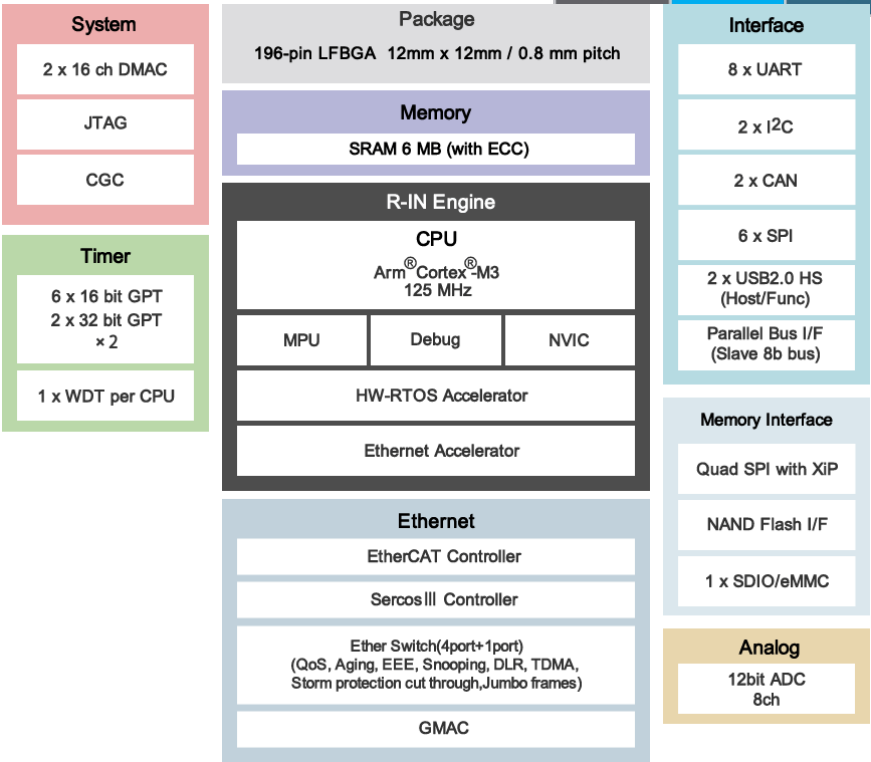
- 1x QSPI, 2x SDIO/eMMC
- Several storage devices can be chosen based on application requests

## LCD Controller, Multiple Timers, RTC

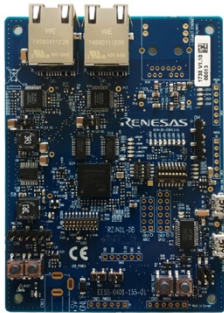
## Rich Interfaces

- USB2.0, 2x CAN, 8x UART, 6x SPI, 8ch 12bit ADC etc.

## Temperature range -40..+110°C



Name	P/N	Package
RZ/N1L	R9A06G034VGBA	196BGA, 12x12mm



# RX66T – 160MHz RXv3 MCU with Advanced Motor Control

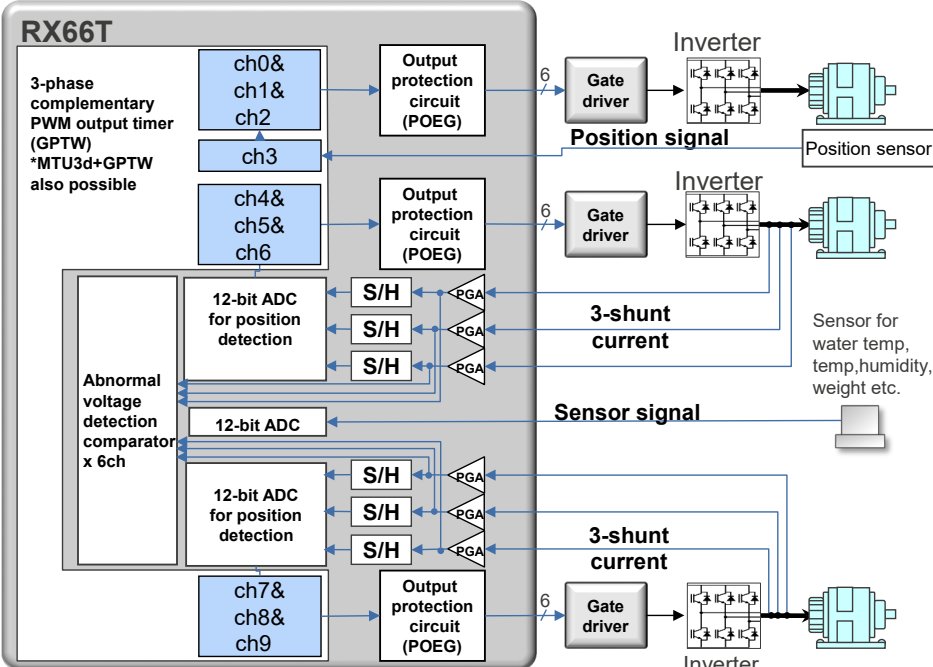
## Optimal for Motor Control in Industrial, Home Appliances, and Robotics Applications

### High Performance and Built-In Functions

- RXv3 Core 160 MHz operation (5.82 CoreMark/MHz)
- 2.7 to 5.5 V operation
- Operating temperature: -40 to 105 °C
- High-speed flash memory with 120 MHz
- Program Flash up to 1 MB, SRAM up to 128 KB
- 160 MHz PWM and high-resolution PWM (min 195 ps timing adjustment)
- Enhanced Analog (ADC 3 units, DAC, comparator, pseudo-differential PGA)
- Trusted Secure IP Lite (AES/TRNG)
- 64-pin, 80-pin, 100-pin, 112-pin and 144-pin packages

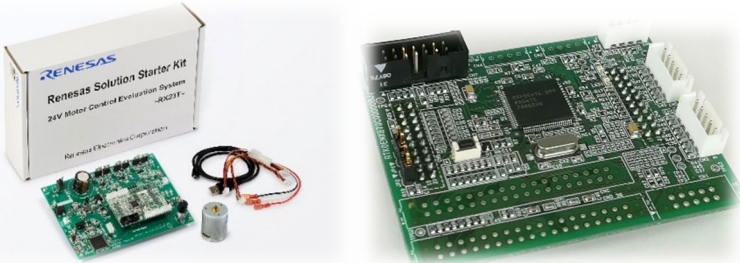
### Benefits for Motor Control

- Support inverter control with high performance RXv3 CPU (931 CoreMark@160MHz and on-chip floating point-unit (FPU))
- Enables simultaneous control of up to three/four motors
- Reduces footprint and component count by multi motor control and built-in analog functions
- Built-in security and safety features also offer new added value for inverter control applications
- 5V power supply that delivers excellent noise tolerance



System configuration example (3 motors)

Part #	ROM	RAM	Package
R5F566TAxxxx	256KB	64KB	112-LQFP(20x20), 100-LFQFP(14x14), 80-LQFP(14x14), 80-LFQFP(12x12), 64-LFQFP(10x10)
<a href="#">R5F566TExxxx</a>	512KB	64KB	112-LQFP(20x20), 100-LFQFP(14x14), 80-LQFP(14x14), 80-LFQFP(12x12), 64-LFQFP(10x10)
R5F566TFxxxx	512KB	128KB	144-LFQFP(20x20), 100-LFQFP(14x14)
R5F566TKxxxx	1MB	128KB	144-LFQFP(20x20), 100-LFQFP(14x14)



Motor Control Evaluation System & CPU Card

RX72N – RX Flagship MCU with the Highest Performance

RXv3 Core, High Performance, Operates at 240MHz

High Performance and Built in Functions

- 240MHz RXv3 core, double-precision FPU, and register bank save function
- Up to 4MB ROM with dual-bank structure / 1MB SRAM
- Up to 29 extended-function timers (MTU3a x 9 ch), 182 general I/O ports
- SCI x 13/RIICa x 3
- DMACAa x 8 ch/DTCb x 1ch/EXDMAC x 2ch/ DMAC for the Ethernet x 3
- 12-bit ADC: 29ch in 2 units, 12-bit DAC: 2ch
- Encryption engines (AES, 3DES, RSA, ECC, SHA, TRNG), key management, flash memory protection
- Useful functions for IEC60730 compliance
- Trigonometric calculators (sin, cos, arctan, hypot) to speed up motor vector control

High-End HMI Function

- Graphic-LCD controller (GLCDC)
- 2D drawing engine
- Serial sound interface and CMOS camera interface

Networking and Advanced Connectivity

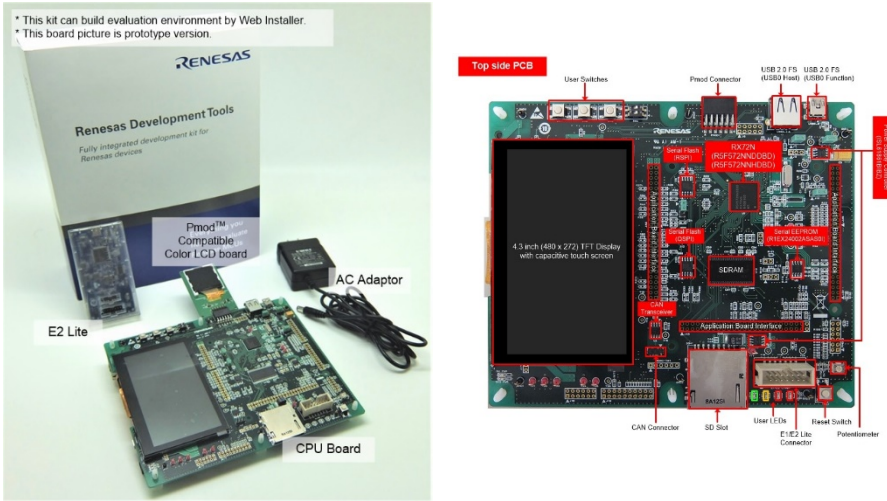
- Ethernet MAC compliant with IEEE 1588 (2ch)
- SD host interface, quad SPI, RSPIc, MMCIF, USB 2.0 full speed and CAN x 3

Part #	ROM	RAM	Temp.(°C)	Package
R5F572NxxxFP	2/4MB	1MB	-40 to 85/105	LFQFP/100/0.5
R5F572NxxxFB	2/4MB	1MB	-40 to 85/105	LFQFP/144/0.5
R5F572NxxxLK	2/4MB	1MB	-40 to 85/105	TFLGA/100/0.5
R5F572NxxxFC	2/4MB	1MB	-40 to 85/105	LFQFP/176/0.5
R5F572NxxxBG	2/4MB	1MB	-40 to 85/105	LFBGA/176/0.8
R5F572NxxxBD	2/4MB	1MB	-40 to 85/105	LFBGA/244/0.8

<div>CPU</div> <div>240MHz RXv3</div> <div>Double-precision FPU</div> <div>Register Bank Save Function</div>	<div>Networking &amp; Advanced Connectivity</div> <div>2ch Ethernet</div> <div>SD Host I/F</div> <div>USB 2.0 Full Speed</div> <div>3ch CAN</div> <div>QSPI</div>	<div>HMI</div> <div>TFT LCD Controller</div> <div>2D Drawing Engine</div> <div>Serial Sound I/F</div> <div>CMOS Camera I/F</div>
<div>Memory</div> <div>4MB Code Flash Memory</div> <div>32KB Data Flash Memory</div> <div>1MB SRAM</div>	<div>Motor Control</div> <div>Arithmetic Unit for Trigonometric Functions</div> <div>PWM Timers</div> <div>2-phase Encoder Pulse Inputs</div> <div>12-bit A/D Converters</div>	<div>Security</div> <div>Encryption Engine (AES, TDES, RSA, ECC, SHA, TRNG)</div> <div>Key Management</div> <div>Flash Memory Protection</div>
<div>Package</div> <div>100, 144, 176-pin LFQFP</div> <div>176, 224-pin LFBGA</div> <div>145-pin TFLGA</div>		

RX72N

RX72N Block Diagram



RX72N Start Kit



# ISL85415 – 0.5A Regulator with Integrated High Side FET

Supports 3V-36V Input Voltage Range for Buck Output

## Wide Working Range

- Power input voltage range from 3V to 36V
- The device provides an easy-to-use high-efficiency, low BOM-count solution for a variety of applications
- Up to 0.5A load over full temperature range

## High Efficiency and Performance (Low Board Space)

- Synchronous operation for high efficiency
- No compensation required
- Integrated high-side and low-side NMOS devices
- Selectable PFM or forced PWM mode at light loads
- Internal fixed (500kHz) or adjustable switching frequency 300kHz to 2MHz

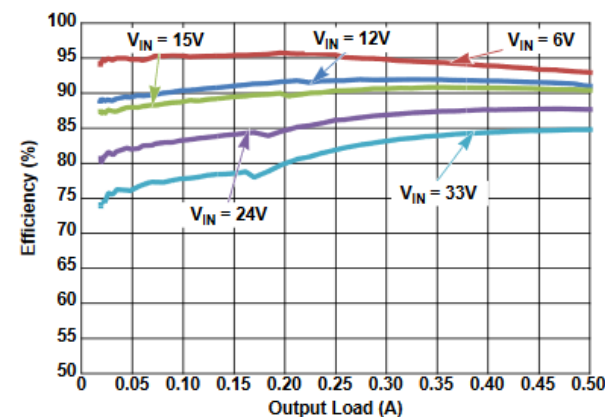
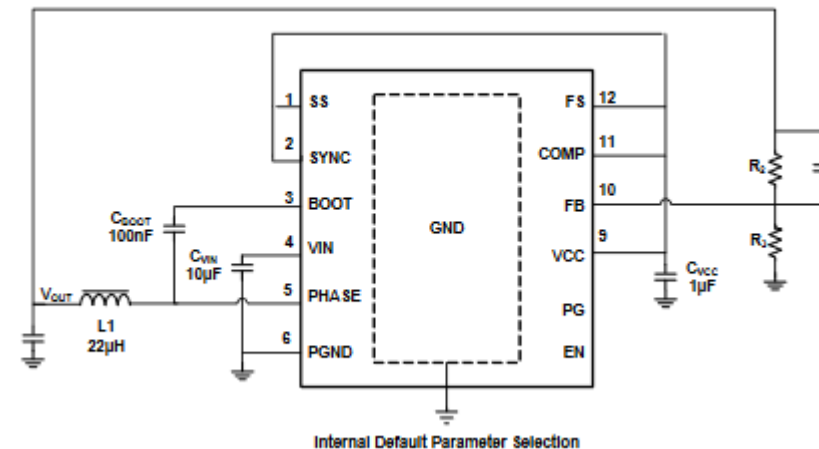


Figure 6. Efficiency vs Load, PFM,  $V_{OUT} = 5V$



FIGURE 1. FRONT OF EVALUATION BOARD ISL85415DEMO02Z

Part #	$V_{IN}$ Range(V)	Temp.(°C)	Package
<a href="#">ISL85415FRZ</a>	3 to 36	-40 to 125	12 Ld DFN 4x3

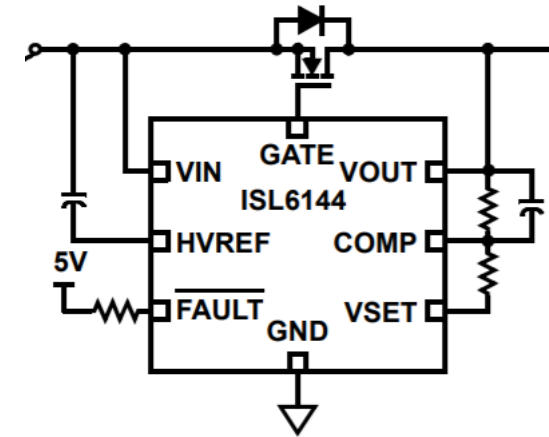


# ISL6144 – High Voltage ORing MOSFET Controller

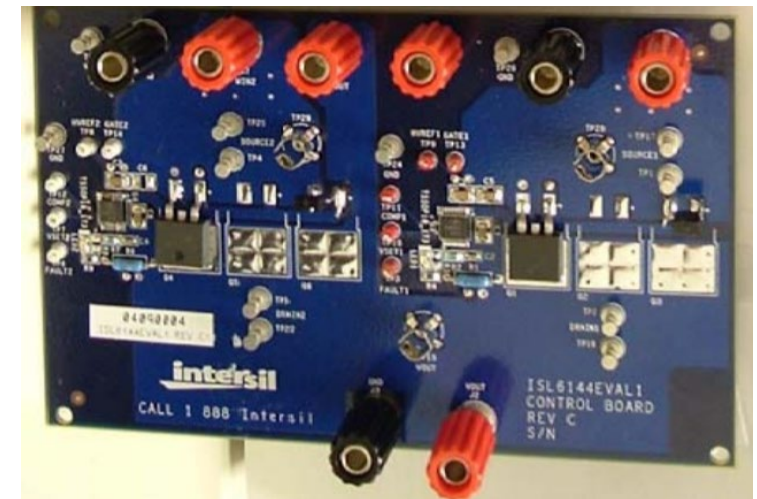
Increases Power Distribution Efficiency when Replacing a Power ORing Diode

## High Performance and Flexible Use

- Wide supply voltage range +9V to +75V
- Transient rating to +100V
- Reverse current fault isolation
- Internal charge pump allows the use of N-Channel MOSFETs
- HS comparator provides very fast  $<0.3\mu\text{s}$  response time to dead shorts on sourcing supply. HS comparator also has resistor-adjustable trip Level
- HR amplifier allows quiet  $<100\mu\text{s}$  MOSFET turn-off for power supply slow shut down
- Open drain, active low fault output with  $120\mu\text{s}$  delay
- Provided in packages compliant to UL60950 (UL1950) creepage requirements



Typical Application Circuit



ISL6144EVAL1Z Evaluation Board

Part #	Temp Range (°C)	Package
ISL6144IVZA	-40 to +105	16 Ld TSSOP
ISL6144IRZA	-40 to +105	20 Ld 5x5 QFN

ISL88016/7 – 6 Lead Voltage Supervisor

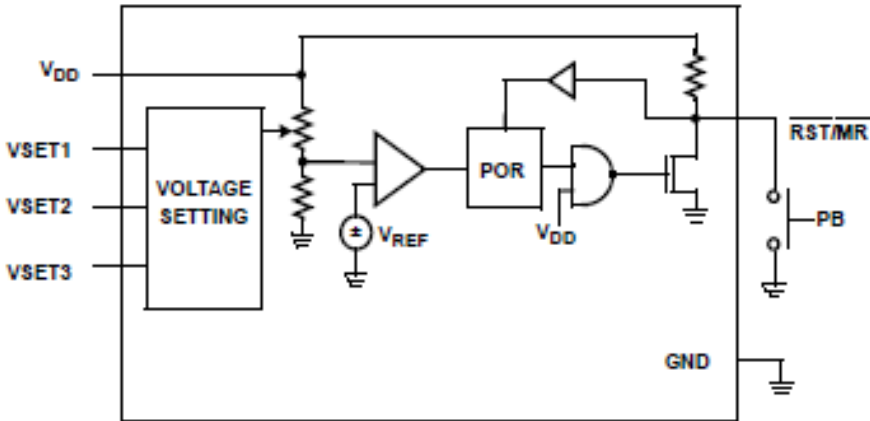
Pin Selectable Voltage Trip Points

Pin-Selectable Voltage Trip Points

- ISL88016: 1.60V to 2.85V in 50mV steps
- ISL88017: 2.15V to 4.65V in 100 mV steps

Low Power and High Performance

- Ultra low 3μA supply current
- Accurate ±2% voltage threshold



ISL88016, ISL88017

Part #	MLQ	Temp.	Package
ISL88016IHTZ-T	3000	-40/+85	6 Ld TSOT-23 Tape & Reel
ISL88016IHTZ-T7A	250	-40/+85	6 Ld TSOT-23 Tape & Reel
ISL88016IHTZ-TK	2000	-40/+85	6 Ld TSOT-23 Tape & Reel
ISL88017IHTZ-T	3000	-40/+85	6 Ld TSOT-23 Tape & Reel
<a href="#">ISL88017IHTZ-T7A</a>	250	-40/+85	6 Ld TSOT-23 Tape & Reel
ISL88017IHTZ-TK	2000	-40/+85	6 Ld TSOT-23 Tape & Reel

Product Features Table

FUNCTION	ISL88016	ISL88017
Active-Low Reset ( $\overline{\text{RST}}$ )	x	x
Manual Reset Input ( $\overline{\text{MR}}$ )	x	x
1.60V to 2.85V (50mV Increments) Pin-Selectable Voltage Trip Range	x	
2.15V to 4.65V (100mV Increments) Pin-Selectable Voltage Trip Range		x
Pb-Free Package Option Available	x	x

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