CN252
Voice Controlled Ambient Lighting with DALI

May 2020

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Voice Controlled Ambient Lighting with DALI

■ Overview

The digital addressable lighting interface (DALI) is a lighting control protocol for intelligent lighting systems. The DALI system is widely used in commercial lighting control and building lighting control. The DALI 2.0 standard improves the ability to control brightness, glare, color rendering, and presence detection, and adds multi-vendor interoperability to the DALI standard, IEC 62386. It also introduces standardization of control devices, such as application controllers and input devices.

Renesas provides both DALI and DALI 2.0 control/communication software. In this reference design, Renesas features the RL78/G12, RL78/G13, RL78/I1A, and Synergy S128 Series microcontrollers (MCUs). In addition to highly integrated MCUs, the design also features an LED driver, power components, light sensors, and proximity sensors for DALI 2.0, as well as transceivers/receivers for the host computer interface.

■ System Benefits

– The RL78/I1A is a one-chip solution for DALI, PWM dimming controls, and voice control
– The ISL97901 is an RGBW light driver with a maximum output of 1.5A
– Includes the ISL29035/ISL29125 light sensor and the ISL29501 presence detection sensor
– Highly integrated power components and RS232 interface support

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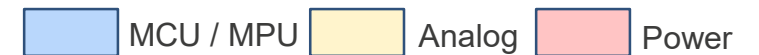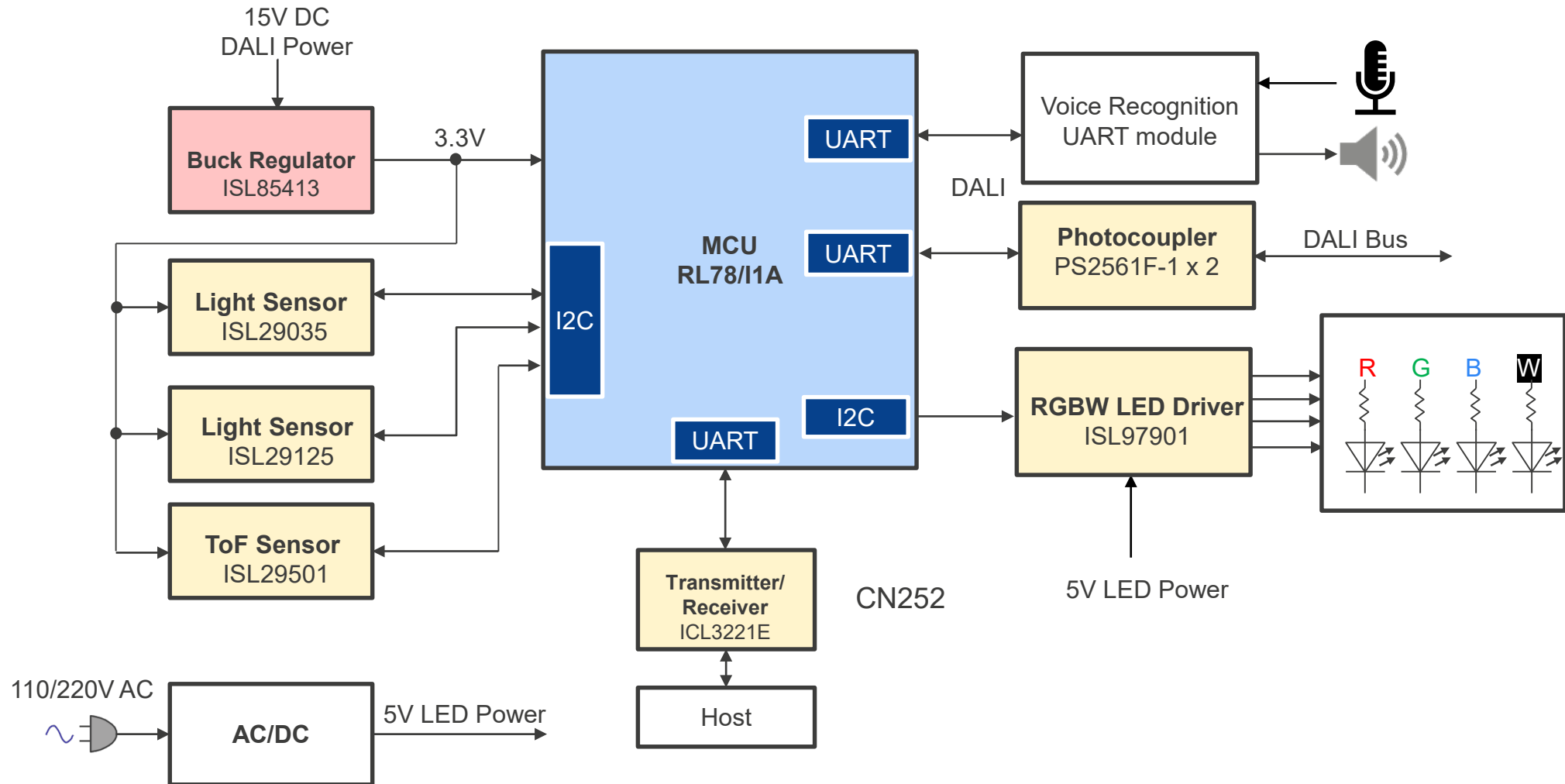
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Device Category	P/N	Key Features
MCU	RL78/I1A R5F107xxxxSP	Microcontrollers that output high-resolution PWM for fine dimming and toning of LED lighting. DALI/DMX512 lighting communication and power management bus (PMBus) and system management bus (SMBus) power communication are supported.
Analog	ISL29035	Integrated digital light sensor close to human eye response
	ISL29125	RGB light sensor with IR blocking filter and small package
	ISL29501	TOF sensor, ISL29501 is a Time of Flight (ToF) based signal processing integrated circuit
	PS2561F-1	DC input/single transistor output photocouplers are suitable for applications such as I/O interfaces and signal transmission circuits
	ISL97901	RGB LED driver, up to 1.5A, 4 channel
	ICL3221E	1µA Supply-Current, +3V to +5.5V, 250kbps, RS-232 transmitters/receivers
Power	ISL85413	3.5V to 40V V_{IN} 300mA synchronous buck regulator

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RL78/I1A – MCU for Lighting and Power Supply
Output High Resolution PWM for Fine Dimming and Toning of LED Lighting

Basic Functions for Lighting and Power Supply Applications

- Timers for LED control and PFC control：64 MHz source clock, zero current detection, forced output stop function
- 10-bit A/D converter (2.125 μs. conversion), PGA, comparator
- Support for high temperatures up to 105°C or 125°C

Low Current Consumption

- LED power supply control: 3.3 mA (main operation)
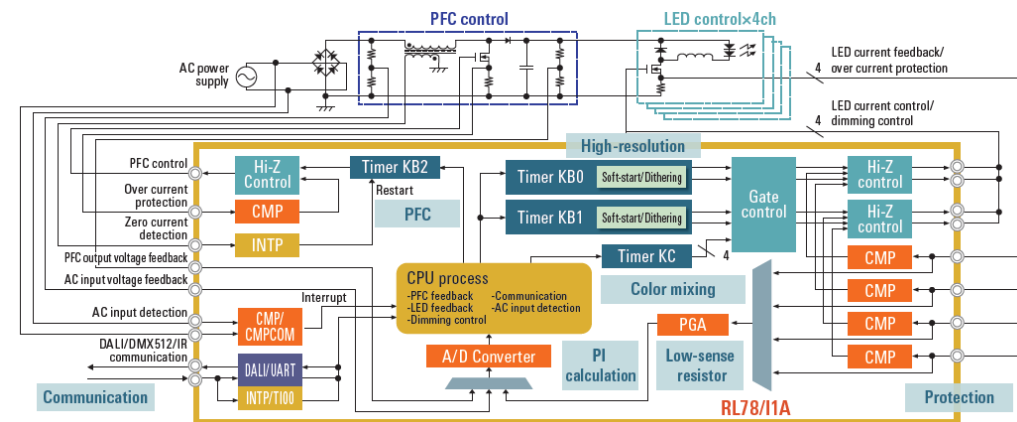- UART (DALI) receive standby: 0.23 μA (STOP current)

Full Complement of Connectivity Functions

- Communication functions (DALI, PMBus, SMBus, DMX512, UART, I^{2}C,CSI)

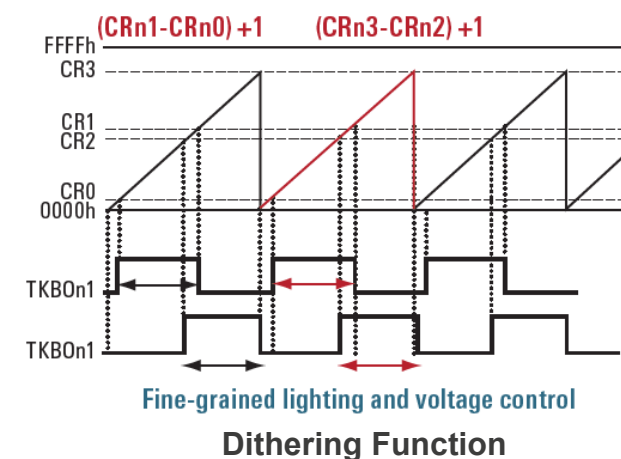**Special Peripheral Functions for "Intelligent" Operation and Improved Efficiency**

- Dithering function (0.98 ns pseudo-resolution), software start function, max. frequency limit function, interleaved PFC, standby communication wait

PFC control + LED constant current control

Delivers min. average resolution of 0.98 ns.

Fine-grained lighting and voltage control

Dithering Function

Part #	Flash ROM	RAM	Timer KB	Timer KC	Package
R5F1076C	32 KB	2 KB	2ch	1 channel (PWM outputs: 3)	20-LSSOP(4.4 x 6.5mm)
R5F107AC	32 KB	2 KB	3ch	1 channel (PWM outputs: 6)	30-LSSOP(7.62mm (300))
R5F107AE	64 KB	4 KB	3ch	1 channel (PWM outputs: 6)	30-LSSOP(7.62mm (300))
R5F107DE	64 KB	4 KB	3ch	1 channel (PWM outputs: 6)	38-LSSOP(7.62mm (300))

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ISL29035 – Integrated Digital Light Sensor with Interrupt

Ambient and Infrared Light-to-digital Converter with I²C (SMBus compatible) Interface
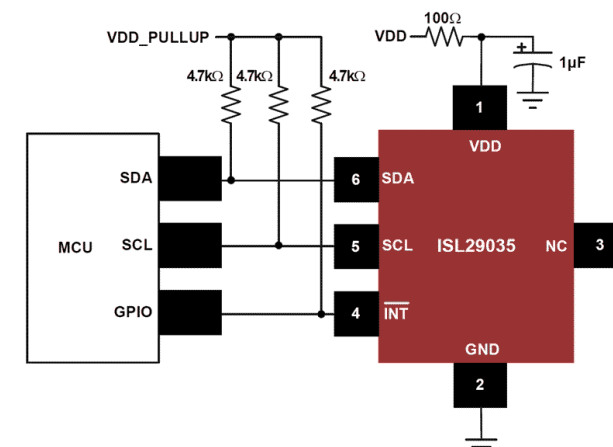
Integrated Functions and Small Package

- 6 pin 1.5mmx1.3mm ODFN
- On-chip 16-bit ADC
- I²C (SMBus compatible) Interface
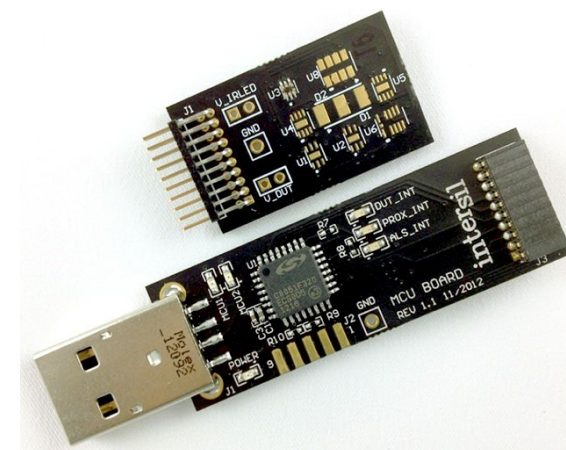- Integrated noise reduction 50/60Hz

High Performance

- Dynamic Range 1: 4,200,000
- Close to human eye response with excellent IR/UV rejection
- Operation across -40 to +85°C

Low Power Design

- Normal operation 57uA
- 2 power down mode support shutdown current < 0.51uA

Part #	ALS Sensing	Interrupt Pin	Package
ISL29034IROZ	Yes	No	4 Ld 1.5x1.3 ODFN
ISL29035IROZ-T7	Yes	Yes	6 Ld 1.5x1.6 ODFN

Typical Operating Circuits

ISL29035EVAL1Z Evaluation Board

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ISL29125 – RGB Color Light Sensor
## Digital RGB Color Light Sensor with IR Blocking Filter

High Sensitivity, Accurate and Flexible Design

- Selectable range (Via I^{2}C)
- I^{2}C (SMBus compatible) output
- ADC resolution 16 bits
- Programmable interrupt windows
- Two optical sensitivity ranges:
 - Range 0 = 5.7m lux to 375 lux
  - Range 1 = 0.152 lux to 10,000 lux

Low Power and Small Package

- 56µA operating current, 0.5µA shutdown current
- Operating power supply 2.25 to 3.63V
- I^{2}C power supply 1.7V to 3.63V
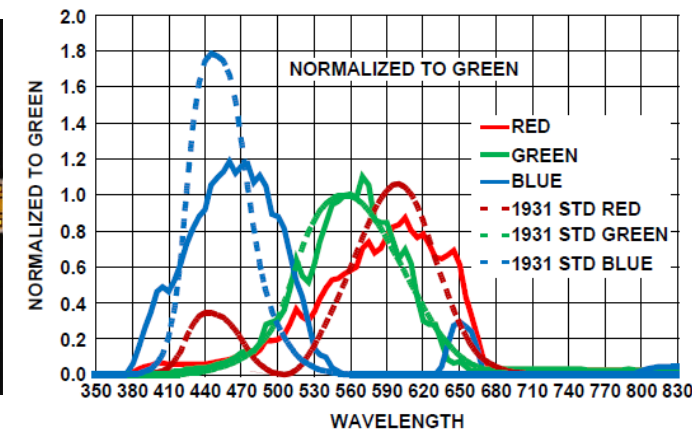- 6 Ld ODFN (1.65x1.65x0.7mm) package

Part #	Temp range	Tape and Reel Quantity	Package
ISL29125IROZ-T7	-40 to 85 °C	3000	6 Ld 1.65 x 1.65 ODFN
ISL29125IROZ-T7A	-40 to 85 °C	250	6 Ld 1.65 x 1.65 ODFN
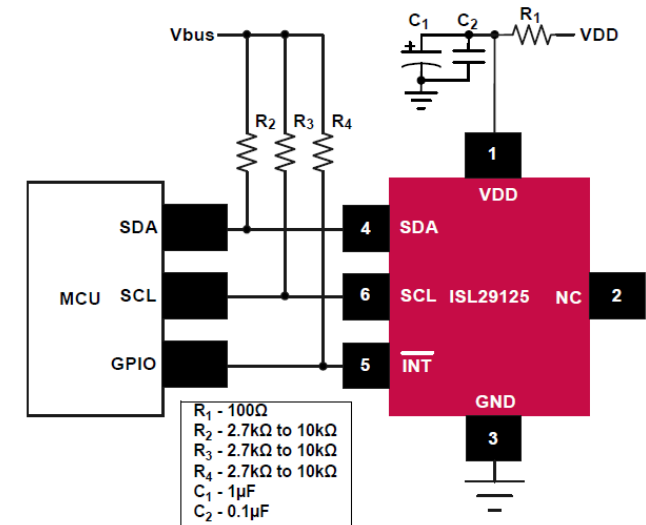
Typical Application Diagram
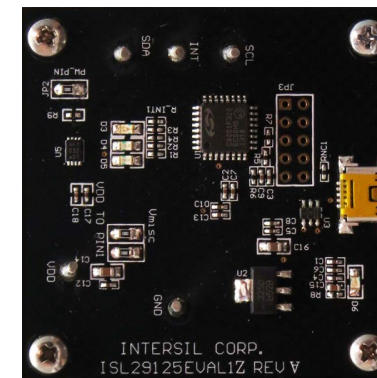
ISL29125EVAL1Z Evaluation Board

Normalized Spectral Response for RGB Sensing

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ISL29501-Time of Flight (ToF) Signal Processing IC
Low Cost, Low Power, and Long Range Optical Distance Sensing

Application-Level Integrated
- On-chip Digital Signal Processor calculates the time of flight
- Built-in current DAC circuit that drives LED or laser
- On-chip active ambient light rejection

Easy Control
- I^{2}C interface for configuration and control.
- Operates in Continuous and Single Shot mode
- Auto gain control mechanism
- Interrupt controller
- Modulation frequency of 4.5MHz

Suitable for Different Designs
- Enables proximity detection and distance measurement
- Allows to optimize for performance/ power/ distance, etc
- Wavelength agnostic
- Emitter DAC with programmable current up to 255mA
- I^{2}C interface supporting 1.8V and 3.3V bus
- Low profile 24 Ld 4x5 QFN package

Part #	VDD Range (V)	Temp Range (°C)	Package
ISL29501IRZ-T7	2.7V to 3.3V	-40 to +85	24 Ld QFN
ISL29501IRZ-T7A	2.7V to 3.3V	-40 to +85	24 Ld QFN
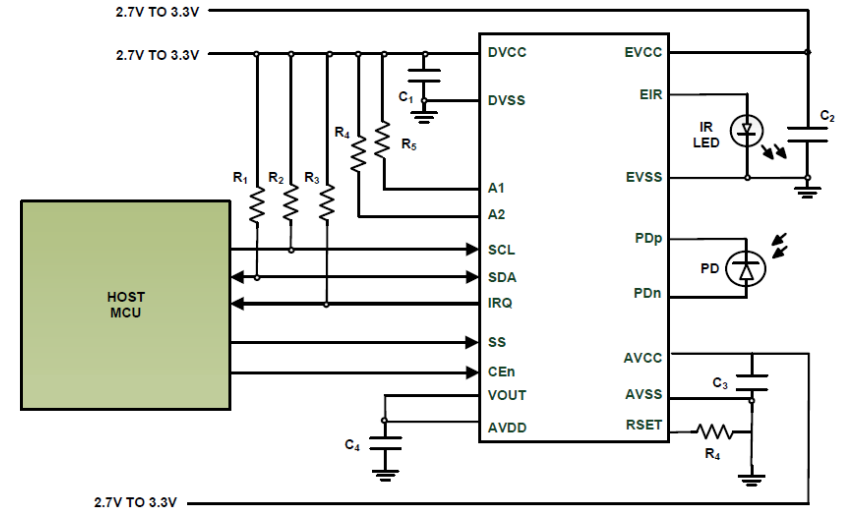
Typical Application Circuit
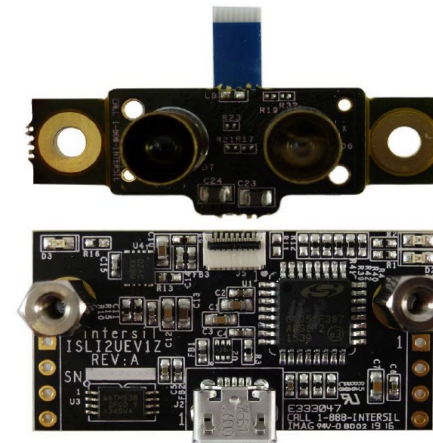
ISL29501-CS-EVKIT1Z Cat Shark

ISL29501-ST-EV1Z Sand Tiger

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PS2561F-1 – DC Input/Single Output Photocouplers
Dip Photocoupler, Operating Ambient Temperature 110°C
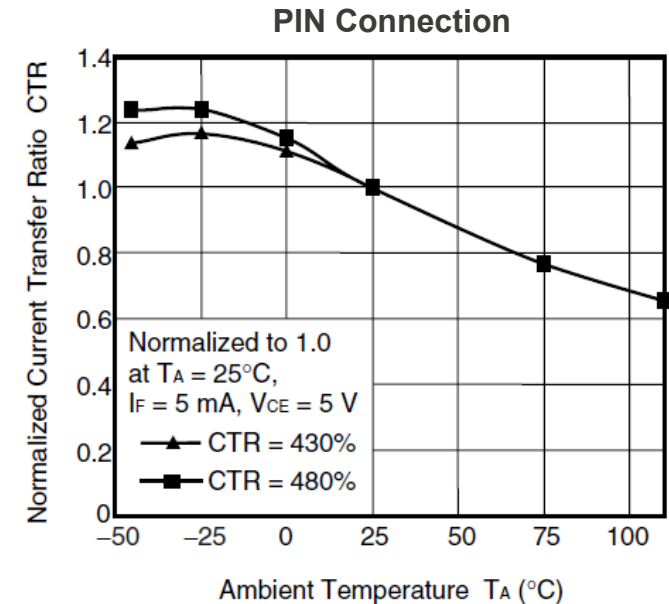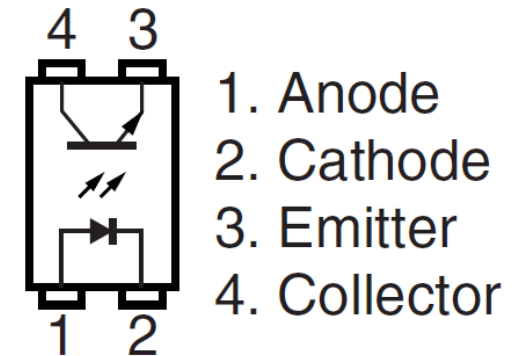
High Isolation Voltage and High Speed

- High isolation voltage (BV = 5000 Vr.m.s.)
- High-speed switching (tr = 5 µs TYP., tf = 7 µs TYP.)

High Current Transfer Ratio and Wide Operation Temp

- High current transfer ratio (CTR = 450% TYP.)
- High collector to emitter voltage (VCEO = 80 V)
- Operating ambient temperature: 110°C

Safety Standards

- UL approved: No. E72422

Part #	Safety Standard	Package
PS2561F-1	UL	4-PIN DIP(4.6mm x 6.5mm)
PS2561FL-1	UL	4-PIN Lead Bending Type(4.6mm x 6.5mm)
PS2561FL-1-F3	UL	4-PIN Lead Bending Type(4.6mm x 6.5mm)

4 3

1. Anode
2. Cathode
3. Emitter
4. Collector

1 2

PIN Connection

Normalized to 1.0 at T_A = 25°C, I_F = 5 mA, V_{CE} = 5 V
- CTR = 430%
- CTR = 480%

Normalized Current Transfer Ratio CTR

Ambient Temperature T_A (°C)

Normalized Current Transfer Ratio vs. Ambient Temperature

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ISL97901 – RGB Buck-Boost Four-Channel LED Driver
Color Sequencing and Automatic White Balance

High Efficient and Integrated Feature

- Buck-Boost Based LED Driver
- RGB, RGGB or RGBW Color Sequencing
- Up to 1.5A Output Current
- Photo Detector Feedback Interface
- Dual Green LED Drive Support
- Closed-Loop White Balancing Dynamic Current Scaling
- Standby Current less than 70µA
- 150mV Feedback Voltage Reference for Current Regulation to Maximize Efficiency
- Programmable Output Voltage for each LED
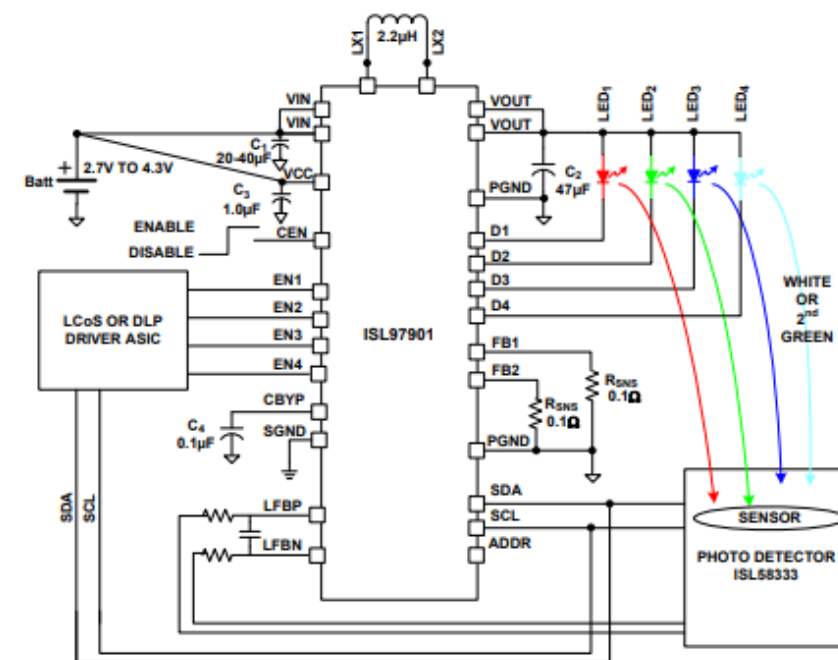
Typical Application Circuit

Part #	MOQ	Temp.(℃)	Package
ISL97901CRZ-T	6000	0 to 70	28Ld 5x4 QFN
ISL97901CRZ-TK	1000	0 to 70	28Ld 5x4 QFN
ISL97901CRZ	750	0 to 70	28Ld 5x4 QFN

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ICL3221 – Low Power RS-232 Transmitter/Receiver

1µA Supply-Current, +3V to +5.5V, 250kbp

Communication Speed

- 250kbps data rate min.

Key Features

- Wide power supply range: single +3V to +5.5V
- Low supply current in power down state: 1uA
- ESD protection for RS-232 I/O pins to ±15kV (IEC61000)
- On-chip voltage converters require only four external 0.1µF capacitors
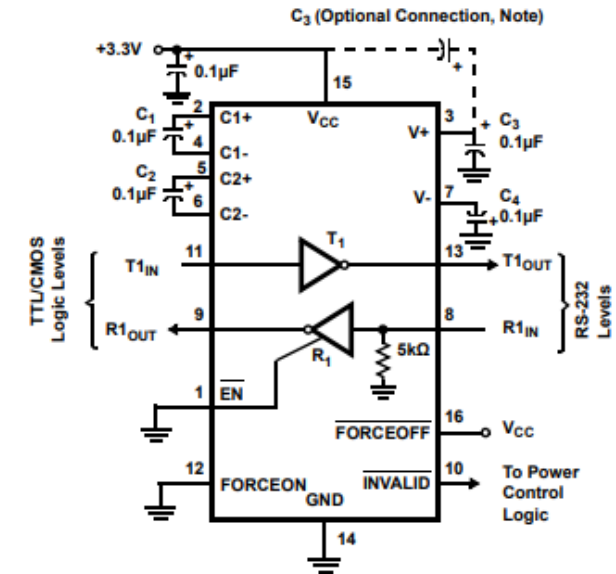
Good Connectivity

- RS-232 compatible with VCC = 2.7V

Industry Standard

- Meets EIA/TIA-232 and V.28/V.24 specifications at 3V

Part #	Temp. Rang	MOQ	Package
ICL3221CAZ	0 to +70	3080	16 Ld 5x4.4mm SSOP
ICL3221CAZ-T	0 to +70	2000 (T&R)	16 Ld 5x4.4mm SSOP
ICL3221IAZ	-40 to +85	3080	16 Ld 5x4.4mm SSOP
ICL3221IAZ-T	-40 to +85	2000 (T&R)	16 Ld 5x4.4mm SSOP

Typical Operating Circuits

Pin out

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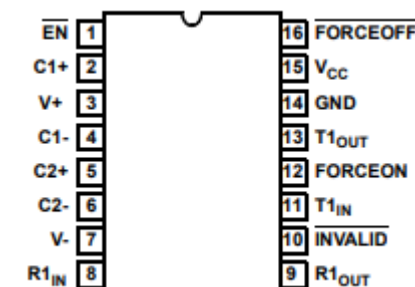
ISL85413 – 300mA Synchronous Buck Regulator
Support 3.5V-40V Input Voltage Range for Buck

Wide Working Range and Small Package

- Power input voltage range variable 3.5V to 40V
- Internal switching frequency 700kHz
- Continuous output current up to 300mA
- 3mm x 3mm TDFN

High Integration to Reduce Cost

- Integrates both high-side and low-side NMOS FETs

Best Fit for Applications

- PFM mode for improved efficiency at light loads, could be disable as well
- Requires very robust design for high voltage industrial applications
- High efficient requirement for battery powered applications

Part #	V_{IN} /Vout Range(V)	Switch frequency	Peak efficiency	Package
ISL85413FRTZ	3.5 to 40	0.6-0.784 MHz	92%	8 Ld TDFN
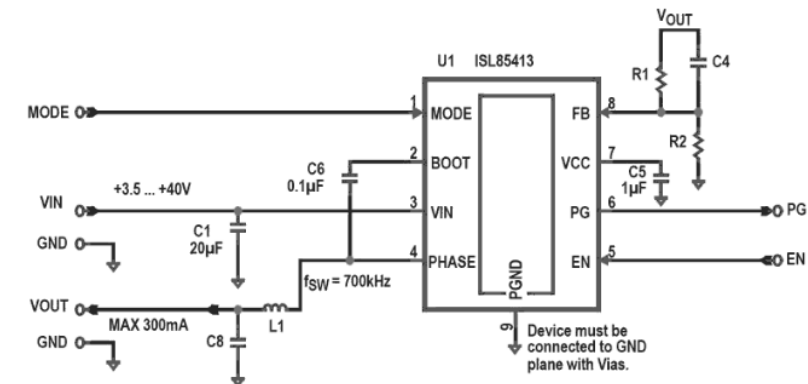
Typical Application Circuit
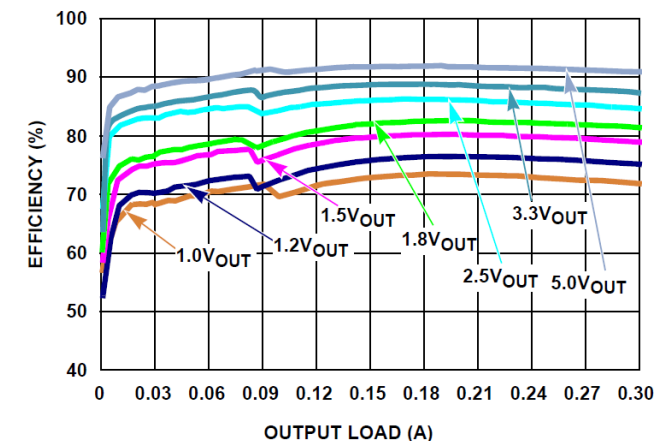
Efficiency vs Load, PFM, V_{IN} = 12V

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