



# Leveraging NFC and EEPROM for enhanced smart mobility solutions

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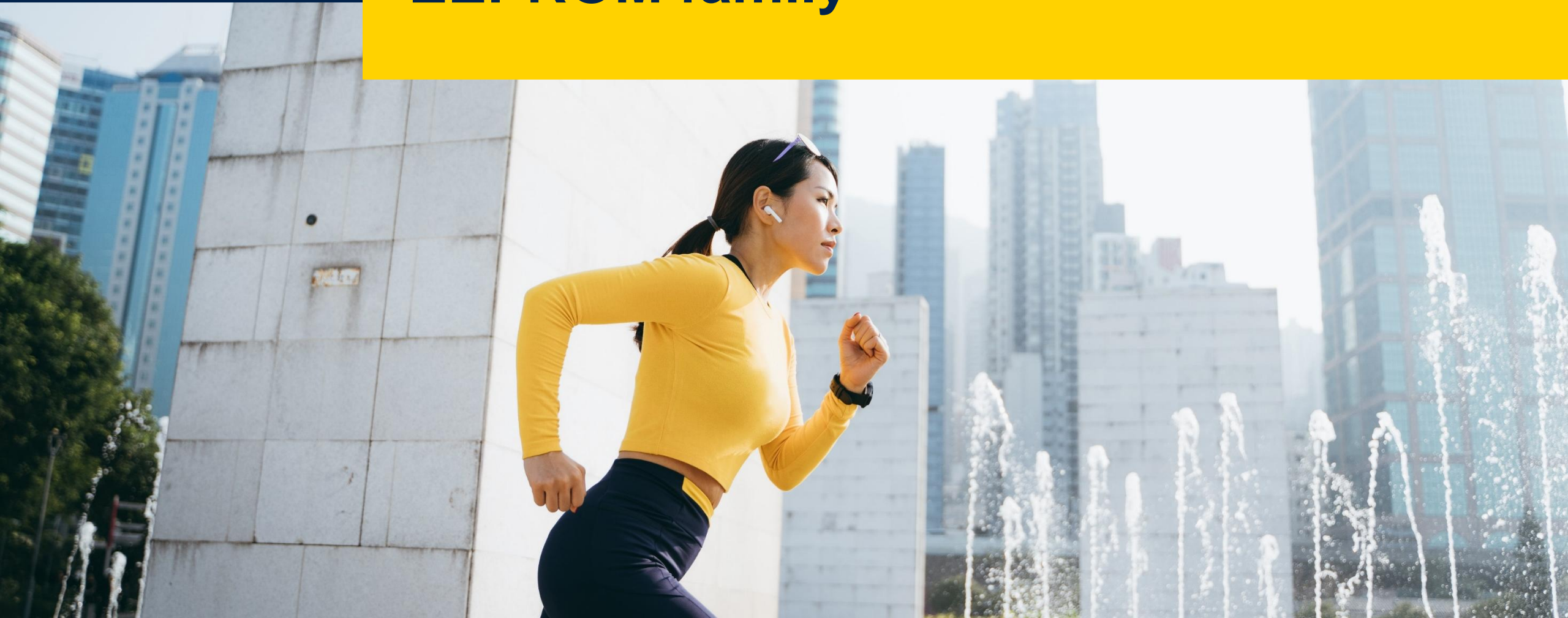
STMicroelectronics

# Agenda

1 [EEPROM family](#)

2 [ST25R500/501 Automotive NFC Reader](#)

# EEPROM family





# #1 in EEPROM worldwide for 20 years

2005 -> 2025



**Almost 40 years since introduction**

EEPROM Initiatives launched between 1985 and 1987 (SGS & Thomson)

**30% WW market share\***

200 patents registered

\*Source: OMDIA Competitive landscaping tool – March 2025



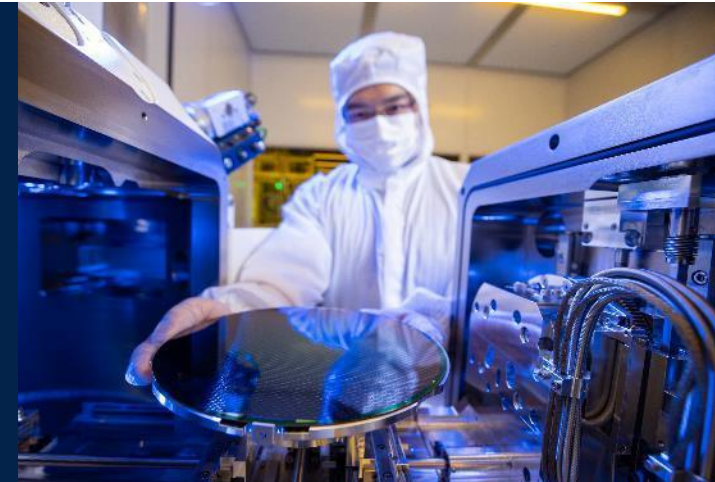
**> 50% Auto market share\***

More than 4 ST EEPROM in every car

\*Source: Estimated ST

**Over 40 billion units**

More than 400 part numbers





# ST EEPROM extended portfolio

Serial EEPROM

**NEW** Page EEPROM

**NEW** UID EEPROM

F9V



256Kb 512Kb 1Mb 2Mb 4Mb

E40

8Mb → 64Mb

32Kb → 2Mb

F8H

2Kb - - 128Kb 256Kb 512Kb 1Mb 2Mb

SPI QUAD  
85°C, 105°C, 125°C  
SO8N, DFN8, WLCSP

I<sup>2</sup>C, 85°C, SO8N

I<sup>2</sup>C, SPI, Microwire  
85°C, 105°C, 125°C, 145°C  
SO8N, TSSOP, DFN8, DFN5, WLCSP, Bare die

Standard  
30% market share

Automotive  
50% market share

New perspectives  
Best power/performance ratio!

New perspectives  
Identification, sustainability





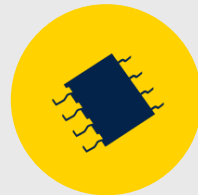
# Assets identification with unique ID EEPROM



UID EEPROM
User memory
128-bit UID

The UID EEPROM consists of reliable **user memory** and a factory-programmed-and-locked **128-bit Unique Identifier**.

- **User memory:** 32-Kbit to 2-Mbit
- **Bus protocol:** I<sup>2</sup>C
- **Voltage range:** 1.7 to 5.5 V
- **Package:** SO8N
- **UID size:** 128 bits



Note: Any other device available upon request

<b>1</b>	<b>Identification</b>	<ul style="list-style-type: none"> <li>• Device recognition</li> <li>• Counterfeiting detection</li> </ul>
<b>2</b>	<b>Traceability</b>	<ul style="list-style-type: none"> <li>• Manufacturing Tracking</li> <li>• Supply chain management</li> </ul>
<b>3</b>	<b>Sustainability</b>	<ul style="list-style-type: none"> <li>• Recycling and reparability</li> <li>• Regulatory compliance</li> </ul>





# Industrial EEPROM portfolio

		1Kb	2Kb	4Kb	8Kb	16Kb	32Kb	64Kb	128Kb	256Kb	512Kb	1Mb	2Mb	4Mb
<b>I2C</b>	SO8N	•	•	•	•	•	•	•	•	•	•	•	•	
	TSSOP8	•	•	•	•	•	•	•	•	•	•	•	•	
	DFN8		•	•	•	•	•	•	•	•	•	•	•	
	DFN5		•	•	•	•	•	•	•	•				
	WLCSP				•	•	•	•	•	•	•	•	•	
	Wafer form / Die					•	•	•	•	•	•	•	•	
<b>SPI</b>	SO8N	•	•	•	•	•	•	•	•	•	•	•	•	•
	TSSOP8	•	•	•	•	•	•	•	•	•	•	•		•
	DFN8		•	•	•	•	•	•	•	•	•			
	WLCSP					•		•	•	•	•		•	•
	Wafer form / Die						•			•	•	•		•
<b>MW</b>	M93C - SO8N	•	•	•	•	•								
	M93C - TSSOP8	•	•	•	•	•								
	M93C - DFN8			•		•								
	M93S* - SO8N	•	•	•										

Note: M93S series feature a programmable write protect

## Available Packages

SO8N	TSSOP8	DFN8	DFN5	WLCSP
				
6 mm x 5 mm 1.75 mm Thick 80 mg	6.4 mm x 3 mm 1.2 mm Thick 34 mg	2 mm x 3 mm 0.6 mm Thick 16 mg	1.4 mm x 1.7 mm 0.6 mm Thick 6 mg	~1 mm <sup>2</sup> 0.5 mm Thick 1 mg
up to 4Mb	up to 4Mb	up to 512Kb	up to 256Kb	up to 4Mb





# Industrial plus EEPROM portfolio

		2Kb	4Kb	8Kb	16Kb	32Kb	64Kb	128Kb	256Kb	512Kb
I2C	105°C	-	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8
SPI	105°C	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8

## Available Packages

SO8N	TSSOP8
 <p>6 mm x 5 mm 1.75 mm Thick 80 mg</p> <p>up to 512Kb</p>	 <p>6.4 mm x 3 mm 1.2 mm Thick 34 mg</p> <p>up to 512Kb</p>





# Automotive EEPROM portfolio

		1Kb	2Kb	4Kb	8Kb	16Kb	32Kb	64Kb	128Kb	256Kb	512Kb	1Mb	2Mb	4Mb
SPI	125°C	-	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8	SO8N	SO8N TSSOP8
	145°C	-	-	TSSOP8	TSSOP8	TSSOP8 Wafer	TSSOP8	TSSOP8 Wafer	TSSOP8	TSSOP8	TSSOP8	TSSOP8		TSSOP8
I2C	125°C	-	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8 DFN8	SO8N TSSOP8	SO8N	
MW	125°C	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8	SO8N TSSOP8								

## Available Packages

SO8N	TSSOP8	DFN8
		
6 mm x 5 mm 1.75 mm Thick 80 mg	6.4 mm x 3 mm 1.2 mm Thick 34 mg	2 mm x 3 mm 0.6 mm Thick 16 mg
up to 4Mb	up to 4Mb	up to 512Kb

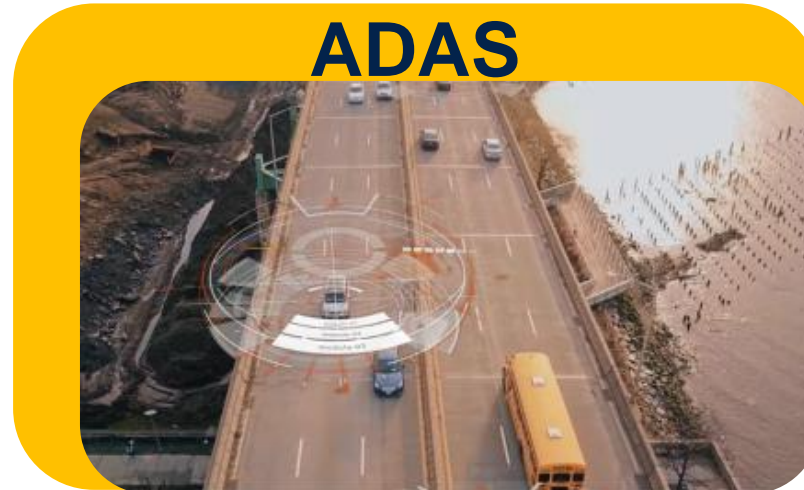


# ST EEPROM in All car Applications

**Powertrain**



**ADAS**



**Body & convenience**



**Multimedia**



**Chassis & safety**



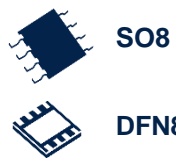
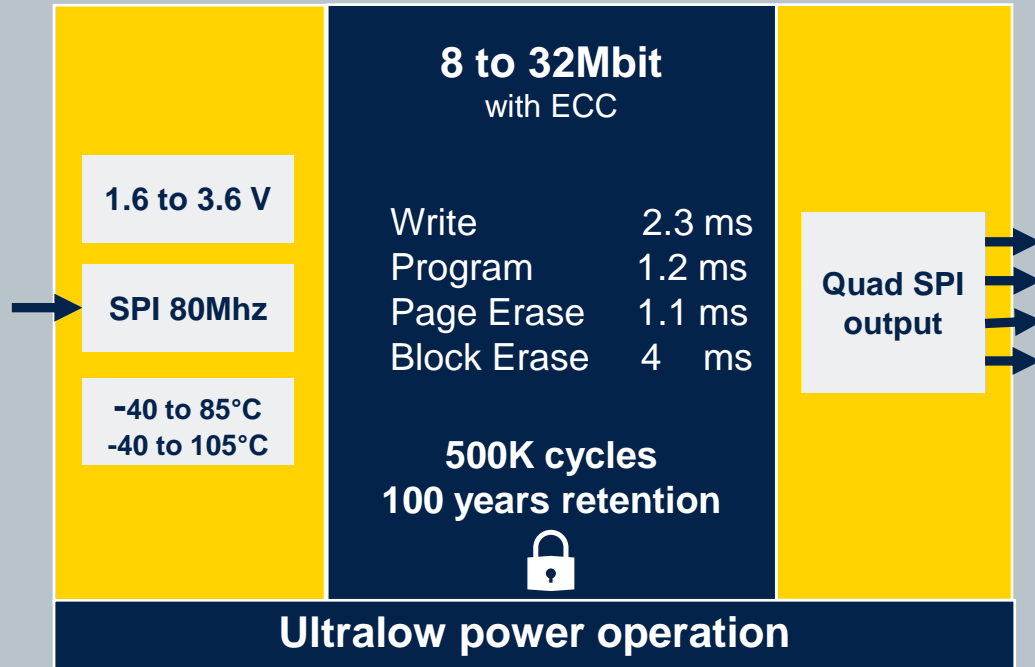
**Page EEPROM**





# Page EEPROM ID Card

## Page EEPROM



## SPI interface

- Wide voltage & temperature range
- Fast wake-up
- SPI Single input
- SPI Single/Dual/Quad output

## Memory architecture

- Page size 512 bytes
- Write byte flexibility
- Fast program page
- Fast erase page, sector, block, chip
- Buffer load while program

## Ultra Low Power

- Lowest operating current on market
- Peak current control
- Deep power down

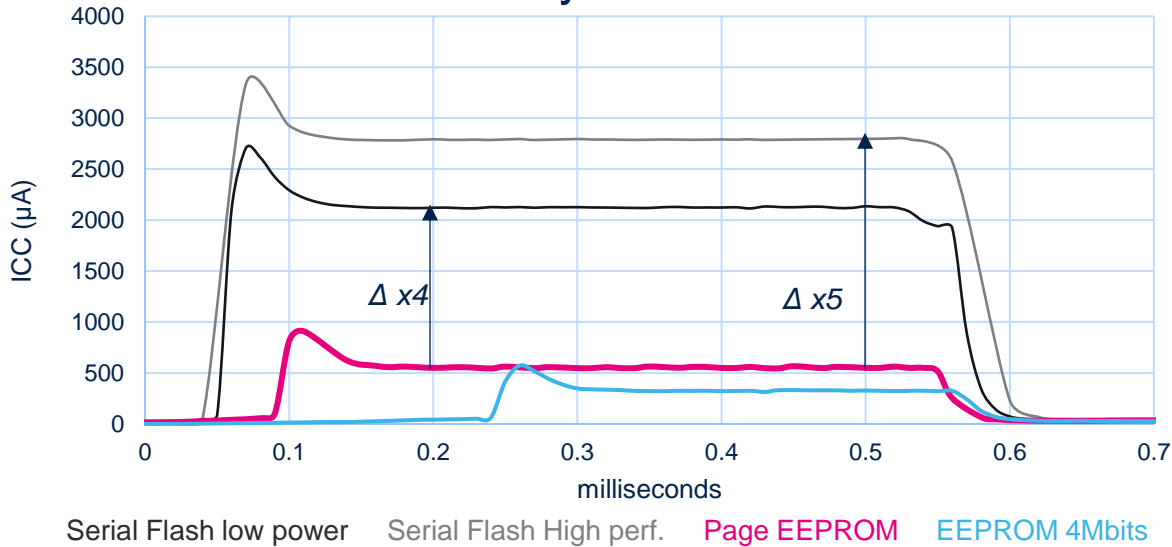
## High quality

- Error Code Correction (ECC)
- Safety flags
- Read only protection
- High endurance and retention

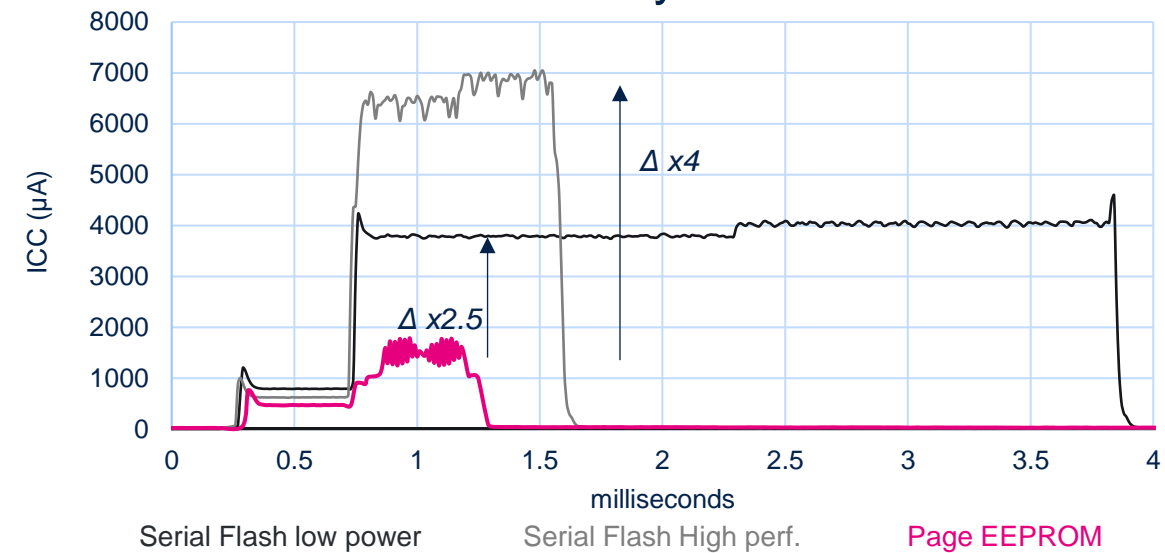


# Ultralow power consumption

## READ 256 bytes 1.8 V at 4 MHz



## PROGRAM 256 bytes 1.8 V at 4 MHz



- Page EEPROM Read **current = 500µA** (1.8 V 4 MHz)
  - Consumption **divided by 5** vs Serial FLASH
- Current peak **< 1 mA**

**Consumption close to EEPROM 4 Mbit**

- Page Program consumption and peak **< 2 mA**
- Page Program instruction **faster than Serial Flash**

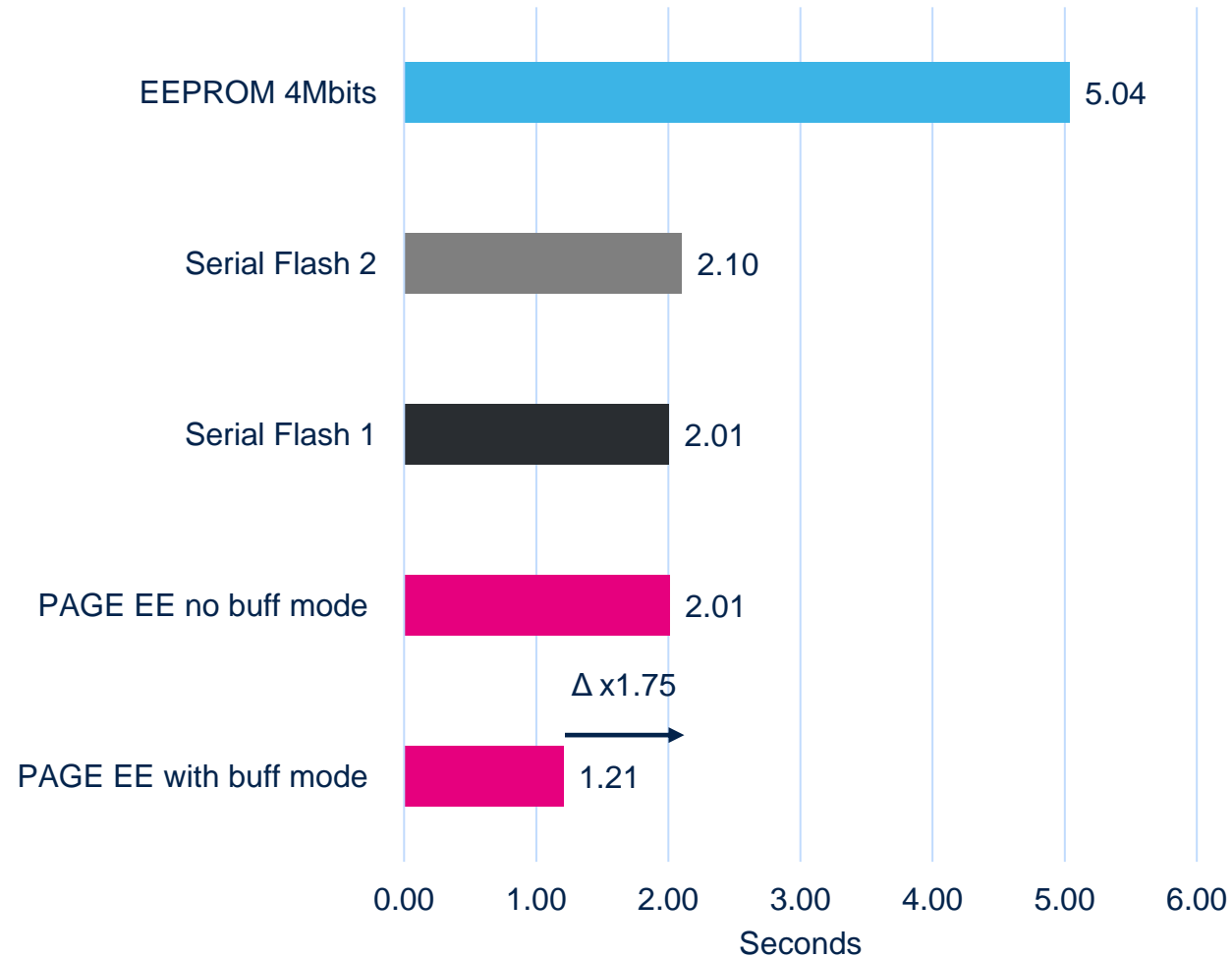
**High energy\* reduction (x6 to x12)**

\*Voltage x Current x Time



# Manufacturing

## Programming 4 Mbit of data at 5 MHz



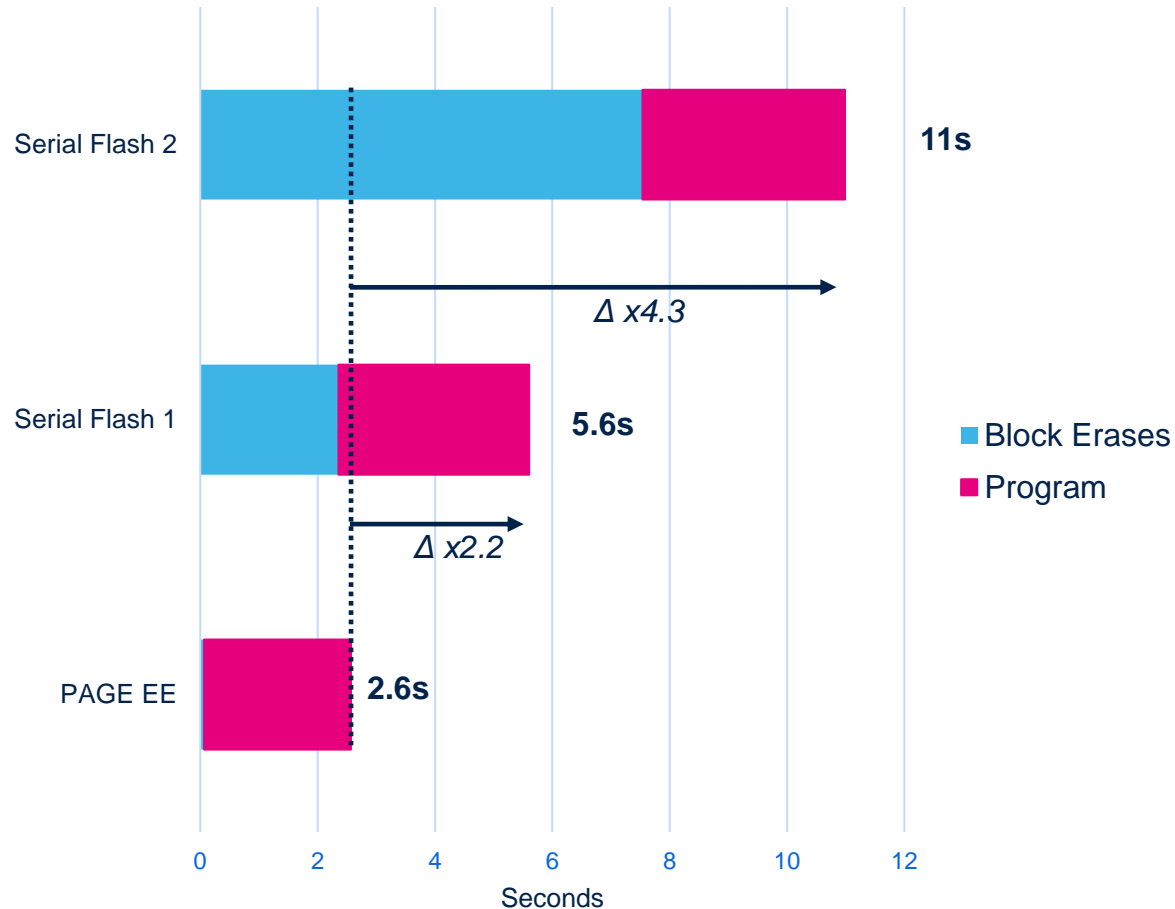
- **Fast Page Program: 512 bytes in 1.2ms**
- Buffer mode is **x1.75 faster** than Serial flash
  - Buffer mode hides SPI communication
  - Very efficient between 4MHz to 40Mhz
- To program 100k parts it takes:
  - ~ 33h with Page EEPROM
  - ~ 55h with serial Flash

**One production day is saved**



# Firmware over the air (FOTA)

FOTA scenario : 8Mbits uploaded at 80MHz



- **Ultra fast erase:**

- Page erase in 1.1ms
- Sector erase in 1.3 ms
- Block erase in 4 ms
- Chip erase in 15 ms

- **Program and Erases are both faster than Serial Flash**

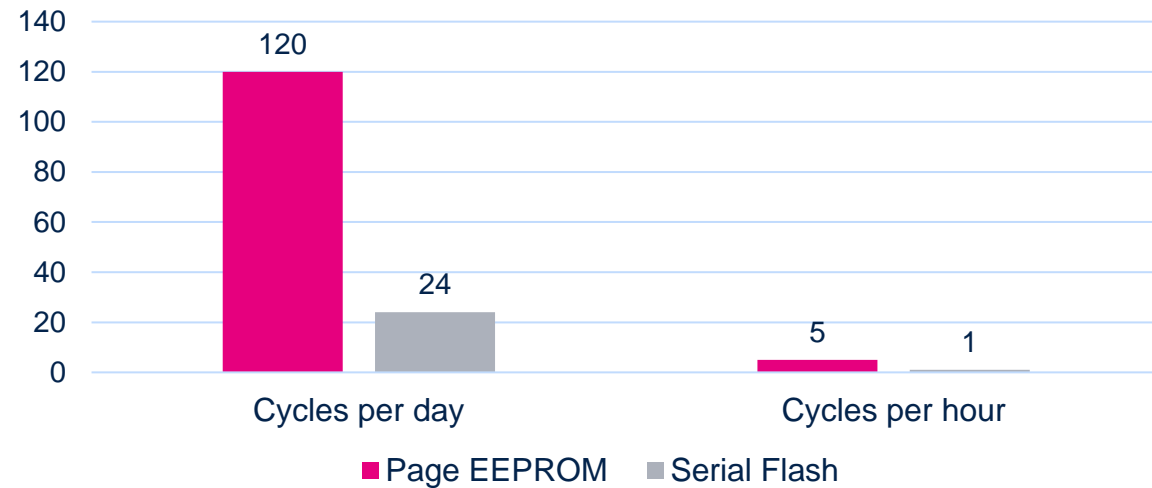
**Application downtime highly reduced with Page EEPROM**





# Data logging & event recording

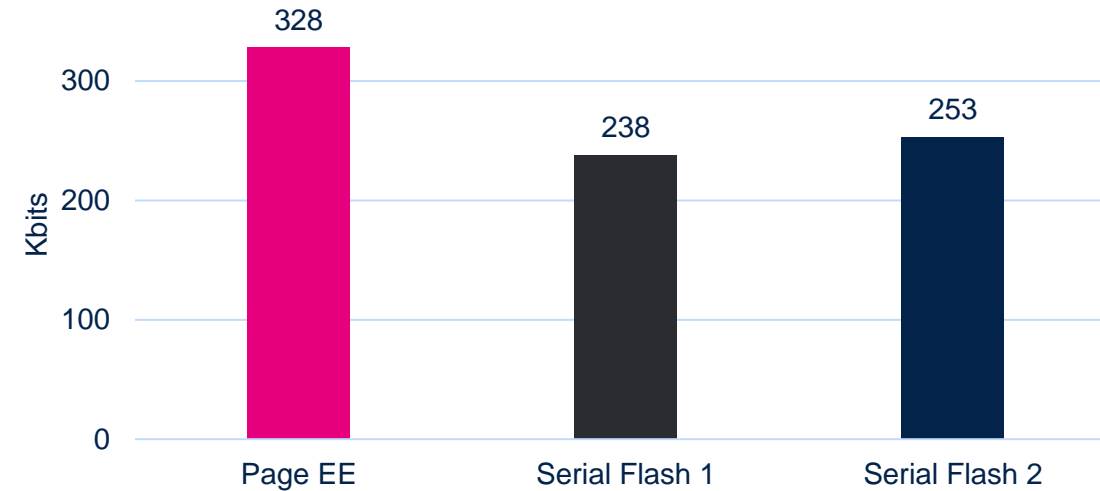
### Datalogging frequency over a page for 10 years



- Page EEPROM **high endurance**:
  - **500k** cycles per page (full T°)
  - **x5 more cycling** than Serial Flash

**Easy update with page write instruction**

### Event Recording: 100 ms of programming at 80MHz



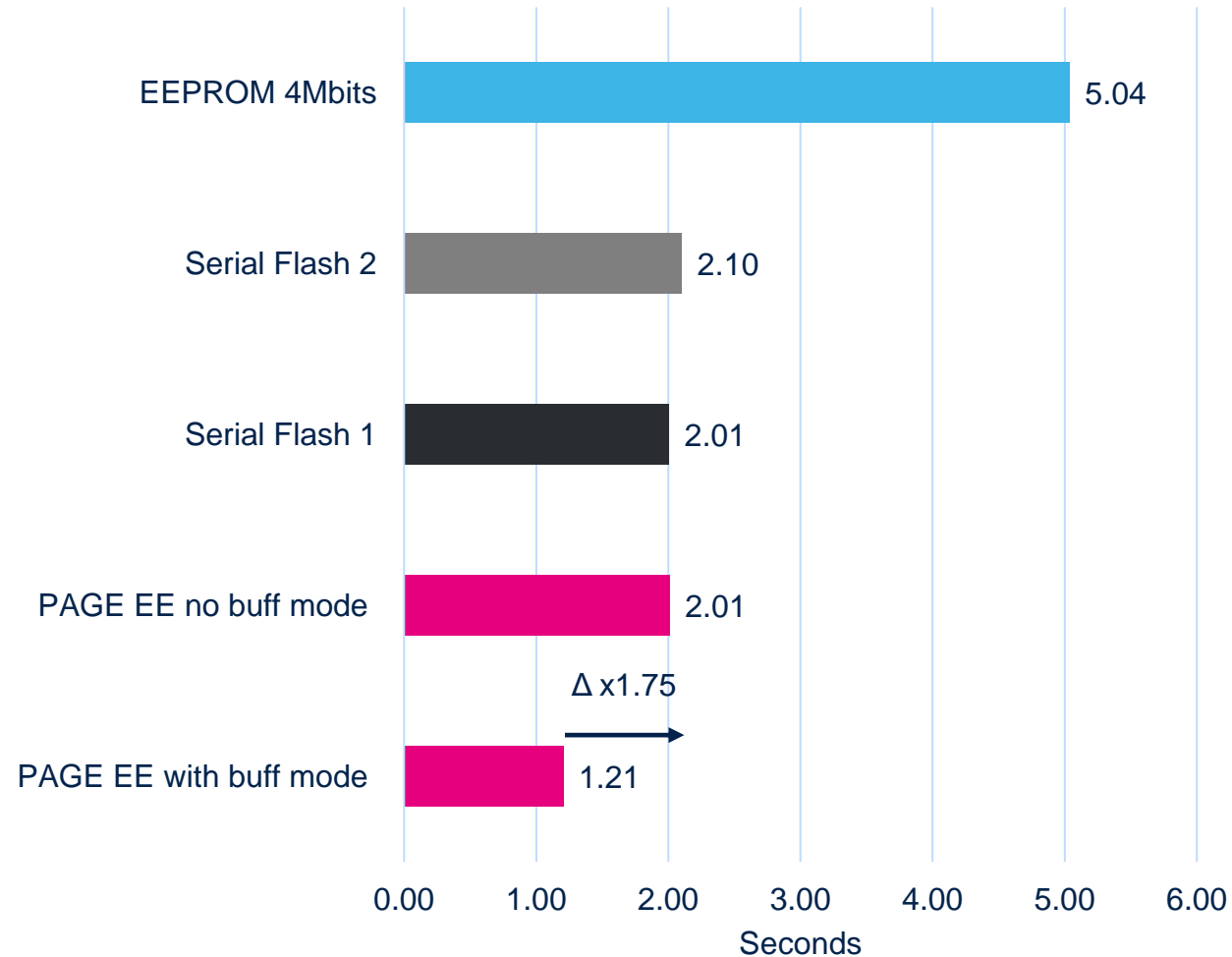
- Fast program **512 bytes in 1.2ms**

**+35% data stored than Serial Flash**



# Manufacturing

## Programming 4 Mbits of data at 5 MHz



- **Fast Page Program: 512 bytes in 1.2 ms**
- **Buffer mode is x1.75 faster** than Serial flash
  - Buffer mode hides SPI communication
  - Very efficient between 4MHz to 40MHz
- To program 100k parts it takes:
  - ~ 33h with Page EEPROM
  - ~ 55h with serial Flash

**One production day is saved**



# Merging EEPROM and Serial Flash benefits

## Standard EEPROM

Easy datalogging  
High cycling endurance  
very long retention

## Serial NoR Flash

Firmware management  
High density memory  
High speed communication



**Page EEPROM**

# ST25R500/501 Automotive NFC Reader





# NFC Automotive Reader – Key messages

## What it does



- ST25R is the Master device and provides power: phone readout with empty battery
- Communication with NFC enabled mobile phone (>70% adoption rate) for iOS or Android



**>2W power** for excellent interaction range and

**smallest antenna** size, combined with

**long range phone/card detection**

for **best customer experience**

by **tapping** a phone to the car.

Payment, Car access, Car start, ...

[www.st.com/st25r](http://www.st.com/st25r)



or



# ST25R500/501 use cases

## Car access



Compliant to CCC DK3.0 specs  
Largest wake up range on market

## NFC card protection



Protects NFC cards like credit card,  
access cards from powerful Qi field

## Car start



Compliant to CCC DK2.0 specs

## Car sharing



Allows shared key  
with preference settings

## Consumable authentication



Increases safety, traceability, and  
convenience of replacement parts

## Payment



In-car or external payment  
for electric charge



# ST25R500/501



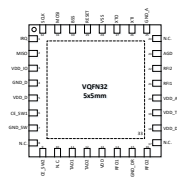
## ST25R500/501

<b>Reader Writer</b>	<b>ISO14443 ISO15693 FeliCa</b>	<b>RAM BUFFER</b>	<b>SPI</b>
P2P	<b>NFC</b>  848kb/s	256-Byte	Vdd: 2.7-5.5V
Card Emulation			VddIO: 1.65-5.5V 10Mb/s >2.7V 5Mb/s <2.7V
2W	DPO: Dynamic Power Output LRCD: Long Range Card Detection AWS: Active Wave shaping NSR: Noise Suppression Receiver AAT: Automatic antenna tuning		
1.6W			



5x5 QFN32  
Wettable flank

4x4 QFN24  
Wettable flank



### Use cases

- CCC DK3.0 access and start, NFC charging (keyfob), NFC card protection, pairing, Consumable detection

### Key features

- CR13 NFC, CCC DK, MFi compliant
- Up to **2W** power (R500), **Active Wave shaping, Noise Suppression**
- **Largest phone/card detection, LPCD compliant to MFi, Heartbeat**
- **Single supply 2.7-5.5V Vdd** with reduced capacitor BOM;
- QFN-32 WF 5x5mm (R500) **very small QFN24 WF 4x4mm** (R501)
- -40°C to 105/**125°C** ambient temperature range

### Key benefits

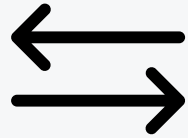
- Outstanding wake-up/card detection range equals read range
- Best performance for Digital Key center console applications



# ST25R500/501

## Key performance parameters

### Outstanding range Best customer experience



- Largest detection range (phone or card) on the market
- Up to 70% more range vs state of the art devices
- Achieves device makers range requirements much easier and with smaller antenna size

### Low power consumption



- Increase battery lifetime during key detection
- Fully autonomous wakeup compliant to MFi Specs

### Noise immunity Low emissions



- Increased immunity to interference from noise sources
- simplifies electro-magnetic immunity and certification.

### Distinguish phone from NFC card



- Protects valuable asset and the brand image using WPC
- Protects against relay attacks of a card with a phone

### Very small package



- 4x4mm package reduces PCB size by 40% or 9mm<sup>2</sup>
- Easier designs on small doorhandle PCB (sometimes less than 14mm height)

### MFi/ CCC/ NFC Forum compliant



- Satisfies all requirements of mobile phone makers
- Makes NFC Forum and CCC DK easier to achieve

### others

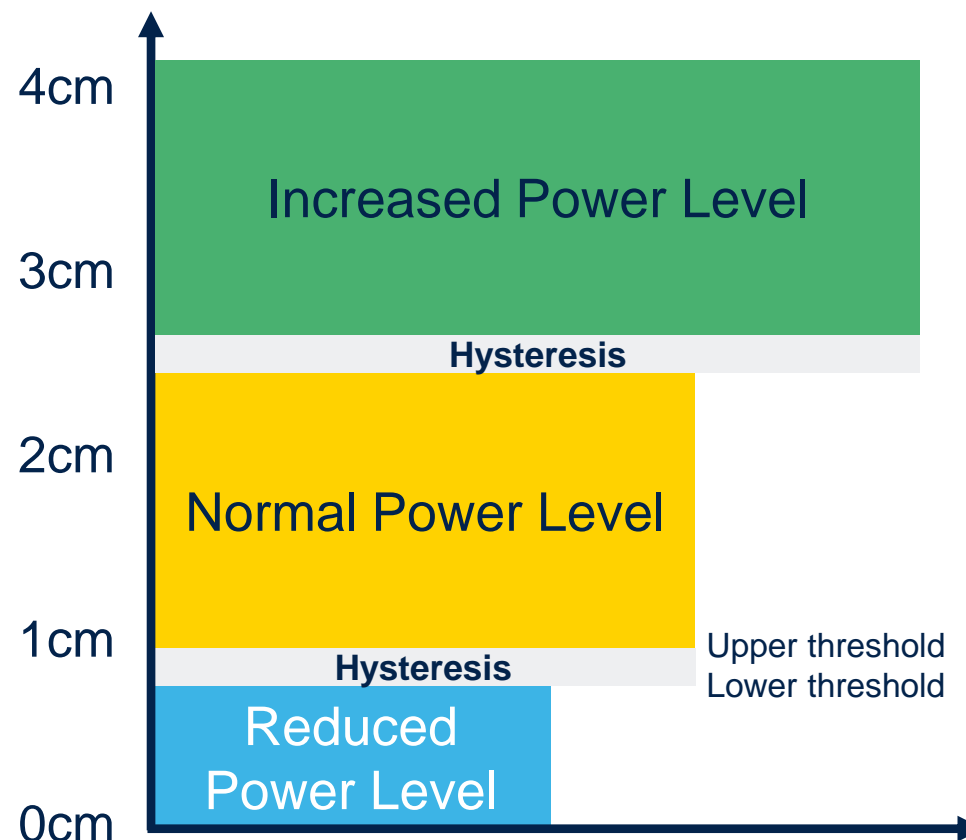


- Single 2.7 – 5.5V supply (vs 2 supply voltages)
- Up to 125°C ambient
- EMVCo/Payment capable
- 2W power to charge Keyfob



# ST25 Reader DPO: Dynamic Power Output

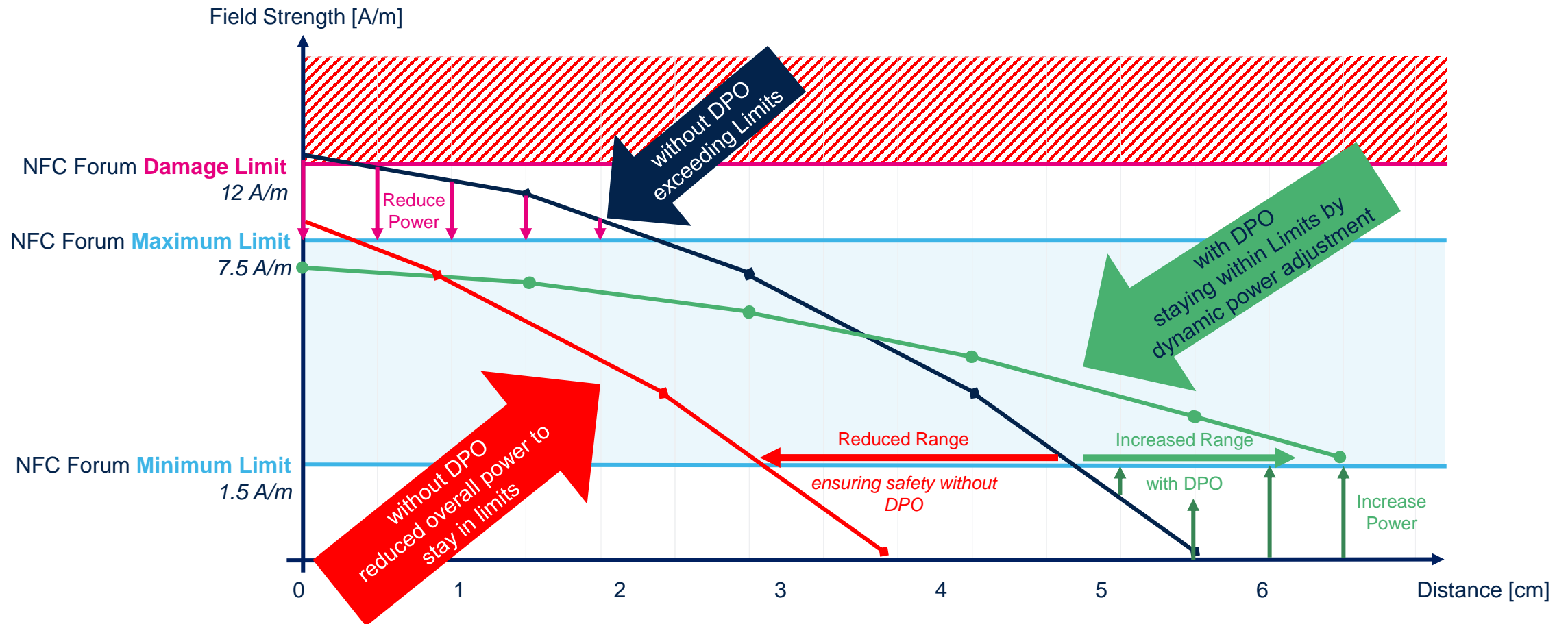
- Achieve min/max power limits easier  
The ST25R series allows to adjust the output power dynamically via Dynamic Power Output
- Optimal performance from weak to strong card response  
ST25R series allows to adopt to different power levels of card responses via Active Gain Control
- Improved noise immunity  
Squelch feature allows to scale the signal level to have improved immunity against noise

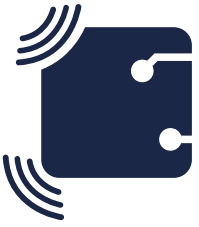




# ST25 Reader DPO: Dynamic Power Output

DPO of reader will keep power levels within requirements & limits

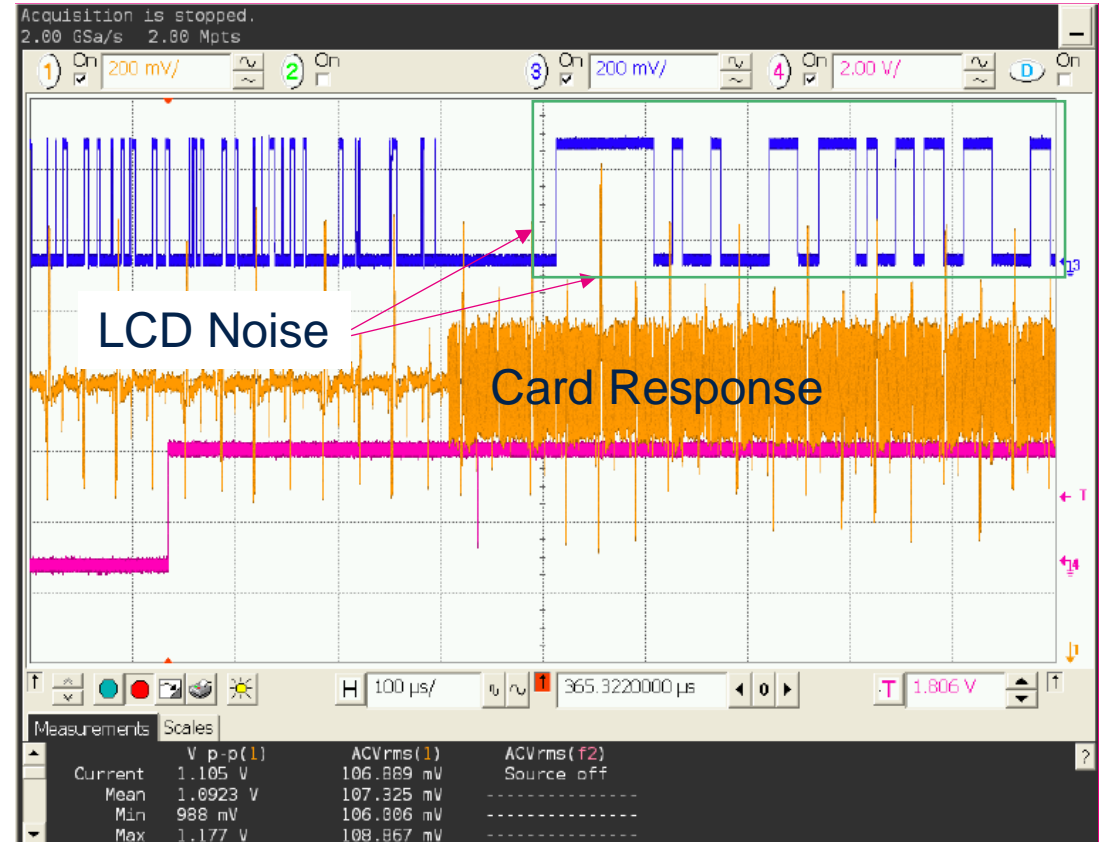




# NSR: noise suppression receiver

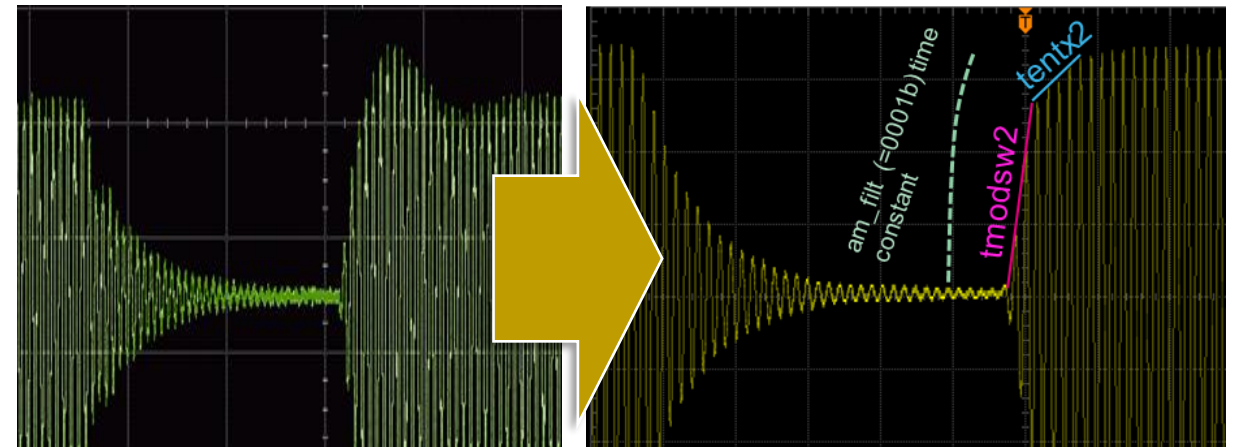
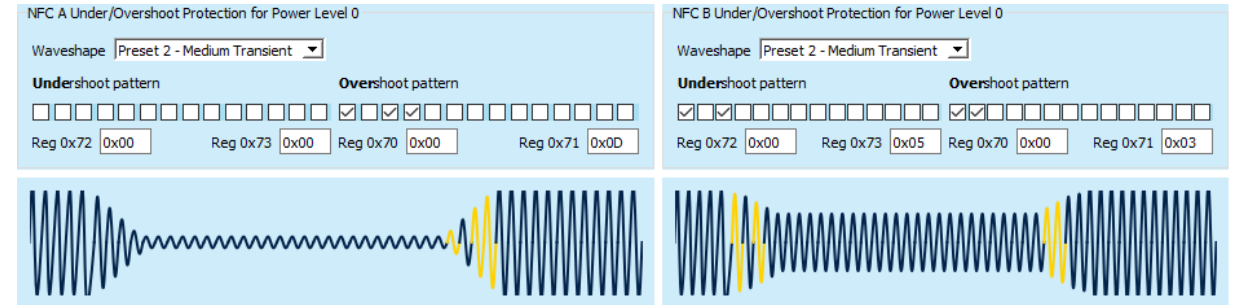
- Proper decoding
  - Proper decoding still possible even though LCD noise level exceeds card signal strength
  - ANS jumps in as soon as the receiver locks on a card response.
- Noise immunity compared to non NSR

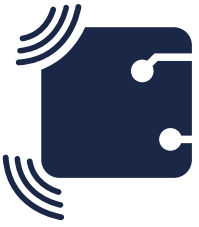
Correct Datastream



# AWS: active wave shaping

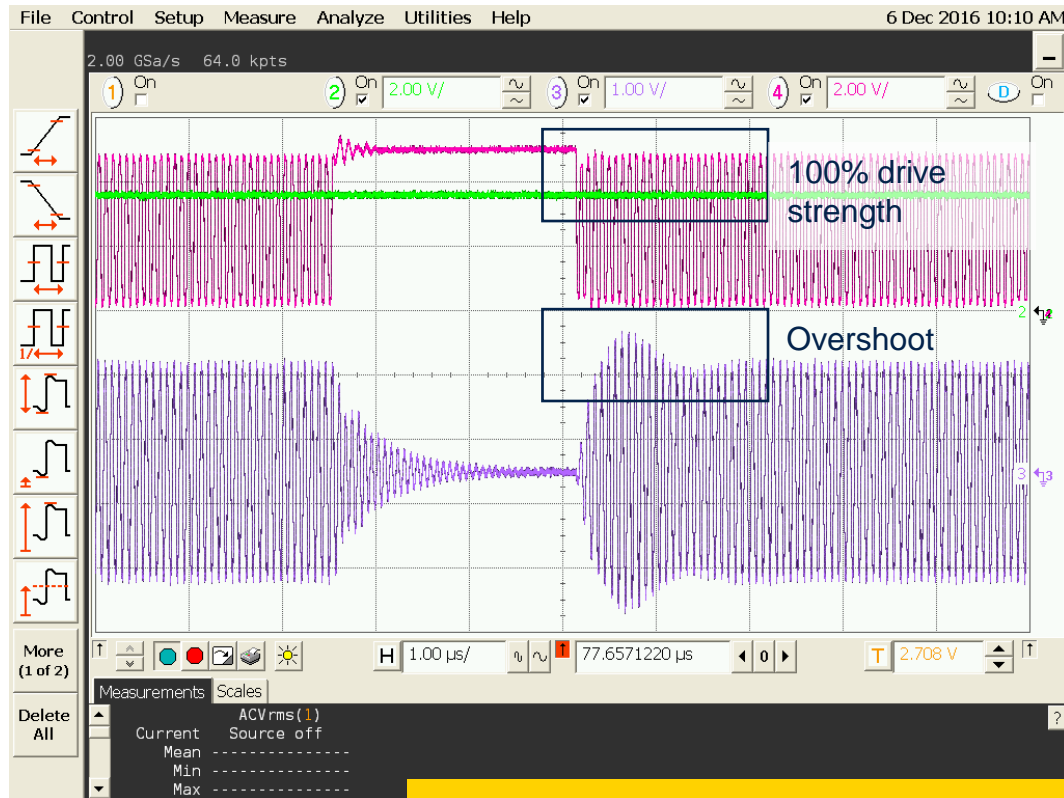
- The improved active waveshape (AWS) function will reduce over- and undershoots even easier than before.
- The function is easily enabled by using the bits in the corresponding registers.
  - 2 register and 14 bits for each over and under shoot protection are available and allow for easy adjustment
- to an acceptable level in challenging designs



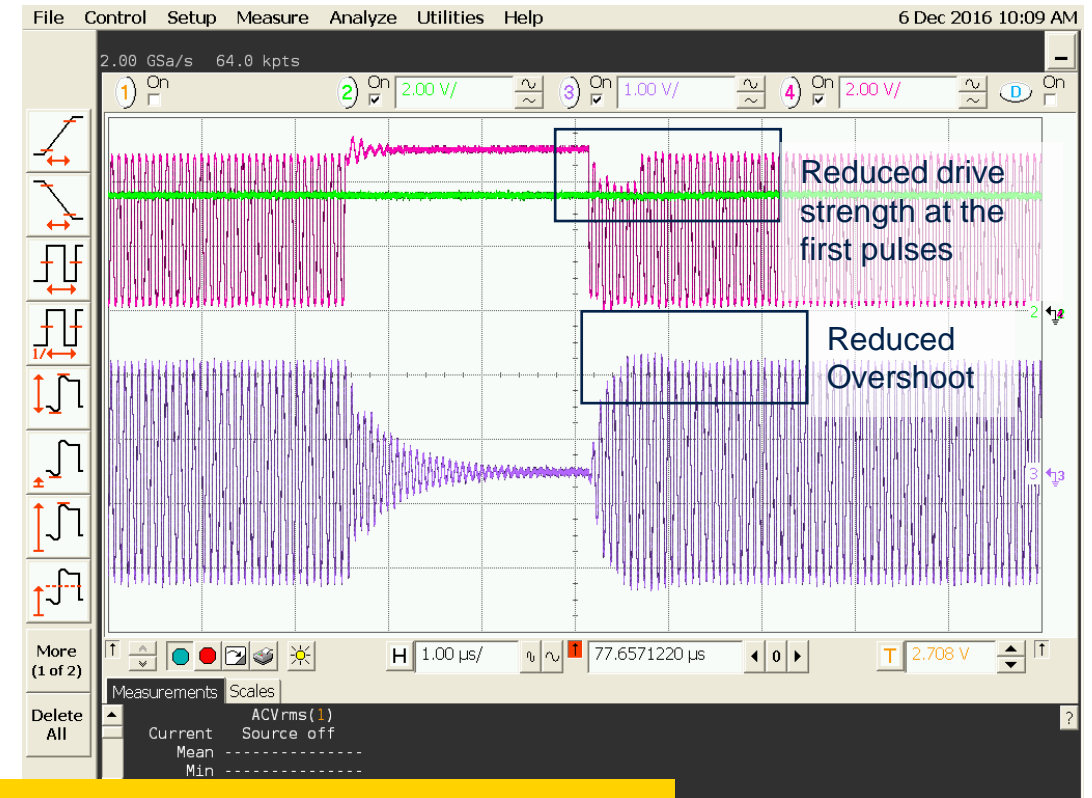


# AWS: active wave shaping

- Traditional A 106 modulation pulse



- Improved A106 modulation pulse with Over/Undershoot Protection



Over/undershoots can be solved with register settings  
No rematching of antenna required

# Average LPCD range improvement

- 18x56 mm Antenna

**R500 & R3920B** matched for same read<sup>1)</sup> range  
typA card avg. RR: 60mm max:95mm  
avg. WU: 68mm max:105mm

- 66x66 mm Antenna

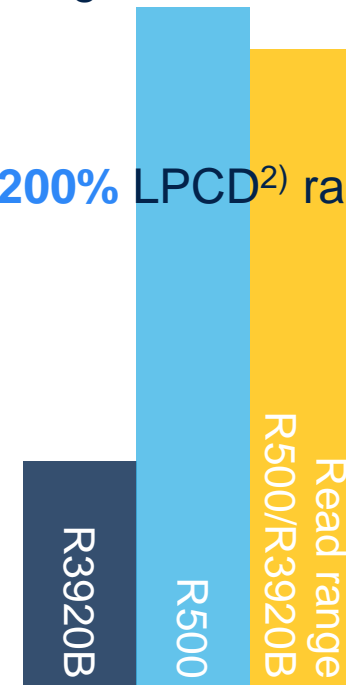
**R500 & R3920B** matched for same read<sup>1)</sup> range  
typA card avg. RR: 91mm; max: 140mm  
avg. WU: 99mm; max: 140mm

**+>50%** LPCD<sup>2)</sup> range vs 3920B



R500<sup>3)</sup>  
LPCD wake up  
=  
110% read range

**+200%** LPCD<sup>2)</sup> range vs 3920B

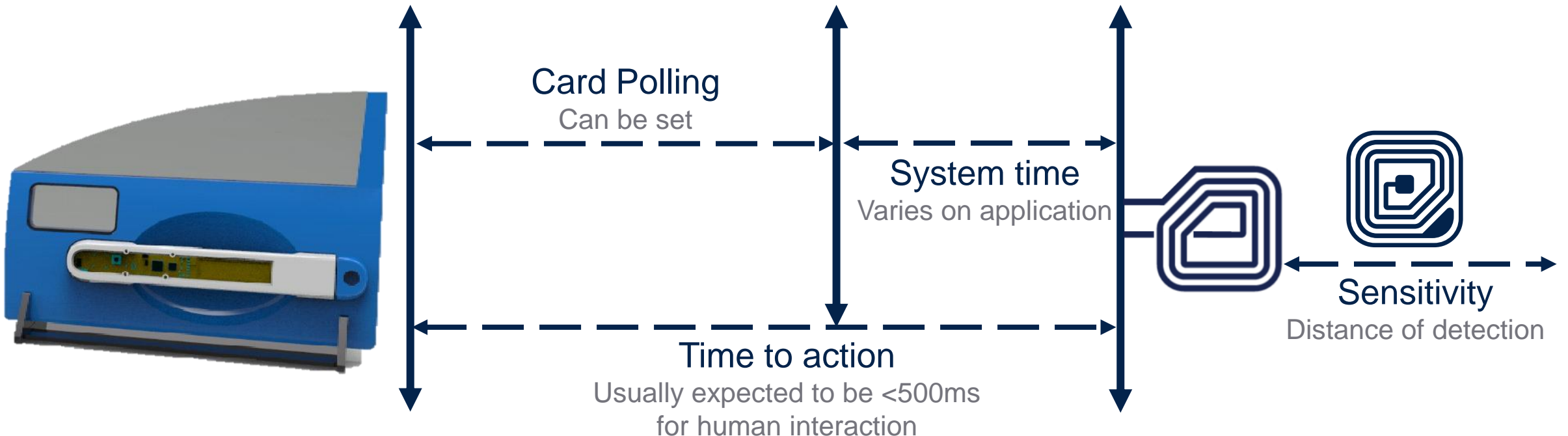


- 1) Read range means maximum range up to which reader can exchange data with card/phone
- 2) LPCD (WU) range means maximum distance where reader is recognizing card/phone in proximity
- 3) Tests done on a set of 64 cards tested (including typ A(21)/ B(9)/ F(3)/ V(31)). 110% reached with stable wake up and can be of course reduced to equal read range.



# Reduce power consumption while offering good detection range

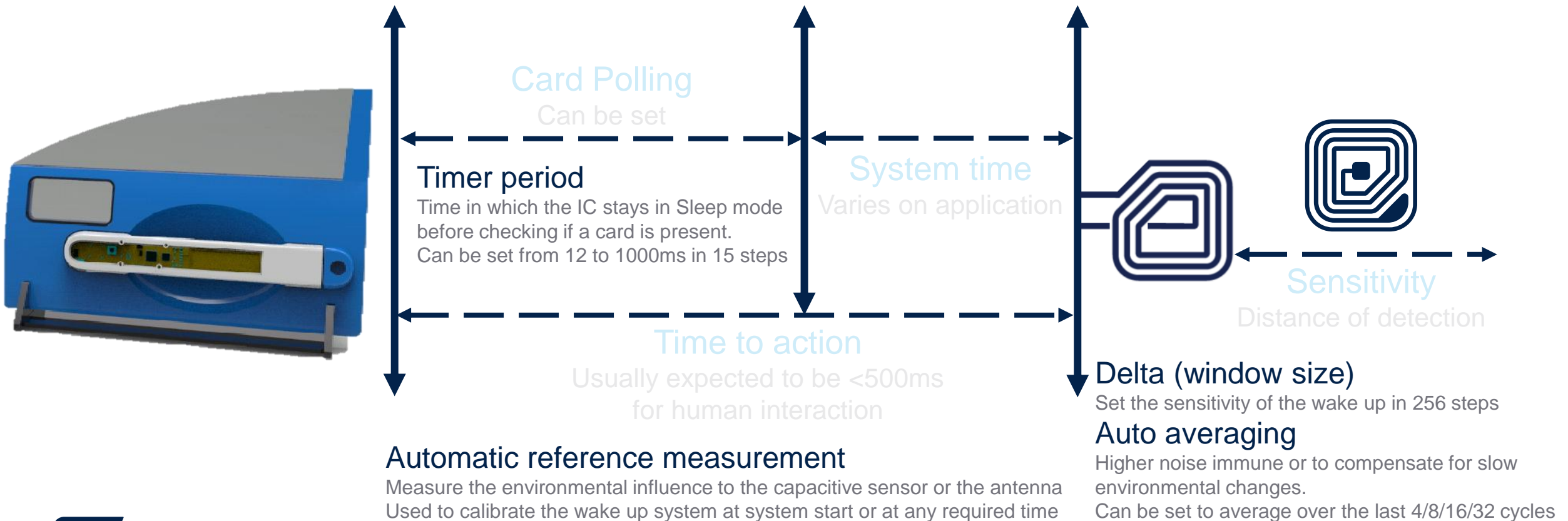
Consider reaction time/sensitivity of the system





# Reduce power consumption while offering good detection range

## Consider reaction time/sensitivity of the system



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