3-IN-1 SMART SPEAKER SOLUTION

RENESAS ELECTRONICS CORPORATION

Q1, 2019

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3-IN-1 SMART SPEAKER SOLUTION

What is it:

- Reference design that can be configured for smart speaker, powered speaker, and sound bar applications

- Includes all needed files for immediate implementation

- No cost – Download it from the Renesas website

- Features Renesas:
  - D2 Audio DSP
  - RX65N MCU

Value:

- Turnkey solution that can be implemented as provided

- Or, can remove design blocks if features are not required

- Or, can customize the solution with minimal engineering effort.

Three Solutions

One Design

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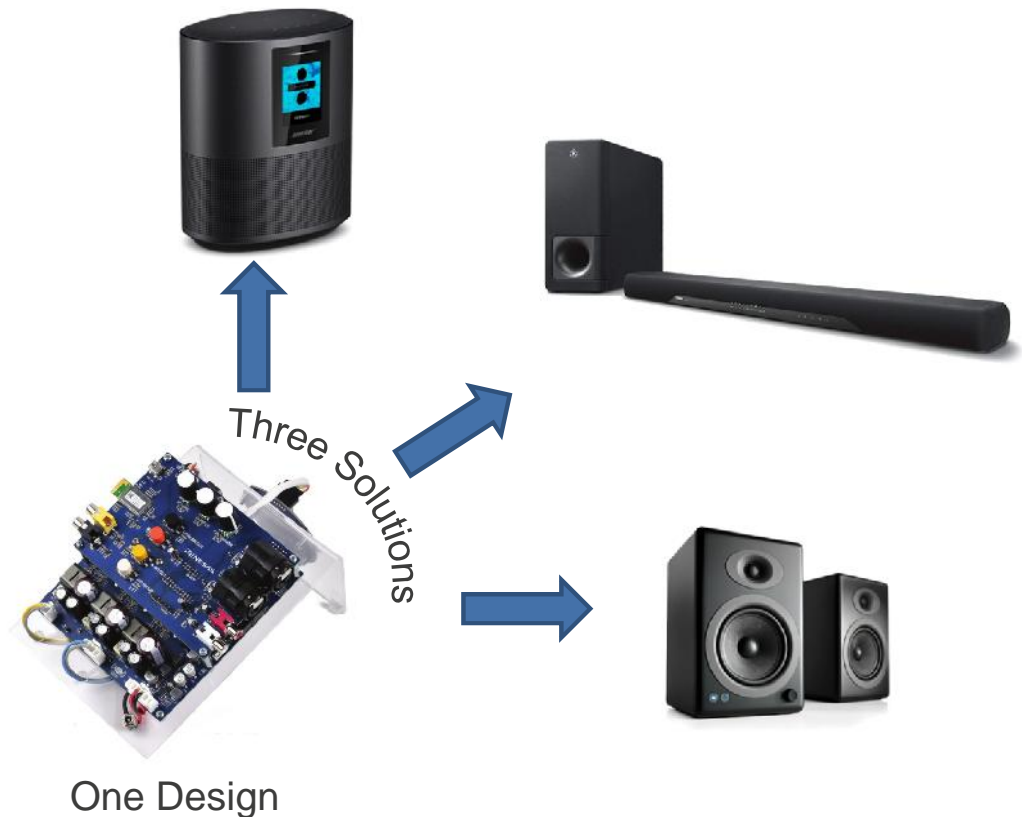
FEATURES AND SPECIFICATIONS

Audio Performance
- Amp Freq Response: 20Hz to 20kHz, ±0.5dB
- THD+N: < 0.3%
- SNR: > 110dB (ref Full Power)

Audio Inputs Available
- RCA Phono Jack
- XLR/TRS Combicon
- Coaxial S/PDIF
- USB Audio Streaming

Wireless Connectivity Available
- WiFi w/"Alexa" Voice Control (Linkplay)
- Bluetooth 4.2

App Control Available
- Portable app code for iPhone or Android OS

System Microcontroller
- Renesas RX65N

Audio DSP Engine
- Renesas D2-3 or D2-6 family Audio Processor
- Configurable sound stream using D2 Audio Customization GUI
- Optional Dolby Digital, Dolby Digital Plus, and/or DTS decoding

Audio Outputs Available
- GaN FET Power Output Stage
- Stereo Digital Output: Coaxial Digital
- Wireless Subwoofer link available
- Wireless Surround Sound or Stereo Speaker pairing available

Include Wifi module for smart speaker applications. Remove the module for traditional sound bar or powered speaker applications

Dolby or DTS decoding and enhancement available (license required)

App controllable – basic code available for free

Block Diagram
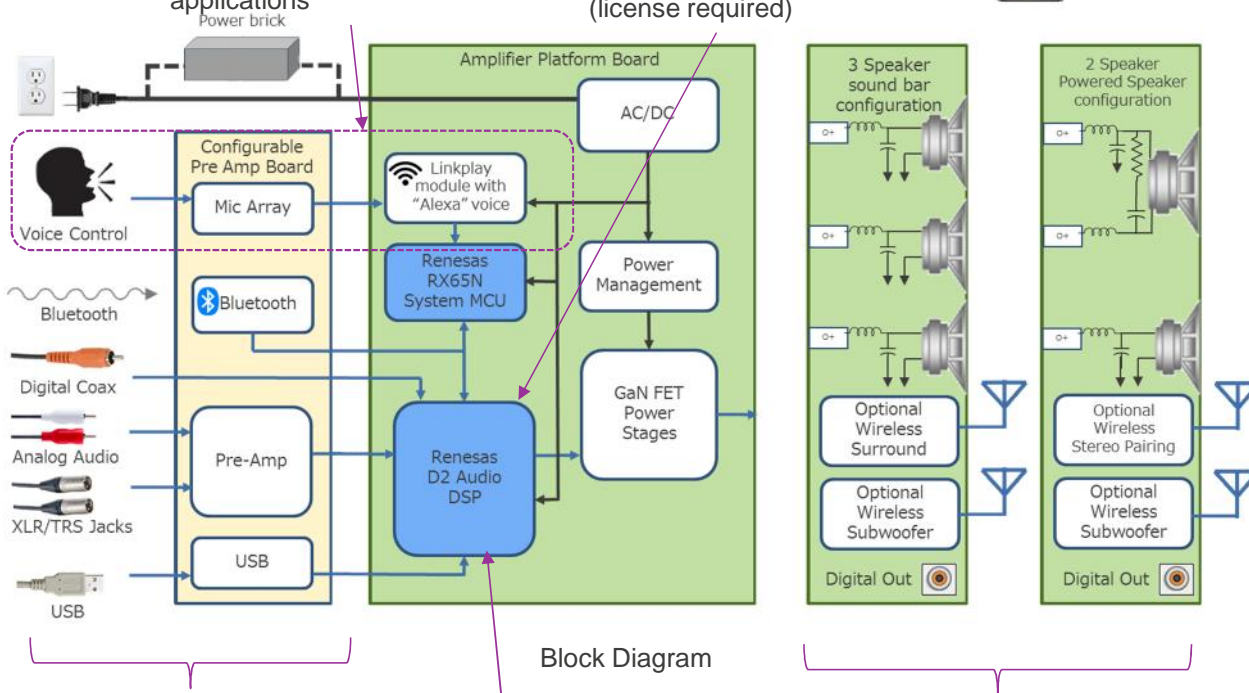
Use or remove inputs as desired

Use provided sound streams or customize with free, no programming software

Use or remove output devices as desired. Basic 2.0 bookshelf speaker to full 5.1 surround sound system

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AMPLIFIER BOARD – KEY FEATURES

Wifi module with "Alexa" voice:
- Use for smart speaker applications
- Remove from design for traditional speaker applications

Wireless output
- Remove from design if no wireless output features desired
- Wireless output for Sub woofer in either application
- Wireless output to drive surround speakers (Sound Bar) or a paired speaker (Powered Speaker)

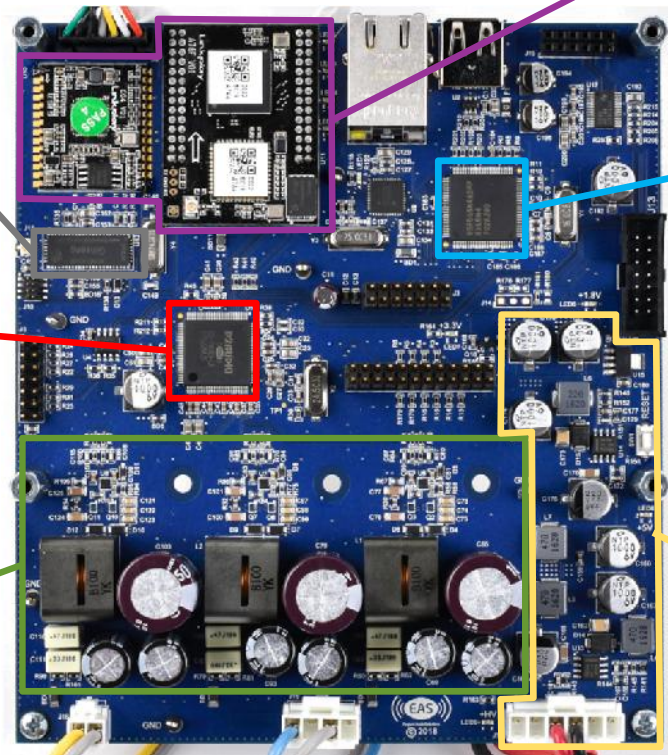**Renesas D2-3 or D2-6 Audio SOC (D2-74053-LR used in demo board)**
- Dolby and/or DTS decoding and enhancement available depending on actual product used
- Complete System on Chip audio processor and Class D amplifier with integrated DSP

Output Power Stage
- GaN FET Output Power stage drives up to 100W of power
- Can replace with integrated power stage such as D2-24044 for budget applications
- Configure to drive 2 speakers (woofer and tweeter) for Powered speaker applications
- Configure to drive 3 speakers (left, center, right) for Sound bar applications

Renesas RX65N MCU
- 32-bit core with DSP, 546 Coremarks at120MHz
- Free software stacks from Renesas FreeRTOS support

Power Management

KS25-3WBAEVALZ Demo board available

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INPUT BOARD – KEY FEATURES

USB (underneath)

Manual volume control

Bluetooth

Apple APC co-processor IC (not included with demo board)

XLR/TRS Combicon inputs

Analog Input

Digital In and Out

Function Buttons:
L/R/M – Select the input/Audio sourcel (left, right, mono)
Bond – Connect the wireless subwoofer or surround speaker
In Select – Select the input channel
W/B Setup – Configure and setup the Wifi

KS25-3WBAEVALZ Demo board available

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D2AUDIO SOC SOLUTION

RAM ROM

System-level Knowledge and Expertise

Reference Designs

BT
WIFI
AUX
HDMI
S/PDIF
USB

Digital I/O Sample Rate Converter

10W to **250W** (full range)
50W to 1kW (Subwoofer)

D2AUDIO SoundSuite

Royalty Free Audio Processing

AudioCanvas - Control GUI

DOLBY DIGITAL PRO LOGIC II
DOLBY DIGITAL VIRTUAL SPEAKER
SRS TruSurround HD

Optional Proprietary Audio Processing*

6

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D2 AUDIO PRODUCT PORTFOLIO MATRIX

	Sound Processors			Power Stage
Family	**D2-4 (4P)**	**D2-3 (3S)**	**D2-6**	**D2-IPS**
ASRC Channels	2x	8 Channels		-
PWM Channels	5 Channels	12 Channels		4 Channels
Signal Flow	Fixed	Configurable		-
Optional Decoders	DTS® Wow	Dolby® Digital, Dolby® Pro Logic® II	Dolby® Digital, Dolby® Pro Logic® II, DTS® Digital Surround Dolby® Digital Plus*	-
Supported Audio Inputs	1x I^{2}S 1x S/PDIF 4x fault INT	4x I^{2}S 2x (1x) S/PDIF 8x fault INT ADC (non-HT only)	4x I^{2}S 2x S/PDIF 8x fault INT ADC	4
Supported Audio Outputs	5x (4x) PWM 3x PWM 1x S/PDIF	12x PWM 4x I^{2}S 1x S/PDIF	12x PWM 4x I^{2}S 1x S/PDIF	10W x 4 25W x 2 50W x 1
Value Add Features	D2 Audio PWM Engine, Graceful Fault Recovery, D2 Audio Sound Enhancement Algorithms, D2 Audio Customization GUI			

Customers must obtain licenses from Dolby and DTS to use the decoders

*coming soon

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D2 AUDIO CUSTOMIZATION GUI DESIGN TOOL

Drag and drop processing blocks

Visually intuitive sound customization

Visual hardware performance optimization
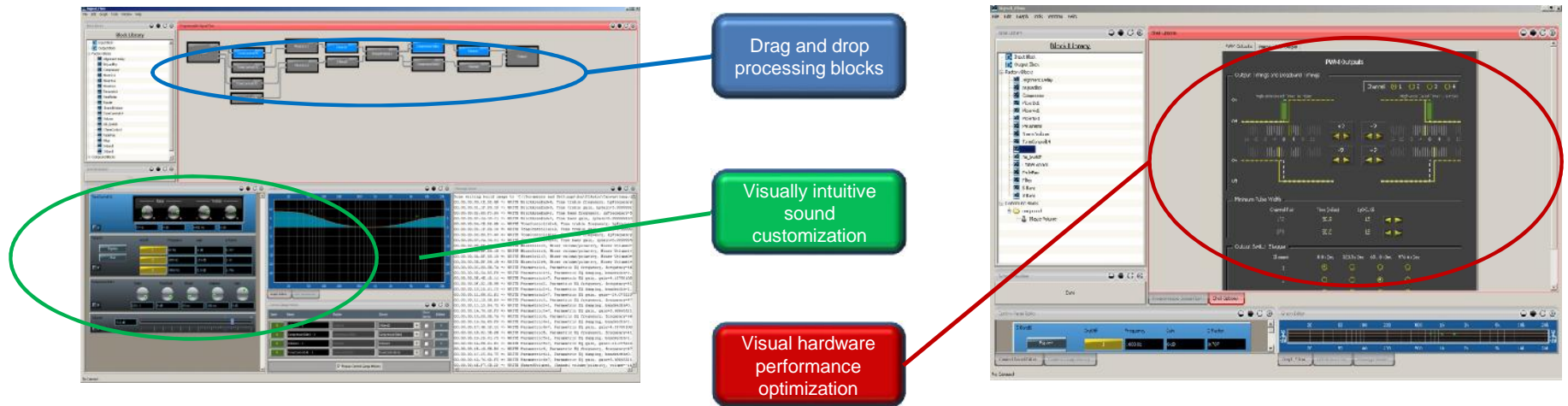
Generate custom firmware for your solution using simple drag and drop audio blocks and visually intuitive control interfaces
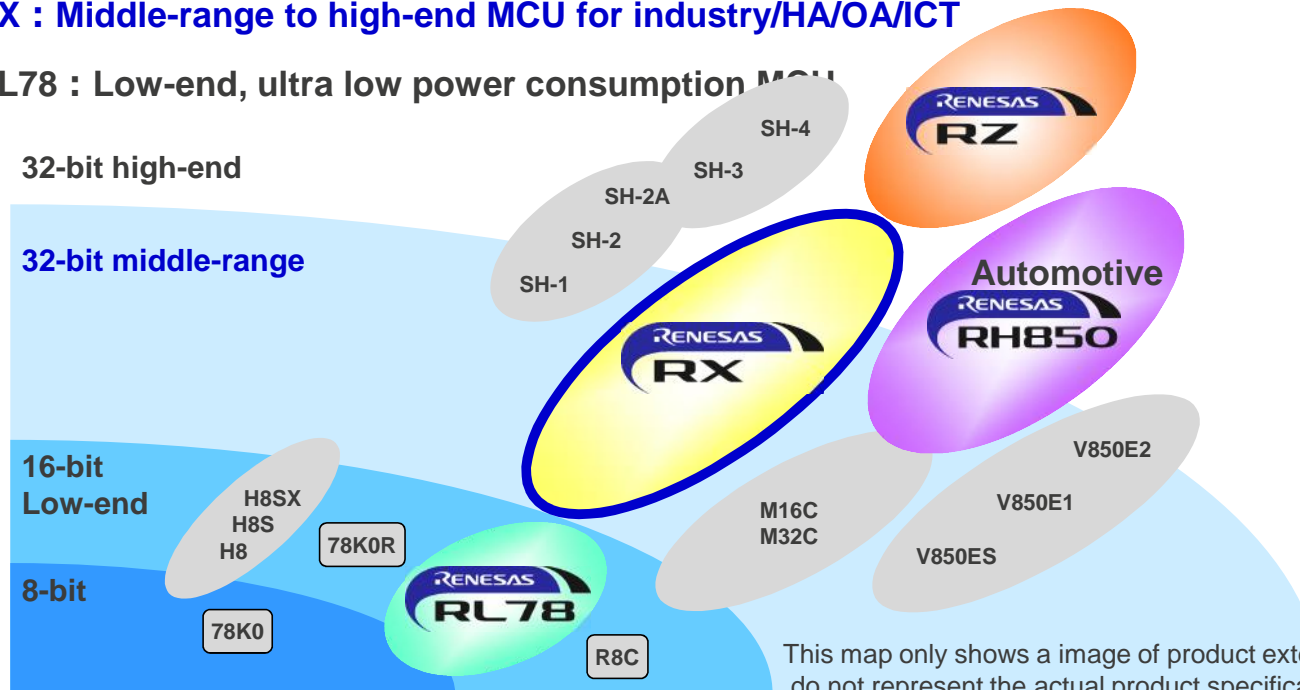
No direct coding required

Customization can be done in hours using the D2 Audio GUI instead of days or weeks using a traditional programming methods

Available to customers for no charge

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RENESAS MCU/MPU LINEUP

- **RZ : High-end Arm core MPU for HMI/connectivity/motor control**

- **RX : Middle-range to high-end MCU for industry/HA/OA/ICT**

- **RL78 : Low-end, ultra low power consumption MCU**

32-bit high-end

SH-4
SH-3
SH-2A
SH-2
SH-1

32-bit middle-range

RENESAS **RZ**

Automotive
RENESAS **RH850**

RENESAS **RX**

V850E2

16-bit Low-end

H8SX
H8S
H8

78K0R

M16C
M32C

V850E1

V850ES

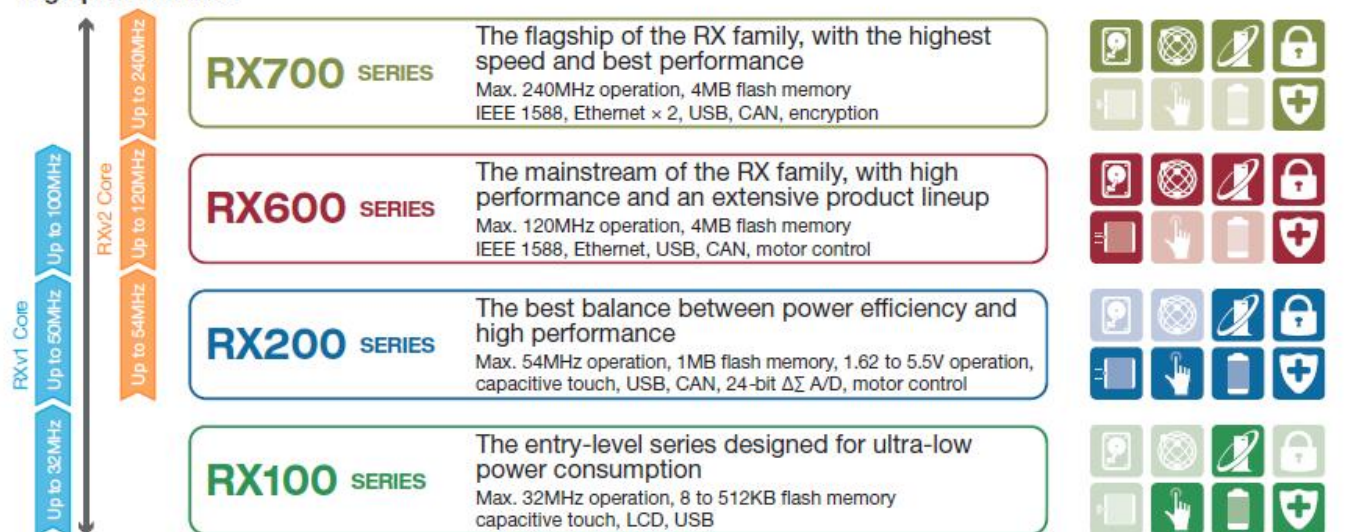**8-bit**

RENESAS **RL78**

78K0

R8C

This map only shows a image of product extensibility, and horizontal and vertical lines do not represent the actual product specifications
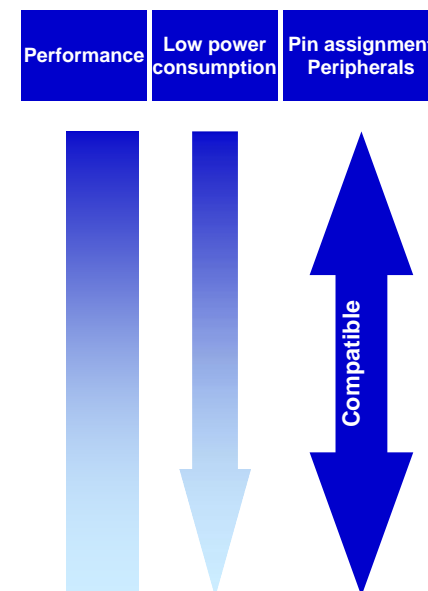
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FEATURES OF RX FAMILY

Unified architecture covering the low end to the high end

High performance

RXv1 Core | Up to 32MHz | Up to 50MHz | Up to 100MHz
RXv2 Core | Up to 54MHz | Up to 120MHz | Up to 240MHz

RX700 SERIES
The flagship of the RX family, with the highest speed and best performance
Max. 240MHz operation, 4MB flash memory
IEEE 1588, Ethernet × 2, USB, CAN, encryption

RX600 SERIES
The mainstream of the RX family, with high performance and an extensive product lineup
Max. 120MHz operation, 4MB flash memory
IEEE 1588, Ethernet, USB, CAN, motor control

RX200 SERIES
The best balance between power efficiency and high performance
Max. 54MHz operation, 1MB flash memory, 1.62 to 5.5V operation, capacitive touch, USB, CAN, 24-bit ΔΣ A/D, motor control

RX100 SERIES
The entry-level series designed for ultra-low power consumption
Max. 32MHz operation, 8 to 512KB flash memory
capacitive touch, LCD, USB

Low power

Large memory capacity High performance

Ethernet

Connectivity

Security functions

Motor control

Touch functions

Power efficient/battery

Hardware support for safety functions

Performance | Low power consumption | Pin assignment Peripherals

Compatible

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RX651/RX65N SPECIFICATION
120MHZ RXV2 CPU, BROAD CONNECTIVITY, UP TO 1MB FLASH MEMORY

Technology

Performance / Flash Density

- RX100 — 1,8-3.6V 32MHz
- RX200 — 1,62-5,5V 50-84MHz
- RX600 — 2.7-5.5V 100-120MHz
- RX700 — 2.7-5.5V 240MHz

- 40-nm high-performance process
- 32-bit RXv2 Core with FPU and DSP capability
- Operating temperature range: Ta = -40°C to 85°C
- Ports:
  - I/O pins: 111
  - Input pin: 1
  - Pull-up resistors: 111
  - Open-drain outputs: 111
  - 5-V tolerance: 18
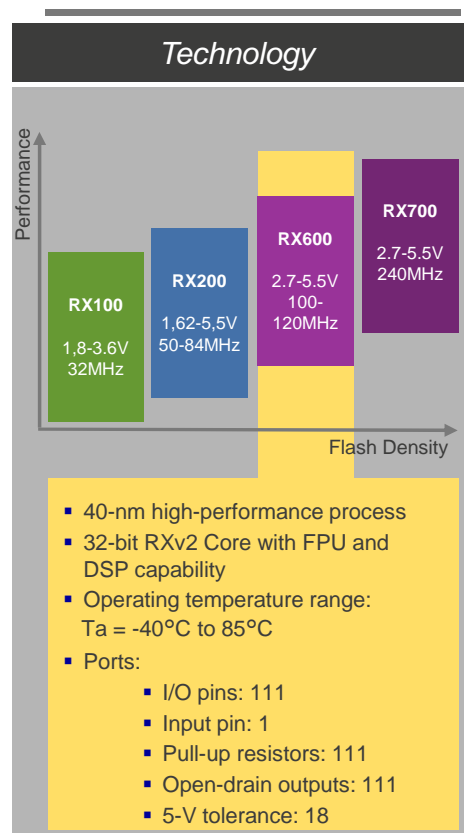
120MHz 32-Bit RXv2 Core

RX651 **RX65N**

1MB Flash

Memory
- Code Flash (512kB, 768kB, 1MB)
- SRAM (256kB)
- StandbyRAM (8kB)

Analogue
- 12-bit A/D (21ch) **
- 12-bit A/D (8ch) ** S&H (3ch)
- 12-bit DAC (2ch) **
- Temperature Sensor

Timers
- MTU3a x1 (8ch)
- MTU3a 32bit (1ch)**
- TPUa x1 (6ch)
- PPG x2
- TMR x4
- CMTW(2ch)**,CMT(4ch)
- WDT, I-WDT
- RTC,Calendar,Vbat

HMI
- Parallel Data Capture Unit

Communication
- Ethernet MAC with DMA (on RX65N)
- USB2.0 FS x1
- CAN x2
- I2C x2
- SCI x11, SCIF x2**
- SPI x3
- QSPI x1
- SDHI x1** / SDIO x1 **
- External Bus with SDRAM

System
- Data Transfer Controller ExDMA (2ch) DMA (8ch)
- Interrupt Controller
- Clock Generation High-speed on-chip oscillator
- Event Link Controller

Safety
- Memory Protection Unit
- POR / LVD
- Trusted Memory
- Register Write Protection Unit
- Clock Frequency Accuracy Measurement
- CRC Calculator
- Data Operation Circuit

Encryption
- AES (128/192/256)
- TRNG

Package
- LQFP100 to 144
- LGA100 to 145

** Enhanced from RX631/N
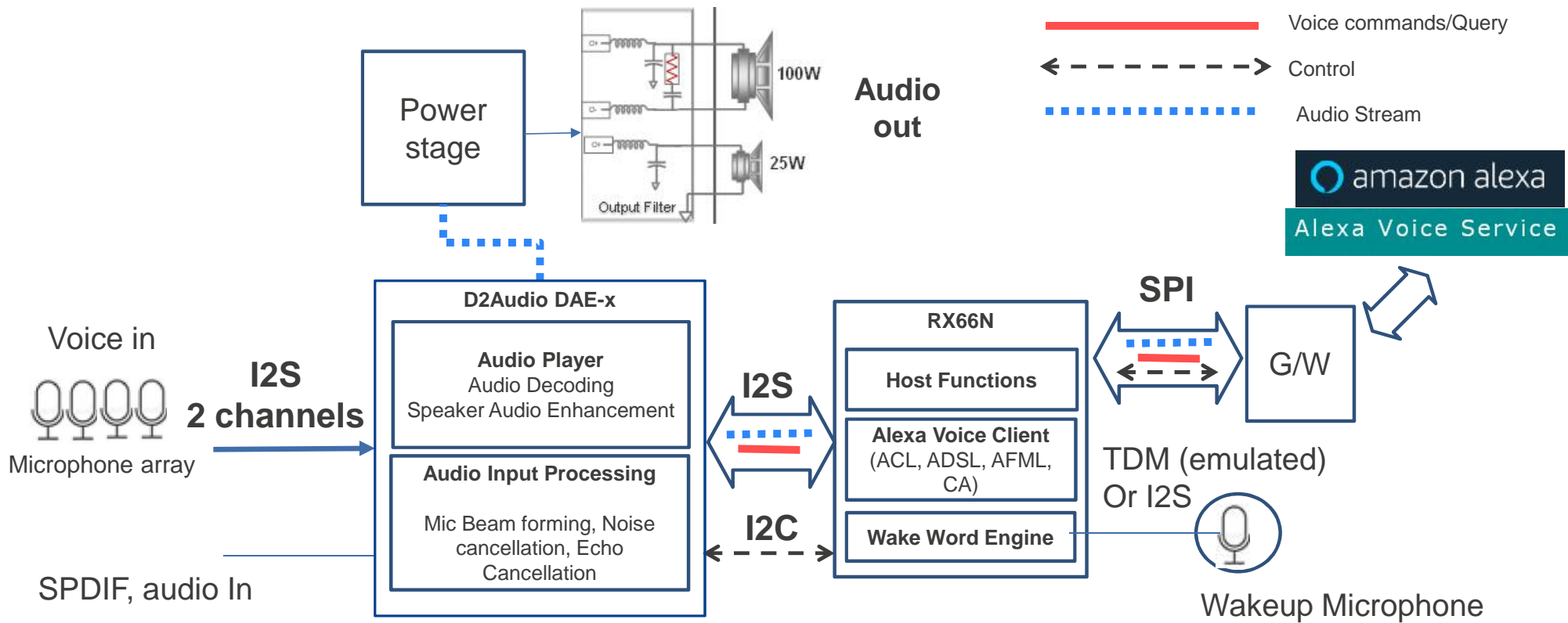
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IN DEVELOPMENT : VERSION 2 OF SMART POWERED SPEAKER

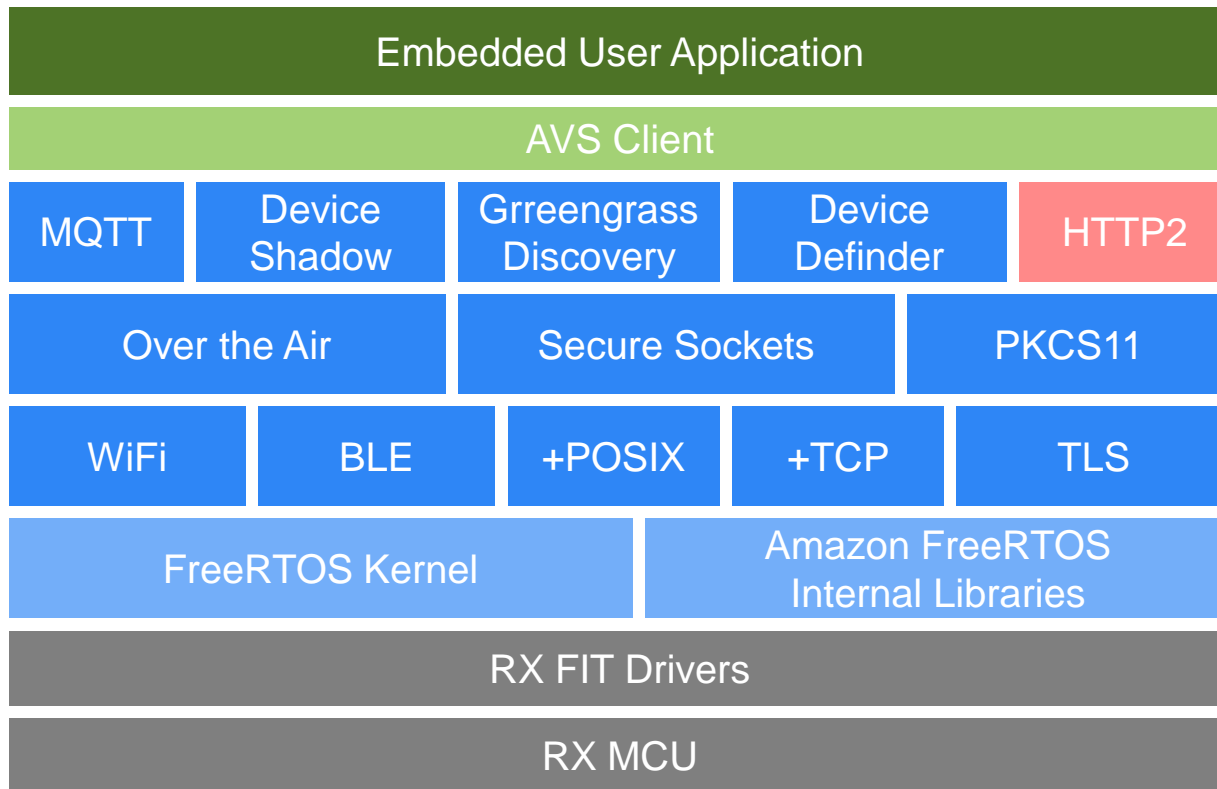New smart powered speaker design with integration of the voice control function
in Renesas ICs
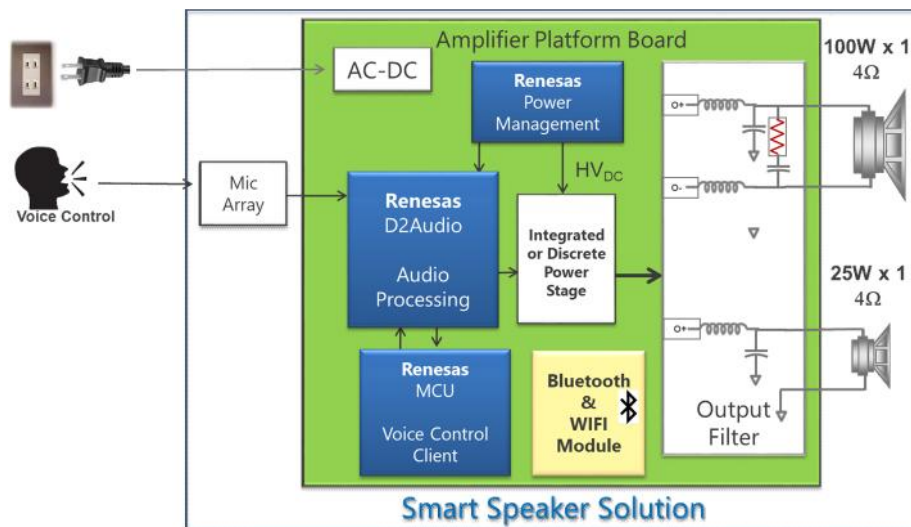
SMART SPEAKER
BLOCK DIAGRAM

Voice commands/Query

Control

Audio Stream

Power stage

Audio out

100W

25W

Output Filter

amazon alexa

Alexa Voice Service

D2Audio DAE-x

Audio Player
Audio Decoding
Speaker Audio Enhancement

Audio Input Processing

Mic Beam forming, Noise cancellation, Echo Cancellation

Voice in

Microphone array

I2S 2 channels

SPDIF, audio In

I2S

I2C

RX66N

Host Functions

Alexa Voice Client
(ACL, ADSL, AFML, CA)

Wake Word Engine

SPI

G/W

TDM (emulated) Or I2S

Wakeup Microphone

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SMART SPEAKER
SOFTWARE STRUCTURE

Embedded User Application				
AVS Client				
MQTT	Device Shadow	Grreengrass Discovery	Device Definder	HTTP2

Over the Air	Secure Sockets	PKCS11

WiFi	BLE	+POSIX	+TCP	TLS

FreeRTOS Kernel	Amazon FreeRTOS Internal Libraries

RX FIT Drivers

RX MCU

AliOS Things already supported on RX600 (RX651/N) available on GitHub

Client should work on FreeRTOS.

SUPPORT AVAILABLE

Evaluation Boards

Reference Design Demo Board
KS25-3WBAEVALZ
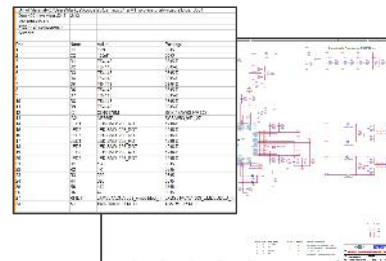
D2 Audio Eval Boards
KS10-6TEVALZ
KS10-6TEVAL1Z
KS10-6TEVAL2Z
KS10-6TEVAL3Z

RX65N Starter Kit
YRTK500565NS0000BE
RTK500565NS0000BE
RTK500565NS10000BE
RTK500565NS80000BE

Reference Design

Brochure

Datasheets

RX65N D2-3 D2-6

Application Notes

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