Instruction

500 Series Calibration User Guide

Document No.:	INS12524
Version:	8
Description:	Guide for calibration of the 500 Series Z-Wave chips
Written By:	ANI;CRASMUSSEN;JFR;MHANSEN;BBR
Date:	2018-03-06
Reviewed By:	ANI;BBR;CRASMUSSEN
Restrictions:	None

Approved by:

Date	CET	Initials	Name	Justification
2018-03-06	09:26:44	NTJ	Niels Thybo Johansen	

REVISION RECORD

Doc. Rev	Date	By	Pages affected	Brief description of changes
1	20130513	ANI	ALL	Initial version based on INS11552
2	20130905	ANI	Section 2 and 3	Detailed description of connection to ZDP03A added
3	20130925	ANI PNI	Section 1 Section 5	Only crystal calibration is done in module production Added section about Tx calibration
3	20131023	JFR	Section 3.1	Corrected calibration hex file name
4	20140102 20140203	ANI	Section 5.1 Section 3.1-3.2	Fix polarity of enable signal Change description to fit calibration with a single file and auto input selection
5	20140320	ANI	ALL	Updated template
6	20150407	ANI	Section 4	Added description for new calibration hardware
7	20160926	JFR	Section 5	Clarified calibration hex file used.
8	20180306	BBR	All	Added Silicon Labs template

Table of Contents

Table of Figures

Table of Tables

1 ABBREVIATIONS

Abbreviation	Explanation
DCO	Digitally Controlled Oscillator
DFSK	Distributed Frequency Shift Keying
FSK	Frequency Shift Keying
ITU-T	Standardization organization for telecommunication
NVR	Non Volatile Register
OCXO	Oven Controlled Xtal Oscillator, A temperature controlled stable oscillator
PLL	Phase Locked Loop
SD35xx	500 series Z-Wave single chip
SIP	System In Package
ZDP03A	Z-Wave Development Platform, which also supports Z-Wave 500 Series programming and calibration
ZM5xxx	500 series Z-Wave SIP module
ZW05xx	500 series Z-Wave Chip Die

2 INTRODUCTION

2.1 Purpose

The purpose of this document is to give a description of a mandatory crystal- and TX calibration of the Z-Wave 500 Series Chips and modules.

Crystal calibration has the purpose of tuning the TX- and RX frequency to a minimum of error. TX calibration has the purpose of tuning the frequency separation during modulation to an optimum.

Beware that as crystal calibration is relative to the system crystal, the calibration cannot be performed if the chip is not connected to the final system crystal.

The calibration box is identical to the version used for crystal calibration of the 400-series.

Below it can be seen which devices are factory calibrated with crystal calibration, and which that must be both TX and crystal calibrated in product.

Table 1, Which devices has to be calibrated

Device	Calibration
ZM5101	Module is crystal calibrated from factory. TX calibration is required during customer production
ZM5202	Module is crystal and TX calibrated from factory.
ZM5304	Module is crystal and TX calibrated from factory.
SD35XX	Both crystal- and TX calibration is required during customer production
ZW05XX	Each die must be both TX and crystal calibrated after assembly.

Devices must be calibrated once, and the calibration is valid in the entire product lifetime, they can however be recalibrated if the calibration by mistake has been deleted.

2.2 Audience and prerequisites

The audience is Z-Wave partners and Silicon Labs.

3 CRYSTAL CALIBRATION HARDWARE CONFIGURATION WITH RBK-ZWAVECALIBOX-1

For doing crystal calibration a calibration box need to be connected. The calibration box 1 can be seen on Figure 1.

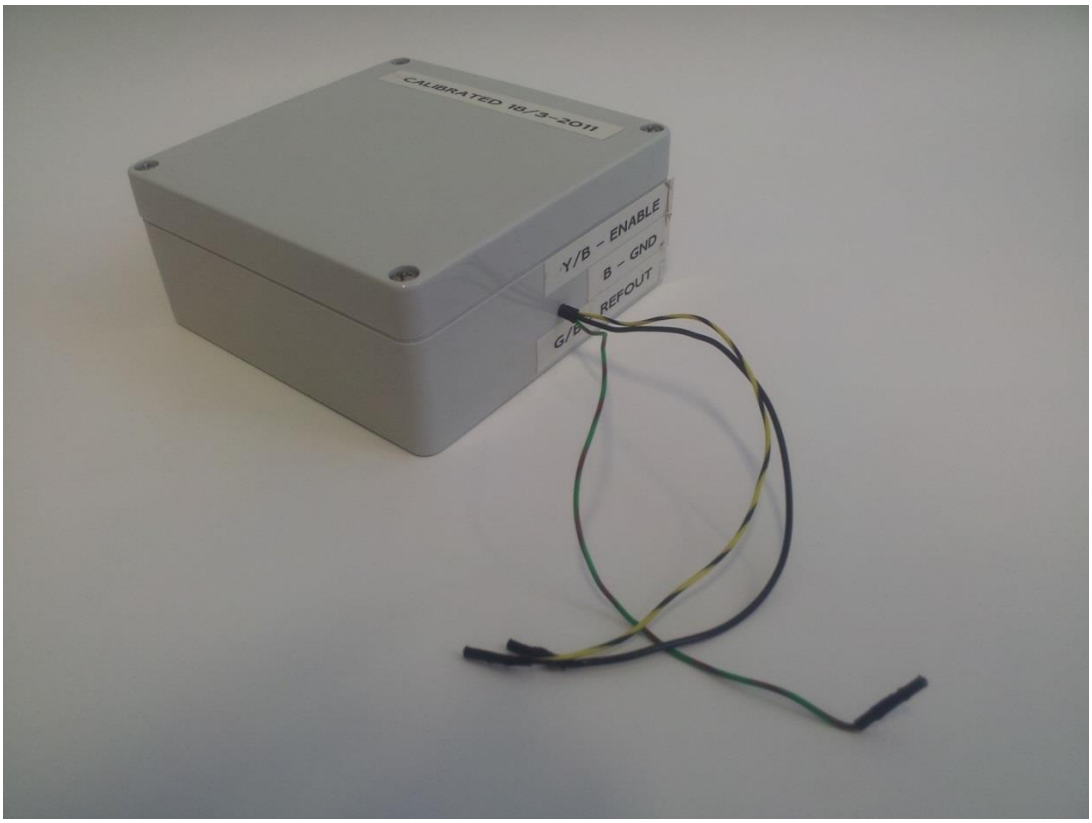


Figure 1 Calibration box 1

The crystal calibration box must be supplied with 100VAC-240VAC, 50/60Hz. There are 3 flywires, which must be connected as shown in the following sections. The startup time of the calibration unit is 2 minutes.

Calibration is done as a step in the programming process when using the Z-Wave programmer.

3.1 Calibration of a device connected to ZDP03A through SPI

This is applicable to all modules except ZDB5304, see Table 2 for connection. The calibration box must be connected directly to ZDP03A using the pins listed in column ZDP03A pin name.

Table 2, Calibration box interface for SPI programming through ZDP03A

Calibration Box Cable Labeling	ZDP03A conn. Pin Name
REF_OUT	J16 pin 10
ENABLE	J10 pin 1
GND	J10 pin 10

3.2 Calibration of a device connected to ZDP03A through UART

This is applicable to all modules except ZDB5202, see Table 3 for connections. The calibration box must be connected directly to ZDP03A using the pins listed in column ZDP03A pin name.

Table 3, Calibration box interface for UART programming through ZDP03A

Calibration Box Cable Labeling	ZDP03A conn. pin Name
REF_OUT	J16 pin 11
ENABLE	J9 pin 6
GND	J10 pin 10

4 CRYSTAL CALIBRATION HARDWARE CONFIGURATION WITH RBK-ZWAVECALIBOX-2

For doing crystal calibration a calibration box need to be connected. The calibration box 2 can be seen on Figure 2.

Figure 2: IOMOD10-CB1 with IOMOD10 calibration board

The crystal calibration board must be powered using the adapter supplied with it. The supplied power adaptor only supplies the crystal. The onboard logic must be powered externally from the ZDP03A. To power the calibration box from ZDP03A, the following jumpers must be shorted:

- ZDP03A J8
- IOMOD10-CB1 LK1

There calibration box has a 2x5 Molex connector (J3) to connect to J6 on ZDP03A, and a fly wire for connecting enable. Enable must be connected as shown in the following sections. The warmup time of the calibration unit is 2 minutes. No calibration must be done before warmup time has been exceeded.

Calibration is done as a step in the programming process when using the Z-Wave programmer.

4.1 Calibration of a device connected to ZDP03A through SPI

This is applicable to all modules except ZDB5304, see Table 4 for connection. The calibration box must be connected directly to ZDP03A using the pins listed in column “ZDP03A Conn. Name”.

Table 4, Calibration box interface for SPI programming through ZDP03A

Signal Name	Calibration Box Cable Labeling	ZDP03A Conn. Name
V_{cc} (3.3V)	J3 pin 1	J6 pin 1
GND	J3 pin 9	J6 pin 9
Reference clock	J3 pin 4	J6 pin 4
Enable	LK2 pin 2	J10 pin 1

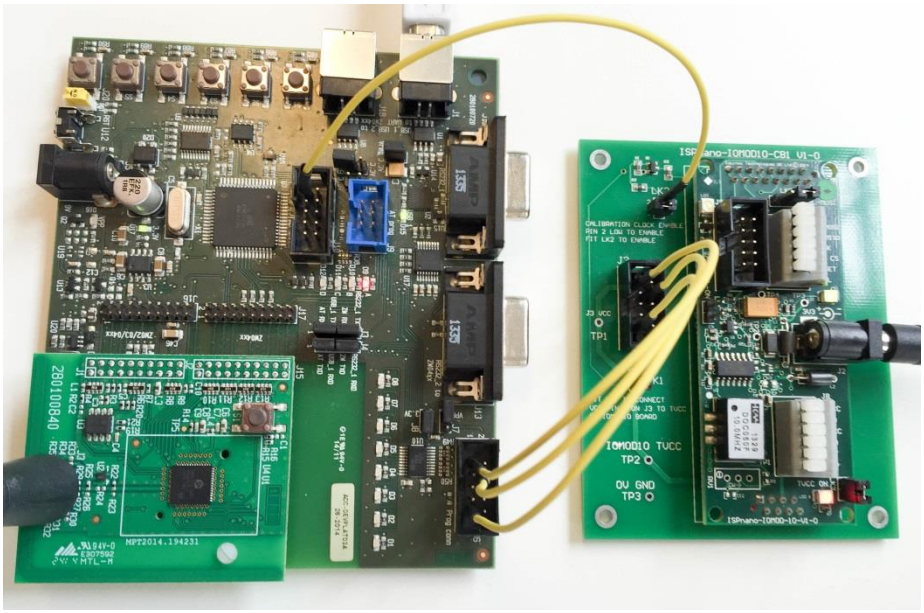


Figure 3: Calibration connections when programming through SPI

4.2 Calibration of a device connected to ZDP03A through UART

This is applicable to all modules except ZDB5202, see Table 5 for connections. The calibration box must be connected directly to ZDP03A using the pins listed in column “ZDP03A Conn. Name”.

Table 5, Calibration box interface for UART programming through ZDP03A

Signal Name	Calibration Box Cable Labeling	ZDP03A Conn. Name
V_{cc} (3.3V)	J3 pin 1	J6 pin 1
GND	J3 pin 9	J6 pin 9
Reference clock	J3 pin 4	J16 pin 11
Enable	LK2 must be shorted	N/A

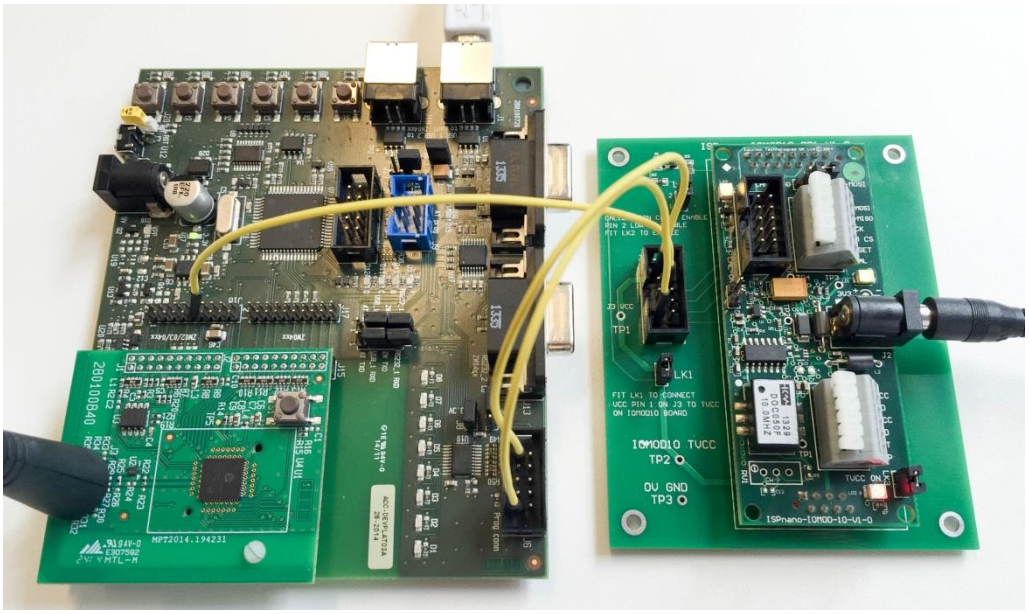


Figure 4: Calibration connections when programming through SPI

5 CALIBRATION SEQUENCE

This section describes the calibration sequence. This is ONLY meant to be used by developers that want to integrate the calibration sequence into their own programming solution.

As mentioned in Table 1 there is two different cases: either both TX- and crystal calibration must be performed, or Only TX calibration must be performed. These two options are described in the sections below.

5.1 Combined TX and Crystal calibration flow

For chips that need both crystal and Tx calibration the necessary sequence is shown below:

1. Disable the calibration box (ENABLE = 1)
2. Download the calibration hex file **ZW050x_calibration_en_JTCK_ref_auto.hex** to the chip in normal mode (see [1]). The calibration hex file is located in the directory …\ZWaveProgrammer_vX_YY\Calibration\
3. Tristate all IOs of the programming interface (SPI1) (on the programming hardware)
4. Enable the calibration box (ENABLE = 0)
5. Release reset and wait 1.2 second for the calibration to terminate.
6. Disable the calibration box (ENABLE = 1)
7. Read the crystal calibration result (CCAL) from SRAM address 0x0FFF through the programming interface.
8. Read the Tx calibration result from SRAM address (TXCAL1) 0x0FFD & (TXCAL2) 0x0FFE. through the programming interface
9. If the crystal calibration value is 0x80 crystal calibration has failed, otherwise write the calibration values to NVR to the location defined in [2] (CCAL)
10. If either of the TX calibration values are 0xff TX calibration has failed, otherwise write the calibration values to NVR to the location defined in [2] (TXCAL1 and TXCAL2)
11. Remember to set the NVR content revision number and to recalculate the NVR CRC [2]

5.2 TX only calibration flow

For modules that already have been crystal calibrated the necessary sequence for Tx calibration is shown below:

1. Read CCAL from NVR (See [2])
2. Download the calibration hex file **ZW050x_calibration_en_JTCK_ref_auto.hex** to the chip in normal mode (see [1]). The calibration hex file is located in the directory …\ZWaveProgrammer_vX_YY\Calibration\

3. Release reset and wait 1.2 second for the calibration to terminate.

4. Read the Tx calibration result from SRAM address (TXCAL1) 0x0FFD & (TXCAL2) 0x0FFE. through the programming interface

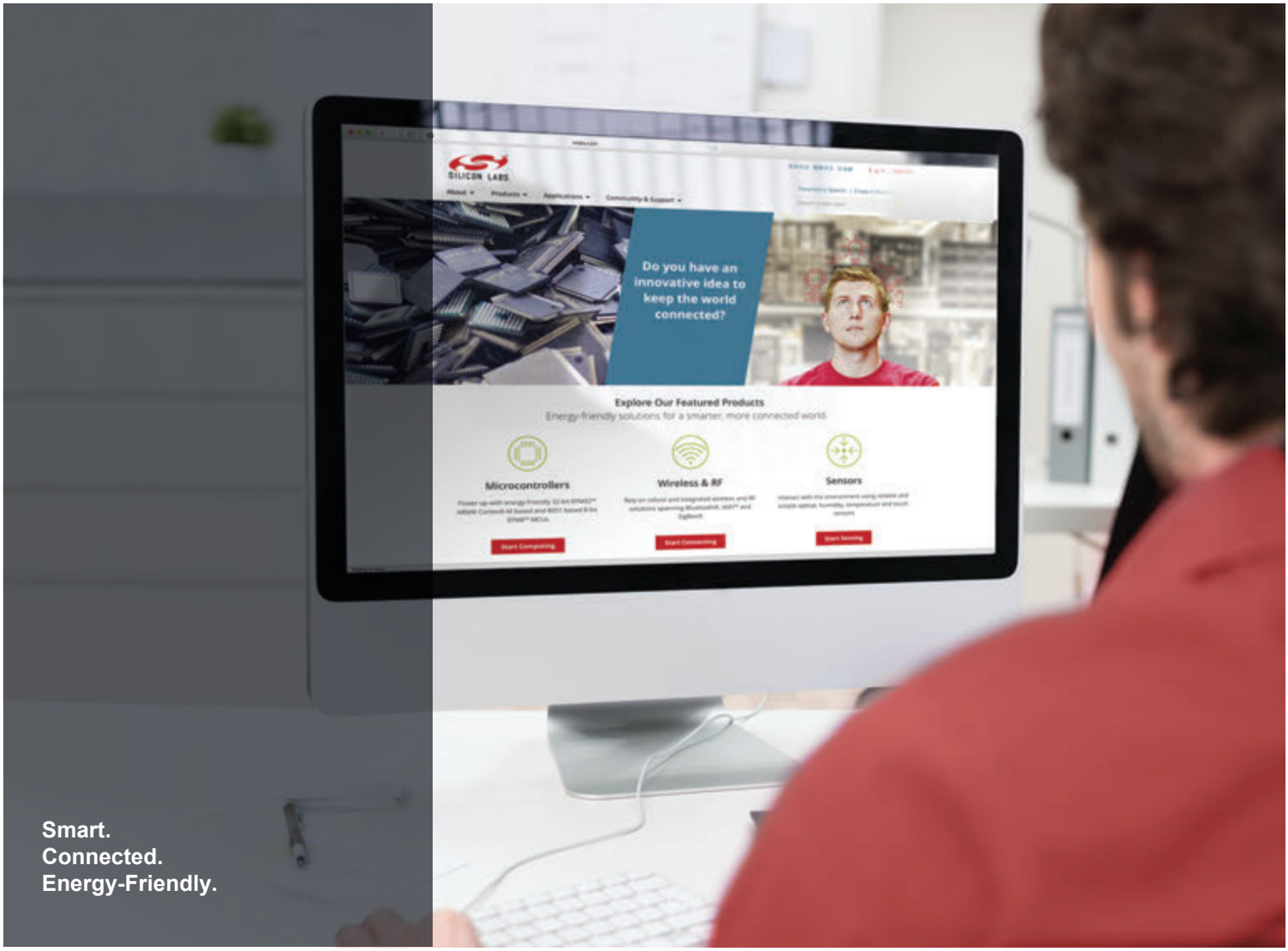
5. If either of the Tx calibration values are 0xff Tx calibration has failed, otherwise write the calibration values to NVR to the location defined in [2] (TXCAL1 and TXCAL2). CCAL read from step 1 must also be written to NVR

6. Remember to set the NVR content revision number and recalculate the NVR CRC [2]

REFERENCES

[1] Silicon Labs, INS10679, Instruction, Z-Wave Programmer User Guide.
[2] Silicon Labs, SDS12467 500 series NVR Flash page contents

INDEX



Products
www.silabs.com/products

Quality
www.silabs.com/quality

Support and Community
community.silabs.com

SILICON LABS®

Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

http://www.silabs.com