

EU017 Electronic Drug Delivery System

December 2019



Electronic Drug Delivery System

■ Overview

For healthcare drug delivery devices, such as infusion pumps or insulin pumps, exact dosing is crucial. Drug delivery measurements and exact control of the dosing motor is required. Motors are typically three-phase BLDC types with a few watts (e.g. using 12V). For flow sensing, a factory-calibrated sensor or custom sensors may be used. Bluetooth® communication, to provide an up-to-date GUI via smartphone and additional interfaces (like Ethernet or a medical-grade isolated USB), may also be needed. Some end products may also require an uninterrupted power supply (e.g. using Li-ion cells).

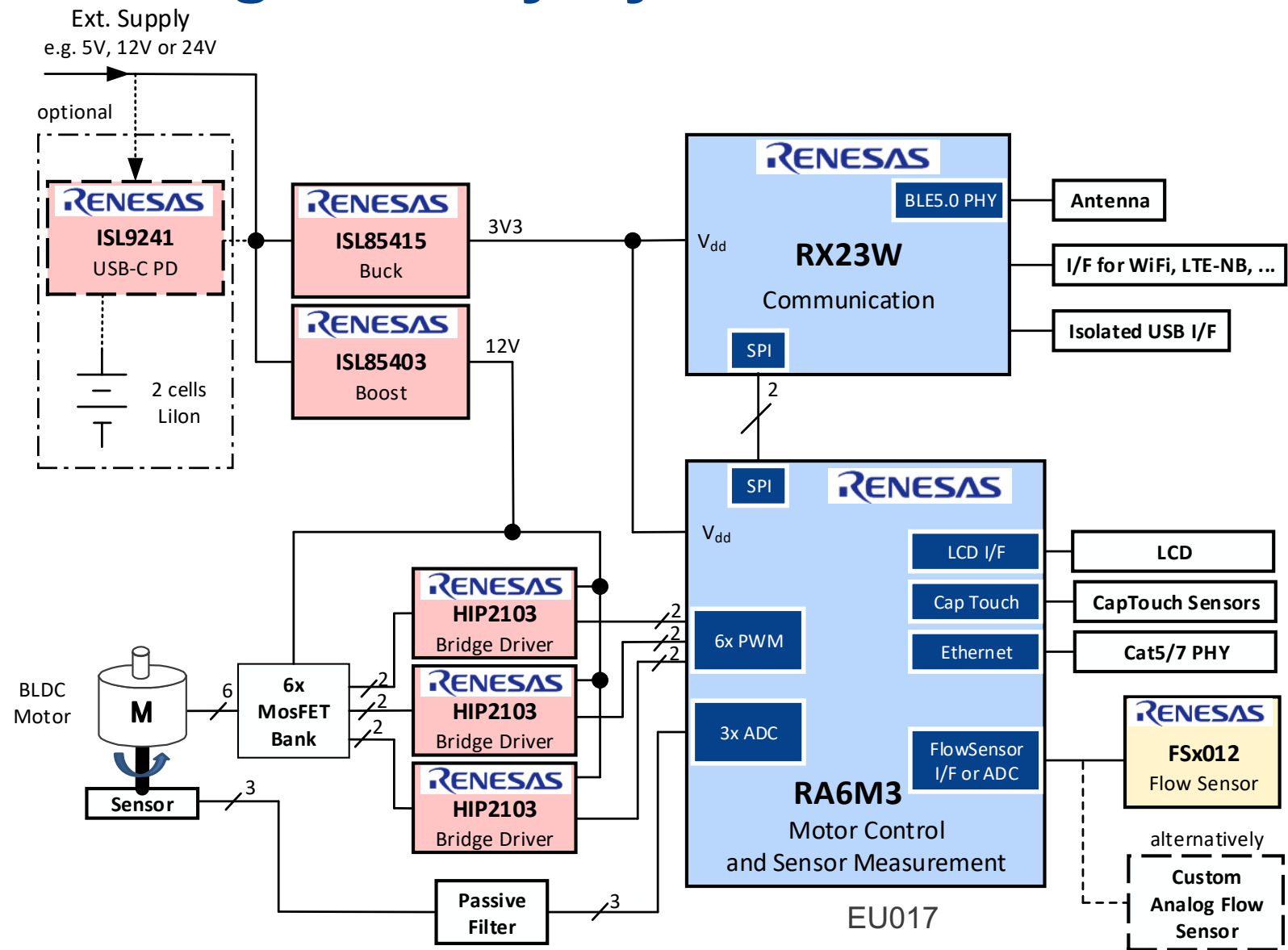
This design uses a combination of two MCUs, which includes the latest RA6M3 for motor control and sensor measurement, and the RX23W for Bluetooth Low Energy (BLE) 5 communication. It also includes analog components, like DC/DC regulators, a Li-ion battery charger, a MOSFET bridge driver, and a factory-calibrated flow sensor.

■ System Benefits

- Both pump types supported: infusion pump and insulin pump
- Motor control for BLDC or PMSM with analog or hall sensors/encoders, optional gear (also with a high gear ratio)
- Flow measurement: Integrated sensor or use MCU-integrated AFE for custom sensor setup
- Communication: BLE 5, Wi-Fi, Ethernet (e.g. for infusion pump) and multiple serial interfaces for optional NB-IoT, isolated USB I/F
- HMI: LCD (for infusion pump) and touch and/or gesture control for better sterile environments
- Optional battery management (e.g. 2x Li-ion cells for uninterrupted power supply)

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Device Category	P/N	Key Features
MCU	RA6M3	120MHz Arm® Cortex®-M4 integration with USB HS, Ethernet and TFT controller
	RX23W	32 Bit, BT5.0 MCU with enhanced security
Power	ISL9241	USB-C PD Li-ion battery charger for 2-4 cells
	ISL85415	3-36V / 500mA output, buck regulator
	ISL85403	2.5A regulator with integrated high-side MOSFET for synchronous buck or boost buck converter
Analog	HIP2103	60V, 1A/2A peak, 1/2 bridge driver
	FSx012	Solid-state MEMS flow sensor module for liquids and gases

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RA6M3 – Ultra-Low Power 120-MHz Arm® Cortex®- M4 Core

Fully Featured for Applications Needing HMI/Control/ Security/Graphical and Capacitive Touch

High Performance

- 120MHz Arm® Cortex®-M4 CPU

Highly Integrated Capabilities

- 1MB-2MB Flash Memory and 640kB SRAM
- 128-bit unique ID
- 12-Bit ADC (x2)
- 12-Bit DAC

Communication Interfaces

- USB 2.0 (Full Speed/ High Speed)
- Ethernet Controller with DMA
- SCI x10/SPIx2/IICx3

HMI Interface

- Capacitive Touch Sensing Unit (18ch.)
- Graphics LCD Controller

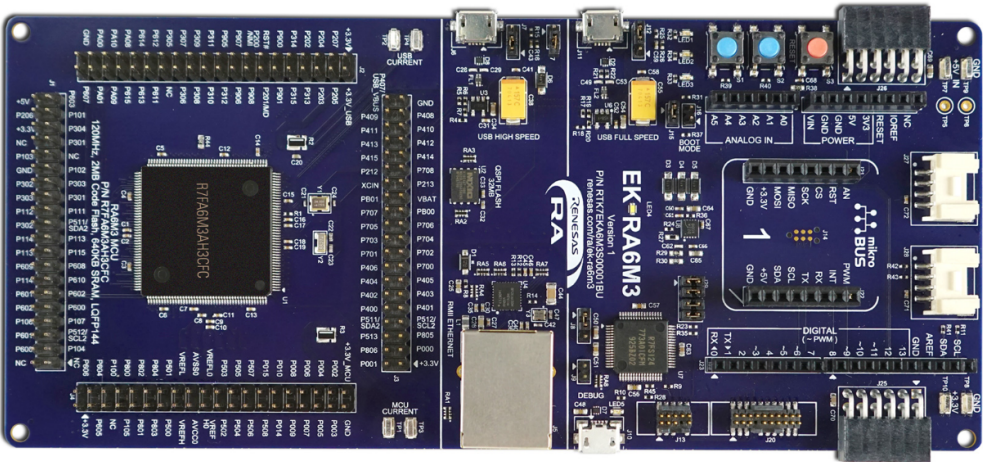
Security and Encryption

- AES128/192/256, 3DES/ARC4, SHA1/SHA224/SHA256/MD5, GHASH, RSA/DSA/ECC
- True Random Number Generator (TRNG)

Part #	Flash Memory	RAM	Temp	Package
R7FA6M3AH3CFC#AA0	2MB	640KB	40~105°C	176 LQFP
R7FA6M3AF3CFC#AA0	1MB	640KB	40~105°C	176 LQFP

FLASH / RAM	2MB / 640KB	RA6M3	RA6M3	RA6M3	RA6M3	RA6M3
	1MB / 640KB	RA6M3	RA6M3	RA6M3	RA6M3	RA6M3
Pin Count Package Size Pitch		100pin LQFP 14x14 0.5mm	144pin LQFP 20x20 0.5mm	145pin LGA 7x7 0.5mm	176pin LQFP 24x24 0.5mm	176pin BGA 13x13 0.8mm

Flash/ RAM/ Package Table



RTK7EKA6M3S00001BU

RX23W – 32-bit MCU, BT5.0 and Enhanced Security

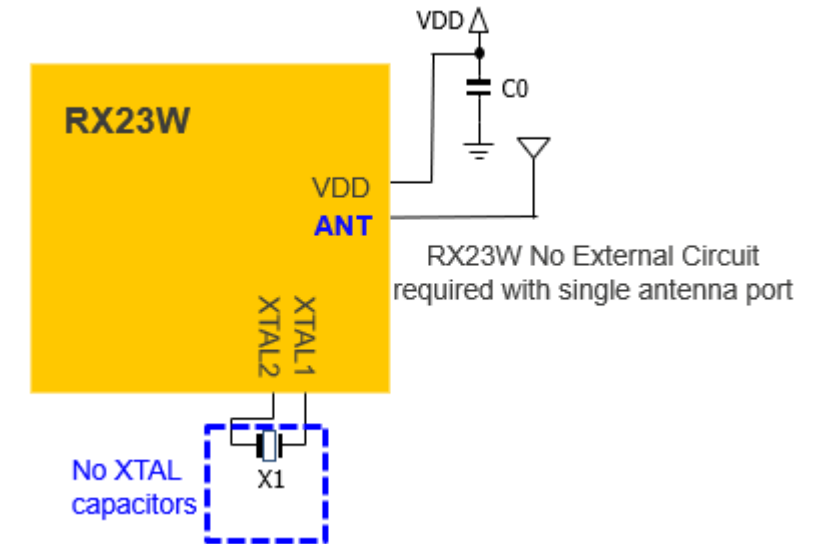
54 MHz RX v2 Core with FPU, Low Power Design, RTC and Encryption functions

Support for Multiple Communication Functions

- Bluetooth Low Energy (1Channel)
- An RF transceiver and link layer compliant with the Bluetooth Low Energy 5.0 specification
- LE 1M PHY, LE 2M PHY, LE Coded PHY (125 kbps and 500 kbps), and LE Advertising extension support
- On-chip Bluetooth-dedicated AES-CCM (128-bit blocks) encryption circuit
- USB 2.0 host/function/On-The-Go (OTG) (one channel), full-speed = 12 Mbps, low-speed = 1.5 Mbps, isochronous transfer, and battery charger supported
- CAN (one channel) compliant to ISO11898-1: Transfer at up to 1 Mbps
- Including many others

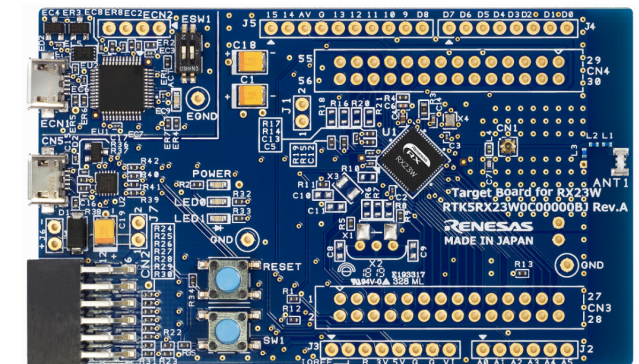
High Performance and Low Power Design

- Operation from single 1.8 to 3.6V supply
- Max. operating frequency: 54 MHz, Capable of 88.56 DMIPS in operation at 54 MHz
- Enhanced DSP and FPU modules
- RTC capable of operating on the battery backup power supply
- Security: 128- or 256-bit key length of AES for ECB, CBC, GCM, others. TRNG and safe management of keys.



System Block

Part #	ROM (Kbytes)	RAM (Kbytes)	Security Functions	Package
R5F523W8ADNG#30	512	64	N/A	QFN/56/0.4
R5F523W7ADNG#30	384	64	N/A	QFN/56/0.4
R5F523W8BDNG#30	512	64	Available	QFN/56/0.4
R5F523W7BDNG#30	384	64	Available	QFN/56/0.4



Target Board for RX23W – RTK5RX23W0C00000B

ISL9241 – Buck-Boost Battery Charger

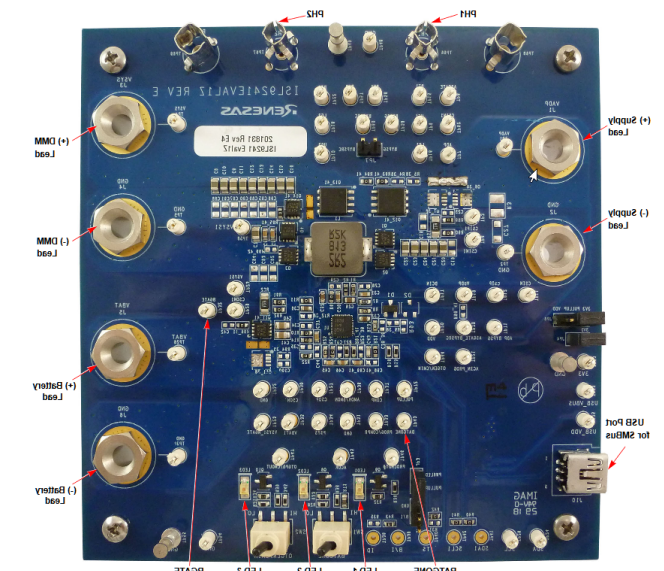
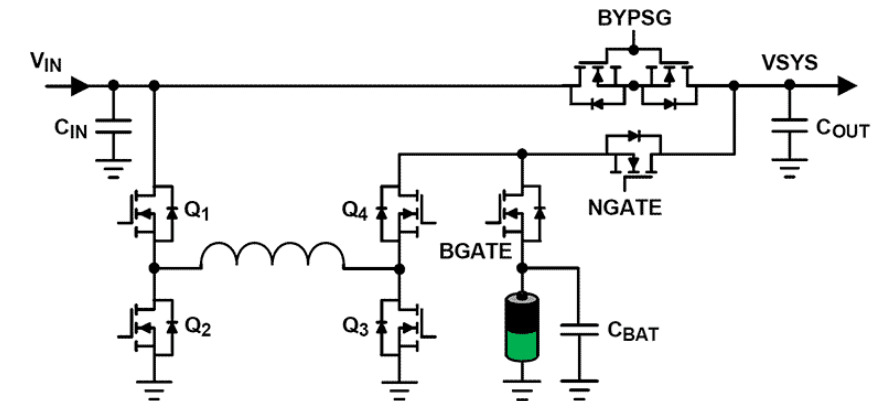
Configurable Battery Charger with SMBus Interface and USB Power Delivery

Digitally Configurable Buck-boost Battery Charger

- Buck-boost charger for 2-, 3-, or 4-cell Li-ion batteries
- Input voltage range: 3.9V to 23.4V (no dead zone)
- System/battery output voltage: 3.9V to 18.304V

Different Charge Modes

- Narrow Voltage Direct Charging (NVDC)
- Hybrid Power Buck Boost (HPBB/Bypass) charging
- Switch between the modes is possible using firmware control
- Bypass mode is supported using a controller's firmware, allowing the adapter to provide power directly to the system



Part #	Input Voltage Range	System/Battery Output Voltage	Temp.Range	Batteries	Package
ISL9241HRTZ	3.9V to 23.4V	3.9V to 18.304V	-10°C – 100°C	2-4	32 Ld 4x4 TQF
ISL9241IRTZ	3.9V to 23.4V	3.9V to 18.304V	-40°C – 100°C	2-4	32 Ld 4x4 TQF

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

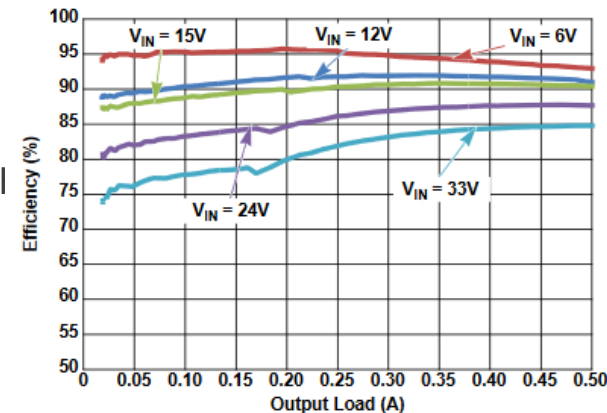
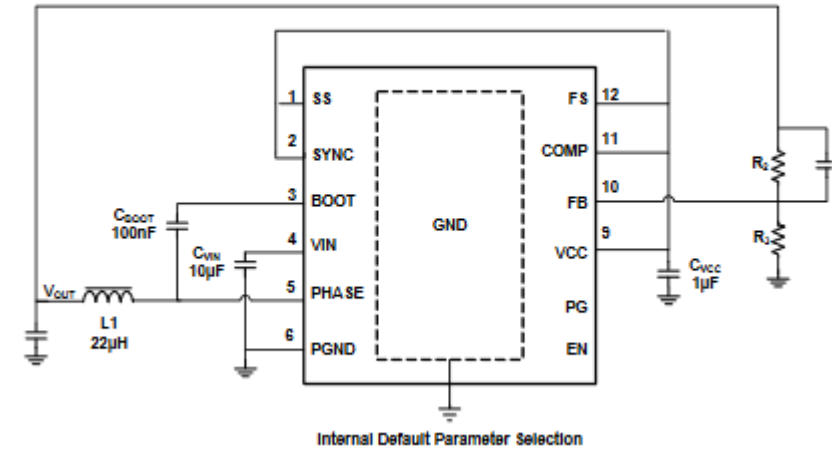


Figure 6. Efficiency vs Load, PFM, $V_{OUT} = 5V$

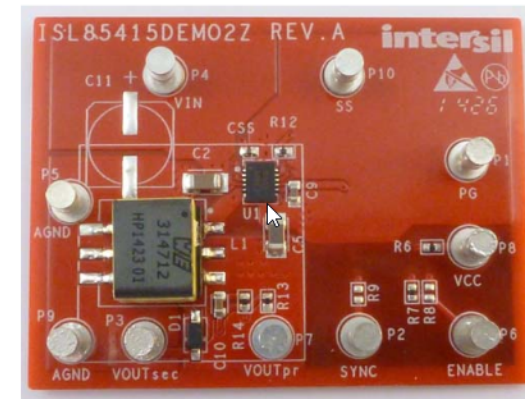


FIGURE 1. FRONT OF EVALUATION BOARD ISL85415DEMO02Z

Part #	V_{IN} Range(V)	Temp.(°C)	Package
ISL85415FRZ	3 to 36	-40 to 125	12 Ld DFN 4x3

ISL85403 – 2.5A Regulator with Integrated High Side FET

Supports 3V-40V Input Voltage Range for Buck or Boost-buck Output

Wide Working Range

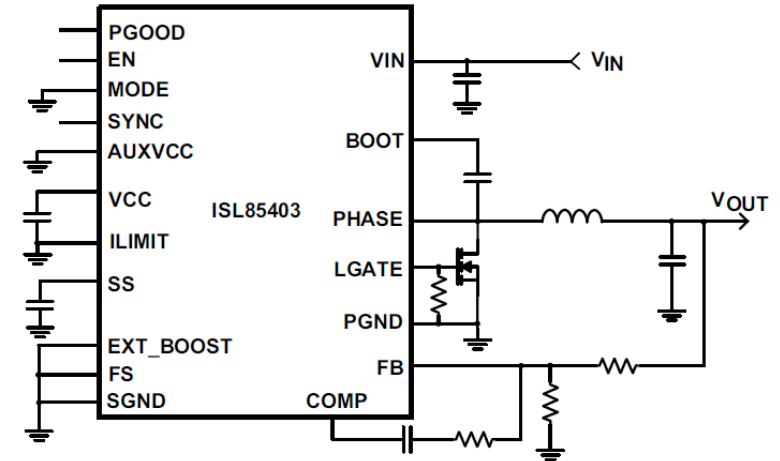
- Power input voltage range from 3V to 40V
- Supports both step down (buck) or boost+buck outputs
- Up to 2.5A load over full temperature range

High Efficiency

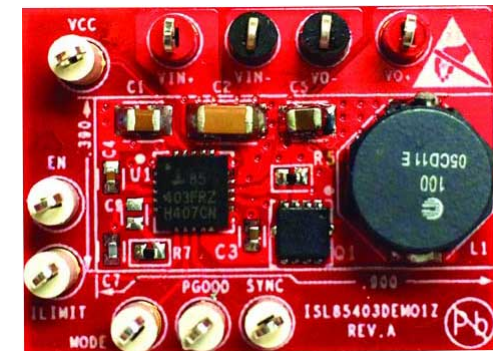
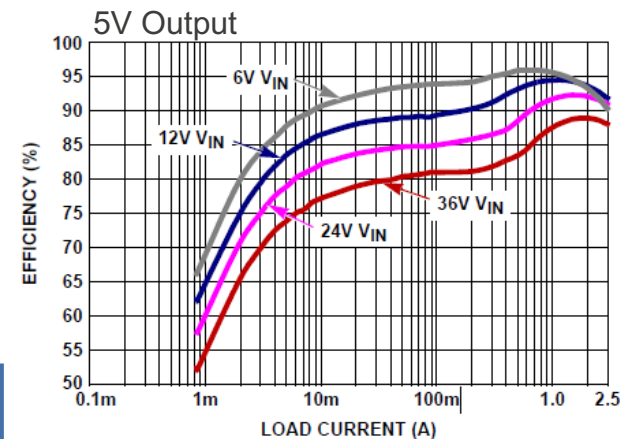
- Optional external low side FET for higher efficiency
- Selectable PWM / PFM modes
- 300uA input quiescent PFM mode current
- Less than 5uA shutdown current

High Performance

- 200KHz to 2.2MHz frequency range
- +/- 1% voltage regulation accuracy



Typical Application Circuit



ISL85403EVAL1Z Evaluation Board

Part #	V _{IN} Range(V)	Temp.(°C)	Package
ISL85403FRZ-T	3 to 40	-40 to 125	20 Ld 4x4 QFN

HIP2103/4 – 60V, 1A/2A, Half-Bridge Driver

High Voltage Drivers for Industrial Motor Control

Flexible Half-Bridge Drivers

- Supports half bridge, full bridge, and 3-phase configurations
- Enables DC and 3-phase BLDC motors

Independent High & Low Inputs

- Reduces connections to MCU and lowers cost
- Supports 3.3V and 5V signals

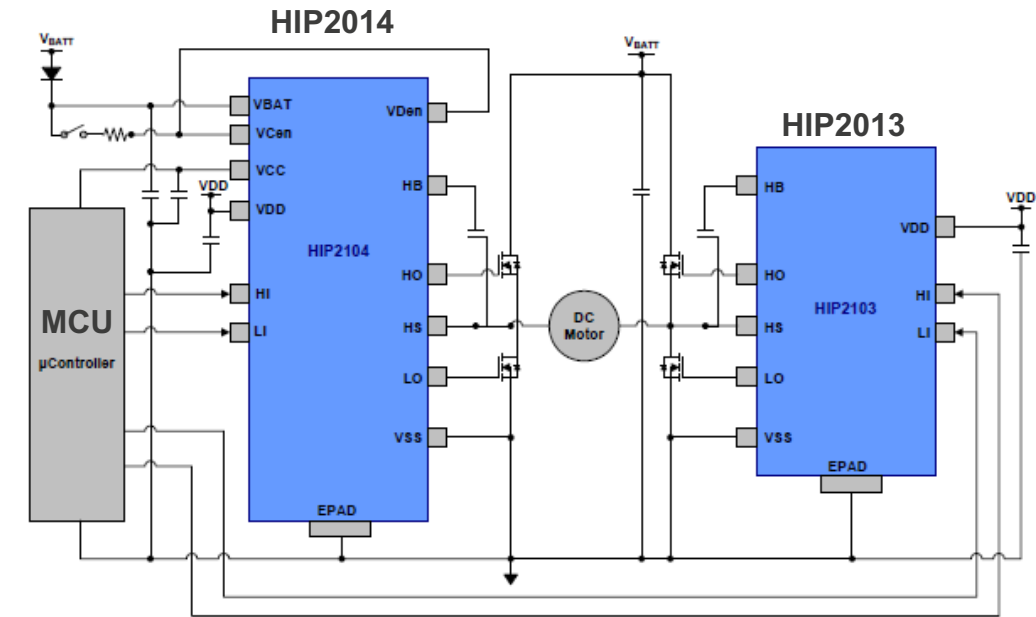
Sleep Mode

- Low quiescent current (5uA) with unique sleep mode
- Allows direct connection to battery without disconnect switch

Integrated LDO (HIP2104)

- HIP2104 includes integrated 12V & 3.3V LDOs
- Provides bias to external MCU plus HIP2103 & HIP2104 drivers

Part #	UVLO	VCC Reg	VDD Reg	Package
HIP2103FRTAAZ-T	4.0V	N/A	N/A	8L 3x3 TDFN
HIP2104FRTAAZ-T	4.0V	3.3V	12V	12L 4x4 DFN



Typical Application Circuit

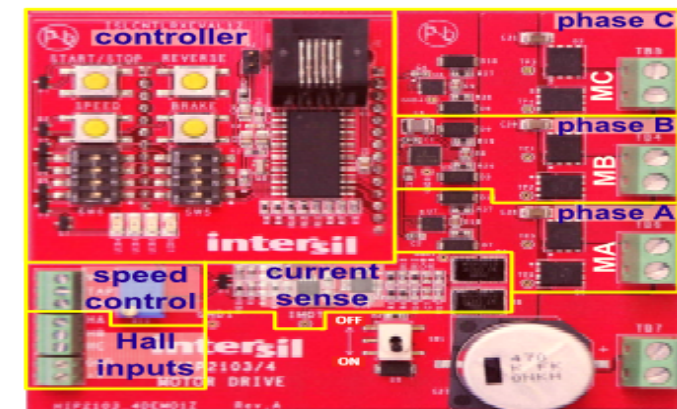


FIGURE 1. HIP2103-4DEMO1Z INPUTS AND OUTPUTS

FS1012 – Gas or Liquid Flow Sensor Module

Highly sensitive/fast response at low flow rates for low power industry applications

Capable of Measuring Medium:

- Gas or liquid medium
- Wetted materials consist of a glass fiber reinforced PA66 resin, epoxy, and silicon carbide

Fast Response and Low Power:

- Fast response: <5ms
- Low power consumption: Millivolt output

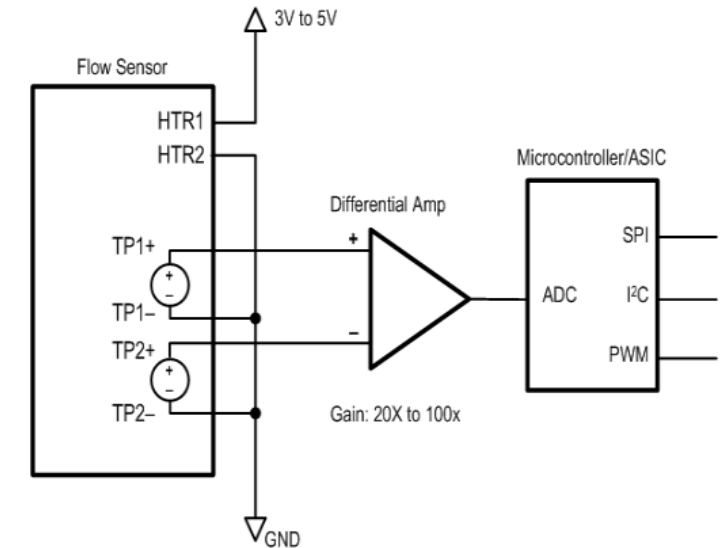
High Performance Robust in Use:

- Robust “solid” isolation technology
- Resistant to surface contamination
- No cavity to cause clogging
- Resistant to vibration and pressure shock
- Sensitive at low flow rates and differential pressure levels
- Supply voltage: 3V to 5V
- Module operating temperature range: 0°C to +85°C

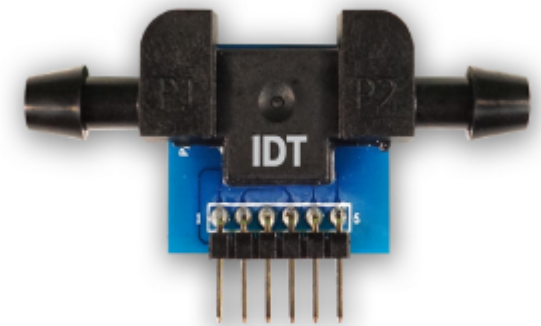
Part #	Parameter	Maximum
FS1012-1020-NG	Gas Flow	2(2000) SLPM(SCCM)
FS1012-1020-NG	Gas Flow	10(10000) SLPM(SCCM)
FS1012-1001-LQ	Liquid Flow	0.5(500) SLPM(SCCM)
FS1012-1002-LQ	Liquid Flow	1.0(1000) SLPM(SCCM)

SLPM: Standard liter per minute.

SCCM: Standard cubic centimeter per minute.



FS1012 Typical Circuit



FS1012 Module (front)

[Renesas.com](https://www.renesas.com)