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ORIGA™ SLE95050

Original Product Authentication and Brand Protection Solution

Short Product Information

www.infineon.com/ORIGA

Industrial & Multimarket
ASIC & Power IC

Never stop thinking

SLE95050
All characteristics described in this document might change without further notice.

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1 Overview

Infineon Technologies' ORIGA™ SLE95050 is an authentication chip that offers a robust cryptographic solution, designed to assist system manufacturers to ensure the authenticity and safety of their original products, and protection of their investments against after-market replacements.

It leverages Infineon's market leading security knowhow into the battery and accessory authentication markets. With its innovative asymmetric cryptography approach, it significantly reduces system cost whilst making a leap up in security.

SLE95050 is available in two versions. In SLE95050F1 the integrated temperature sensor with built-in Analog-to-Digital Convertor (ADC) allows convenient monitoring of temperature through the single wire interface which enhances the safety of the system. This feature is especially useful in applications like battery authentication and may be mandatory in the future in markets like Japan, where there is a pending legislation requiring temperature monitoring of Lithium batteries. The SLE95050 is available also without the temperature sensing feature in the SLE95050F2 version.

1.1 Advantages

Infineon Technologies' ORIGA™ SLE95050 family offers the following advantages:

- Improved security using unique asymmetrical public/private key cryptography with two different keys for encryption and decryption
- Improved total system cost by allowing a host-side software implementation without compromising security and reducing maintenance or support efforts created by wrong accessories
- Improved safety of the system by ensuring system integrity and control
- Large Non-Volatile Memory (NVM) of 576bit (standard customer NVM of 512bit + 64 bits protected NVM) for storage of device behavior or logistic information (e.g. store number of usage cycles, store data for logistic chain traceability)
- Convenient Temperature Monitoring (only for SLE9505F1). The built-in ADC of the specific SLE95050F1 version can provide the internal temperature value or the value read from a connected external thermistor, or any other analog value like battery cell voltage or other sensor output

1.2 Application Domains

The main area of application is authentication leading to increased safety, functionality and reliability of the accessories, replacement parts and disposables.

The Infineon Technologies' ORIGA™ family lends itself for use in multiple application domains which use its safety and highly reliable authentication features. These protect the systems from unauthorized accessories, replacement parts and disposables. Such unauthorized accessories will be easily and immediately detected, allowing the systems decide a suitable next execution step.

Application Domain Examples:

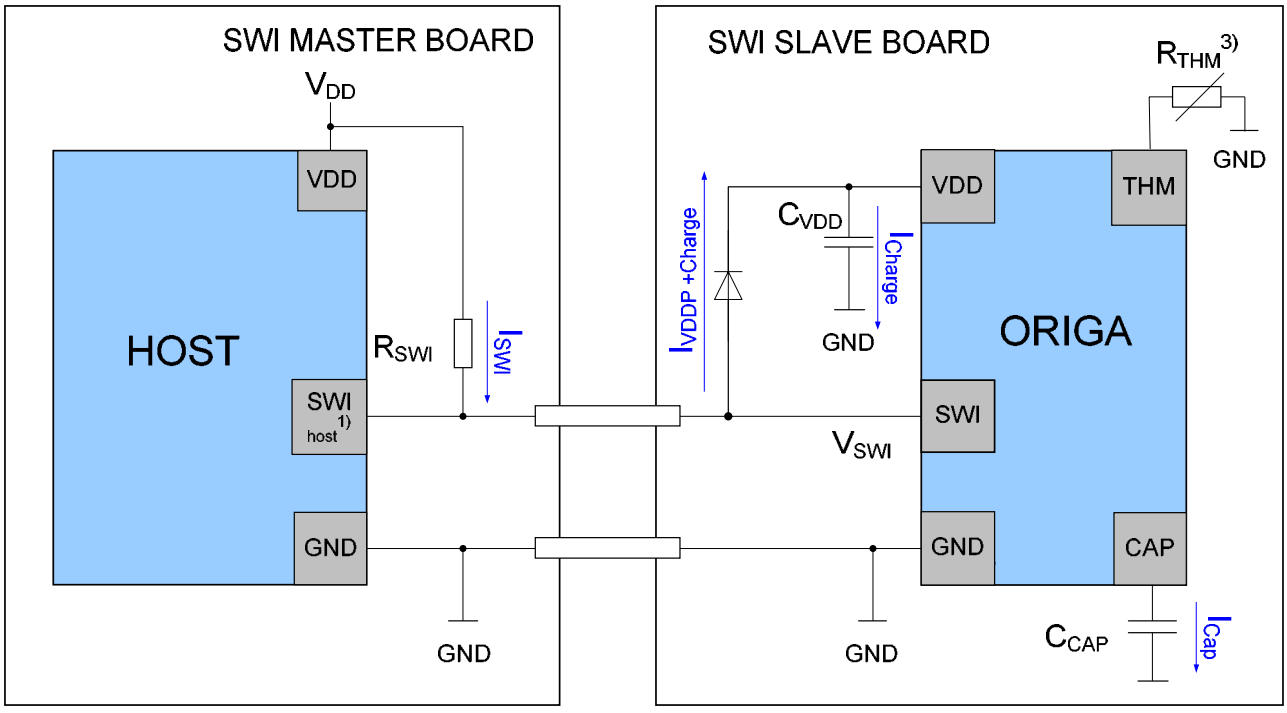
- Batteries
  - Computing Devices, Digital Imaging, Mobile Phones
- Printer Cartridges
- Accessories
  - Earphones, Speakers, Docking Stations, Game Controller, Chargers
- Other Peripherals
- Original Replacement Parts
- Medical Equipment & Diagnostic Supplies
- Authentication of system services, functionalities and parts in networked systems

2 System Configuration

The ORIGA™ devices are a compact design which encompasses the authentication function and analog function in a single solution.

The entire functionality of the SLE95050 ORIGA™ devices is supported via Infineon's proprietary smart Single-Wire Interface protocol which supports three communication modes: Uni-cast, Multi-cast and Broadcast communication. Unicast mode allows commands to be sent, written and read to a single device, while Multicast mode allows commands for multiple devices, and Broadcast for all devices.

The authentication system (Figure 1) consists of a host device serving as the master communicating through the Single Wire Interface (SWI) to the accessory(ies) containing the SLE95050.



1) GPIO configured as open drain output with drive capability of >1mA – 10mA
3) Thermistor only needed for external temperatur measurement, if not needed THM stays n.c.

Figure 1 System Building Blocks of SLE95050F1 – Indirect Powered via Single-Wire-Interface.

3 System Features

Main Features:

- Strong Asymmetric Cryptography Engine
- Temperature and/or Voltage Monitor
- Non-volatile Memory
- Infineon Technologies Single Wire Interface (SWI) as I/O interface
- Power Management – Low Power Consumption
- Power Supply – Single Wire Interface powered or Battery powered solution.

3.1 Strong Asymmetric Cryptography Engine

- Elliptic Curve Cryptography (ECC) – based authentication
- Host challenge by software (master – slave)
- Processing time of less than 60ms for authentication on ORIGA
- Processing time of complete challenge/response: Less than 200ms (w/o pre-computing of ECC challenge/response, depending on host microcontroller)
- Library Concept for easy host side integration available

3.2 Temperature and/or Voltage Monitor

- External temperature sensing -25 .. 85°C ambient @±2°C Junction temperature accuracy (depending on external thermistor selection)
- Full temperature range is -40 .. 110°C. @±10°C Junction temperature accuracy
- Internal temperature sensing -25 .. 85°C ambient @±3°C Accuracy
- 12-bit ADC with clock frequency @ 1MHz ±10%
- Internal / external temperature sensing
- Voltage monitoring (e.g. for fuel gauge functionality or any other sensor) instead of external temperature monitoring possible

3.3 Non-Volatile Memory

- 512-bits unprotected NVM for user mode area (704 bit for SLE95050F2)
- Up to 192 bits protected NVM read-only space for customer specified information which cannot be modified by the end user

3.4 Single-Wire Interface as I/O Interface

- Up to 500kbit/s transmission speed and programmable
- Supports adaptive learning mode

- Powered directly (e.g. from Battery) or indirect via Single-Wire interface (SWI)
- Multiple device capabilities in direct powered mode
- Device ID search scheme and address manage for multiple device capabilities
- Unique Chip ID of 96bits (16bit vendor, 16bit product, 64bit unique chip ID)
- Power-up detection (within 10ms)
- Power-down detection (175us ±10%).
- Communication library concept for easy to use integration on host side available

3.5 Clock

- ADC Operating frequency of 1MHz ±10%
- Digital system operating frequency of 4 MHz ±10% (Programmable for 1/2/4/16 MHz)

3.6 Power Supply – Low Power

- Typical usage of $0.8mA_{rms}$ – $1.3mA_{rms}@2V_{DD}$
- Indirect (SWI) power supply: current consumption $1.3mA_{rms}@2V_{DDP}$ during signaling, $0.3mA_{rms}@2V_{DDP}$ during idle
- Wide operating conditions: 2.0 to 5.5V at V_{DDP} Pin
- For Single-Wire-Interface powered mode (indirect power) the communication line has to be connected via pull-up to at least 3V (see V_{DD} in figure 2)
- Less than 1.0uA in power-down/sleep mode.
- Power-up: 10ms for full system power up
- Power-down: after continuous logic 0 for >500µs on SWI

3.7 Decrease-only counter / Lifespan indicator

- Counter can be decremented on command by the system host, in conjunction with certain events, such as expired time, dispensed units, charging cycles etc…
- The counter value can only be read by the host, it cannot be reprogrammed

3.8 Others

- ESD –
  - HBM = 2kV
  - CDM = 500V
- EEPROM updating (erase and program) time @ 4ms per page (64 bits)
- EEPROM endurance 10^5 write/erase cycles @ 25°C
- Data retention for minimum of 10 years @ 25°C
- Lifetime: 5 years / 100% duty cycle = 438000h

4 Electrical Characteristics

4.1 Input/Output Signals

Table 1 I/O & Power Signals.

Pin No.	Pin Name/ Pad Inst	Pin Type	Buffer Type	Function
4	VDD	PWR	-	2V to 5.5V power supply. I/O / V_{DDP} power supply.
5	SWIO	I/O	OD	Open-drain input and pull-down wired-AND. Supports single-wire interface protoccol.
6	VSS	GND	-	SWIO / VDD ground.
1	CAP	PWR	-	Digital power supply.
3	THM	I/O	AIO	ADC measurement pad for temperature (Voltage).

4.2 Thermistor Characteristics

Supports temperature measurement with external thermistors:

- Resistance @25°C: Typical 47kOhm (with limited temperature range 0-85°C also 10 and 100kOhm)

4.3 Operating Characteristics

Table 2 Power Supply.

Parameter	Symbol	Values			Unit
		Min	Typ	Max	
Digital Supply (internal)	V_{DIG}	1.4	1.55	1.7	V
I/O / VDD Power Supply	V_{DDP}	2.0		5.5	V
Standby Current[1)]	I_{VDDP}	0.6	1.0	1.5	mA_{rms}
Operating Current[2)]	I_{VDD}	1.0	1.5	t.b.d.	mA_{rms}
Power-down Current[3)]	I_{VDD}	0.1	0.5	1.0	uA

All Min, Typ and Max values contained in this table are preliminary. Final values are to be confirmed.

1) Standby Current: Origa is active, current consumption when idle (conditions: Vddp: 3.3V, fsys: 4MHz, T: 25°C)

2) Operating Current: Origa is active, current consumption during NVM, ECC operation (conditions: Vddp: 3.3V, fsys: 4MHz, T: 25°C)

3) Power-down Current: Origa is in power-down mode (conditions: Vddp: 3.3V, T: 25°C)

Table 3 Thermal Characteristics.

Parameter	Symbol	Values			Unit
		Min	Typ	Max	
Ambient Temperature	T_A	-25	25	85	°C
Temperature Sensitivity (-40°C to -20°C)	$A_{TA(-40\ to\ -20)}$			10	± °C
Temperature Sensitivity (85°C to 110°C)	$A_{TA(85\ to\ 110)}$			10	± °C
Temperature Sensitivity at Junction Temperature (-20°C to 85°C)	$A_{TA(-20\ to\ -85)}$			2	± °C

All Min, Typ and Max values contained in this table are preliminary. Final values are to be confirmed.

Table 4 I/O Characteristics.

Parameter	Symbol	Values			Unit	Conditions/ Remarks
		Min	Typ	Max		
Input High Voltage	V_{IH}	2		5.5	V	LVTTL
Input Low Voltage	V_{IL}	0		0.8	V	LVTTL
Input High Current	I_{IH}			1	uA	
Input Low Current	I_{IL}			1	uA	
Output Low Current	I_{OL}			10	mA	
Output Low Voltage	V_{OL}			0.4	V	I_{OL}= 10mA

All Min, Typ and Max values contained in this table are preliminary. Final values are to be confirmed.

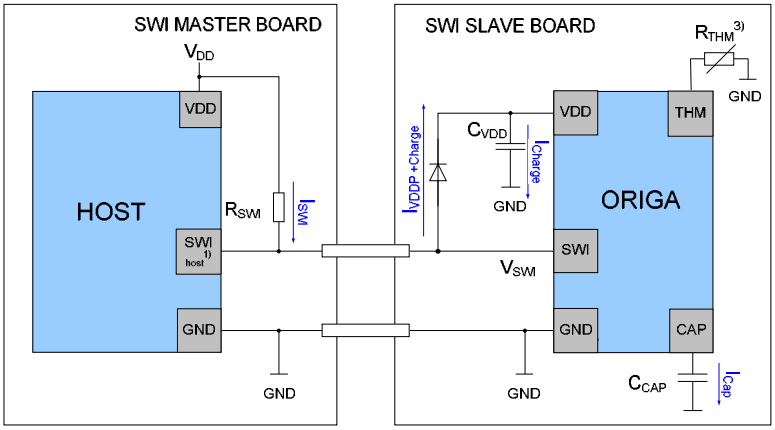
Output High Voltage and Current depend on external pull-up circuitry

4.4 Device Configuration and Electrical Schematics

The SLE95050 ORIGA™ supports multiple configuration options:
1) Host Software to single SLE95050.
2) Host Software to multiple SLE95050.

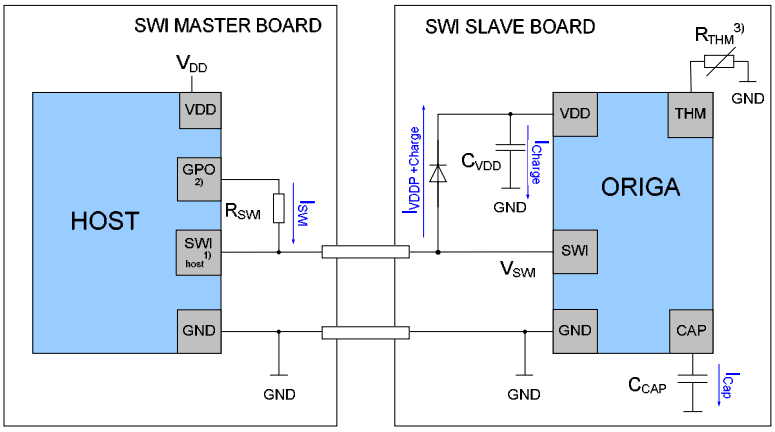
Once initialized the host system may trigger a search ID sequence to identify ORIGA™ devices. After identification of such devices, the host can execute a challenge, verify the response and then determine the success of the authentication.

The following figures illustrate the SLE95050F1 powering options.



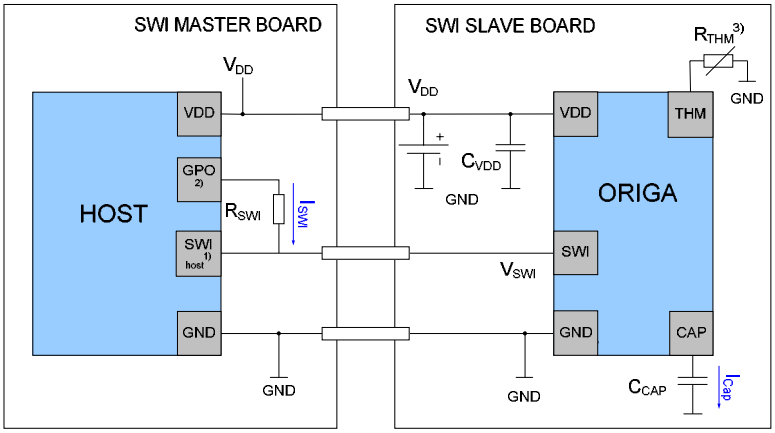
1) GPIO configured as open drain output with drive capability of >1mA – 10mA
3) Thermistor only needed for external temperatur measurement, if not needed THM stays n.c.

Figure 2 Single Wire Interface (SWI) Powered (Indirect Power) using one GPIO



1) GPIO configured as open drain output with drive capability of >1mA – 10mA
2) General purpose Output with drive capability of >1mA – 10mA, needed for low power mode
3) Thermistor only needed for external temperatur measurement, if not needed THM stays n.c.

Figure 3 Single Wire Interface (SWI) Powered (Indirect Power) using two GPIOs



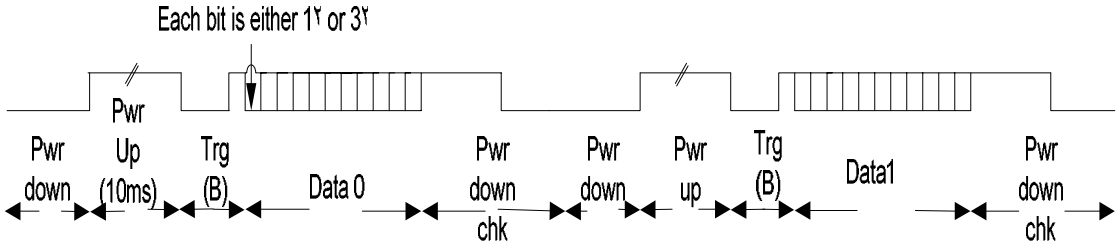
1) GPIO configured as open drain output with drive capability of 1mA – 10mA
2) General purpose Output with drive capability of 1mA – 10mA, needed for low power mode
3) Thermistor only needed for external temperatur measurement, if not needed THM stays n.c.

Figure 4 Direct Powered using two GPIOs

5 Single-Wire Interface

5.1 Single-Wire Transaction

Each SWI packet consists of 11 bits (3 command, 8 data bits). When logic 1 on the SWI is seen for a time longer than the power-up time of 10ms, the chip is powered-up and reset.



٢ (tau) = 0.5 *(1/Data baud rate). The baud rate of SWI is represented by toggling of state of logic “1” voltage level and logic “0” voltage level per second transferred.

Figure 5 A Typical Single Transaction of the SWI Protocol.

In power-up mode, the host can send instructions based on the SWI protocol. When the communication is done, the host can decide to maintain the SWI line at logic 1 or to set it to logic 0 for a time longer than the power-down time of 500µs to power-down the chip to save power.

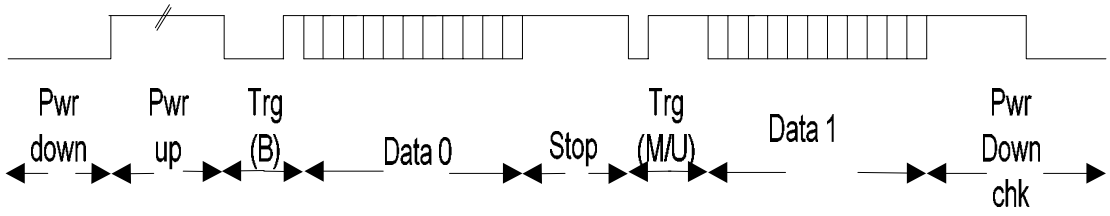


Figure 6 Power-Up Single Packet Transaction.

In power-down mode, the power sequence and timing is required again before the host can start communication with the chip.

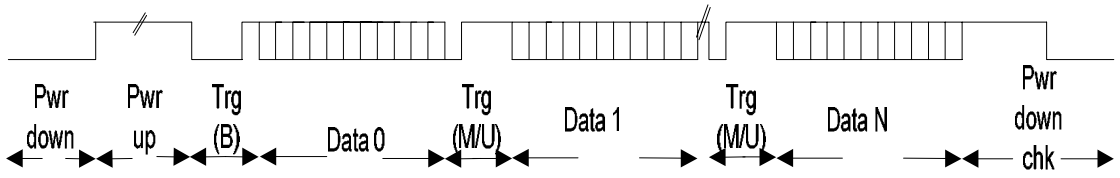


Figure 7 Back-to-Back Data Packet Transaction.

Interrupt can be enabled by the host controller. The host controller must first send an interrupt enable control on the SWI to enable the interrupt on the device(s). Once the device is allowed to interrupt, the host holds the line at logic 1 and if any interrupt- enabled device needs an interrupt, it will pull the line low for a period no greater than the designated interrupt period of 1². Once the host detects the logic 0, it interprets that there is an interrupt and will initiate a check on the devices for the interrupt flag.

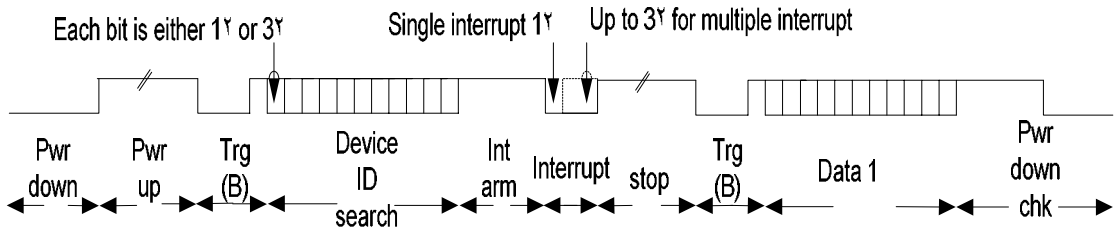


Figure 8 Device-ID Search Data Packet Transaction.

6 Packaging

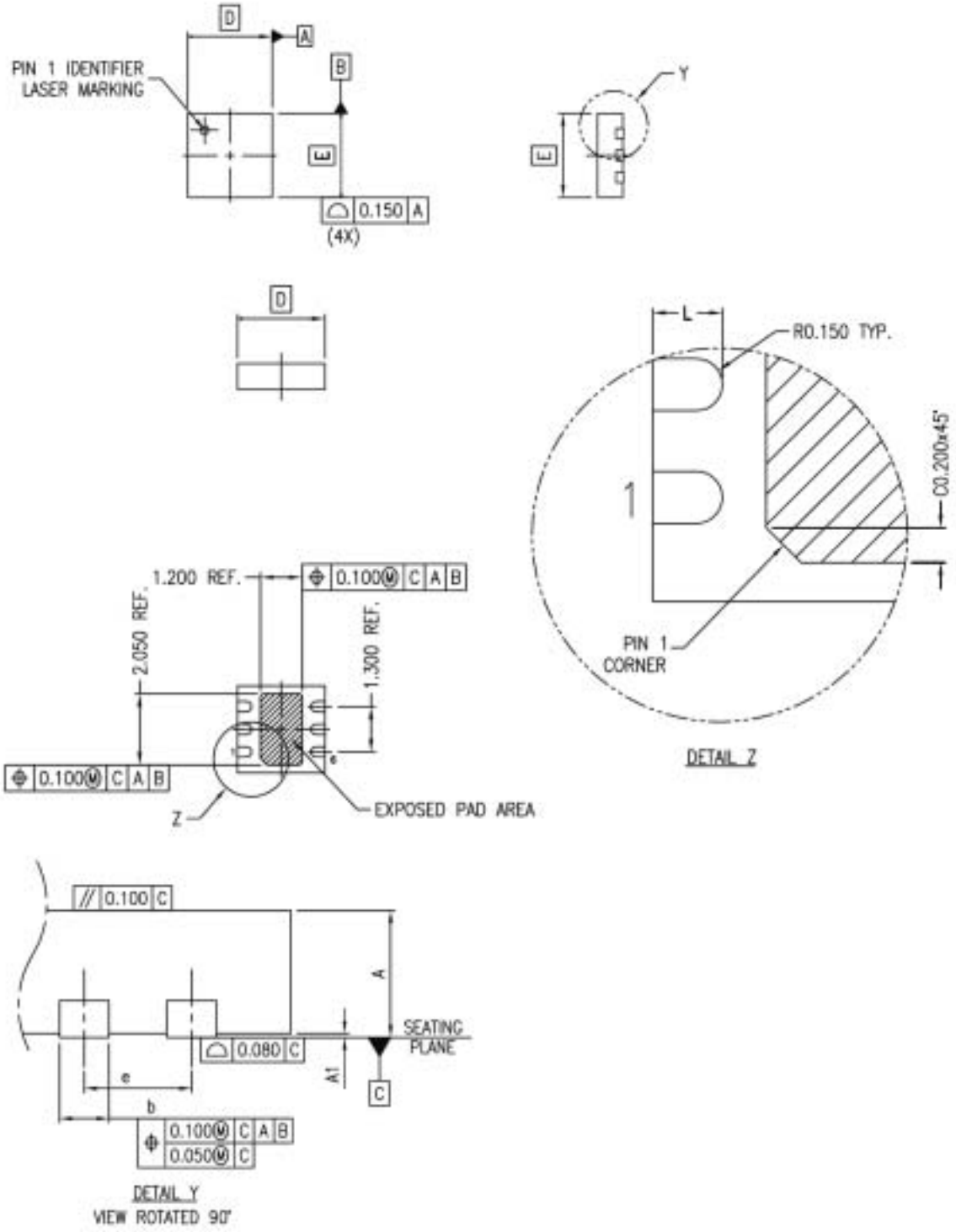
The SLE95050 comes in a WQFN-6 type package.

6.1 Pin Out

Pin No.	Pin Name/ Pad Inst	Pin Type	Pad Description	Domain
4	VDDP	Supply	2.0V - 5.5V power supply	VDDP
5	SWIO	I/O	Bi-dir pad with input and open-drain pull output driver	VDDP
6	VSS	GND	Digital ground	VDDP
1	CAP	O	1,5V supply pad	VDD
3	THM	I/O	Empty bi-dir pad with only ESD protection in output and an additional 400ohm resistor input	VDD

Table 5 Pin Assignment and Pin Description. Non mentioned pins are not connected.

6.2 Package Dimensions of WQFN-6



DIMENSION LIST (FOOTPRINT: 0.80)

S/N	SYM	DIMENSIONS	REMARKS
1	A	0.750±0.050	OVERALL HEIGHT
2	A1	0.020 $^{+0.030}_{-0.020}$	STANDOFF
3	D	2.500±0.100	PKG. LENGTH
4	E	2.500±0.100	PKG. WIDTH
5	L	0.400±0.100	FOOT LENGTH
6	b	0.300±0.050	LEAD WIDTH
7	e	0.650 BASE	LEAD PITCH

NOTES :

S/N	DESCRIPTION		SPEC.
1	GENERAL TOLERANCE.	DISTANCE	±0.100
		ANGLE	±2.5°
2	MATTE FINISH ON PACKAGE BODY SURFACE EXCEPT EJECTION AND PIN 1 MARKING.		Ra 0.3~1.2 um
3	FRAME BASE METAL THICKNESS		0.203 BASE
4	ALL MOLDED BODY SHARP CORNER RADII UNLESS OTHERWISE SPECIFIED.		MAX. R0.200
5	DRAWING DOES NOT INCLUDE PLASTIC OR METAL PROTRUSION OR CUTTING BURR.		
6	COMPLIANT TO JEDEC STANDARD: MO-229		

Figure 9 WQFN-6

6.3 Tape & Reel, Marking and Soldering Info

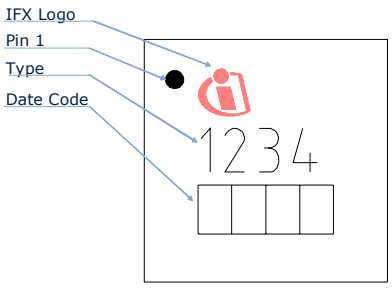
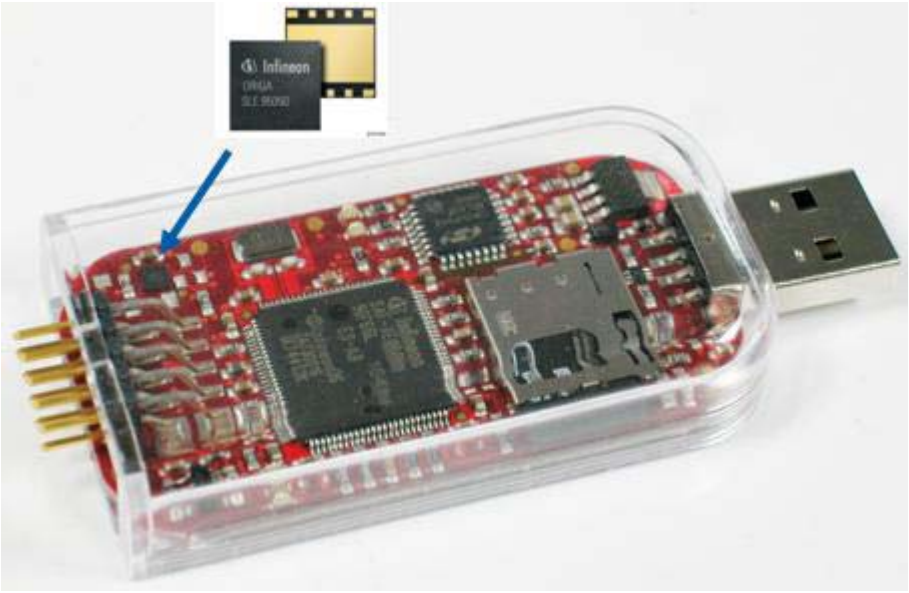


Figure 10 Tape & Reel: 13” with 4” hub, 4x4mm; 6.000 units/reel, reels/box: 1;

7 Evaluation Kit

ORIGA™ SLE95050 Evaluation Kit makes it as convenient as possible for the customer to install ORIGA™ on a host microcontroller platform.

It consists of the ORIGA EvalKit USB Stick, which comes with pre-loaded PC GUI, Application Notes and Databook plus the libraries for ECC, SWI and ADC. A valid Non-Disclosure Agreement is required to receive the EvalKit and the full documentation. An Evaluation Agreement is needed for the usage of the Libraries.



No installation of software is required to use the EvalKit, it runs directly from USB device.

8 Authentication Implementation & Cryptographic Details

The Infineon ORIGA™ SLE95050 is a novel asymmetric key authentication device offering superior cryptography and functionality at reduced system cost compared to other solutions.

It is based on Infineon's long standing experience and market leadership in security solutions. It offers a cost effective level of physical hardware security, e.g. versus bus probing and memory analysis attacks and shares the same highly secure front-end facilities, logistics & personalization processes as high security application devices, such as banking and PayTV smart cards.

Due to its unique asymmetric cryptography implementation the Infineon authentication chip

can be used in a software-to-hardware authentication configuration - No hardware master device on the host side is needed in this configuration.

In this lowest system cost configuration (software-to-hardware authentication), the implementation on the host side can be done with a small piece of code library (about 3kB of code, needing less than 2kB of RAM for execution on preferably 16bit or 32bit, but also possible with 8bit microcontrollers). The host-side implementation runs on the host processor in Software without compromising the security of the system, unlike in a symmetrical cryptography system (e.g. SHA/DES/TDES/AES).

The reference code can be licensed by Infineon for use in conjunction with the ORIGA™ device.

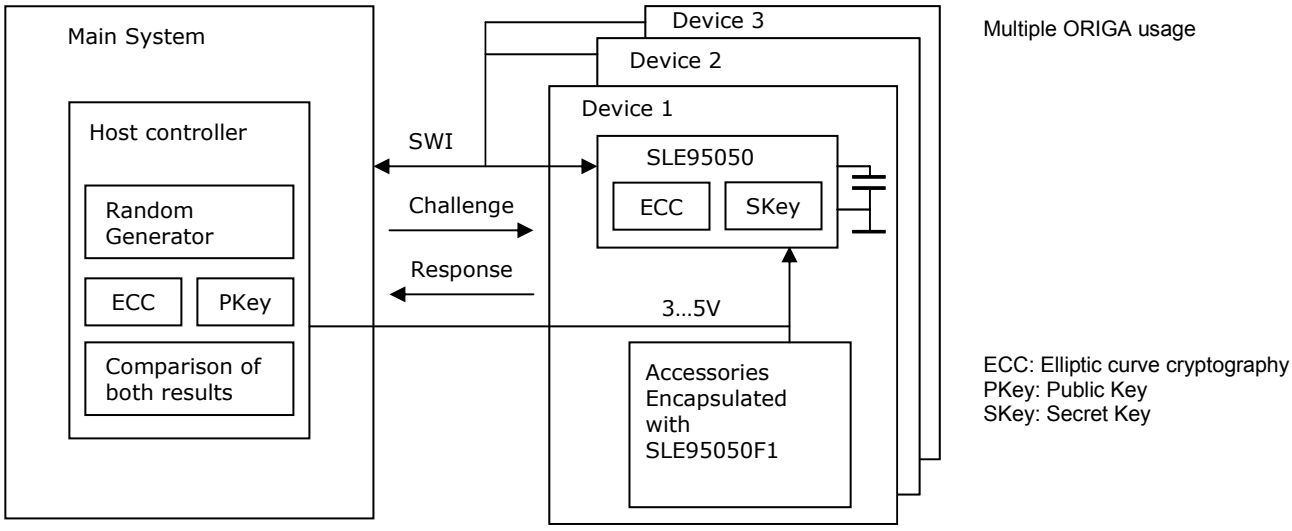


Figure 11 Software-to-Hardware Authentication Implementation

Symmetric vs. Asymmetric Cryptography

In symmetric cryptography the same key is used for encryption and decryption. If one key is hacked, the entire security protection is broken. Software stored keys can be comparably easy to read out. Typically, symmetric algorithms are used in situations where a secure surrounding environment can be established, like in banking and data transmission.

Asymmetric cryptography uses two different keys for encryption and decryption. One key, the so called public key (PKey), can be made public (and therefore used in the Software implementation), as long as the other key, the secret key (SKey, sometimes also called private key), is still in the safe hardware environment of the chip. Asymmetric cryptography is typically used in applications requiring a high level of security in a critical environment

like military or government implementations and it is used for identity protection in electronic passports worldwide.

Leveraging the advantages of asymmetric cryptography, Infineon has implemented the most modern and suitable for embedded applications asymmetric cryptography algorithm. The ORIGA™ device from Infineon uses discrete elliptic curve cryptography (ECC) logarithm implementation, a mathematically very complex and highly secure form of ECC. It combines top level operational security with cost efficient implementation. It protects data such as the Private Key, the unique chip ID and other customer information in a protected memory space, which is secured from modification. Also up to 192bit of read only data can be written into this space.

Additionally, the Infineon ORIGA™ SLE95050F1 devices offer unprotected and freely usable NVM of 512 bit (SLE9505F2 offers 704 bit) for different purposes such as traceability of manufacturing and logistics chain, personalization data for the accessory or other end-user behavior like charging cycle documentation.

9 Personalization and Key Management

Authentication Chips are produced in a standard version. For different customers and different applications these chips have to be individualized / personalized.
This is done by configuring chips with customer specific information (keys, etc).

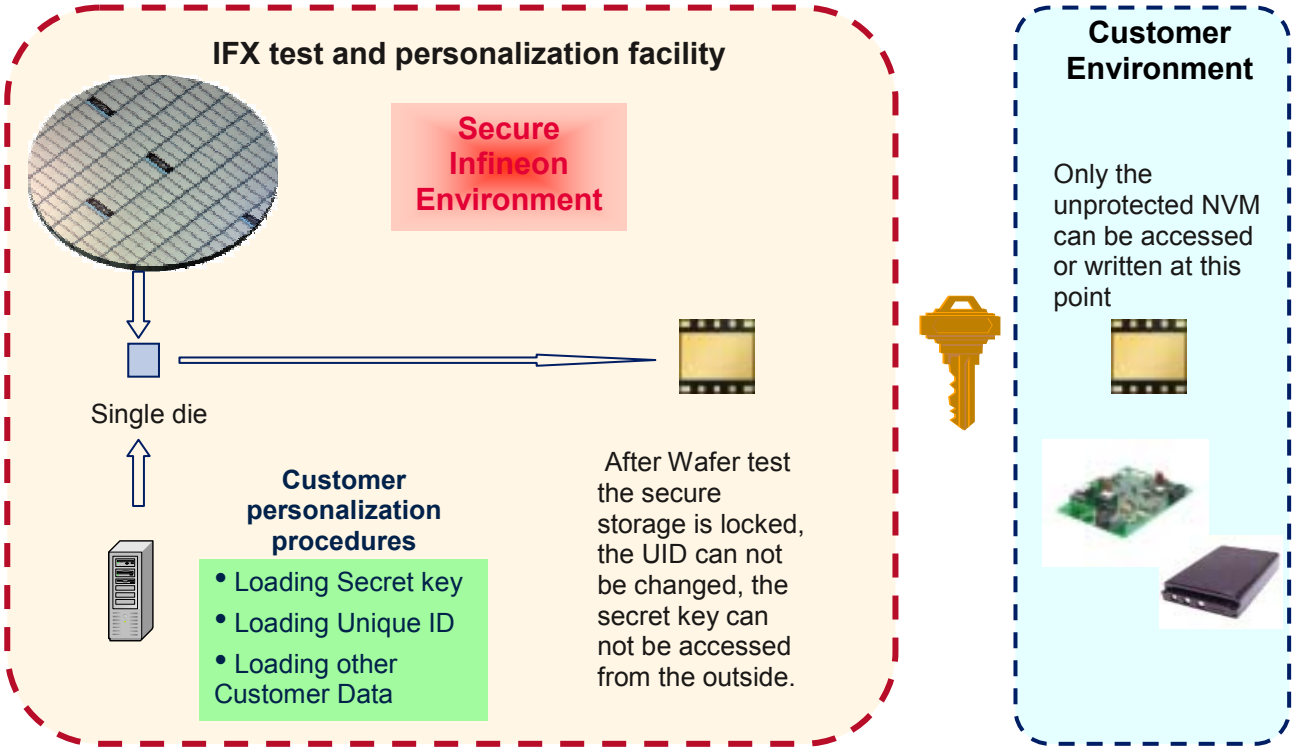


Figure 12 Personalization

Personalization must be performed in a controlled, trusted and protected environment, to prevent any misuse or illegal use of chips. Customer parameters must be protected against unauthorized knowledge or use.

Infineon‘s security chip manufacturing and testing facility is security certified and evaluated by a third party authority, and it meets the requirements for performing the critical personalization flow.

ORIGA™ SLE95050 customers (or their approved contracted manufacturers) receive unique sets of key pairs associated with customers’ products.

The secret key should be the same for one accessory product type (e.g. headset) or across a range of products (battery, headset, docking station) to assure interoperability. The corresponding host side public key will be provided to the customer with the host side personalization package.

10 Summary

Infineon Technologies ORIGA™ Original Product Authentication and Brand Protection Solution provides superior security at improved system cost compared to other solutions by using unique asymmetrical cryptography with two different keys for encryption and decryption.

With this novel approach it can protect your products and brand, while improving the safety of the overall system.

The temperature monitoring feature on the SLE95050F1 supports temperature sensing on detachable accessories without increasing pin count by reading out over the Single Wire Interface, either the chip’s internal temperature or that measured from an external thermistor. The integrated ADC provides convenient temperature monitoring by just sending a command.

Its non-volatile memory (NVM) of 512bit can be used for storage of device behavior (e.g. number of usage cycles or data for logistic chain traceability).

The Single Wire Interface is easy to implement without design changes to peripherals or the target accessory interface. The device supports host powered mode via SWI as well as battery powered mode.