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1 Introduction

This application note explains the procedure for the oscillator frequency adjustment and additional considerations regarding the effects of the adjustment. The ZSSC3154 Sensor Signal Conditioner IC has a feature for internal oscillator frequency (f_{OSC}) adjustment via EEPROM configuration settings. The recommended frequency range is from 2.6MHz to 3.2MHz range which enables and provides full performance of the ZSSC3154.

2 Oscillator Frequency Requirements and Recommendations

Minimum recommended oscillator frequency of 2.6MHz guarantees the 1ms response time and 1kHz bandwidth as specified for the ZSSC3154 sensor signal conditioner for both simple and complex measurements, including advanced diagnostics. To achieve low noise ADC conversion, the maximum oscillator frequency of 3.2MHz should not be exceeded. Above this frequency the analog output signal may deteriorate as well.

The maximum adjustment step is guaranteed according to the test limit of 200kHz. The target frequency can be adjusted with an accuracy of 125 kHz, over the operational temperature range. Within the operational voltage range, it can deviate by an additional 35 kHz. Therefore, the adjustment accuracy is better than 6% for oscillator frequencies greater than 2.6MHz. Overall the target frequency can be expected to have accuracy of 10%.

The oscillator frequency affects the ZSSC3154 calibration microcontroller (CMC) performance and therefore the following system parameters: Startup time duration, response time, sample rate, supply current, A/D conversion time, start-up time, Power-on diagnostic output duration [1] τ_{PDO} (see the *ZSSC3154 Functional Description* for details), I²C™ interfaces [2, 3] (interface timing specification conditions are $f_{OSC} \geq 2MHz$), OWI interface 3 and start condition (interface timing specification conditions are $f_{OSC} \geq 2MHz$), sequential Analog Output Mode duration 1 τ_{SEQ} for a given phase of the sequential output and command processing time

EEPROM programming duration is typically 12.5ms and is independent of the programmed clock frequency.

The oscillator frequency can be finely adjusted in the recommended range of 2.6MHz (minimum) with a maximum of 3.2MHz.

The configuration word *CFGAPP2* (EEPROM/RAM address 16_{HEX} is used to adjust f_{OSC}:

Bits 0:3 (OSCADJ: adjust frequency f_{OSC} of internal oscillator)

Bit 4 (OSCSS: enable Oscillator Spread Spectrum Mode)

Using the Oscillator Spread Spectrum Mode reduces electromagnetic emission (EME).

[1] Timing can be shortened by adjusting the divider CFGAPP:TIMEDIV (configuration word at EEPROM/RAM address 15_{HEX}).
[2] I²C™ is a trademark of NXP.
[3] Internal clock frequency f_{OSC} must be at least 5 times higher than the communication clock frequency.

3 Oscillator Adjustment

The steps below describe the sequence for f_{OSC} adjustment. The objective is to determine the actual oscillator frequency and to adjust it as needed to meet design specifications.

As an example, the target frequency is f_{OSC} = 2.6MHz for the steps below.

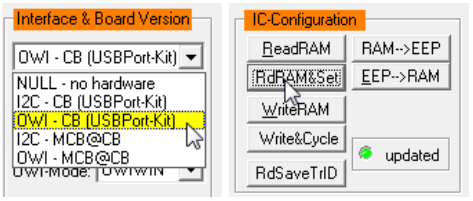
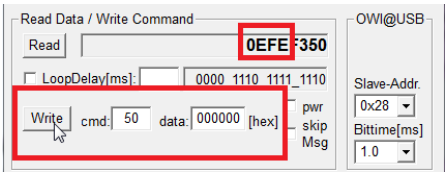
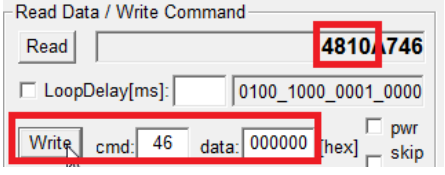
Preliminary settings:

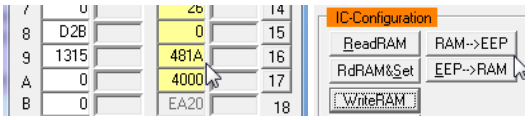
- Slave address is 28_{HEX}.
- OWI bit time is 1ms (f_{OWI} = 1kHz).
- Oscillator adjustment bits [0:3] in CFGAPP2:OSCADJ are 0000_{BIN} for maximum frequency and 1111_{BIN} for minimum frequency.
- Target for the frequency adjustment for this example is 2.6MHz.

3.1. Oscillator Adjustment using the ZSSC3154 Evaluation Kit

The ZSSC3154 Evaluation Kit can be used to provide hardware and a graphical user interface (GUI) to communicate with the ZSSC3154 to adjust f_{OSC}. Before attempting the oscillator adjustment procedures in Table 3.1, refer to the *ZSSC3154 Evaluation Kit Description* for full instructions for using the kit.

Table 3.1 Steps for Adjusting the Internal Oscillator Frequency f_{osc} with the Evaluation Kit

Step	Procedure	Evaluation Kit GUI Display
#1	Establish OWI communication from the main window. Command Mode is activated automatically. Read and set the IC RAM configuration in to the GUI software.	
#2	In the top menu, click the  icon or select “Calibration” and then “Send Command” to access the “Send Command” window. Acquire the frequency ratio (f_{RATIO} = f_{OSC} / f_{OWI}) by sending the command 50_{HEX} (ADJ_OSC_ACQ). The software automatically reads four bytes for which the first two bytes are the ratio result ($0EFE_{HEX}$ in adjacent example).	
#3	Read the CFGAPP2 register via the RAM-EEPROM dialog or by sending the command 46_{HEX} (READ_EEP for address16_{HEX}). Bits [0:3] contain the present oscillator adjustment setting: 0000_{BIN}, which corresponds to the maximum f_{OSC} setting 3.838MHz.	
#4	Convert the f_{RATIO} readout ($OEFE_{HEX}$ for this example) to decimal (3838_{DEC}) and calculate the oscillator frequency with f_{OWI} = 1kHz.	$f_{RATIO} = \frac{f_{OSC}}{f_{OWI}}$ $f_{OSC} = f_{OWI} \cdot * f_{RATIO} = 1kHz * 3838 = 3.838MHz$

Step	Procedure	Evaluation Kit GUI Display
#5	Calculate the steps count for frequency adjustment to target frequency of 2.6MHz for this example. Average step size is approximately 125kHz.	$\text{Steps} = \frac{f_{OSC} - f_{TARGET}}{125\text{kHz}} = \frac{3.838\text{MHz} - 2.6\text{MHz}}{125\text{kHz}} = 9.9 \approx 10_{DEC} = A_{HEX}$
#6	Add the result to the existing oscillator adjustment settings and generate the new CFGAPP2 register content.	$0_{\text{HEX}} + \text{A}_{\text{HEX}} = \text{A}_{\text{HEX}}$ $\text{CFGAPP2}_{\text{NEW}} \rightarrow 481\text{A}_{\text{HEX}}$
#7	Write the new CFGAPP2 register content to the EEPROM using the RAM-Register dialog or click the WriteRAM and RAM->EEP buttons on the main screen. The enable for EEPROM writing and signature generation are done automatically by the GUI software.	

3.2. Oscillator Adjustment using the SSC Terminal Program

An alternate method of adjusting f_{OSC} is to use the SSC Terminal Program, which is available for download from www.IDT.com/ZSSC3154KIT.

The SSC Terminal Program enables sending commands to the ZSSC3154 using the OWI interface. Table 3.2 gives the steps for adjusting f_{OSC} using the commands in the adjacent columns.[1] Refer to *SSC Command Syntax* for more information about interface commands. This spreadsheet is included with the SSC Terminal Program download.

[1] Commands can also be sent using the ZSSC3154 Evaluation Kit.

Table 3.2 Steps for Adjusting the Internal Oscillator Frequency f_{OSC} with the SSC Terminal Program

Step	Procedure	Command (HEX)	Data (HEX)	Terminal Program syntax1	Result (HEX)
#1	Reset the CB and trigger the power supply at next command.			r tso31150 os_14 t11030	
#2	Establish OWI communication and enter the Command Mode by sending the START_CM command.	72	74	OWT280027274	$C372_{HEX}$ upon success
#3	Acquire frequency ratio f_{RATIO} (the longer the OWI bit time is, the more accurate the result will be). Convert the f_{RATIO} readout ($OEFE_{HEX}$ for this example) to decimal (3838_{DEC}) and calculate the f_{OSC} oscillator frequency with f_{OWI} = 1kHz.	50	-	OW_2800150 OR_28002	$f_{OSC} = f_{OWI} * f_{RATIO}$ $f_{OSC} = 1\text{kHz} * 3838_{DEC}$ $= 3.838\text{MHz}$
#4	Read the CFGAPP2 register to determine the present setting for OSCADJ by sending the command 46_{HEX} (READ_EEP for address16_{HEX}).	46	-	OW_2800146 OR_28002	Result: 4810_{HEX} OSCADJ = 0000_{BIN} (presently set for maximum frequency, which is 3.838MHz) OSCSS = 1_{BIN} (Spread Spectrum Mode Enabled)
#5	Adjust to the target frequency of 2.6MHz from 3.838MHz by setting OSCADJ to 10 steps (A_{HEX}) as calculated in Table 3.1.	65	481A	OW_2800365481A	OSCADJ =0_{HEX} + A_{HEX} CFGAPP2 = $481A_{HEX}$
#6	Enable data write to EEPROM	6C	F742	OW_280036CF742	$C36C_{HEX}$ upon success
#7	Write $CFGAPP2_{new}$ to EEPROM at address 16_{HEX}.	B6	481A	OW_28003B6481A	
#8	Generate and write EEPROM signature by sending the GEN_EEP_SIGN command.	C9	-	OW_28001C9	

4 Related Documents

Document
ZSSC3154 Data Sheet
ZSSC3154 Functional Description
SSC Command Syntax
ZSSC3154 Evaluation Kit Description

Visit www.IDT.com/ZSSC3154 and www.IDT.com/3154KIT or contact your nearest sales office for the latest version of these documents.

5 Glossary

Term	Description
CMC	Calibration Microcontroller
EME	Electromagnetic Emission
OWI	One-Wire Interface

6 Document Revision History

Revision	Date	Description
1.00	August 28, 2013	First release
	April 1, 2016	Changed to IDT branding.

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