

Smart Speaker

■ Overview

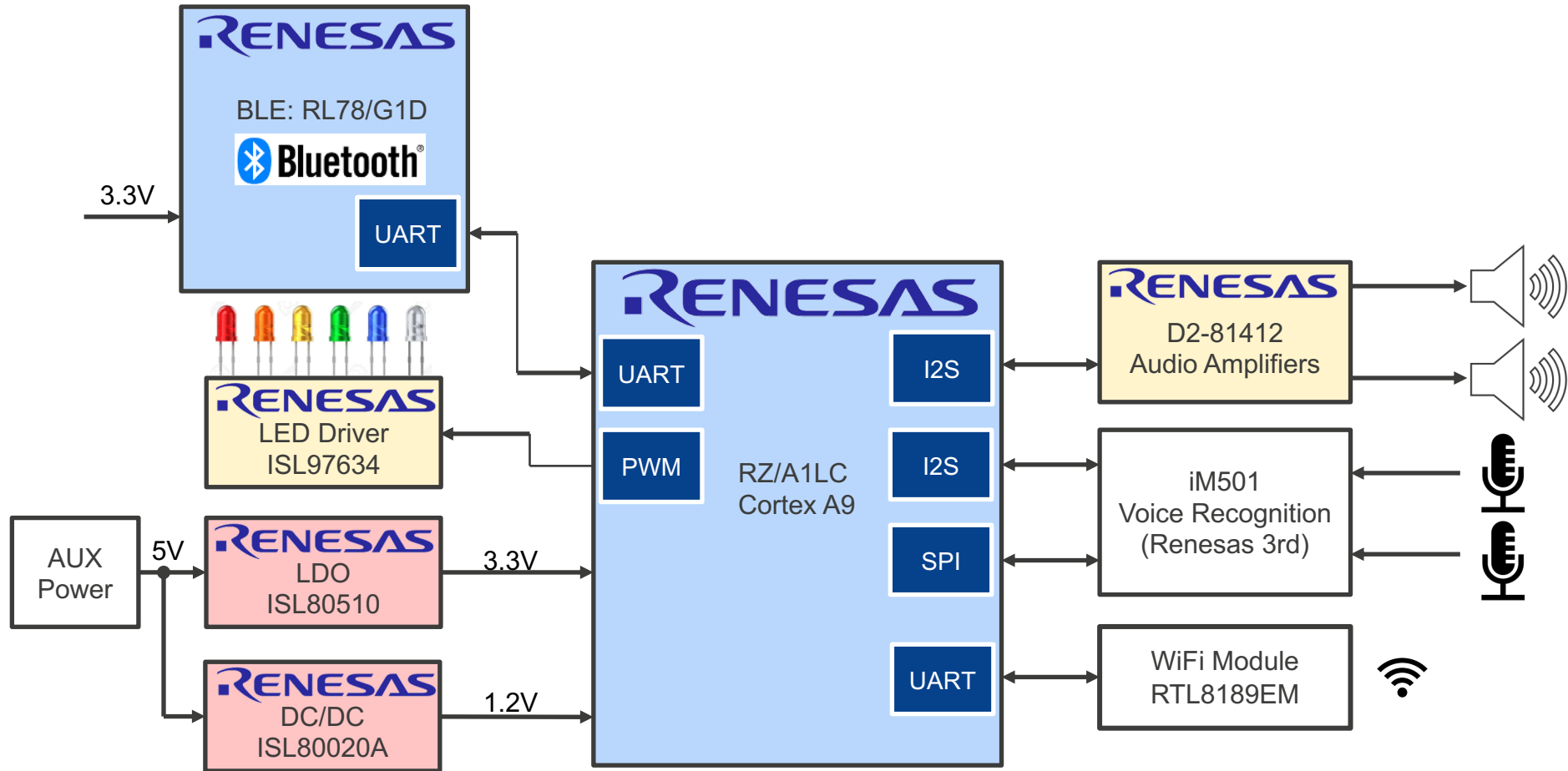
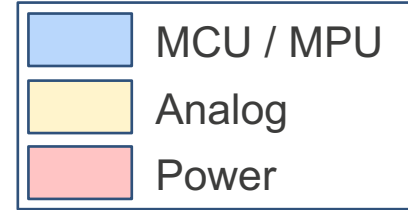
This design demonstrates a smart speaker that utilizes wireless functions like Wi-Fi and Bluetooth® to stream music and also respond to voice commands for hands-free operation. The RZ/A1LC is an advanced MPU design featuring high levels of performance with 2MB of on-chip SRAM and a 400MHz Arm® Cortex®-A9 core to implement any functions required. Additional analog features are wrapped around the MPU, including a Class-D audio solution, the ISL97634 for controlling multiple LEDs with a wide range of PWM dimming control capabilities, and a complete power management solution.

■ System Benefits

- Arm® Cortex®-A9 core running at 400MHz with 2MB of on-chip SRAM. Supports DRAM-less solution with low cost. Low power MCU supports BLE.
- High performance, low input voltage and high PSRR LDO. Highly efficient, synchronous buck delivering up to 2A of continuous output current. PWM boost LED driver allowing up to 7 LEDs.
- High performance Class-D audio amplifiers with digital switching controller.

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Smart Speaker



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Device Category	P/N	Key Features
MCU	RZ/A1LC R7S721034VCBG	Arm® Cortex®-A9/400MHz MPU includes 2 Mb SRAM and support Ethernet, USB, video display controller, SD host, CAN, I ² S ,etc.
	RL78/G1D R5F11AGx	Supports BLE and realized the lowest level of current consumption in the industry at 4.3 mA RF transmission current and 3.5 mA RF receiving current.
Analog	ISL97634	Integrated over-voltage protection(OPV) 14V,18V and 26V for various number of LEDs series. Small package 8 Ld TDFN (2mm x 3mm)
	D2-81412	4-channel digital amplifier controller with low development cost.
Power	ISL80510	1A output current and output voltage can be programmed from 0.8V to 5.5V. (TJ= -40° C to +125° C).
	ISL80020A	Highly efficient synchronous step-down DC/DC converters that can deliver up to 2A continuous output current.

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ISL80505/510 – High Performance 0.5A/1A LDO

Low Noise for Instrument, Industrial, Medical applications

Stable Output Voltage

- $\pm 1.8\%$ V_{OUT} accuracy guaranteed over line, load
- Stable with a $4.7\mu\text{F}$ output ceramic capacitor

High Efficiency

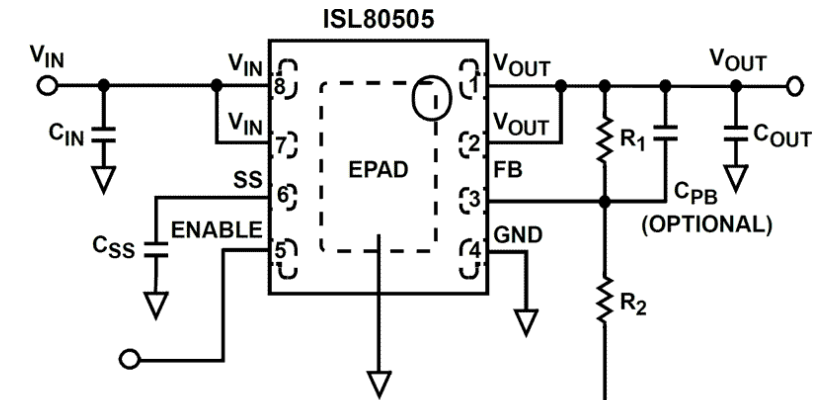
- Very low 45mV dropout voltage at $V_{OUT} = 2.5\text{V}$
- Very fast transient response

High Performance

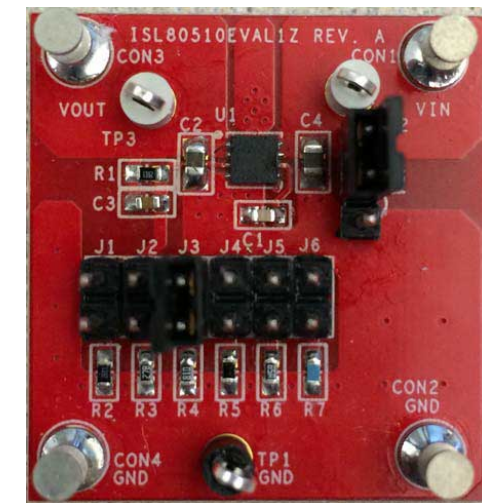
- Excellent PSRR over wide frequency range
- Programmable output soft-start time

Excellent Safety

- Current limit protection
- Thermal shutdown function



Typical Application Circuit



ISL80510EVAL1Z 1A LDO Eval Board

Part #	Vin (V)	Iout (A)	Package
ISL80505	1.8V to 6V	0.5	3x3 DFN
ISL80510	2.2V to 6V	1	3x3 DFN

ISL80020/20A – Vin 5.5V/2A Sync Buck DC/DC

Compact Synchronous Buck Converters with High Efficiency

Compact for Space Limited Applications

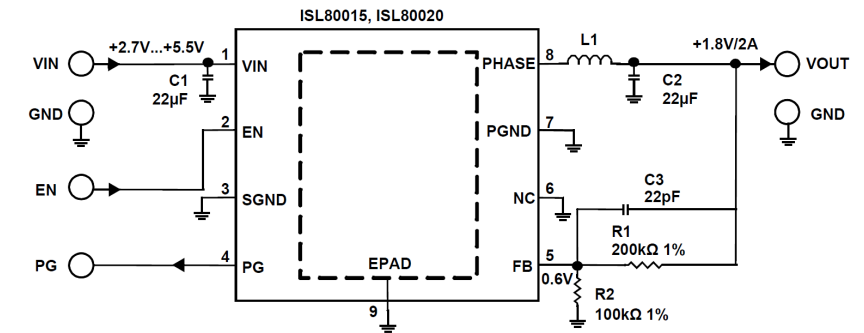
- 8 pin 2mmx2mm TDFN
- 1MHz or 2MHz switching frequency, allowing for the use of small inductors
- The high-side PMOS reduce the external Boot capacitor

High Efficiency

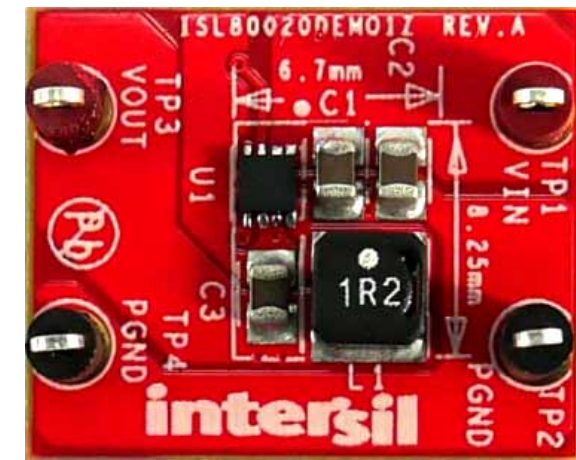
- Integrate very low $r_{DS(ON)}$ MOSFETs maximize efficiency up to 95%
- 100% duty cycle(1MHz)

Excellent Safety

- Overcurrent and short circuit protection
- Over-temperature/thermal protection
- V_{IN} Undervoltage Lockout and V_{OUT} Overvoltage Protection
- Negative current protection



Typical Application Circuit



ISL80020A DEMO1Z Evaluation Board

Part #	I _{OUT} (MAX)(A)	f _{SW} (MHZ)	V _{IN} Range(V)	V _{OUT} Range(V)	Package
ISL80020FRZ-T	2	1	2.7 to 5.5	0.6 to 5.5	2x2 TDFN
ISL80020AFRZ-T	2	2	2.7 to 5.5	0.6 to 5.5	2x2 TDFN

RZ/A1L – Arm[®] Cortex[®]-A9 Processor with Embedded SRAM

Cost-effective MPU running at 400 MHz and 2MB or 3MB On-chip SRAM

Cost-effective:

- With up to 3MB on-chip SRAM, no external frame buffer memory needed for graphics display
- Super efficient internal bus for storage of input images or fetch multiple layers of display data
- Less cost, more robust, easier design

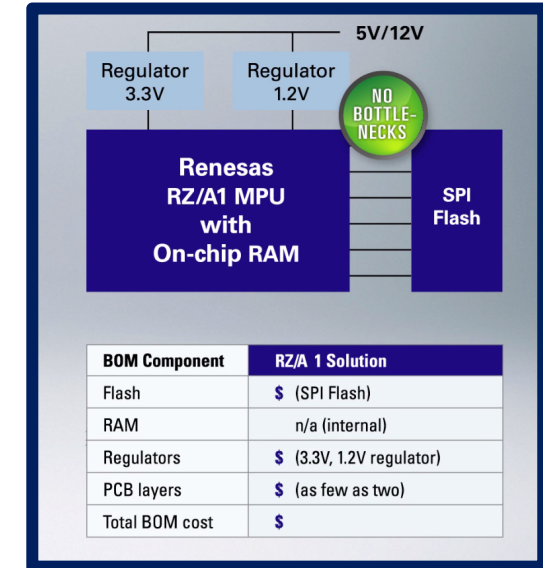
Graphics Functions:

- CMOS Camera I/F
- Hardware JPEG CODEC Engine (RZ/A1LU only)
- Video display controller

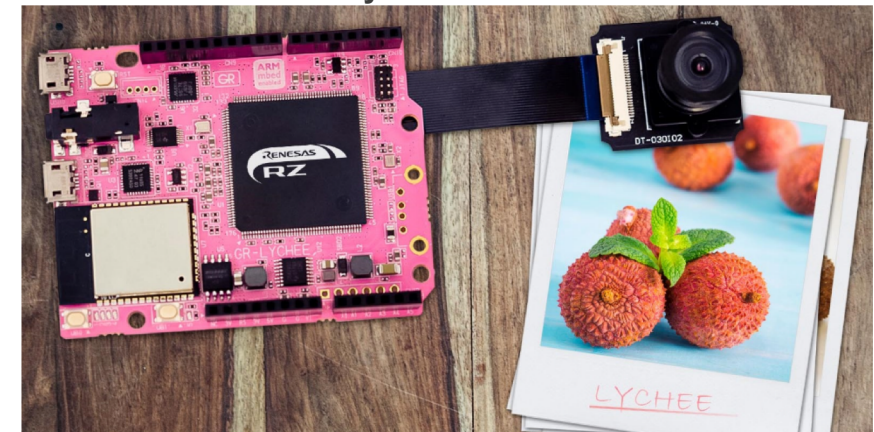
Rich Peripheral Functions:

- Ethernet controller (10 Mbps/100 Mbps transfer, IEEE802.3 PHY interface MII)
- USB2.0 x 2 (FS/HS) SD x 2 MMC host interface
- SSI x 4, SPI, CAN, I2C
- Secure Boot(Optional)

Part #	CPU (MHz)	On-chip RAM(MB)	JPEG Codec	Secure Boot	Supported Flash	Package
R7S721034VCBG	400	2	-	-	NOR, SDR	176BGA
R7S721020VCFP	400	3	-	-	NOR, SDR	176QFP
R7S721021VCFP	400	3	-	-	NOR, SDR	208QFP
R7S721030VCFP	400	3	Y	Y	NOR, DDR	176QFP
R7S721031VCBG	400	3	Y	Y	NOR, DDR	233BGA



System Block



IoT Prototyping Board (GR-LYCHEE)

RL78/G1D – Bluetooth® Low Power MCU

Compact Module with Built-in 32 MHz Crystal Resonator for RF and Antenna

High Integration

- MCU part: incorporating the RL78 CPU core
- RF transceiver part
 - . Bluetooth® v4.2 Specification (Low Energy Single mode)
 - . 2.4 GHz ISM band, GFSK modulation, TDMA/TDD frequency hopping (including AES)
 - . Adaptivity, exclusively for use in operation as a slave device

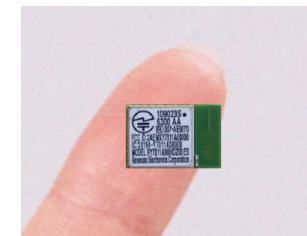
Easy to Develop and Use

- Only need for few external components (antenna) helps simplify design and quality control
- The best Bluetooth® low energy small size (8.95 × 13.35 × 1.7 mm) module is available
- Software stack supports wireless updating

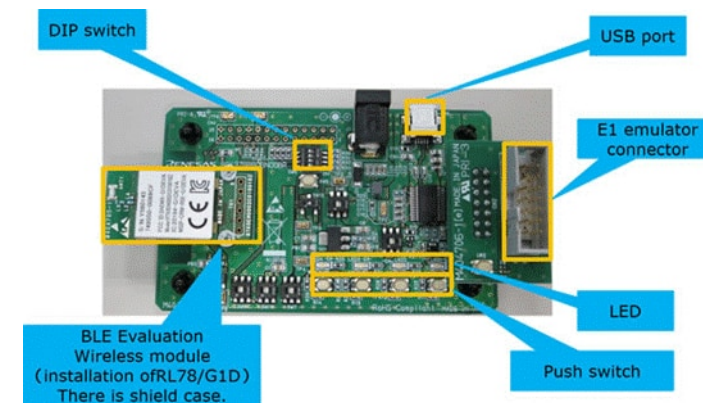
Low Power Consumption

- Realized the lowest level of current consumption in the industry (3.0V / MCU part: STOP)
 - . RF transmitter active normal mode: 4.3 mA (TYP.), Low power mode: 2.6 mA (TYP.)
 - . RF receiver active normal mode: 3.5 mA (TYP.), Low power mode: 3.3 mA (TYP.)
 - . RF sleep operation: 0.3 µA (TYP.), power down mode: 0.1 µA (TYP.)
- Different standby mode for MCU: HALT, STOP, SNOOZE
- Low power saving mode with 6 setting (min. 0.1 µA) for RF part

Part #	Flash ROM	RAM	Package
R5F11AGG	128KB	12KB	48-pin HWQFN (6 × 6) (0.4mm pitch)
R5F11AGH	192KB	16KB	
R5F11AGJ	256KB	20KB	



RL78/G1D module
(RTK0EN0002C01001BZ)
Size: 8.95 × 13.35 × 1.7 mm



RTK0EN0001D01001BZ
RL78/G1D Evaluation Board

ISL97634 – LED Driver with Wide PWM Dimming Range

Highly Efficient and Integrated PWM Boost LED Driver Up to 26V Output

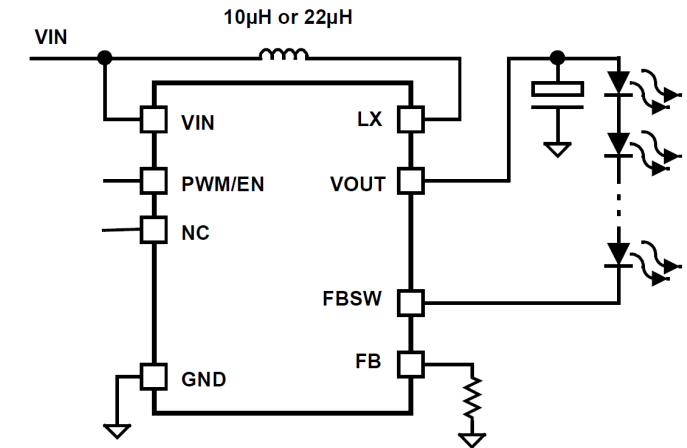
Simple and Flexible Use

- Drives up to 26V output
- Integrated over-voltage protection (OVP) of 14V, 18V, and 26V for various number of LEDs in series
- PWM dimming control from DC to 32kHz
- 2.4V to 5.5V input

High Efficient and Integrated Feature

- 8 Ld 2mmx2mm DFN
- 85% efficiency
- 1µA shutdown current
- Integrated schottky diode
- Output disconnect switch

Part #	OVP Options(V)	V _{IN} Range(V)	Temp.(°C)	Package
ISL97634IRT14Z-T	14	2.4 to 5.5	-40 to 85	8 Ld 2x3 TDFN
ISL97634IRT18Z-T	18	2.4 to 5.5	-40 to 85	8 Ld 2x3 TDFN
SL97634IRT26Z-T	26	2.4 to 5.5	-40 to 85	8 Ld 2x3 TDFN



Typical Application Circuit

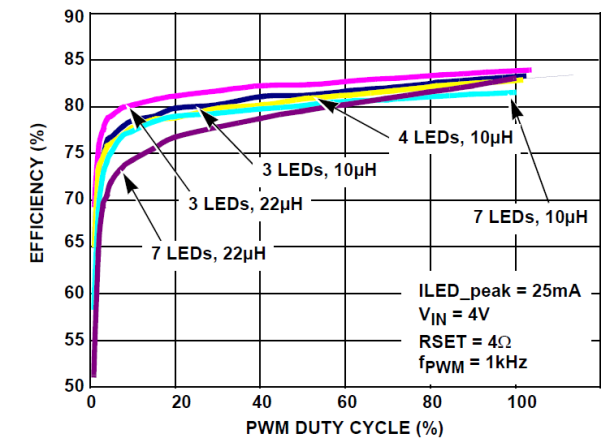


FIGURE 2. EFFICIENCY vs PWM DUTY CYCLE

Efficiency vs PWM Duty Cycle

D2-81412 – High Performance Class-D Audio Amplifiers

Fully Self-contained 4-channel Digital Amplifier Controller SOC

Complete Class-D Amplifier Controller SOC

- Digital switching controller, flexible audio input sources
- 4 channels, multiple controller synchronization
- Bridge and non-bridged output topologies
- Stand-alone or microcontroller boot option

High Performance Sound

- Unique performance for each part number
- Superior dynamic range
- >110 dB SNR, <0.1% THD+N
- 20Hz-20kHz ± 0.5 dB frequency response

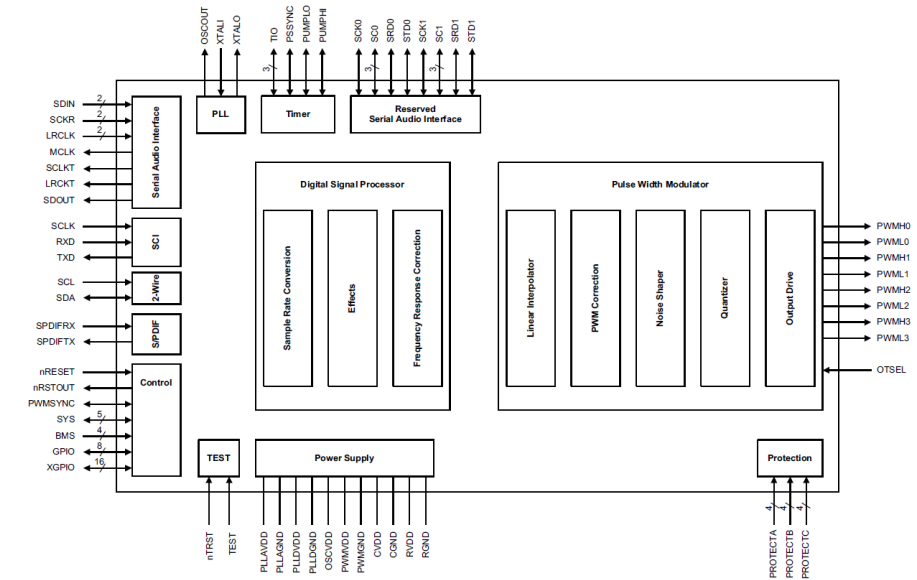
Graceful Protection and Recovery

- Complete short-circuit, overcurrent, and overvoltage fault protection

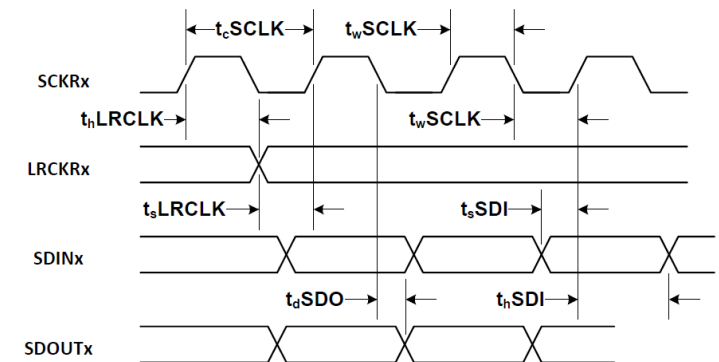
Pure Digital Path

- Digital audio inputs which support I²S and left-justified formats with linear PCM (32kHz to 192kHz, 16 to 24-bit)
- Digital audio input which supports S/PDIF format with linear PCM (32kHz to 192kHz, 16 to 24-bit)

Part #	Input Channels	PWM Output Channels	Temp.(°C)	Package
D2-81412-LR	4	4	-10 to 85	144 Ld LQFP
D2-81431-LR	4	4	-10 to 85	128 Ld LQFP
D2-81435-LR	4	4	-10 to 85	128 Ld LQFP



Block Diagram



Serial Audio Port Timing