How to Bypass VCO Calibration for the ADF4355-2

By Robert Brennan

VCO CALIBRATION

Bypass VCO Calibration for Faster Lock Times

For any given output frequency, the ADF4355-2 uses 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 and stored in a lookup table. Using this lookup table to bypass the AUTOCAL routine dramatically decreases the total lock time when changing the frequency. For example, lock times of less than 30 µs are possible with a 59.7 kHz loop bandwidth. Figure 1 shows an example of a suitable loop filter.

Because each ADF4355-2 chip is unique, a new lookup table must be generated for every chip.

VCO Readback Procedure

The VCO readback procedure is as follows:

1. Load all registers to lock to the desired frequency.
   a. Ensure VCO read is set to VCO core and band (R10, DB[28:26] = 0b001) (see Figure 5).
   b. Ensure VCO readback is set to VCO calibration complete (R7, DB[14:12] = 0b110) (see Figure 4).
   c. Ensure MUXOUT is set to VCO readback (R4, DB[29:27] = 0b111) (see Figure 3).
   d. Ensure AUTOCAL is enabled (R0, DB21 = 0b1); see the ADF4355-2 data sheet for the R0 register map.
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) (see Figure 5).
4. Pulse SPI CLK while LE is kept high. The data outputs on MUXOUT. Extract the 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 through Step 6 to build a lookup table for all desired frequencies. For Step 1, writing R10, R7, R2, R1, and R0 is only required after the first iteration. R2 and R1 are optional if they have not changed.

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), bypass the VCO calibration routine and set the VCO data manually with the following steps:

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 the desired VCO core, VCO band, and VCO bias setting as defined in Figure 6. Note that the 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 the desired frequency by programming R2, R1, and R0, respectively.
Expanded ADF4355-2 Register Maps

Figure 3. Register 4

Figure 4. Register 7
### Figure 5. Register 10

| DB31 | DB30 | DB29 | DB28 | DB27 | DB26 | DB25 | DB24 | DB23 | DB22 | DB21 | DB20 | DB19 | DB18 | DB17 | DB16 | DB15 | DB14 | DB13 | DB12 | DB11 | DB10 | DB9 | DB8 | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

- **VR3** VR2 VR1
  - 0 0 0 NORMAL OPERATION
  - 0 0 1 VCO CORE AND BAND
  - 0 1 0 RESERVED
  - 0 1 1 VCO BIAS CODE
  - 1 0 0 RESERVED
  - 1 0 1 RESERVED
  - 1 1 0 RESERVED
  - 1 1 1 RESERVED

- **AD8** AD7 AD6 AD5 AD4 AD3 AD2 AD1
  - 0 0 0 0 0 1 0 1
  - 0 0 0 0 1 0 0 2
  - 0 0 0 1 0 0 2
  - 0 0 1 0 0 1 1 1
  - 0 0 1 1 0 1 1 0
  - 0 1 0 0 0 0 0 8

### Figure 6. Register 11

| DB31 | DB30 | DB29 | DB28 | DB27 | DB26 | DB25 | DB24 | DB23 | DB22 | DB21 | DB20 | DB19 | DB18 | DB17 | DB16 | DB15 | DB14 | DB13 | DB12 | DB11 | DB10 | DB9 | DB8 | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

- **C4** C3 C2 C1
  - 0 0 0 0 VCO CORE
  - 0 0 0 1 VCO CORE AND BAND
  - 0 1 0 0 RESERVED
  - 0 1 0 1 VCO BIAS CODE
  - 1 0 0 0 RESERVED

- **BA8** BA7 BA6 BA5 BA4 BA3 BA2 BA1
  - 0 0 0 0 0 0 0 0
  - 0 0 0 0 0 0 0 0
  - 0 0 0 0 0 0 0 0
  - 0 0 0 0 0 0 0 0

- **VCO BAND**
  - 0 0 0 0 0 0 0 0
  - 0 0 0 0 0 0 0 0
  - 0 0 0 0 0 0 0 0
  - 0 0 0 0 0 0 0 0
Read Timing Characteristics

Table 1. Read Timing

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit at T_MIN to T_MAX</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_1 )</td>
<td>15</td>
<td>ns min</td>
<td>LE high to CLK high</td>
</tr>
<tr>
<td>( t_2 )</td>
<td>15</td>
<td>ns min</td>
<td>CLK high to DATA ready</td>
</tr>
<tr>
<td>( t_3 )</td>
<td>25</td>
<td>ns min</td>
<td>CLK high duration</td>
</tr>
<tr>
<td>( t_4 )</td>
<td>25</td>
<td>ns min</td>
<td>CLK low duration</td>
</tr>
<tr>
<td>( t_5 )</td>
<td>10</td>
<td>ns min</td>
<td>CLK high to LE low (next write)</td>
</tr>
</tbody>
</table>

Read Timing Diagram

Figure 7. Read Timing Diagram

NOTES
1. LE MUST BE KEPT HIGH DURING READBACK.
2. X = DON'T CARE.