Application Note

Using Instant Calibration With the LMX2820

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ABSTRACT

This application note includes various features available with instant calibration and shows the sequence of steps to go through for each feature in instant calibration.

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Trademarks

1 Introduction

For changing from one frequency to another in LMX2820, there are multiple ways to do that namely No assist, Full assist, Partial assist, and Instant calibration. There are some limitations with each approach. No assist takes more settling time. Full assist requires user to know before what to write for VCO and doubler settings. Partial assist helps in faster settling but not as fast as full assist. To get better of all the three approaches, there is a new approach in LMX2820 is called *Instant Calibration.* This document includes the instant calibration feature.

The instant calibration feature of the LMX2820 is very popular and allows the user to switch frequencies at blazing fast speeds. This feature works by storing VCO calibration values to a lookup table. There are use cases and special restrictions that are not stated in the data sheet that are discussed in this application note.

1. When delay for instant calibration needs to be increased from 2.5µs to 5µs.
2. Special handling when generating the lookup table when the VCO doubler is used
3. Read back the look up table through SP interface
4. Write the look up table through SP interface
5. Dealing with the case where the phase detector frequency is changed without forcing the need for the lookup table to be re-generated.

2 Various Options in Instant Calibration

2.1 When Delay for Instant Calibration Needs to be Increased From 2.5µs to 5µs

The LMX2820 data sheet suggests a minimum delay for instant calibration of 2.5µs. However, there are cases when this is not sufficient and that this delay needs to be increased to 5µs. This is when the voltage at the VbiasVCO pin changes significantly. This can happen when switching across VCO cores or when the amplitude calibration setting changes significantly. Register used for this is INSTCAL_DLY(R2<11:1>).

2.2 Generating the Lookup Table for Instant Calibration With the VCO Doubler

When generating the lookup table for the VCO doubler with the LMX2820 with instant calibration, the device can fail rarely coming out of calibration. The software workaround for this is for the user to read back from the device to make sure the lookup table was properly generated. This does involve registers that are not disclosed in the data sheet. The general procedure is:

1. Power off the supply and on.
2. Load Default 6GHz tics pro file with 100MHz as input OSCIN.
3. Program the following registers with the stated conditions
    a. Register R0:
        i. INSTCAL_SKIP_ACAL(R0[13]) = 1
    b. Register R70:
        i. DBLBUF_PLL_EN(R70[4]) =1
        ii. DBLBUF_CHDIV_EN(R70[5]) = 1
        iii. DBLBUF_OUTBUF_EN(R70[6]) = 1
        iv. DBLBUF_OUTBUF_EN(R70[7]) = 1
    c. Register R1:
        i. INSTCAL_DBLR_EN(R1[1]) = 1
        ii. INSTCAL_EN(R1[0]) = 1
        iii. LUT_GEN_SEL(R4[15]) = 0
    d. Register R106:
        i. INDEX_TEST(R106[10]) = 1
        ii. INDEX_WR_RD(R106[11]) = 1
4. Initialize the look up table look up table entries to zero
    a. For Index = 514 to 519
        i. INDEX_NO(R106[9:0]) = Index
        ii. INDEX_TEST_WRDATA_37_32(R107[5:0]) = 0
        iii. INDEX_TEST_WRDATA_31_16(R108[15:0]) = 0
        iv. INDEX_TEST_WRDATA_15_0(R109[15:0]) = 0
        v. INDEX_WR_RD(R106[11) = 1
        vi. INDEX_WR_RD(R106[11]) = 0
5. Program the following registers
    a. INDEX_TEST(R106[10]=1) as 0.
    b. R36 [14:0], PLL_N as 28
    c. R42(MSB),R43(LSB) as 250 (NUM)
    d. R38(MSB),R39(LSB) as 1000(DEN)
    e. R44(MSB),R45(LSB) as 2^30 (2^32*(NUM/DEN) INSTCAL_PLL_NUM)
    f. FCAL_EN (R0[4]) = 0
    g. FCAL_EN (R0[4]) = 1
    h. FCAL_EN (R0[4]) = 0
6. Check for rb_DBLR_CAL_DONE(R75<12]).
    a. If it is 1, proceed further.

b. If not, RESET(R0[1]) = 1 and repeat the above steps till rb_DBLR_CAL_DONE =1

2.3 Reading Back the Instant Calibration Lookup Table Through SPI

1. Write the following registers
   a. INDEX_WR_RD(R106[11])=0
   b. INDEX_TEST(R106[10]) =1
2. For Index = 0 to 519
   a. INDEX_NO(R106[9:0]) =Index
   b. Readback the following
      i. INDEX_TEST_WRDATA_37_32(R107<5:0])
      ii. INDEX_TEST_WRDATA_31_16(R108<15:0])
      iii. INDEX_TEST_WRDATA_15_0(R109<15:0])

2.4 Writing the Lookup Table Through SPI

1. Power off the supply and on.
2. Load Default 6GHz tics pro file with 100MHz as input OSCIN.
3. Write the following registers
   a. R70
      i. DBLBUF_PLL_EN(R70<4]) = 1
      ii. DBLBUF_CHDIV_EN(R70<5]) = 1
      iii. DBLBUF_OUTBUF_EN(R70<6]) = 1
      iv. DBLBUF_OUTBUF_EN(R70<7]) = 1
   b. R1
      i. INSTCAL_DBLR_EN (R1[1])=1
      ii. INSTCAL_EN (R1[0]) = 1
   c. R4
      i. LUT_GEN_SEL (R4[15]) = 1
   d. R36
      i. PLL_N (R36[14:0] = 28
   e. PLL_NUM
      i. R42(MSB),R43(LSB) as 250 (NUM)
   f. PLL_DEN
      i. R38(MSB),R39(LSB) as 1000(DEN)
   g. INSTANT_PLL_NUM
      i. R44 and R45; R44(MSB),R45(LSB) as 2^30 (2^32*(NUM/DEN) INSTCAL_PLL_NUM)
   h. Toggle FCAL
      i. FCAL_EN (R0[4] =0
      ii. FCAL_EN (R0[4] =1
      iii. FCAL_EN (R0[4] =0
4. INDEX_TEST(R106[10]=1), INDEX_WR_RD(R106[11]=0)
5. For Index = 0 to 519
   a. Write INDEX_NO(R106[9:0]) =Index
      i. Ensure INDEX_WR_RD(R106<11]) = 1
      ii. Ensure INDEX_WR_RD(R106[11]) = 0
      iii. Write stored value for INDEX_TEST_WRDATA_37_32(R107<5:0])
      iv. Write stored value for WRDATA_31_16(R108<15:0])

v. Write stored value for INDEX_TEST_WRDATA_15_0(R109<15:0])

6. After writing to LUT, make INDEX_TEST(R106<10]) as 0.

After above steps, LUT writing is done and user can change the frequency of output faster just by writing the required N.F and INSTCAL_PLL_NUM with PFD not changed. Writing to R0 is needed for the N.F change to take place as doubler buffering is enabled. This can help in faster setting behavior.

2.5 Dealing With Case When Phase Detector Frequency is Changed Without Re-generating the Lookup Table

There can be use cases where PFD needs to be changed. In that case, re-creating LUT again can be avoided with following changes:

Example: Above example is with PFD as 200MHz but let's assume that PFD is changed to 100MHz. Following sequence shows the steps followed to change PFD and how to take care of PFD change to avoid generating LUT again.

1. LUT_GEN_SEL=1(R4[15])
2. PLL_R_PRE(R14[11:0]) as 1
3. OSC_2X(R11[4]) as 0
4. FCAL_HPFD_ADJ(R0<10:9]) as 0
5. R36<14:0], PLL_N as 56
6. OUTA_MUX(R78[1:0]) as 1
7. R42(MSB),R43(LSB) as 500(NUM)
8. R38(MSB),R39(LSB) as 1000(DEN)
9. R44(MSB),R45(LSB) as 2^31 (2^32*(NUM/DEN) INSTCAL_PLL_NUM)
10. Write R0 with FCAL_EN as 1
11. INSTCAL_EN=1(R1[0])
12. INSTCAL_EN=0(R1[0])
13. INSTCAL_EN=1(R1[0])
14. R0[4][FCAL_EN] as 1
15. R0[4][FCAL_EN] as 0
16. User needs to see Frequency as 5.65GHz at the output.

INSTANT_CAL toggling procedure is needed whenever PFD changes. If PFD is not changed, after doing sufficient frequency change related settings, just toggling FCAL is enough.

3 Summary

This document covers various option present in instant calibration which helps customers in various use cases and get the most of the features present in LMX2820 related to fast locking options.

4 References

- Texas Instruments, *LMX2820 22.6-GHz Wideband PLLatinum™ RF Synthesizer With Phase Synchronization and JESD204B Support*, data sheet.
- Texas Instruments, *Dramatically Improve Your Lock Time with VCO Instant Calibration*, application note.

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