

Richtek Digital Cockpit Solutions

Central Marketing Division

Ted Mao

March 2023

Outline

- Automotive Technology Trends
- Richtek Automotive Business
- Richtek Automotive Product Portfolio
- Richtek Digital Cockpit Solutions

Automotive Technology Trends

A stylized graphic of a circuit board in a light yellow color, positioned on the right side of the slide. It features a central square chip with the word "RICHTEK" printed on it, and various lines and dots representing circuit traces and components.

Automotive Technology Trend

Application

C

Connected

A

Autonomous

S

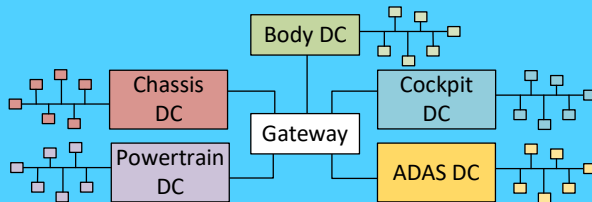
Shared

E

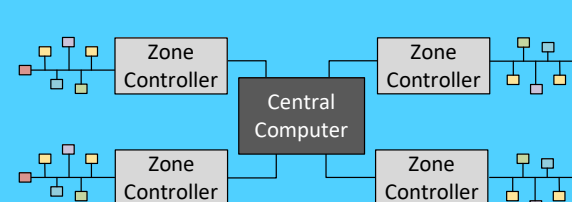
Electrified

Architecture

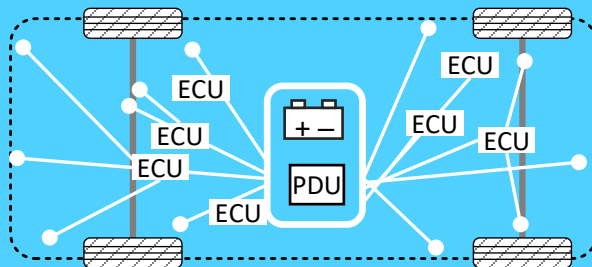
Domain Architecture



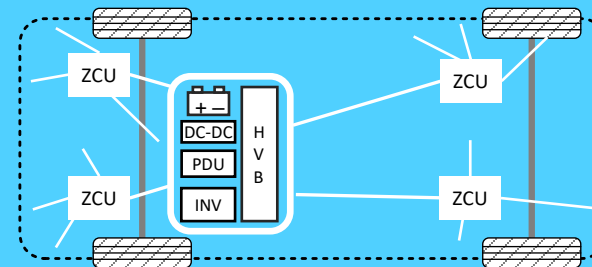
Zonal Architecture



Traditional Power Distribution



Dependable Power Distribution



Power Management



High Reliability



High Voltage



High Efficiency



Low Iq



Low Noise / EMI



Low dppm



Functional Safety

Richtek Automotive Business

Richtek Automotive Business

Shipment Quantity

Over 200Mu of ICs shipped per year

Strategic Product Portfolio

- Type-C USB Charger
- PMIC for Camera, Display
- Power IC for IVI, ADAS, T-box

Differentiation

- Technology Leading (e.g.: Input range, EMI, noise level)
- Flexible and instant technical support



Proven Record

Customers from OEMs, Tier-1s & Tier-2s world-wide

Broad IP Library Leverage

Strong and proven IPs from Computing Communication & Consumer

Automotive Quality

- Zero defect mindset
- AEC-Q100
- ISO-26262



Richtek Automotive Product Portfolio

A decorative graphic on the right side of the slide, featuring a complex circuit board pattern with various traces and components. A rectangular box is integrated into the design, containing the word "RICHTEK" in a bold, sans-serif font.

Richtek Automotive Product Portfolio

ADAS

- ADAS ECU / Domain Controller
- Camera Module / Dash Cam
- Driver Monitoring
- Radar
- Surround View System

DR LI PM PO SW

Body & Lighting

- Interior Lighting
- Body ECU
- Network Gateway
- Thermal Management

LE LI PO SW

Chassis & Safety

- Active Suspension
- Electric Power Steering

LI PO SW

AU Audio Amplifier

DR DDR DRAM

LC LCD & OLED Display Power

LE LED Drivers

LI Linear Regulators

PM PMICs

PO Power Switch

SW Switching Regulators

PD USB Type-C & PD Solutions

Digital Cockpit

- Central Information Display
- Cockpit Domain Controller
- Digital Cluster
- E-Mirror
- Head-up Display
- In-vehicle Infotainment
- Rear Set Entertainment
- Telematics Control Unit
- USB Charging
- V2X / C-V2X

AU DR LC LE LI PM PO SW PD

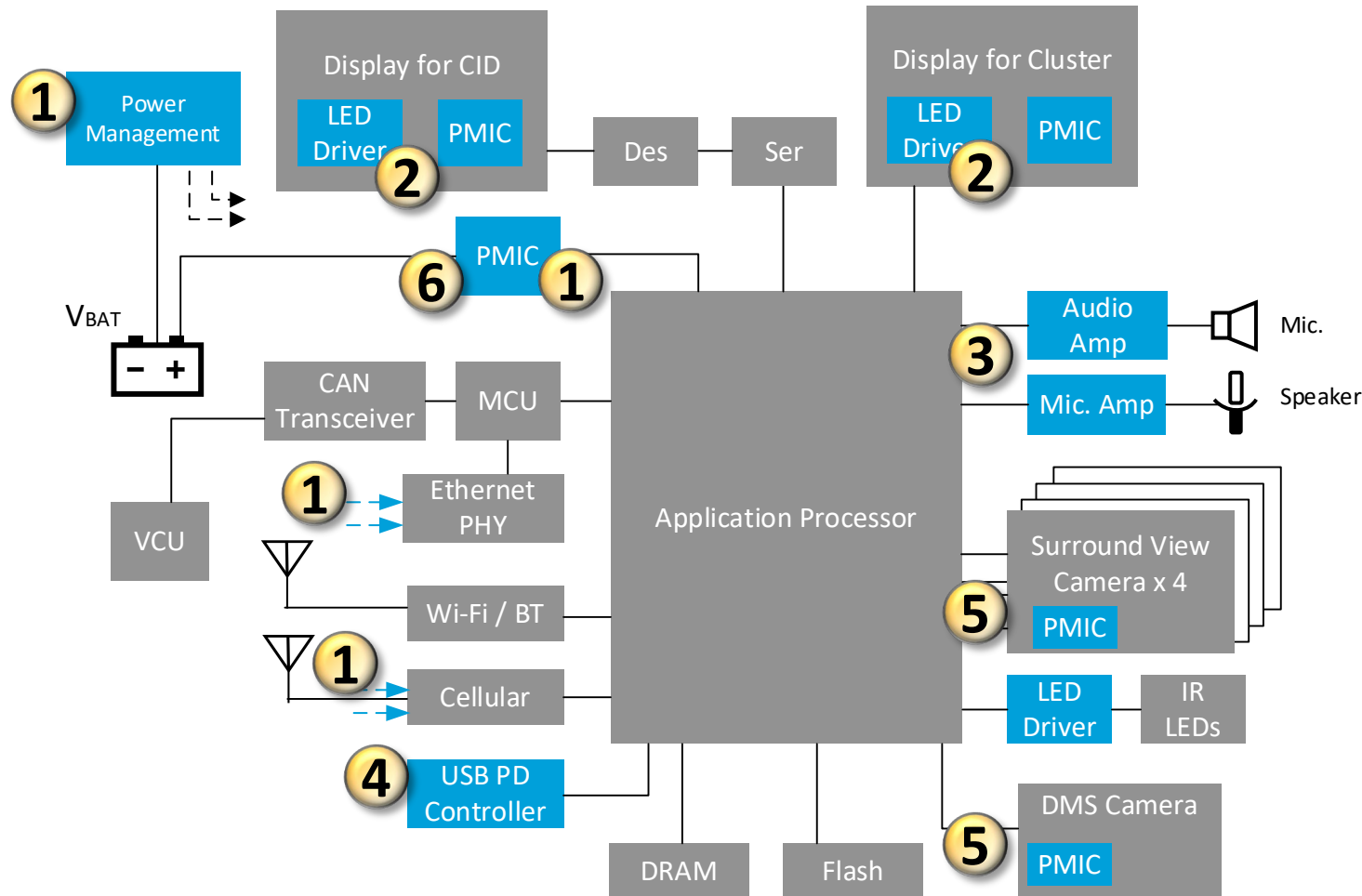
Electrified Powertrain

- DC-DC Converter
- On-board Charger
- Virtual Engine Sound System

AU LI

Richtek Digital Cockpit Solutions

Richtek Digital Cockpit Solutions Overview



1 Discrete Power Management Solutions

- High PSRR / Low Iq LDOs
- Step-down (Buck) Converters
- Step-up (Boost) Converters
- Step-up / down ((Buck-boost) Converters
- Power Switch

2 Display Solutions

- B/L LED Drivers
- Display PMICs

3 Audio Solutions

- Audio Amp

4 USB Charging Solutions

- USB Type-C PD Charging ICs

5 Camera Power Solutions

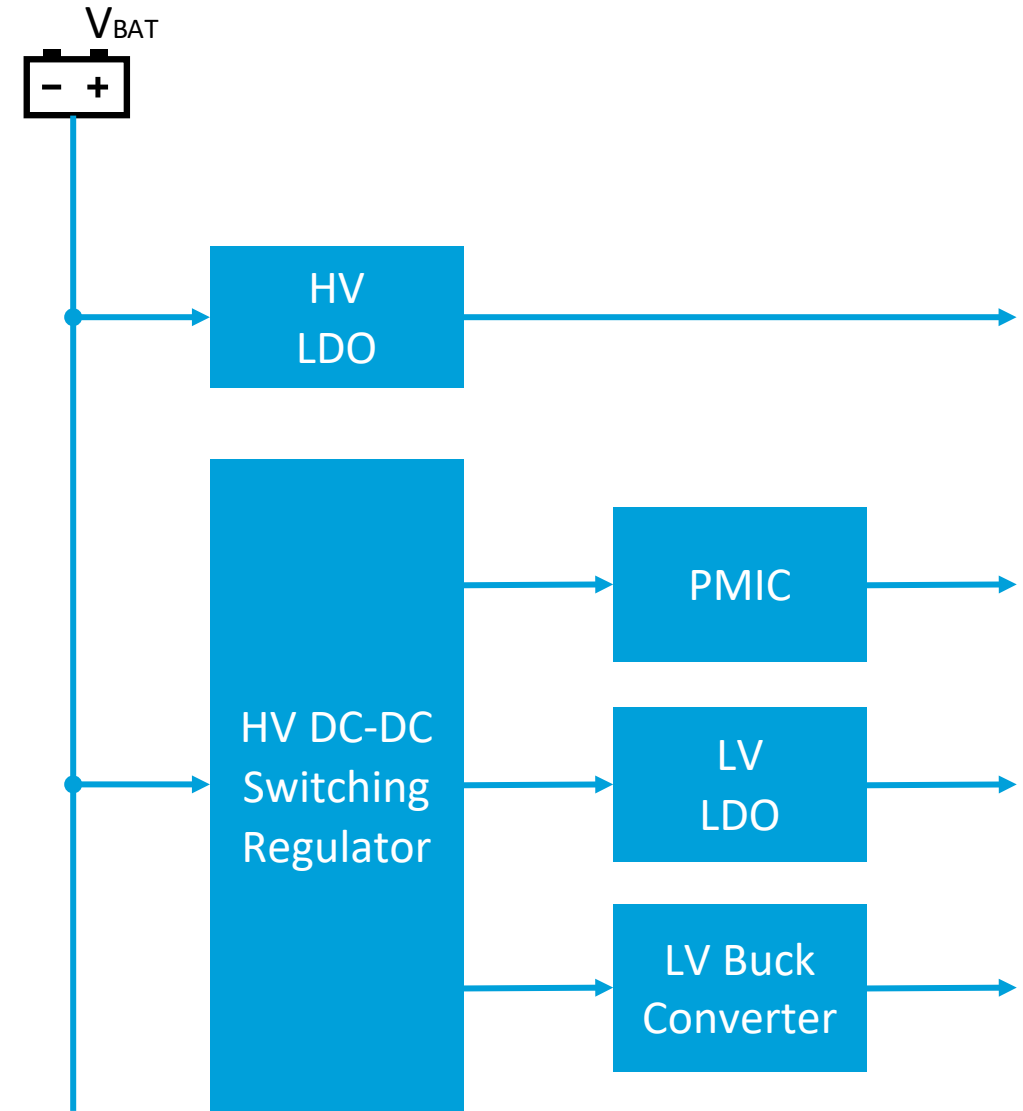
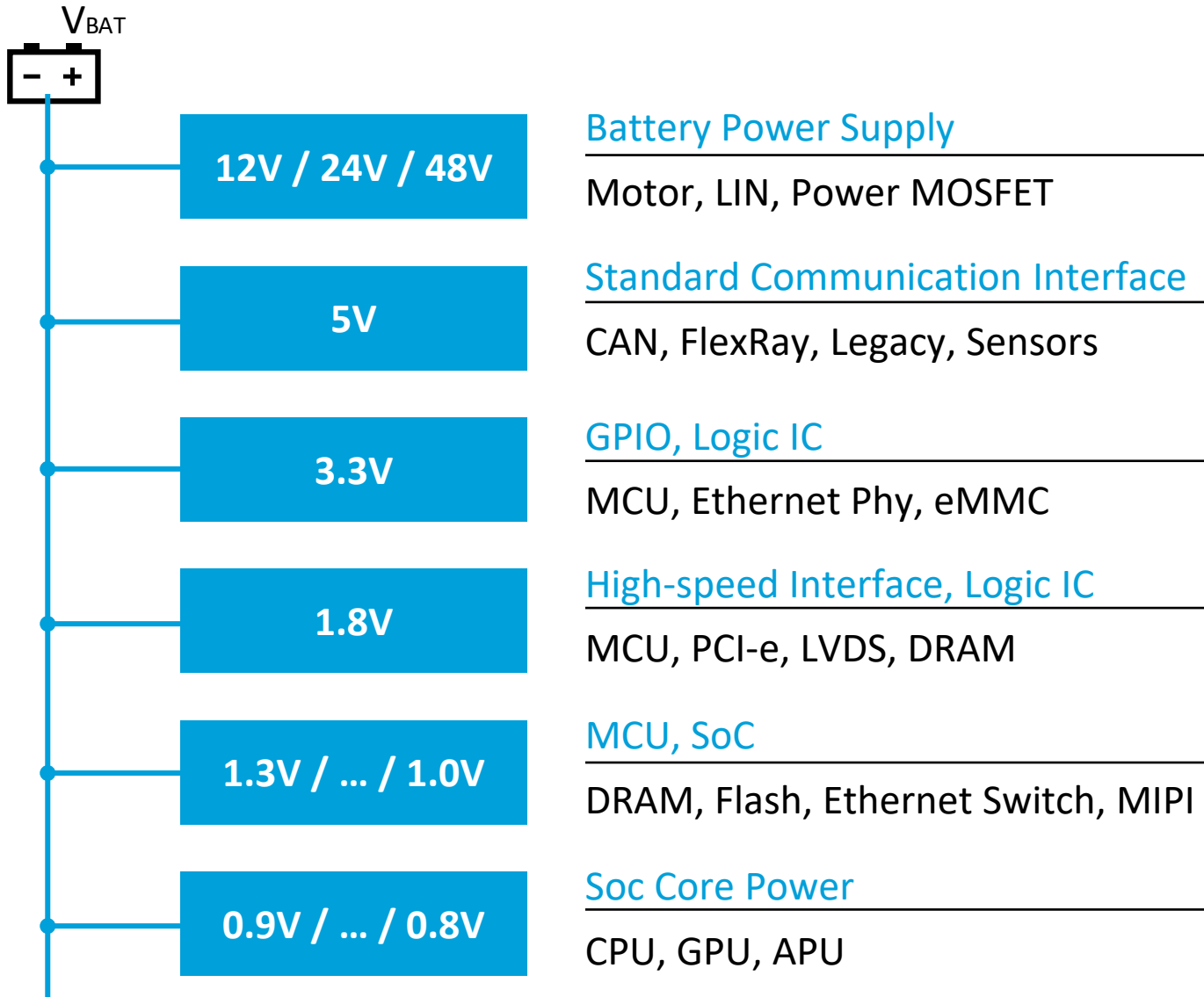
- PMICs for viewing camera
- PMICs for sensing camera (with Functional Safety)

6 IVI Platform SoC Solutions

- PMICs for Infotainment / AVN Platform

Digital Cockpit Solutions – DC-DC

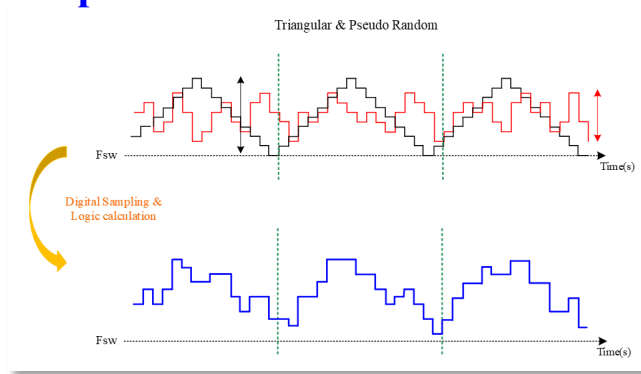
Automotive Power Rails In General



Core Technology in Switching Regulators

Low EMI

- Switching Random Spread Spectrum

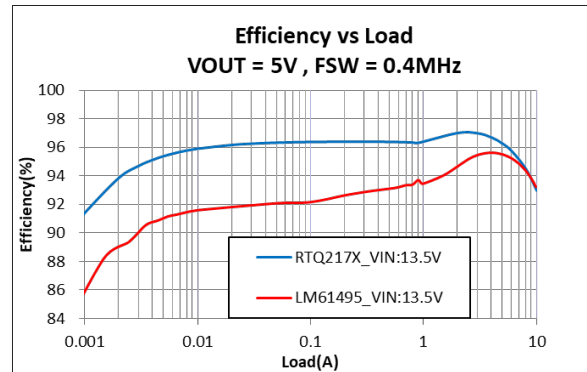


- Optimize 150k ~ 108MHz FFT performance

Unit : dB	RTQ2179 EMI
Fundamental	12.5
2nd harmonic	0.5
3rd harmonic	-8.7
30.8MHz	-21.5
37.2MHz	-23.3
41MHz	-25.0
82.2MHz	-32.6
99.2MHz	-34.4

High Efficiency

- Good efficiency from light load to heavy load. (Typical Eff. > 96%)



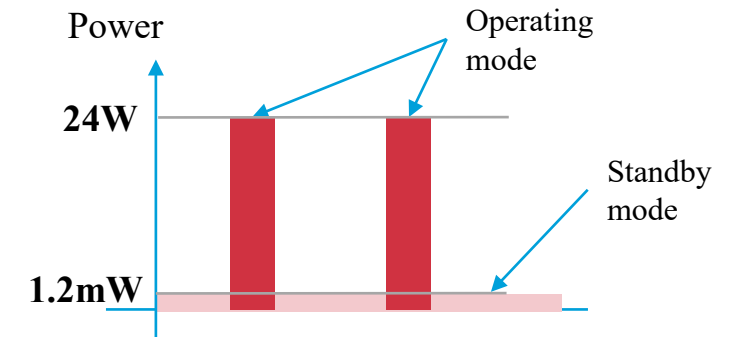
- Better thermal performance !

	RTQ217X	LM61495
	Vo=5V, 6A 2.1MHz	Vo=5V, 6A 2.2MHz
TA=25°C		
Vin=8V Tj (°C)	58.3	63.0
Vin=13.5V Tj (°C)	65.0	70.4
Vin=16V Tj (°C)	68.4	74.5



Longer Standby Time

- Extend battery lifetime
- General ECU board standby current < 100uA



Our value to system:

T-Box system standard operating@2A, 12V
Standby mode@100uA, 12V

RTQ217X standby power consumption is only 0.06mW!!



HV (Battery Connected) Power Solutions

Commercial Vehicle						
For 24V System	60 Vin Buck	< 0.5A	1.5A	2.5A	3.5A	5A
		RTQ2960-QA	RTQ2961-QA	RTQ2962-QA	RTQ2963-QA	RTQ2965-QA
		RTQ6360	RTQ6361	RTQ6362	RTQ6363	RTQ6365

Passenger Vehicle							
For 12V System	42 Vin Buck	< 0.5A	1.5A	2.5A	3.5A	5A	
		RTQ2940-QA	RTQ2941-QA	RTQ2942-QA	RTQ2943-QA	RTQ2945-QA	
	36 Vin Buck	0.7A	1A		3A		4A ~ 10A
		RTQ2130B-QT	RTQ2131B-QA	RTQ2132B-QT	RT2872	RT2875A/B	Sample: April '23
					RTQ2104/B-QA	RTQ2105-QA	
	36 Vin LDO	0.1A	0.2A				
		RT2560Q	RTQ2569-QA				

Automotive Grade

Industrial Grade

LV Solutions – Switching Regulators

	< 1A	1.5A	2A	3A	4A	> 6A	
Buck (ACOT)		RTQ2102A-QA 6Vin 1.5A Gr. 1 DFN 3x3-8 100% Duty, 2.7MHz Auto PSM/PWM Int. SS, PG, Iq 30uA Fast Transient	RTQ2103A-QA 6Vin 2A Gr. 1 PSOP-8 100% Duty, 2.7MHz Auto PSM/PWM Int. SS, PG, Iq 30uA Fast Transient			RTQ2158-QA 6Vin 8A/12A, Gr. 1 WET-QFN 4x4-21 460KHz/2.1MHz Auto PSM/PWM Int. SS, PG, High Eff. Fast Transient	RTQ2159-QA 6Vin 8A, Gr. 1 WET-QFN 4x4-21 2.1MHz (default) PSM/PWM Selectable Int. SS, PG, High Eff. Fast Transient I2C, VID 10mV
Buck (Current Mode)	RT2657BQ 5.5Vin 0.6A Gr. 3 DFN 3x3-8 100% Duty, 2.25MHz Forced PWM Int. SS		RT2101B 6Vin 2A Gr. 2 QFN 3x3-16 700KHz~2MHz, Sync. Forced PWM Adj. SS, PG High Eff., Ext. Comp.	RT2101A 6Vin 3A Gr. 2 QFN 3x3-16 700KHz~2MHz, Sync. Forced PWM Adj. SS, PG High Eff., Ext. Comp.	RT5701 5.5Vin 4A Gr. 2 TSSOP-14 100% Duty, 3MHz PSM/PWM Selectable Int. SS, PG I2C, DVS, Iq 10uA Remote GND Sense		
Boost (Current Mode)				RTQ9297 5.5Vin 3A Gr. 2 WDFN 3x3-10 640KHz~1.2MHz, Forced PWM Adj. SS,			

LV Solutions – LDO Regulators

	0.2A	1.0A	> 1.0A
6Vin		RT2517B Vin (max.) 6V Vout (min.) 1.2V ULDO, RCP EN/ADJ PSOP-8 (5x4)	RTQ2516-QT Vin (max.) 6V Vout (min.) 0.5V Iout (max.) 2.0A ULDO, RCP EN/ADJ PSOP-8 (5x4)
14Vin	RTQ2511-QA 14Vin 0.2A Gr. 1 DFN 3x3-8 Iq 2uA	RTQ2510-QA Vin (max.) 6V Vout (min.) 0.5V UHPSRR EN/ADJ VQFN3x3-8	

System PMICs & Multi-phase Buck Converter

	System PMICs & Multi-phase Buck Converter
System PMICs	RTQ5115-QA 5.5Vin Gr. 2 QFN 7x7-56 CH1: Buck 2.4A, CH2: Buck 2A, CH3: Buck 1.6A, CH4: Buck 2A, CH5~12: LDO 300mA DCDC Fsw up to 2MHz I2C: SEQ, Mode, SS, Fsw, Spread Spectrum, Automotive grade MTP
Multi-phase Buck Converter (2 + 2 / 2 + 1 + 1)	RTQ2134-QA 6Vin 4-PH 20A, Gr. 1 QFN 5x4.5-30 (Wettable), 2.1MHz Multiple PH Combination I2C, DVS, SR, SS Remote Sense

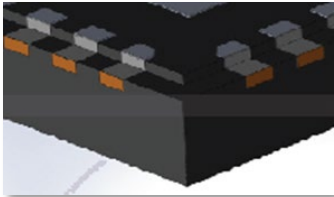
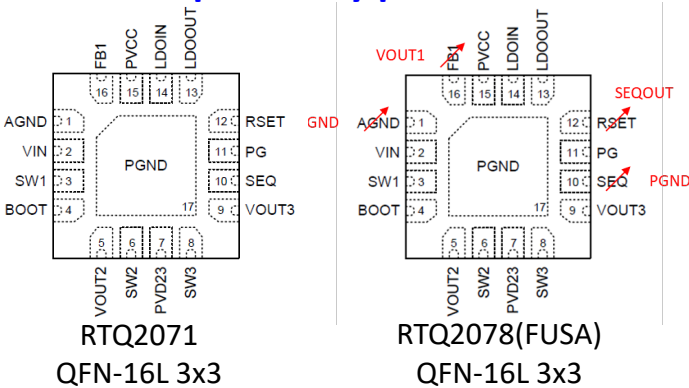
Digital Cockpit Solutions – Camera PMIC

A decorative graphic on the right side of the slide, featuring a stylized circuit board pattern with various traces and components, rendered in a light yellow color against the dark blue background.

Core Technology in CIS PMIC (1)

Compact Size

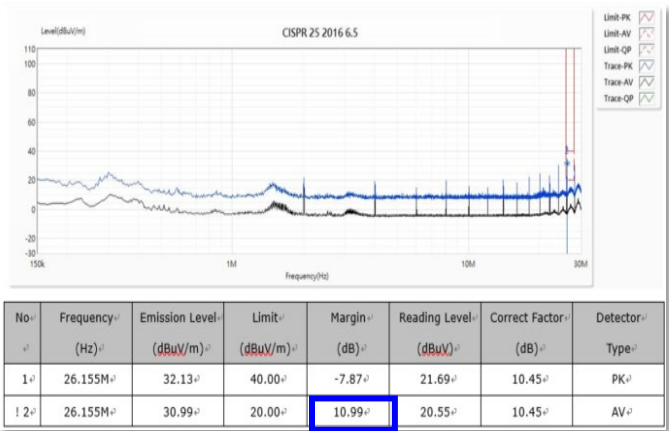
- World smallest CIS PMIC(3x3 mm)
- Pin-to-pin family products



Wettable Flank QFN package for automotive reliability consideration

EMI Performance

Pseudo Spread Spectrum improves EMI performance

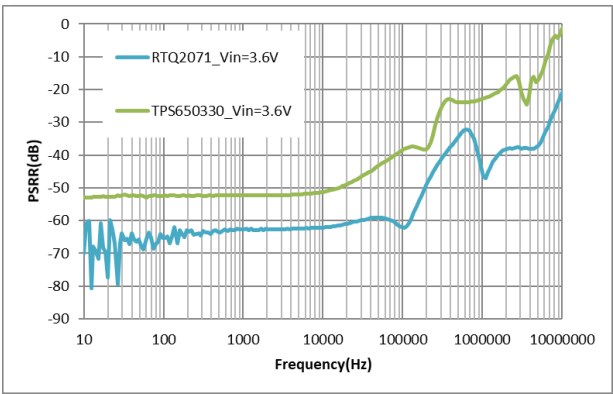


PASS CISPR25 Class 5 test

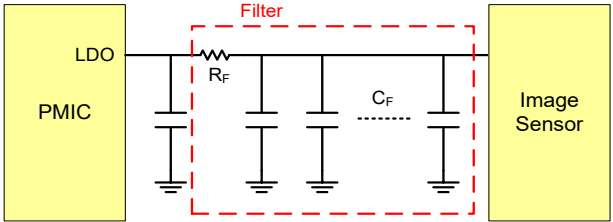
Test condition : RTQ2071, DC 6V, maximum load. → 150kHz ~ 30MHz

High PSRR LDO

- Lower external capacitors usage
- Improve image quality (40dB@1MHz, 60dB@100kHz)



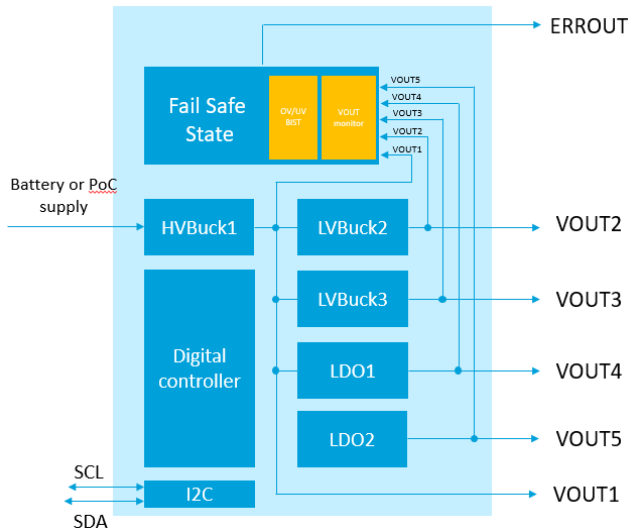
BOM Cost and space saving via high PSRR design



Core Technology in CIS PMIC (2)

Functional Safety

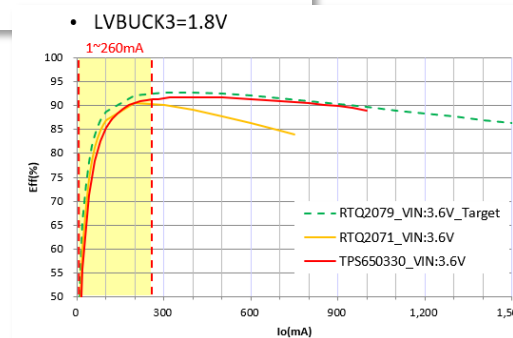
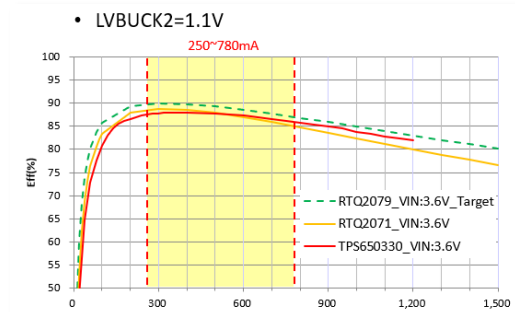
Safety goal : SPFM 95%, LFM :92.1%



- BIST mode
- I2C for error reporting
- Support Automotive Imager Vendors

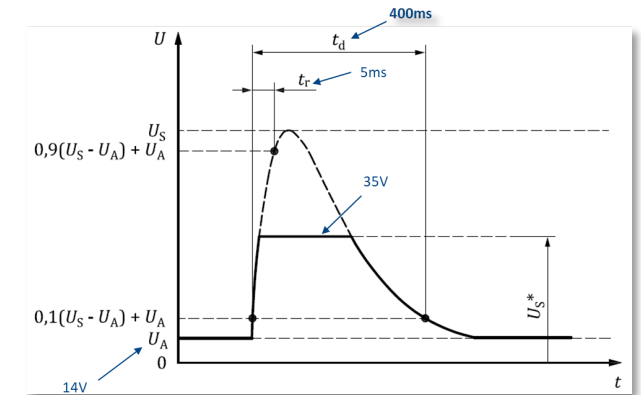
High Efficiency

- Industry highest efficiency, LVBUCK >90%, HVBUCK > 92%
- High efficiency can reduce shot noise and thermal noise



Support Battery Connection Application

- FUSA CIS PMIC RTQ2078/RTQ2079 support battery connected applications
- Design for ISO16750-2 define the 5b test



Automotive Products Roadmap – CIS PMIC

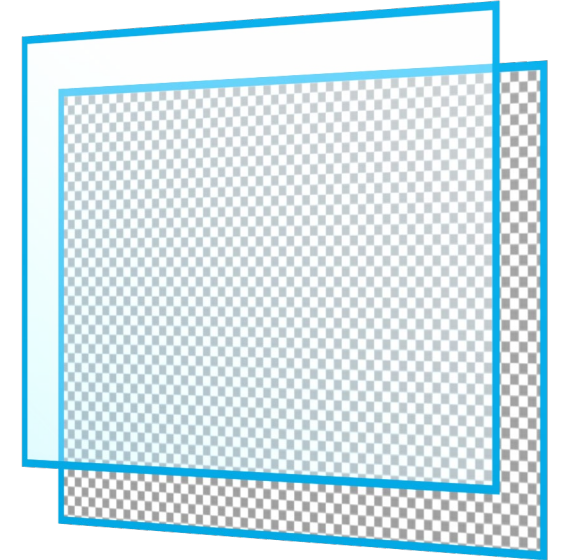
● MP ● Sample

	2021	2022	2023	2024
Non-Fusa	RTQ2070 MP 15Vin Gr. 1 QFN 4x4-24 CH1: Buck 2A/15V CH2: Buck 1A/5.5V CH3: Buck 1A/5.5V CH4: LDO 500mA/5.5V CH5: LSW 500mA/5.5V DCDC Fsw up to 2MHz I2C: SEQ, Mode, SS, Protection, OC, Fsw	RTQ2071 MP 18.5Vin (AMR 24V) Gr. 1 4CH, QFN 3x3-16 Super Compact, High Image Quality		
Fusa		RTQ2079 HV input. Gr. 1 5CH, QFN24 4x4 BIST, Vout Monitor, High PSRR, I2C, EN, Restin, Errin1/2, VMONIN, Errout, PGOOD	RTQ2078 – HV input. Gr. 1 4CH, QFN 3x3-16 (P2P w/I RTQ2071) BIST, Vout monitor, PGOOD, High PSRR	

Digital Cockpit Solutions – Display

Automotive Full-array Local Dimming Display

Features	OLED	Full array Local Dimming	Edge-lit Global Dimming
Contrast Ratio	Best (up to 1,000,000:1)	Better (up to 500,000:1)	Good (several thousands to 1)
Number of zones	Millions	Mainstream: 200 – 1,200 zones Premium: more than 2,400 zones	Single digit
LEDs / Zone	1	1 / 4 / more	20 to 40
Cost	Most expensive	Higher. Depending on zone numbers	Lowest



Why Local Dimming LCD

- Higher contrast ratio and lower light leakage than edge-lit global dimming LCD
- Power saving
- Longer lifetime and more reliable under extreme environment than OLED

How Many Zones / LEDs

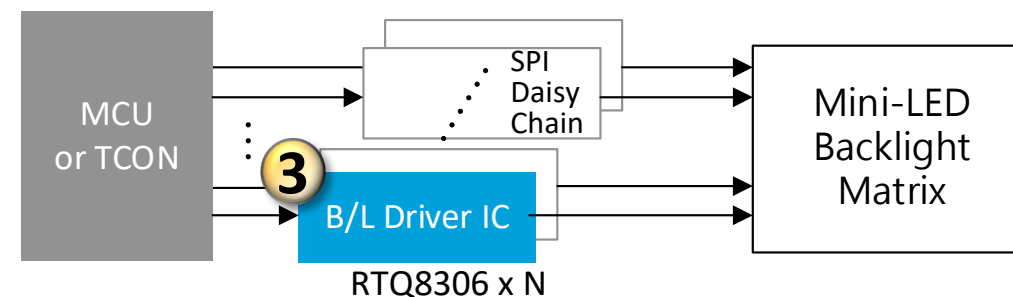
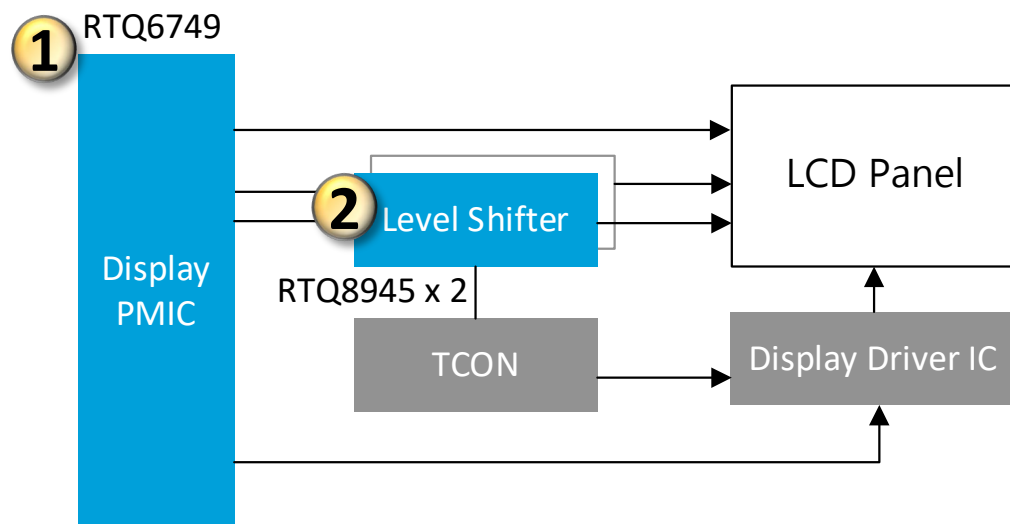
- It's a balance of system performance and cost
- Halo effect, thickness of backlight module, thermal issue, contrast ratio are all factors to consider

Automotive Display with Local Dimming



Display Solutions

- Display PMIC: RTQ6749 x 2 ~ 3 pcs
- Level Shifter: *RTQ8945 x 2 (L + R)
- LED Driver IC for Backlight Module
 - Local Dimming: *RTQ8306 x N pcs (144 zones / pc)



Automotive Display Product Family

● MP ● Sample

	~2020	2021	2022	
Display PMIC	RTQ6801 AVDD/VGH/VGL/VCOM 4 Channel QFN 4x4	RTQ6749 PAVDD/NAVDD/VGH/VGL/VCOM 5 Channel QFN 5x5	RTQ6752 PAVDD/NAVDD 2 Channel QFN 5x5	AMOLED RTQ6750/1 PAVDD/VGH/VGL/VDD*2/VREF/Vint WQFN6*6-48L
WLED Driver	RT8577A 4ch, 40V Driver WQFN5*5-20L		RTQ8306 36ch +4 scan 60mA/ch WQFN7*7-56L Local dimming with SPI 144 zones/IC	
Others			RTQ9297 AVDD Boost WDFN 3*3 10L 3A/24V @ vin 2.5V~5.5V	

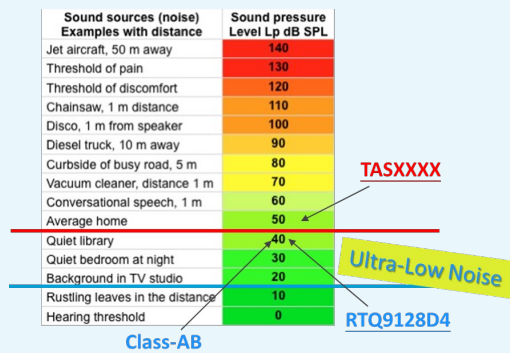
Digital Cockpit Solutions – Audio Amplifier



RTQ9128D4 – 4ch, Class-D Audio Amplifier

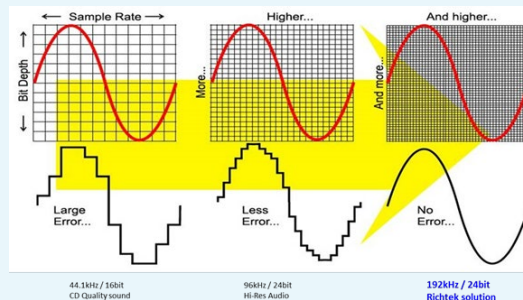
Sound Quality

1. Ultra low noise level



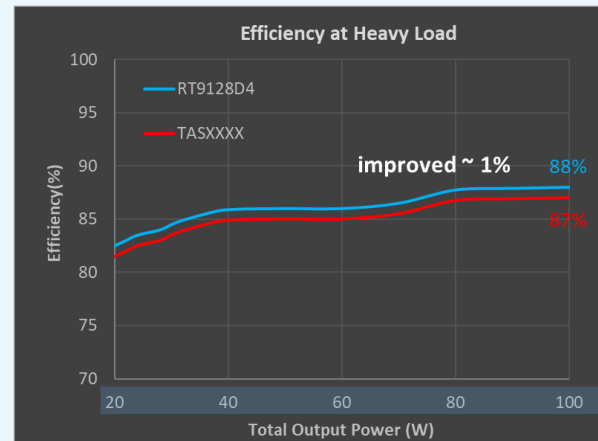
For **18uV (RTQ9128D4)** output noise = -1 dB SPL at 1m
Output SPL = **39 dB SPL @ 1cm** (Closer to ear)
For **42uV (TASXXXX)** output noise = 6.5 dB SPL at 1m
Output SPL = **46.5dB SPL @ 1cm** (Closer to ear)

2. Sampling Rate up to 192kHz for Hi-Res Audio

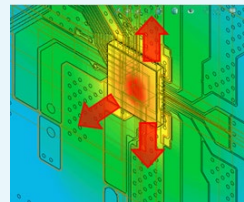


Higher Efficiency

- Higher Efficiency @ Heavy Load (Lower Ron)
- Higher Efficiency @ typical music and speech volume range (light load)



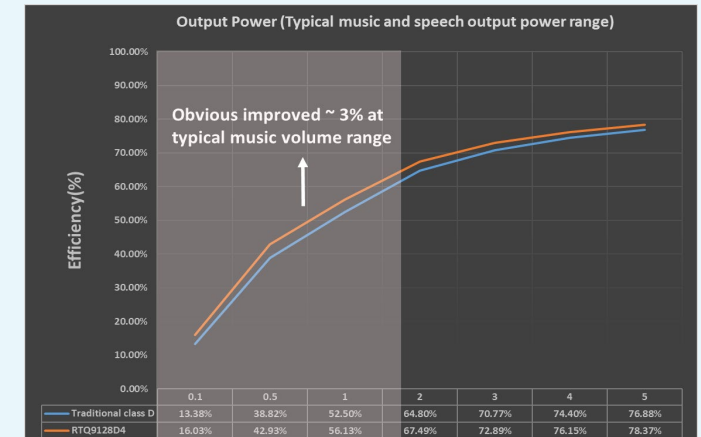
fsw = 2.1MHz @ 4 Ω , PVDD = 14.4V



Benefit :

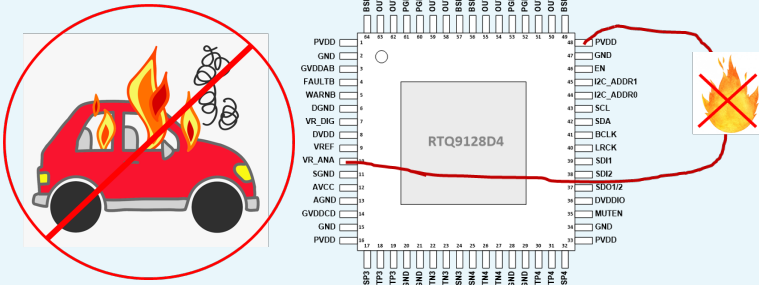
- Reduce 1.3W power dissipation (@ total Po= 100W)
- Cooler system heat
 - Optimize heat-sink size for lower cost

- Ultra low quiescent Mode(ULQM) : standby power only 0.086W



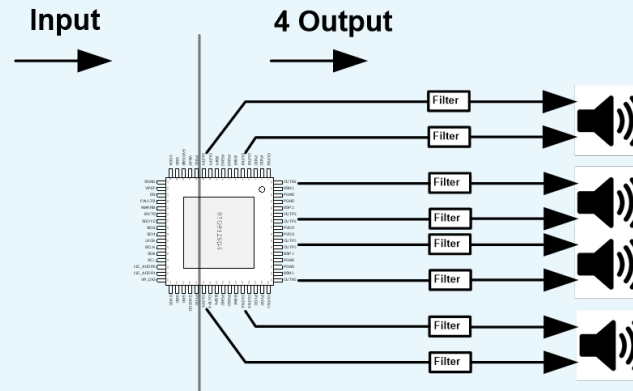
RTQ9128D4 – 4ch, Class-D Audio Amplifier

High Safety (Matrix Short Protection)



- PVDD short to any pins never smoking or fire
- Other protections:
 - Load dump(40V, <400ms)
 - Current limit
 - DC offset
 - OV, OT
 - Thermal foldback

Easy PCB trace routing



- All outputs at one-site make PCB layout easy

Switching Frequency

Up to 2.1MHz Switching Freq.

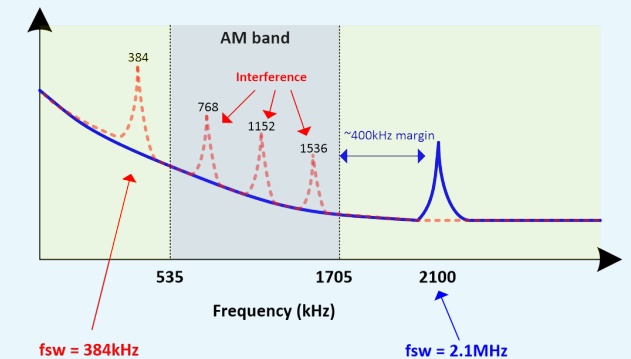
1. Reduce Inductor Size and PCB area



8.2uH @ fsw = 384kHz 3.3uH @ fsw = 2.1MHz

Save over **40%** in inductor space on the PCB

2. Eliminates the AM band interference

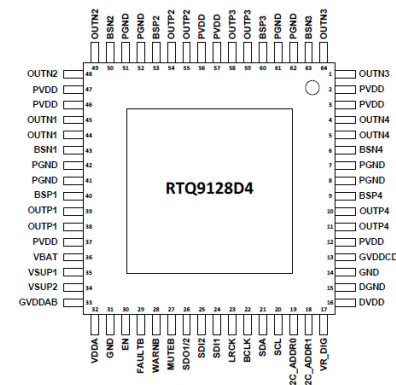


RTQ9128 Automotive Audio Amplifier with I2C Diagnostics

• Features

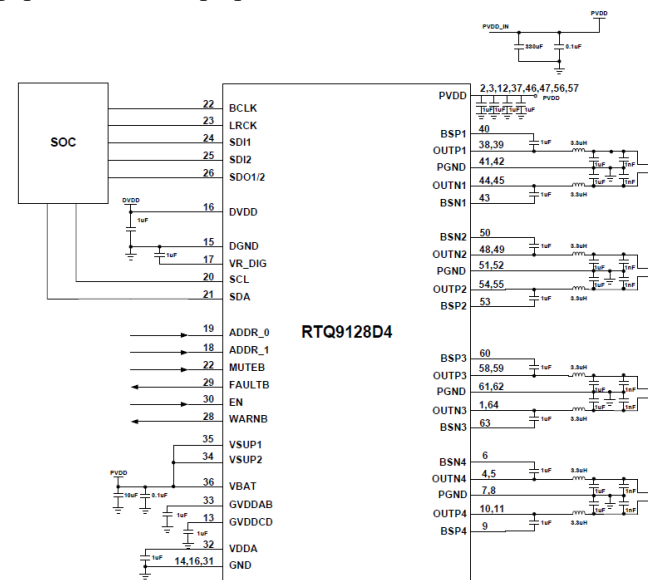
- AEC-Q100 qualified
- **I2S and TDM** input
- 4x22W, THD+N=1%, 4ohm , 14.4V
- 4x27W, THD+N=10%, 4ohm, 14.4V
- 4x45W, THD+N=10%, 2ohm, 14.4V
- 4x75W, THD+N=10%, 4ohm, 25 25V
- THD+N is **0.02%**, SNR up to **116 dB**, Ultra-Low noise = **18 uV**
- Low Rds-on (80 mΩ)
- **Switching** frequency up to **2.1 MHz**
- **Sampling** Frequency from **32kHz to 192kHz**
- I2C Control with 16 address options
- Built-In Anti-Pop Function, thermal fold-back and clip detection
- Load Diagnostics
 - Output Open and Shorted load
 - Output-to-Battery or Ground Shorts
 - DC and AC coupled load detection
- Protection Features
 - Output short-circuit protection
 - Over-voltage and Under-voltage
 - Output Current Limit and protection
 - Over-temperature
 - DC Offset
 - **40V Load Dump**
- RoHS Compliant and Halogen Free

• Pin Configurations



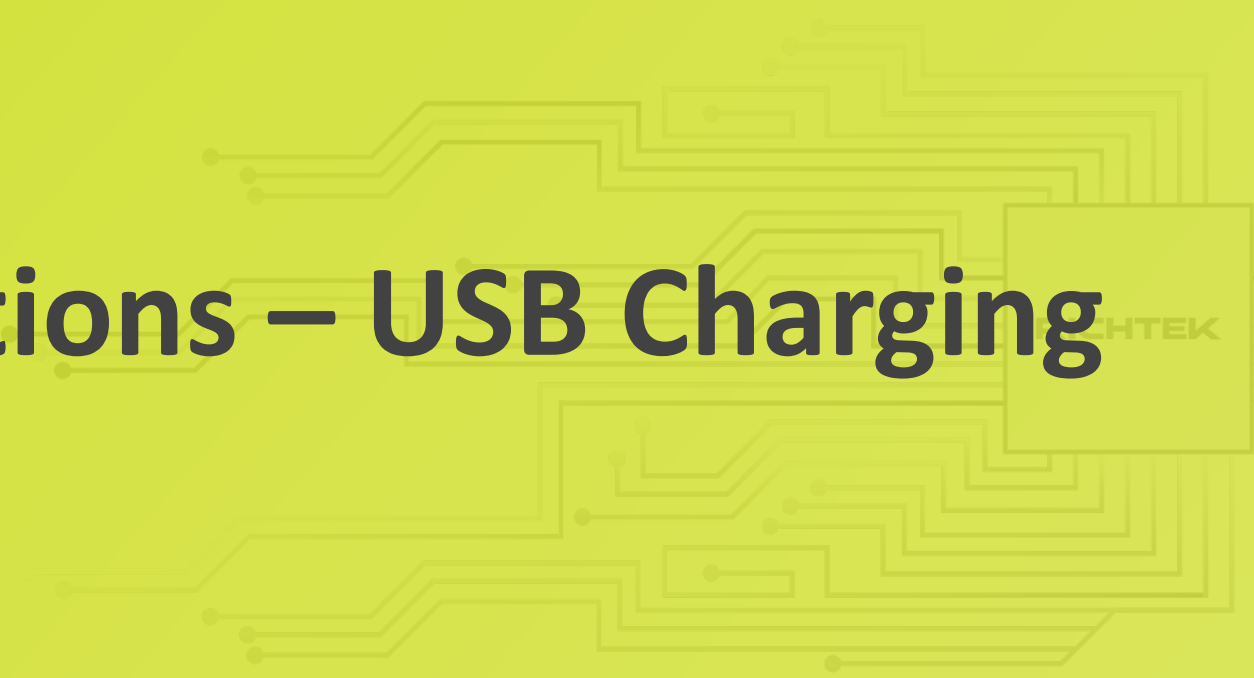
LQFP-64L 10x10

• Typical Application Circuit

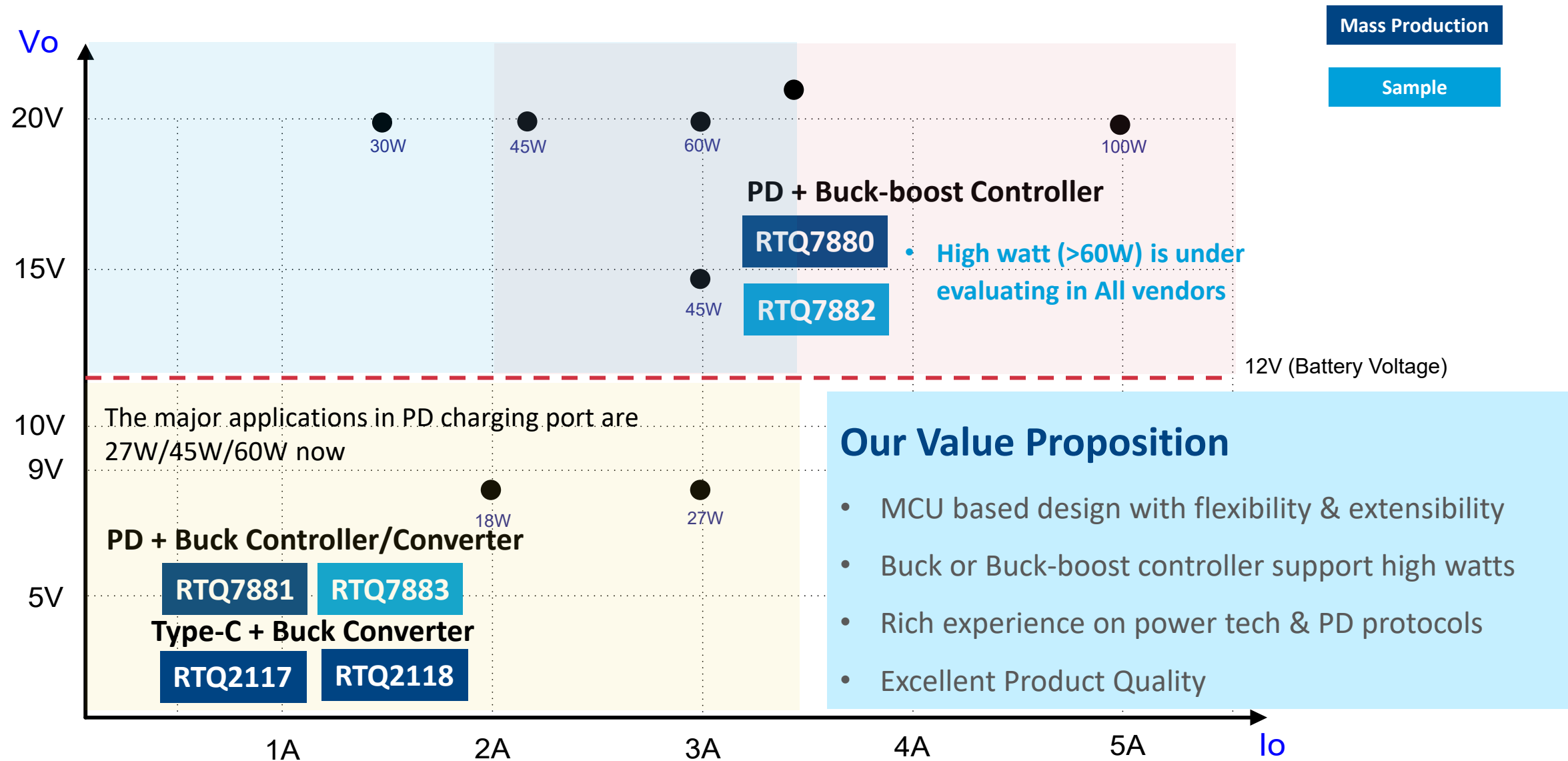


ES Available

Digital Cockpit Solutions – USB Charging



Power Map of Automotive PD Charging Port



Automotive USB Charging Solutions

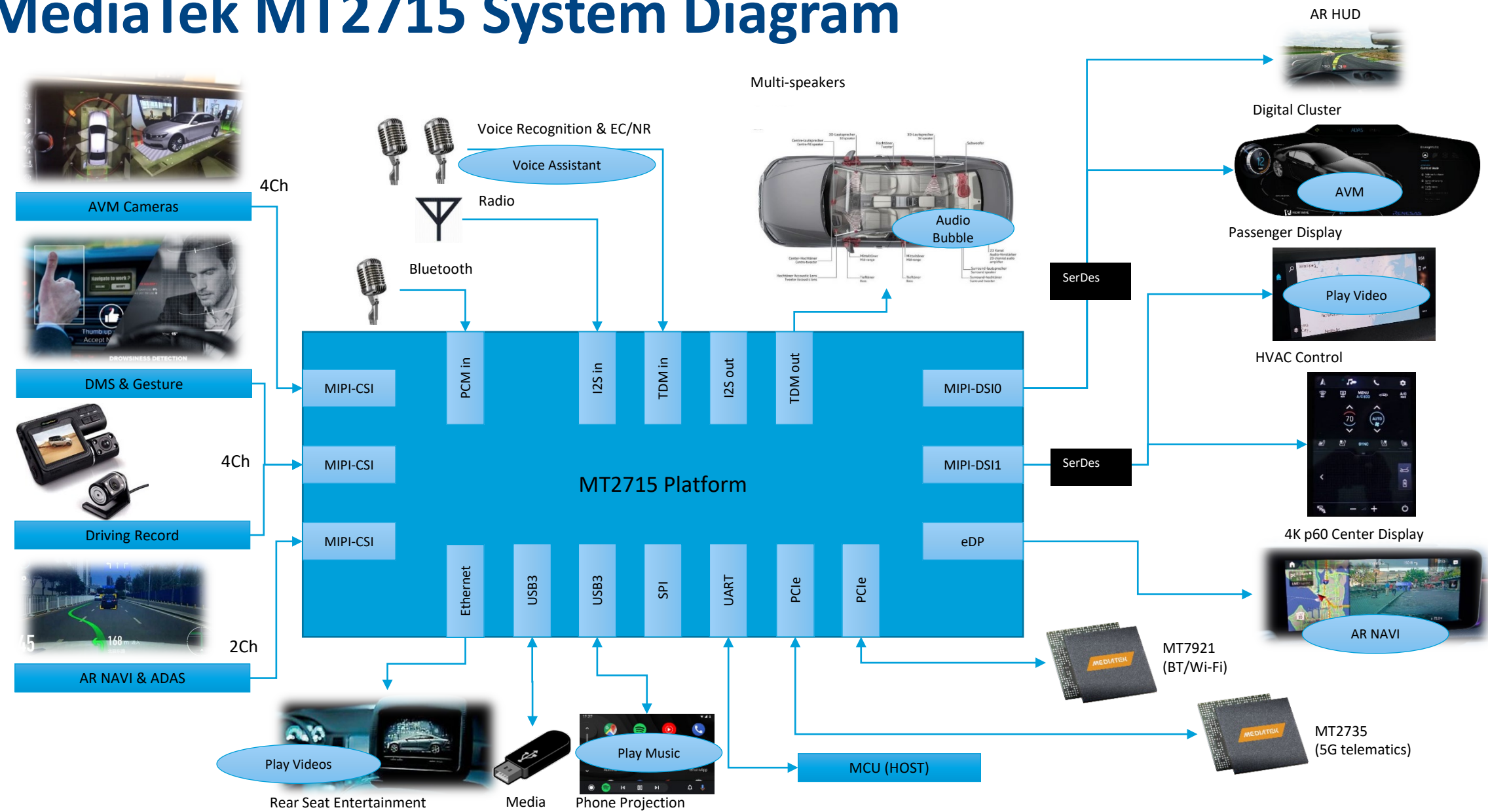
● MP ● Sample

	~ 2020	2021	2022 ~
USB PD & Buck-boost Combo Solution	RTQ7880 USB PD & Buck-Boost Combo Controller PD 3.0 + PPS / BC1.2 / QC2.0 / QC3.0 16k MTP + 16K ROM Wettable Flank	RTQ7880A USB PD & Buck-Boost Combo Controller PD 3.0 + PPS / BC1.2 / QC2.0 / QC3.0 16k MTP + 16K ROM Non-Wettable Flank	RTQ7882 USB PD & Buck-Boost Combo Controller Gen 2 All Protocols & UFCS Ready 20 parts less 32K ROM + 32K MTP
USB PD & Buck Combo Solution	RTQ7881 USB PD & Buck Combo Controller PD 3.0 + PPS / BC1.2 / QC2.0 / QC3.0 16k MTP + 16K ROM Wettable Flank	RTQ7881A USB PD & Buck Combo Controller PD 3.0 + PPS / BC1.2 / QC2.0 / QC3.0 16k MTP + 16K ROM Non-Wettable Flank	RTQ7883 USB PD & Buck Converter All-in One Converter All Protocols & UFCS Ready
Type-C & Buck Combo Solution	RTQ2118A/C USB-C & Buck Combo Controller Type-C Buck Converter with DCP USB2.0 data switch, Cable compensation, Spread spectrum	RTQ2117A/C USB-C & Buck Combo Controller Type-C Buck Converter with CDP/DCP USB2.0 data switch, Cable compensation, Spread spectrum	

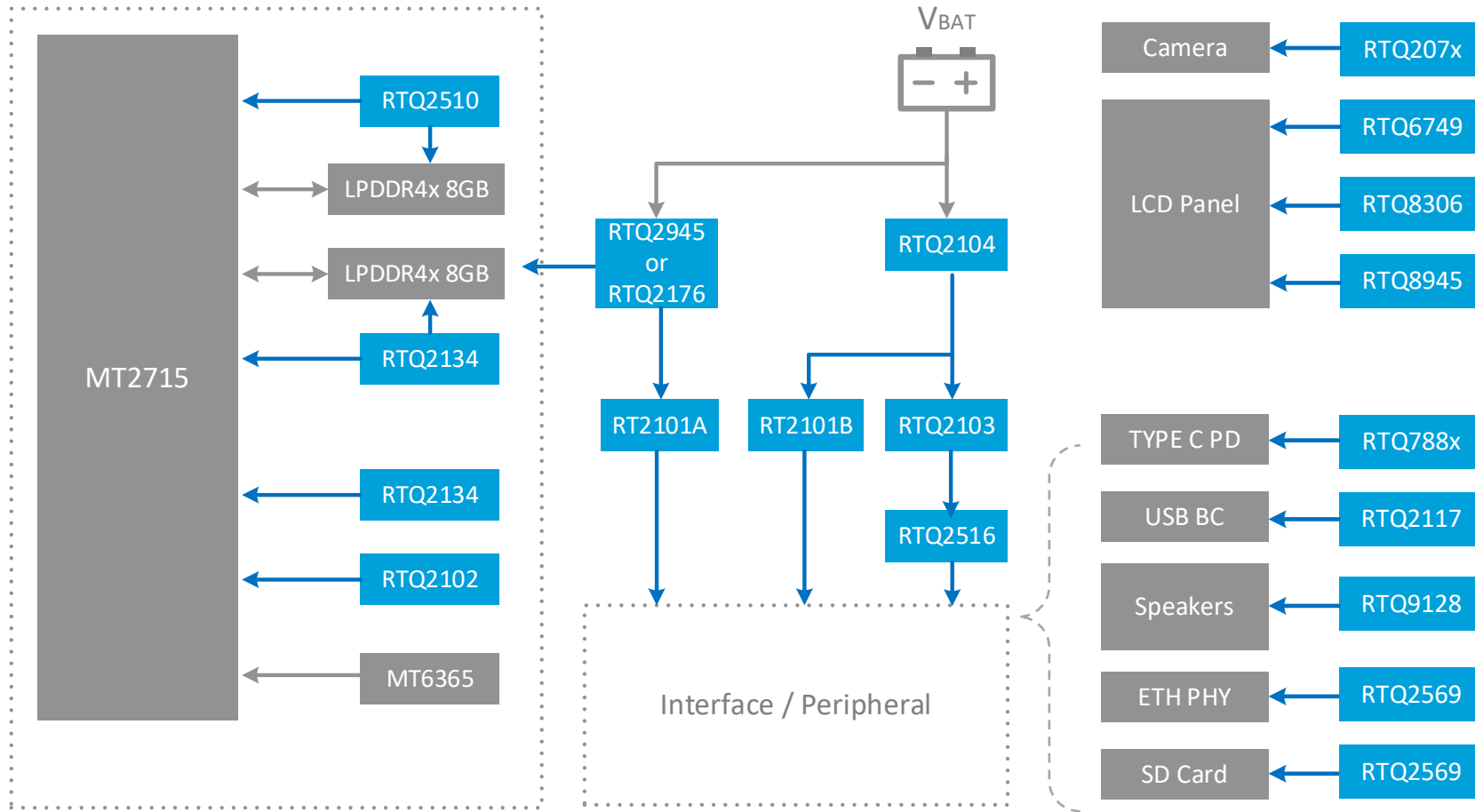
Digital Cockpit Solutions – IVI

A decorative graphic on the right side of the slide, featuring a complex circuit board pattern with various lines, dots, and a central square component labeled 'RICHTEK'.

MediaTek MT2715 System Diagram



Total Solution for IVI using MT2715 Platform



MT2715 CPU Module

- Camera Solutions**
 - PMIC: RTQ2071, RTQ2078, RTQ2079

- Display Solutions**
 - Display PMIC: RTQ6749
 - WLED Driver: RTQ4546, RTQ8306
 - Level Shifter: RTQ8945

- USB Charging Solutions**
 - USB PD: RTQ7880, RTQ7882
 - USB BC: RTQ2117

- Audio Solutions**
 - Class-D Amp: RTQ9128

- Discrete Solutions**
 - HV Buck: RTQ2945, RTQ2176
 - LV Buck: RT2101B, RTQ2102, RTQ2103
 - LDO: RTQ2569, RTQ2510, RTQ2516

- IVI SoC Power**
 - RTQ2134

Automotive LED Driver solution

Will Wang

March, 2023

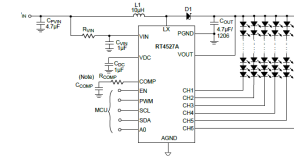
Richtek Display Product Lines

Display PMIC

- OLED/LCD TV
- Monitor
- OLED/LCD MPC
- Automotive Display



LED Driver



WLED Driver

- NB/MNT BLU
- Tablet BLU
- Automotive BLU
- Mini LED

Display PMIC



OLED EL Power

OLED EL Power

- Watch
- Mobile
- Tablet



Automotive LED Driver Product Roadmap

● MP ● ES

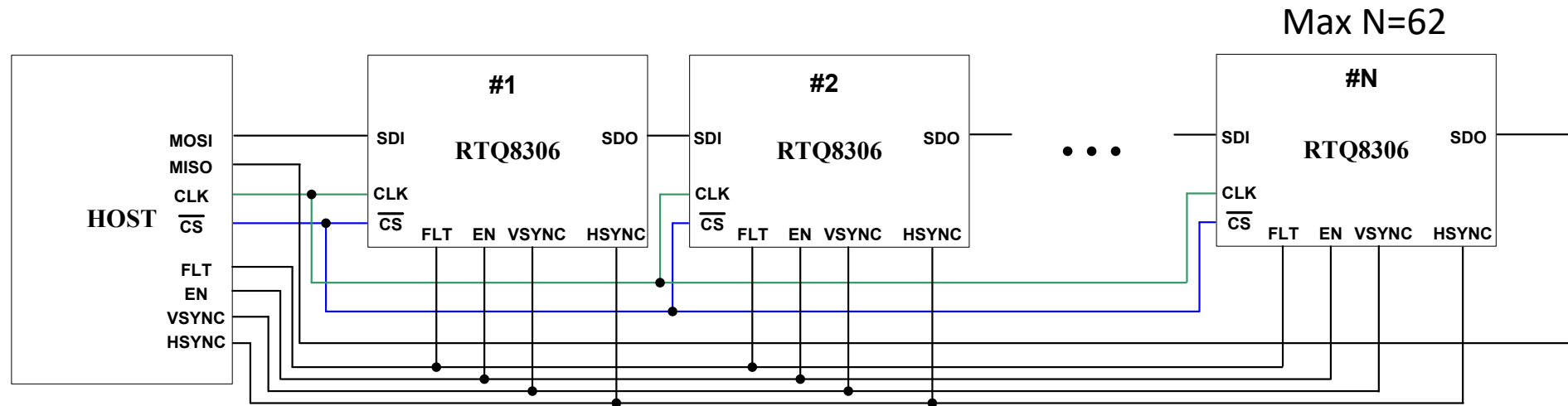
	~2022	2023
Global Dimming		RTQ4546/7 6ch scan 200mA/ch VLED max 45V ASIL-B feature PWM/DC/MIX/Exp I²C QFN4x4, VDFN 9.8x6.4
Local Dimming	RTQ8306 36ch +4 scan 60mA/ch VLED max 24V Local dimming with SPI 144 zones/IC Wettable QFN7-7 56L	

AECQ100 by Apr,23

RTQ8306 Device Address Explanation

Q: At connection by the daisy chain, how will it be identified by the device [5:0] ?

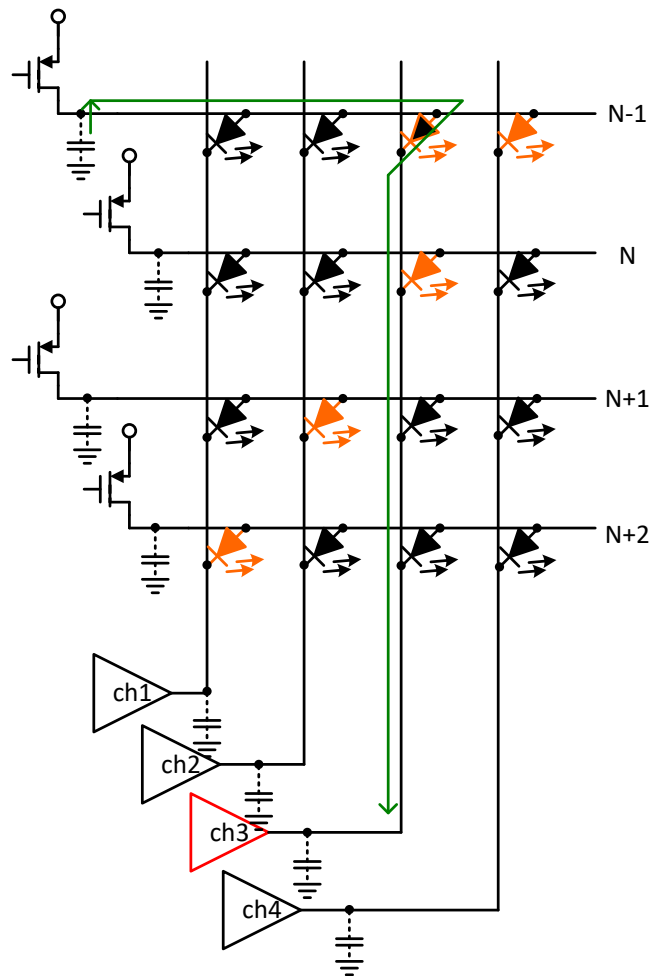
The devices #1 to #62 are marked based on the daisy chain structure: #1 is the device 1 and so on. No need extra setting for device number definition.



- Ghosting Issue

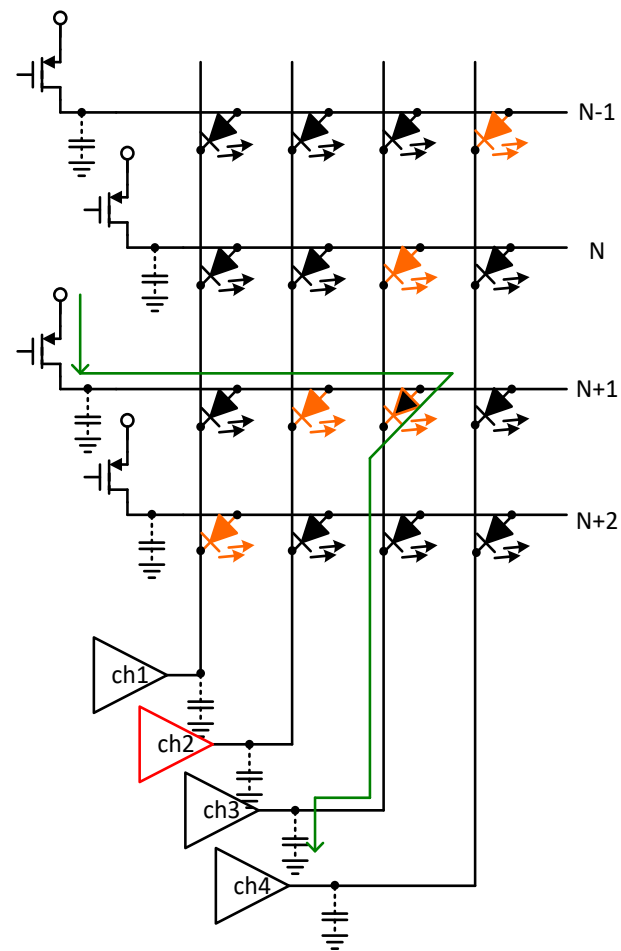
Ghosting Issue : N-1 LED slight

Solution: **VLED Discharge Function**



Ghosting Issue: N+1 LED slight

Solution: **Channel Pre-charge Function**

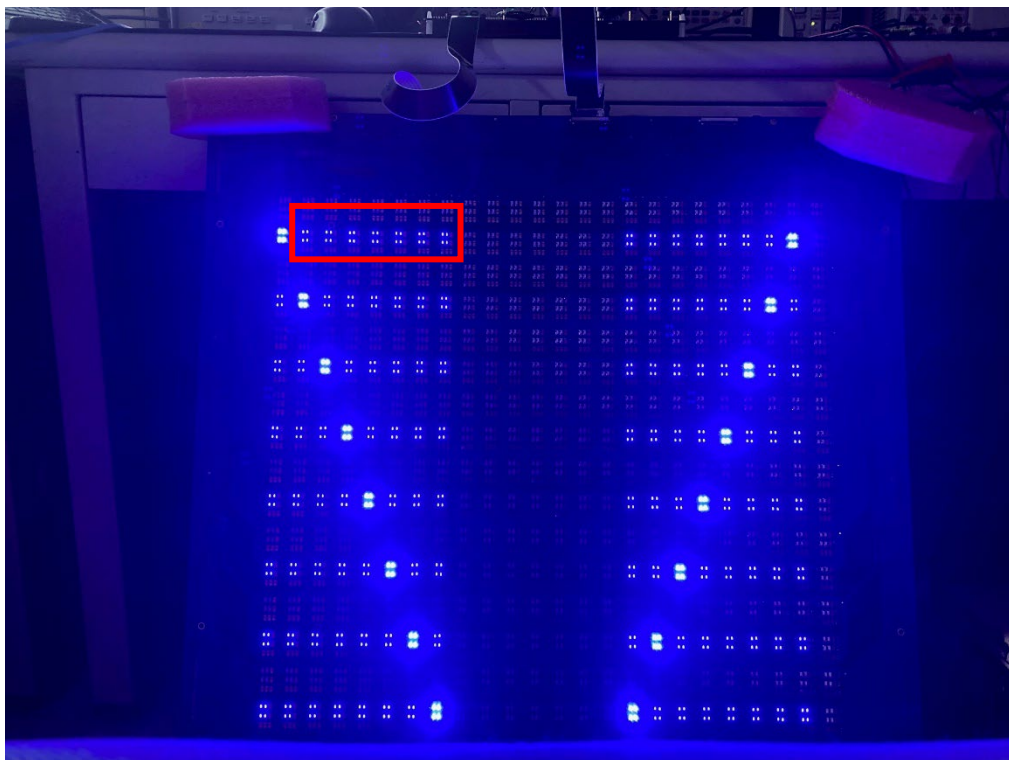


- Ghosting Cancellation

Ghosting Effect

Discharge: off

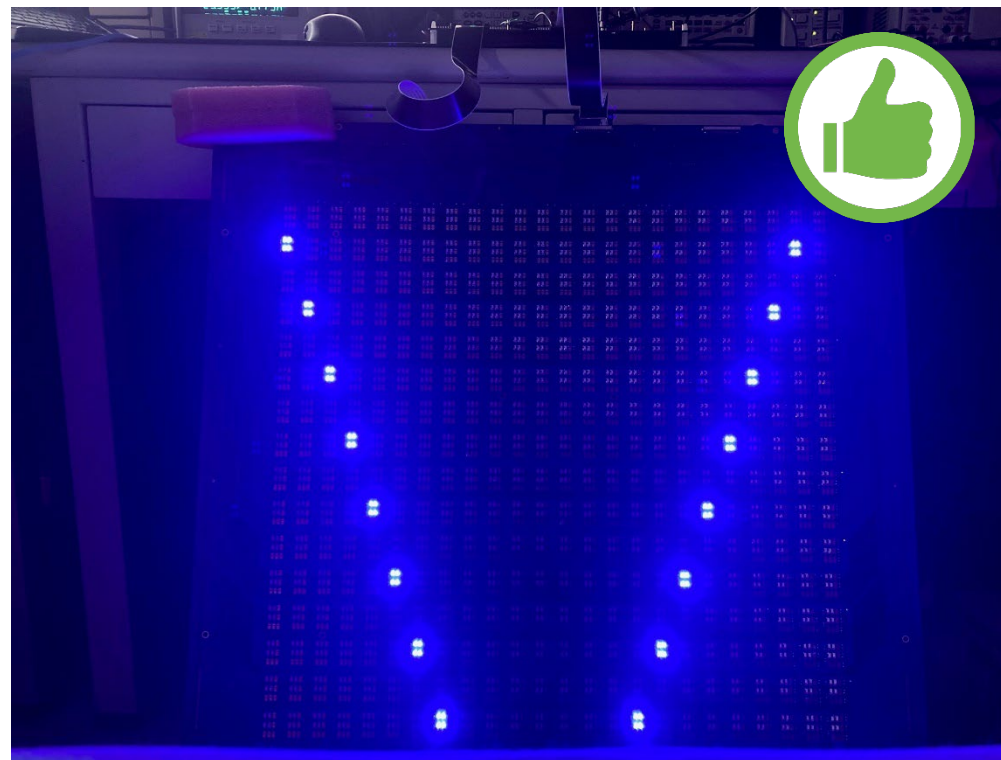
Pre-charge: off



Ghosting Cancellation

Discharge: on

Pre-charge: on



- Advantages of choosing Richtek automotive LED solutions

Cost-effective

Better EMI

Good thermal
performance

Supported by
multiple Tcon

Richtek Automotive Selection Guide

Driving the future of automotive systems.
Starts here.



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Richtek Technology Corporation

Buck Converters

LV Buck Converters: Vin up to 6.5V

AEC-Q100	Part Number	Vin	Vout	Iout	Freq	Ron	Iq
		min (V)					
Grade 1	RTQ2102A-QA	3					
Grade 1	RTQ2103A-QA	3					
Grade 2	RT2101B	2.95					
Grade 2	RT2101A	2.95					
Grade 1	RTQ2158-QA	2.85					
Grade 1	RTQ2159-QA	2.85					

PMICs

AEC-Q100	Part Number	Description	Vin Range (V)	Reg
Grade 2	RTQ6513-QT	10-Bit Program TFT-LCD Panel		
Grade 2	RTQ6749-QT-A2	TFT LCD Integ Automotive Inf		
Grade 2	RTQ6752-QT	TFT LCD Integ Automotive Inf		
Grade 2	RTQ6801-QT	Boost Convert and High Curr		
Grade 2	RTQ8306-QT	36-Channel C Dimming Appl		
Grade 2	RTQ7880A-QT			
Grade 2	RTQ7881A-QT			
Grade 2	RTQ7882-QT			

USB Type-C PD and PWM Controllers with AnyPower™ PD Safe® Features

AnyPower™: Constant Voltage Output in 9-Bit Resolution.
PD Safe®: Adjustable Converter In Adjustable External OT

AEC-Q100	Part number
Grade 2	RTQ7880A-QT
Grade 2	RTQ7881A-QT
Grade 2	RTQ7882-QT

* All listed specifications and features may vary at our sales offices close to you.

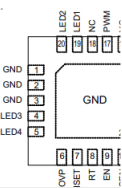
Featured Products

RT8577A High Voltage 4-CH LED Driver

AEC-Q100 Grade 3 Certification

- Key Features**
- Wide Input Supply Voltage Range: 5.5V to 40V
 - Adjustable Boost Controller Switching Frequency from 200kHz to 2.1MHz
 - Programmable Channel Current
 - Channel Current Matching: $\pm 1.5\%$
 - External Dimming Control
 - Boost MOSFET Over Current Protection
 - Automatic LED Open/Short Protection to Avoid Output Over Voltage
 - VCC Under-Voltage Lockout
 - Adjustable Soft-Start Rate

Pin Configurations



Thank You



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