

User Manual



UM_INLC_ADK

April 2019 Revision 0.9

ISELED ADK User Manual

1. Introduction

The ISELED application development kit (ADK) gives quick access to the new automotive lighting ecosystem provided by the ISELED alliance. It allows to demonstrate the digital LED concept and to create dynamic lighting sequences. The kit is based on the ISELED board that shows 16 SmartRGB LEDs from Dominant Opto Technologies. Each RGB package includes an INLC100D controller chip from Inova Semiconductors with which the devices are calibrated to the same colour gamut and brightness. All functions can be controlled via the S32K144 microcontroller unit (MCU) from NXP that provides the ISELED serial communication protocol.

In the default setting, the kit shows an example demo lighting sequence in an endless loop right after power up.

To develop customized sequences and to use the diagnostic features of the controller chip, several control commands are provided in a library of an application programming interface (API) which is implemented in the ISELED driver from NXP. Furthermore, lighting sequences can also be created with the software suite from Lucie Labs which offers an user friendly interface.



Kit content

- ISELED board
- S32K144-EVB-Q100
- Power adapter board
- Board connection cable
- Micro USB 2.0 cable
- Power supply
- Embedded software Lighting stack by Lucie Labs
- Lucie Creator : a PC tool for easy lighting design, 90 days license included





List of Abbreviations and Acronyms

- ADK Application Development Kit
- API Application Programming Interface
- EVB Evaluation Board
- ISELED Integrated Smart Ecosystem Light Emitting Diode
- MCU Microcontroller Unit





Contents

1. Introduction	1
2. Hardware	4
2.1. Hardware Description	. 4
2.1.1. ISELED Board	. 4
2.1.2. S32K144-EVB-Q100	5
2.1.3. Power Adapter Board	. 6
2.1.4. Board Connection Cable	6
2.1.5. Power Supply	6
2.2. Hardware Setup	. 7
3. Software1	0
3.1. Lucie Creator	10
3.2. ISELED Driver	11
3.3. Default Firmware	17
4. Revision History	21



User Manual



2. Hardware

2.1. Hardware Description

2.1.1. ISELED Board

The ISELED board contains 16 calibrated SmartRGB LEDs (D65 white point, 1000mcd) from Dominant Opto Technologies, two blocking capacitors (100nF, 1μ F) at each device, a 7V to 5V low dropout regulator and two 8 position nanoMQS headers from Tyco Electronics.





Figure 1 - ISELED board

Figure 2 - Connector pin assignment topview master side



Figure 3 - Connector pin assignment topview slave side

2.1.2. S32K144-EVB-Q100

The S32K144 evaluation board (EVB) is Arduino UNO footprint-compatible and it contains the S32K144 microcontroller [1]. It provides on-chip connectivity to CAN, LIN and UART/SCI buses and flexible power supply options (micro USB or external 12V).



Figure 4 - S32K144-EVB-Q100





2.1.3. Power Adapter Board

The power adapter board contains a DC power jack to supply the LEDs and the NXP microcontroller. Besides, there are two DC/DC converters (12V to 7V and 7V to 5V) and an INLC100Q16 device [2]. This power adapter board provides the INLC100Q16 LED driver chip in a 16 lead WETQFN package which converts the single ended communication signal between MCU and the device into a differential output signal.



Figure 5 - Power Adapter Board



Figure 6 – Connector pin assignment topview

2.1.4. Board Connection Cable

The 20cm customized eight wire cable contains two twisted wires for the serial differential communication and each three wires for 7V and GND. The wire ends are crimped and connected to nanoMQS plugs from Tyco Electronics [3].

2.1.5. Power Supply

The provided 12V power supply can drive 1A. If more than four ISELED boards are daisy-chained and operated at maximum brightness, the current consumption extends the limit and the power supply must be replaced by a stronger device.





2.2. Hardware Setup

To install the hardware, connect all components the following order:

1. Connect the board connection cable and the power adapter board.



2. Connect the other end of the cable to the ISELED board. Ensure that the orange capacitor on the backside is first in line.







3. Check the position of the J107 jumper and make sure it is in 1-2 position.



4. Connect the power adapter board to the S32K144-EVB-Q100 board.









5. Connect the power supply plug to the jack of the power adapter board. In the default setting, the kit starts to show a demo lighting sequence in an endless loop. By pushing the reset button, the sequence can be restarted.



Optional:

6. To communicate with the MCU (i.g. to create lighting sequences or use the diagnostic functions), connect the USB cable to the S32K144-EB-Q100 board and to the host PC.





User Manual



3. Software

The ISELED ADK can be controlled via Lucie Creator or the ISELED Driver from NXP.

If the default firmware, that shows the demo sequence, is overwritten, the link to the Lucie Creator is removed. To re-establish the link, the default firmware needs to be re-flashed onto the microcontroller. The default firmware can be downloaded at https://iseled.com/products/iseled-application-kit.html. The description how to flash the default firmware is given in chapter 3.3.

3.1. Lucie Creator

Lucie Labs provides the software suite Lucie Creator for the creation of complex lighting effect leveraging the ISELED technology. The user-friendly interface enables to preview live the lighting content directly on the high density LED topology.

To create an account on Lucie Creator, follow the steps explained on this set up guide: https://support.lucielabs.com/LucieCreatorSetupGuide.pdf

The tool can be found at https://demokit.lucielabs.com. The free trial version is limited to 90 days and a maximal number of 16 LEDs.

Once you have registered and you are ready to use Lucie Creator, please check this User Guide to quickly discover all the software's functionalities:

https://support.lucielabs.com/LucieCreatorUserGuide.pdf

As long as the default firmware is not overwritten, the online tool can be used when the USB connection is established.



Figure 7 - Lucie Creator





3.2. ISELED Driver

To use the ISELED protocol, it is necessary to use the S32 Design Studio IDE (S32DS IDE) – NXP's automotive development environment for the S32K platform of MCUs. How to download the S32DS IDE and how to get the required license is described in the "S32K ISELED Driver Installation guide" which can be downloaded at https://iseled.com/products/iseled-application-kit.html.

After successful installation, the pin configurations must be adjusted before generating the Processor Expert Code. To do this, "Window" -> "Show View" -> "Components" must be selected. In the component "iseled1: iseled1: iseled1, the data pin must be set to PTE16 and the clock pin to PTE15 (s. Figure 8).



Figure 8 – Pin configuration & timeout setting

If several ADK strips are connected in series or if a self-developed hardware with more than 17 LEDs is used, the timeout duration must be increased depending on the number of LEDs *n* according to the following equation: *timeout duration* (us) = n x 72 + 40.

In addition, the number of LEDs and the buffer size in the main function (s. Figure 9) must be adjusted. The buffer size must be twice the number of LEDs.

#define NR_OF_LEDS 17U

```
uint32_t digLEDResultBufferStrip1[34];
```



Figure 9 – main.c

The control commands can be sent in debugging mode or using the freemaster GUI project "Iseled_Driver.pmp".

The freemaster GUI can be used after the project has been built and has been flashed onto the microcontroller. To build the project, click on the hammer icon (s. Figure 10).



Figure 10 - Hammer icon





After this, you can flash the microcontroller by clicking on the flash icon (s. Figure 11).



Figure 11 - Flash icon

Select the tab "Debugger". If the NXP board is correctly connected to the PC via USB (Interface: OpenSDA), the corresponding USB port will be displayed (s. Figure 12). If nothing is displayed here, check again if the jumper position J107 is correct.

type filter text Image: Startup Space Image: Startup Space	npatible Hardware fresh 12M15
	npatible Hardware fresh 12M15
PEMicro Interface Settings Interface: OpenSDA Embedded Debug - USB Port Compatible Hard Port: USB1 - OpenSDA (9CC3CE5B) Refresh Select Device Vendor: NXP Family: S32KLox Target: S32K144F512M15 Core: M4	npatible Hardware fresh 12M15
Port: USB1 - OpenSDA (9CC3CE5B) Refresh Select Device Vendor: NXP Family: S32K1ax Target: S32K144F512M15 Core: M4	fresh 12M15
Select Device Vendor: NXP Family: S32KLxx Target: S32K144F512M15 Core: M4	12M15
Core: M4 🔻	
Specify IP Specify Network Card IP	
Additional Options	
Emergency Kinetis Device Recovery by Full Chip Erase 🗹 Use SWD protocol	
Advanced Options	

Figure 12 - OpenSDA Interface





After successful flashing, the console displays "target disconnected" (s. Figure 13).

🖳 Problems 🛛 🙇	Tasks 📃 Conso	le 🔀 🔲 Prop	oerties 🛛 🖳 Debugg
<terminated> isele</terminated>	d_freemaster_s32k	144 Debug_FLA	SH PEmicro [GDB P
Target has bee No breakpoints Disconnected f Disconnected f Target Disconn	n RESET and is currently set rom "127.0.0.1 rom "127.0.0.1 ected.	active. " via 127.0 " via 127.0	.0.1

Figure 13 - Succesful flashing

In order to use the project "Iseled_Driver.pmp", the graphical user interface tool "Freemaster 2.0" must be installed. The tool can be downloaded from the following link:

https://www.nxp.com/support/developer-resources/software-development-tools/freemaster-run-timedebugging-tool:FREEMASTER?&tab=Design_Tools_Tab

Now the freemaster project "Iseled_Driver.pmp" can be opened (s. Figure 14).



Figure 14 - Iseled_Driver.pmp

Please make sure that the settings under "Project" -> "Options" are set as follows:

mm MAP Files Pack Dir HTML Pages Demo Mode ` Communication	Views & Bars
C RS232: Port: COM1 -	
Speed: 9600 - Timeouts	
Plug-in Module: FreeMASTER BDM Communication Pl	ug-in (CortexM, Power 💌
Connect string: drv=6;ptype=9;pnum=1;devid=BA234E	6B;c Configure
Save settings to project file 🔽 Save settings to reg	jistry, use it as default.
Communication state on startup and on project load	
Open port at startup Open port at startup	
Store port state on exit, apply it on startup	
Store state to project file, apply upon its load	Advanced

Figure 15 - Freemaster project options Comm

Connect string: drv=6;ptype=9;pnum=1;devid=;devlock=0;jtagspd=500





Makes sure that the default symbol file is set to the .elf file in the subfolder "Debug_FLASH" in the workspace folder.

Comm MAP Files	Pack Dir HTML Pages Demo Mode Views & Bars	
Default symbol file:	.\Debug_FLASH\iseled_freemaster_s32k144.elf	
File format:	Binary ELF with DWARF2/DWARF4 dbg format.	Del
List of all valid	.\Debug_FLASH\iseled_freemaster_s32k144.elf	New.
symbol files:		Del
		View
	Note: The file selected in the list will be used as default symbol file when the project is opened	
	On Load Let the user select starting symbol file]
	Synchronize variables each time the symbol file loads List errors (variables using undefined symbols)	

Figure 16 - Freemaster project options MAP Files

The link between freemaster and microcontroller is started by clicking on the stop sign icon. If the operation was successful, the question marks in the "Value" column turn into numbers. These values can be changed by the user to set the command parameters.

Iseled_Driver.pmp - FreeMASTER				
File Con View Explorer Project Tools	Help			
: 🗗 🖬 🧰 🔊 🗠 🖓 👘 👘	21 / の気の父旨 今 4 留 12	Tahoma - 8 - B I U		
Project 🗸 🗸 🗙				
2 New Project				^
	Please specify the URL of the do	cument describing the item currently	y selected in the project tree.	
	Chow ma whore can I do it			
	Show the where call 1 do it			E
If you don't want to specify the description document for each item in the project tree, you can hide the "tab" with th message by setting up the single "Control Page". The Control Page will be statically displayed regardless of the project tree selection. When both Control Page and iter				de the "tab" with this
				ontrol Page and item
	description document URL are se	et up, both tabs will be available.		
	Channe and Learner Learner	for the Combined Dece		-
	algorithm block description			
	Variable Watch			- a x
Variable Stimulus 🗸 🕈 🗙	Name	Value	Unit	Period
	ServiceNumber ?	ENUM	1000	
	stateFlag ?	ENUM	1000	
	repeatFlag ?	DEC	1000	
	nrOfLEDs ?	DEC	1000	
	testiniType cr/Enable 2	DEC	1000	
	testinit ype o cenable	DEC	1000	
	testInitType.tempCmpEnable ?	DEC	1000	
	testInitType.voltSwing ?	DEC	1000	
	Set_RGB_Params.Address ?	DEC	1000	
	Set_RGB_Params.Blue ?	DEC	1000	
	Set RGB Params, Green 2	DEC	1000	
	Set RGB Params.Red ?	DEC	1000	
	Set_RGB_Params.Red ? Red_PWM.Param ?	DEC	1000	

Figure 17 - Freemaster





To send the commands, they can be selected in the dropdown list next to the variable "Service Number" (s. Figure 18).

Variable Watch						
	Name	Value				
	ServiceNumber	Do Nothing	·	ENUM		
	stateFlag	Do Nothing	*	ENUM		
	repeatFlag	digLED_Init		DEC		
	nrOfLEDs	digLED_Set_RGB		DEC		
	StripNr	digLED_lest		DEC		
	testInitType.crcEnable	digLED_Reset digLED_Set_Config	Ξ	DEC		
	testInitType.firstLedAdr	digLED_Set_PWM_Red		DEC		
	testInitType.tempCmpEnable	digLED_Set_PWM_Green		DEC		
	testInitType.voltSwing	digLED_Set_PWM_Blue	_	DEC		
	Set_RGB_Params.Address	digLED_Set_Cur_Green digLED_Set_Cur_Blue		DEC		
	Set_RGB_Params.Blue	digLed_Read_Param		DEC		
	Set_RGB_Params.Green	digLED_Read_Temp digLED_Read_Status		DEC		
	Set_RGB_Params.Red	digLED_Read_Diagnostic	Ŧ	DEC		
	Red_PWM.Param	0		DEC		

Figure 18 - Service Number

The application note "AN_INLC_04" from Inova Semiconductors gives a detailed description of the control commands. This document requires a non-disclosure agreement (NDA).





3.3. **Default Firmware**

To re-establish the link, the default firmware needs to be re-flashed onto the microcontroller. The default firmware can be downloaded at https://iseled.com/products/iseled-application-kit.html.

To flash the firmware, open the S32 Design Studio and click on the flash icon (s. Figure 19).



Figure 19 - Flash icon

Select "GBD PEMicro Interface Debugger" and click on the "New" button (s. Figure 20).

eate, manage, and run configurat	ions	
Image: Second	Configure launch settings from this dialog:	
ter matched 4 of 4 items		

Figure 20 - Flash configuration





Select the tab "Debugger" und select the S32K144F5 device. If the NXP board is correctly connected to the PC via USB (Interface: OpenSDA), the corresponding USB port will be displayed (s. Figure 12). If nothing is displayed here, check again if the jumper position J107 is correct. Make sure the GDB client settings have the executable $cross_prefix$ (s. Figure 21). Save the settings by clicking on "Apply".

📄 Main 隊 Del	ougger 🌔 Startup	🧤 Source 🔲 Commo	on 🔑 OS Awa	ireness		
Software Registration						
Please register your software to remove this message.						
Register now						
- PEMicro Interfa	ce Settings					
Interface:	OpenSDA Embedded	Debug - USB Port		✓ Comp	atible Hardwar	e
Port:	USB1 - OpenSDA (9C	C3CE5B)		✓ Refre	esh	
Select Device	Vendor: NXP	Family: S32K	1xx	Target: S32K144F512	2M15	
Core:	M4 ·	-				
Specify IP		Specify Network Car	d IP			
Additional Opti	ons					
Emergency k	Kinetis Device Recovery	by Full Chip Erase 👿	Jse SWD proto	col		
Advanced Opt	ions					
Hardware Interf	Hardware Interface Power Control (Voltage> Power-Out Jack)					
Provide power to target Regulator Output Voltage Power Down Delay ms						
Power off target upon software exit 2V - Power Up Delay ms						
Target Communication Speed						
Debug Shift Freq (KHz) 5000						
Delay after reset and before communicating to target for 0 ms						
GDB Server Sett	ings					
Launch Ser	/er Locally	GDBMI Port Number:	6224			
Hostname or I	P: localhost	Server Port Number:	7224			
Server Paramet	ers:					
GDB Client Sett	ings	and a second			Brauna	Variables
Other options	s{cross_prenx}gabs{c	ross_surix,			browse	variables
Commands:	set mem inaccessible	- by-default off				
	set tcp auto-retry on	-by-deladit off				
	set remotetimeout 60	out 240)				~
Force thread li	st update on suspend					
					Revert	Annhy
					neven	Арру
					Flash	Close

Figure 21 - Flash configuration "Debugger"





Select the "Startup" tab and load the ISELED_ADK_default_firmware.hex file as symbol and executable (s. Figure 22). Save the settings by clicking on "Apply" and press the "Flash" button.

Name: iseled_freemaster_s	lame: iseled_freemaster_s32k144 Debug_FLASH					
📄 Main 🟇 Debugger 🕼	Startup Source Common 🦉 OS Awareness					
Semihosting Settings						
Enable semihosting	Console routed to: 📝 Telnet 🛛 GDB client					
Enable Telnet consol	e Telnet Port: 51794					
Load Symbols and Execu	table					
Load symbols						
O Use project binary:	iseled_freemaster_s32k144.elf					
Ose file:	C:\user\ISELED_ADK_default_firmware_rev01.hex	Workspace File System				
Symbols offset (hex):						
Load executable						
O Use project binary:	iseled_freemaster_s32k144.elf					
Ose file:	C:\user\ISELED_ADK_default_firmware_rev01.hex	Workspace File System				
Executable offset (hex):						
Runtime Options						
🔲 Attach to Running Ta	arget 🔽 Run on reset					
Set PC (hex):	Set breakpoint at: main					
GDB run commands:						
		A				
		Revert Apply				

Figure 22 - Flash configuration "Startup"

After successful flashing, the console displays "target disconnected" (s. Figure 23).



Figure 23 - Succesful flashing





References

- [1] https://www.nxp.com/products/processors-and-microcontrollers/arm-based-processors-and-mcus/s32-automotive-platform/s32k144-evaluation-board:S32K144EVB.
- [2] https://iseled.com/products/inlc100q16.html.
- [3] http://www.te.com/usa-en/industries/automotive/insights/nanomqs.html?variant=b&tab=pgp-story.
- [4] https://demokit.lucielabs.com.





4. Revision History

Revision	Date	Changes
0.1	February 2018	Initial Release
0.2	April 2018	Update chapter 2.2 Update chapter 3.0 New chapter 4.0
0.3	April 2018	Update chapter 3.1
0.4	April 2018	Update chapter 3.2 New chapter 3.3
0.5	April 2018	Update chapter 3.2
0.6	June 2018	Update chapter 3.2
0.7	June 2018	Update chapter 3.2
0.8	March 2019	Update chapter 3.2
0.9	April 2019	Update chapter

Table 1 – Revision history



User Manual



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