

DS2X0DF810 Junction Temperature Readback and Temperature Lock Range (TLR) Extension Procedures



ABSTRACT

A key parameter when using the DS2X0DF810 25-28G retimers is the temperature lock range (TLR) of the device. The TLR refers to the CDR stay-in-lock ambient temperature range that can be supported without any loss-of-lock event. For debug and link monitoring, it may be beneficial to read back the internal junction temperature from the on-die temperature sensor. In particularly challenging operating environments where the ambient temperature varies beyond the default TLR range mentioned in the DS2X0DF810 data sheet, the TLR may be extended to approximately 150°C by applying changes to the CDR loop filter control voltage based on the junction temperature readback. This application note addresses how to configure the DS2X0DF810 retimer to read back junction temperature and extend the TLR through I2C programming.

Table of Contents

1 Introduction	2
2 Reading Junction Temperature Procedure	3
3 Extending Temperature Lock Range (TLR) Procedure	4
4 Summary	5

List of Tables

Table 2-1. Programming Procedure for Reading Junction Temperature.....	3
Table 3-1. Programming Procedure for Each Channel to Achieve Extended TLR.....	4

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1 Introduction

A key parameter when using the DS2X0DF810 25-28G retimers is the temperature lock range (TLR) of the device. The TLR refers to the CDR stay-in-lock ambient temperature range that can be supported without any loss-of-lock event. In the data sheet, TLR is specified in the *Electrical Characteristics* in terms of both $TEMP_{LOCK-}$ (maximum temperature change when ramping down below the initial CDR lock acquisition ambient temperature) and $TEMP_{LOCK+}$ (maximum temperature change when ramping up above the initial CDR lock acquisition ambient temperature).

The DS2X0DF810 25-28G retimers offer a method through I2C programming to extend the TLR to approximately 150°C (typical) in applications where the device junction temperature may vary beyond the default TLR range mentioned in the DS2X0DF810 data sheet. This is made possible by reading back the internal junction temperature through an on-die temperature sensor and then configuring the CDR loop filter control voltage accordingly. This method allows for the maximum change in the loop filter control voltage to tolerate all supported temperature scenarios, including worst-case scenarios when the device locks at extreme temperatures such as -40°C ambient or 110°C junction temperature.

This application note addresses the I2C programming procedure regarding how to read back the junction temperature and how to extend the device TLR based on the junction temperature readback.

2 Reading Junction Temperature Procedure

Table 2-1 provides a programming procedure to read the junction temperature from the DS2X0DF810 25-28G retimers. This procedure is beneficial for occasional debug and link monitoring.

Note

The accuracy of the on-die temperature sensor is not ensured by production testing. Through empirical observation, the temperature sensor readback exhibits a typical T_J accuracy of approximately $\pm 7^\circ\text{C}$. Therefore, the procedure should be restricted to occasional debug use only.

Table 2-1. Programming Procedure for Reading Junction Temperature

STEP	REGISTER SET	OPERATION	REGISTER ADDRESS [HEX]	REGISTER VALUE [HEX]	WRITE MASK [HEX]	COMMENT
Normal Retimer configuration						
Perform all steps to configure the Retimer as normal. Junction temperature measurements are the most useful when the device is operating in a configuration which mimics the mission-mode configuration.						
Configure Retimer for temperature readback						
1	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
2	Shared	Write	04	40	40	Reset Channel 0 – Channel 3 shared registers
3	Shared	Write	FF	20	FF	Select Channel 4 – Channel 7 shared registers
4	Shared	Write	04	40	40	Reset Channel 4 – Channel 7 shared registers
5	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
6	Shared	Write	0F	00	FF	Enable temperature detection CH0-CH3
7	Shared	Write	FF	20	FF	Select Channel 4 – Channel 7 shared registers
8	Shared	Write	0F	00	FF	Enable temperature detection CH4-CH7
9	Shared	Write	FF	01	FF	Disable broadcast write to all channels, read from channel selected in Shared Reg_0xFC
10	Shared	Write	FC	04	0F	Select single channel
11	Channel	Write	19	01	C1	Enable channel temperature detection
12	Channel	Write	18	01	03	Enable channel temperature detection
13	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
14	Shared	Write	0C	00	38	Configure the input to the analog-to-digital converter (ADC)
15	Shared	Write	0C	02	03	Enable ADC
16	Shared	Write	0C	04	04	Reset ADC
17	Shared	Write	0C	00	04	Set ADC to capture Analog Voltage
18	Wait 200 μs					
19	Shared	Write	0C	00	02	Disable ADC to freeze value
Temperature readback						
20	Shared	Read	0D	--	--	$D_{\text{SAR}}[7:0] = \text{Reg_0x0E}[7:0]$
21	Shared	Read	0E	--	--	$D_{\text{SAR}}[9:8] = \text{Reg_0x0E}[1:0]$
<ul style="list-style-type: none"> Decimal_representation_of_temperature_code = $(\text{Reg_0x0E and 0x03}) \times 256 + \text{Reg_0x0D}$ $T_J = (0.73 \times \text{Decimal_representation_of_temperature_code}) - 340$, in degrees C Note: The numbers 256 and 340 in the previous equations are <i>decimal</i> numbers. 						
22	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
23	Shared	Write	04	40	40	Reset Channel 0 – Channel 3 shared registers
24	Shared	Write	FF	20	FF	Select Channel 4 – Channel 7 shared registers
25	Shared	Write	04	40	40	Reset Channel 4 – Channel 7 shared registers
26	Shared	Write	FF	01	FF	Enable read/write from/to channel selected in Reg_0xFC
27	Shared	Write	FC	04	0F	Select single channel

Table 2-1. Programming Procedure for Reading Junction Temperature (continued)

STEP	REGISTER SET	OPERATION	REGISTER ADDRESS [HEX]	REGISTER VALUE [HEX]	WRITE MASK [HEX]	COMMENT
28	Channel	Write	19	00	C1	Disable channel temperature detection
29	Channel	Write	18	00	03	Disable channel temperature detection

3 Extending Temperature Lock Range (TLR) Procedure

The DS2X0DF810 retimer TLR can be extended to support CDR stay-in-lock between -40°C ambient temperature to 110°C junction temperature. This is accomplished by expanding on the internal junction temperature readback procedure shown in [Section 2](#).

To extend TLR based on the internal junction temperature readback, the complete programming procedure in [Table 3-1](#) should be included as part of the normal retimer programming procedure. For simplicity, this procedure is written assuming all channels in the retimer are being configured at the same time. Refer to the *Common Device Configurations* section of the DS2X0DF810 Programming Guide for example programming procedures.

Note

Insert this procedure just prior to the step where the CDR reset is asserted and de-asserted.

Table 3-1. Programming Procedure for Each Channel to Achieve Extended TLR

STEP	REGISTER SET	OPERATION	REGISTER ADDRESS [HEX]	REGISTER VALUE [HEX]	WRITE MASK [HEX]	COMMENT
Normal Retimer configuration						
Perform all steps to configure the Retimer as normal, except for the final step, which is to assert and de-assert the CDR reset. This step will be performed at the conclusion of this <i>Extended TLR</i> programming procedure.						
Configure Retimer for temperature readback						
1	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
2	Shared	Write	04	40	40	Reset Channel 0 – Channel 3 shared registers
3	Shared	Write	FF	20	FF	Select Channel 4 – Channel 7 shared registers
4	Shared	Write	04	40	40	Reset Channel 4 – Channel 7 shared registers
5	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
6	Shared	Write	0F	00	FF	Enable temperature detection CH0-CH3
7	Shared	Write	FF	20	FF	Select Channel 4 – Channel 7 shared registers
8	Shared	Write	0F	00	FF	Enable temperature detection CH4-CH7
9	Shared	Write	FF	03	FF	Enable broadcast write to all channels, read from channel selected in Shared Reg_0xFC
10	Shared	Write	FC	04	0F	Select single channel
11	Channel	Write	0A	00	0C	Release CDR from reset
12	Channel	Write	14	80	80	Force-enable signal detect to ensure all channels are powered on prior to reading device temperature
13	Channel	Write	19	01	C1	Enable channel temperature detection
14	Channel	Write	18	01	03	Enable channel temperature detection
15	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
16	Shared	Write	0C	00	38	Configure the input to the analog-to-digital converter (ADC)
17	Shared	Write	0C	02	03	Enable ADC
18	Shared	Write	0C	04	04	Reset ADC
19	Shared	Write	0C	00	04	Set ADC to capture Analog Voltage
20	Wait 200 µs					
21	Shared	Write	0C	00	02	Disable ADC to freeze value

Table 3-1. Programming Procedure for Each Channel to Achieve Extended TLR (continued)

STEP	REGISTER SET	OPERATION	REGISTER ADDRESS [HEX]	REGISTER VALUE [HEX]	WRITE MASK [HEX]	COMMENT
Temperature readback and Loop Filter Voltage calculation						
22	Shared	Read	0D	--	--	$D_{SAR}[7:0] = \text{Reg_0x0E}[7:0]$
23	Shared	Read	0E	--	--	$D_{SAR}[9:8] = \text{Reg_0x0E}[1:0]$
<ul style="list-style-type: none"> • Decimal_representation_of_temperature_code = (Reg_0x0E and 0x03) × 256 + Reg_0x0D • LPF_Setting = $0.44 \times \text{Decimal_representation_of_temperature_code} - 55$ <ul style="list-style-type: none"> – If (LPF_Setting < 120), then LPF_Setting = 120 – If (LPF_Setting > 210), then LPF_Setting = 210 • Note: The numbers 256, 55, 120, and 210 in the previous equations are <i>decimal</i> numbers. 						
Configure Loop Filter Voltage						
24	Shared	Write	FF	03	03	Enable broadcast write to all channels, read from channel selected in Shared Reg_0xFC
25	Channel	Write	9D	LPF_Setting	FF	Configures the Loop Filter Voltage based on the results of the previous equation
26	Channel	Write	17	25	FF	Enable extended temperature lock range
De-activate device temperature sensing						
27	Shared	Write	FF	10	FF	Select Channel 0 – Channel 3 shared registers
28	Shared	Write	04	40	40	Reset Channel 0 – Channel 3 shared registers
29	Shared	Write	FF	20	FF	Select Channel 4 – Channel 7 shared registers
30	Shared	Write	04	40	40	Reset Channel 4 – Channel 7 shared registers
31	Shared	Write	FF	03	FF	Enable writing to all channels
32	Channel	Write	19	00	C1	Disable channel temperature detection
33	Channel	Write	18	00	03	Disable channel temperature detection
34	Channel	Write	14	00	80	Undo force-enable of signal detect
Conclude normal Retimer configuration						
35	Channel	Write	0A	0C	0C	Assert CDR reset
36	Channel	Write	0A	00	0C	De-assert CDR reset
37	Shared	Write	FF	01	01	Disable Broadcast write operation

4 Summary

This application note addresses how to program the DS2X0DF810 25-28G retimers to read the internal junction temperature from the on-die temperature sensor and how to extend the TLR based on the junction temperature readback. By applying these procedures, designers have a method to monitor the approximate junction temperature of the DS2X0DF810 retimer. Moreover, the robustness of the DS2X0DF810 may be further increased in challenging operating environments where the ambient temperature varies beyond the default TLR range mentioned in the DS2X0DF810 data sheet.

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