NXP LED Lighting Solution – ISELED and S32K

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SECURE CONNECTIONS
FOR A SMARTER WORLD

Agenda

- Challenges of Ambient Lighting

- ISELED Overview

- NXP ISELED Solution

- ISELED Demo

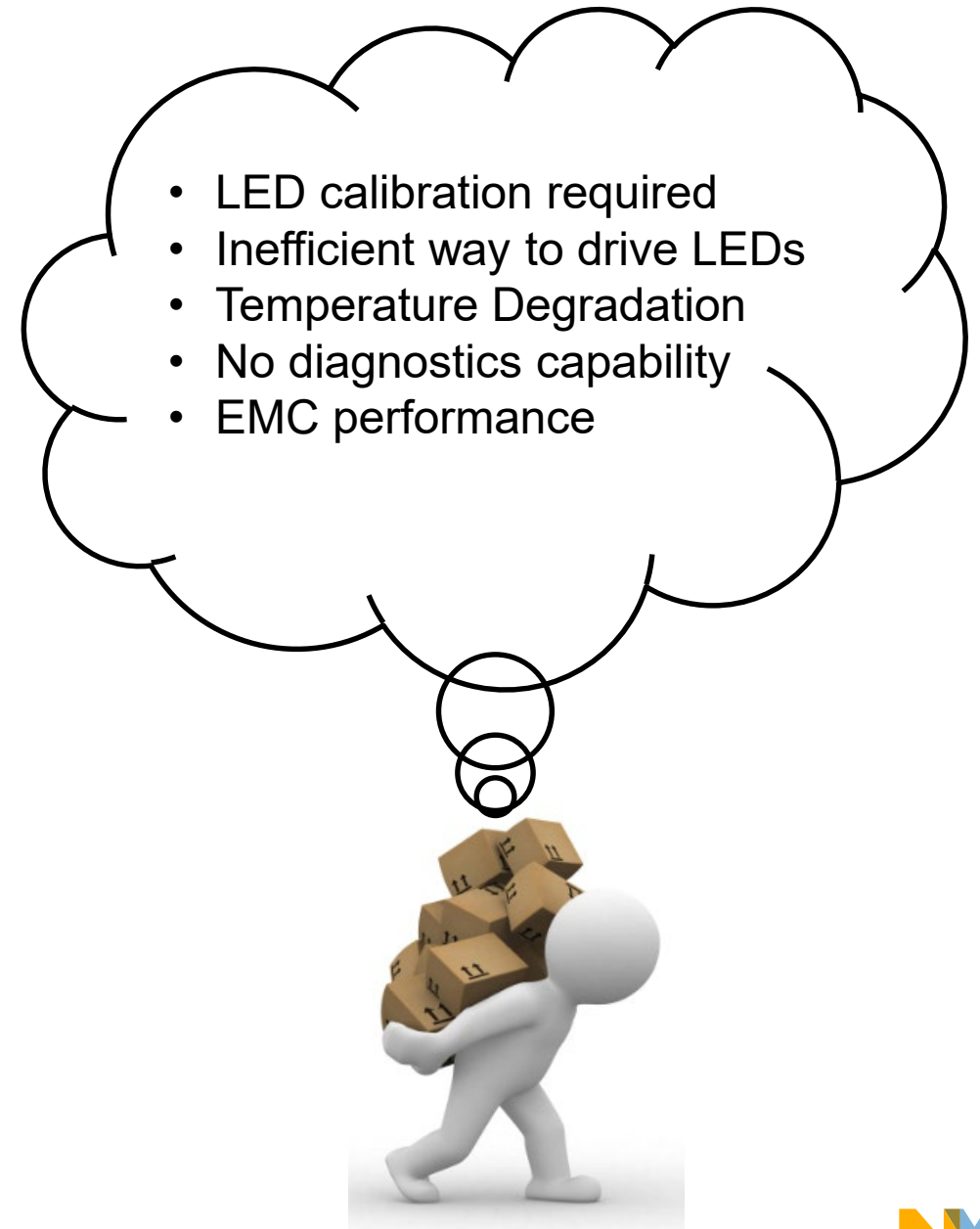# Challenges of Ambient Lighting

Challenges for Ambient Lighting

- Growing demand for dynamic lighting effects in the car

- Demand for lower implementation effort & cost

- Automotive requirements for robust and low emitting bus system

- LED calibration required
- Inefficient way to drive LEDs
- Temperature Degradation
- No diagnostics capability
- EMC performance

ISELED Overview

ISELED – Digital LED Solution for Automotive

- LED based interior lighting

- Creating unique in-car lighting experience

- Creating emotional connection between the driver and the car

Target applications:

- Ambient Lighting
  - Automotive
  - Aerospace
  - Cruise Ships
- Functional Lighting
  - Steering wheel – HMI in ADAS systems
  - External display for autonomous taxi / buses
  - Dynamic Daytime Running Lights (DRL) applications for pedestrian communication
- Display Backlighting
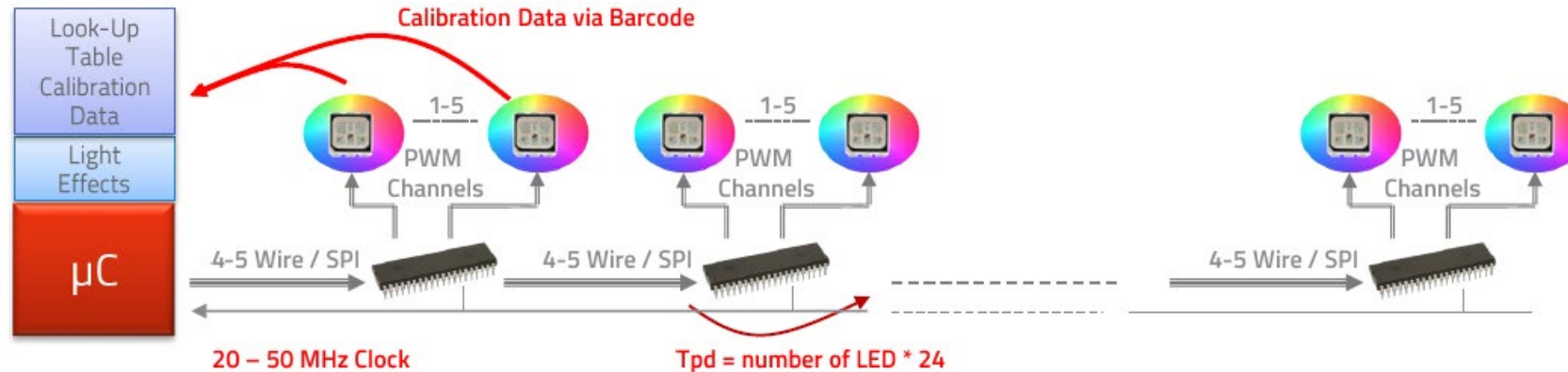- Industrial & consumer applications

ISELED Alliance

Open Alliance to provide complete systems solution for smart LED, initially targeting automotive interior lighting

inova Semiconductors

NXP — **System controller supplier**

Valeo

TE connectivity

DOMINANT™ Opto Technologies *Innovating Illumination*

HELLA

Melexis INSPIRED ENGINEERING

novem

LUCIE LABS

OSRAM Opto Semiconductors

feno

Allegro MicroSystems High-Performance Semiconductors

LIGHTWORKS PASSION FOR LIGHT

Brightek OPTOELECTRONIC

UG SYSTEMS

MICROCHIP

MAGNA

ITSWELL

GRUPO ANTOLIN

iSYS RTS AN UNO MINDA COMPANY

DISPLAY LAB PFORZHEIM UNIVERSITY

PRETTL group

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Traditional LED Drive Method

- Multiple, independent RGB LED drivers connected over LIN bus/proprietary buses – low speed and high cost/complexity

- Calibration of each driver and LED necessary to ensure stable colour and brightness over temperature and lifetime
  - LED binning and bar coding
  - Extensive and complex s/w management – look-up table required in main MCU memory

- 1-way communication to LED and sub-controllers with latencies
  - High speed single-ended communication impacting robustness
  - To change a paramater in one LED, all LEDs have to be addressed/updated (shift register approach)
 - No diagnostics

ISELED LED Drive Method

✓ **Packaged LED module with RGB LEDs and ISELED INLC100Q16 Controller IC (Inova Semiconductor)**
- Brightness and colour calibration performed during manufacture and data stored in LED controller IC non-volatile memory – no LED binning classes, bar coding or look-up table in main control MCU
- Integrated temperature sensor for automatic compensation

✓ **Proprietary protocol**
- Serial, differential communication
    - EMI robust design with up to 2Mbps data rate and no dedicated clock
    - Simple RGB based colour control for addressing up to 4076 LEDs
    - Fast update rate – 100 LEDs in 5.25ms
    - Efficient bandwidth utilisation – address LEDs individually, by group or in broadcast mode to check status
- Bus initialisation on start-up, auto detection of new or replaced LEDs

SMART LED Communication – Write Operation

- **Individual addressing**
 - Command is processed individually by LED with matching address
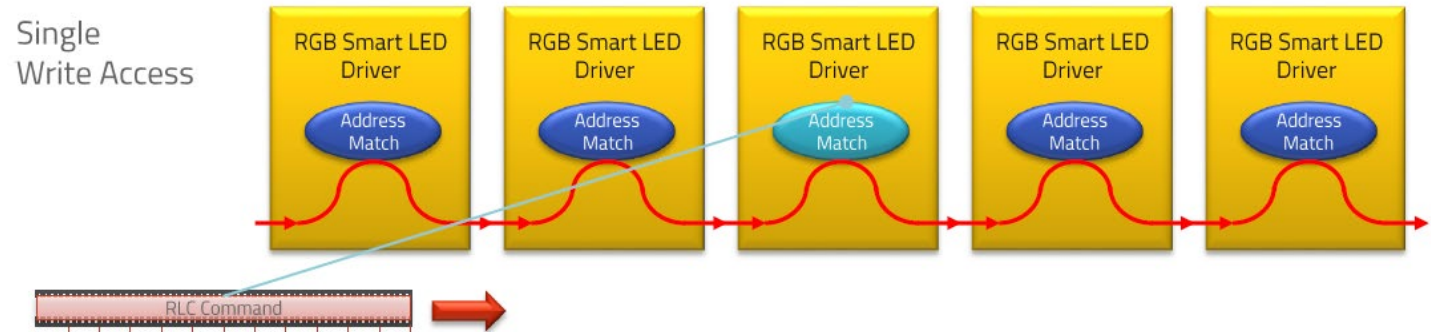
- **Broadcast addressing**
  - Command is processed by all LEDs in chain
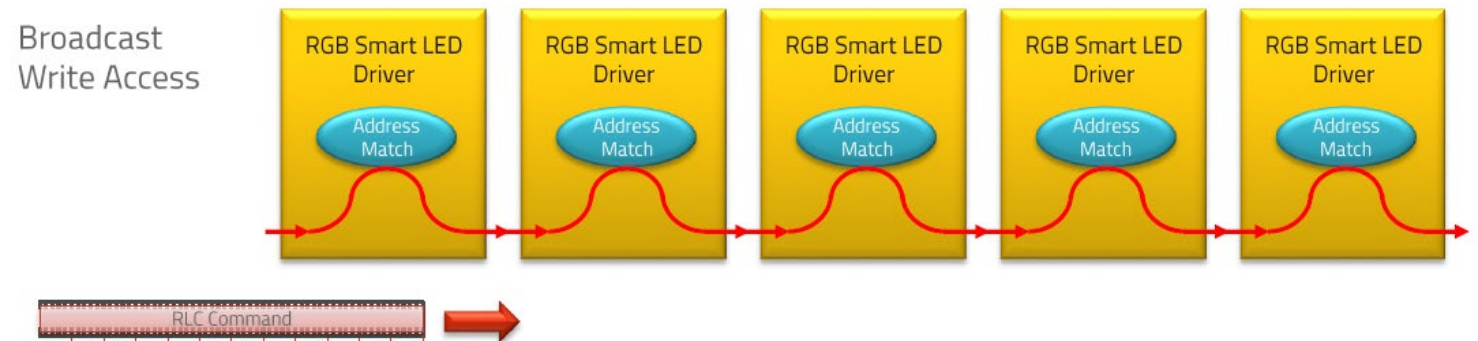
SMART LED Communication – Read Operation

- **Broadcasting always used**
- **Default direction is downstream**
- **LEDs switch direction depending on the flow:**
  - From downstream to upstream when decoding a READ cmd
  - From upstream to downstream again upon READ cmd response completion.
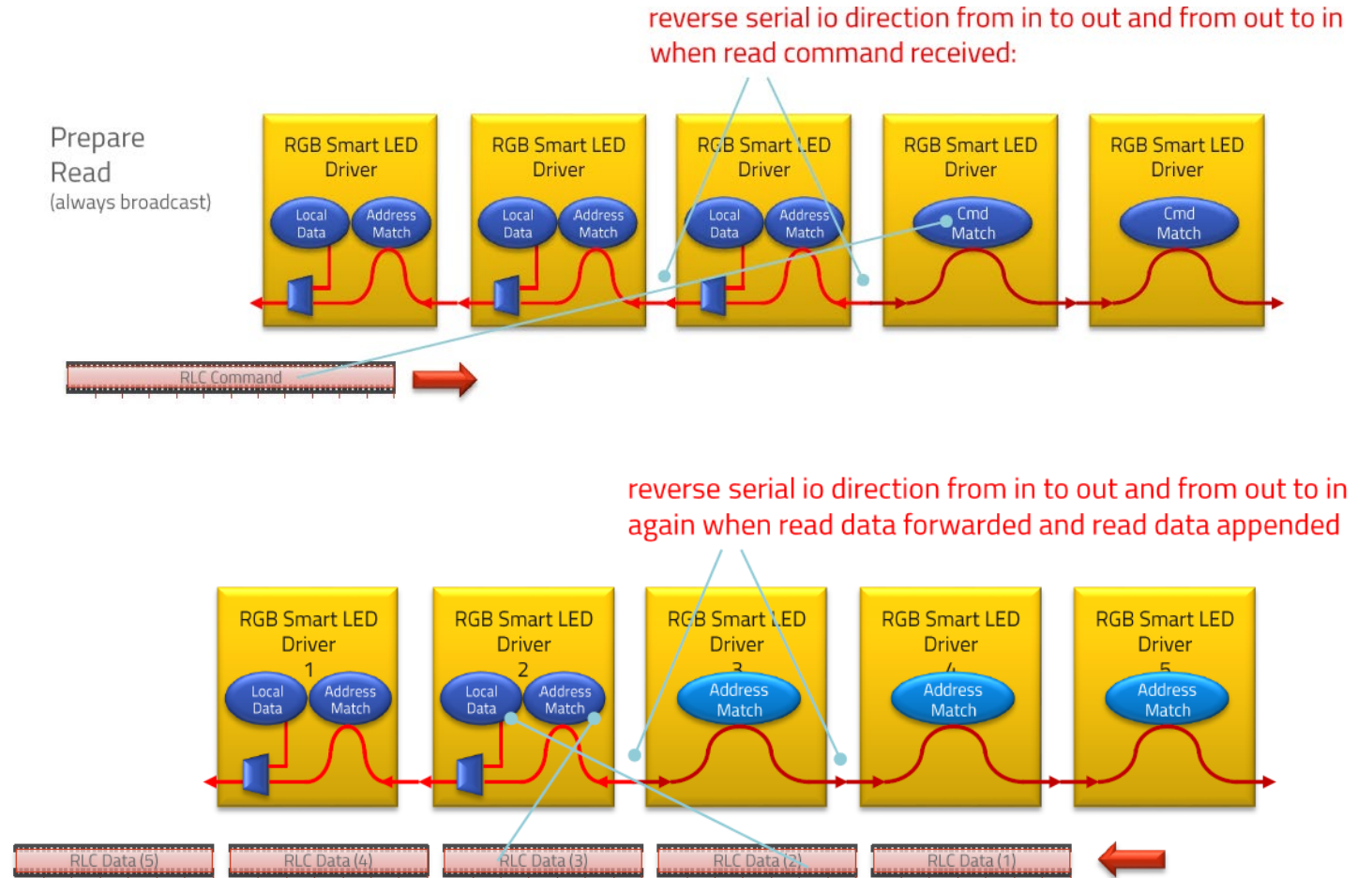
ISELED vs. LIN Protocol for LED Drive

	LIN	ISELED
Lighting streaming	Change of color and brightness (latency = no real time and no streaming)	Real time streaming Up to 25 frames per second, up to 4076 devices
Bus speed	19,6 Kbits/s	2 Mbits/s
Number of supported devices	Max = 15 devices	Max = 4076 devices
Network	Multiple sub network bus needed = cabling complexity	1 bus for each zone
Command	Unitary + broadcast	
Protocol	Master (gateway) + Slaves	
Calibration (color + brightness)	Assembly line calibration	Chip comes calibrated
Package	ASIC + RGB led	System in package with COB

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NXP ISELED Solution

S32K1 Family – Accelerating Automotive Software Design

Performance & Integration

Future proof designs

- ARM Cortex M4F and M0+ cores

- ISO CAN-FD, CSEc hardware security, ISO26262 ASIL-B functional safety

- Ultra low power

Automotive-grade SW

Minimized complexity

- S32 Design Studio IDE

- Automotive-grade Software Development Kit (SDK)

- Autosar MCAL & OS, 3rd party ecosystem

Broad Portfolio

Maximised reuse

- 128KB to 2MB, 32 to 176 pins

- H/w and S/w compatibility

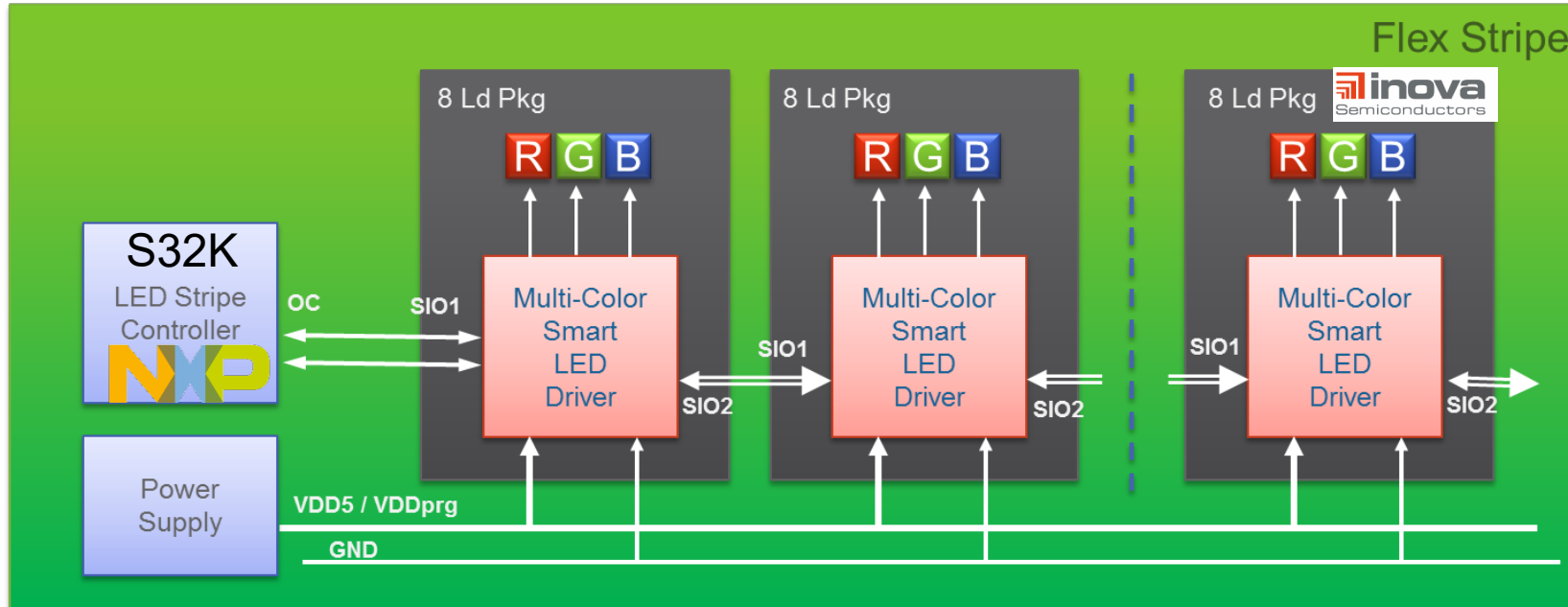- AEC Q100 grade 1 qualified (125°C), min. 15 year longevity

Flash	Pin Count								
	16/24	32	48	64	80	100 LQFP	100 BGA	144	176
2M						S32K148	S32K148	S32K148	S32K148
1M					S32K146		S32K146	S32K146	S32K146
512K			S32K144 S32K144 M1	S32K144 S32K144 M1			S32K144	S32K144	
256K			S32K142 S32K142 M1	S32K142 S32K142 M1			S32K142		
			S32K116	S32K116					
128K		S32K116	S32K116	KEAZ128	KEAZ128				
64K	KEAZN64		KEAZ(N) 64	KEAZ64					
32K	KEAZN32		KEAZ32						
16K	KEAZN16		KEAZ16						
8K	KEAZN8								

ISELED System Control MCU – S32K1xx

- ✓ Bi-directional communication between μC and LED module

- ✓ Single ended 5V connection between μC and 1st LED chip

- ✓ S32K1 FlexIO module – faster and more flexible

- ✓ ±30% clock accuracy required - both external and internal oscillator

S32K ISELED Solution – Hardware

S32K Control MCU

- Choice of 6 scalable MCU families:
  - S32K116/118: CM0+, 128/256KB
  - S32K142/144/146/148: CM4F, 256kB-2MB

MCU Family	ISELED Part Number	Core	Flash	RAM	Package	Key Features	Ambient Temperature
S32K116	FS32K116LIT0VFMT	Arm CM0+	128KB	17KB	32QFN	48MHz + DMA + FlexIO + ISELED	-40 to 105°C
	FS32K116LIT0VLFT				48LQFP	48MHz + DMA + FlexIO + ISELED	
S32K118	FS32K118LIT0VLFT		256KB	25KB	48LQFP	48MHz + DMA + FlexIO + ISELED	
S32K142	FS32K142UIT0VLHT	Arm CM4F	256KB	32KB	64LQFP	112MHz + DMA + FlexIO + ISELED	
S32K144	FS32K144UIT0VLHT		512KB	64KB	64LQFP	112MHz + DMA + FlexIO + ISELED	
	FS32K144ULT0VLHT					112MHz + DMA + FlexIO + ISELED + CAN FD + CSEc	
	FS32K144ULT0VLLT				100LQFP	112MHz + DMA + FlexIO + ISELED + CAN FD + CSEc	
S32K146	FS32K146UIT0VLLT		1MB	128KB	100LQFP	112MHz +DMA + FlexIO + ISELED	
	FS32K146ULT0VLLT					112MHz + DMA + FlexIO + ISELED + CAN FD + CSEc	
S32K148	FS32K148UIT0VLQT		2MB	256KB	144LQFP	112MHz + DMA + FlexIO + ISELED	
	FS32K148UGT0VLQT					112MHz + DMA + FlexIO + ISELED + CAN-FD + CSEc + ENET	

NOTE: ISELED feature only available with above S32K1 part numbers, both Tray and Reel (16th PN character = T or R)

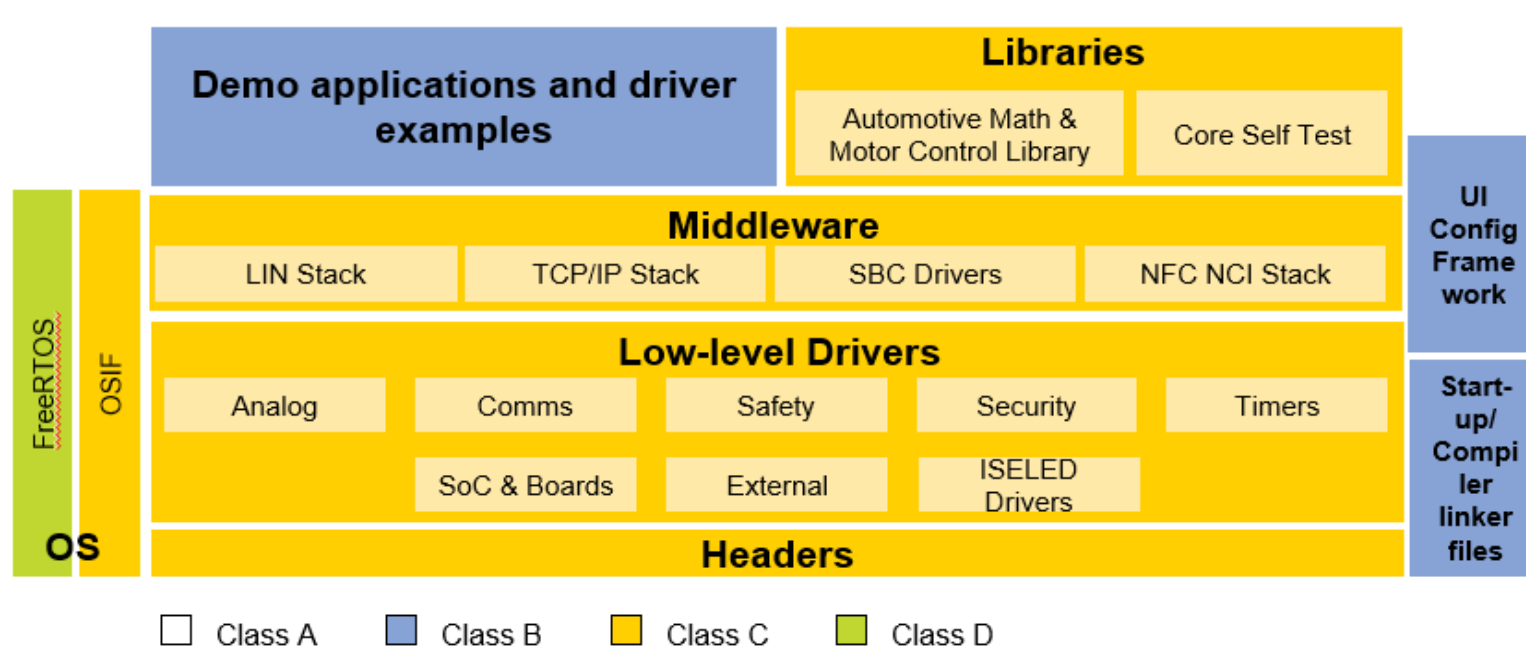Visit www.nxp.com/S32K-ISELED for sample ordering

S32K ISELED Solution – Software

- **SDK Non-AUTOSAR Solution**
  - S32K1 ISELED SDK Driver RTM (QM)
  - S32 SDK RTM (QM)
  - Supported devices: S32K11x, K14x
  - Code size: ~14KB (text + data)

- **AUTOSAR Solution**
  - S32K1 ISELED MCAL (4.0/ 4.2) Driver RTM (ISO 26262)
  - S32K1 AUTOSAR MCAL 4.0 / 4.2 (QM / ISO 26262)
  - Supported devices: S32K118, K14x

- Driver delivered in binary format
- IP protection mechanism implemented
  - For non-ISELED custom parts: Mandatory driver re-initialization after 150,000 (SDK version) or 10,000 (AUTOSAR version) ISELED commands
  - Full functionality available by using ISELED custom parts

S32K SDK – Production Qualified SW Package

- Free & production-grade: SPICE/CMMI Level 3 compliant, MISRA 2012 tested

- Graphical-based configuration

- FreeRTOS operating system

- Supports multiple toolchains

- Integration with NXP S32 Design Studio and 3rd party IDE

- Documented source code, examples, cookbook and demos for fast application start-up via simple drag & drop functionality


OS		Demo applications and driver examples	Libraries		UI Config Frame work
FreeRTOS	OSIF		Automotive Math & Motor Control Library	Core Self Test	
		Middleware			
		LIN Stack / TCP/IP Stack / SBC Drivers / NFC NCI Stack			Start-up/ Compiler linker files
		Low-level Drivers			
		Analog / Comms / Safety / Security / Timers			
		SoC & Boards / External / ISELED Drivers			
		Headers			

☐ Class A   ■ Class B   ■ Class C   ■ Class D

www.nxp.com/S32SDK

ISELED Driver in S32 SDK

- ISELED driver stacked on two types of peripherals:
  - Customized communication interface: FlexIO, LPSPI
  - Timing: Timing_PAL
- Effect Interpreter library ('Lucie Creator') available from Lucie Labs
- LIN stack available for node connectivity
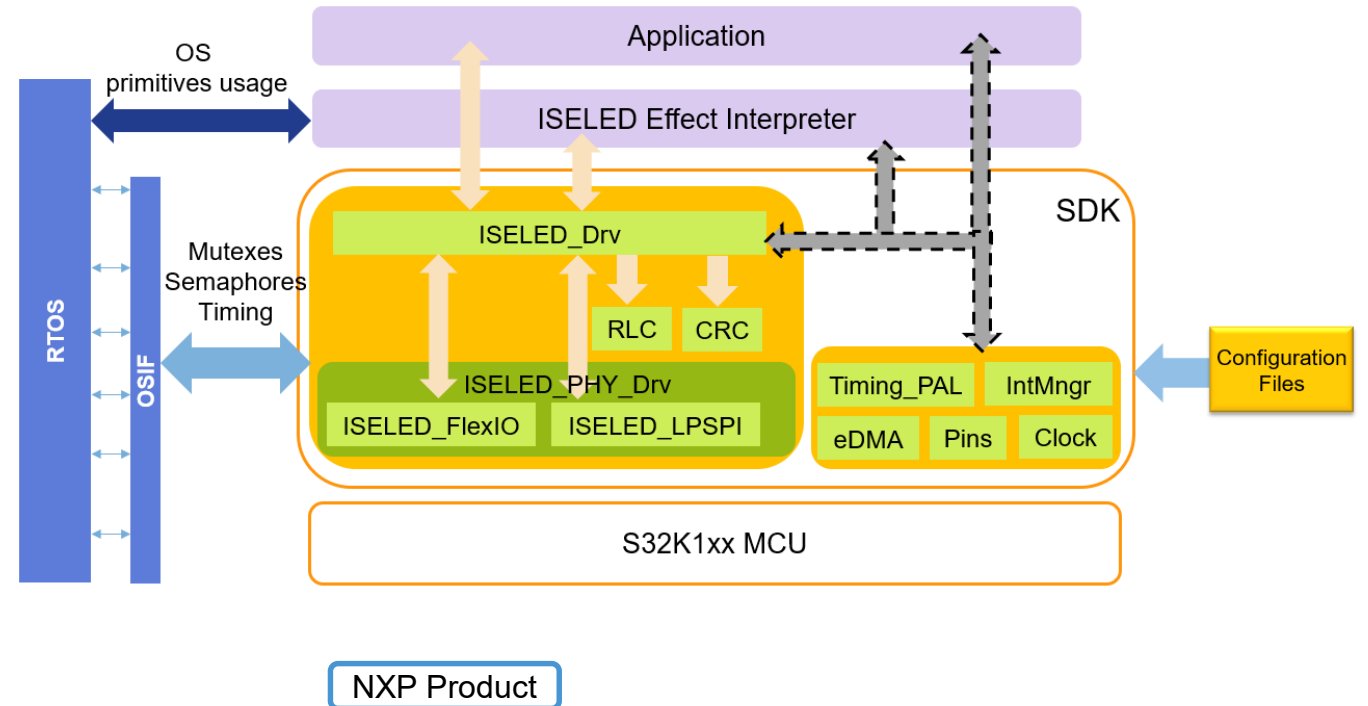
ISELED Processor Expert Configuration Component

- Dual communication interface
  - FlexIO
  - LPSPI
- Multiple (up to 13) strips supported in parallel
- Callback based application notification
  - Tx/Rx completion
  - Comm. timeout detected
  - CRC error
  - Chainlength error
- 2 pins needed for clock and data

Selectable interface
Selectable physical pins
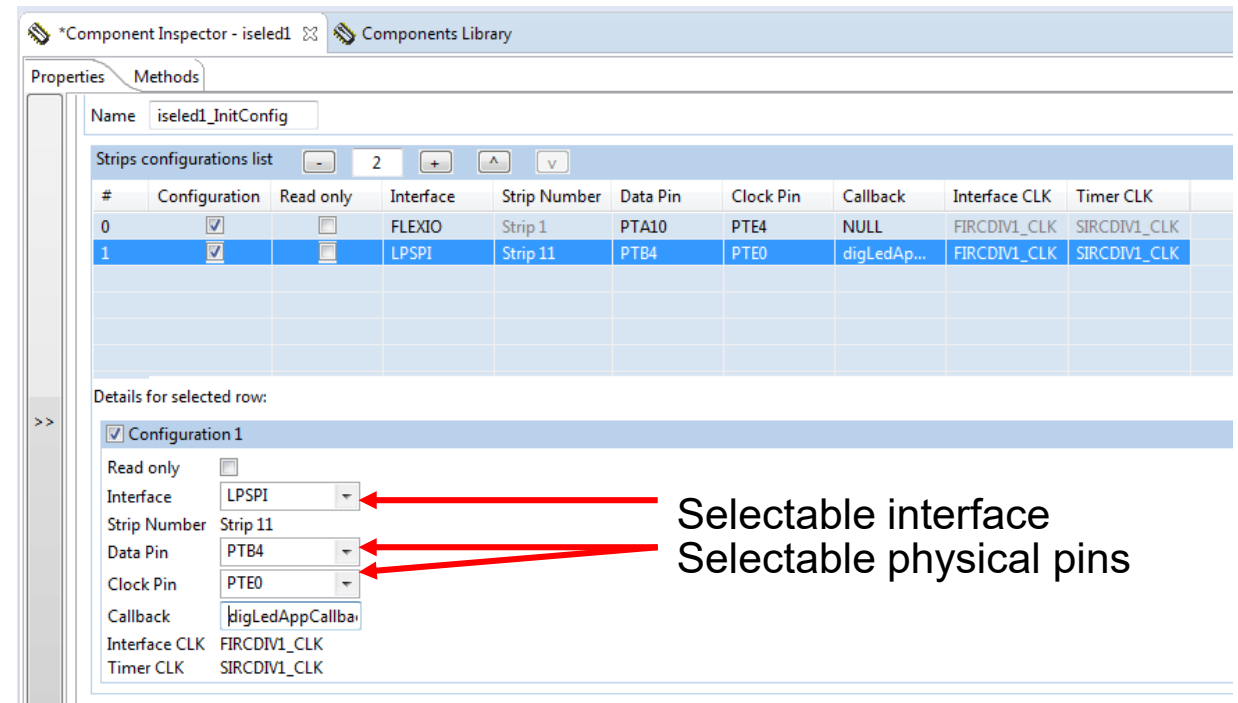
ISELED Example – How to Set an LED
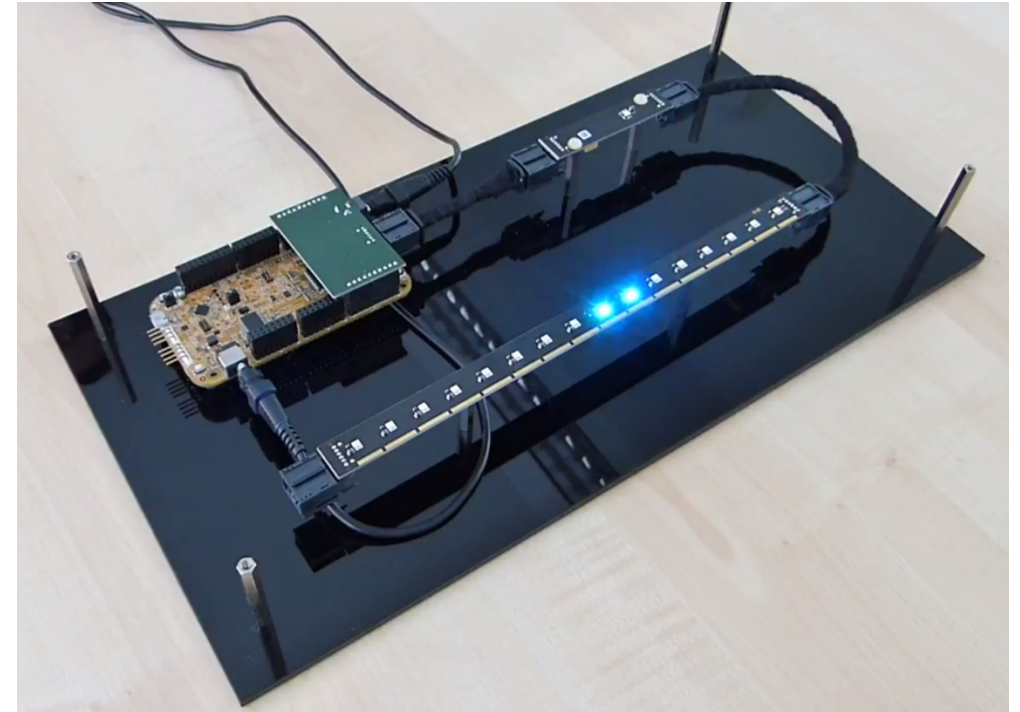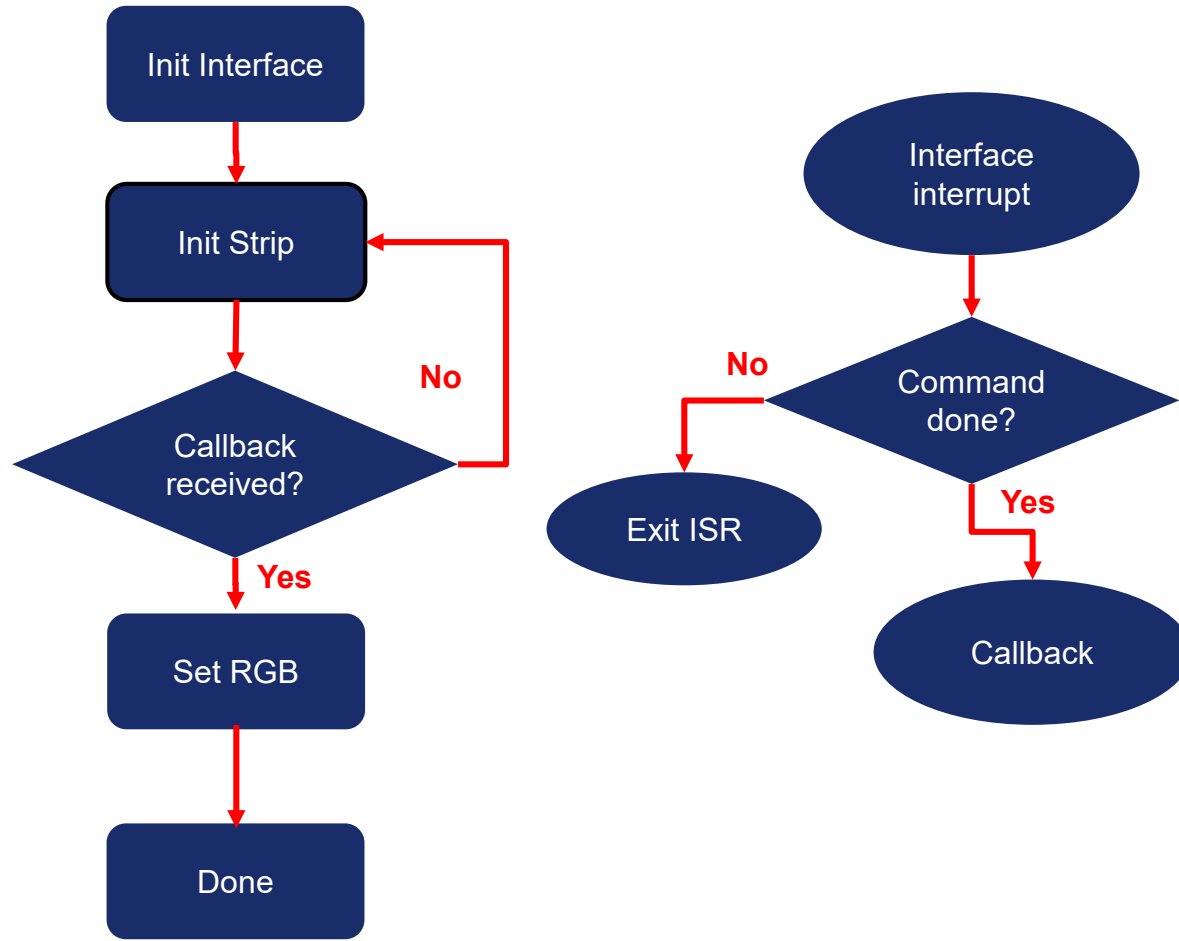
How to Get Started with NXP's ISELED Solution?

- **Step 1:** Purchase ISELED Application Development Kit (ADK)
  - Orderable via Element14/Farnell website (www.farnell.com)

- **Step 2:** Download ISELED s/w Driver
  - Visit www.nxp.com/S32K-ISELED for installation guide and download link

- **Step 3:** Evaluation Phase
  - When using the ADK or a non-ISELED-enabled standard S32K MCU:
    - *License is for evaluation use only. Restricted functionality: Mandatory driver re-initialization after 150K commands (SDK version), or 10K commands (AUTOSAR version)*

- **Step 4:** Production Phase
  - Purchase custom S32K1 ISELED MCU part number (www.nxp.com/S32K-ISELED)
  - Includes unrestricted license for evaluation and production use

S32K ISELED Solution – Application Development Kit (ADK)

- Orderable only from Etailer Element14/Farnell (as per ISELED Alliance Distribution policy)

- ADK Contents:
  - S32K144EVB-Q100   (NXP)
  - ISELED Power Adaptor board   (Inova Semiconductor)
  - 1 x 16-LED 'Bar'   (Dominant Opto or OSRAM LEDs)
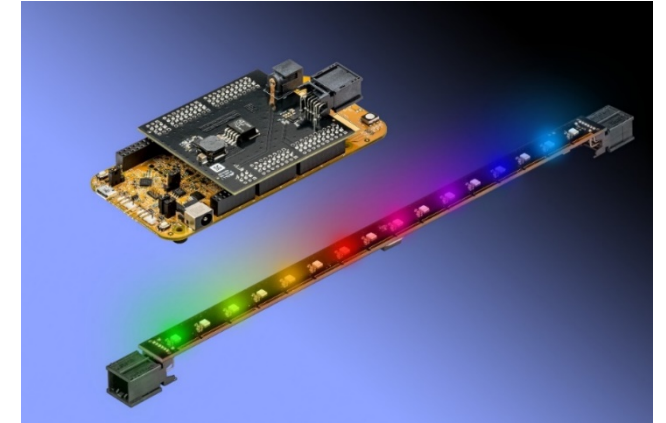
- Part numbers & Availability:
  - Dominant Opto LED version   //**available now**
    - **ISELED_ADK_D**   //includes 1x 16-LED bar
    - **ISELED_ADK_EXT_D**   //1 x 16-LED bar for daisy-chain

  - OSRAM LED version   //**in development**
    - **ISELED_ADK_O**   //includes 1x 16-LED bar
    - **ISELED_ADK_EXT_O**   //1 x 16-LED bar for daisy-chain

- S32K1xx EVB Compatibility with ISELED Power Adaptor Board:
  - S32K142/144/146 EVBs: 100% compatible
  - S32K116/118/148 EVBs: minor h/w changes needed
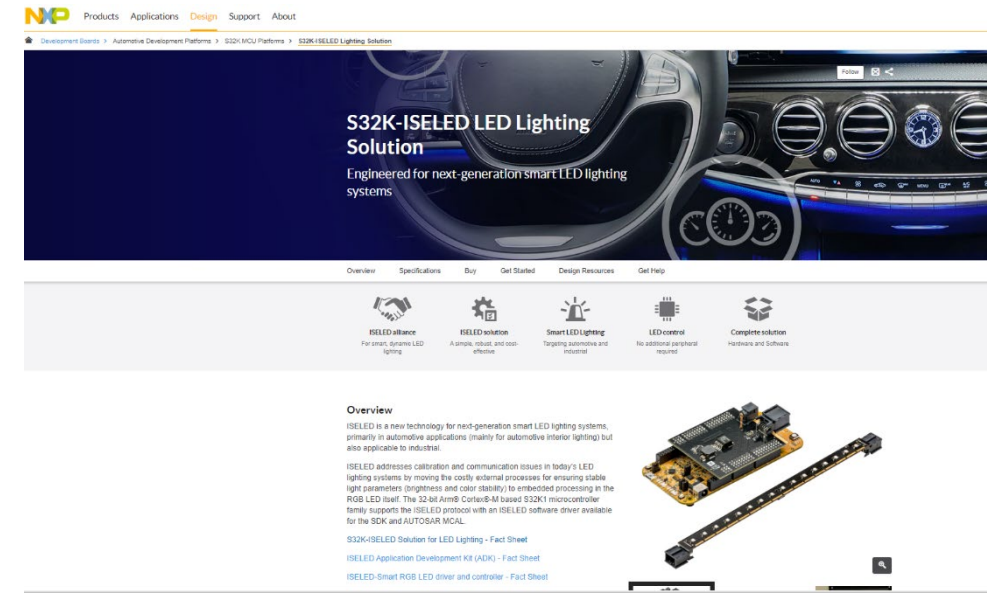
ISELED ADK – S32K1 EVB Compatibility

Device	Evaluation Board Part Number	Compatibility to ISELED ADK	Modifications needed
S32K116	S32K116EVB-Q048	Modifications needed	• ISELED Adapter needs two wires (clock and data) routed from J5 to J4: J5-19 routed to J4-13 ; J5-17 routed to J4-09
S32K118	S32K118EVB-Q064	Modifications needed	• ISELED Adapter must be connected to EvalBoard so that all the pins from ISELED Adapter header J3 are connected to header J4 from EvalBoard • In case ISELED Adapter pins hit GND2 test point and don't allow the Adapter to be inserted completely in headers, GND2 must be bent (if Adapter pins are touching GND2 it's not a problem)
S32K142	S32K142EVB-Q100	100% compatible	No
S32K144	S32K144EVB-Q100	100% compatible	No
S32K146	S32K146EVB-Q144	100% compatible	No
S32K148	S32K148EVB-Q176	Modifications needed	• ISELED Adapter needs two wires (clock and data) routed from ISELED Adapter header J5 to EvalBoard header J2: J5-19 routed to J2-25 ; J5-17 routed to J2-28 • ISELED Adapter must be connected to EvalBoard so that all the pins from ISELED Adapter header J5 are connected to header J5 from EvalBoard

Summary

- ISELED provides a simple, robust and cost-effective solution for creating dynamic lighting effects in Automotive, Industrial & Consumer applications

- NXP and the ISELED Alliance provide the complete ISELED ecosystem:
  - Scalable S32K1 Arm Cortex MCU family with low power, connectivity, security, ASIL-B & AEC-Q100 Auto qual (125°C)
  - Production-grade ISELED s/w driver
  - S32K ISELED ADK available for immediate evaluation & development

- More info @
  - www.nxp.com/S32K-ISELED
  - https://iseled.com/
  - https://inova-semiconductors.de/iseled.html

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