Software Design Specification

500 Series Z-Wave Chip NVR Flash Page Contents

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Description:	This document describes the 500 Series Z-Wave Chip NVR Flash Page Contents
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Date	CET	Initials	Name	Justification
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REVISION RECORD

Doc. Ver.	Date	By	Pages affected	Brief description of changes
1	20130220	PSH	ALL	Initial revision
1	20130308	PSH JFR	ALL	Added NVR layout revision Changed SAW filter according to review comments Added description of CRC16 algorithm Minor typos and CRC16 reference
2	20130319	TRO	Section 3.1	Add IDVEN (Vendor ID) and IDPROD (Product ID) to the document
2	20130429	PSH	Section 3.1	Added NVR fields for new sensitivity calibration values
2	20130514	MVO	All	Renamed fields, added CRC16 example, clean-up
2	20130515	ANI	Section 3.1	Changed not calibrated CCAL value to 0x80
3	20130618	MVithanage	Section 3.1	Changed the REV field data format and added the current revision. Added the Z-Wave products to the MTYP field data. Changed the MREV field data format to match REV. Added standard values for the regions in SAWC. Added standard values for the regions in SAWB. Extended the description of NVMP.
3	20130618	ANI	Section 3.1	Corrected valid range
3	20130619	PSH	Section 3.1	MTYP field changed to PINS field. MREV changed to NVMCS field. Current revision changed to 0.1
4	20131013	MVO	Section 3.1	Now the CRC16 example is calculated over correct data range
5	20140224	MVO	Section 4	Added mandatory/optional field info to the tables
6	20140320	MVO	Section 4 Section 3	Corrected text Added initial description of the NVR data area
7	20140401	EFH	Section 3.1	Added NVMT=1, EEPROM with page size 256
7	20140403	MVO	Appendix A Table 4	Added CRC16 calculation C source code and sample calculation Corrected SAWC and SAWB fields for ZM5202
8	20140623	JFR	Section 3.1	Added limitations with respect to configuration of the NVM chip select pin in NVR (NVMCS field).
9	20150809	TRO	Section 3.1	Add HW version
10	20160707	JBU	Section 3.2	Added ECDH keypair to NVR. To be used by slave libraries without external NVM.
11	20160801	JBU	Section 3.2, 3.1, Section 4 Section 5	Elaborated PUK/PRK with generation algorithm. Removed PUK/PRK from section 3.2 since these fields don't exist in rev 0.1. Added PUK/PRK as CM fields if S2 enabled protocol version is used. Added code samples for PUK/PRK generation
12	20161123	JFR	Section 3.1.7	Updated manufacturer list
13	20170201	JFR	Section 3.2	PUK and PRK only stored in NVR for all slaves.
14	20170206	JBU	Section 5.2	Added linux source code example
15	20170428	JBU	Section 5.2	Better printing of linux source code example
16	20170606	SSE	Section 3.1.7	Added a new value for the DATAFLASH NVM type from adesto This type of chips have special power down mode
16	20170619	PSH	Section 3.1.7	Corrected NVM type table wrt. NVMT = 0x03
17	20170814	JFR	Section 3.1.9	Truncation of non-volatile memory page size
18	20180302	BBR	All	Added Silicon Labs template

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1 ABBREVIATIONS

Abbreviation	Explanation
CCAL	Crystal CALibration NVR field
CRC16	Cyclic Redundancy Check, 16 bit NVR field
EPx	Erase and Programming protection lock bit
MREV	Module REVision NVR field
MSB	Most Significant Byte
PINS	Pin swap
NVMCS	NVM chip select
NVMP	Non-Volatile-Memory Page size NVR field
NVMS	Non-Volatile-Memory Size NVR field
NVMT	Non-Volatile-Memory Type NVR field
NVR	Non Volatile Registers
PID	USB Product IDentifier NVR field
RBAP	Read Back and Auto Programming mode lock bit
REV	NVR layout REVision NVR field
SAWB	SAW Bandwidth NVR field
SAWC	SAW Center frequency NVR field
TXCAL1	Frequency Calibration 868.4MHz NVR field
TXCAL2	Frequency Calibration 929.4MHz NVR field
UUID	Universally Unique IDentifier NVR field
VID	USB Vendor IDentifier NVR field

2 INTRODUCTION

2.1 Purpose

This document defines the content of the NVR flash page in the 500 Series chips.

2.2 Audience and prerequisites

This document is targeted 500 Series Z-Wave chip programmer designers and Z-Wave SW designers.

3 NVR FLASH PAGE IN THE 500 SERIES

The NVR flash page is used to store NVM data throughout a Z-Wave product lifetime. The NVR data can be read from the MCU embedded in the 500 series chip. But it can only be programmed using a programming interface. The Z-Wave protocol and peripheral drivers utilize some of the NVR data for RF calibration data and for data that can be used to identify the peripherals. A part of the NVR data area can be used by the application, e.g. for calibration data, serial numbers etc.

3.1 NVR Flash page contents revision v.0.1

The NVR flash page, NVR0, contains the following fields:

<table>
<tr><th>Byte</th><th>0/8</th><th>1/9</th><th>2/A</th><th>3/B</th><th>4/C</th><th>5/D</th><th>6/E</th><th>7/F</th></tr>
<tr><td>0x00</td><td>EP0</td><td>EP1</td><td>EP2</td><td>EP3</td><td>EP4</td><td>EP5</td><td>EP6</td><td>EP7</td></tr>
<tr><td>0x08</td><td>RBAP</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>0x10</td><td>REV</td><td>CCAL</td><td>PINS</td><td>NVMCS</td><td colspan="3">SAWC</td><td>SAWB</td></tr>
<tr><td>0x18</td><td>NVMT</td><td colspan="2">NVMS</td><td colspan="2">NVMP</td><td colspan="3">UUID</td></tr>
<tr><td>0x20</td><td colspan="8">UUID</td></tr>
<tr><td>0x28</td><td colspan="5">UUID</td><td colspan="2">VID</td><td>PID</td></tr>
<tr><td>0x30</td><td>PID</td><td>TXCAL1</td><td>TXCAL2</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>…</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>0x78</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">CRC16</td></tr>
<tr><td>0x80</td><td>HW</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>..</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>0xF8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Addresses from 0x00 to 0x08 are used for lock bits
Addresses from 0x10 to 0x7F are used by Z-Wave protocol and peripheral drivers.
Addresses from 0x80 to 0xFF are reserved for the application

Lock bits are described in the 500 series Z-Wave single chip programming mode document [1].

Note: All multi byte fields should be written with the MSB at the lowest address

3.1.1 REV – NVR layout revision (8bit)

This field contains the revision number of the NVR page layout. The layout described in this section corresponds to revision 1.

REV	Description
`0xFF`	Unknown revision
`0x00`	v0.0
`0x01`	v0.1
`0x02`	v0.2
.	.
.	.
.	.
`0x10`	v1.0
`0x11`	v1.1
.	.
.	.

Standard usage:

Current revision	REV
v0.1	`0x01`

3.1.2 CCAL – Crystal Calibration (8bit)

This byte contains the byte used calibrating the RF frequency after the variation in the crystal frequency. The value is a two-compliment number. Refer to [4] for a description of how to generate the calibration value.

CCAL	Description
0x80	Not calibrated
0x00-0x7F 0x81-0xFF	Valid calibration value

3.1.3 PINS – Pin Swap (8bit)

This byte contains information about pin swapping in the Z-Wave module/chip.

PINS	Description
0xFF	Unknown pin swapping or no pin swapping
0x00	No pin swapping
0x01	ZM5202 mode. UART0 Tx is moved to P3.5, UART0 Rx is moved to P3.4 and PWM output is moved to P1.0
0x02-0xFE	Reserved values

3.1.4 NVMCS – NVM Chip Select (8bit)

This byte contains information about what pin we are using for chip select for the NVM chip. The 4 MSB are the port number and the 4 LSB are the pin number. Notice the limitations with respect to configuration of the NVM chip select pin in NVR.

NVMCS	Description
0xFF	Unknown chip select
0xXY	X = Port Number, Y = Pin number Supported port and pin numbers: NVMCS = 0x04 - PORT0.4 NVMCS = 0x14 - PORT1.4 NVMCS = 0x15 - PORT1.5 NVMCS = 0x17 - PORT1.7 NVMCS = 0x25 - PORT2.5 NVMCS = 0x30 - PORT3.0 NVMCS = 0x34 - PORT3.4 NVMCS = 0x36 - PORT3.6 NVMCS = 0x37 - PORT3.7

3.1.5 SAWC – SAW Center Frequency (24bit)

This field contains the center frequency mounted on the Z-Wave module. The center frequency is given as an integer in kHz. This field can, in combination with the SAWB field, be used to verify that the SAW filter complies with the frequency contained in the flash code image.

SAWC	Description
0xFFFFFF	Unknown center frequency
0x000000	Direct connection (All frequencies will pass)
0x000001-0xFFFFFD	SAW filter center frequency
0xFFFFFE	No SAW filter mounted (RF won't work)

Standard usage:

Region	SAWC	F_c
E	0x0D3CDE	867550kHz
U	0x0DEB7A	912250kHz
H	0x0E1578	923000kHz

3.1.6 SAWB – SAW Bandwidth (8bit)

This byte contains the bandwidth of the SAW filter mounted on the Z-Wave module. The bandwidth is given as an integer in MHz. This field can, in combination with the SAWC field, be used to verify that the SAW filter complies with the frequency contained in the flash code image.

SAWB	Description
0xFF	Unknown bandwidth
0x00-0xFE	SAW filter bandwidth

Standard usage:

Region	SAWB	BW
E	0x05	5MHz
U	0x08	8MHz
H	0x07	7MHz

3.1.7 NVMT – Non-Volatile-Memory Type (8bit)

This byte contains the interface type of the NVM chip mounted on the Z-Wave module.

NVMT	Type	Manufacturer
0xFF	-	Unknown NVM chip
0x00	-	No External NVM chip
0x01	EEPROM	Atmel Corporation: AT25256B ON Semiconductor: CAT25256
0x02	FLASH	Micron Technology: M25PE10, M25PE20, M25PE40 & M25PE80 Adestotech (enters only deep sleep): AT45DB021E, AT45DB041E, AT45DB081E, AT45DB161E, AT45DB321E & AT45DB641E
0x03	EEPROM	ON Semiconductor: CAT25M01
0x04	DATAFLASH	Adestotech (enters ultra-deep sleep): AT45DB021E, AT45DB041E, AT45DB081E, AT45DB161E, AT45DB321E & AT45DB641E

Refer to [5] for details about recommended external NVM components.

3.1.8 NVMS – Non-Volatile-Memory Size (16bit)

This field contains the size of the NVM chip mounted on the Z-Wave module. The size is given in kB (kilo bytes)

NVMS	Description
0xFFFF	Unknown NVM size
0x0000-0xFFFE	NVM size

3.1.9 NVMP – Non-Volatile-Memory Page Size (16bit)

This field contains the page size of the NVM chip mounted on the Z-Wave module. The size is given in bytes.

FLASH: This value represents the smallest erasable size.
EEPROM: Size of the write buffer.

NVMP	Description
0xFFFF	Unknown NVM page size
0x0000-0x0100	NVM page size

Notice: Enter 256 bytes (0x0100) in case page size is bigger than 256 bytes in datasheet.

3.1.10 UUID – Universally Unique Identifier (128bit)

This field contains a universally unique identifier that is used for giving the USB interface a unique identifier .This makes it possible for the OS, to which the Z-Wave module is connected, to uniquely identify each Z-Wave device when more than one Z-Wave device is connected via USB.

NOTICE: Optional to set UUID in UZB devices.

UUID	Description
0xFF..FF	No UUID
0xYY.YY	Valid UUID

3.1.11 VID – USB Vendor ID (16bit)

This field contains the USB Vendor ID. The Vendor ID is assigned by USB Implementers Forum Inc.

The Silicon Labs Vendor ID, 0x0658, is used if this field is 0xFFFF.

NVR Vendor ID values will not be used if Vendor ID is changed by calling USB API interface.

VID	Description
0xFFFF	Uses Silicon Labs Vendor ID 0x0658
0x0000-0xFFFE	Vendor specific ID

3.1.12 PID – USB Product ID (16bit)

This field contains the USB Product ID. Product ID is assigned by the end-product manufacturer. Silicon Labs Product ID for USBVCP protocol, 0x0200, is used if this field is 0xFFFF.

NVR Product ID values will not be used if Product ID is changed by calling USB API interface.

Please refer to [3] for Silicon Labs Vendor ID's.

PID	Description
0xFFFF	Uses Silicon Labs Product ID 0x0200 (UZB)
0x0000-0xFFFE	Product specific ID

3.1.13 TXCAL1 – Frequency Calibration (8bit)

This byte contains a value that, together with TXCAL2, is used for calibrating the RF Tx frequency

TXCAL1	Description
0xFF	Not Calibrated
0x00-0xFE	Calibration Value

3.1.14 TXCAL2 – Frequency Calibration (8bit)

This byte contains a value that, together with TXCAL1, is used for calibrating the RF Tx frequency

TXCAL2	Description
0xFF	Not Calibrated
0x00-0xFE	Calibration Value

3.1.15 CRC16 – CRC (16bit)

This word contains a CRC16 value calculated from address 0x10 to address 0x7D. If the CRC16 is not correct all fields in the NVR should be read as 0xFF. The CRC16 is calculated using a CRC-CCITT algorithm with an initialization value of 0x1D0F [2].

CRC16	Description
0xYYYY	CRC16 value

The CRC16 value is 0xC13D when the value of all the bytes from form address 0x10 to 0x7D is 0xFF. That is, the content of address 7Eh becomes 0xC1 and the content of address 0x7F becomes 0x3D.

3.1.16 HW – Hardware version (8 bit), Application area

The Hardware Version field is unique to this particular version of the product. It is reported in command class Version Report. Please read information about hardware version document SDS12652. The Framework is capable to read the hardware version (CommandClassVersion.c).

HW	Description
0x00-0xFF	HW version value is version of the entire product.

3.2 NVR Flash page contents revision v.0.2

The NVR flash page, NVR0, contains the following fields:

Byte	0/8	1/9	2/A	3/B	4/C	5/D	6/E	7/F
0x00	EP0	EP1	EP2	EP3	EP4	EP5	EP6	EP7
0x08	RBAP							
0x10	REV	CCAL	PINS	NVMCS	SAWC			SAWB
0x18	NVMT	NVMS		NVMP		UUID		
0x20	UUID							
0x28	UUID					VID		PID
0x30	PID	TXCAL1	TXCAL2	PUK1	PUK2	PUK3	PUK4	PUK5
…								
0x50	PUK30	PUK31	PUK32	PRK1	PRK2	PRK3	PRK4	PRK5
…								
0x70	PRK30	PRK31	PRK32	-	-	-	-	-
0x78	-	-	-	-	-	-	CRC16	
0x80	HW							
..								
0xF8								

Addresses from 0x00 to 0x08 are used for lock bits
Addresses from 0x10 to 0x7F are used by Z-Wave protocol and peripheral drivers.
Addresses from 0x80 to 0xFF are reserved for the application

Lock bits are described in the 500 series Z-Wave single chip programming mode document [1].

Note: All multi byte fields should be written with the MSB at the lowest address

3.2.1 REV – NVR layout revision (8bit)

This field contains the revision number of the NVR page layout. The layout described in this section corresponds to revision 2.

REV	Description
0xFF	Unknown revision
0x00	v0.0
0x01	v0.1
0x02	v0.2
.	.
.	.
.	.
0x10	v1.0
0x11	v1.1
.	.
.	.

Standard usage:

Current revision	REV
v0.2	0x02

3.2.2 PUK – Public Key for Security2 (256bit)

The PUK field contains the Public key of the Curve25519 ECDH Keypair used during S2 inclusion.

PRK contains the private key. The PUK and PRK MUST always are stored in the NVR of S2 enabled devices.

Algorithm for creating the PUK and PRK fields

1. Fill PRK with 32 bytes of high-quality random numbers. A high quality can be obtained on linux by reading from /dev/urandom or using the getrandom(2) syscall. On Windows, the System.Security.Cryptography.RNGCryptoServiceProvider or CryptGenRandom() function can be used.
2. Call crypto_scalarmult_curve25519_base(PUK, PRK) to compute PUK. The source code for crypto_scalarmult_curve25519_base can be obtained from keypair_generation_curve25519.zip included with SDK 6.70.
3. Once a module has been programmed with a PUK and PRK, the first 16 bytes of the PUK must be stored and printed on the packaging or casing of that particular module. The PRK MUST be discarded along with all log files listing it after the production run is complete.

Detailed instructions on random number generation and PUK computation can be found in Section 5.

It is RECOMMENDED to repeat this algorithm *before* production starts and create a collection of (PUK, PRK) values sufficient for the entire production run. The PRKs MUST is discarded after production. The PUKs MUST is retained and printed on the module and finished product.

3.2.3 PRK – Private Key for Security2 (256bit)

The private part of the Curve25519 key pair used for key exchange in Security2.
See section 3.2.2 for a detailed description.

4 NVR FLASH PAGE HANDLING IN PRODUCTION

The fields in the Z-Wave protocol and peripheral driver part (addresses 0x10-0x7F) of the NVR flash page, NVR0, are divided in fields that are mandatory to be set, fields that are conditionally mandatory to be set and in fields that can be set as an option. It is the Z-Wave end-product manufacturer's responsibility to check that the fields have been set correctly.

The fields REV, CCAL, PINS, TXCAL1, TXCAL2 and CRC16 must be set in the NVR Flash page, NVR0, for all 500 Series Z-Wave Chip based products.

The fields NVMT, NVMS and NVMP must be set in the NVR Flash page in all 500 Series Z-Wave Chip based products that has an external NVM.

Additionally, the fields VID and PID must be written to the NVR Flash page in all 500 Series Z-Wave Chip based products where a vendor specific USB interface is utilized.

Optionally, the field UUID can be set in the NVR Flash page during production of a 500 Series Z-Wave Chip based products where the USB interface is utilized. It is also optional to set the SAWC and SAWB fields.

All fields that are not set to a specific value should be set to 0xFF (the contents after erase)

The table below shows a summary of what fields that should be programmed in different Z-Wave module types:

Table 1, Mandatory and optional NVR fields 1/3

	REV	CCAL	PINS	NVMCS	SAWC	SAWB	NVMT	NVMS
ZM5304	M	M	M	M	O	O	M	M
ZM5202	M	M	M	CM	O	O	CM	CM
ZM5101	M	M	M	CM	O	O	CM	CM
SD3502	M	M	M	CM	O	O	CM	CM
SD3503	M	M	M	CM	O	O	CM	CM
M	Mandatory. Must be programmed with a valid value							
CM	Conditional Mandatory. Must be programmed with a valid value if an external NVM is connected to the 500 Series module/chip							
O	Optional. Can optionally be programmed with a valid value							

Table 2, Mandatory and optional NVR fields 2/3

	NVMP	UUID	VID	PID	TXCAL1	TXCAL2	PUK	PRK
ZM5304	M	O	CM	CM	M	M	CM	CM
ZM5202	CM	O	CM	CM	M	M	CM	CM
ZM5101	CM	O	CM	CM	M	M	CM	CM
SD3502	CM	O	CM	CM	M	M	CM	CM
SD3503	CM	O	CM	CM	M	M	CM	CM
M	Mandatory. Must be programmed with a valid value							
CM	Conditional Mandatory. Must be programmed with a valid value if an external NVM is connected to the 500 series module/chip							
CM	Conditional Mandatory. Must be programmed with a valid value if a vendor specific USB interface is utilized							
CM	Conditional Mandatory. Must be programmed with a valid value if an S2-enabled protocol is used.							
O	Optional. Can optionally be programmed with a valid value							
D	Default. Must have the default value 0xFF							

Table 3, Mandatory and optional NVR fields 3/3

	CRC16	*Other*						
ZM5304	M	D						
ZM5202	M	D						
ZM5101	M	D						
SD3502	M	D						
SD3503	M	D						

M	Mandatory. Must be programmed with a valid value
CM	Conditional Mandatory. Must be programmed with a valid value if an external NVM is connected to the 500 series module/chip
CM	Conditional Mandatory. Must be programmed with a valid value if a vendor specific USB interface is utilized
CM	Conditional Mandatory. Must be programmed with a valid value if an S2-enabled protocol is used.
O	Optional. Can optionally be programmed with a valid value
D	Default. Must have the default value 0xFF

The 500 Series Z-Wave Modules will have some fields pre-programmed by Silicon Labs. The NVR flash page of the SD3502 and SD3503 chips are not programmed. The following table shows which fields that are pre-programmed in the 500 Series Z-Wave modules (including the Z-Wave development modules):

Table 4, Pre-programmed NVR fields 1/2

	REV	CCAL	PINS	NVMCS	SAWC	SAWB	NVMT	NVMS
ZM5304	P	P	P	P	P	P	P	P
ZM5202	P	P	P	D	P	P	P	D
ZM5101	P	P	P	D	D	D	D	D
SD3502	D	D	D	D	D	D	D	D
SD3503	D	D	D	D	D	D	D	D
ZDB5202	P	P	P	P	P	P	P	P
ZDB5304	P	P	P	P	P	P	P	P
ZDB5101	P	P	P	P	P	P	P	P
UZB	P	P	P	P	P	P	P	P

P	Pre-programmed with a valid value
D	Default value (0xFF)

Table 5, Pre-programmed NVR fields 2/2

	NVMP	UUID	VID	PID	TXCAL1	TXCAL2	CRC16	*Other*
ZM5304	P	D	D	D	P	P	P	D
ZM5202	D	D	D	D	P	P	P	D
ZM5101	D	D	D	D	D	D	P	D
SD3502	D	D	D	D	D	D	D	D
SD3503	D	D	D	D	D	D	D	D
ZDB5202	P	D	D	D	P	P	P	D
ZDB5304	P	D	D	D	P	P	P	D
ZDB5101	P	D	D	D	P	P	P	D
UZB	P	D	P	P	P	P	P	D

P	Pre-programmed with a valid value
D	Default value (0xFF)

4.1 NVR Flash page handling in programmer

The NVR page is erased when a Flash "Erase Chip" is performed, so the programming software must preserve the NVR contents when programming the chip. All Z-Wave programmers must always read the NVR flash page before running the "Erase chip" programming command, and then optionally modify the NVR fields, and finally write the NVR contents including the modified CRC16 field back to the NVR page.

5 PUK AND PRK CREATION

The PUK and PRK is a Curve25519 keypair. The procedure for generating keypairs is slightly different depending on the platform used.

5.1 Windows

The following example shows how the PC Programmer creates a keypair:

```
public static void GenerateKeys(byte[] priv, byte[] pub)
{
  RNGCryptoServiceProvider rnd = new RNGCryptoServiceProvider();
  rnd.GetBytes(priv);
  CryptoScalarmultCurve25519Base(pub, priv);
}

public static void GenerateOneKeyPair()
{
  byte[] priv = new byte[32];
  byte[] pub = new byte[32];
  GenerateKeys(priv, pub);
}
```

CryptoScalarmultCurve25519Base is an external call to our s2crypto32.dll (or s2crypto64.dll) method crypto_scalarmult_curve25519_base. DLL binaries are provided as a part of Z-Wave PC based Controller release and is situated in the folder …\Source\Libraries\ZWaveDll\lib\CryptoLibraryS2:

- s2crypto32.dll – Windows 32bit version
- s2crypto64.dll – Windows 64bit version

In C# and Mono projects, CryptoScalarmultCurve25519Base can be implemented like this:

```
[DllImport("s2crypto32", EntryPoint = "crypto_scalarmult_curve25519_base",
CallingConvention = CallingConvention.Cdecl)]

private extern static void CryptoScalarmultCurve25519Base_32([Out,
MarshalAs(UnmanagedType.LPArray, SizeConst = KeySize)] byte[] public_key,[In,
MarshalAs(UnmanagedType.LPArray, SizeConst = KeySize)] byte[] private_key);

[DllImport("s2crypto64", EntryPoint = "crypto_scalarmult_curve25519_base",
CallingConvention = CallingConvention.Cdecl)]

private extern static void CryptoScalarmultCurve25519Base_64([Out,
MarshalAs(UnmanagedType.LPArray, SizeConst = KeySize)] byte[] public_key,[In,
MarshalAs(UnmanagedType.LPArray, SizeConst = KeySize)] byte[] private_key);

private static void CryptoScalarmultCurve25519Base(byte[] public_key, byte[]
private_key)
{
     if (IntPtr.Size == 8) // 64 bit process.
     {
         CryptoScalarmultCurve25519Base_64(public_key, private_key);
     }
     else
     {
```

```
          CryptoScalarmultCurve25519Base_32(public_key, private_key);
      }
}
```

5.2 Linux

Algorithm for creating the PUK and PRK fields on Linux

1. Fill PRK with 32 bytes of high-quality random numbers. A high quality can be obtained by reading from /dev/urandom or using the getrandom(2) syscall.
2. Call crypto_scalarmult_curve25519_base(PUK, PRK) to compute PUK. The source code for crypto_scalarmult_curve25519_base can be obtained from Tools\KeypairGeneration directory included with SDK 6.71.xx.

The following sample code illustrates how to generate a keypair. It must be linked with the source code mentioned in step 2 above.

```
#define _GNU_SOURCE
#include <unistd.h>
#include <sys/syscall.h>
#include <stdint.h>
#include <stdio.h>
#include <arpa/inet.h>
#define DllExport extern

#include "curve25519.h"

static void print32(uint8_t *p)
{
    for (int i=0; i<32; i++)
    {
        printf("%02x", p[i]);
    }
    printf("\n");
}

static void print_dsk(uint8_t *p)
{
    int i;
    uint16_t *n;
    printf("DSK:          zws2dsk:");
    n = (uint16_t *)p;
    for (i = 0; i < 8; i++)
    {
        printf("%05d", htons(*n));
        n++;
        if(i < 7)
        {
            printf("-");
        }
    }
    printf("\n");
}
```

```
int main()
{
    static uint8_t private_key[32], public_key[32];
    long r = syscall(SYS_getrandom, private_key, 32, 0);
    if (r != 32) {
        printf("Error obtaining random number, aborting.");
        return -1;
    }
    crypto_scalarmult_curve25519_base(public_key, private_key);
    printf("Public key:  ");
    print32(public_key);
    printf("Private key: ");
    print32(private_key);
    print_dsk(public_key);
    return 0;
}
```

APPENDIX A CRC16 CALCULATION

Appendix A.1 C source code example

```
#include <stdio.h>
#include <stdint.h>

/*===========================   Defines   ============================*/
#define NVR_START             0x10
#define NVR_END               0x7F
#define POLY                  0x1021          /* crc-ccitt */
#define REV_ADR               0x10
#define CRC16_MSB_ADR         0x7E
#define CRC16_LSB_ADR         0x7F

/*===========================   ccittCrc16   ============================
 *    CRC-CCITT (0x1D0F) calculation / check
 *
 *    In:  byte string excluding 16bit check field
 *    Out: CRC-16 value
 *  or
 *    In:  byte string including 16bit check field
 *    Out: zero when OK
 *
 *  and
 *    In: The crc input should be set to the initialization
 *        value = 0x1D0F.
 *        It can also be used to carry over crc value between separate
 *        calculations of multiple parts of a frame, e.g. header and body.
 *
 *---------------------------------------------------------------------------
*/
uint16_t
ccittCrc16(
  uint16_t crc,
  uint8_t *pDataAddr,
  uint16_t bDataLen
  )
{
  uint8_t WorkData;
  uint8_t bitMask;
  uint8_t NewBit;

  while(bDataLen--)
  {
    WorkData = *pDataAddr++;

    for (bitMask = 0x80; bitMask != 0; bitMask >>= 1) {
      /* Align test bit with next bit of the */
      /* message byte, starting with msb.    */
      NewBit = ((WorkData & bitMask) != 0) ^ ((crc & 0x8000) != 0);
      crc <<= 1;
      if (NewBit) {
        crc ^= POLY;
      }
    } /* for (bitMask = 0x80; bitMask != 0; bitMask >>= 1) */
  }
  return crc;
```

```
}
/*=========================== main ===============================
 * Run the ccittCrc16 function on a NVR array where all data is 0xFF
 * except for the REV field which is 0x01
 * ---------------------------------------------------------------*/
int main(void)
{
  uint8_t bNVRArray[256];
  uint16_t wCRC16;
  uint16_t i;

    /* Initialize NVR array to 0xFF's */
  for (i=0;i<256;i++)
  {
    bNVRArray[i]=0xFF;
  }
    /* Set Revision field to 0x01 */
  bNVRArray[REV_ADR]=0x01;

    /* Run CRC16 calculation from address NVR_START */
    /* to the data byte before the CRC16 field      */
  wCRC16 = ccittCrc16( 0x1D0F, &bNVRArray[NVR_START], NVR_END-NVR_START+1-2);

    /* store CRC16 value in NVR array */
  bNVRArray[CRC16_MSB_ADR]=(unsigned char)((wCRC16>>8)&0x00FF);
  bNVRArray[CRC16_LSB_ADR]=(unsigned char)(wCRC16&0x00FF);

    /* print out CRC16 value */
  printf("CRC16: %02X%02X\n", bNVRArray[CRC16_MSB_ADR],
bNVRArray[CRC16_LSB_ADR]);


    /* Check CRC16 value by running CRC calculation */
    /* from address NVR_START to the CRC16 field    */
  wCRC16 = ccittCrc16( 0x1D0F, &bNVRArray[NVR_START], NVR_END-NVR_START+1);

    /* Print out result */
  if (wCRC16==0)
    printf("CRC16 verified\n");
  else
    printf("Error: CRC16 mismatch\n");

  return 0;
}
```

Appendix A.2 Sample calculation

The CRC16 value is C564 for a NVR where the contents of address 0x10 is 0x01 and all other are 0xFF as seen below.

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
10:	01	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
20:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
30:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
40:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
50:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
60:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
70:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	C5	64

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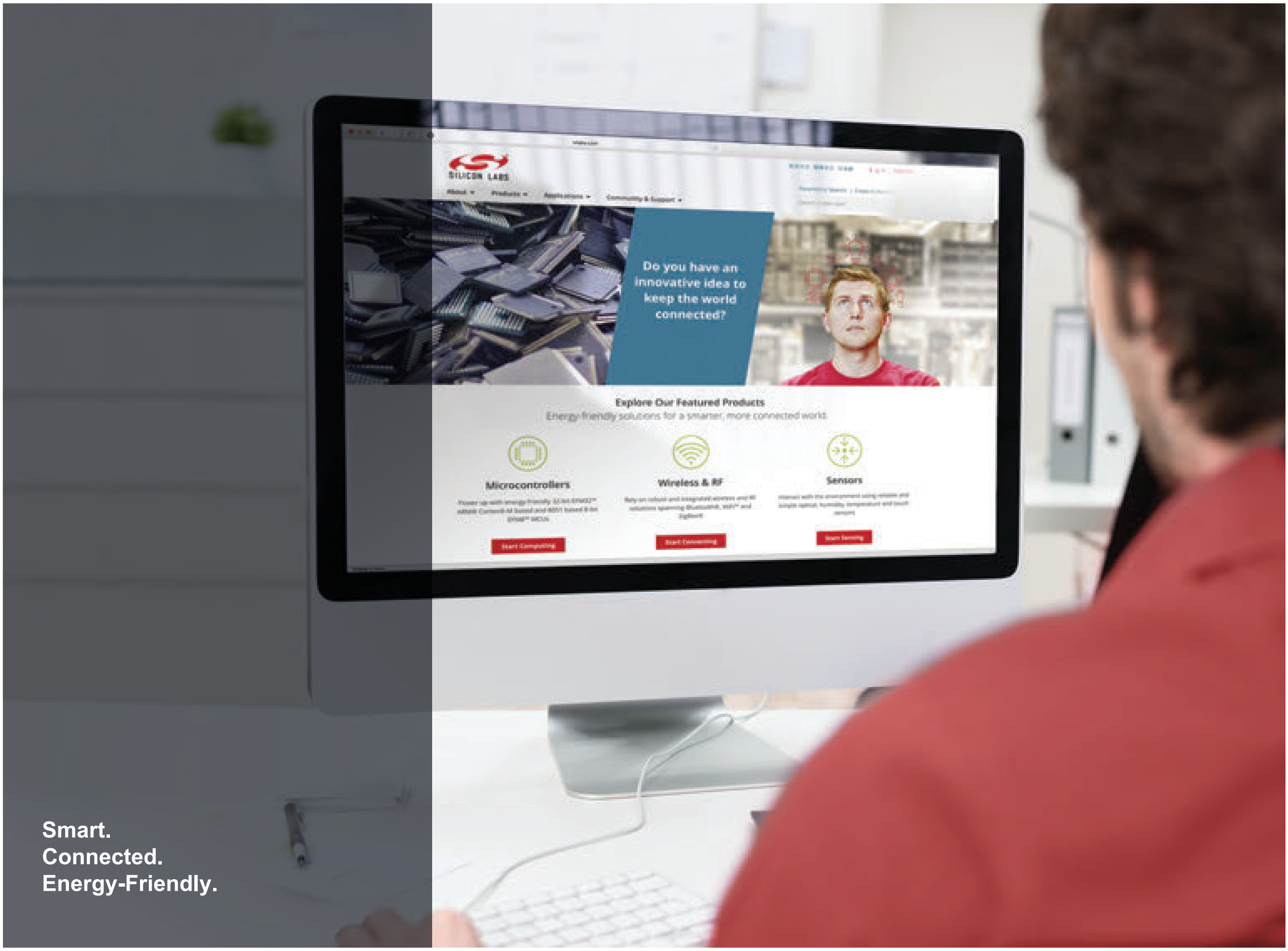

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