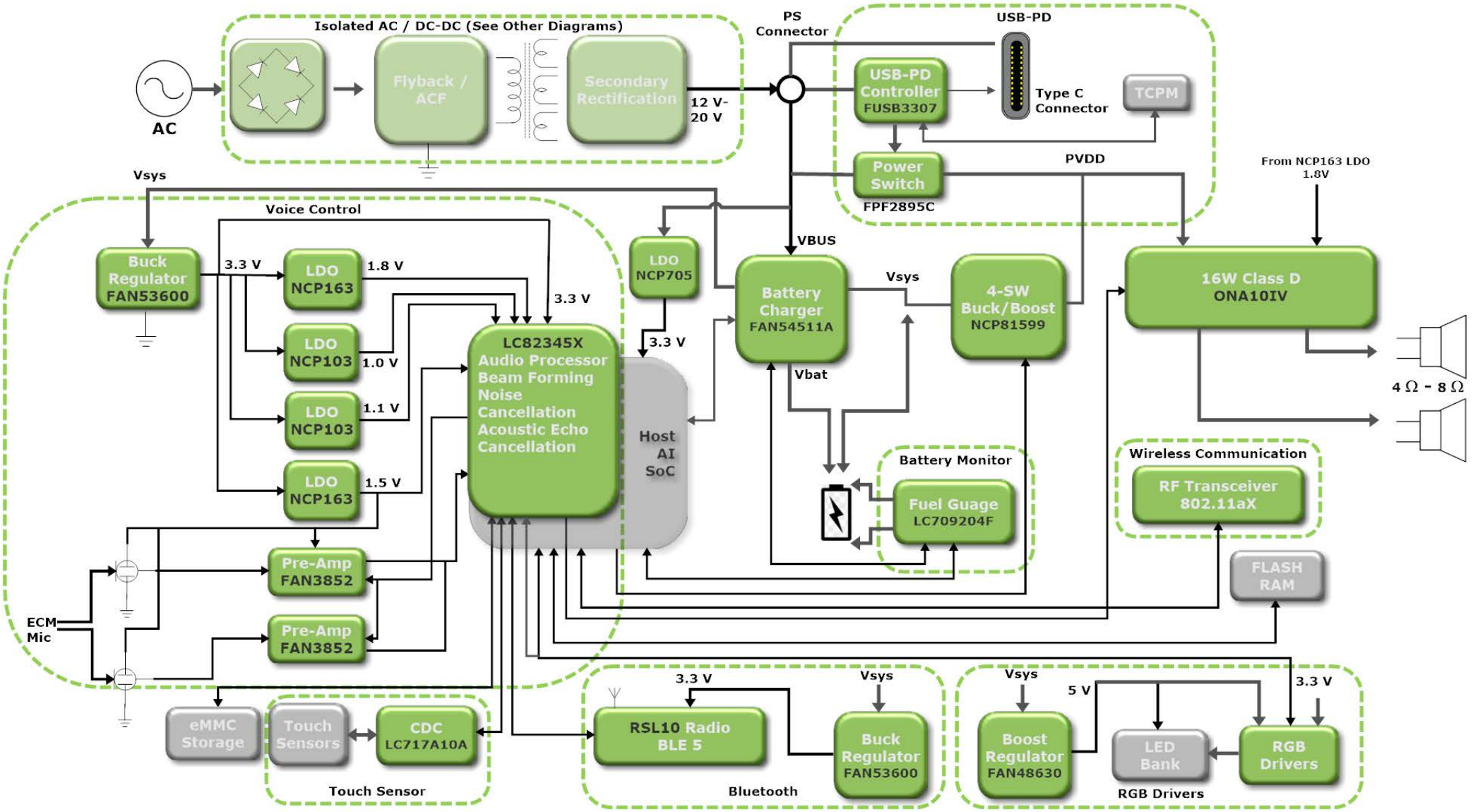
Smart Audio Solution Diagram



Solution Description

Product Recommendation Table

NOTE: Click on green blocks to obtain additional information.

Blocks containing multiple product options will take you to the product recommendation table labeled by block name. Blocks with only one product recommendation will take you to the product page at onsemi.com.

Greetings and welcome to another edition of the Block Diagram of the Month. Each month we provide a specific application solution with recommended content from our various business units. This month we look at smart audio.

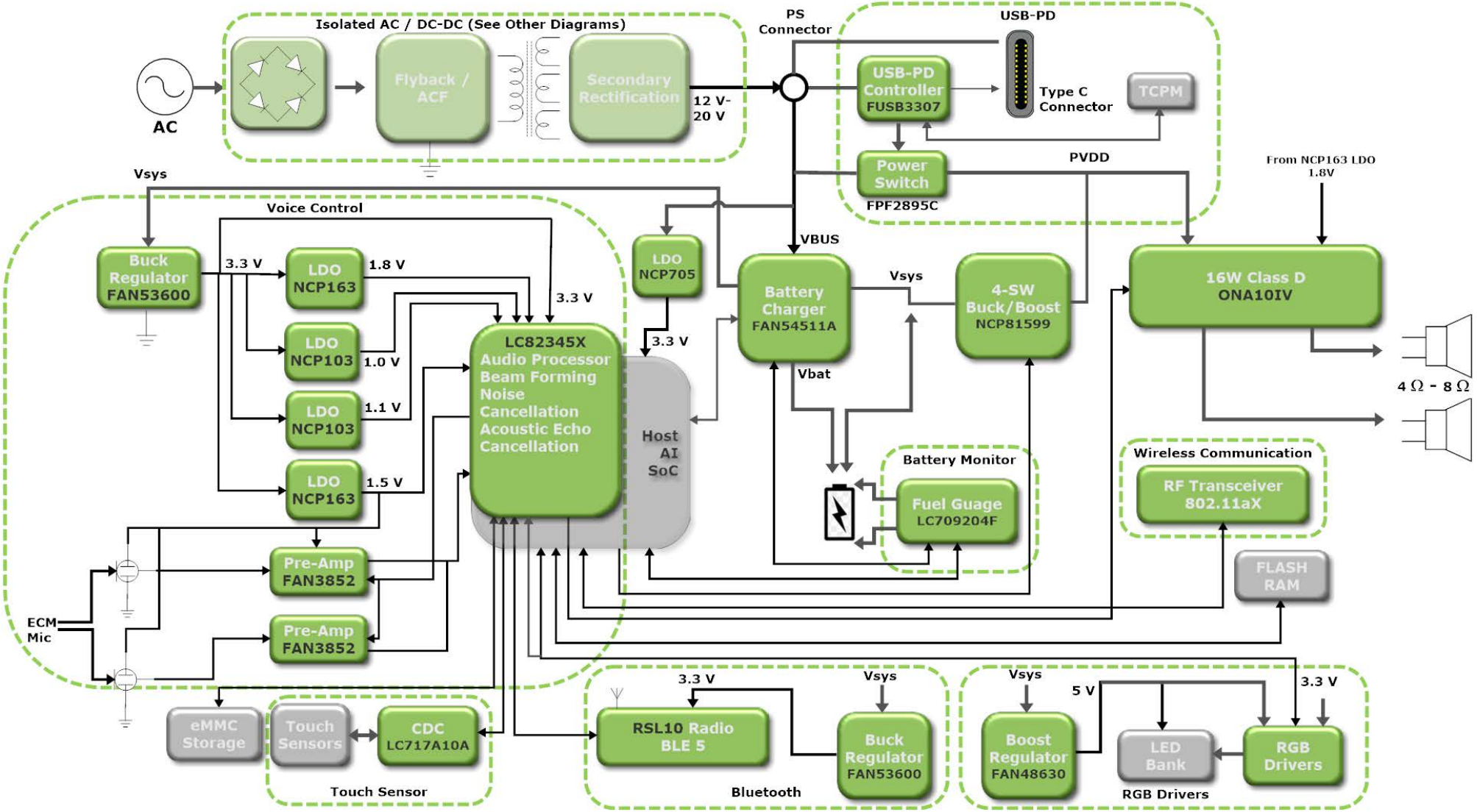
Smart Audio

Smart audio products continue to play vital roles into daily life. In addition to controlling appliances, temperature, ambient settings around the home and even home security, its integration with the entertainment platform has also accelerated to staggering heights. Smart audio has become the standard for TV companions accessing “smart” services that provide streaming movies and music right into the living room entertainment center, personal computer or any handheld smart device. In addition, the audio device may retrieve the latest news and current events information, accessing a cloud based calendar service to generate scheduling and needless to say, the digital universe of shopping. The deployment of smart speakers has also been found useful in children’s edification where the smart device has access to an infinite wealth of cloud-based information such as when a child asks for help in spelling or pronouncing words and sentences over countless different languages.

What are smart speakers and smart hearing? From a fundamental level, they are artificial intelligence (AI) based enabled voice-user interface (VUI) with AI-centric speech recognition technologies that when properly interlaced together, produce two types of responses from human voice input:

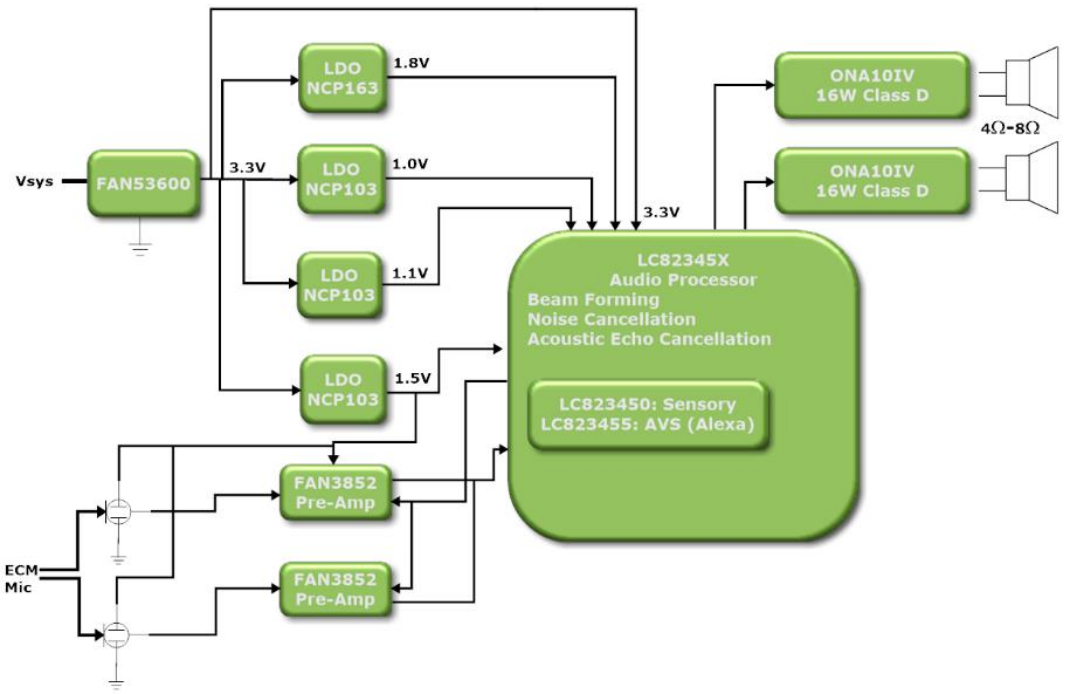
a) A direct interactive verbal exchange or verbal dialogue with the embedded virtual assistant.
b) Connection to the vast array of resources, services, information and possibly hands-free device(s) activation. Examples of these are as follows:
    a. Music, audio and video playback streaming from a long list of cloud services.
    b. Control of smart home devices and appliances through a conversational user interface.
    c. Voice commands for automobile: A growing trend, however much more challenging to the effect that the driver - VUI’s verbal exchange must not be too much of a distraction while the vehicle is in operation.

Top Level Diagram of the Smart Audio Platform



Return to top

Voice Control



The upward trend of AI in digital voice assist continues to infuse its way into the consumer electronics and smart home appliance spaces. In areas of home automation where users and consumers simply begin speaking a song they'd like to hear or re-order perishables for this week's food supply from a digital grocery store and the fresh produce and dairy products will be at the door within a matter of hours. When integrating virtual assistance technology and AI enabled VUI, household safety regarding both security and damage prevention can be achieved. In home security hubs and devices such as doors and window locks mounted with pressure sensors can be vocally activated before leaving the home for a long trip or can be as simple as saying the voice commands before going to bed. Additionally, power mapping all of the in-home appliances through a network connected circuit breaker service panel can verbally alert the user if an appliance piece has been drawing current for a period of time longer than it should. And pre-emptively or in a reactionary manner, the user talks into the VUI to cut of power for that specific e-Relay or e-Breaker either from within the premise or a remote location, thus preventing a fire-hazard situation.

Accompanied with a host AI SoC, the **LC823455** can be leveraged to make the most of AI-enabled VUI technology. It is a 32-bit, high resolution audio DSP core companion with several proprietary DSP codes (codecs) for audio functions, noise and echo cancelling. It features dual-core configuration providing extensive processing power when interfaced with large scale programs for full spectrum WLAN connectivity and beamforming characteristics.

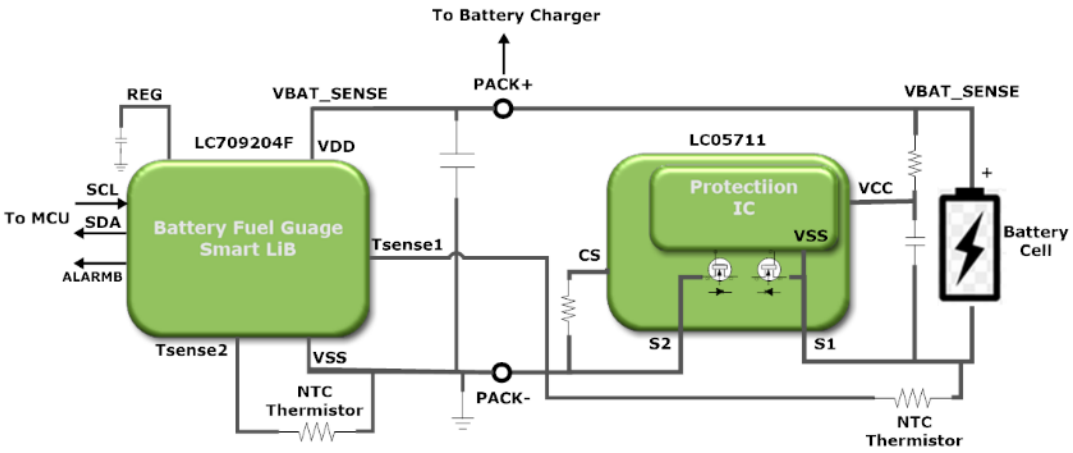
The **ONA10IV** is a Class-D audio amplifier used for driving a 4Ω to 8Ω output loudspeaker. It features a 16W, high efficiency, H-bridge configuration with a low 42uVRMS noise floor. Refer to the 4-Switch buck/boost section of this document for supplying power to this power amplifier.

Human voice input are amplified through the use of the **FAN3853** – microphone pre-amplifier through an electret condenser microphone (ECM). The pre-amplifier has an on board LDO with high noise rejection. The **FAN3852** outputs digital pulse density modulation (PDM) data stream where it compatibly interfaces with the **LC82345X** audio DSP.

Return to top

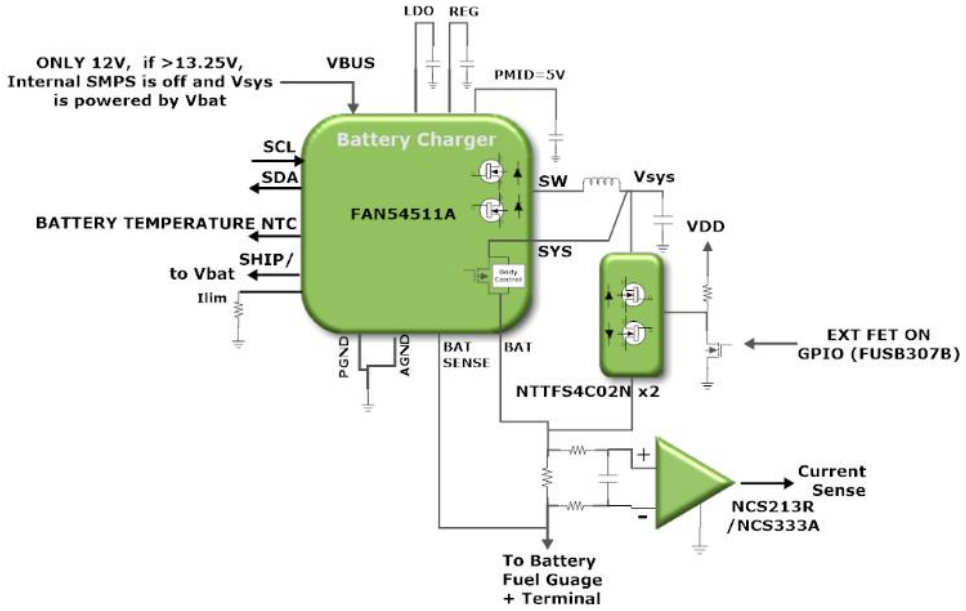
Battery Monitor

Monitoring the smart speaker's lithium-ion battery Cell (s) is the LC709204F battery fuel gauge (smart LiB gauge). It measures the relative state of charge of the battery during normal as well as unstable conditions such as changes in temperature, loading, aging and discharge. State of health reporting is also an integrated safety monitoring feature. Battery parametric measurements can begin immediately after cell insertion. The LC05711ARA adds a protection loop providing battery prevention from over charging, over dis-charging, over-current discharging and over-current charging.



Battery Charger

Spear heading the mobile attributes of an AI enabled consumer device with VUI characteristics is the FAN54511A battery charger module. It is a highly versatile power management system, capable of several modes of operation. From being able to accurately sense a depleted battery cell through an internal switch to entering a high impedance state, allowing the fully charged battery to power the entire system of the smart device. The FAN54511A offers full featured solution to cater to the industry's demanding mobile power management applications. When the battery requires charging, the module enters the DC/DC step down synchronous regulator mode to supply charging current for the cell as this current branch re-enters the module through the accurately controlled switch (SYS) as well as supplying current for the entire system platform (Vsys) to carry out housekeeping functions. In mobile or battery mode, the module enters the DC/DC boost function to step up and regulate the main input rail (VBUS), re-directing current to be able to provide power to the USB on-the-go (OTG) feature connected peripherals. Optionally, an external pass device may be used to direct current into the system, while in boost mode, minimizing power dissipation - taking advantage of the much lower discrete device channel impedance. Moreover, the FAN54511A can also operate in "supplemental" mode where in cases while the converter is in step-down mode but isn't able to provide enough current to regulate and maintain the "system" rail (Vsys), the internal switch enters a fully

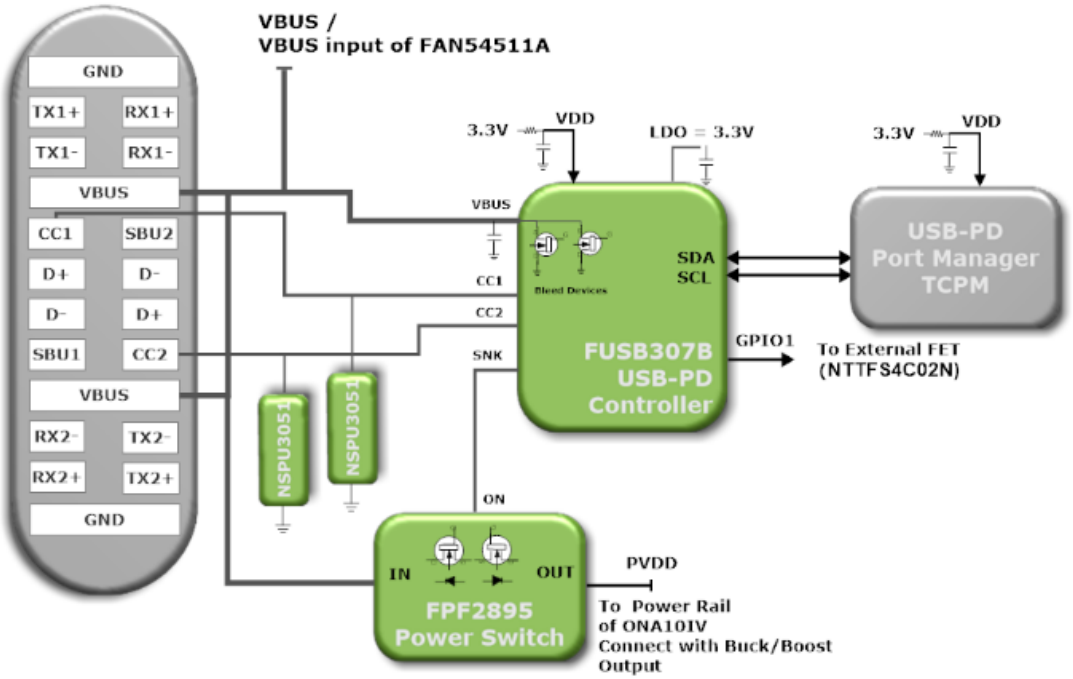


Return to top

“enhanced” mode minimizing channel resistance. This mode provides the lowest impedance path for the battery to supplement the current required to sustain the output load, hence remaining witvhin the regulation window. An external device may be used in this mode as well to further minimize power dissipation, extending battery cycle usage. VBUS supplements the FAN54511A input rail during switch-mode regulation only when the input rail is 12V. When the input is above 13.25V, the FAN54511A’s DC/DC converter power switches enters high impedance and no longer sustains Vsys (output). Vsys is then supplemented by the battery cell either through the well controlled internal switch or through the external NTTFS4C02N switches.

USB-PD

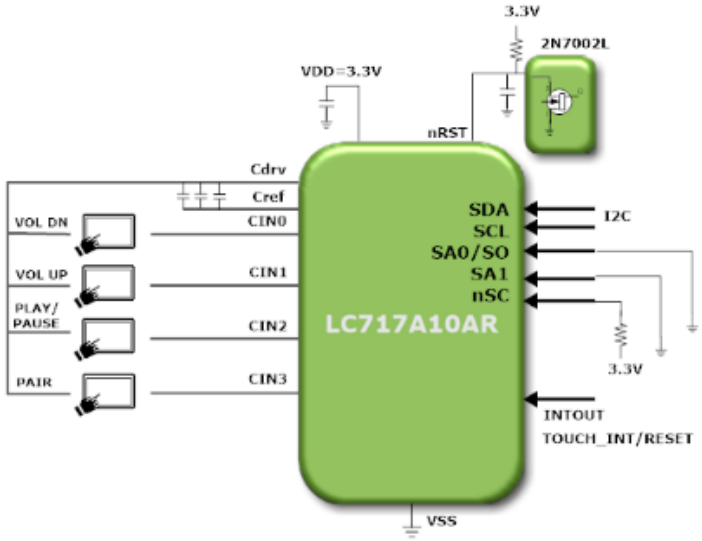
A tremendously popular “smart audio” mobile device feature is the ability to transfer power of up to 100W to peripherals or another device through the USB Type-C port connector. Companioned with a Type-C port manager (TCPM), the **FUSB307B** is a USB Type-C port controller compliant with USB-PD interface specs Rev 1.1 – able to determine port attachment / detachment, cable insertion orientation and dual-role detection. The configuration channels (CC1 and CC2) are signal lines that allow the host (charger) and peripheral device to deliver information bi-directionally regarding precise power levels needs and specifically appropriate current level. Bi-phase mark coding power delivery is utilized to communicate through these channels and negotiations for current level contracts are determined between the two devices. Dual role power enables automatic fast role swapping, automatically determining which device is the charger and which device is the one being charged.



Return to top

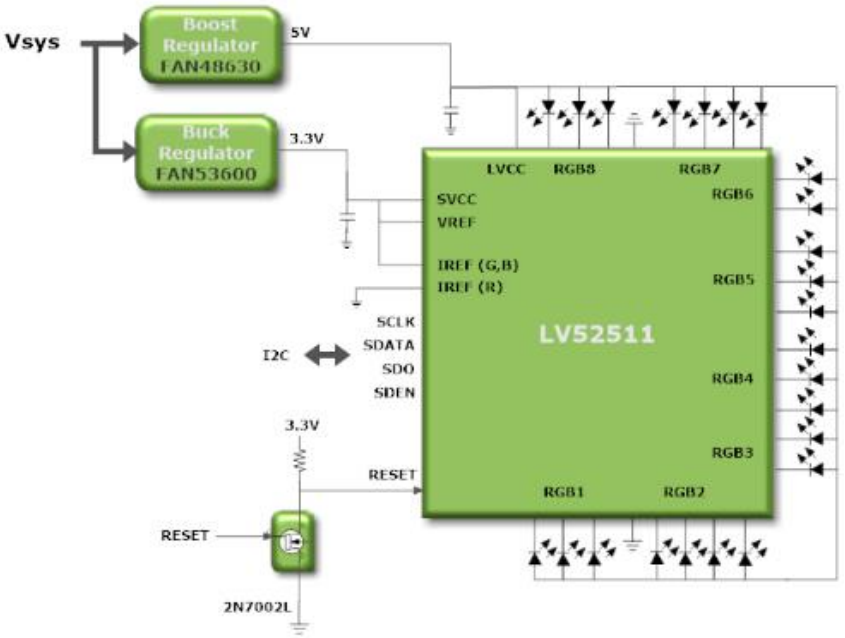
Touch Sensor

Human touch interfacing is made possible with the use of capacitive touch sensors. Touch sensors also provide an alternative interface to the AI enable VUI. By initializing a charging current to the capacitor plate, the default initial conditions (voltage / charge) are established. Changes in these capacitance and charge values beyond the calibration period are processed, measured and activated/de-activated by ON's capacitance-digital converter (CDC), the **LC717A10AR**. The user's finger, when approaching the sensor electrodes, acts as a secondary capacitor plate, causing the LC717A10AR to drive additional charging current, rendering a change in capacitance along the localized point of finger contact. The CDC is capable of detecting changes in capacitance in the order of femto farads. Up to 16 touch switch patterns can be mounted at the sensor input pins. To eliminate and prevent any of up to 16 external sensors to falsely-trigger, an on-chip calibration procedure is automatically performed upon start-up as to compensate for capacitance measurements changes caused by the surrounding ambient temperature and environment factors. Any changes in capacitive measurement produces analog amplitude output values as an on-board 8-bit ADC converts these measurements in bit-stream format. Serial communication through I2C or SPI logic conveys this data stream to external devices that are also capable of serial communication or logic control such as the Audio DSP LC823455 or the host AI SoC.



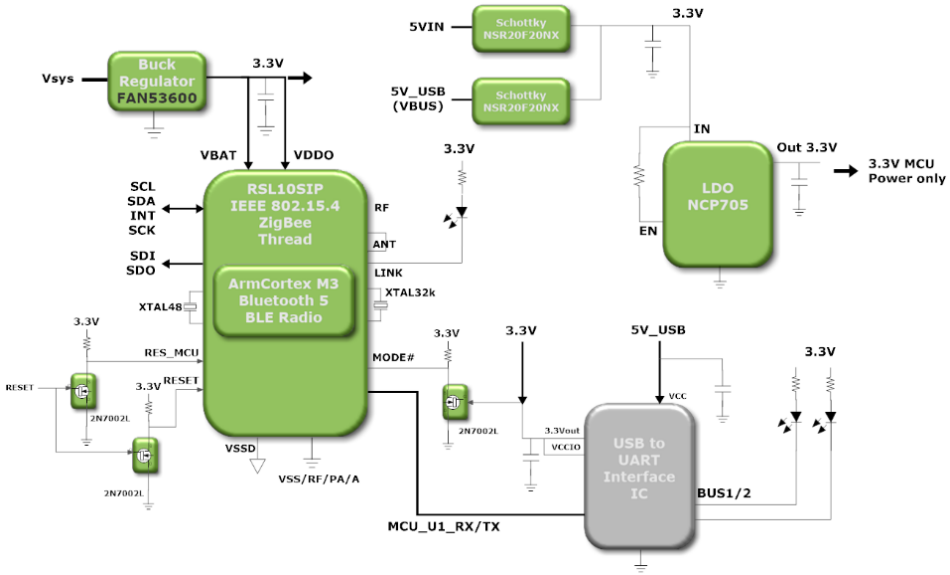
RGB Drivers

Illumination and lighting characteristics are important features in the mobile smart audio landscape serving the human-machine interfacing effort. Applications as simple as an LED status for power-on or power-off state, battery level indicator, device to device Bluetooth pairing symbol being displayed on the top surface of the consumer product or WiFi connection status to more complex and colorful display paneling – our Linear LED drivers can provide solutions to many of the smart mobile lighting and illumination needs. The LV52511 linear LED driver with 24-channesl, grouped in three color blocks (RGB) with up to 60mA maximum current for each channel. Characteristics such as dimming, independent current adjustability for each color group, three to 100% adjust for color temperature and thermal shutdown fault detection are a few parameters featured in this 2/3 wire and I2C serial Bus interface format compatible LED driver.



Return to top

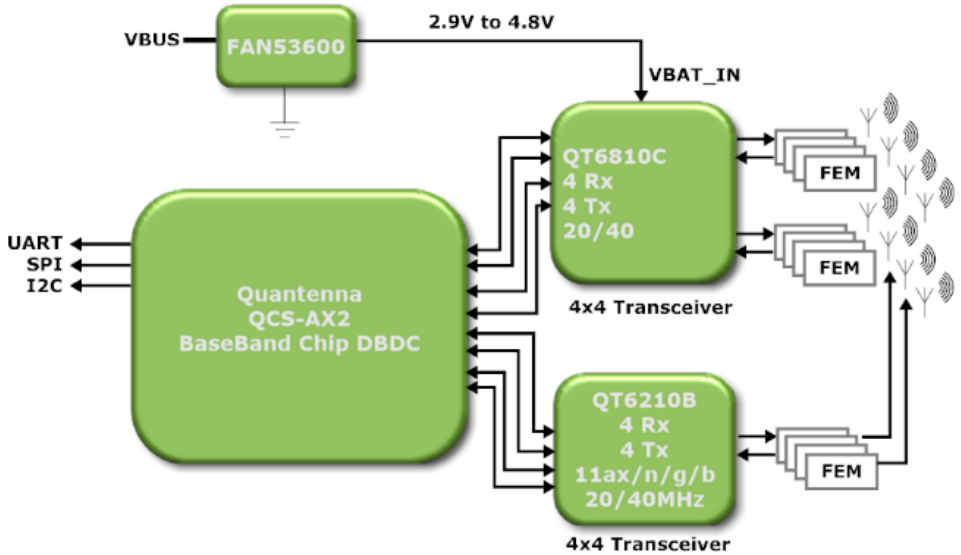
Bluetooth 5 (SoC)



Bluetooth Low Energy (BLE) and IEEE 802.15.4 are two dominating technologies in the IoT space. Due to the practical use of low power consumption while fascilitating optimum inter-operability between a smart speaker and a smart phone (for example) to extend the full potential of network – layer compatibility. Our **RSL10** platform, equipped with these technologies features an ARM Cortex – M3 Processor with clocking up to 48Mhz and LPDSP32 DSP core for audio codec purposes, this Bluetooth 5 enabled product family not only supports low energy technology and 2.4Ghz protocol stacks, it accomodates backward compatibility for earlier **BLE** specifications.

Wireless Connectivity

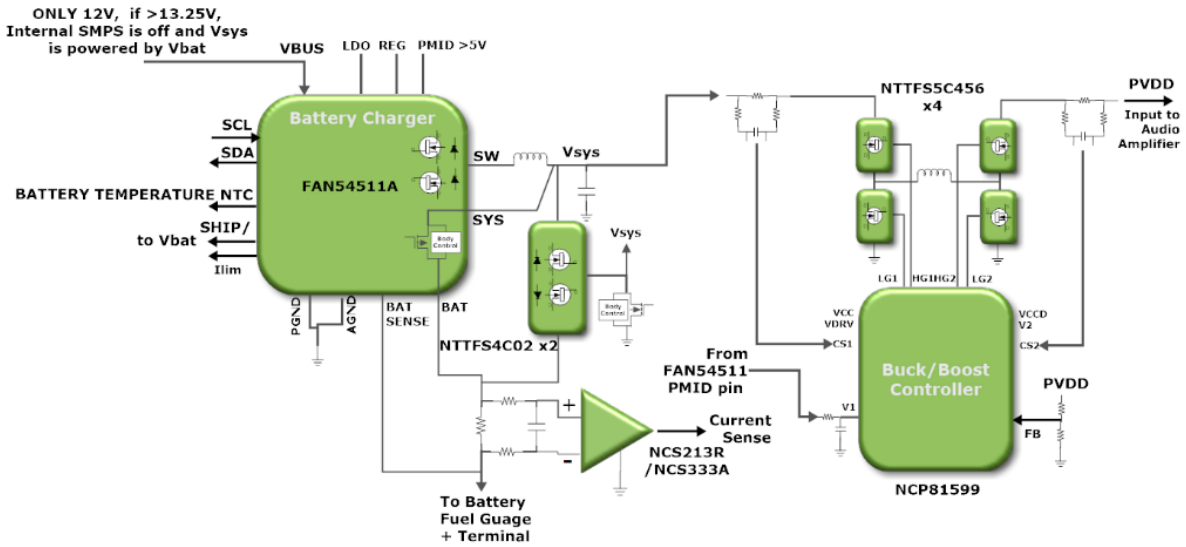
In applications where TV companions such as soundbars requiring reliable network connection, we introduce an entire line of RF transceivers featuring 2x2 and 4x4 (2.4Ghz operation mode) spacial stream compliant supporting 802.11ax technology. The **QT6810C** or the **QT6210B** solution may help solve common wireless interference challenges causing audio or sound dropoffs and/or sudden disappearance of smart devices/speakers from the network app. In addition to the robust connection requirement necessitated by the vast amount of AI enabled parameters featured in smart speaker devices, our family of RF transceivers maybe part of a viable solution for entertainment.



The base band and transceiver devices receive power from a point-of-load (POL) rail between 2.9V to 4.8V. The **NCP3170** DC/DC converter provides the proper transient voltage regulatory features and power up/down sequencing the radio board may require. Most of our DC/DC converters, regulators, POLs and/or PMICs (power management IC) come with industry standard or customizable on-board fault detection characteristics such as under voltage lock-out, short circuit, over voltage and over current protection features.

Return to top

4-Switch Buck-Boost



There are two methods to supply power to the **ONA10IV** mono Class-D audio power amplifier. When the proper input voltage range of 12V-20V is present through the power supply connector, power is routed directly through the FPF2895C load switch and to the amplifier's power rail (refer to top diagram). This would satisfy the power amplifier's 14V input rail requirement. The other method is when the system is in battery mode, power is drawn from the single cell which becomes the input rail (Vsys) of the 4-switch buck-boost configuration, with the deployment of the NCP81599 controller and NTTFS5C456 MOSFET switches, where the boosted output (PVDD) is maintained within the 12V-14V regulation window. The buck boost controller with its internal MOSFET drivers are capable of driving external MOSFETs to deliver USB-PD standard power requirements of up to 100W when operating in combination with the FUSB307 USB-PD C-type interface controller. Enough current can be generated to supplement both the audio power amplifier and any USB on-the-go peripheral or device that is connected at the USB Type C connection port. The NCP81599, with its dual edge peak current mode control feedback loop allows seamless transitioning from boost to buck mode or vise-versa based on the accurately controlled transconductance amplifier's output COMP signal.

Return to top

Suggested Block	OPT	QTY	WPN	WPN Desciption
Voice Control				
Buck Regulator	1	1	FAN53600	3 MHz, 600 mA / 1A Synchronous Buck Regulator
LDO Regulator	1	2	NCP103	LDO Regulator, 150 mA, High PSRR
LDO Regulator	1	2	NCP163	LDO Regulator, 250 mA, Ultra-High PSRR, Ultra-Low Noise
Audio DSP	1	1	LC823455	Low Power & High-Resolution Audio Processing System LSI for Portable Sound Solutions
Pre-Amplifier	1	1	FAN3852	Microphone Pre-Amplifier with Digital Output
Power Amplifier	1	1	ONA10IV	16 Watt Digital Input Class-D Audio Amplifier With Speaker Sense Digital Output
4-Switch Buck Boost				
Buck/Boost Controller	1	1	NCP81599	I2C Configurable, 4-Switch Buck Boost Controller for USB-PD Power Delivery and Type-C Applications
Power MOSFET	1	2	NTTFS4C02	Single N−Channel Power MOSFET 30V, 170A, 2.25mΩ
MOSFET	1	4	NTTFS5C45X	Single N-Channel Power MOSFET 40V, 3.X mOhms
USB-PD				
USB-PD Controller	1	1	FUSB307B	USB Type-C Port Controller with USB-PD
Power Switch	1	1	FPF2895C	Current Limit Load Switch with OVP and TRCB, 28 V, 5 A
Protection IC			NSPU3051	5.5 V Unidirectional Surge Protection Device
Battery Charger				
Battery Charger Controller	1	1	FAN54511A	Battery Charge Controller, Switching, Dual-Input, 3.2 A, with Integrated Power Path, BC1.2 Support and USB-OTG Boost Regulator
Power MOSFET	1	2	NTTFS4C02	Single N−Channel Power MOSFET 30V, 170A, 2.25mΩ
Current Sense - Op-Amp	1	1	NCS213R	Current Sense Amplifier, 26V, Low-/High-Side Voltage Out, Bidirectional Current Shunt Monitor
Current Sense - Op-Amp	1	1	NCS333A	Low Power, Zero-Drift Operational Amplifier with 10 µV Offset
Battery Monitor				
Fuel Guage	1	1	LC709204F	Battery Fuel Gauge for 1-Cell Lithium-Ion/Polymer (Li+) [Smart Lib Gauge] with low-power 2 µA operation
Protection IC	1	1	LC05711ARA	Battery Protection IC, Integrated Power MOSFET, 1-Cell Lithium-Ion
Load Switch	1	1	FPF2895C	Current Limit Load Switch with OVP and TRCB, 28 V, 5 A
Touch Sensor				
Electro-Capac. Converter	1	1	LC717A10AR	Capacitance-Digital-Converter for Electrostatic Capacitive Touch Sensors
Reset Switch	1	1	2N7002L	N-Channel Small Signal MOSFET 60V 115mA 7.5 Ω
RGB Drivers				
Buck Regulator	1	1	FAN53600	3 MHz, 600 mA / 1A Synchronous Buck Regulator
Boost Regulator	1	1	FAN48630	2.5MHz, 1500mA, Synchronous TinyBoost™ Regulator with Bypass Mode
LED Driver	1	1	LV52511MN	Linear LED Driver, 24-channel, BUS controlled
Reset Switch	1	1	2N7002L	N-Channel Small Signal MOSFET 60V 115mA 7.5 Ω

Return to top

Suggested Block	OPT	QTY	WPN	WPN Desciption
Bluetooth				
Buck Regulator	1	1	FAN53600	3 MHz, 600 mA / 1A Synchronous Buck Regulator
Bluetooth System-in-Package	1	1	RSL10SIP	System-in-Package, Bluetooth® 5 Certified, SDK 3.4
LDO Regulator for MCU (Host AI SoC)	1	1	NCP705	LDO Regulator, 500 mA, Ultra-Low Iq, High PSRR, Ultra-Low Noise
Reset Switch	1	3	2N7002L	N-Channel Small Signal MOSFET 60V 115mA 7.5 Ω
Schottky Diode	1	2	NSR20F20NX	Schottky Barrier Diode, 2.0 A, 20 V
Wireless Connectivity				
Buck Regulator	1	1	FAN53600	3 MHz, 600 mA / 1A Synchronous Buck Regulator
RF Transceiver	1	1	QT6210X	RF Transceiver, 4x4, 2.4 GHz, WiFi 6
RF Transceiver	2	1	QT6210B	RF Transceiver, 4x4, 2.4 GHz, WiFi 5

Return to top