

Digital Audio Signal

Johnson WANG

12 December 2025

DAS products and market segments

Audio Power amplifiers

Class D/Class AB - analog and digital input



Smart Cockpit & Head Units



High-end / Branded sound systems

Positioning

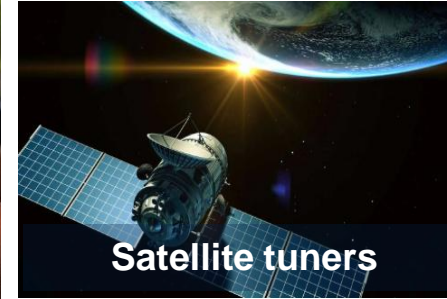
GNSS chips and modules



Automotive In-vehicle systems, ADAS and AD

Radio

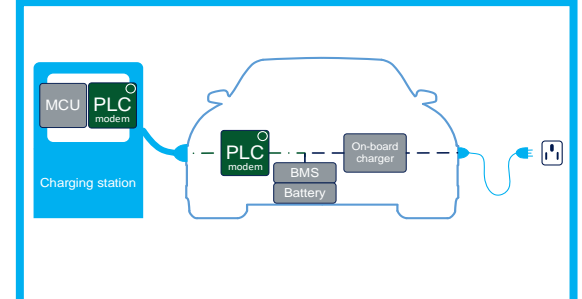
Satellite and Terrestrial



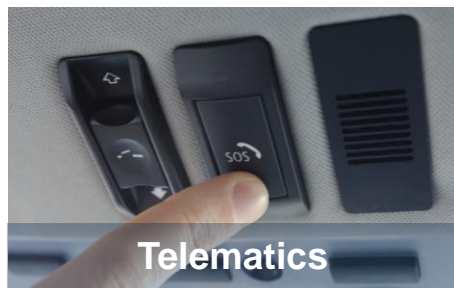
Satellite tuners

PLC

Analog/Digital ASSP



EV sound and AVAS



Telematics



Industrial applications



Terrestrial tuners



Smart Charging

GNSS solutions



Why ST GNSS ?

Innovation, Quality, and Service



ST GNSS chipset innovation began in the 90's

- Firsts:
 - Teseo II Tri-Constellation (2011)
 - Teseo V Dual-Band (2020)
 - TeseoAPP ASIL-B (2020)
 - Teseo V MCM Tri-Band (2021)
- Teseo VI (2025) our 6th generation, bringing low-cost Quad-Band innovation

Automotive-grade solutions drives quality

- Our HW/FW solutions are designed to meet automotive's stringent requirements
- Extensive Automotive/Industrial design & application expertise

Service

- Superior world-wide technical marketing & application support
- **Mission statement:** provide high-quality, reliable GNSS solutions & support customers at the highest level to achieve success!

TeseoVI portfolio

Family	Part Numbers	Description	Form Factor
TeseoVI	STA8600A(S)	Single die Automotive Quad band GNSS receiver	QFN56 (7x7)
	Teseo-VIC6A	Automotive Quad band GNSS Module with 6-axis IMU	LCC24 (16x12)
TeseoVI+	STA8610A(S)	Automotive multi band RTK/PPP	BGA100 (8.5x8.5)
	Teseo-ELE6A	Automotive Multi band RTK/PPP Module with 6-axis IMU	LCC54 (17x22)
TeseoAPP2	STA9200MA	ASIL multi band GNSS precise measurement	QFN56 (7x7)



A: AEC-Q100 105°C
S: Secure option

Teseo GNSS modules and applications



Asset Tracking

Teseo-LIV3FL

Teseo-LIV3R

Teseo-LIV4F



Fleet Management

Teseo-VIC6A

Teseo-VIC3DA

Teseo-LIV4F

Teseo-LIV3FL



Automotive

Teseo-VIC6A

Teseo-VIC3DA



Smart lighting

Teseo-LIV3R

Teseo-LIV3F

Teseo-LIV3FL

Teseo GNSS modules and applications



Drone

Teseo-LIV3FL

Teseo-LIV3R

Teseo-LIV4F



Timing Infrastructure

Teseo-VIC6A

Teseo-LIV3FL

Teseo-LIV3F



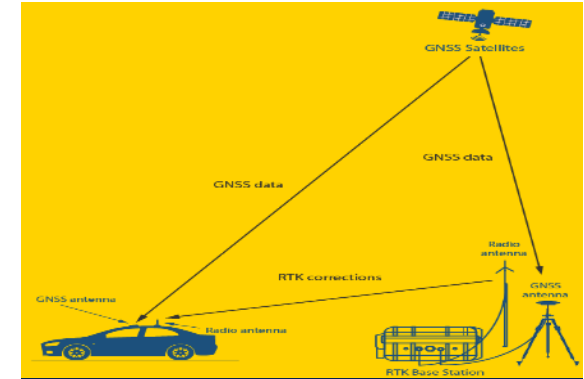
Marine

Teseo-VIC6A

Teseo-LIV4F

Teseo-LIV3FL

Teseo-LIV3F



RTK/PPP

Teseo-ELE6A

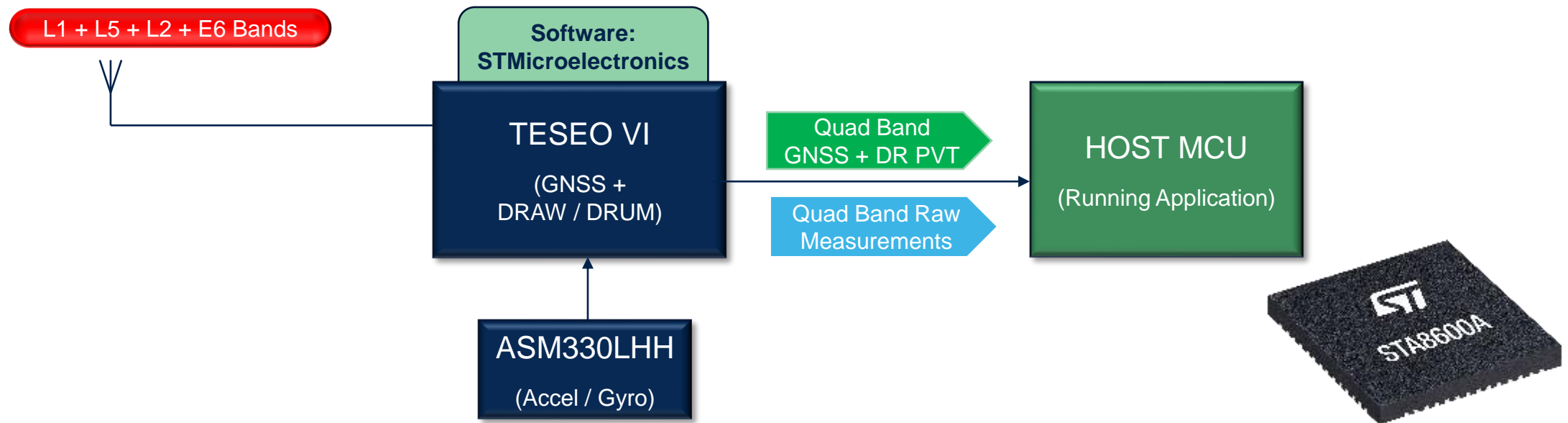
Teseo-VIC6A

Teseo-LIV4F

Teseo-LIV3FL



Teseo VI as SPP/Precise Positioning Engine



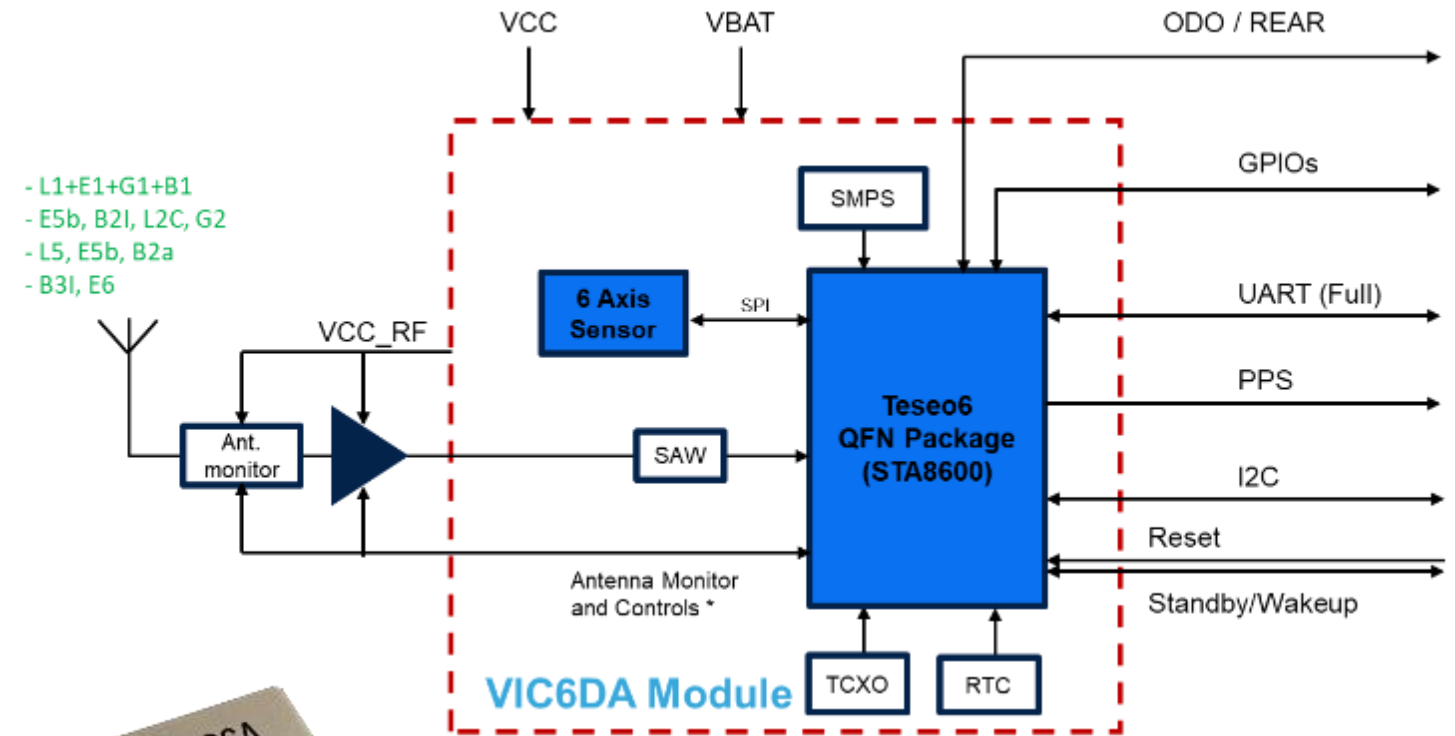
Teseo VI SPP leverages Quad Band to improve accuracy and satellite availability in all environments



TeseoVI VIC6A module

TeseoVI VIC6A Reference Schematic / BOM / Gerber Files available

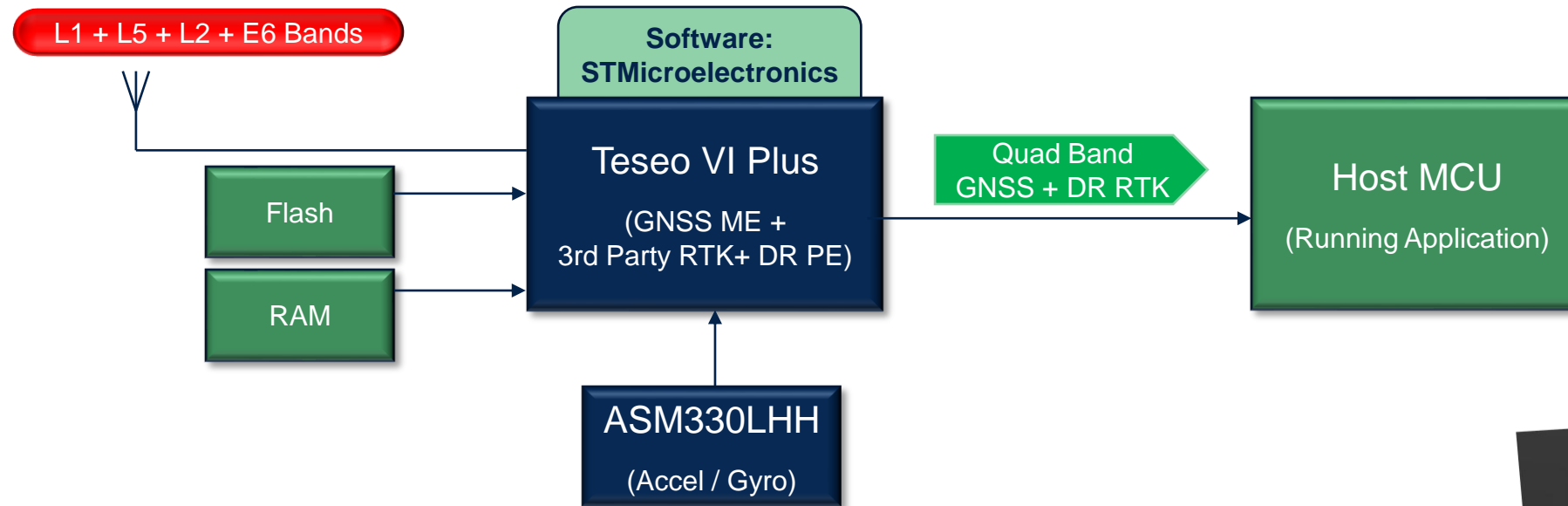
Module name	TESEO-VIC6A
Features	Quad band GNSS module
Teseo 6 IC/package	STA8600A QFN 7x7mm
Module pins and size	24 pins, 16x12.2mm
Supply voltage	3.3V VBAT and VCC
Core regulator	SMPS integrated inside the module
IMU (6-axys)/DR support	Yes/DRAW
SAW filter	Yes
External memory	No
Antenna monitoring	Yes (Antenna current measurement circuit must be implemented outside the module)
Temperature range	-40°C to +105°C





Teseo VI Plus as RTK Positioning Engine

Low-cost, high-quality, single-chip, quad-band RTK solution



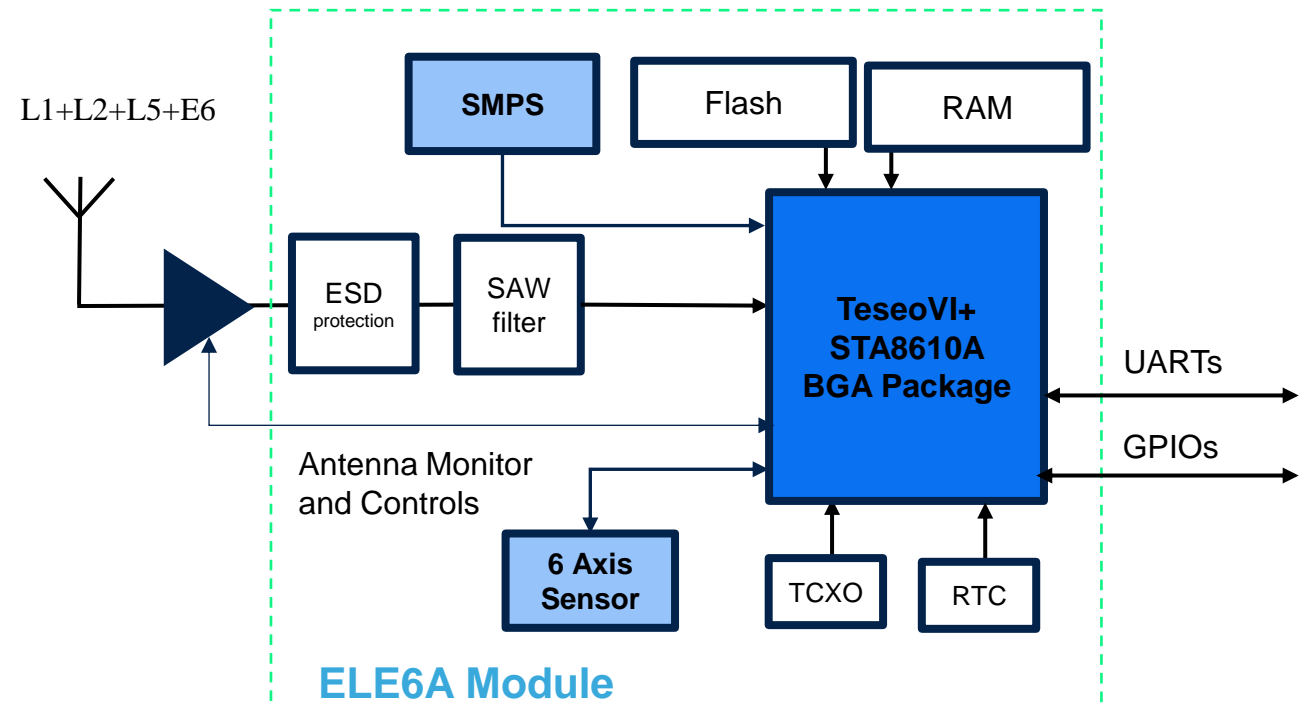
Ideal for automotive, robotics, drones, agricultural, and many other markets.



TeseoVI+ ELE6A module

TeseoVI+ ELE6A Reference Schematic / BOM / Gerber Files available

Module name	TESEO-ELE6A
Features	Quad band GNSS module
Teseo VI+ IC - package	STA8610A LFBGA100 8.5 × 8.5 × 1.4 mm 0.8 mm ball pitch
Module pins and size	54 pins, 17x22 mm
Supply voltage	3.3V VBAT and VCC
Core regulator	SMPS integrated inside the module
IMU (6-axys)/DR support	Yes/DRAW
SAW filter	Yes
External memory	Yes
Antenna monitoring	Yes
SW features	Measure, PVT and DR single Bin SDK offer to add RTK
Temperature range	-40°C to +105°C



Automotive Audio solutions

Power audio systems for automotive applications

Optional Sound System

FDAXXX HFDA80X TDA780X

- From 4 to 30 channels, class-D or class-AB

EV Sound & AVAS

FDA90X FDA803/903X HFDA80X

- Single or dual, low power, low space

Battery-operated applications

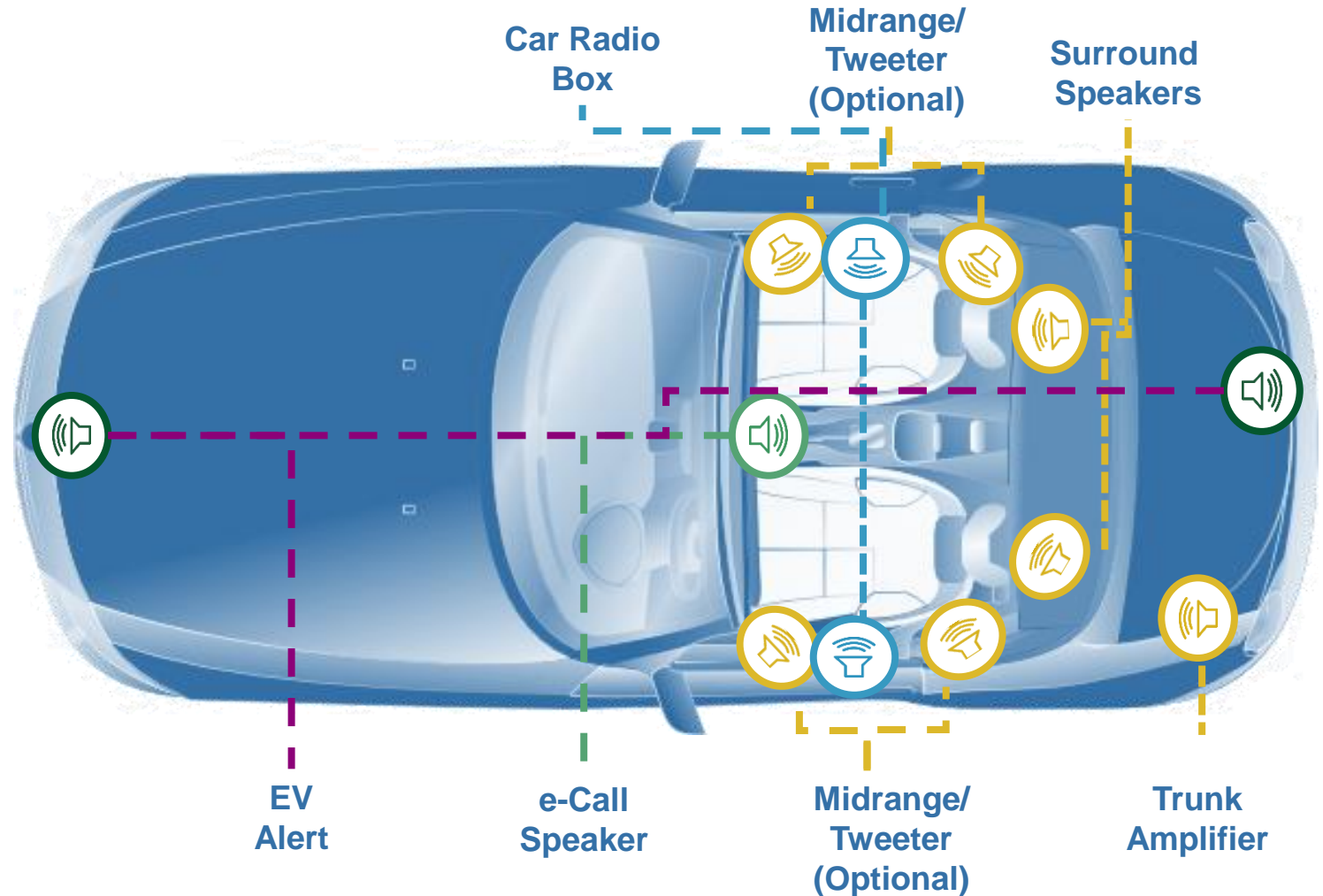
TDA780X TDA756X FDAXXX HFDA80X

- Head-units (4CH to 8CH) – OEM and AM
- E-cockpit smart cockpit
- Cluster audio channels
- Smart antenna

Telematics & e-Call

FDA803/903X

- Single or dual, low power, compact



Audio amplifier portfolio

Covering the full range of automotive applications

- 1-, 2-, and 4-channel audio solutions
- Wide voltage range
- Advanced diagnostics
- High efficiency
- Automotive grade
- Digital & analog input
- Extremely low noise
- Class D & Class AB
- Support for all automotive applications
- Pin to pin compatible families

Class D

Class AB

Head units, clusters, & cockpits

TDA780X

4-ch -18 V
Fully digital
High efficiency

TDA756X

4-ch -18 V
Analog input
High efficiency

HFDA8/90D/P 2MHz

4-ch - 18 V
2 MHz PWM
High efficiency low system cost

HFA80A 2MHz

4-ch - 18 V
2 MHz PWM
Analog input
High efficiency low system cost

TDA7901

4-ch -18 V
Load current monitor
Class G - HD ready

High-end sound systems

FDA801/B

4-ch - 25 V
>90% efficiency
Full diagnostics

FDA802A/B

2-ch - 50 V
High power
Full diagnostics

FDA901

4-ch - 25 V
>90% efficiency
Load current monitor

FDA802P

2-ch - 40 V
High power
Full diagnostics

HFDA801A 2MHz

4-ch - 25 V
2 MHz PWM
HD ready

Telematics and AVAS

FDA803D/U

1-ch - 3-18 V
>90% efficiency
Full diagnostics in play

FDA903D/U

1-ch - 3-18 V
>90% efficiency
Load current monitor

FDA8/903s

1-ch - 3-18 V
10 W - full diagnostic
Load current monitor

HFDA802 2MHz

2-ch - 25 V
2 MHz PWM
HD ready



Audio amplifier portfolio

High-end, branded sound systems

- Outstanding audio performance ≥ 110 dB SNR
- High power/ high voltage
- Feedback after filter
- Advanced diagnostics
- Load current monitoring
- 400 kHz and 2 MHz options
- HD ready solutions



FDA802A/B 2-ch digital input 5.5 to 50 V, Power limiting Full diagnostics DIM (AB version)	FDA802P/B 2-ch digital input 5.5 to 40 V, Power limiting Full diagnostics DIM (PB version)	HFDA802 2-ch - 25 V 80 W 2 MHz PWM HD ready
FDA801/B 4-ch digital input 6 to 25 V Efficiency > 90% DIM (B version)	FDA901 4-ch digital input 6 to 25 V Load current monitor, Efficiency > 90%	HFDA801A 4-ch - 25 V 80 W 2 MHz PWM HD ready

Class D

Mass production

Audio amplifier portfolio

Head units and entry-level sound systems

- Analog and digital
- High robustness
- High efficiency
- Low system cost
- Widest portfolio
- 2- and 4-channel devices
- Automotive EMC compliancy
- New: Class G and Class D

<p>TDA75610s/EP</p> <p>4-ch 45 W High efficiency start stop, I2C diagnostics analog input</p>	<p>TDA7803A</p> <p>4-ch 45 W Digital input, Improved High efficiency start stop and I2C diagnostics</p>	<p>TDA7901</p> <p>4-ch 43 W Digital input, 4.5-18 V Class G efficiency Load current monitor & HD ready</p>	<p>HFDA8/9D/P ^{2MHz}</p> <p>4-ch - 18 V 2 MHz PWM High efficiency low system cost Digital input Parallel mode (P version) Load current monitor (9 version)</p>
<p>STPA003/8</p> <p>4-ch 45/50W start stop, analog input</p>	<p>TDA75616/EP</p> <p>4-ch 45 W High efficiency start stop, I2C diagnostics analog input</p>	<p>TDA7808</p> <p>4-ch Digital input, Improved High efficiency start stop</p>	<p>HFA80A ^{2MHz}</p> <p>4-ch - 18 V 2 MHz PWM High efficiency low system cost Analog input</p>

Class AB

Class D

Mass production

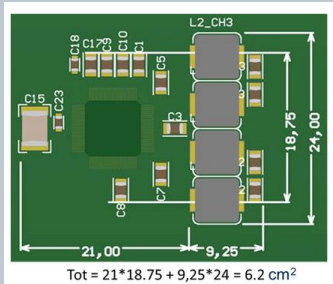


HFA80A HFDA80D HFDA80D2

The compact and efficient complete classD family

Easy and space saving “One-way input-output” PCB design solution

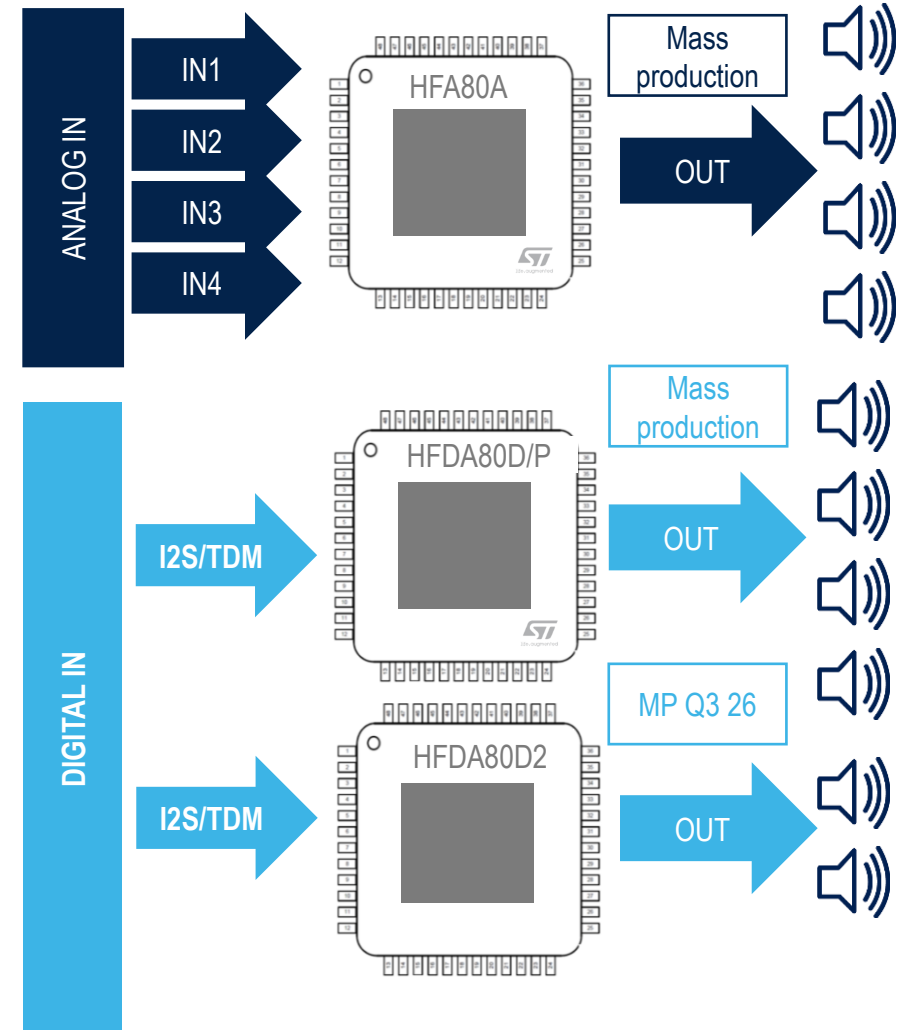
The HFDA80D/HFDA90D total space occupation 6.2cm² HFA80A Total space occupation is about 6.5cm²
 Pin to pin compatible analog digital 2Ch and 4CH
 Parallel mode HFDA80P available



HFDA80D Experimental PCB Layout example

BOM saving	
HFA80A vs Generic 2MHz PWM Class-D	-15%
HFDA80D/HFDA90D vs Generic 2MHz PWM Class-D	-15%
HFDA80D2/HFDA90D2 vs Generic 2MHz PWM Class-D	

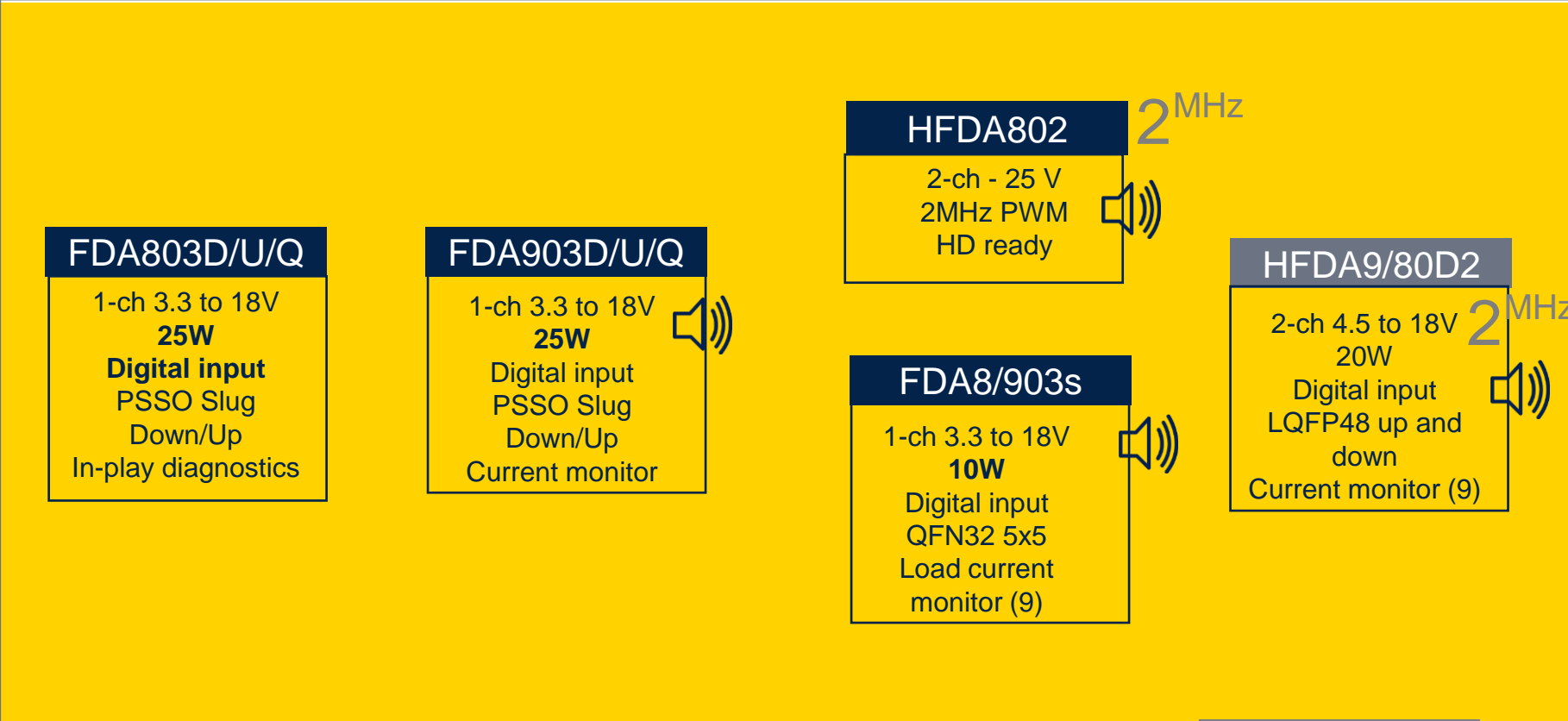
Output stage topology (CMOS): **No bootstrap capacitor**
 Selectable digital input voltage level: **No level shifter**
 High input resistance (HFA80A) : **small decoupling capacitors**



Audio amplifiers AVAS & telematics portfolio

Telematics, EV sound and accessories

- Full diagnostics
- Wide operating voltage
- High robustness
- In-play diagnostic
- Load current monitor
- Small size packaging
- Slug up and slug down



Class AB

Class D

Current monitor

Coming soon

Mass production




Development

Digital class AB Audio AMP – Class AB with High Efficiency


Performance

Integration and system miniaturization

>20Mu delivered to automotive customers

TDA7802 

Digital input
4Ch I2C DC and AC diagnostic
Improved high efficiency
105db SNR

TDA756xLV 

Analog input
4Ch and 2CH I2C diagnostic
High efficiency (up to 50% more efficient than AB)



TDA7803A 

I2S and TDM Digital input
4Ch I2C diagnostic
IMPROVED High efficiency

TDA7808

4CH Digital input
IMPROVED High efficiency

Up to **50% higher efficiency** than class AB
No additional BOM
High audio performance
No EMC interference

TDA7901  

Digital input
4Ch I2C diagnostic
IMPROVED High efficiency
ClassG and Load current monitor

ClassD like efficiency @1W
Diagnostic in play and continuous load current monitor

 Digital input

 Analog input

 Load Current monitor

BCD5 / BCD6

BCD8sA

Time



2013

2018

2022

Digital input, high-efficiency amplifiers

TDA7803A TDA7808

The most compact and efficient class AB

- 24-bit integrated DAC with I2S and TDM (8CH) input
- High-efficiency SBI mode up to 50% more efficient than other class AB
- No additional external components
- Full I2C diagnostics (DC and AC)
- 4 x 25 W on 4Ω @ 10% THD
- 2 and 1 Ω driving (parallel mode)
- 113 dB SNR
- No I2C pin-to-pin version (TDA7808)
- PowerSo36 slug up and Flexiwatt 27



TDA7901

The most efficient non class D amplifier

- 24-bit integrated DAC for I2S/TDM (16 channel) input
- High-efficiency SBI mode and integrated class G driver
- Full I2C diagnostics (DC and AC) and load current monitoring function
- 4 x 25 W on 4Ω @ 10% THD, 2 Ω driving
- 80 kHz bandwidth ready
- 115dB SNR
- PowerSo36 slug up



Easy EMC compliancy

Compact & low BOM

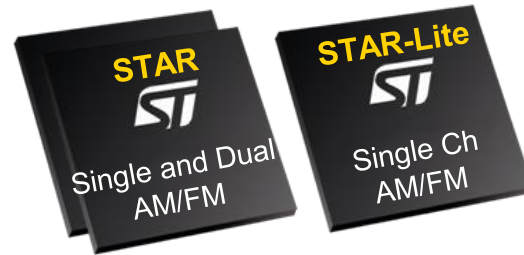
High audio performance

Tuner portfolio & roadmap

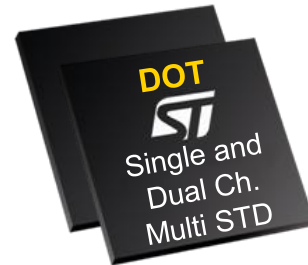


Terrestrial tuner roadmap

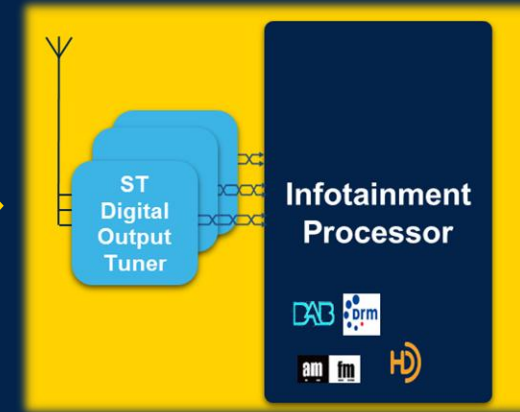
Integrated AM/FM
radio receiver



Multi-standard
Front-end

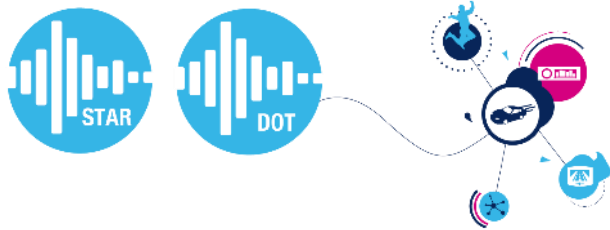


Transition to
software-defined
radio architectures



Digital
coprocessor





CMOS tuner family

ST advanced radio receiver (STAR)



- Dual channel
- AM / FM Phase Diversity integrated
- DAB / AM / FM IQ data output



- Single channel
- AM / FM integrated
- AM / FM IQ data output

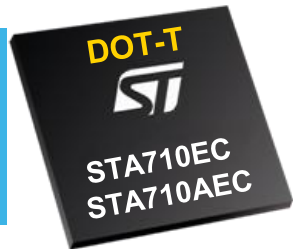


- Single channel
- AM / FM integrated
- Dedicated background only variant



Digital output tuners (DOT)

- Dual channel
- **STA710EC:** DAB / AM / FM IQ output
- **STA710AEC:** AM / FM IQ output



- Single channel
- **STA709:** DAB / AM / FM IQ data output
- **STA709A:** AM / FM IQ data output



- All variants are pin-to-pin and API compatible

STAR family product matrix

Feature		TDA7707	TDA7708	TDA7708LX	TDA7708L	TDA7708B
Reception	FM/MW/SW/LW audio	✓	✓	✓	✓	x
	FM phase diversity	✓	x	x	x	x
	Weather Band audio	✓	✓	x	x	x
	HD-radio/DRM single-channel	✓	✓	x	x	x
	HD-radio/DRM dual-channel	✓	x	x	x	x
	DAB single/dual-channel	✓	x	x	x	x
Interfaces	DAB baseband I/F	✓	x	x	x	x
	DRM/HD baseband I/F	✓	✓	x	x	x
	Audio I2S I/F	✓	✓	✓ (*)	✓ (*)	x
	DARC (VICS) out I/F	✓	✓	✓	x	✓
	SPI control I/F	✓	✓	✓ (**)	✓ (**)	x
Processing	VPA (phase diversity)	✓	x	x	x	x
	DANCE (channel equalizer)	✓	✓	✓	✓	x
	MMA (Multipath interference mitigation)	✓	✓	✓	x	x
	DNR (Dynamic Noise Reduction)(AM/FM)	✓	✓	✓	x	x
	RDS decoder	✓	✓	✓	✓	✓
	Enhanced RDS decoder	✓	✓	✓	x	✓
	SAME full band scan	✓	x	x	x	✓

(*) Audio I2S DIN not available

(**) Not available in 32-pin package version



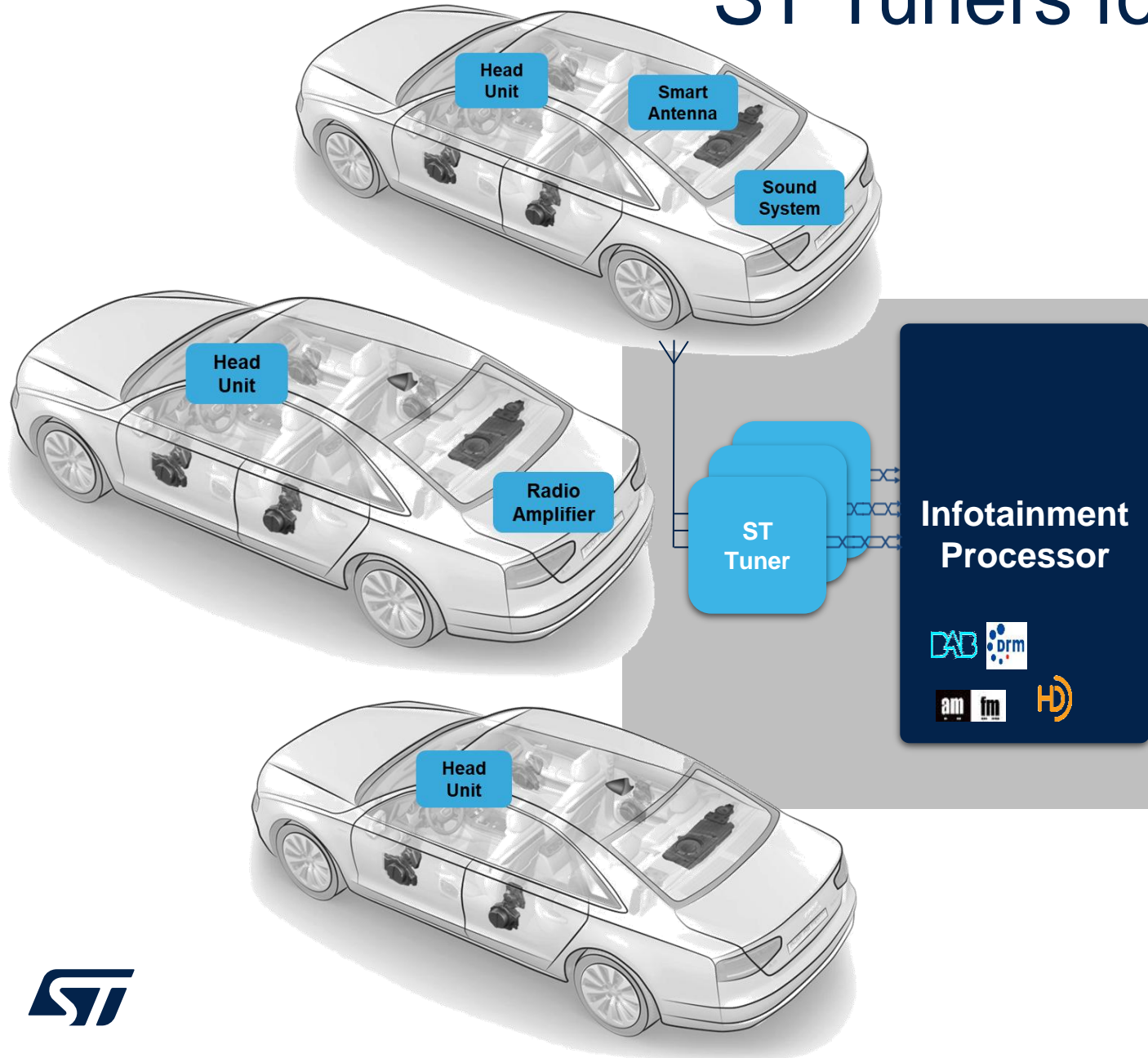
STAR family product matrix

Device	QFN 32-pin 6x6	QFN 52-pin 8x8	QFN 64-pin 9x9
TDA7707 - STAR-Double full feature	-	-	TDA7707EB
TDA7708 - STAR-Single full feature	-	TDA7708SCB	TDA7708CB
TDA7708LX - STAR-Lite full feature, no dig. BB I/F	TDA7708LX32	TDA7708LX52	TDA7708LX64
TDA7708L - STAR-Lite entry level	TDA7708L	TDA7708L52	-
Data Tuner	TDA7708B	-	-

Software-defined radio ecosystem



ST Tuners for software-defined radio



ST RF front-ends are compatible both with dedicated ST Processors and with **standard SOCs**, supporting centralized and remote architectures

Production has started and Development projects are active on multiple Infotainment Processor platforms

Qualcomm

SAMSUNG

TEXAS INSTRUMENTS



RENESAS

MEDIATEK

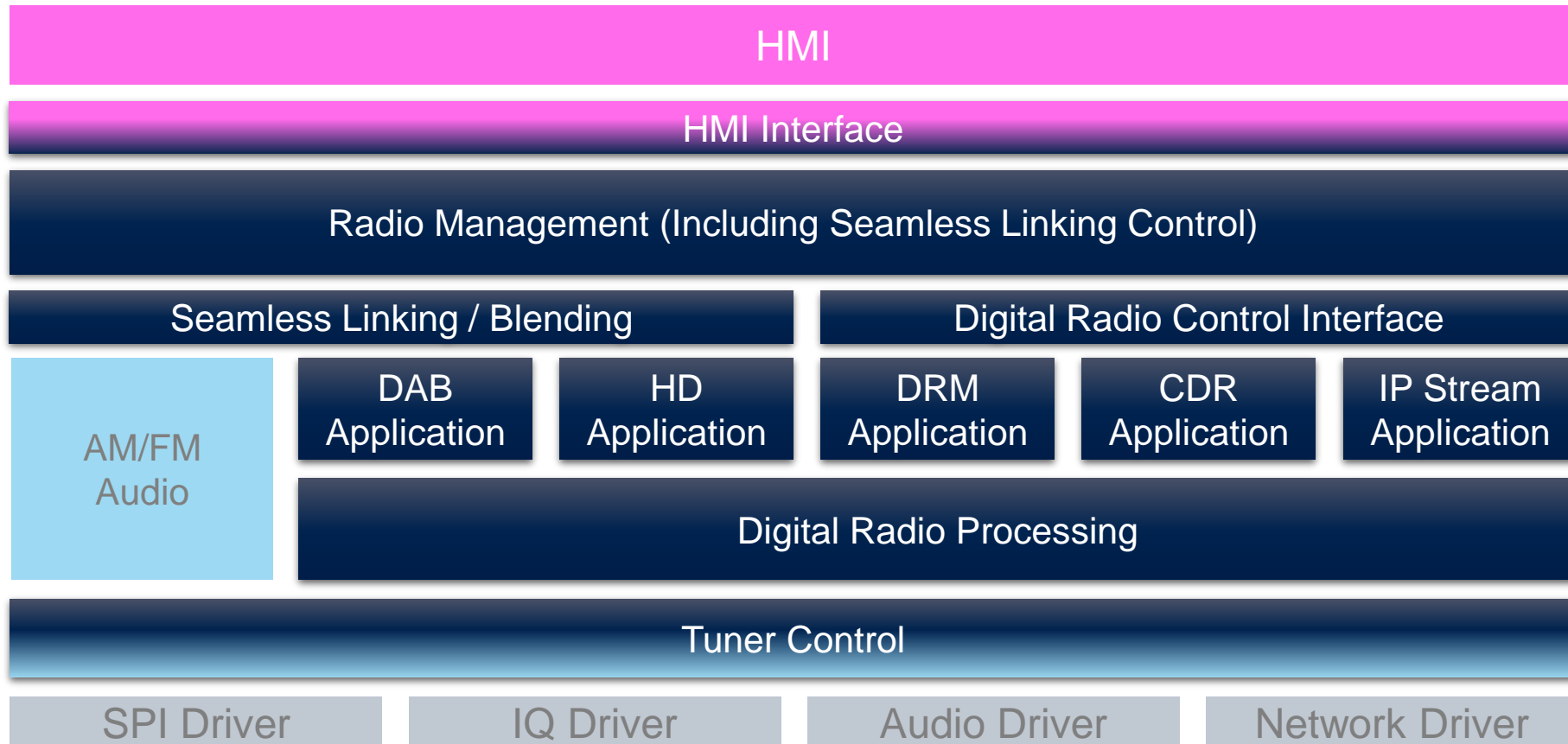
SDR partnership

ST has partnered with a world leading provider of Radio Solutions and Services and is engaged in multiple cooperation projects to develop, implement and promote SDR solutions based on major SOC platforms

 **RF2DIGITAL** is a member of ST Partner Program

Software Libraries/Components								Services		
	AM/FM	DAB	DRM	CDR	Tuner Drivers	Radio Ctrl	Audio Processing	Integration	Validation	Customer Support
	✓				✓			✓	✓	✓
		✓	✓	✓	✓	✓	✓	✓	✓	✓
SOC Vendors							✓		✓	✓

SW architecture

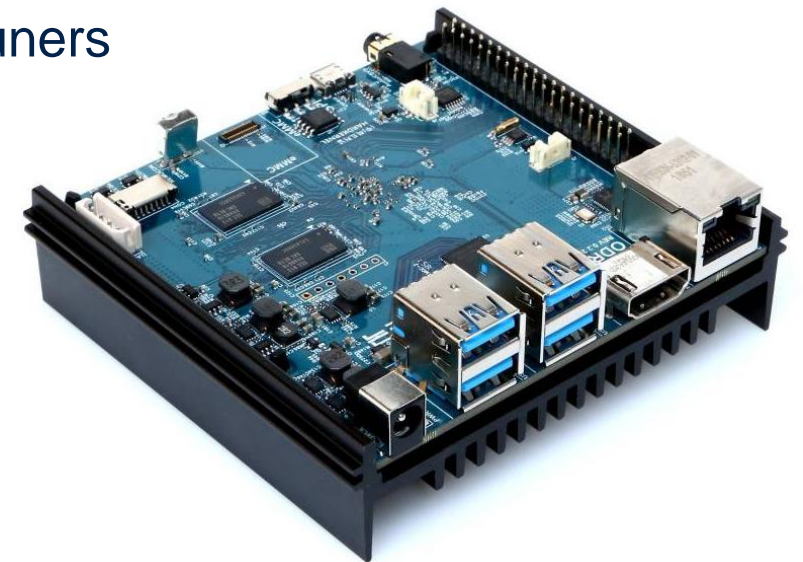
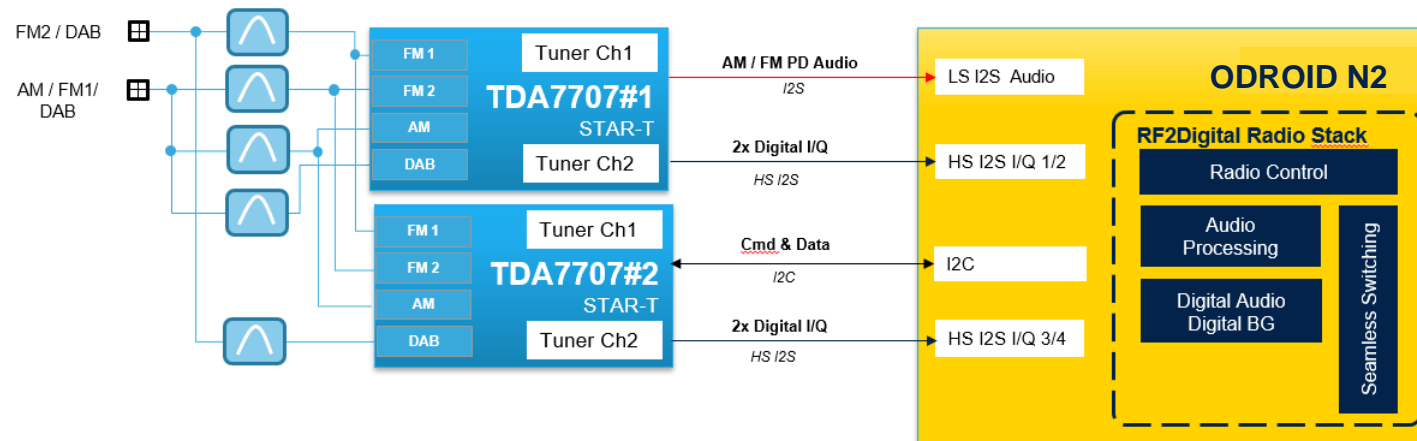


Tier1 SW Partner ST SoC

ST Tuner SDR Demo Kit

Common development with RF2Digital of an SDR demonstrator

- Based on standard Arm Cores
- Can support up to 4x high-speed I2S I/F for tuner
- Adapter Tuner Card for 4-channel use case with ST RF Tuners
- Rf2Digital SW stack with ST Tuner driver

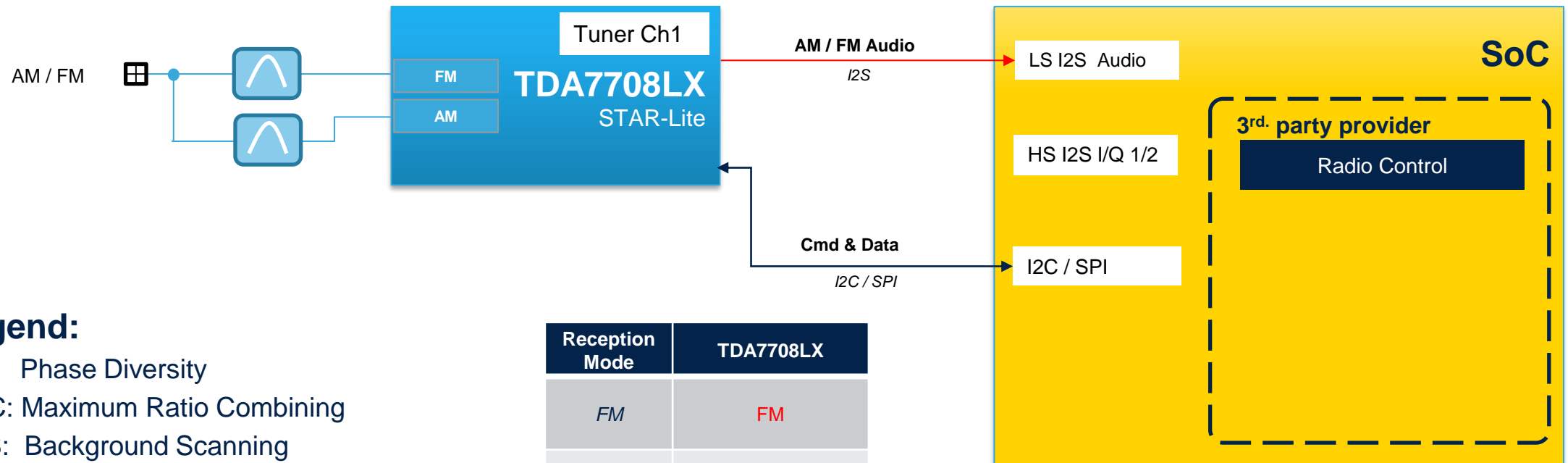




Hybrid SDR – Use Case Examples

Analog only – 1 Tuner channel

FM/AM Audio



Legend:

PD: Phase Diversity

MRC: Maximum Ratio Combining

BGS: Background Scanning

SSW: Seamless Service Switching

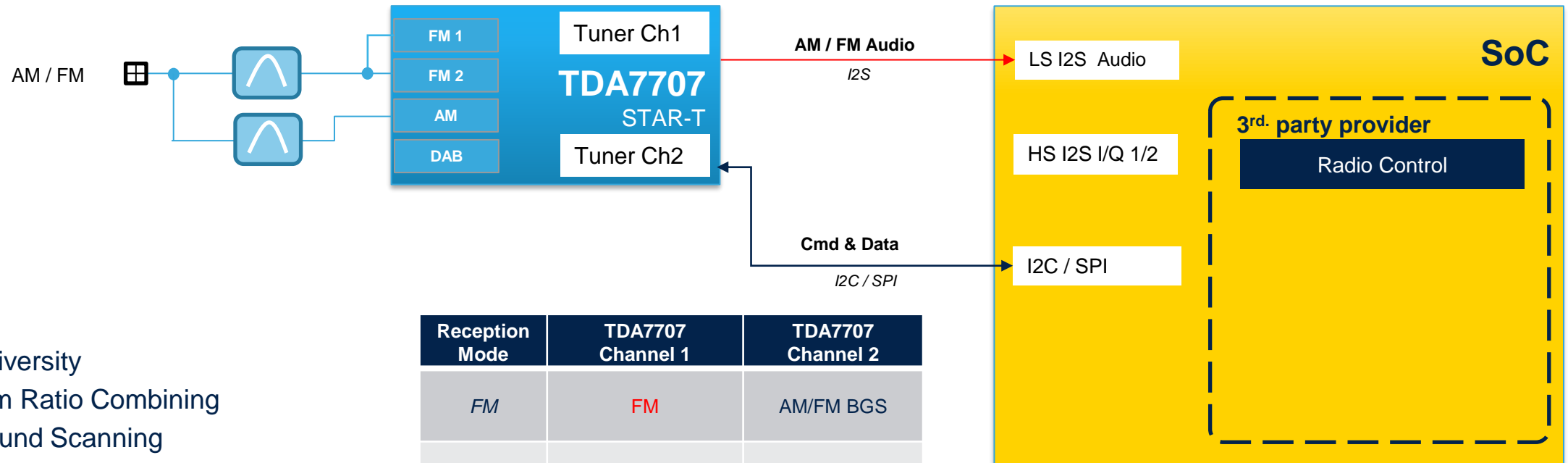
Red: Listening Channel

Reception Mode	TDA7708LX
FM	FM
AM	AM

Marked in red: Listening Channel

Analog only – 2 Tuner channel

FM/AM Audio + FM/AM BGS



Legend:

PD: Phase Diversity

MRC: Maximum Ratio Combining

BGS: Background Scanning

SSW: Seamless Service Switching

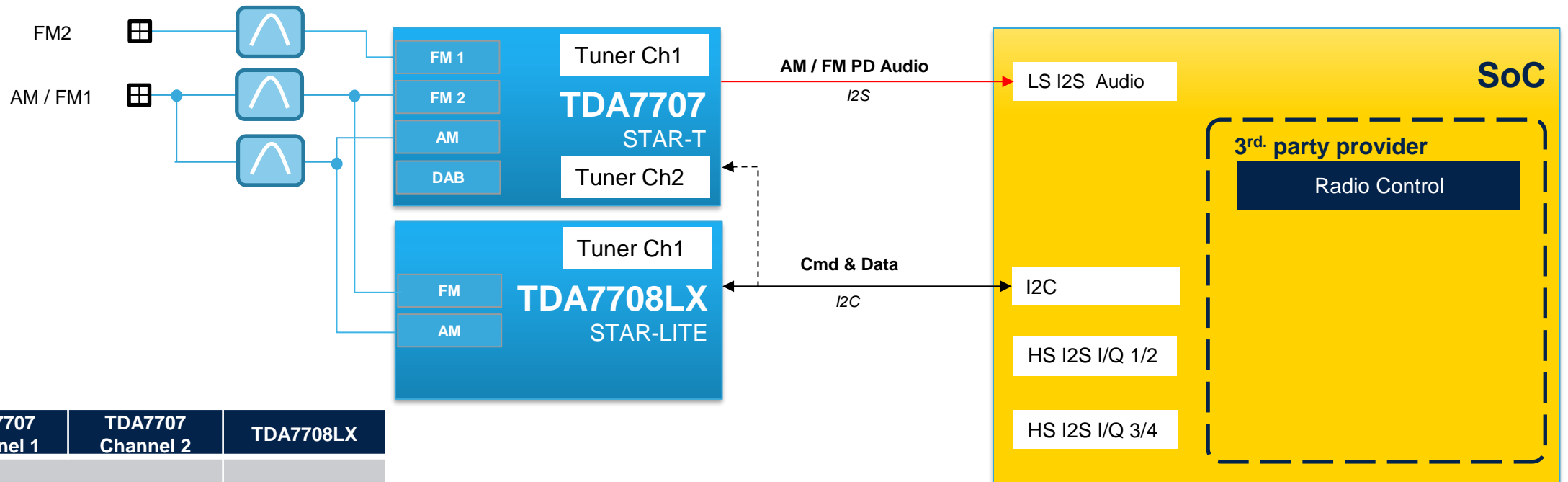
Red: Listening Channel

Reception Mode	TDA7707 Channel 1	TDA7707 Channel 2
FM	FM	AM/FM BGS
AM	AM	AM/FM BGS

Marked in red: Listening Channel

Analog only – 3 Tuner channel

FM-PD/AM Audio + FM/AM BGS

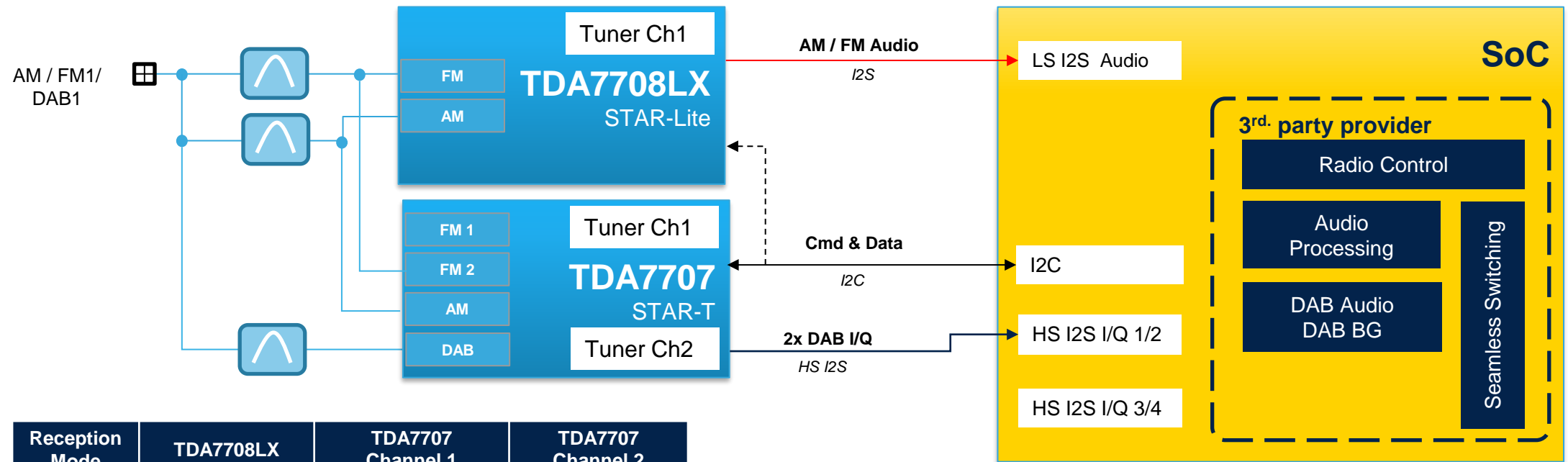


Reception Mode	TDA7707 Channel 1	TDA7707 Channel 2	TDA7708LX
FM	FM PD		AM / FM BGS
AM	AM	Unused	AM / FM BGS

Marked in red: Listening Channel

EU – DAB: 3 Tuner channel

FM/AM Audio + DAB Audio + FM/AM/DAB BGS

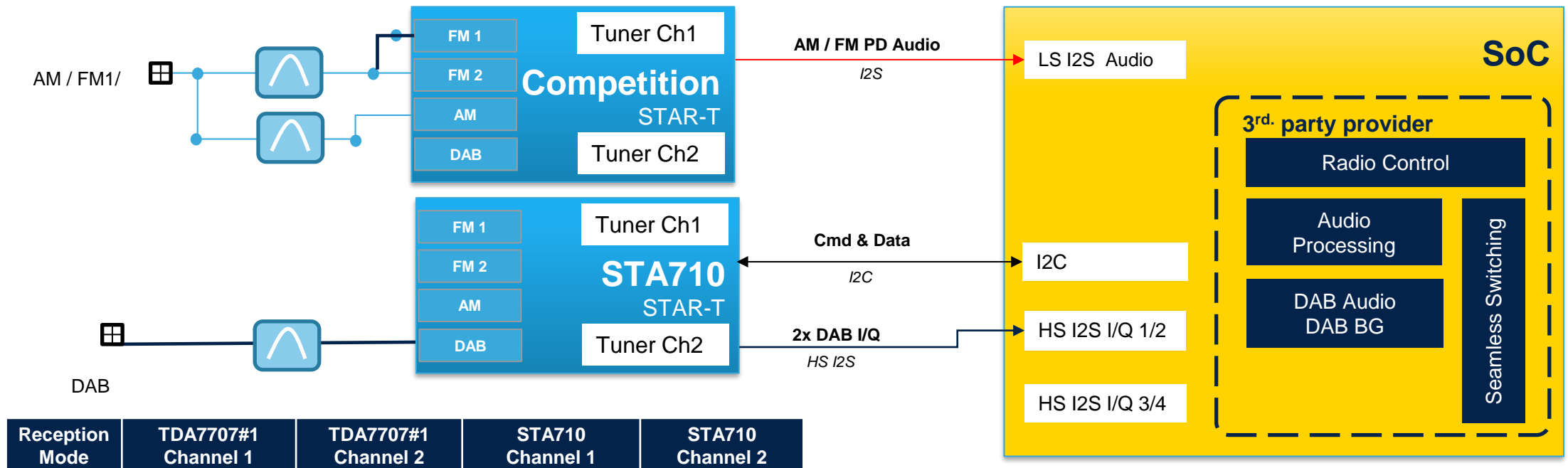


Reception Mode	TDA7708LX	TDA7707 Channel 1	TDA7707 Channel 2
FM	FM	DAB SSw	AM/FM/DAB BGS
DAB	FM SSw	DAB	AM/FM/DAB BGS DAB SSw
AM	AM	DAB BGS	AM/FM DAB BGS

Marked in red: Listening Channel

EU – DAB: 4 Tuner channel

FM/AM Audio + DAB Audio + AM/FM BGS + DAB BGS

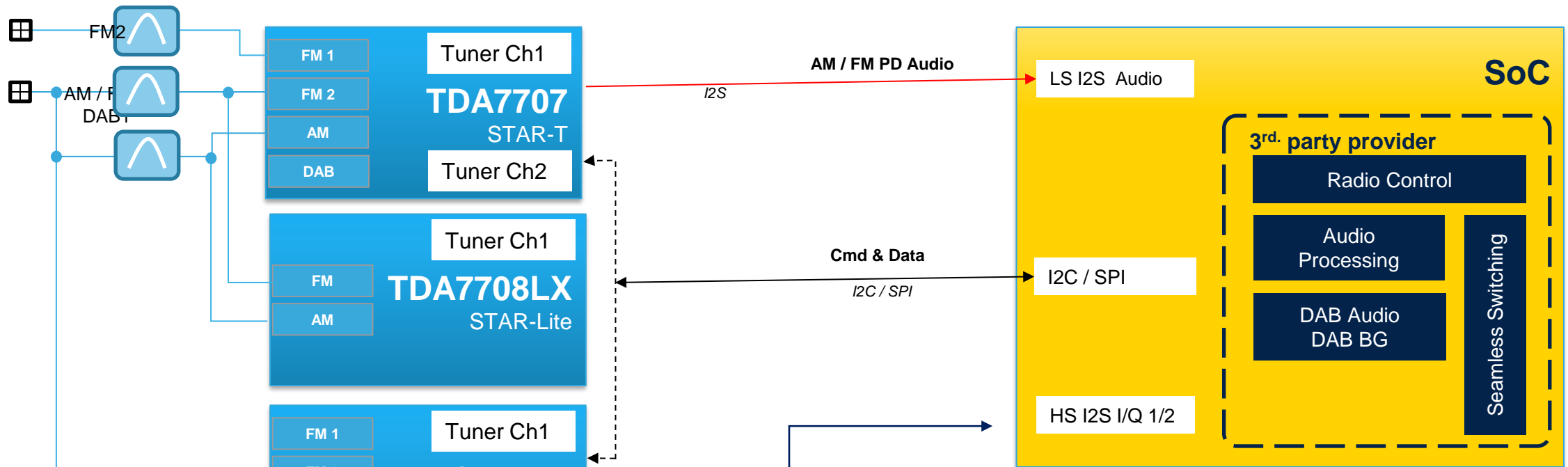


Reception Mode	TDA7707#1 Channel 1	TDA7707#1 Channel 2	STA710 Channel 1	STA710 Channel 2
FM	FM	AM/FM BGS	DAB SSw	DAB BGS
DAB	FM SSw	AM/FM BGS	DAB	DAB BGS DAB SSw
AM	AM	AM/FM BGS	Unused	DAB BGS

Marked in red: Listening Channel

EU - DAB: 5 Tuner channel

FM/AM Audio + FM/AM BGS + DAB Audio + DAB BGS / Audio



Reception Mode	TDA7707 Channel 1	TDA7707 Channel 2	TDA7708LX	STA710 Channel 1	STA710 Channel 2
FM	FM PD		AM/FM BGS	DAB SSw	DAB BGS
DAB		FM PD SSw	AM/FM BGS	DAB	DAB BGS /DAB SSw
AM	AM	Unused	AM/FM BGS	Unused	DAB BGS

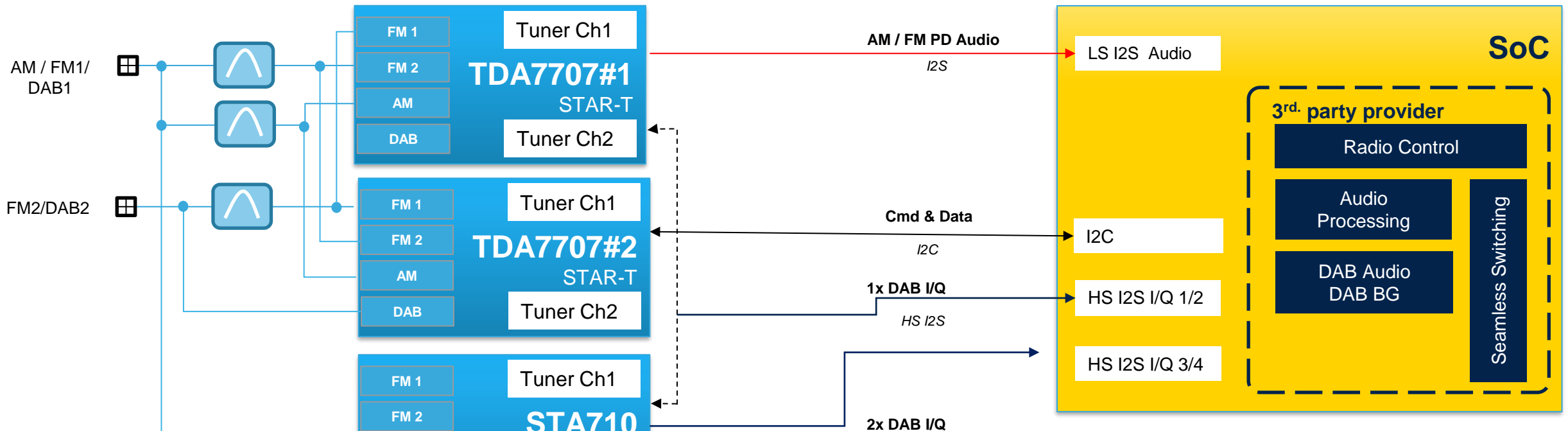
Marked in red: Listening Channel



EU - DAB: 6 Tuner channel

FM-PD/AM-AUDIO + FM/AM BGS + DAB MRC AUDIO + DAB BGS / AUDIO

FM-PD/AM Audio + FM/AM BGS + DAB MRC Audio + DAB BGS / Audio



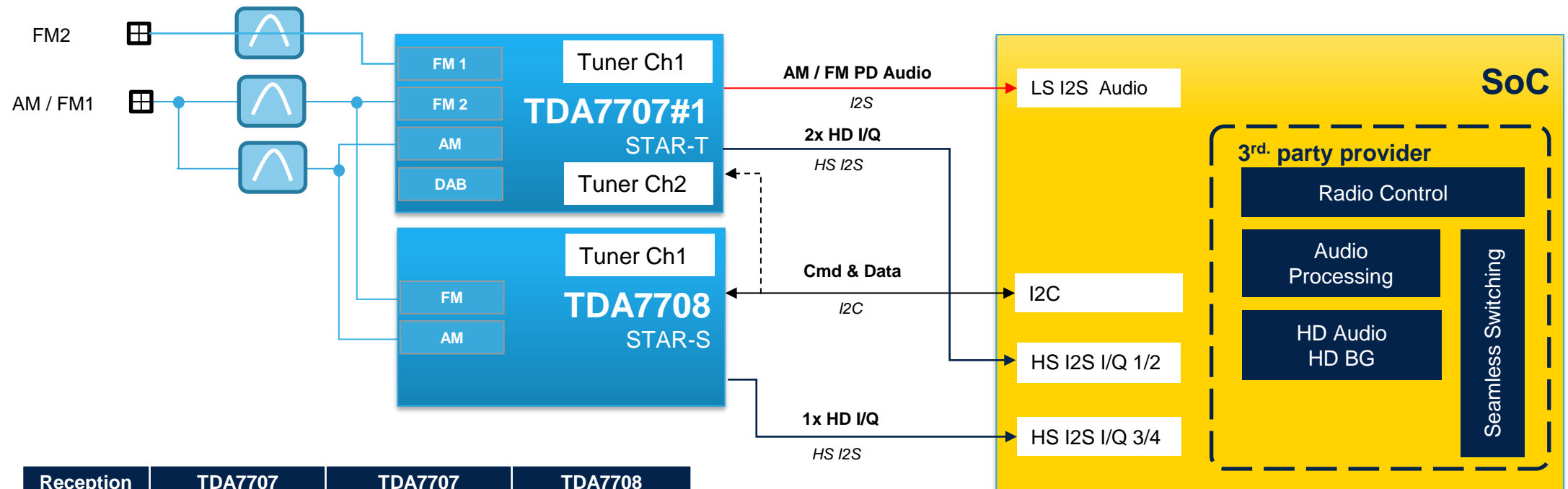
Reception Mode	TDA7707#1 Channel 1	TDA7707#1 Channel 2	TDA7707#2 Channel 1	TDA7707#2 Channel 2	STA710 Channel 2	STA710 Channel 1
FM	FM PD		AM/FM BGS		DAB MRC SSw	DAB BGS
DAB		FM PD SSw	AM/FM BGS		DAB MRC	DAB BGS / DAB SSw
AM	AM	Unused	AM/FM BGS	Unused	Unused	DAB BGS

Marked in red: Listening Channel



US – AM/FM HD

FM-PD(HD-MRC)/AM(HD)-AUDIO + FM-PD(HD)/AM(HD) BGS

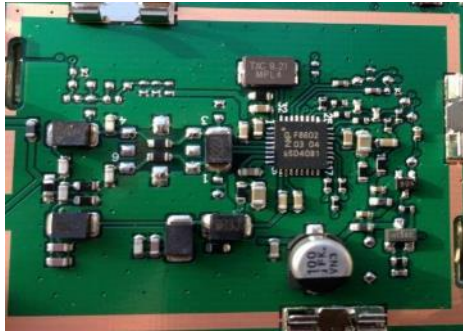


Reception Mode	TDA7707 Channel 1	TDA7707 Channel 2	TDA7708
FM (HD)	FM PD FM HD MRC		AM/FM BGS AM/FM HD BGS
AM (HD)	AM AM HD	Unused	AM/FM BGS AM/FM HD BGS

Marked in red: Listening Channel



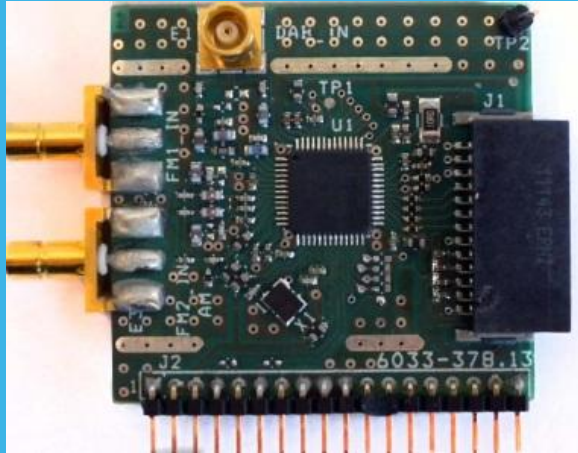
TDA7708 vs. Competitor



- 對照表:
 - 更小的PCB面積
 - 更低的BOM成本
- 不需要大的外部線圈
- 不需要大電解電容
- 不需要射頻變壓器
- 無需提高數位介面的驅動能力

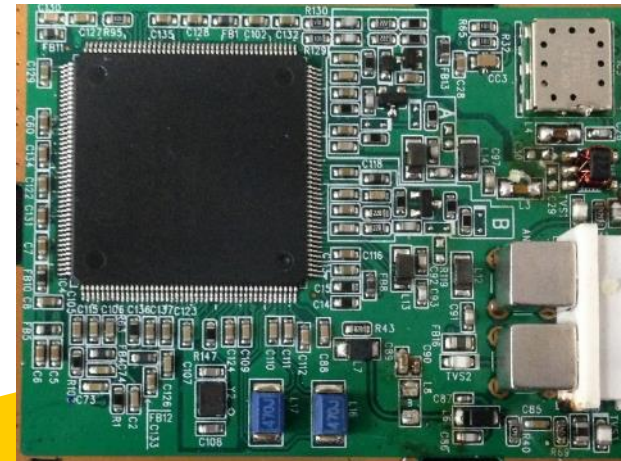
Component	Competitor	TDA7708	Note
Resistor	22	6	
Inductor	5	2	
Capacitor	27	20	Competitor需要一個額外的100uF電解電容
Quartz	1	1	
BLM	0	2	用於電源濾波
Transistor	2	0	
RF Transformer	1	0	配合高性能應用，Competitor需要外加一個接收變壓器

TDA7707 vs Competitor



Comparison:

- Smaller chip size and PCB area
- Lower BOM cost
- No embedded audio processing



Component	TDA7707	Competitor
R	8	15
C	34	74
L	8	10
BLM	7	8
Xtal	1	1
T	0	3

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