AN-1353
APPLICATION NOTE

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How to Bypass VCO Calibration for the ADF4355-2, ADF4355, ADF4355-3, ADF4356, ADF5355, and ADF5356

INTRODUCTION

This application note describes how to bypass the automatic VCO core and band select and automatic VCO bias level calibration. VCO bias level calibration and VCO core and band select are collectively known as AUTOCAL on the ADF4355-2, ADF4355, ADF4355-3, ADF4356, ADF5355, and ADF5356 phase locked loop (PLL) family. In most applications, AUTOCAL takes up to 3 ms. This is too slow for applications that need to cover a wide range of frequencies as quickly as possible, like signal and network analyzers.

On application of the bypass VCO calibration or bypass procedure, the user first programs each frequency using the standard AUTOCAL procedure, and for each frequency, reads back the VCO core, VCO band, and VCO bias. It is recommended that the user use AUTOCAL to build up a table of these values for each frequency and on application of the bypass procedure, load these values to the ADF4355-2, ADF4355, ADF4355-3, ADF4356, ADF5355, or the ADF5356 when programming a new frequency, which eliminates the additional time taken by the AUTOCAL procedure.

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REVISION HISTORY

11/2018—Rev. C to Rev. D

Change to Table 1 8

10/2017—Revision C: Initial Version

VCO CALIBRATION

BYPASS VCO CALIBRATION FOR FASTER LOCK TIMES

For any given output frequency, the ADF4355-2, ADF4355, ADF4355-3, ADF4356, ADF5355, and ADF5356 use a certain voltage controlled oscillator (VCO) core, band, and bias code. These three settings are selected automatically during the VCO automatic calibration (AUTOCAL). The settings are read from the ADF4355-2, ADF4355, ADF4355-3, ADF4356, ADF5355, or ADF5356 and stored in a lookup table. Use the lookup table to bypass the AUTOCAL routine, which dramatically decreases the total lock time when changing frequency. For example, lock times of less than 30 µs are possible with a 60 kHz loop bandwidth. Figure 1 shows an example of a suitable filter.

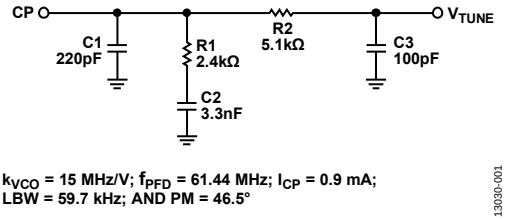


Figure 1. Example Loop Filter with a 60 kHz Loop Bandwidth

Generate a new lookup table for every chip because each chip is unique.

The VCO calibration bypass and lookup table functionality is implemented in the evaluation board control software.

VCO READBACK PROCEDURE

Skip Step 5 and Step 6 for the ADF4355-3 as this product uses a fixed VCO bias code. The VCO readback procedure is as follows:

1. Load all registers to lock to desired frequency.
   a) Ensure VCO read is set to VCO core and band (R10, DB[28:26] = 0b001).
   b) Ensure VCO readback is set to VCO calibration complete (R7, DB[14:12] = 0b110).
   c) Ensure MUXOUT is set to VCO readback (R4, DB[29:27] = 0b111).
   d) Ensure AUTOCAL is enabled (R0, DB21 = 1); see the corresponding data sheet for the R0 figure.
2. Wait until MUXOUT outputs a logic high (VCO calibration complete).
3. Load R7 with VCO readback set to VCO readback (R7, DB[14:12] = 0b111).
4. Pulse SPI CLK while LE is kept high. Data is output on MUXOUT. Extract data as shown in Figure 2.
5. Load R10 with VCO read set to VCO bias code (R10, DB[28:26] = 0b011).
6. Repeat Step 4 for bias data.
7. Repeat Step 1 to Step 6 to build a lookup table for all desired frequencies. For Step 1, it is only required to write R10, R7, R2, R1, and R0 after the first iteration. R2 and R1 are optional if they have not changed.

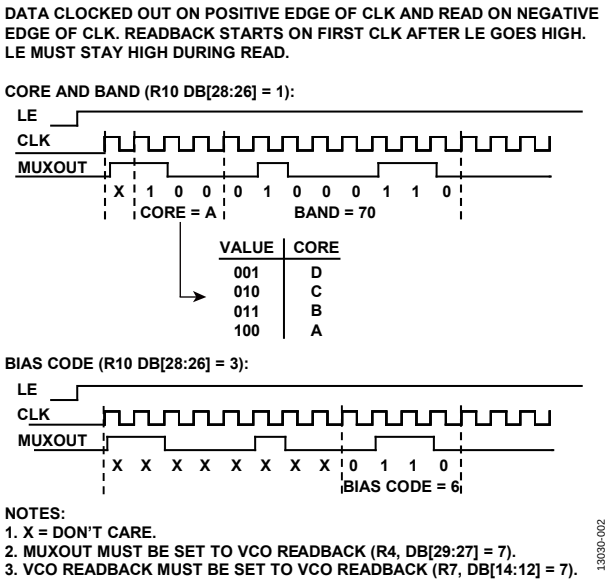


Figure 2. VCO Readback

BYPASS AUTOMATIC CALIBRATION (AUTOCAL) TO MANUALLY SELECT VCO AND LOCK

If the required VCO core, band, and bias code for a desired frequency is known (for example, in a lookup table), the VCO calibration routine can be bypassed and the VCO data set manually with the following steps.

ADF4355-2, ADF4355, and ADF5355

1. Load R0 with AUTOCAL disabled (R0, DB21 = 0b0). This step is optional if AUTOCAL is already disabled.
2. Load R10 with VCO write set to VCO core and band (R10, DB[31:29] = 0b001).
3. Load R11 with VCO core, band, and bias code set as defined in Figure 7. Note VCO core bits are different for read and write.
4. Load R10 with VCO write set to VCO bias code (R10, DB[31:29] = 0b011).
5. Reload R11 with the same value as in Step 3.
6. Lock to desired frequency by programming R2, R1, and R0 in that order.

ADF4355-3

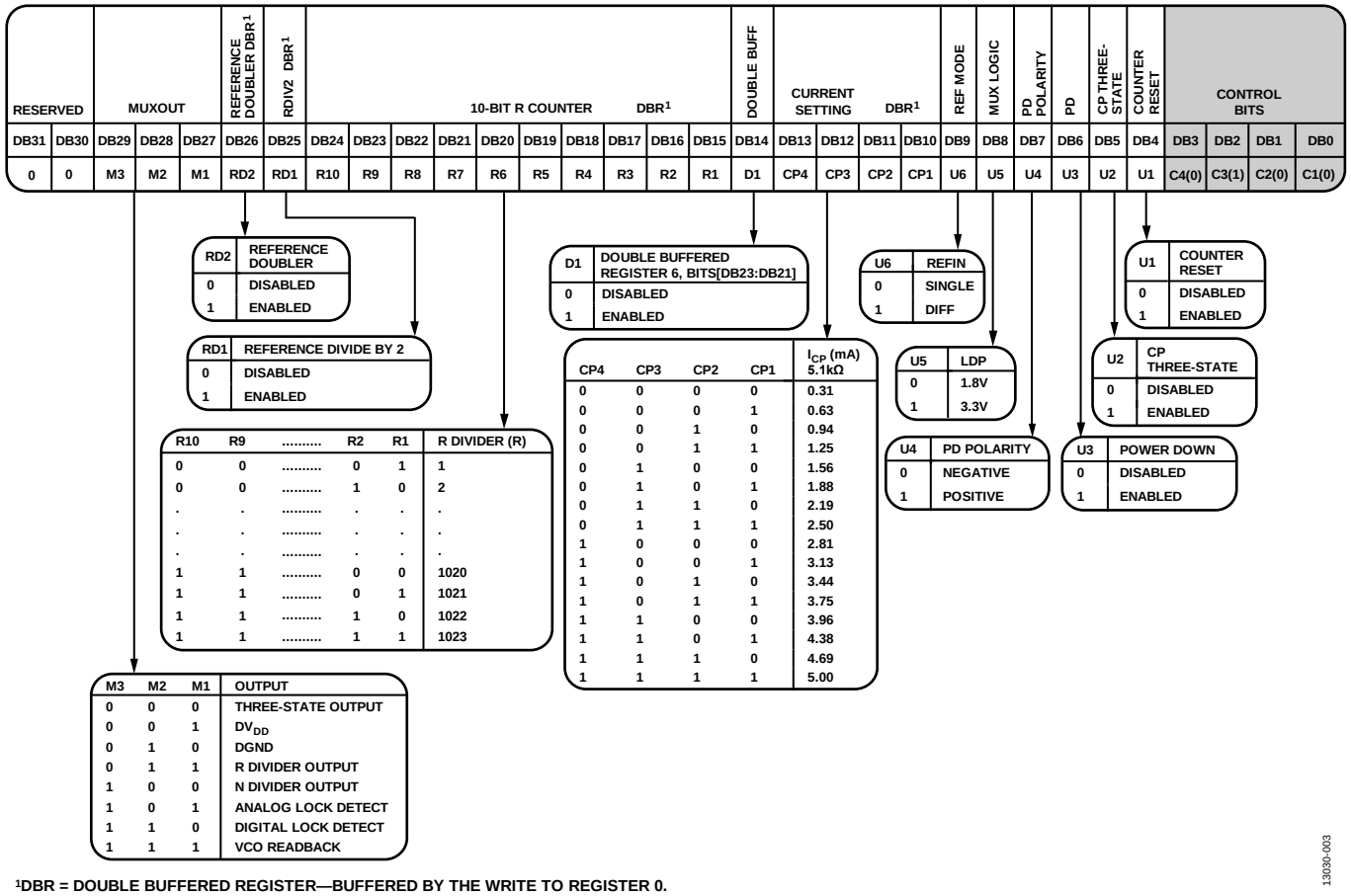
1. Load R0 with AUTOCAL disabled (R0, DB21 = 0b0). This step is optional if AUTOCAL is already disabled.
2. Load R10 with VCO write set to VCO core and band (R10, DB[31:29] = 0b001).
3. Load R11 with VCO core and band, set as defined in Figure 7 and VCO bias code = 2 (normal operation). Note VCO core bits are different for read and write.
4. Load R10 with VCO write set to VCO bias code (R10, DB[31:29] = 0b011).
5. Lock to desired frequency by programming R2, R1, and R0 in that order.

ADF4356 and ADF5356

The ADF4355 method can be used for the ADF4356; however, the following method is preferred because there are fewer register writes:

1. Load R0 with AUTOCAL disabled (R0, DB21 = 0b0). This step is optional if AUTOCAL is already disabled.
2. Load R10 with VCO write set to VCO core, band and bias code (R10, DB[31:29] = 0b011).
3. Load R11 with VCO core, band, and bias code set as defined in Figure 8. Note VCO core bits are different for read and write.
4. Lock to desired frequency by programming R13, R2, R1, and R0 in that order.

EXPANDED REGISTER MAPS



[1]DBR = DOUBLE BUFFERED REGISTER—BUFFERED BY THE WRITE TO REGISTER 0.

Figure 3. Register 4 ADF4355-2, ADF4355, ADF4355-3, ADF4356, ADF5355, and ADF5356

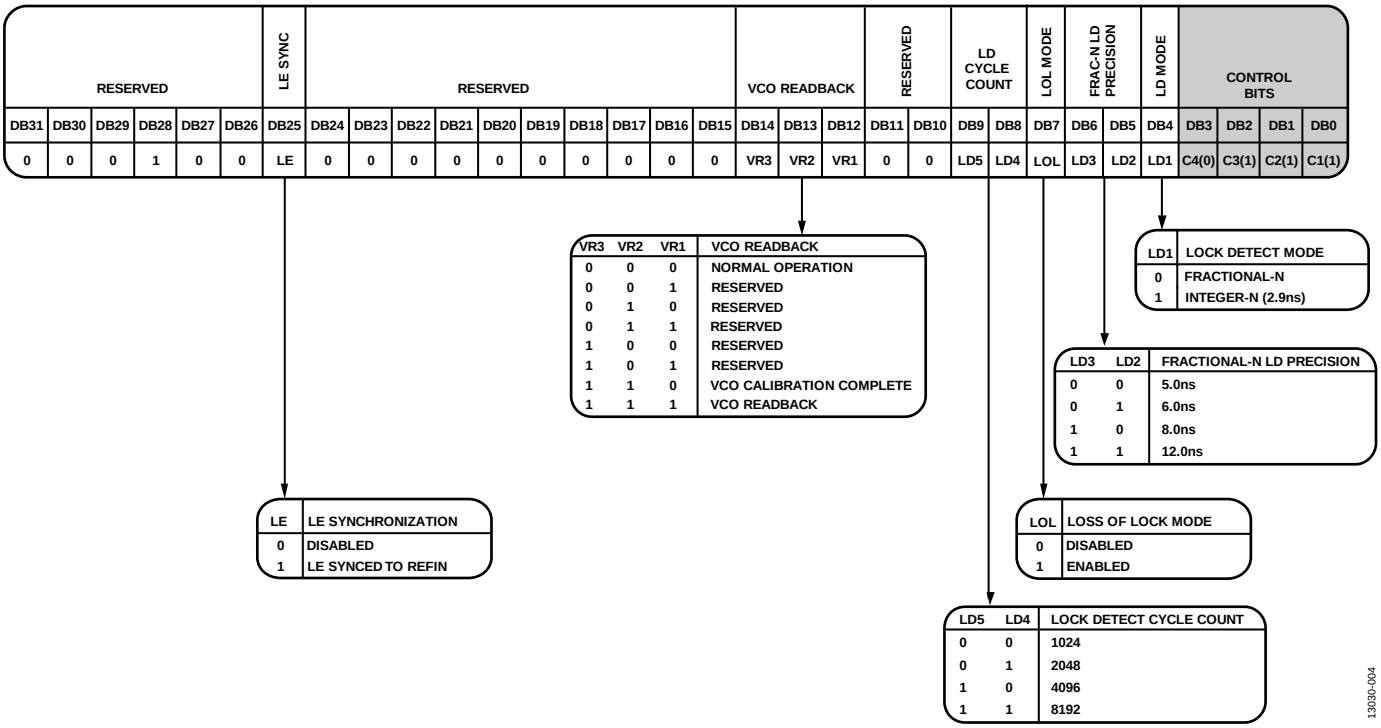


Figure 4. Register 7 (ADF4355-2, ADF4355, ADF4355-3, and ADF5355)

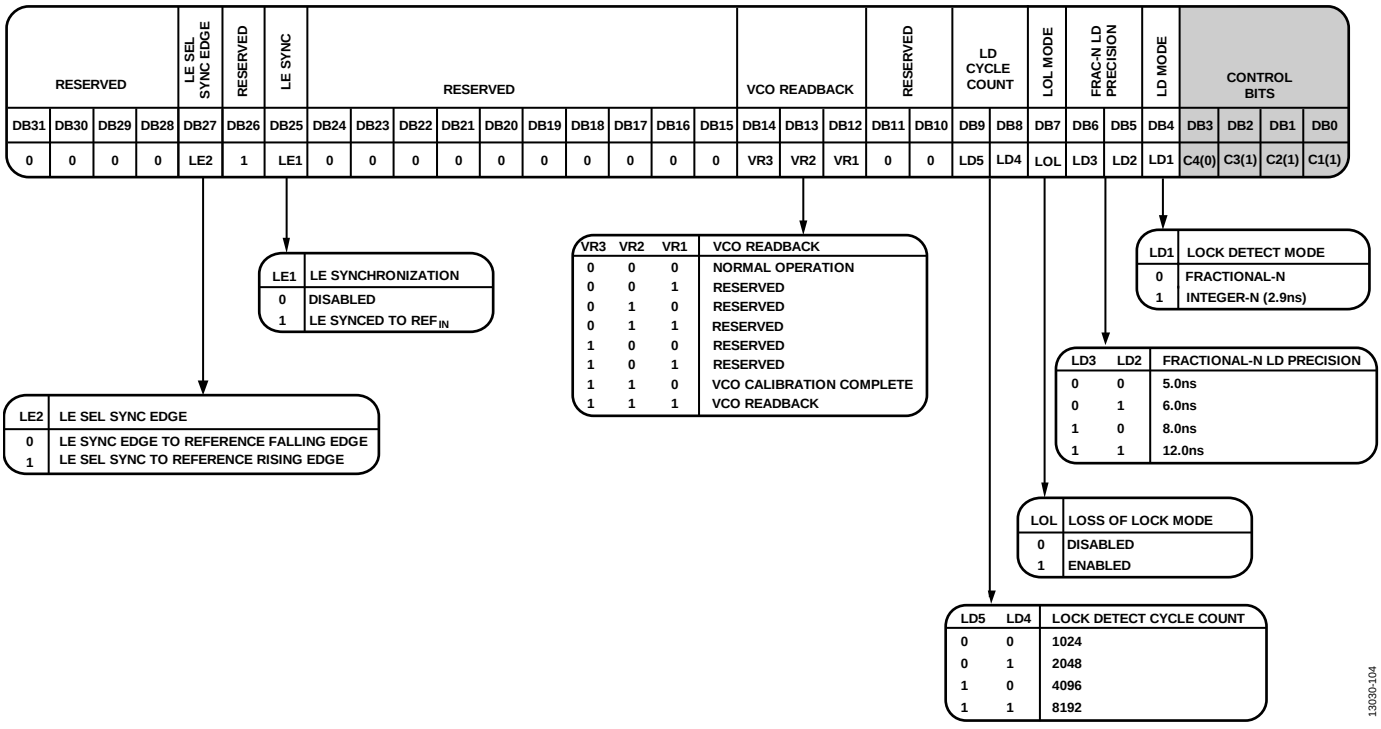


Figure 5. Register 7 (ADF4356 and ADF5356)

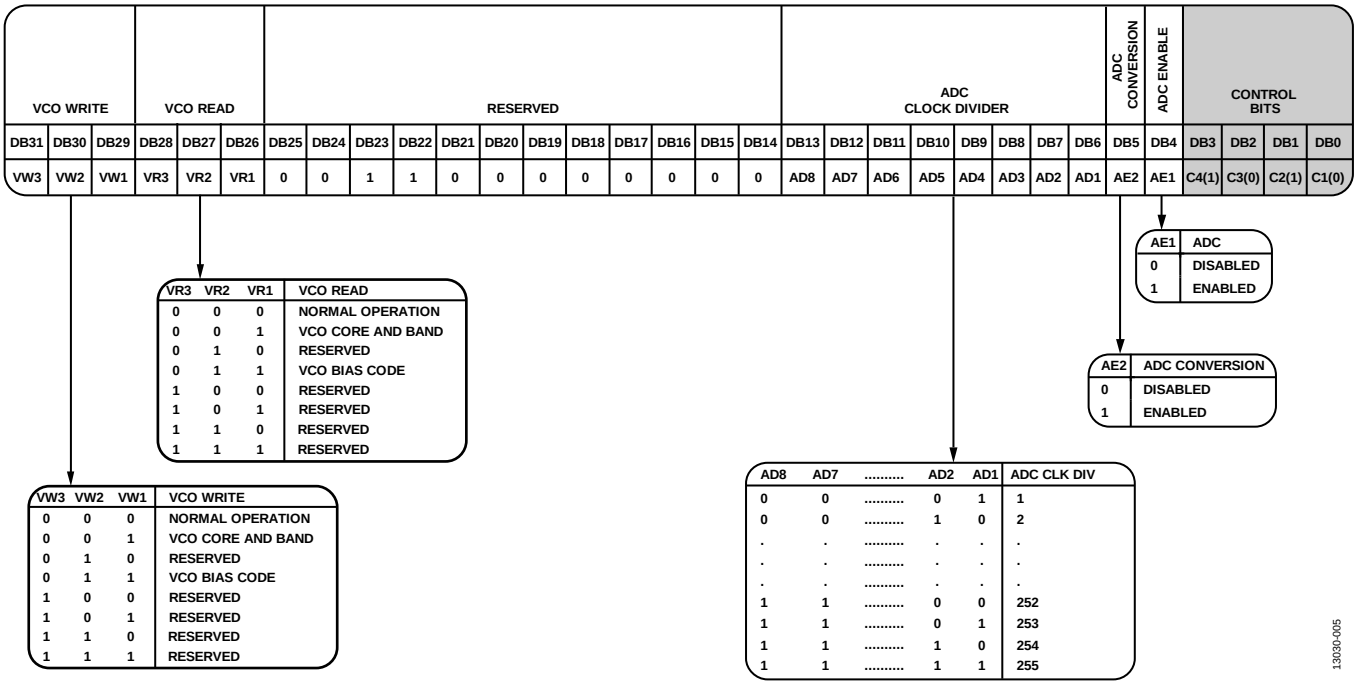


Figure 6. Register 10 (ADF4355-2, ADF4355, ADF4356, ADF5355, and ADF5356)

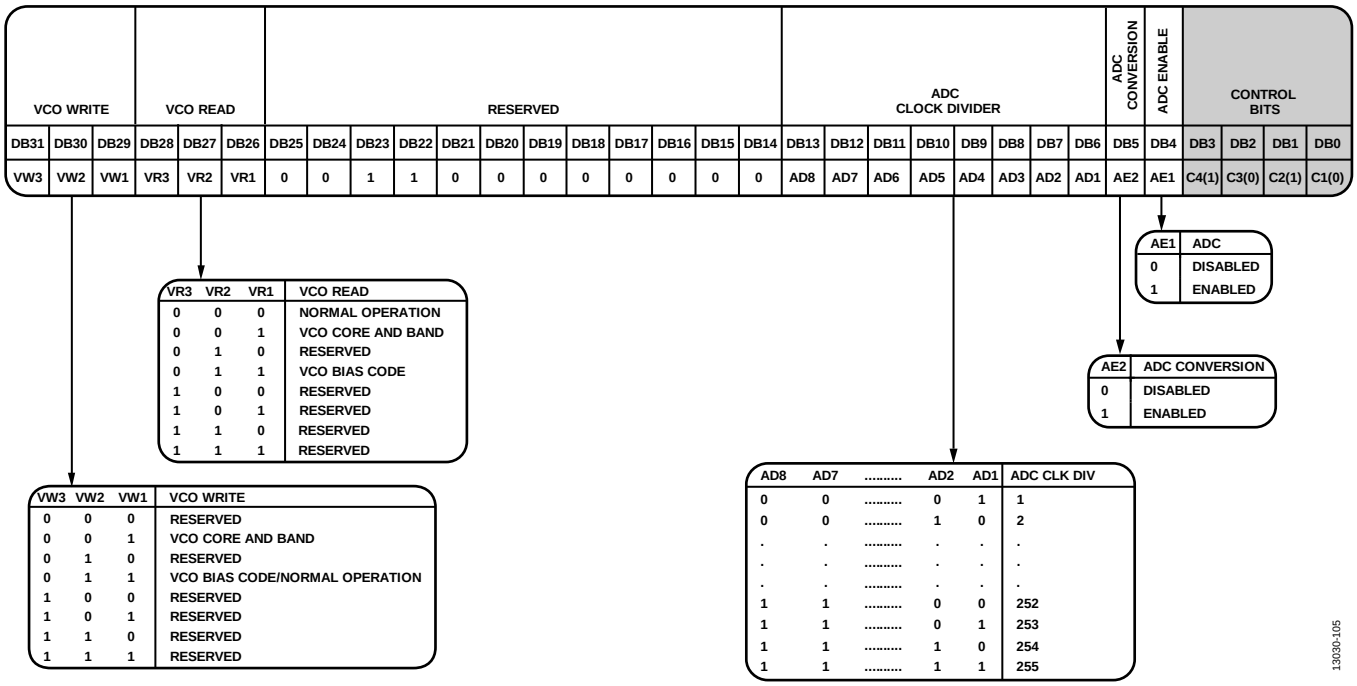


Figure 7. Register 10 (ADF4355-3)

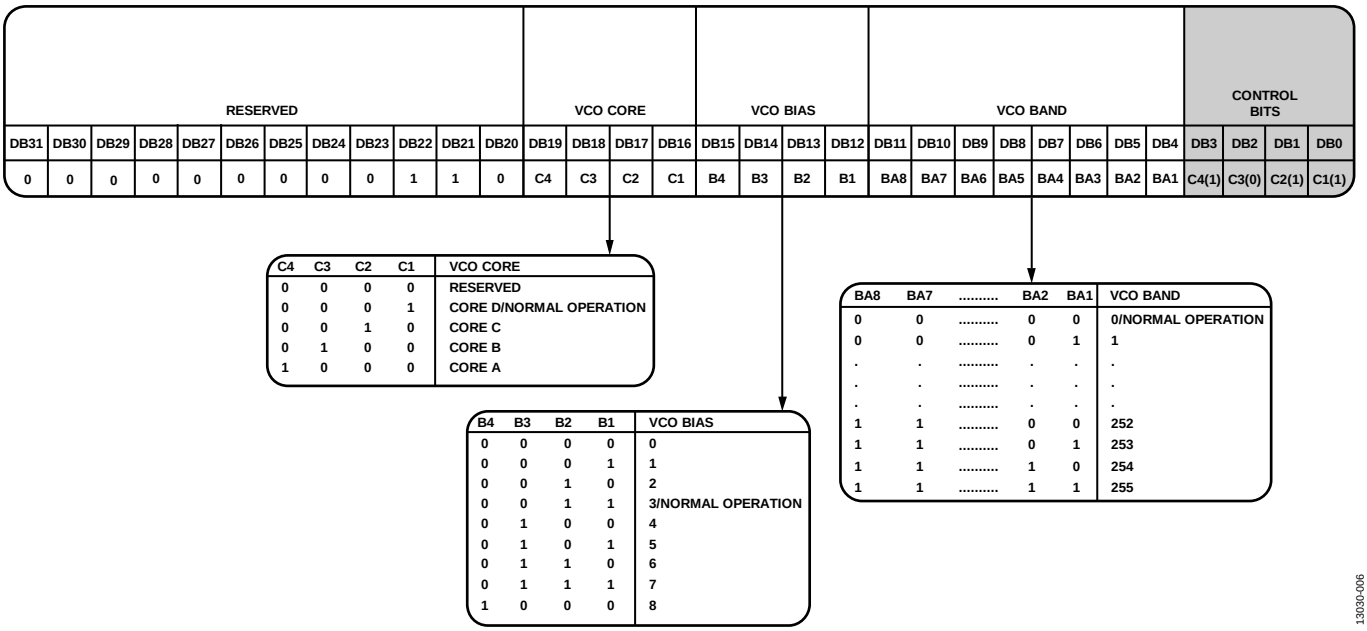


Figure 8. Register 11 (ADF4355-2, ADF4355 and ADF5355)

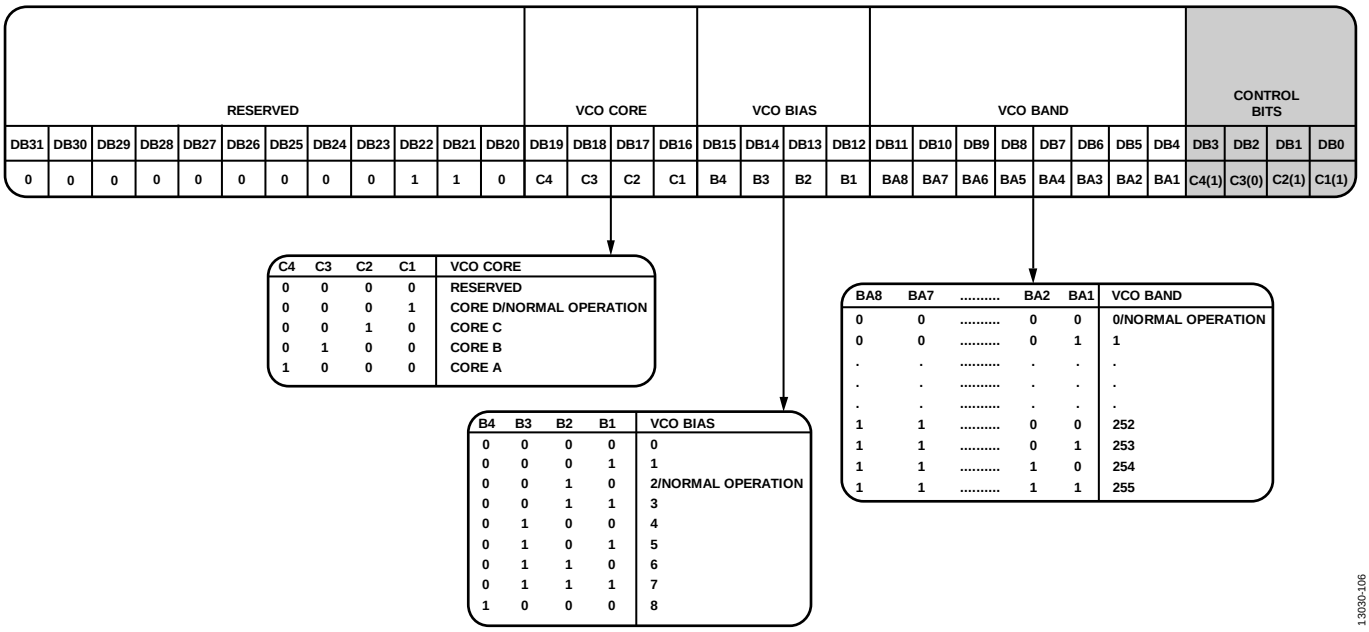


Figure 9. Register 11 (ADF4355-3)

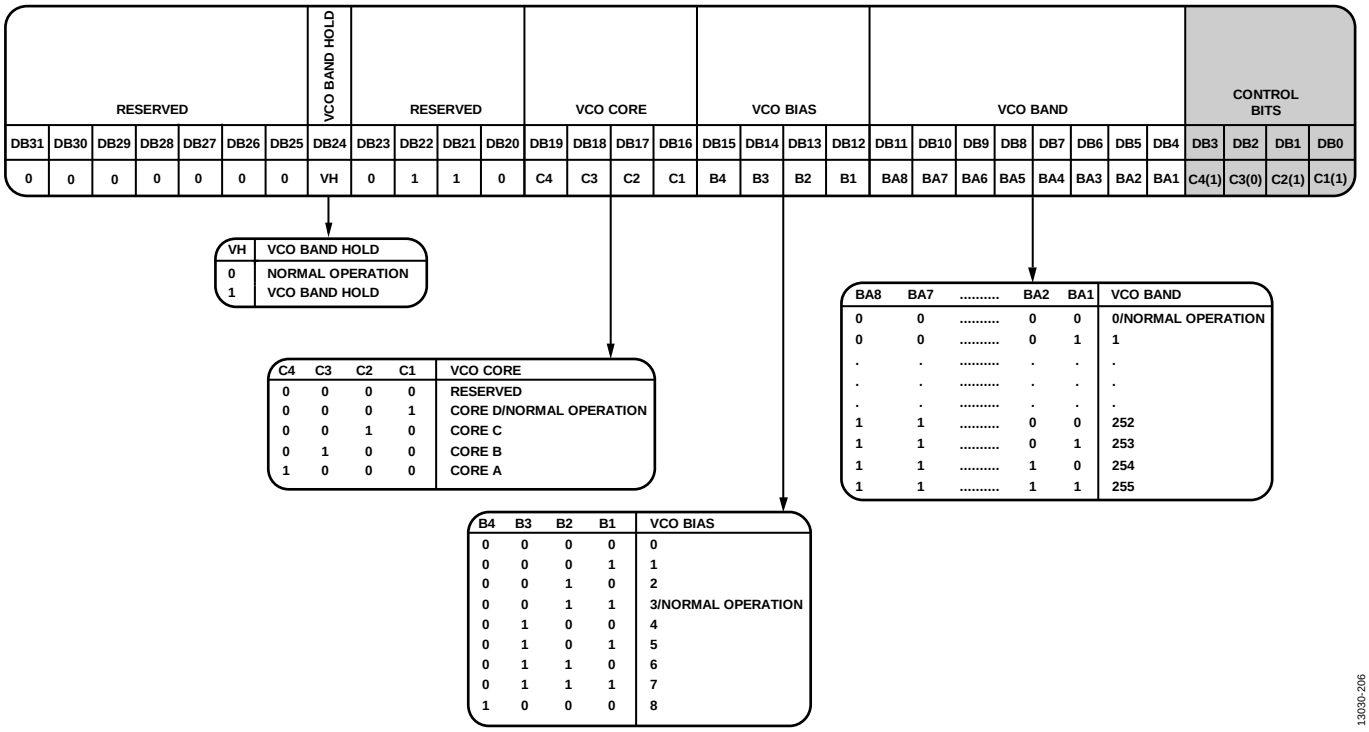
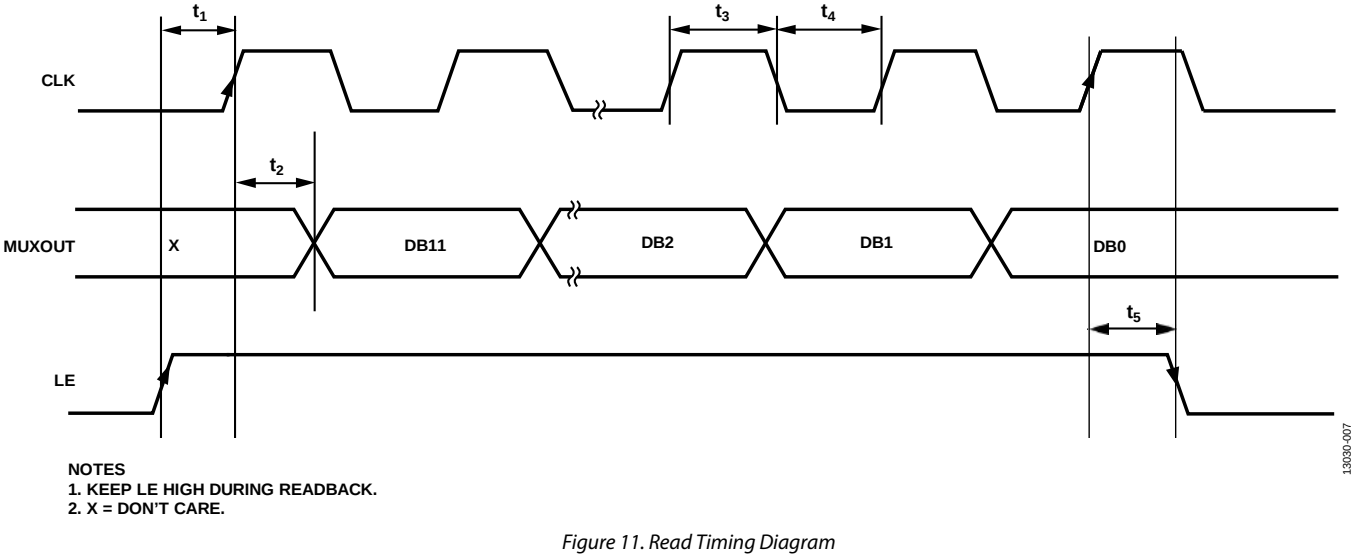


Figure 10. Register 11 (ADF4356 and ADF5356)

Table 1. Read Timing

Parameter	Limit at T_{MIN} to T_{MAX}	Unit	Description
t_1	15	ns min	LE high to CLK high
t_2	15	ns max	CLK high to DATA ready
t_3	25	ns min	CLK high duration
t_4	25	ns min	CLK low duration
t_5	10	ns min	CLK high to LE low (next write)



NOTES
1. KEEP LE HIGH DURING READBACK.
2. X = DON'T CARE.

Figure 11. Read Timing Diagram

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