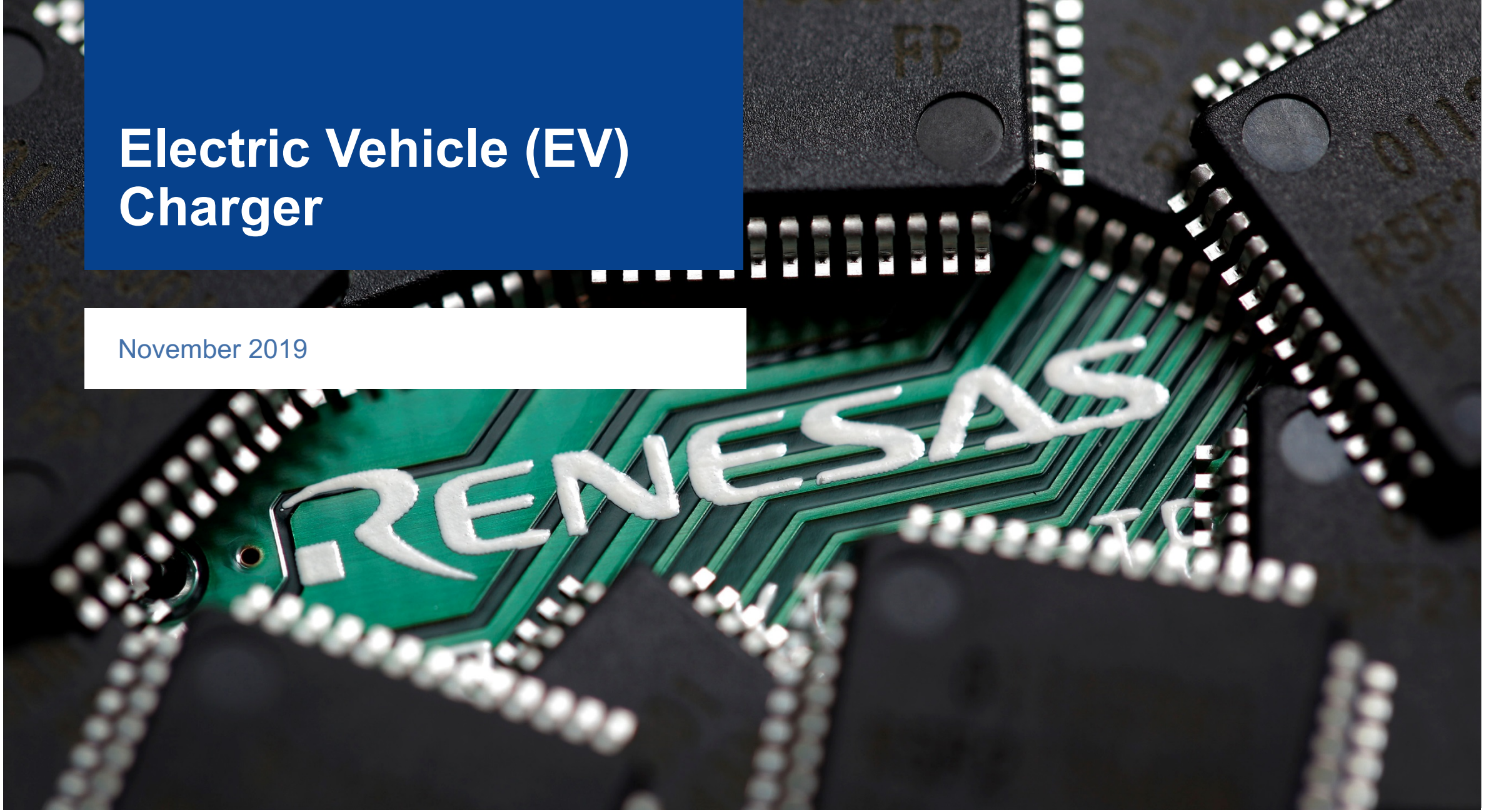
Electric Vehicle (EV) Charger

November 2019



Electric Vehicle (EV) Charger

Overview

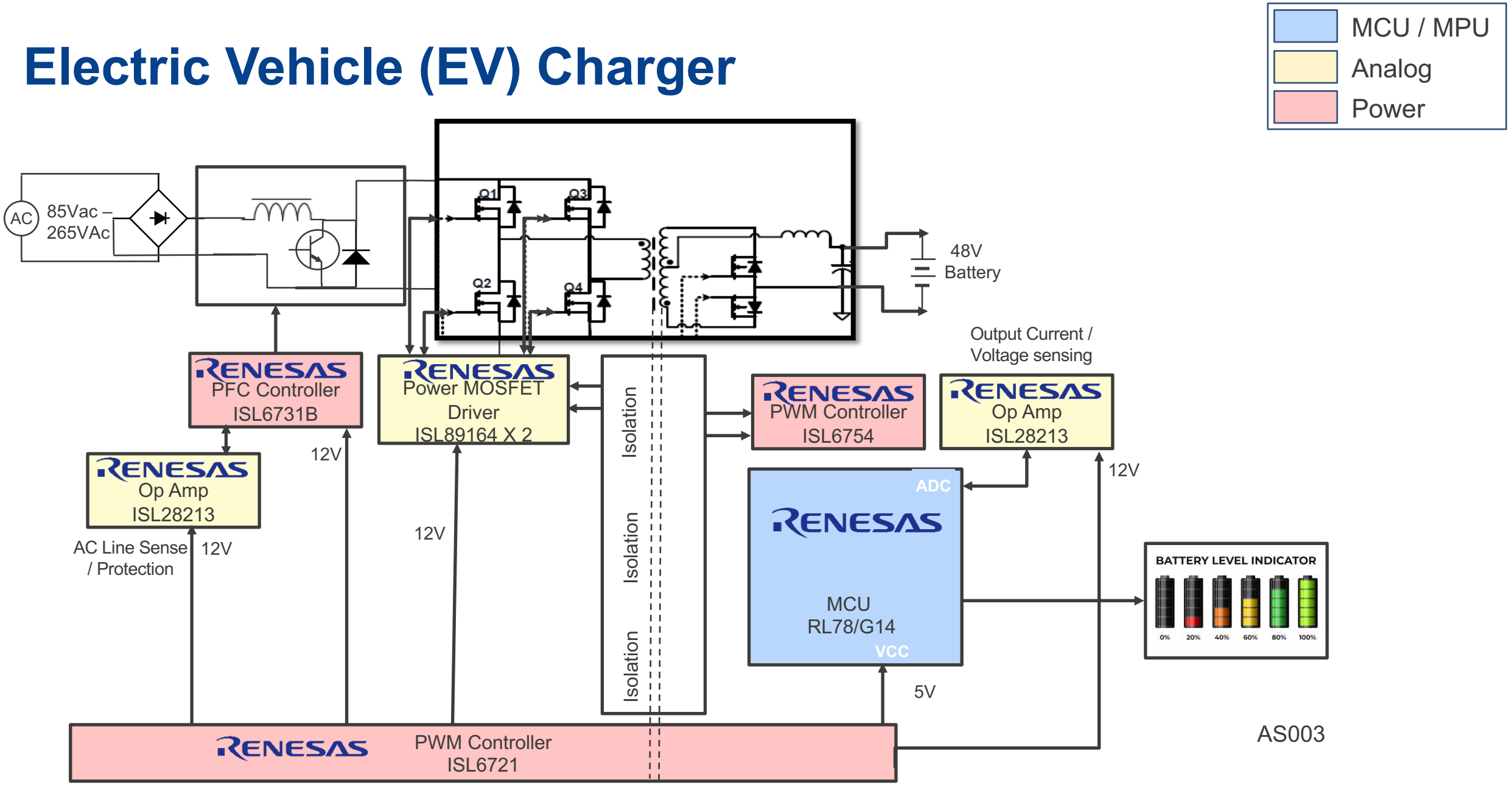
As electro mobility (e-mobility) increasingly becomes part of daily life, there is a growing need for more efficient charging solutions. EVs can help broaden the number of fuel choices available for transportation. EVs can also reduce the emissions that contribute to climate change and smog, improving public health and reducing ecological damage. Fueling with electricity offers some advantages that are not available in conventional internal combustion engine vehicles. Because electric motors react quickly, EVs are very responsive and have very good torque. EVs are often more digitally-connected than conventional vehicles, with many EV charging stations providing the option to control charging from a smartphone app. This design approach utilizes an active PFC and asymmetrical full-bridge ZVS converter, along with an RL78/G14 MCU for EV charger applications.

System Benefits

- Highly integrated MCU
- The ISL6731B provides adaptive control that enables extremely low THD and high PF without DSP
- The RL78/G14 MCU allows users to implement working logic, protections, and features for the driver
- Battery health implementation features

AS003

Electric Vehicle (EV) Charger



Electric Vehicle (EV) Charger

Device Category	P/N	Key Features
MCU	RL78/G14	Built-in communications functions such as USB and IrDA, a capacitive touch sensor (CTSU), a segment LCD, and a serial sound interface (SSI).
Power	ISL6731B	Active Power factor correction (PFC) controller ICs that use a boost topology. The controllers are suitable for AC/DC power systems up to 2kW and over the universal line input.
	ISL6754	The ISL6754 is a high performance extension of the family of Zero-Voltage Switching (ZVS) full-bridge PWM controllers. It offers adjustable resonant delay for ZVS operation. The ISL6754 features complemented PWM outputs for Synchronous Rectifier (SR) control.
	ISL89164	High speed, dual channel, 6A, power MOSFET driver with enable inputs
	ISL6721	The ISL6721 is a low power, single-ended Pulse Width Modulating (PWM) current mode controller designed for a wide range of DC/DC conversion applications, including boost, fly nack and isolated output configurations. Peak current mode control effectively handles power transients and provides inherent overcurrent protection.
Analog	ISL28213	Single, dual, quad general purpose micropower, RRIO operational amplifier

AS003

RL78/G14 – Advanced Functions MCU

Suitable for motor control as well as industrial and metering applications

Added instruction functions to CPU core

- Added multiply, divide, and multiply-accumulate instructions that enable high-speed operation by direct execution without needing to utilize library functions
- High calculation performance: 51.2 DMIPS(32 MHz)

High performance peripheral functions

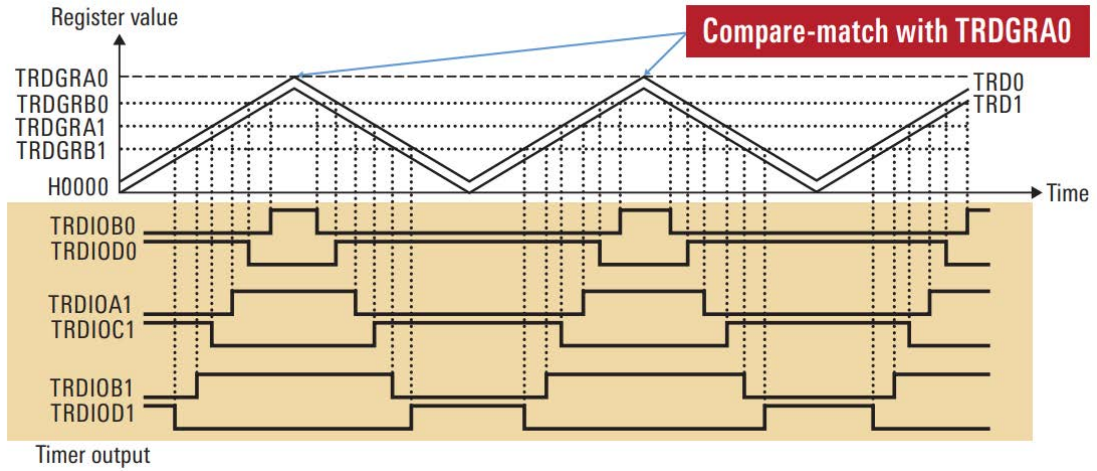
- Timer RD(Complementary PWM Mode for brushless DC motor control), Timer RG (Phase Count Mode), Timer RJ (asynchronous timer)
- Data Transfer Controller (DTC); Event Link Controller (ELC)
- Comparator, 8bit Digital Analog Converter

Easy to Develop and Use

- Scalable lineup packages, pin-counts and Flash ROM, RAM
- Released Starter Kit and Motor Solution Evaluation Kit

Part #	Flash ROM	RAM	Package(mm)
R5F104A	16 ~ 128 KB	2.5 ~ 16 KB	30-LSSOP(7.62)
R5F104B			32-HWQFN(5 × 5), 32-LQFP(7 × 7)
R5F104C			36-WFLGA(4 × 4)
R5F104E	16 ~ 192 KB	2.5 ~ 20 KB	40-HWGFN(6 × 6)
R5F104F	16 ~ 256 KB	2.5 ~ 24 KB	44-LQFP(10 × 10)
R5F104G	16 ~ 512 KB	2.5 ~ 48 KB	48-LFQFP(7 × 7), 48-HWQFN(7 × 7)
R5F104J	32 ~ 256 KB	4 ~ 24 KB	52-LQFP(10 × 10)
R5F104L	32 ~ 512 KB	4 ~ 48 KB	64-LFQFP(10 × 10), 64-LQFP(12 × 12), 64-LQFP(14 × 14)*, 64-WFLGA(5 × 5)
R5F104M	96 ~ 512 KB	12 ~ 48 KB	80-LFQFP(12 × 12), 80-LQFP(14 × 14)
R5F104P			100-LFQFP(14× 14), 100-LQFP(14 ×20)

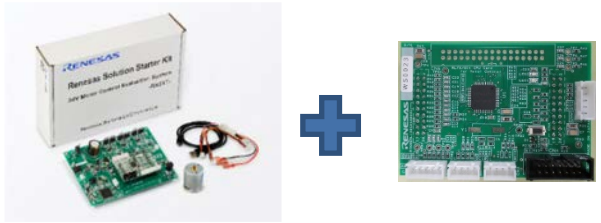
*This product do not exist 384KB/512KB.



Complementary PWM mode operation example

Renesas Starter Kit for RL78/G14

RL78 Family Motor Solution Evaluation Kit



24V Motor Control Evaluation System for RX23T

RL78/G14 CPU Card for Motor Control

ISL6731x – Active Power Factor Correction (PFC) Controller

Up to 2kW and Over the Universal Line Input

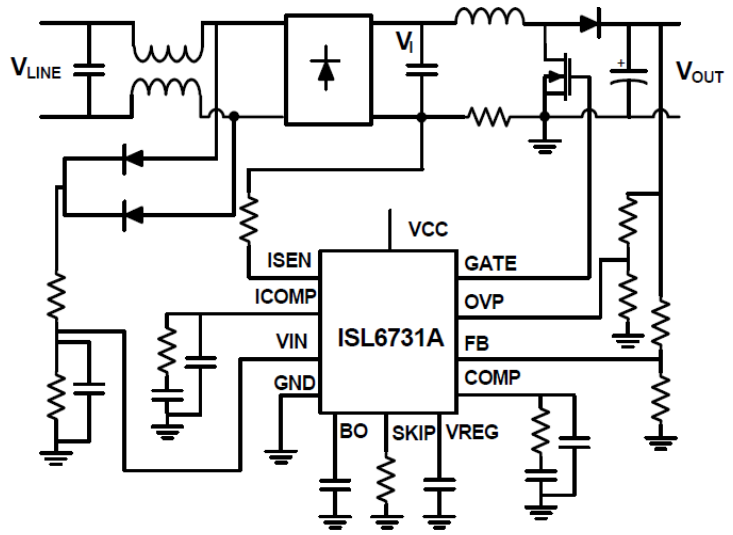
High Performance

- Zero crossing distortion and the magnetic components size are both reduced
- Internally clamped 12.5V gate driver delivers 1.5A peak current to the external power MOSFET
- Protection features include cycle-by-cycle overcurrent, over power limit, over-temperature, input brownout, output overvoltage and undervoltage protection

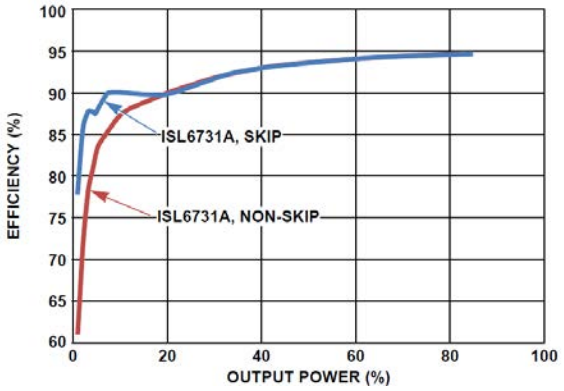
Key Features

- Two switching frequency options are provided:62K/124KHz
- Work in Continuous Conduction Mode (CCM)
- Programmable or automatic shutdown
- Small 14 Ld SOIC package

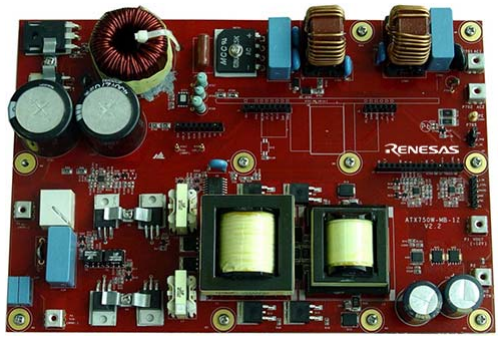
Part #	Switch Frequency(kHz)	Skip Mode	Package
ISL6731AFBZ	124	Yes-Fixed	14 Ld SOIC
ISL6731BFBZ	62	Yes-Fixed	14 Ld SOIC



Typical Application Circuit



PFC Efficiency Chart



ISLACDC750WEVKIT1Z Evaluation Board

ISL6754 – Isolated PWM Controller

ZVS Full-Bridge PWM Controller with Adjustable Synchronous Rectifier Control

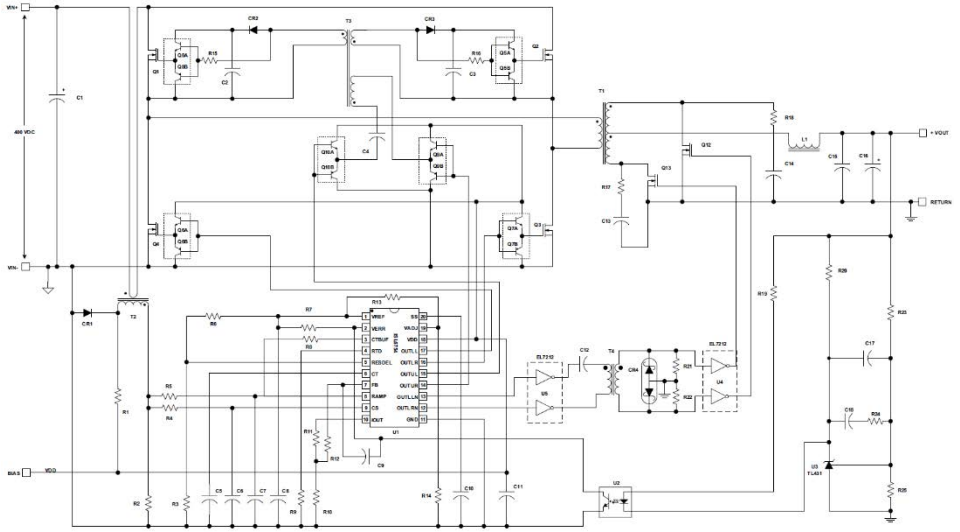
High Performance and Protection

- Adjustable resonant delay for ZVS operation
- Synchronous rectifier control outputs with adjustable delay/advance
- 3% current limit threshold
- 175µA start-up current, supply UVLO
- Fast current sense to output delay
- Internal over-temperature protection
- Multi-pulse suppression
- 70ns leading edge blanking

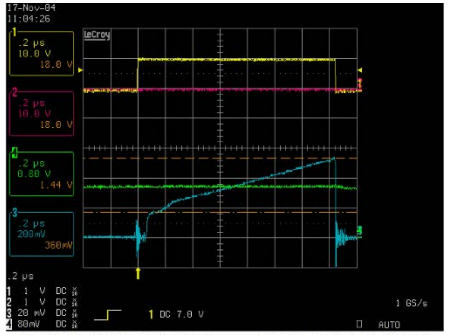
Flexible Use

- Support both voltage- and current-mode control
- Adjustable average current limit
- Adjustable dead time control
- Adjustable oscillator frequency up to 2MHz
- Adjustable cycle-by-cycle peak current limit

Part #	Max Duty	PWM Output	UVLO Rising/Falling	Package
ISL6754AAZA	99%	6ch	8.75V/7V	20 Ld QSOP



Typical Application Circuit



CS Input vs I_{OUT}

ISL6754EVAL1Z Evaluation Board

BIG IDEAS FOR EVERY SPACE RENESAS

ISL89164 – Power MOSFET Driver with Enable Inputs

High Speed, Dual Channel, 6A Power MOSFET Driver

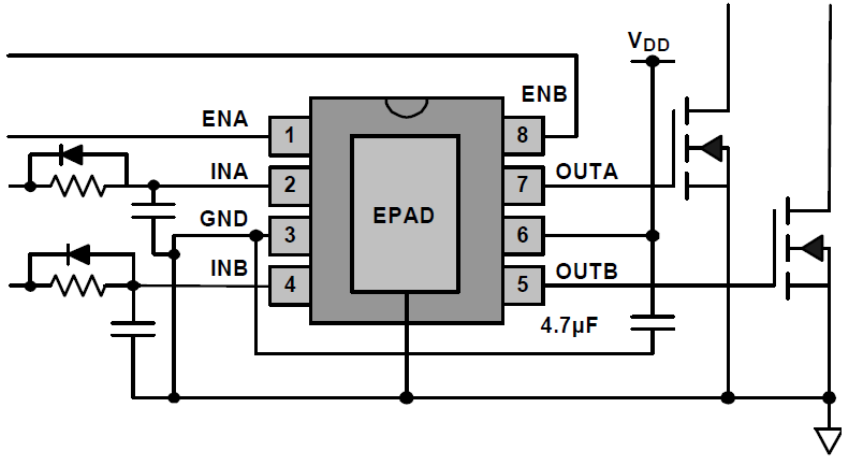
High Performance

- Dual output, 6A peak currents, can be paralleled
- Very low thermal impedance (θ_{JC} = 3°C/W)
- Precision threshold inputs for time delays with external RC components
- 20ns rise and fall time driving a 10nF load
- Typical ON-resistance <1Ω

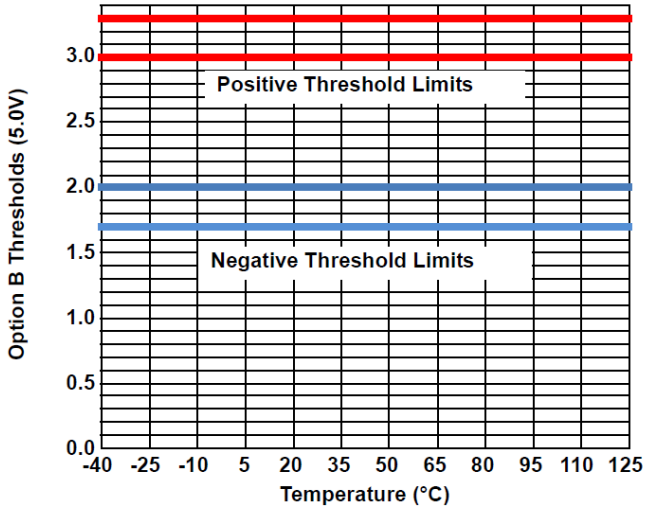
Flexible Operation Mode

- Three input logic thresholds are available: Hysteretic Input logic levels for 3.3V CMOS, 5VCMOS, TTL, and Logic levels proportional to V_{DD}
- Dual AND-ed input logic, (input and enable)

Part #	Input Configuration	Input Logic(V)	Package
ISL89164FRTAZ	Inverting	3.3	8 Ld 3x3 TDFN
ISL89164FRTBZ	Inverting	5.0	8 Ld 3x3 TDFN
ISL89164FBEAZ	Inverting	3.3	8 Ld EPSOIC
ISL89164FBEBZ	Inverting	5.0	8 Ld EPSOIC



Typical Application



Temperature Stable Logic Thresholds

ISL6721 –Flexible Single Ended Current Mode PWM Controller

A design for a wide range of DC/DC Conversion Applications

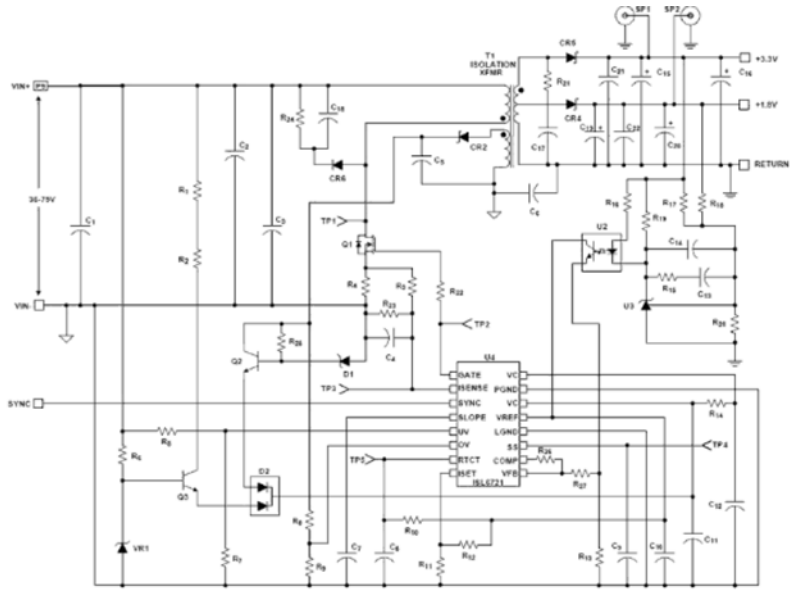
Key Specification

- 1A MOSFET gate driver
- 100µA start-up current
- Adjustable switching frequency up to 1MHz
- Build in boost, flyback and isolated output configurations

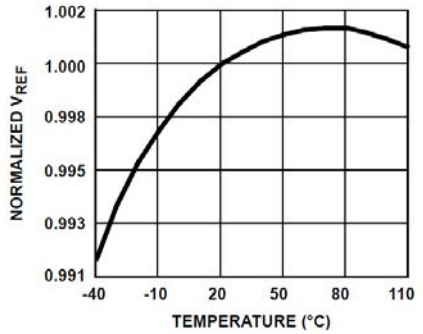
High Performance

- Supply current drops to less than 200µA during overvoltage and overcurrent shutdown faults
- 1% tolerance voltage reference
- Peak current mode control effectively handles power transients and provides inherent overcurrent protection
- Adjustable slope compensation/soft-start/ overcurrent shutdown threshold/ UV and OV monitors

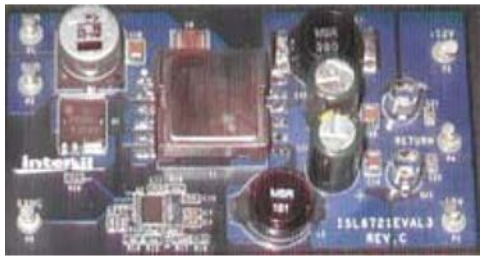
Part #	UVLO Threshold (Start/Stop)(V)	UV Threshold(V)	Temp.(℃)	Package
ISL6721ABZ	8.25/7.7	1.45	-40 to 105	16 Ld SOIC
ISL6721AVZ	8.25/7.7	1.45	-40 to 105	16 Ld TSSOP



Typical Application Circuit



V_{REF} Reference Voltage vs Temperature



ISL6721EVAL3Z Evaluation Board

ISL28x13 – Single/Dual/Quad RRIO Op Amps

General purpose, micropower, RRIO operational amplifiers for a wide range of applications

Good Dynamic Performance

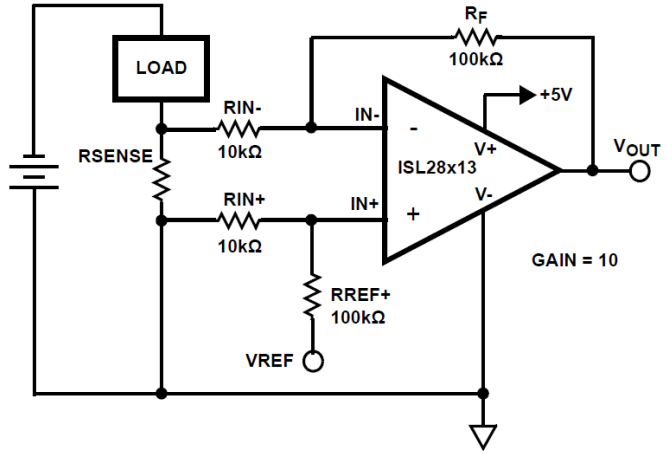
- Rail-to-rail input and output
- Gain-bandwidth: 2MHz

Low Power and Wide Supply Range

- Low current consumption: 130µA maximum per channel
- Input bias current: 20pA, Max
- Wide supply range: 1.8V to 5.5V

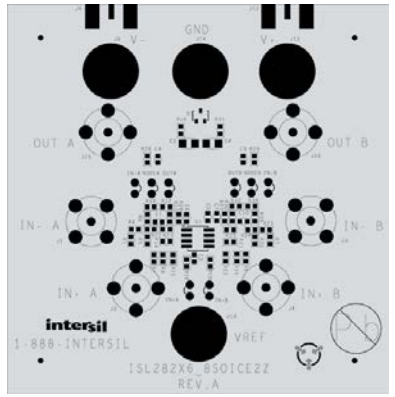
Wide Operating Temperature Range

- All devices operate across the extended temperature range of -40°C to 125°C

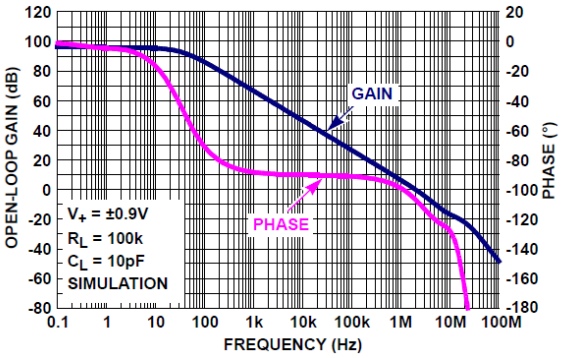


Typical Application

Part #	Channel	Package
ISL28113FEZ-T7	Single	5 Ld SC-70
ISL28113FHZ-T7	Single	5 Ld SOT-23
ISL28213FUZ	Dual	8 Ld MSOP
ISL28213FBZ	Dual	8 Ld SOIC
ISL28213FHZ-T7	Dual	8 Ld SOT-23
ISL28413FVZ	Quad	14 Ld TSSOP
ISL28413FBZ	Quad	14 Ld SOIC



ISL28213MSOPEVAL2Z Evaluation Board



Open-loop Gain, Phase vs Frequency, R_L = 100KΩC_L = 10pF, V_S = ±0.9V

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