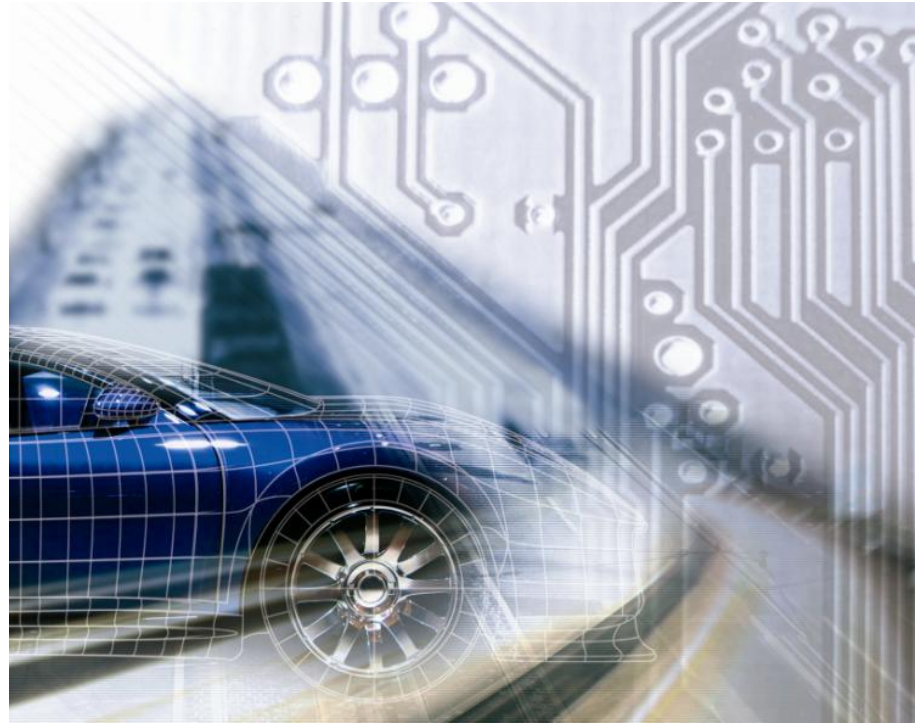


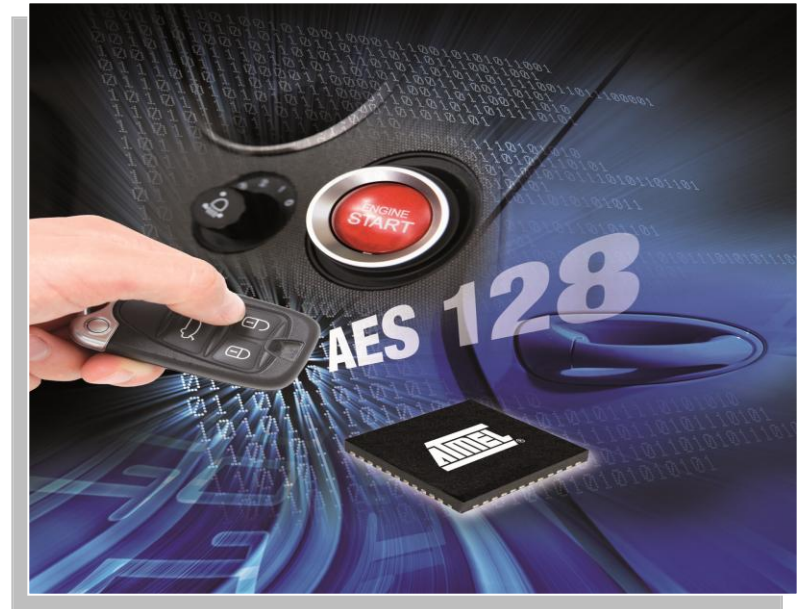


Car Access

PEPS, RKE, AES Immobilizer

Atmel Car Access System Solutions

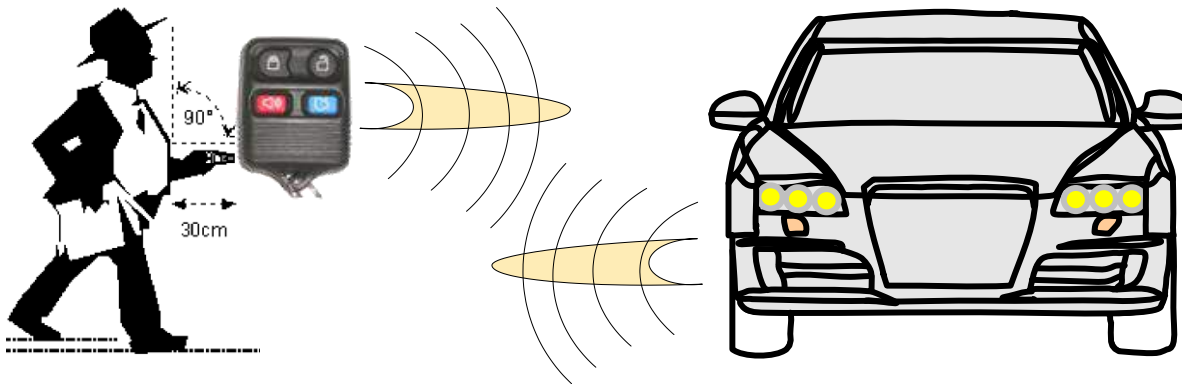
- Atmel® launched the first dedicated transmitter PLL U2741B for Remote Keyless Entry (RKE) applications in 1997
- Atmel is a leading car access supplier and delivered already more than 250 Mio ICs in this application
- Strong relationships to the key players in the automotive market



Car Access – Basic of RKE

Remote Start

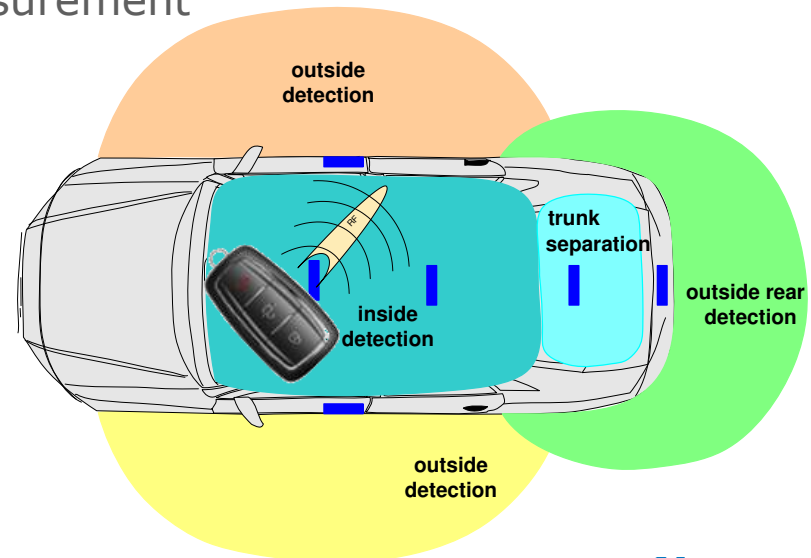
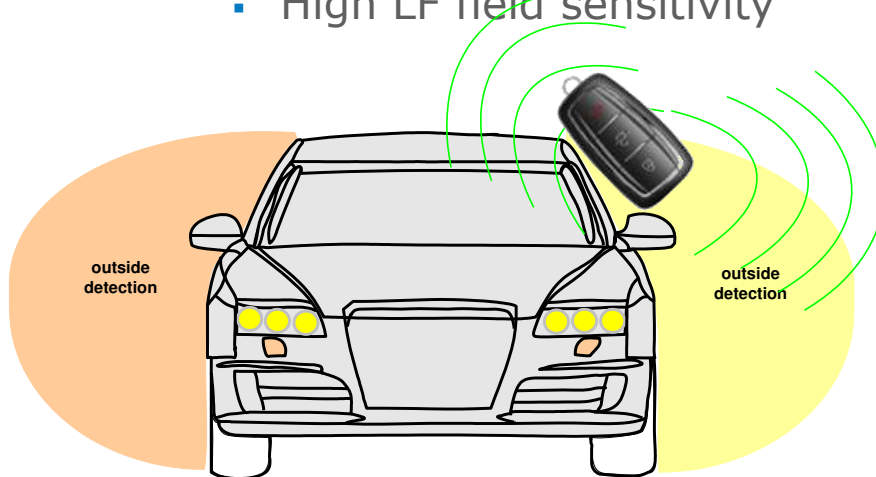
- Like RKE but RF is typically 2-way
 - Fob sends RF to car to "start engine"
 - Car replies with RF to fob "engine running"
- Important Design Considerations
 - Very long range, > 300m, requires high RF link budget
 - RF Link budget = f (TX power, RX sensitivity, antenna efficiencies)
 - Higher TX power by managing R (averaging)
 - Higher RX sensitivity with narrower IF bandwidth & lower data rate
 - Requires tight frequency control & compensation (temp/voltage/lot)



Car Access – Basic of PEPS

Passive Entry / Passive Start

- From outside the vehicle: Touch car door (PE)
- From inside the vehicle: Press "start" button on dashboard (PS)
- LF from car awakens fob (LF downlink)
- Fob measures field strength vectors & sends info to vehicle
 - Fob orientation is arbitrary - must measure x, y, & z axis (3D)
 - Fob localized: Allow "Unlock" if outside (confirm if 2-way RF)
 - Fob localized: Allow "Start" if inside (confirm if 2-way RF)
- Important system design considerations:
 - LF field strength regulation over across voltage/temp/coil variation
 - Accurate LF field strength measurement
 - High LF field sensitivity

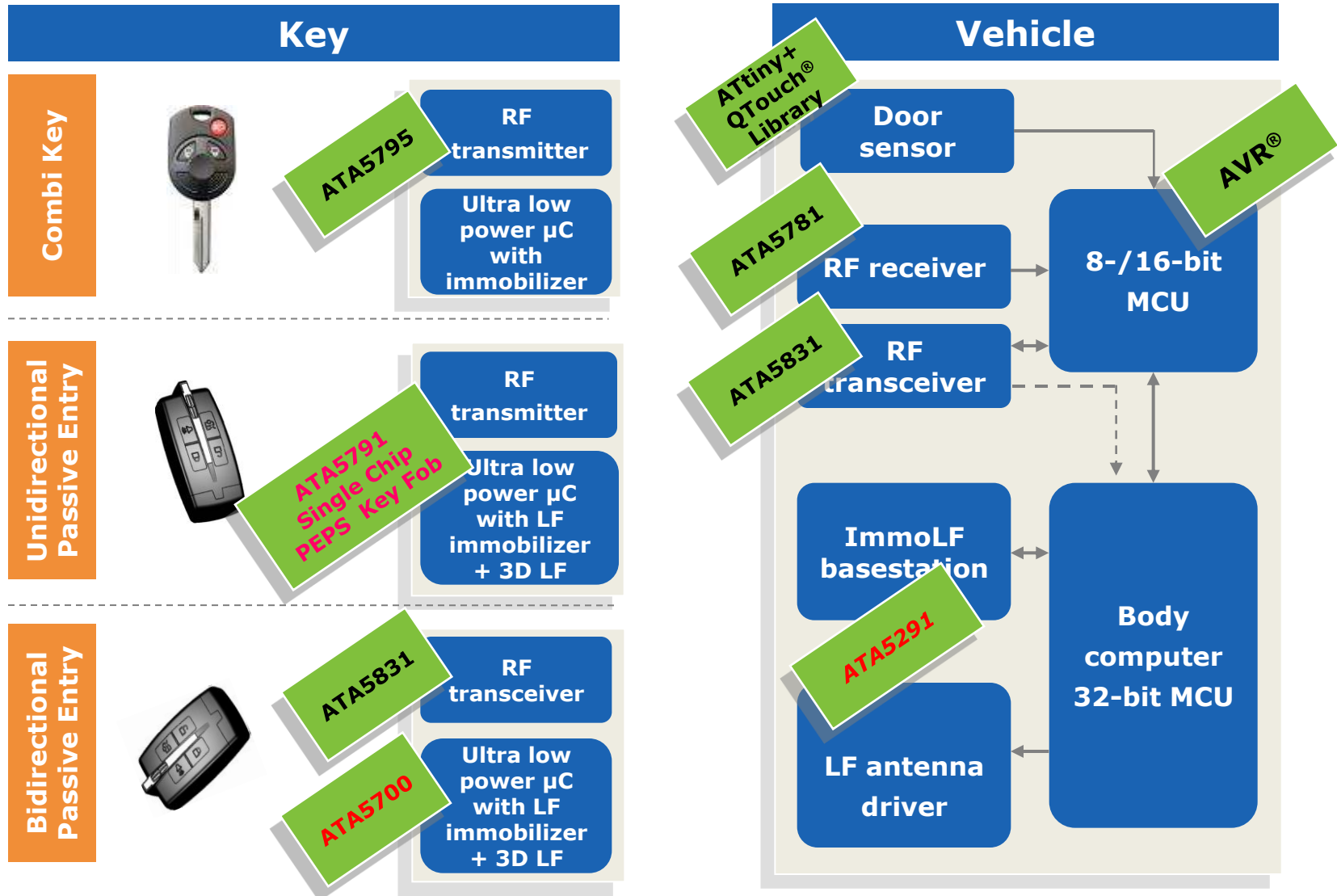


Wide Range Of Car Access Solutions

RKE	RKE + Immo	PKE + Immo	Optional
Single chip key solution, best in class performance – ATA5774C Best in class receiver, with minimum external component, no external IF filter, supports self polling – ATA5724C / ATA5781	Single chip key solution, 128 bit AES H/W encryption engine, up to 12.5dBm output power, works down to 1.9V – ATA5795C Best in class receiver, with minimum external component, no external IF filter, supports self polling – ATA5724C / ATA5781 Immo transponder with built in coil, AES standard – ATA5580	Single chip MCU, Immo + 3D LF Wake up – ATA5791 Single chip LF driver + Immo Basestation – ATA5291 Immo transponder with built in coil, AES standard – ATA5580	RF transceiver for smart key and 2 way BCM basestation – ATA5831 Smart RF receiver with Flash+MCU – ATA5782 TPMS Receiver support Door handle touch



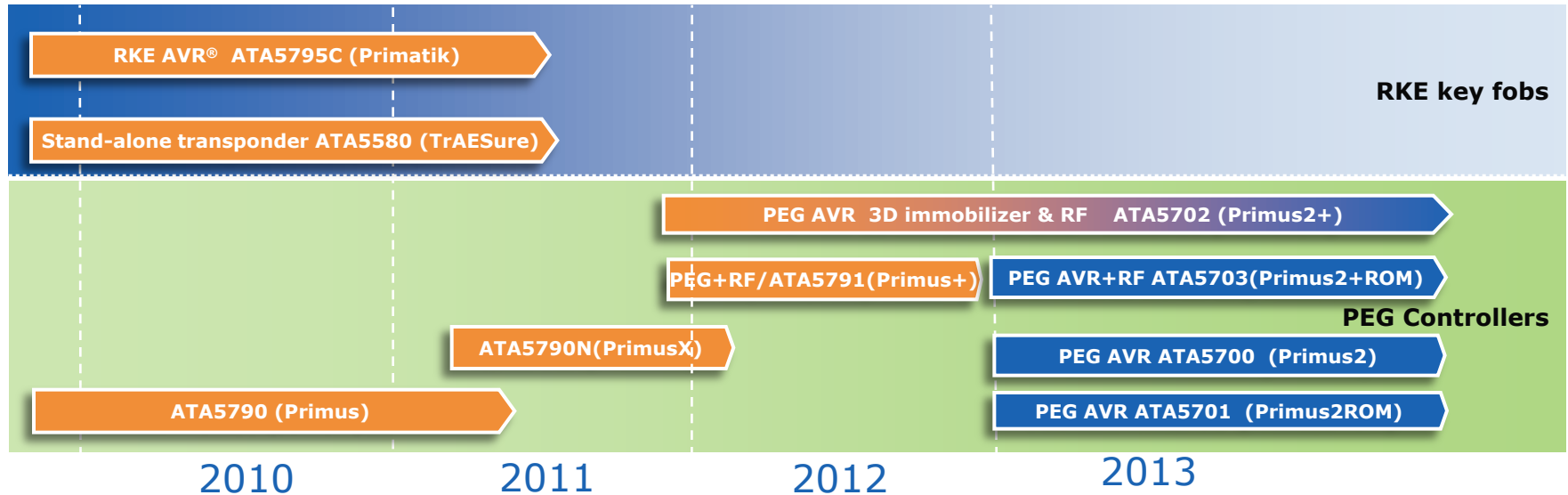
Car Access: System Solution



Product Availability

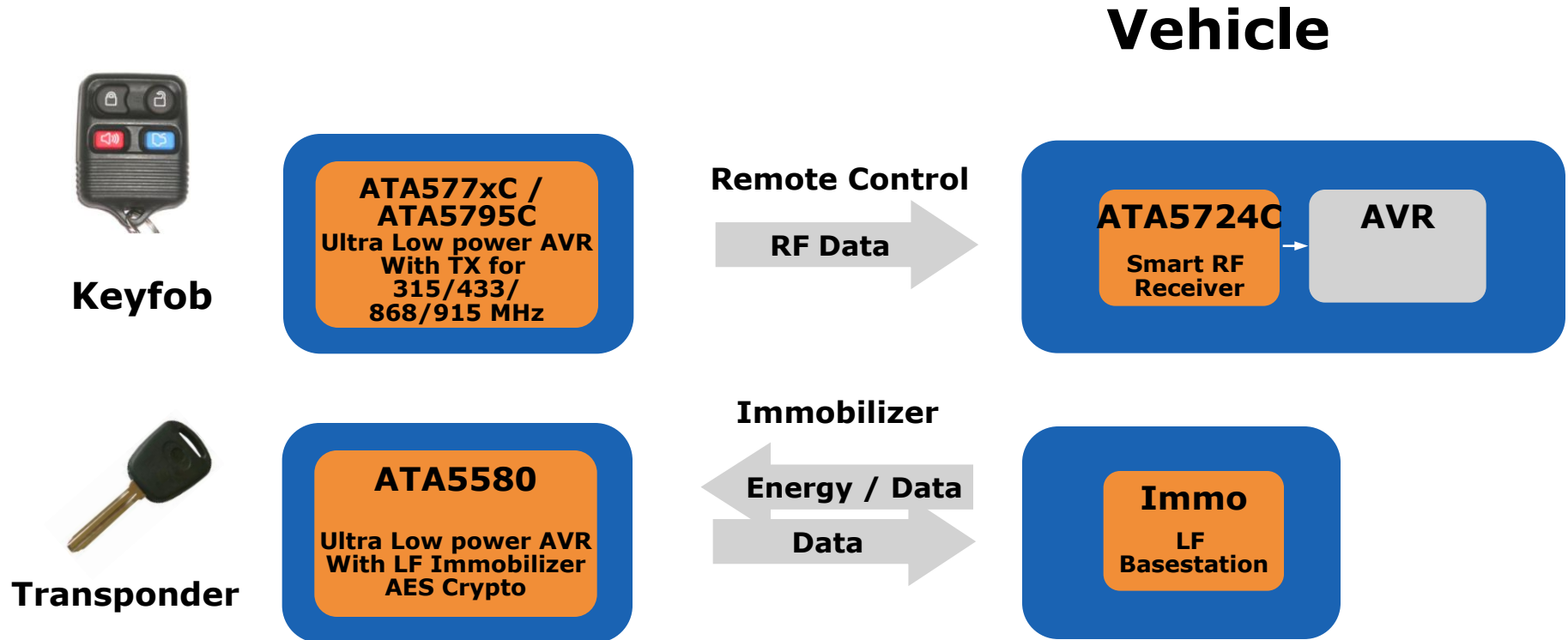
Car / Fob	Function	Embedded AVR	Part Number	Availability
Both	Immobilizer protocol stack		Software	Production
Key fob	AES immobilizer transponder		ATA5580	Production
Key fob	AES RKE AVR with immobilizer and RF transmitter		ATA5795	Production
Key fob	AES PEG AVR with immobilizer and 3D wake-up		ATA5791	Production
Key fob	Fractional-N RF transmitter		ATA5749C	Production
Both	Fractional-N RF transceiver AVR®		ATA5831	Production
Car	Fractional-N RF receiver		ATA5781	Production
Car	Fixed-frequency RF receiver		ATA572x	Production
Car	6-channel LF driver		ATA5279C	Production
Car	4-channel LF driver with Immobilizer Basestation		ATA5291	Sampling

Car Access Key Fob Controllers



Part Number	Description
ATA5795	RKE AVR® controller with AES-128, 315/433MHz RF transmitter and immobilizer
ATA5580	Stand-alone AES-128 transponder, 8K Flash, 2K EEPROM
ATA5790	PEPS AVR controller with AES-128, 3D LF, immobilizer, 16K Flash, 2K EEPROM
ATA5790N	PEPS AVR controller with AES-128, 3D LF (enhanced), immobilizer, 16K Flash, 2K EEPROM
ATA5791	PEPS AVR controller with AES-128, 3D LF (enhanced), immobilizer, 315/433MHz RF transmitter, 16K Flash, 2K EEPROM
ATA5700	PEPS AVR controller with AES-128, 3D LF, 3D immobilizer, 16K/32K Flash, 1K/2K EEPROM
ATA5701	PEPS AVR controller with AES-128, 3D LF, 3D immobilizer, 16K/32K ROM, 1K/2K EEPROM
ATA5702	PEPS AVR controller with AES-128, 3D LF, 3D immobilizer, 315/433/868/915MHz, 16K/32K Flash, 1K/2K EEPROM
ATA5703	PEPS AVR controller with AES-128, 3D LF, 3D immobilizer, 315/433/868/915MHz, 16K/32K ROM, 1K/2K EEPROM

Remote Keyless Entry (with Immo)



Two different ICs for Keyfob and Transponder allows a cost optimized approach on the key side

Single Chip LF + RF with μ C: ATA5795C

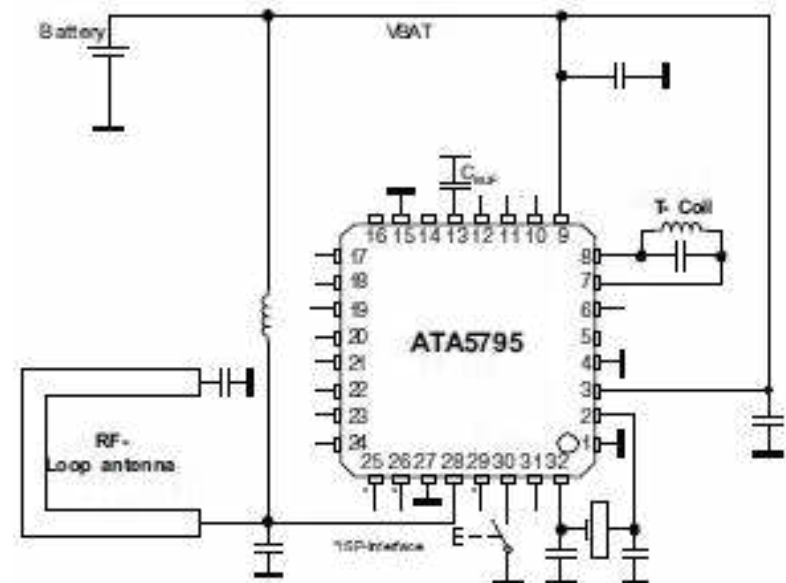
Remote Keyless Entry: key

Key characteristics

- RKE low-power AVR[®] with immobilizer and RF TX
- 125kHz immobilizer interface compatible to existing base-station ICs
- 315MHz – 433MHz Fractional-N RF TX with 12.5dBm Pout
- Fast AES hardware crypto engine for both RF and LF
- CMMI-certified immobilizer stack

Key features

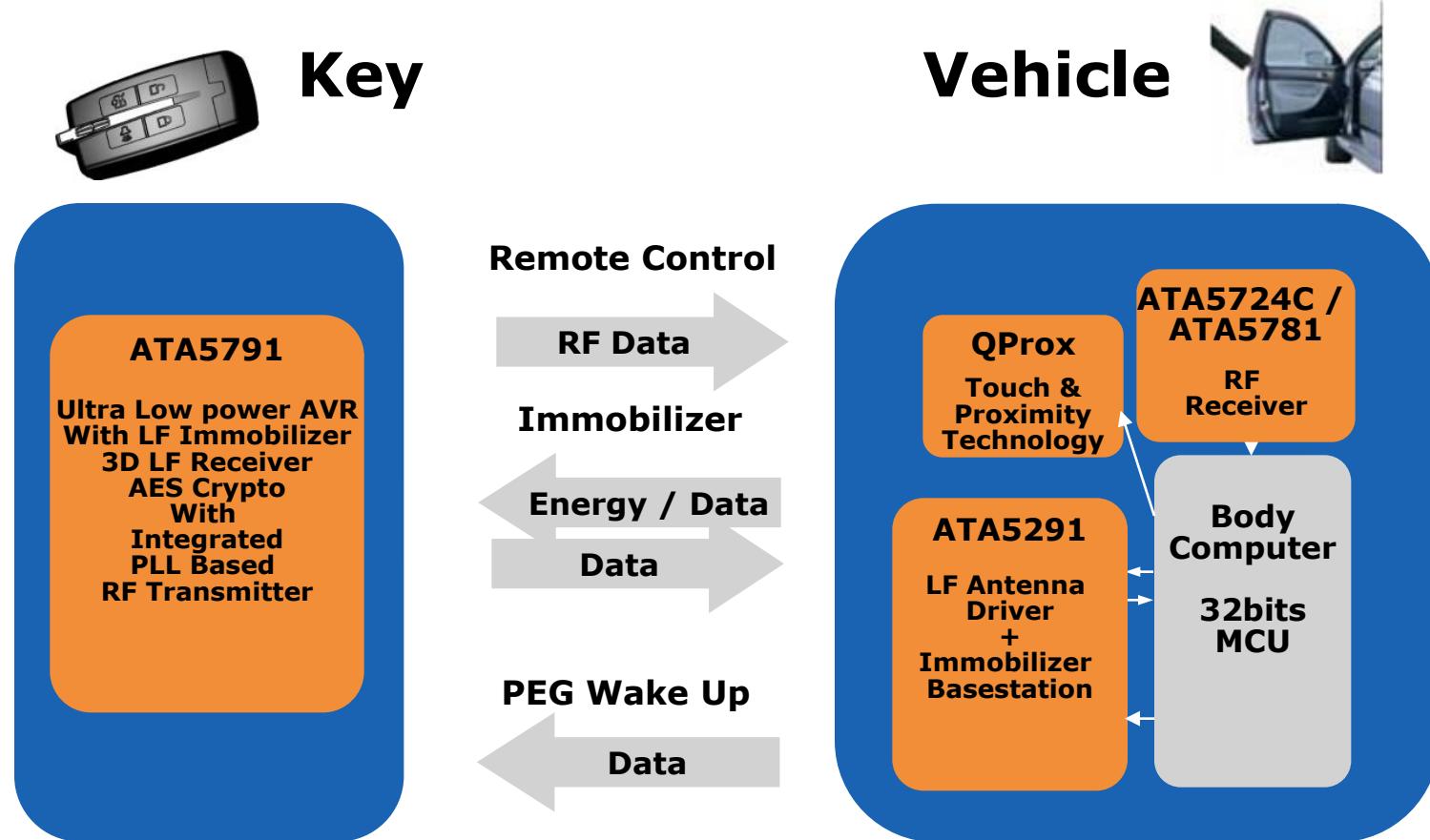
- AES is basis for open-source immobilizer software library
- Highest security level for encryption (128bit)
- Special memory protection secures immobilizer software
- High power TX allows extended coverage
- Easy software design with existing AVR tool set
 - Low-power effective AVR microcontroller
 - 6kB Flash for customer software available
- Small package and low external component count allows small board design
- 1.9V to 3.6V supply voltage



Package:
Samples available:
PPAP available:

QFN32, 5x5mm
now
now

Passive Entry Go - Unidirectional



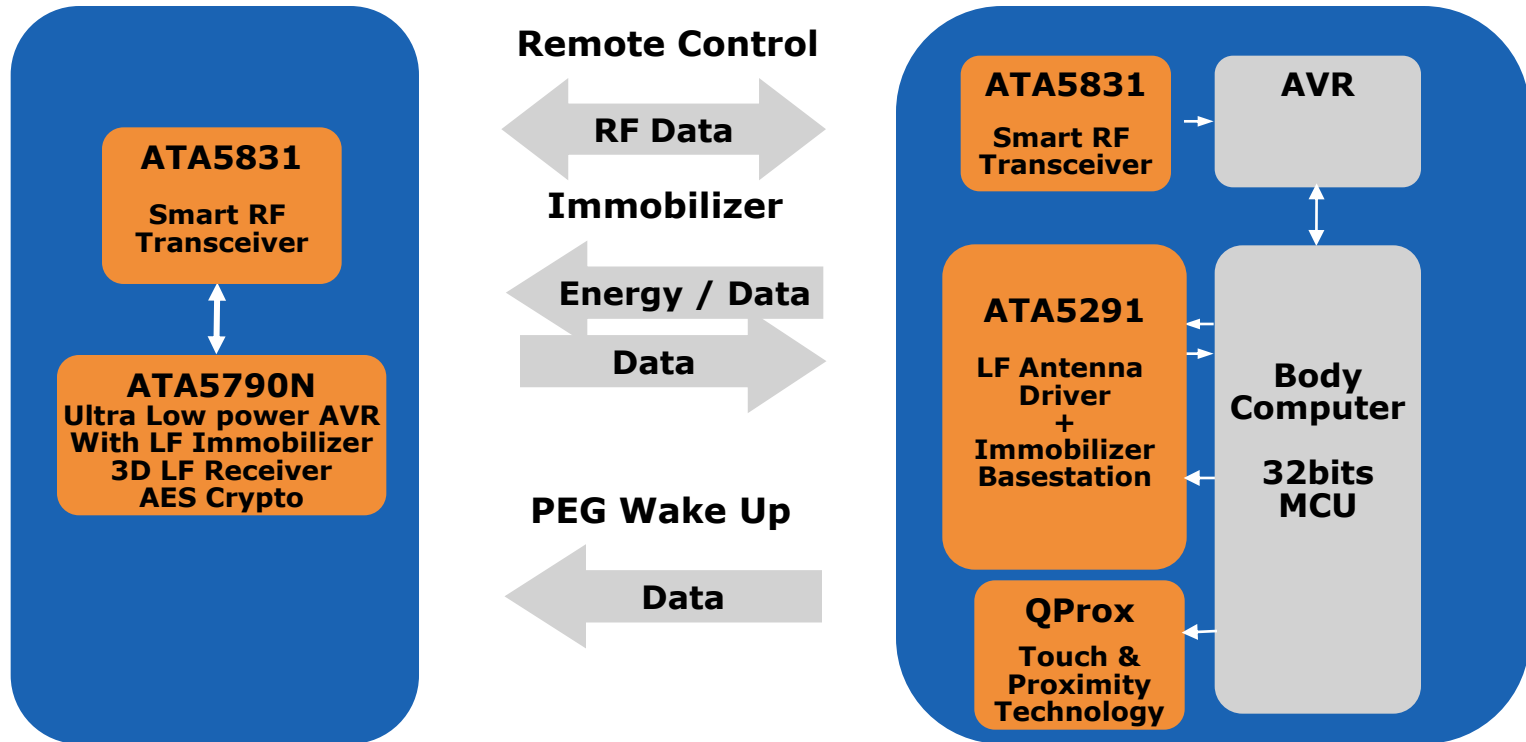
- Single chip PEPS Keyfob solution

Passive Entry / Go – Bidirectional RF



Key

Vehicle



- Complete PEPS solution with Atmel chipset, including capacitive sensing

Microcontroller with Immobilizer, 3D LF and RF Transmitter: ATA5791

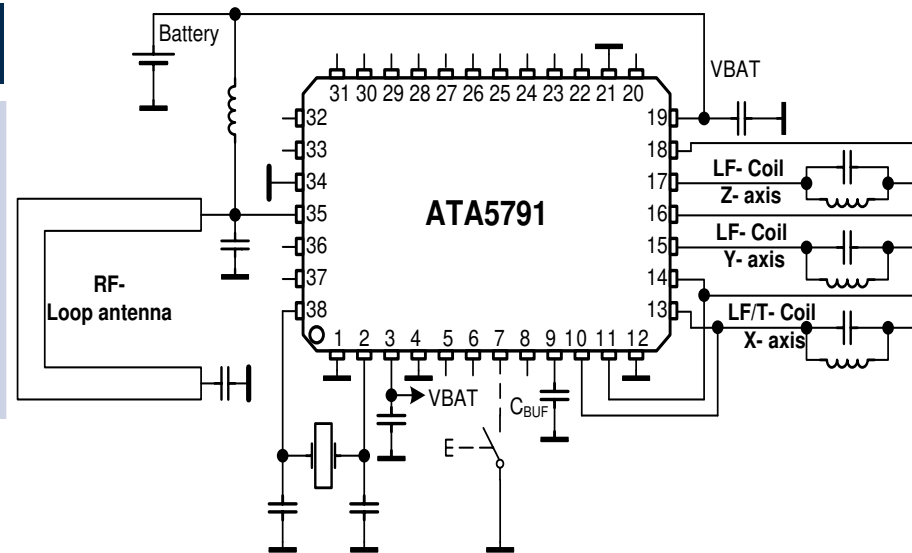
Passive Entry Go: key

Key characteristics

- Low-power AVR® with immobilizer and 3D LF
- 125kHz immobilizer interface
- 3D LF receiver with RSSI: 1.5mVpp worst case
- Current consumption in listening mode $\sim 4\mu\text{A}$
- 300 to 450MHz RF Transmitter up to 12.5dBm
- Fast AES hardware crypto engine

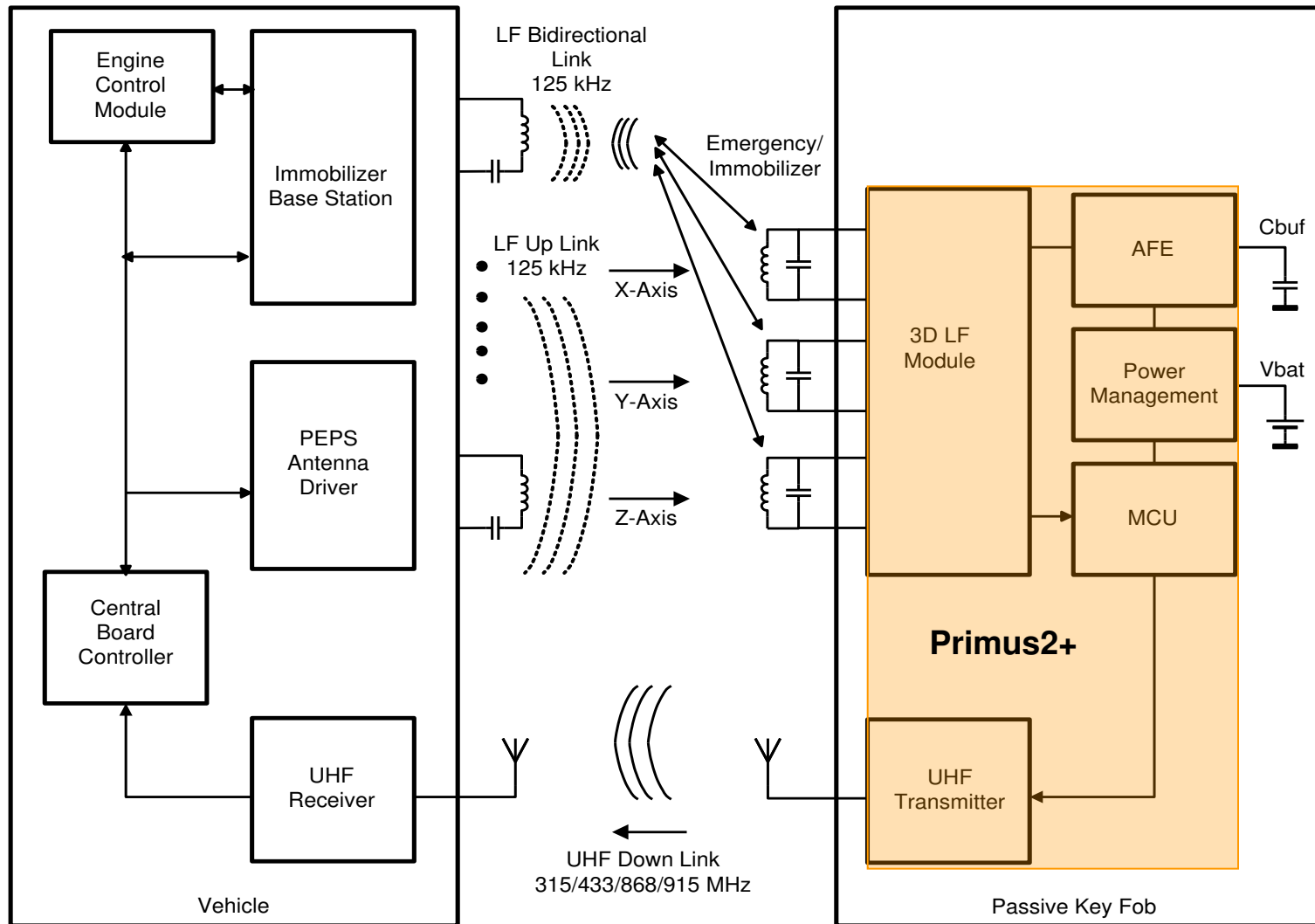
Key features

- AES is basis for open-source immobilizer SW library and comes along with integrated fast AES encryption engine
 - 32-bit unique identification number
 - Two 128-bit secret keys, one 128-bit transponder key
- Highest security level for encryption (128bit)
- Special memory protection secures immobilizer software
- Highly sensitive 3D LF RSSI measurement allows fast wake-up
- Tolerance compensation for 3D RSSI measurement
- Easy software design with existing AVR tool set
 - Low-power, effective AVR microcontroller
 - 14kB Flash for customer software available
- Frac-N RF Transmitter (300MHz – 450MHz) up to 12.5dBm
- 1.9V to 4.2V supply voltage



- **Package:** QFN38 5x7mm
- **Samples available:** Now
- **PPAP available:** Now

ATA5702 – 3rd Gen PEPS KeyFob with 3D Immobilizer



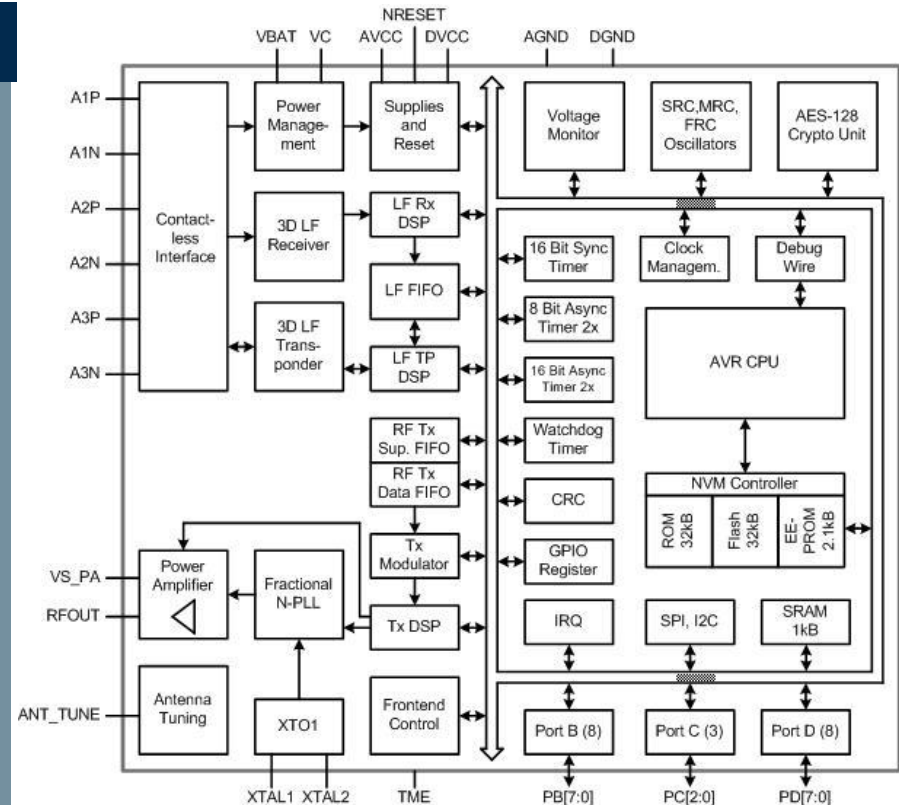
ATA5702 – One chip PEPS Keyfob

2nd Generation Key Fob uC with AES-128, 3D IMMO & RF TX

RKE + PEPS + IMMO: Key

Key Features

- Monolithic Immobilizer/PEPS solution with AES 128
- Open immobilizer Stack
- LF Interface:
 - 3D Transponder and 3D LF wake-up
 - Programmable sensitivity: 100uV_{pp} / 250uV_{pp} / 500uV_{pp}
 - 4.7uA current consumption at 250uV_{pp}
 - Programmable LF bitrates: 1.95k / 3.9k / 7.8kbits/s
 - Logarithmic RSSI measurement for better spatial localization
 - RSSI measurement on 3 channels simultaneously <2.4ms
 - 3D LF Battery charging capability
- AVR Core:
 - 16kB/32kB User Flash, 1/2kB EEPROM, 1kB SRAM
 - 32kB System Firmware (RF protocol handling, LF handling)
- RF Transmitter:
 - Programmable Frac-N PLL covering 310 – 318MHz, 418-477MHz, 836-956MHz in 93Hz / 185Hz steps
 - Programmable RF Output Power: -12 to 14.5dBm
 - Up to 80kBit/s Manchester coded data stream
- Controller Interfaces:
 - 19 GPIOs, SPI & I2C interfaces, Debug-wire
 - Supply voltage: 1.9V to 4.2V
 - QFN 5x7 – 38 pins



Status:

Engineering samples:

Final Samples:

PPAP:

In Design

Nov 2013

Jun 2014

Sep 2014

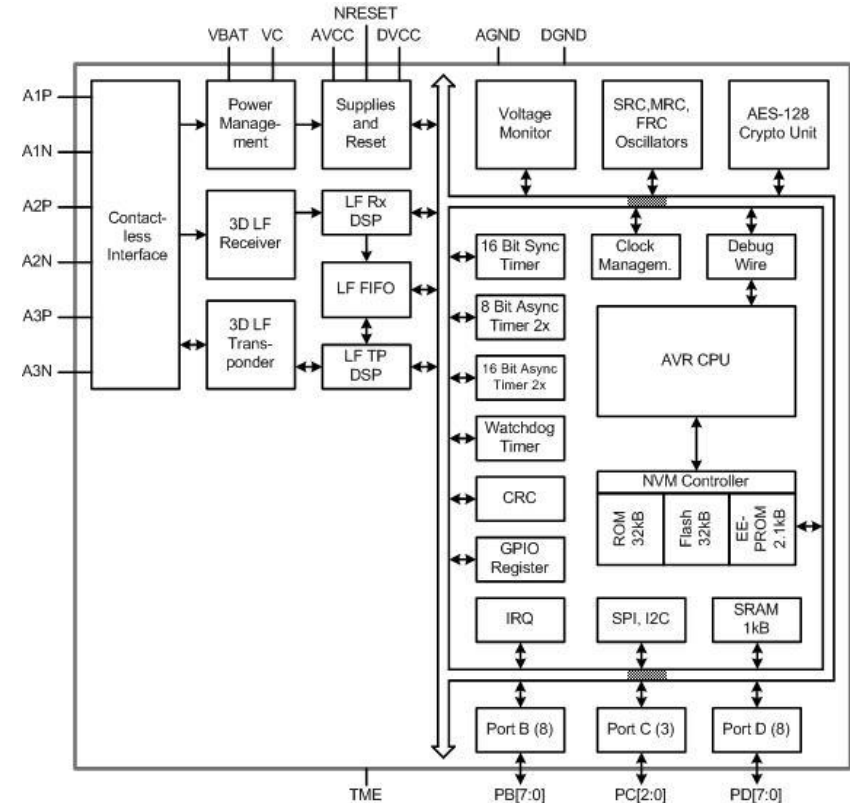
ATA5700 – Primus2 (No Transmitter)

2nd Generation Key Fob uC with AES-128 & 3D IMMO

PEPS + IMMO: Key

Key Features

- Monolithic Immobilizer/PEPS solution with AES 128
- Open immobilizer Stack
- LF Interface:
 - 3D Transponder and 3D LF wake-up
 - Programmable sensitivity: 100uV_{pp} / 250uV_{pp} / 500 uV_{pp}
 - 4.7uA current consumption at 250uV_{pp}
 - Programmable LF bitrates: 1.95k / 3.9k / 7.8kbits/s
 - Logarithmic RSSI measurement for better spatial localization
 - RSSI measurement on 3 channels simultaneously <2.4ms
 - 3D LF Battery charging capability
- AVR Core:
 - 16kB / 32kB User Program Memory, 1/2kB EEPROM, 1kB SRAM
 - 32kB System Firmware (RF protocol handling, LF handling)
- Controller Interfaces:
 - 19 GPIOs, SPI & I2C interfaces
 - Debug-wire
 - Supply voltage: 1.9V to 4.2V
 - QFN 5x7 – 38 pins



Status:
Engineering samples:
Final Samples:
PPAP:

In Design
Nov 2013
Jun 2014
Sep 2014

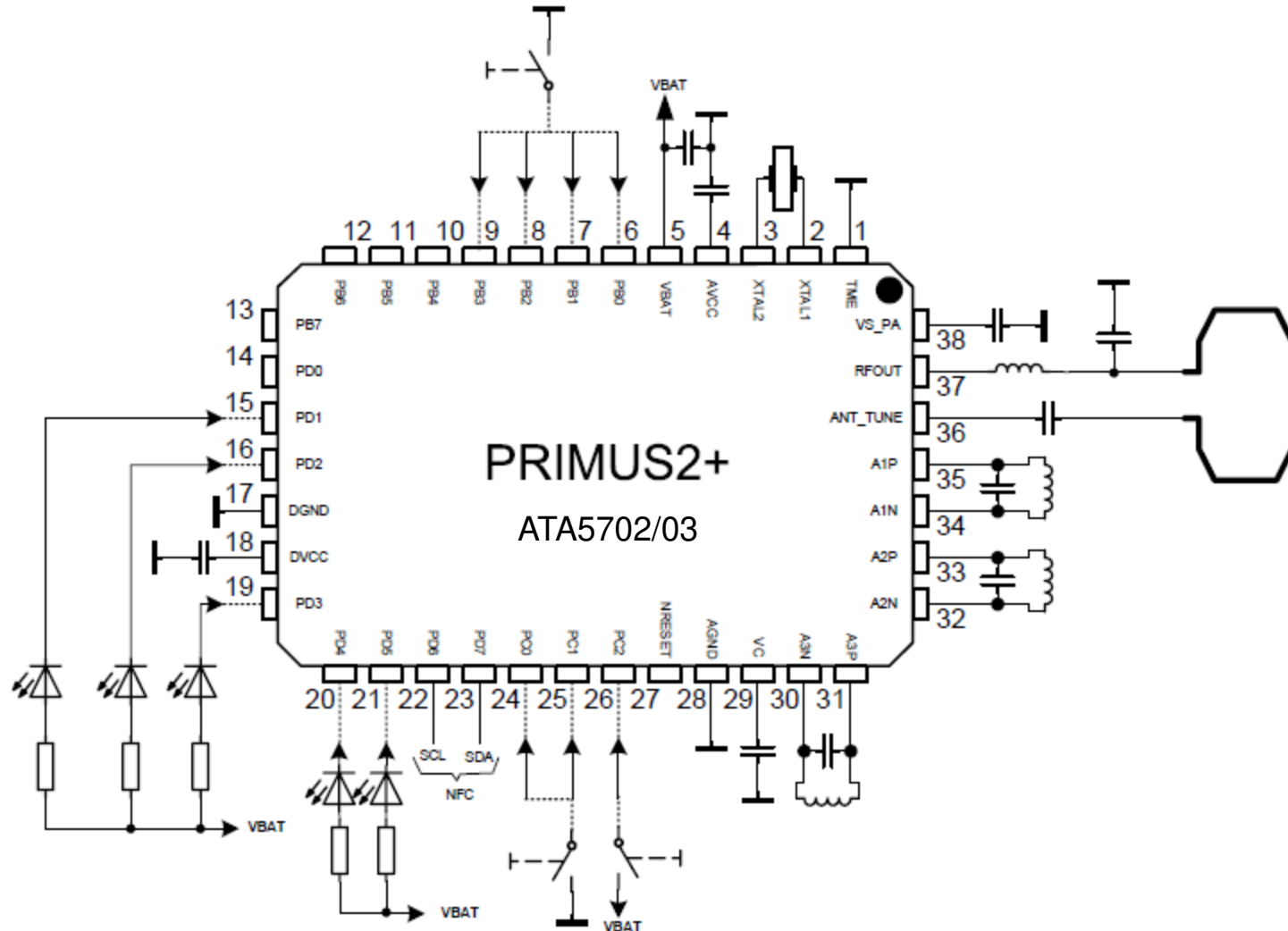
Primus2plus – ATA5700

Competitive Assessment

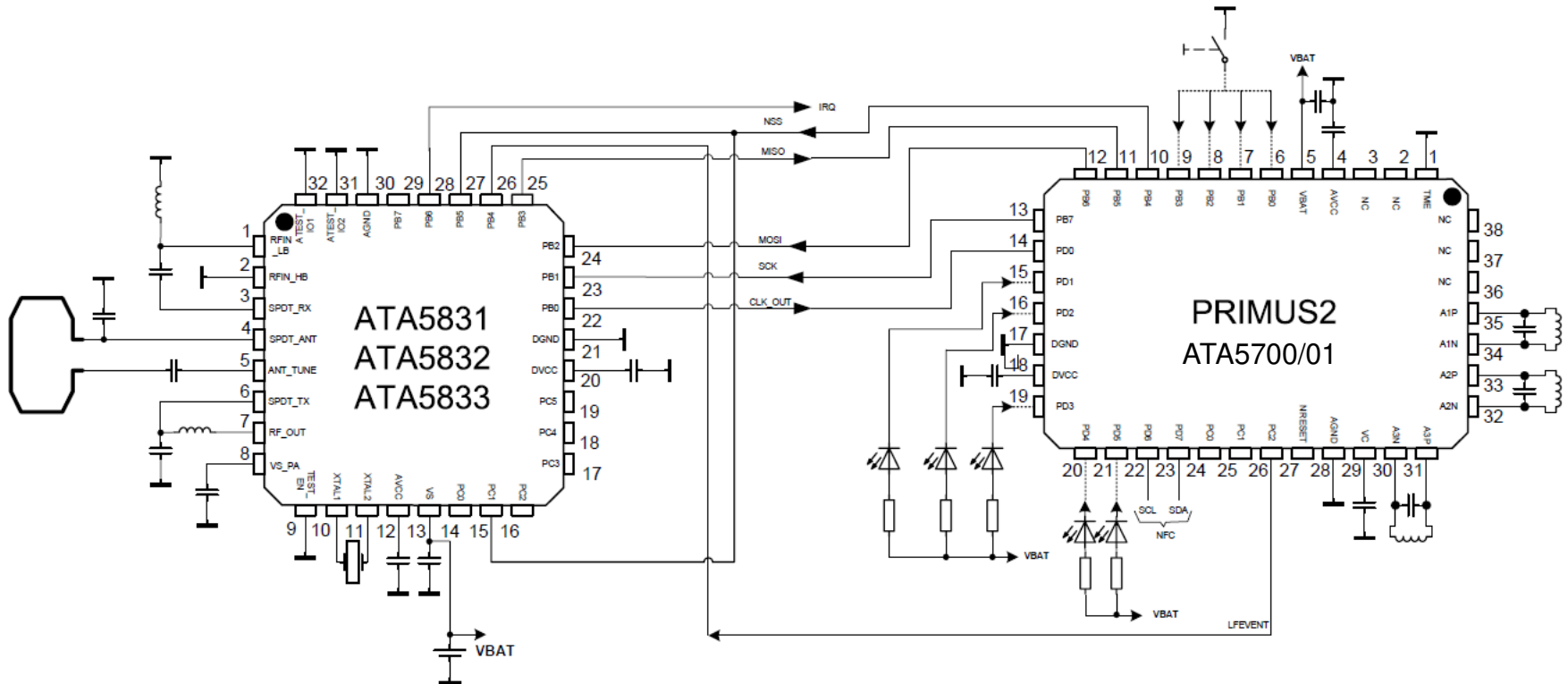
- ✓ 3D Immobilizer , no direction base
- ✓ Best in class range detection (sensitivity - 100uVpp) vs battery lifetime (power consumption) with good out of band blocking
 - ✓ Allows approach lighting/walk away with acceptable battery lifetime
 - ✓ Possible range measurement for Convertible cars
- ✓ Fastest in/out car detection thanks to direct RSSI measurement on 3 channels simultaneously
- ✓ Best in class RF performance due to the integration of PLL based Transmitter
- ✓ Compatible with almost all Immobilizer Base-station in the market
- ✓ Small package to accomodate small keyfob

ATA5702/Primus2+

Application 3D-LF/RF-Transmitter

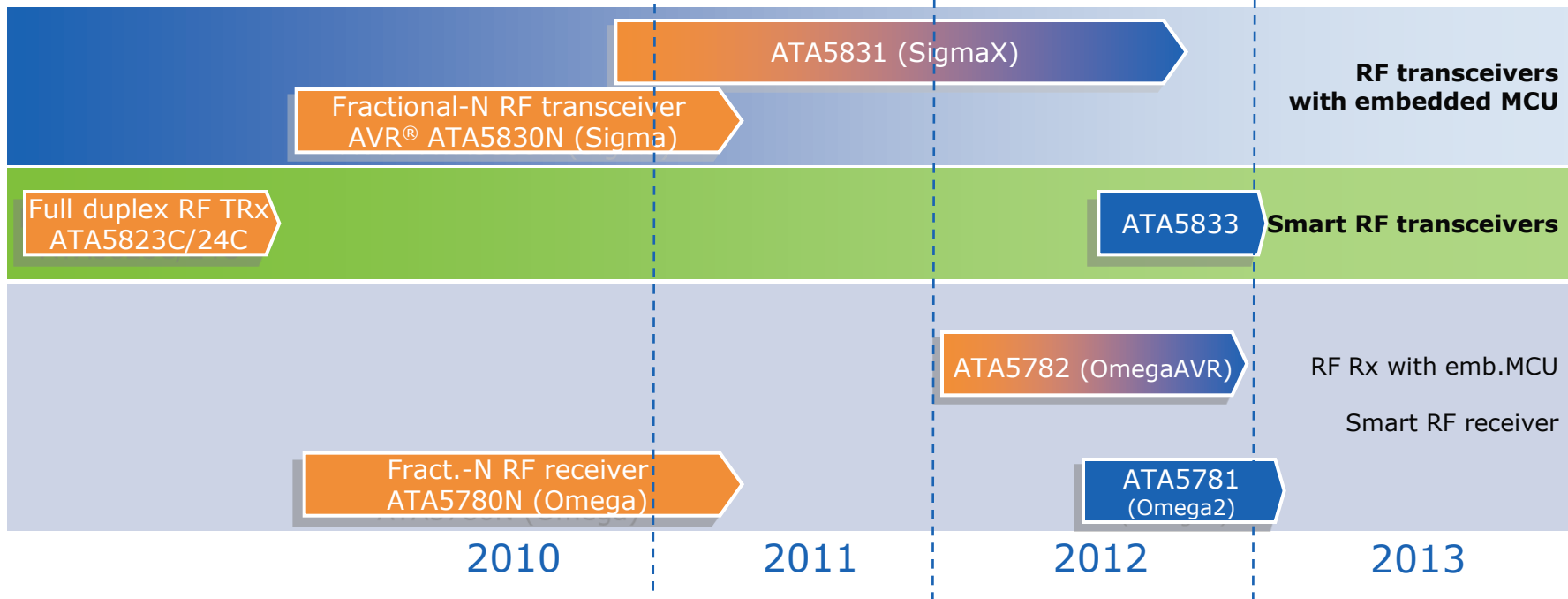


Application 3D-LF/RF-Transceiver



- LFEVENT: Trigger Signal for fast TRX wake up: $< 2\text{ms}$
- SPI-Builder: Library for easier SPI communication between Primus2 and TRX
- Crystal clock from TRX

RF Roadmap



Part Number	Frequencies	Description
ATA5823C	315MHz	Full duplex RF transceiver
ATA5824C	433/868MHz	Full duplex RF transceiver
ATA5830N	315/433/868-915MHz	RF transceiver AVR® microcontroller – 6KByte user Flash
ATA5831	315/433/868-950MHz	RF transceiver AVR microcontroller – 20KByte user Flash
ATA5833	315/433/868-950MHz	Fractional-N smart RF transceiver for key fobs
ATA5780N	315/433/868-915MHz	Fractional-N smart RF receiver
ATA5781	315/433/868-950MHz	2nd-generation Fractional-N smart receiver
ATA5782	315/433/868-950MHz	RF receiver AVR microcontroller – 20KByte user Flash

Sigma (TrX) & Omega (Rx) Family Roadmap

	ATA5830N	ATA5780N	ATA5831		ATA5781	ATA5782
Flash (KB)	6	—	20		—	20
User ROM (KB)	—	—	—	20	—	—
RF Transmitter	✓	—	✓		—	—
Independent Services	3	3	5	5	5	5
Enhanced RF switch time	—	—	✓		✓	✓
Enhanced sensitivity	—	—	✓		✓	✓
	Transceiver				Receiver	

Common Features

Best in class Blocking RF Receiver

24kB ROM RF Library

Package & pin compatible

Advanced RF RX: ATA5781/82

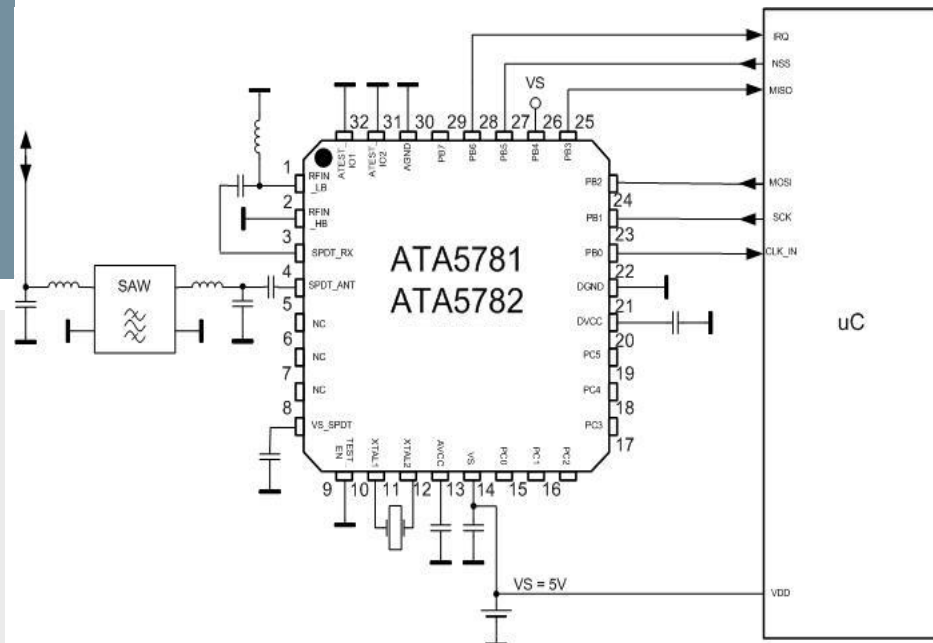
RKE / PEG & TPMS RF Receiver

Key Characteristics

- UHF Receiver AVR with Excellent RF Performance
- Pin, package & Software Compatible with ATA583x family (TRX)
- One Device & Crystal Covers All Frequencies
- Integrated RF Switch
- ATA5782@20 KB user Flash, and AT5781@no user ROM(+24 kB ROM firmware lib. For all versions)
- Autonomous operation possible

Key Features

- **UHF Receiver with excellent RF performance**
- **ASK Sensitivity (Manchester) at 433.92MHz:**
 - 109dBm @ 20kBit/s IFBW=366 kHz
 - 119dBm @ 1kBit/s IFBW=366 kHz
- **FSK Sensitivity (Manchester) at 433.92MHz:**
 - 108dBm @ 20kBit/s $\Delta f = \pm 20\text{kHz}$ IFBW=165 kHz
 - 114dBm @ 5kBit/s $\Delta f = \pm 5\text{kHz}$ IFBW=165 kHz
 - 123dBm @ 0.75kBit/s $\Delta f = \pm 0.75\text{kHz}$ IFBW=25 kHz
- **Best in Class blocking performances**
e.g. 64 dBc@IFBW=165kHz) and 48dBc@IFBW=225kHz at Freq. Offset= 1MHz
- **High image rejection:** e.g. 55dB @ 315/433MHz; 50 dB @868.3MHz/915MHz without calibration
- **Automatic antenna tuning for loop antenna**
- **5 independent services with 3 channels each**
- **Supply range:** 1.9V – 3.6 V; 4.5 - 5.5 V
- **Temperature range** - 40° C to +105° C



Package: Wettable flanks QFN32 5x5mm
Samples Available: Now
PPAP Available: Now

Competitive Battery Lifetime and Blocking Behavior

Operating Mode	ATA5831	A	B
Receive 433MHz	11mA	22mA	22mA
Transmit 433MHz (10dBm)	18mA	25mA	33mA
Off (2.7V, 85C)	0.5uA	5uA	5uA
Multi-profile wake-up	✓	✗	✗

ATA5781	C
11mA	12mA
N/A	N/A
0.5uA	27uA
✓	✗

Operating Mode	ATA5831	A	B
Blocking (typical)	62dBc	40dBc	40-50dBc
Image rejection (typical)	55dBc	45dBc ¹	31dB ²

ATA5781	C
62dBc	tbd
55dBc	40dB ³

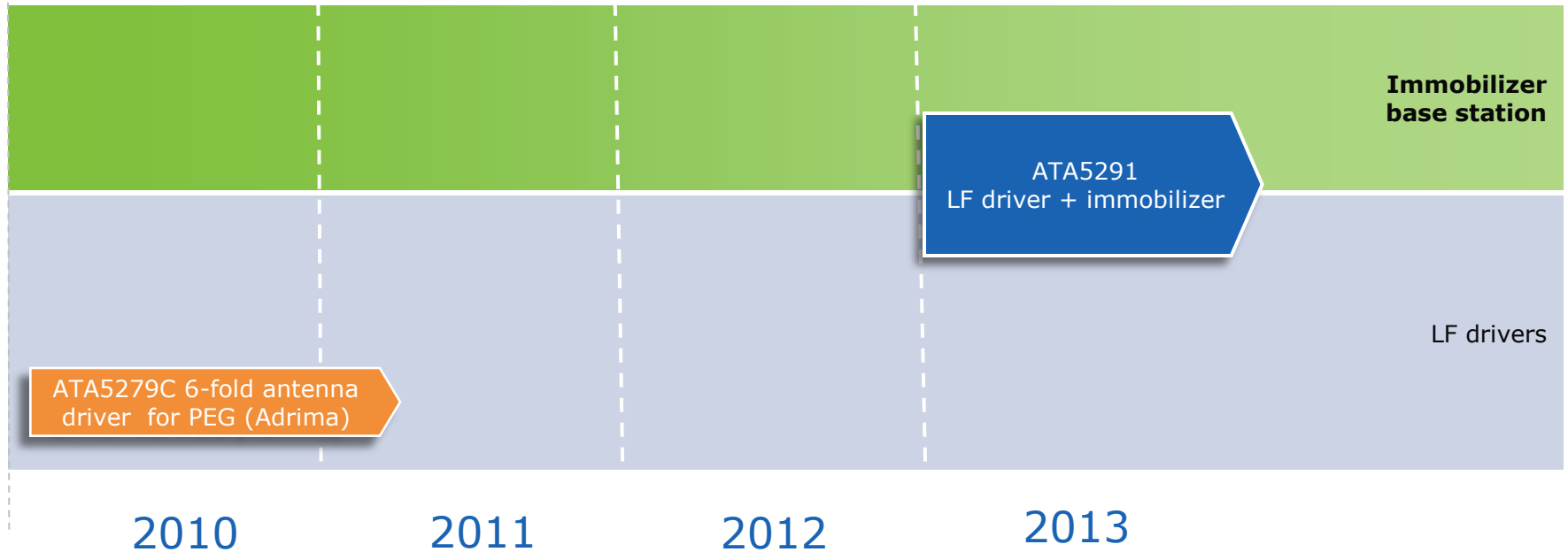
1 ... Requires calibration

2 ... Narrower channel selected

3 ... 10.7MHz IF filter



LF Base-station Roadmap



6-channel LF Antenna Driver: ATA5279C

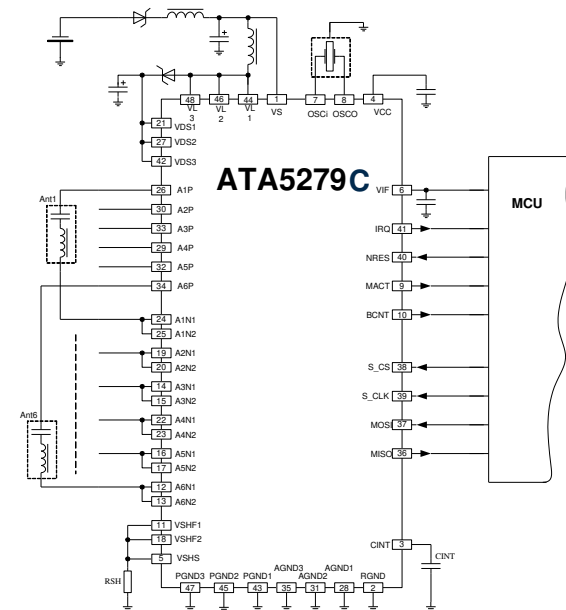
Passive Entry Go: car side

Key characteristics

- 6-channel antenna driver for 125kHz LF coils
- Capability to drive high currents (up to 1A for 3 channels)
- Very low power-down current consumption
- Provides high performance with easy control
- Provides a wake-up and initialized channel to the key fob
- Output driver stage protected against overload and heat

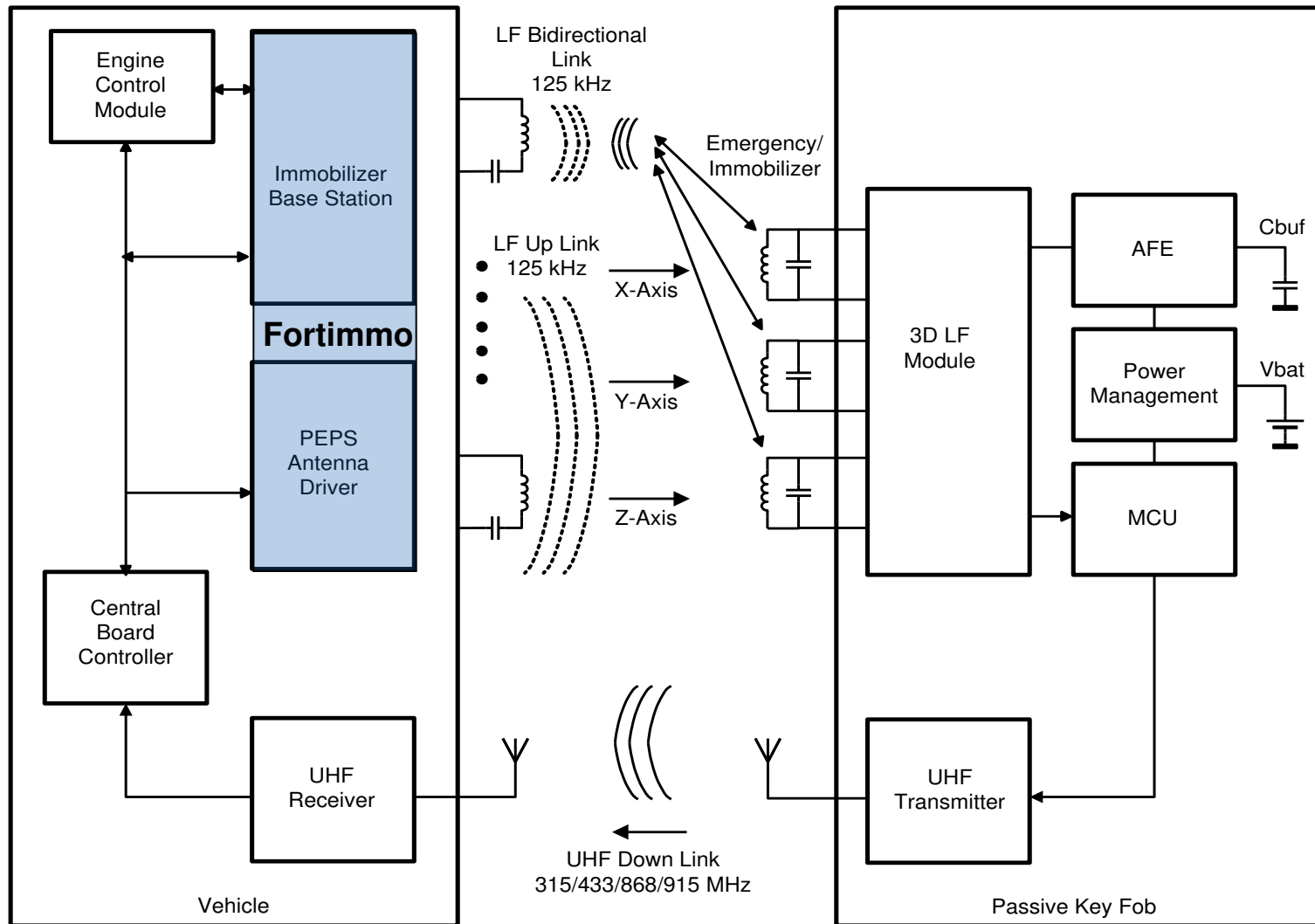
Key features

- Flexible current regulation integrated (20 steps)
- Autonomous timing generation to unload microcontroller
- RSSI measurement supported
- Fault protection and reporting
- Diagnostic mode for antenna check
- Reduced effort for external HOST controller due to:
 - SPI interface for communication and programming
 - Embedded command set (LF data buffer)
 - Low level control
- Cost effective due to low external BOM
- Sinusoidal output signal for improved EMV

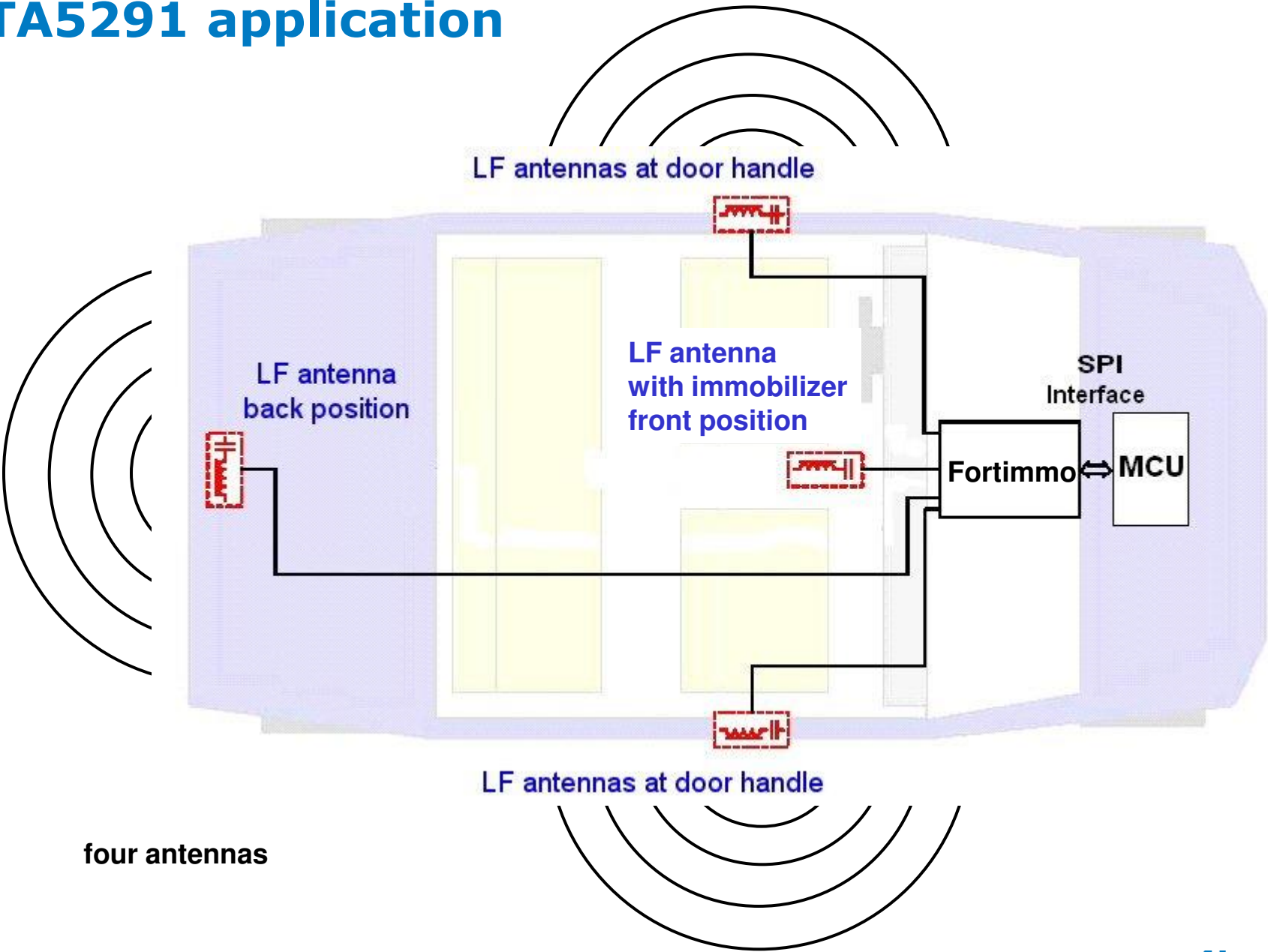


- **Package:** QFN48, 7x7mm
- **Samples available:** now available
- **PPAP available:** available

ATA5291 – LF Driver with Immo Basestation



ATA5291 application



Key Features of LF PEG Products

	ATA5279C	ATA5291
Transmit Channels (Expandable)	6 (9)	4(8)
Current Shaping	Sinus	Prog. Shaping
Immo Base-Station	—	✓
Integrated Boost Converter	✓	✓
Polling	—	✓

ATA5291 – Fortimmo

PEPS Coil Driver & Immobilizer Basestation

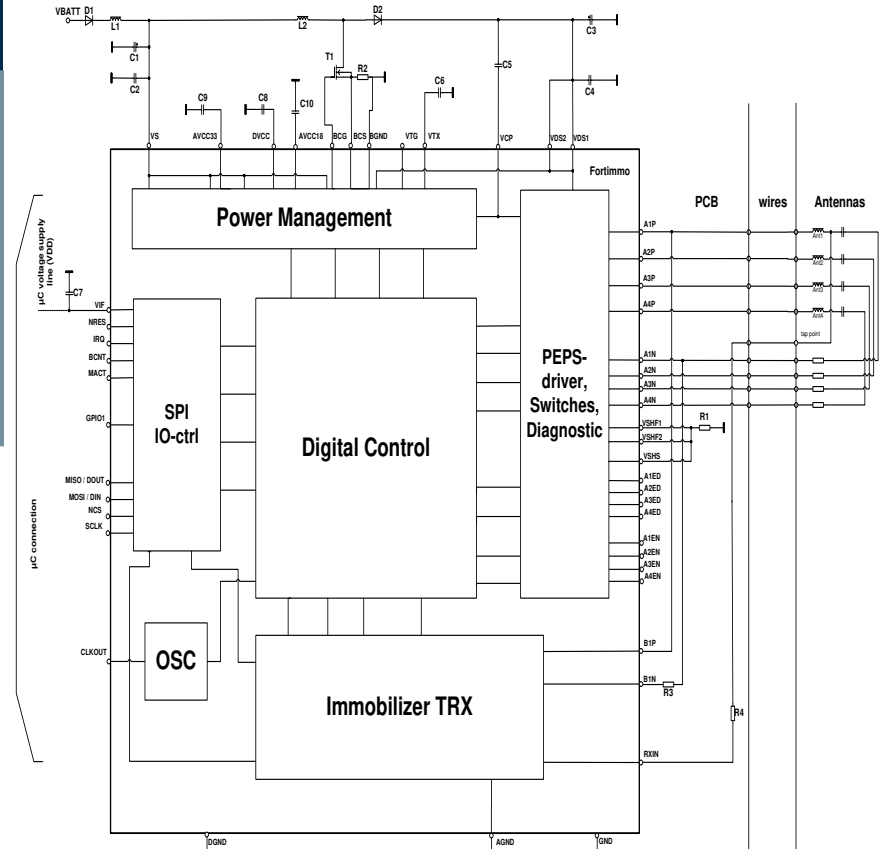
PEPS + IMMO: Vehicle

Key Characteristics

- Derived from the market leading IC ATA5279C
- Highly integrated solution (Base-station + LF drivers)
- Regulated current for stable RSSI measurement
- 1 coil multiplexed for Immo/wakeup function (immo coil can also be separated)
- Compatible with nearly all transponders in the market
- Full diagnostics coverage provides highest safety level

Key Features

- Internal LC Oscillator for carrier generation (+/-0.3%)
- Immobilizer sensitivity of 5mVpp at the tap point
- Wide 7-16.5V operating supply for normal operation
- Jump Start from 7V-28V & Immobilizer down to 5V
- Fast 2Mbit/s SPI interface
- 4 integrated LF drivers with programmable peak current up to 1A adjustable in 20 steps
- Integrated coil multiplexer (4 internal, 4 external) with the ability to drive any of 2 coils together
- Full diagnostic coverage for all channels: Short to GND, VCC and other coil lines. Open detection.
- Programmable carrier shaping (square wave, progressive transitions, sinus)
- Operating temperature: -40° C/125° C



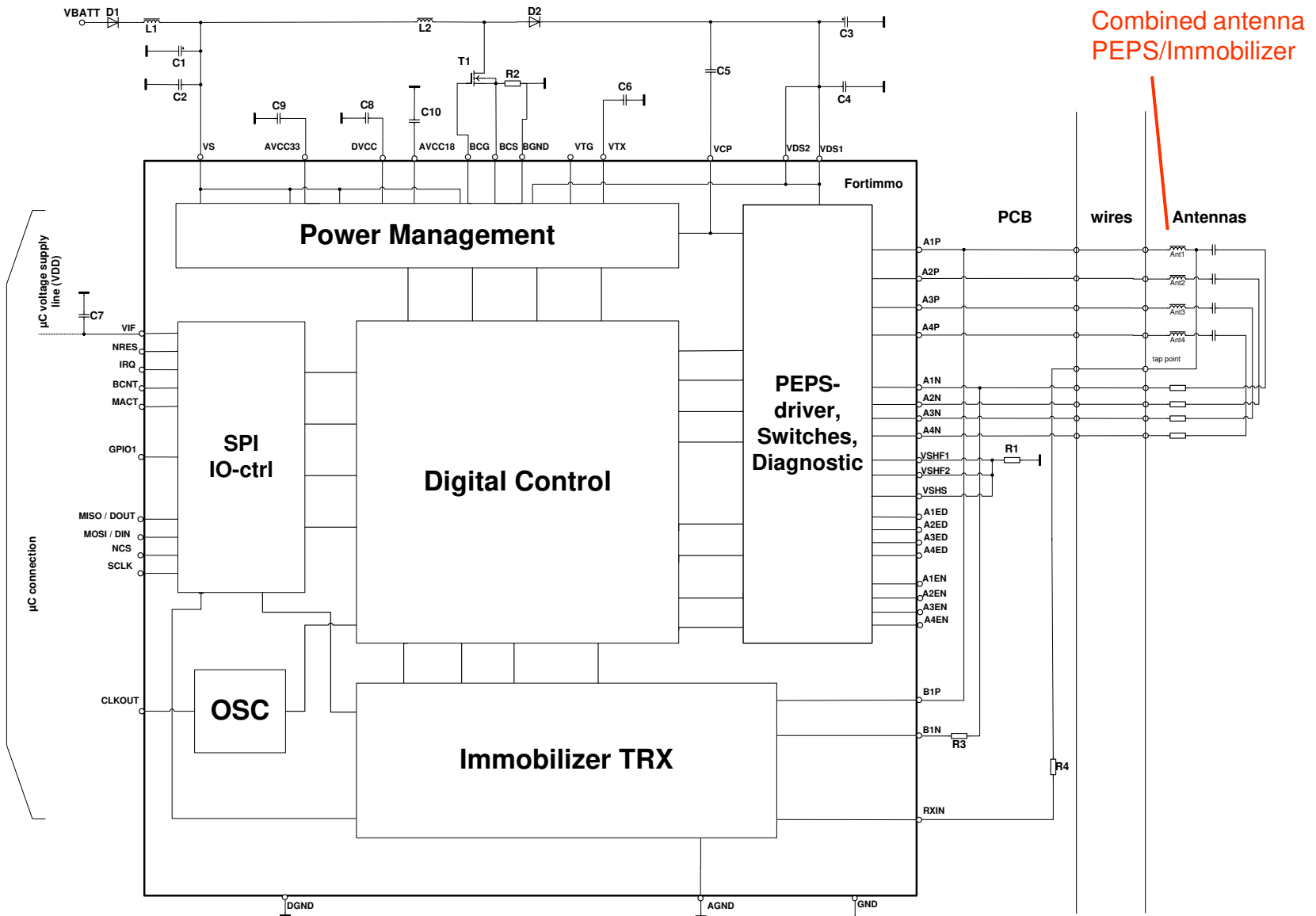
Package:
Samples Available:
PPAP Available:

QFN48 7x7mm
MAY 2013
2Q2014

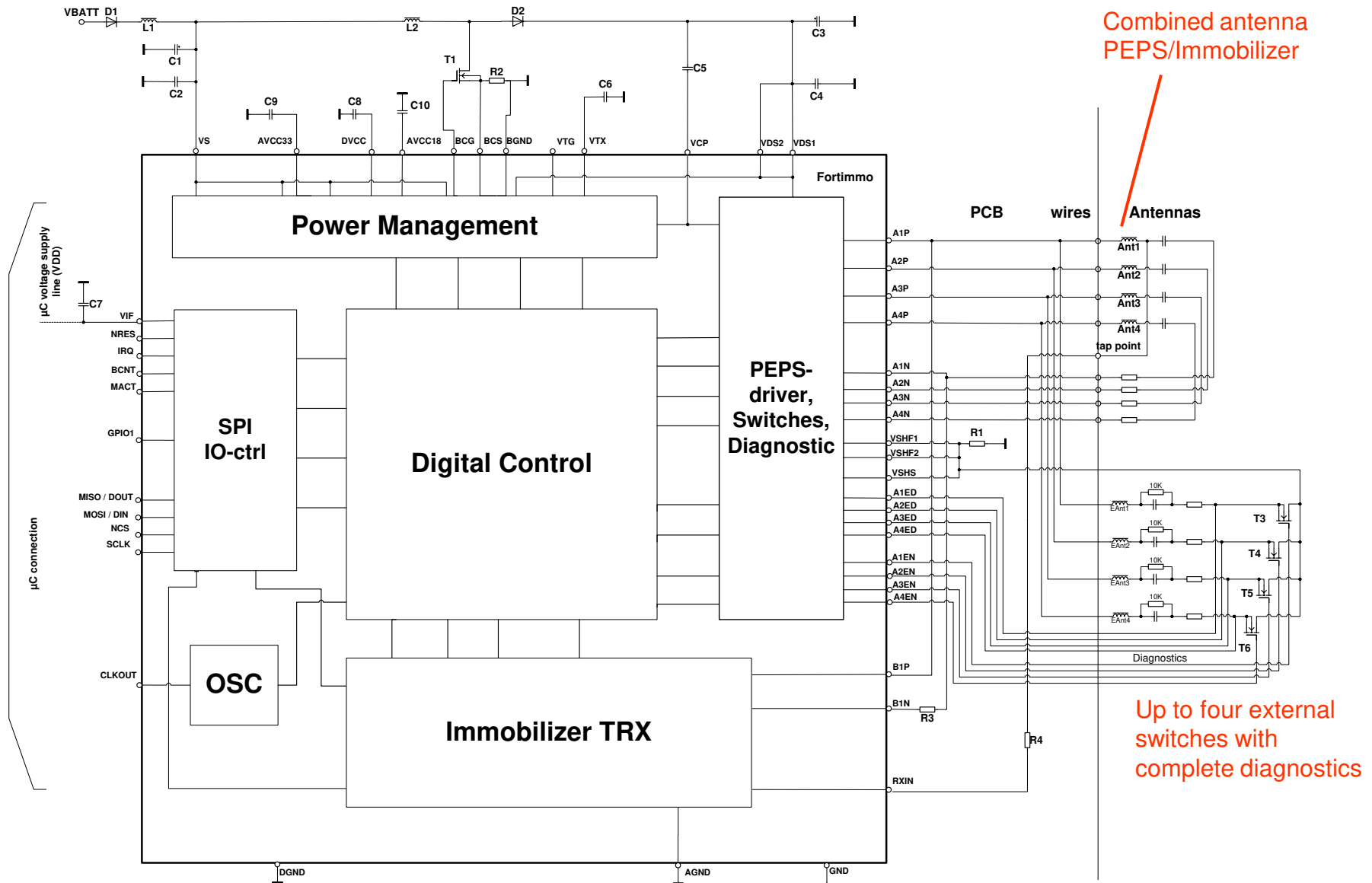
Fortimmo – General Features

- LF carrier frequency from 125 kHz
- Internal LC Oscillator for carrier generation (+/-0.5%)
- Battery power supply voltage from 7V to 16.5V for normal operation, from 7V to 28V for jump start operation and 5V is the minimum required for Immobilizer operation
- Fast SPI interface (2Mbit/s) for Data Access and Configuration, slave select input, multiplex SPI-data with transparent data-in data-out pins
- Ability to support antennas with tuning capacitor far or close to the IC while keeping all diagnostic capabilities.
- Diagnostic functions for electrical and thermal stress conditions
- Output driver stages are protected against electrical and thermal overload
- QFN 7x7-48 with wettable flanks - Operating temperature: -40° C / 125° C

FortImmo application with four coils



FortImmo application with eight coils



Companion Transponder Solution: ATA5580

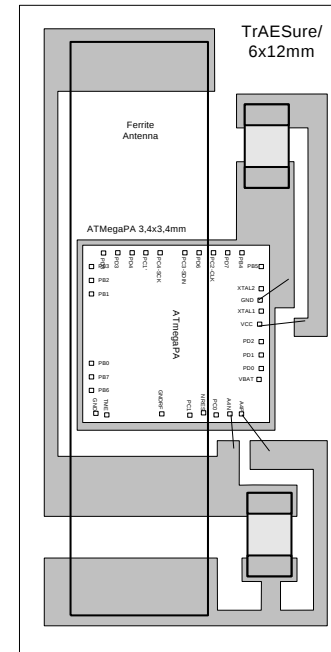
Remote Keyless Entry: service key

Key characteristics

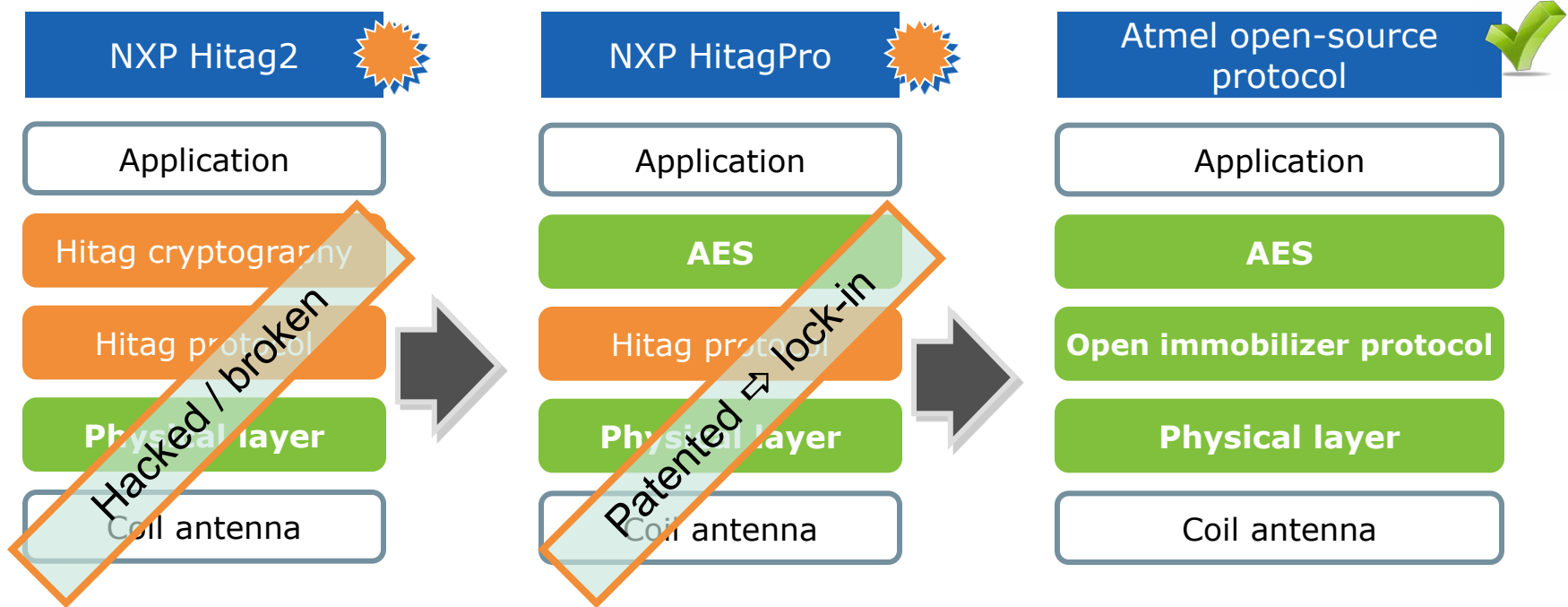
- Stand-alone transponder based on 128bit AES
- Embedded 125kHz antenna
- Atmel open-immobilizer protocol incorporated
- 125kHz immobilizer interface compatible to existing base-station ICs
- Fast AES hardware crypto engine

Key features

- Best companion solution to ATA5795 as the same microcontroller IC is equipped
- Pre-programmed during production process with Atmel's open-source immobilizer protocol
 - AES is basis for open-source immobilizer software library
 - Highest security level for encryption (128bit)
 - Special memory protection secures immobilizer software
- Coupling factor of 1.5
- Same immobilizer approach as in other Atmel ICs
 - ATR5790N (uni- and bi-directional RF)
 - ATR5795 (uni-directional RF)



AES Cipher & Open-source Immobilizer Stack



Download the open immobilizer protocol stack here:
http://www.atmel.com/dyn/products/tools_card.asp?tool_id=17197

Benefits

- Higher security through peer reviewing of protocol design
- Allows mixing LF ICs from different suppliers
- Allows multi-sourcing of immobilizer devices
- Flexible configuration according to customer requirements

Open Immobilizer Stack

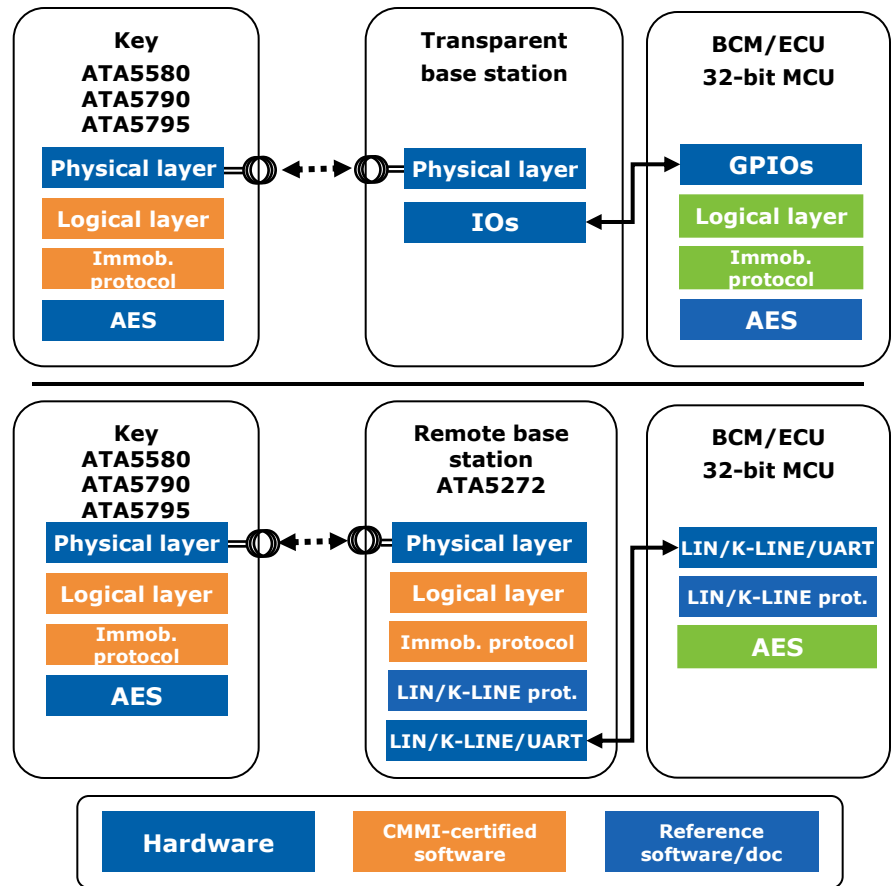
Immobilizer / RKE / PEG: car & key

Key characteristics

- Complete open immobilizer solution
- CMMI certified
- Fast, secure and configurable
 - AES-128 crypto engine with 3 separate keys
 - Configurable uni- and bi-lateral authentication
 - Advanced retry strategy

Key features

- Software runs in all Atmel car access AVR® ICs
- With Atmel ICs a low coupling factor of <1% can be reached
- Compatible with already existing base-station solutions
- Two 128-bit keys stored in protected EEPROM
- One 128-bit transport key
- 32-bit unique identifier
- Configurable challenge/response length (32 – 128 bit)
- Optional CRC on all communication frames
- With enable CRC advanced retry strategy available
- 64-byte configuration stored in EEPROM

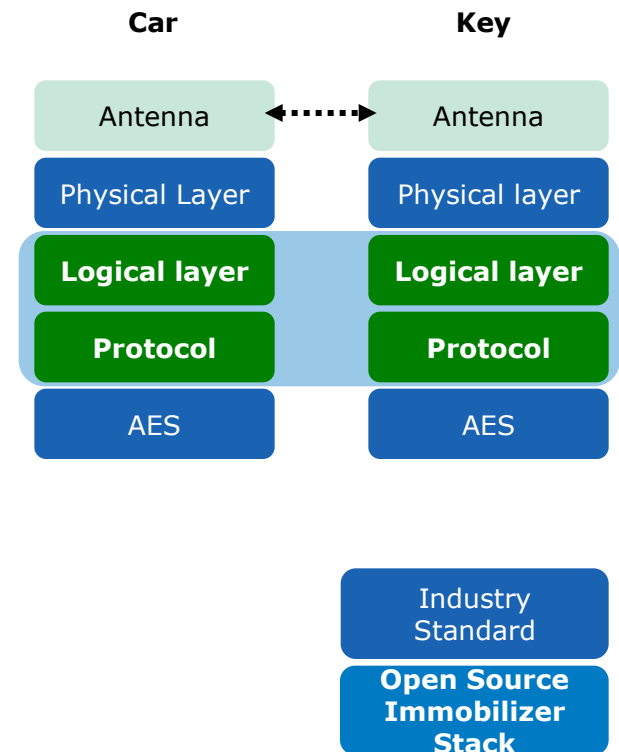


- **CMMI-certified package & doc:** now
- **LIN/K-line protocol example:** now

Open Source Immobilizer Stack

The industry's only fully auditable, immobilizer system!

- Protocol layer definition based on third-party audit firm specializing in Automotive Security, Escrypt GmbH
- Definition reviewed and amended by Tier1 suppliers and Car Manufacturers
- Open Source license allows any party to enhance or review the protocol for the industry's benefit
- Allows interoperability of existing Immobilizer ICs (protocol is implemented in software)
- Available upon free registration on Atmel's website



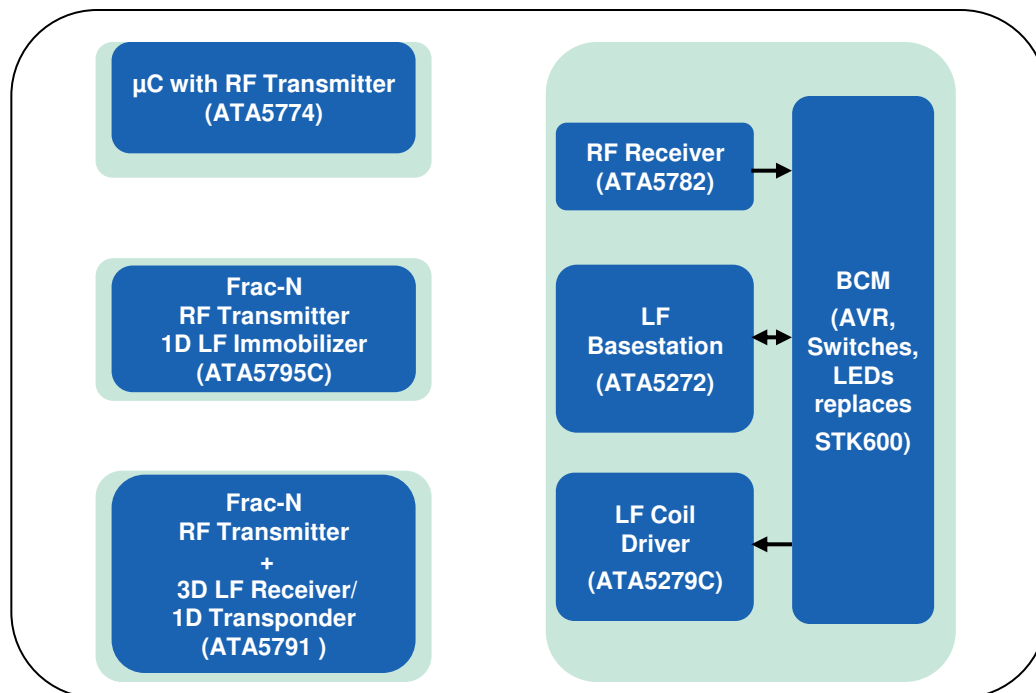
Evaluation Kit: ATAK51003-V1

- Complete Car Access Reference System – IMMO+PEPS+RKE

Key Characteristics

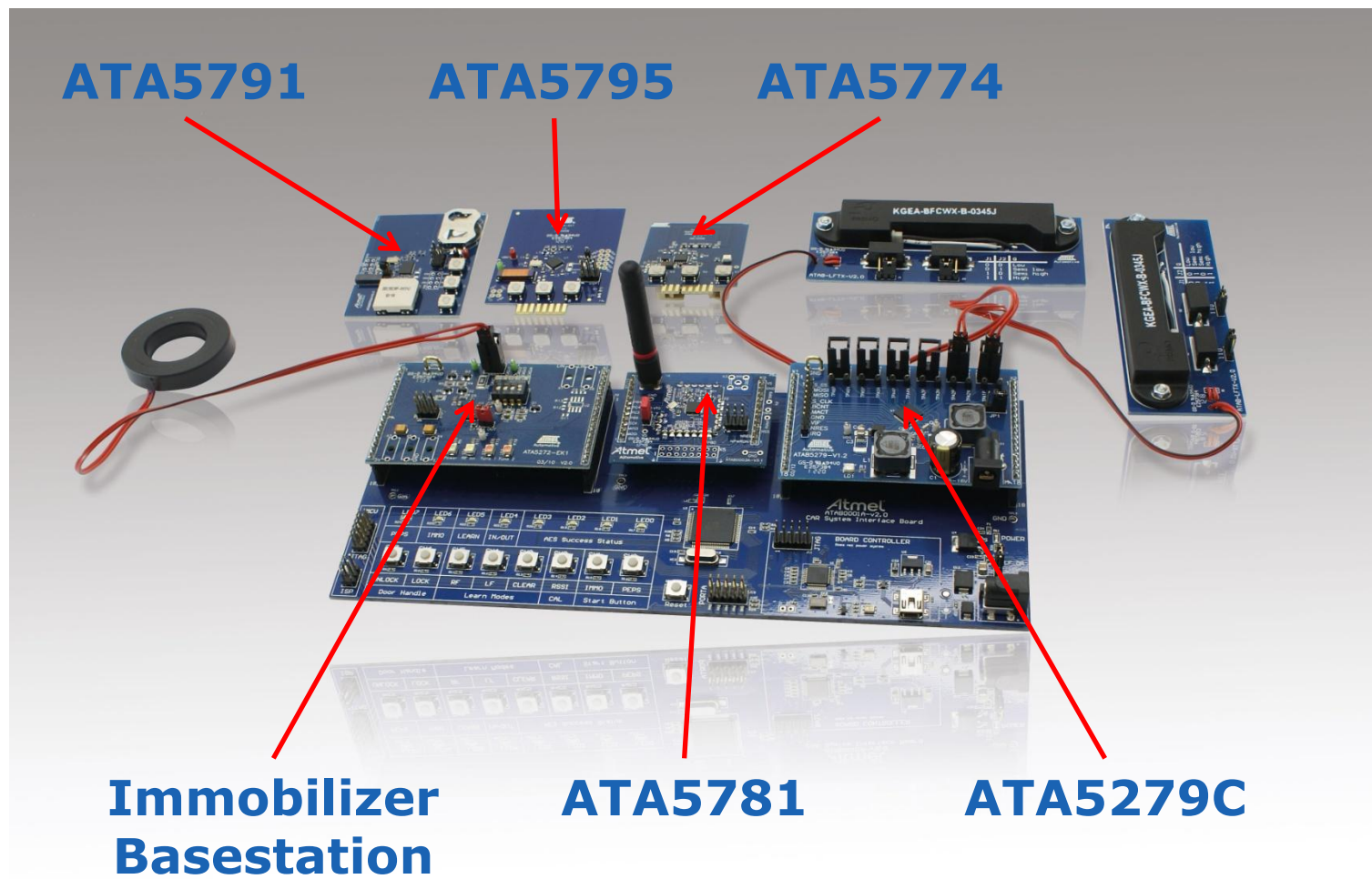
- Contains reference designs for new devices:
 - OmegaII ATA5781
 - PrimusX+ (ATA5791) – PrimusX and Atik die in same package
- Kit uses Open PEPS Protocol (RF+LF) and Open Immobilizer Protocol (LF)

Available:
Now



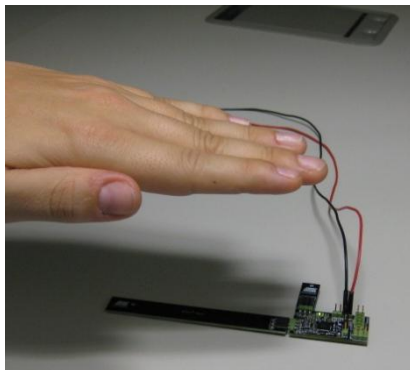
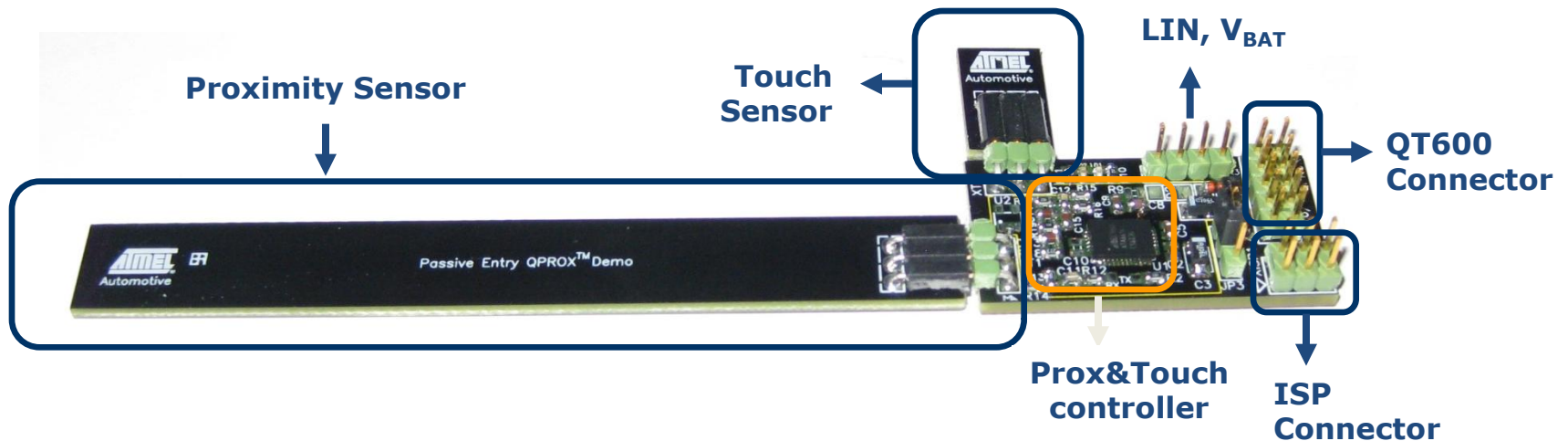
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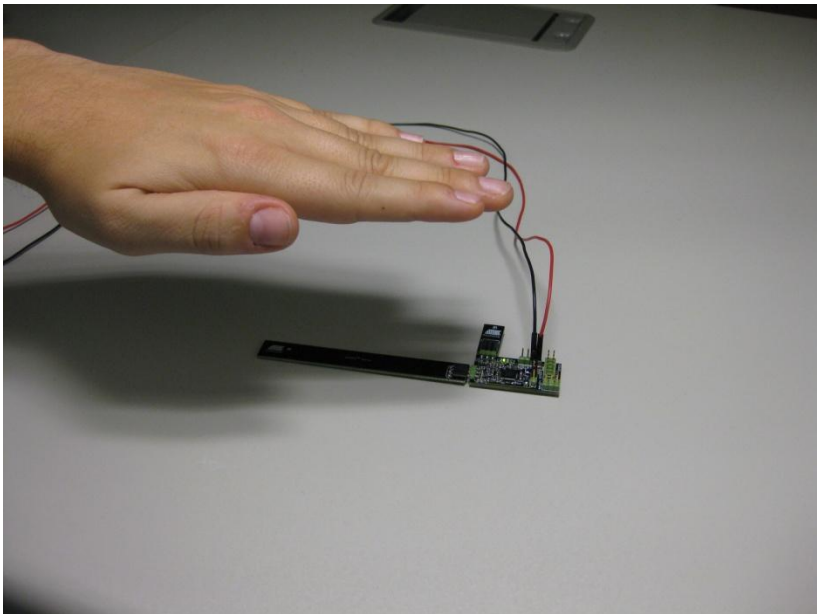
Door Handle Solution

- Using a ATA6616 (LDO, LIN interface and Tiny167 microcontroller)
- Optimized for space and connectivity



Proximity detection at 150mm distance

Real case setup – Approaching Hand



Proximity detection in 150mm distance



Tiny44 Demo within Door
Handler

Innovation Lead By Atmel

- Car manufacturers are locked-in with hacked immobilizer protocols (HiTag-2)
 - Open standard cryptography
 - Open communication protocols
- Crowded RF spectrum: passive start or RKE systems jammed by RF interferers
 - Industry leading RF blocking characteristics
 - Multi-channeling protocols
- Enabling industry longest battery lifetime on key fob while expanding functionality
 - Automatic scanning of TPMS, RKE, PEG and remote start channels without microcontroller assistance

Atmel's Solution Benefits For OEM-Tier 1

- **Innovation**

- TPMS & car access as sub-channels with 1 receiver → ATA5745, ATA5780N
- Ultra low power consumption for PEPS Key fob

- **Performance**

- Increase RKE distance (at reduced power budget) → Up to 12.5dBm outpower for Tx
- Increase passive entry distance → ATA5790N with 1.5mV sensitivity
- Greater robustness against noise (e.g. 3 sub-channel) → ATA5780N

- **Open Platform Immobilizer**

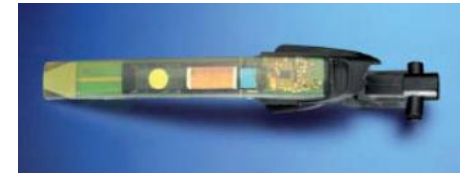
- Remove proprietary protocols that does not require being tied to N** supplier, no monopoly
- OEM- Tier 1 fully in control of Immobilizer software source code

- **Cost Down**

- Next generation PEPS solution with better cost option
- Single chip PEPS keyfob ATA5791
- Complete PEPS, RKE solution, single stop shop (Door handle to PEPS ECU)

Car Access Customer Highlights

- Customer List:
 - Continental
 - Hella
 - BOSCH
 - Lear China
 - Kostal China
 - Magneti Marelli China
 - Mitsubishi Automotive Japan
 - Mobis Korea
 - Denso Japan
 - Alps
 - Omron
- Key OEM
 - BMW
 - GM
 - Ford
 - VW Group
 - FIAT
 - Chrysler



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