

**FEATURES**

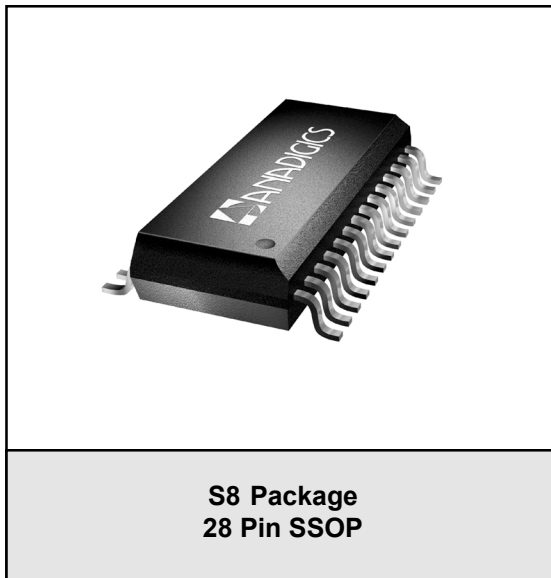
- Integrated Downconverter
- Integrated Dual Synthesizer
- 256 QAM Compatibility
- Single +5 V Power Supply Operation
- Low Power Consumption: <0.6 W
- Low Noise Figure: 8 dB
- High Conversion Gain: 10 dB
- Low Distortion: -53 dBc
- Two-Wire Interface
- Small Size
- -40 °C to +85 °C

**APPLICATIONS**

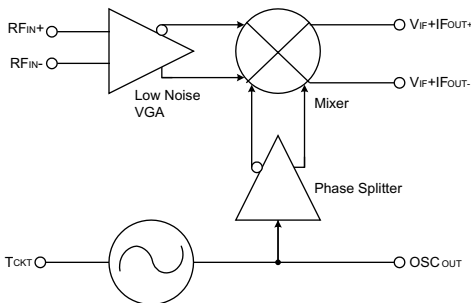
- Set Top Boxes
- CATV Video Tuners
- Digital TV Tuners
- CATV Data Tuners
- Cable Modems

**PRODUCT DESCRIPTION**

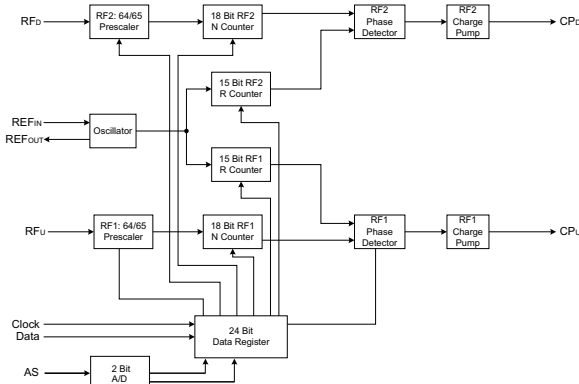
The ACD2203 uses both GaAs and Si technology to provide the downconverter and dual synthesizer functions in a double conversion tuner gain block, local oscillator, balanced mixer and dual synthesizer. The specifications meet the requirements of CATV/TV/Video and Cable Modem Data applications. The ACD2203 is supplied in a 28 lead SSOP package and requires a single +5 V supply voltage.



The IC is well suited for applications where small size, low cost, low auxiliary parts count and a no-compromise performance is important. It provides for cost reduction by lowering the component and packaged IC count and decreasing the amount of labor-intensive production alignment steps, while significantly improving performance and reliability.



**Figure 1: Downconverter Block Diagram**



**Figure 2: Dual Synthesizer Block Diagram**

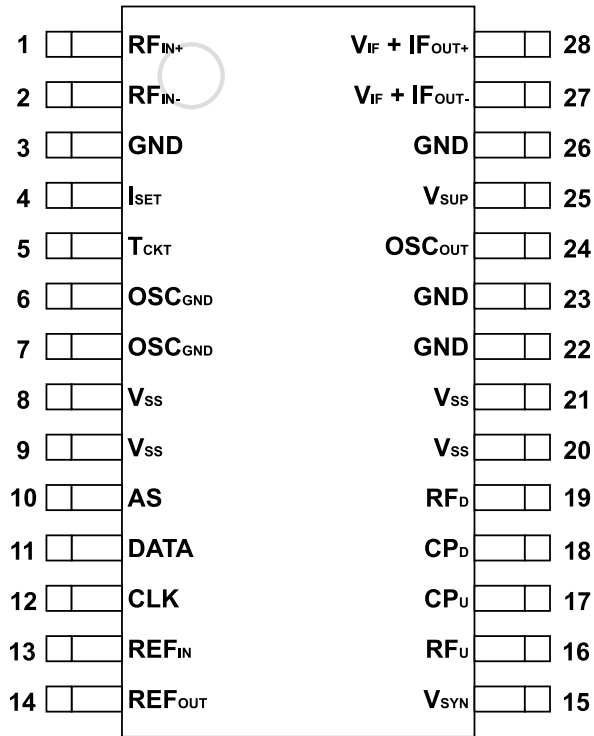


Figure 3: Pinout

Table 1: Pin Description

| PIN | NAME               | DESCRIPTION  | PIN | NAME                   | DESCRIPTION  |
|-----|--------------------|--|-----|------------------------|--|
| 1   | RF <sub>IN+</sub>  | Downconverter Differential RF Input  | 28  | V <sub>IF+IFOUT+</sub> | Downconverter Differential IF Output Inductively coupled to +V <sub>DD</sub> |
| 2   | RF <sub>IN-</sub>  | Downconverter Differential RF Input  | 27  | V <sub>IF+IFOUT-</sub> | Downconverter Differential IF Output Inductively coupled to +V <sub>DD</sub> |
| 3   | GND                | Downconverter Ground (Must be connected)   | 26  | GND                    | Downconverter Ground (Must be connected)                                     |
| 4   | I <sub>SET</sub>   | Downconverter Gilbert Cell Current Source Resistor                               | 25  | V <sub>SUP</sub>       | Oscillator and Phase Splitter Supply (+V <sub>DD</sub> )                     |
| 5   | T <sub>CKT</sub>   | Oscillator Input Port (Tank circuit connection)                                  | 24  | OSC <sub>OUT</sub>     | Oscillator Output (Connected to Synthesizer RF Input)                        |
| 6   | OSC <sub>GND</sub> | Oscillator Tank Circuit Ground (Not to be connected to any other circuit ground) | 23  | GND                    | Downconverter Ground (Must be connected)                                     |
| 7   | OSC <sub>GND</sub> | Same as Pin 6  | 22  | GND                    | Downconverter Ground (Must be connected)                                     |
| 8   | V <sub>SS</sub>    | Synthesizer Ground (Required)  | 21  | V <sub>SS</sub>        | Synthesizer Ground (Required)  |
| 9   | V <sub>SS</sub>    | Synthesizer Ground (Required)  | 20  | V <sub>SS</sub>        | Synthesizer Ground (Required)  |
| 10  | AS                 | Address Select   | 19  | RF <sub>D</sub>        | Synthesizer Downconverter RF Input   |
| 11  | DATA               | 2-Wire Interface Data  | 18  | CP <sub>D</sub>        | Synthesizer Downconverter Charge Pump Output                                 |
| 12  | CLK                | 2-Wire Interface Clock   | 17  | CP <sub>U</sub>        | Synthesizer Upconverter Charge Pump Output                                   |
| 13  | REF <sub>IN</sub>  | Crystal Reference Input  | 16  | RF <sub>U</sub>        | Synthesizer Upconverter RF Input   |
| 14  | REF <sub>OUT</sub> | Crystal Reference Output   | 15  | V <sub>SYN</sub>       | Synthesizer Supply (+V <sub>DD</sub> )                                       |

## ELECTRICAL CHARACTERISTICS

Table 2: Absolute Minimum and Maximum Ratings

| PARAMETER   | MIN  | MAX               | UNIT |
|---|------|-------------------|------|
| Supply Voltage (pins 25, 27 & 28)<br>(pin 15)                       | -    | +9<br>+6.5        | VDC  |
| Voltage on pins 10 through 14, 16<br>through 19 with $V_{SS} = 0$ V | -0.3 | $V_{SYN} + 0.3$   | VDC  |
| Input Voltages (pins 1, 2 & 5)                                      | -    | 0                 | VDC  |
| Input Power (pins 1 & 2)<br>(pin 5)<br>(pins 13, 16 & 19)           | -    | +10<br>+17<br>+20 | dBm  |
| Storage Temperature   | -55  | +150              | °C   |
| Soldering Temperature   | -    | 260               | °C   |
| Soldering Time  | -    | 4                 | Sec  |
| Thermal Impedance, $\theta_{JC}$                                    | -    | 40                | °C/W |

Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability.

Table 3: Operating Ranges

| PARAMETER   | MIN                  | TYP              | MAX                      | UNIT |
|---|----------------------|------------------|--------------------------|------|
| Downconverter Frequencies <sup>(1)</sup><br>RF Input (RF)<br>IF Output (IF)<br>Local Oscillator (LO)  | 900<br>35<br>865     | -<br>-<br>-      | 1200<br>150<br>1350      | MHz  |
| Synthesizer Frequencies<br>Upconverter Synthesizer (RF <sub>U</sub> )<br>Downconverter Synthesizer (RF <sub>D</sub> )<br>Reference Oscillator (REF <sub>N</sub> )<br>Phase Detector | 400<br>400<br>2<br>- | -<br>-<br>4<br>- | 2100<br>1400<br>20<br>10 | MHz  |
| Supply Voltage: $V_{DD}$ (pins 15, 25, 27, 28)  | +4.70                | +5               | +5.25                    | VDC  |
| Ambient Operating Temperature: $T_A$ <sup>(2)</sup>   | -40                  | -                | +85                      | °C   |

The device may be operated safely over these conditions; however, parametric performance is guaranteed only over the conditions defined in the electrical specifications.

Notes:

- (1) Mixer operation is possible beyond these frequencies with slightly reduced performance.
- (2) Case Temperature is 15 °C higher than Ambient Temperature, when Ambient Temperature is +25 °C, using the PC Board Layout shown in Figures 24-26.

**Table 4: Electrical Specifications - Downconverter Section**  
 ( $T_A = +25\text{ }^\circ\text{C}$ <sup>(7)</sup>,  $V_{DD} = +5\text{ VDC}$ ,  $R_{F_{IN}} = 1087\text{ MHz}$ ,  $I_{F_{OUT}} = 45\text{ MHz}$ )

| PARAMETER  | MIN | TYP | MAX   | UNIT   |
|--|-----|-----|-------|--------|
| Conversion Gain <sup>(1)</sup>   | 8   | 10  | 14    | dB     |
| Conversion Gain <sup>(2)</sup>   | 11  | 13  | 17    |        |
| SSB Noise Figure <sup>(2), (3)</sup>   | -   | 4   | 7     | dB     |
| Cross Modulation <sup>(2), (4), (6)</sup>  | -   | -56 | -53   | dBc    |
| 3 <sup>rd</sup> Order Intermodulation Distortion (IMD3) <sup>(2), (5), (6)</sup>   | -   | -   | -53   | dBc    |
| 2-Tone 3 <sup>rd</sup> Order Input Intercept Point (IIP3) <sup>(2), (5), (6)</sup> | +12 | -   | -     | dBm    |
| LO Phase Noise (@ 10 KHz Offset) <sup>(1), (2)</sup>                               | -   | -90 | -85.5 | dBc/Hz |
| LO Output Power (pin 24) <sup>(1), (2)</sup>                                       | -10 | -5  | -     | dBm    |
| Spurious @ IF Output   |     |     |       |        |
| LO Signals and Harmonics   | -   | -10 | -     | dBm    |
| Beats Within Output Channel  | -   | -48 | -     | dBc    |
| Other Beats from 2 to 200 MHz  | -   | -50 | -     | dBm    |
| Other Spurious   | -   | -10 | -     | dBm    |
| IF Supply Current (pin 27 & 28) <sup>(1), (2), (6)</sup>                           | -   | 50  | 65    | mA     |
| Osc/Phase Splitter Supply Current (pin 25)   | -   | 30  | 45    | mA     |
| Power Consumption  | -   | 400 | 550   | mW     |

**Notes:**

- (1) As measured in ANADIGICS test fixture with single-ended RF input.  
 (2) As measured in ANADIGICS test fixture with differential RF inputs.  
 (3) SSB noise figure will be approximately 3 dB higher with single-ended RF input.  
 (4) Two tones: 1085 and 1091 MHz, -20 dBm each, 1091 MHz tone AM-modulated 99% at 15 kHz.  
 (5) Two tones: 1085 and 1091 MHz, -15 dBm each.  
 (6)  $R_1 = 10\text{ Ohms}$ .  
 (7) Case Temperature is 15 °C higher than Ambient Temperature, when Ambient Temperature is +25 °C, using the PC Board Layout shown in Figures 24-26.

**Table 5: Electrical Specifications - Synthesizer Section**  
**( $T_A = +25\text{ }^\circ\text{C}$ <sup>(4)</sup>,  $V_{DD} = +5\text{ VDC}$ )**

| PARAMETER  | MIN | TYP   | MAX | UNIT             | COMMENTS   |
|--|-----|-------|-----|------------------|--|
| Prescaler Input Sensitivity                            |     |       |     |                  | (over operating frequency)   |
| Upconverter: RF <sub>U</sub> (pin 16) <sup>(1)</sup>   | -7  | -     | +20 | dBm              | $T_A = +85\text{ }^\circ\text{C}$ , $V_{DD} = +4.7\text{ V}$<br>$T_A = +85\text{ }^\circ\text{C}$ , $V_{DD} = +4.7\text{ V}$ |
| Downconverter: RF <sub>D</sub> (pin 19) <sup>(2)</sup> | -13 | -     | +20 |                  |  |
| Upconverter: RF <sub>U</sub> (pin 16) <sup>(1)</sup>   | -6  | -     | -   |                  |  |
| Downconverter: RF <sub>D</sub> (pin 19) <sup>(2)</sup> | -11 | -     | -   |                  |  |
| Reference Oscillator Sensitivity (pin 13)              | -   | 0.5   | -   | V <sub>p-p</sub> |  |
| Charge Pump Output Current <sup>(3)</sup>              |     |       |     |                  |  |
| SINK   | -   | 1.25  | -   | mA               |  |
| SOURCE   | -   | -1.25 | -   |                  |  |
| Supply Current   | -   | 35    | 50  | mA               |  |
| Power Consumption                                      | -   | 165   | 250 | mW               |  |

**Notes:**

(1) Measured at 250 kHz comparison frequency.

(2) Measured at 62.5 kHz comparison frequency.

(3)  $CP_U$  and  $CP_D = V_{CC}/2$ .

(4) Case Temperature is 15 °C higher than Ambient Temperature, when Ambient Temperature is +25 °C, using the PC Board Layout shown in Figures 24-26.

**Table 6: Digital 2-Wire Interface Specifications**  
( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ VDC}$ , ref. Figure 4)

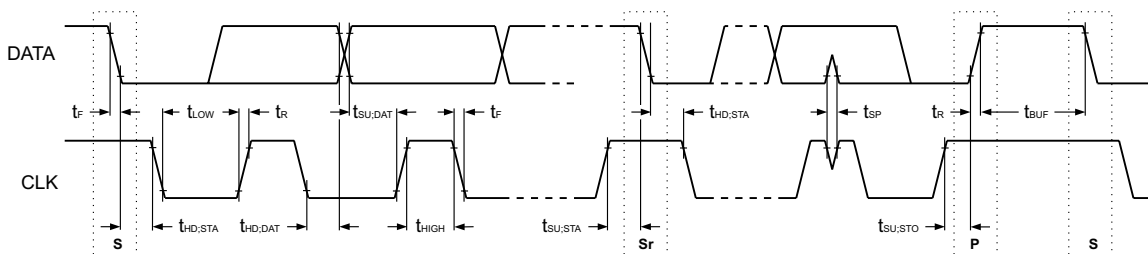
| PARAMETER  | SYMBOL       | MIN                 | MAX | UNIT          |
|--|--------------|---------------------|-----|---------------|
| CLK Frequency  | $f_{CLK}$    | 1                   | 400 | kHz           |
| Logic High Input (pins 11, 12)   | $V_H$        | 2.0                 | -   | V             |
| Logic Low Input (pins 11, 12)  | $V_L$        | -                   | 0.8 | V             |
| Logic Input Current Consumption (pins 11, 12)  | $I_{LOG}$    | -                   | 10  | $\mu\text{A}$ |
| Address Select Input Current Consumption (pin 10)  | $I_{AS}$     | -                   | 10  | $\mu\text{A}$ |
| Data Sink Current <sup>(2)</sup>   | $I_{AK}$     | -                   | 4.0 | mA            |
| Bus Free Time between a STOP and START Condition   | $t_{BUF}$    | 1.3                 | -   | $\mu\text{s}$ |
| Hold Time (repeated) START Condition. After this period, the first clock pulse is generated. | $t_{HD,STA}$ | 0.6                 | -   | $\mu\text{s}$ |
| LOW period of CLK  | $t_{LOW}$    | 1.3                 | -   | $\mu\text{s}$ |
| HIGH period of CLK   | $t_{HIGH}$   | 0.6                 | -   | $\mu\text{s}$ |
| Set-up Time for a Repeated START Condition   | $t_{SU,STA}$ | 0.6                 | -   | $\mu\text{s}$ |
| Data Hold Time (for 2-wire bus devices)  | $t_{HD,DAT}$ | 0.0                 | 0.9 | $\mu\text{s}$ |
| Data Set-up Time   | $t_{SU,DAT}$ | 100                 | -   | ns            |
| Rise Time of DATA and CLK Signals  | $t_R$        | $20 + 0.1C_b^{(1)}$ | 300 | ns            |
| Fall Time of Data and CLK Signals  | $t_F$        | $20 + 0.1C_b^{(1)}$ | 300 | ns            |
| Set-up Time for STOP Condition   | $t_{SU,STO}$ | 0.6                 | -   | $\mu\text{s}$ |
| Capacitive Load for Each Bus Line  | $C_b$        | -                   | 400 | pF            |

Notes:

(1)  $C_b$  is the total capacitance of one bus line in pF.

(2) For maximum 0.8 V level during Acknowledge Pulse.

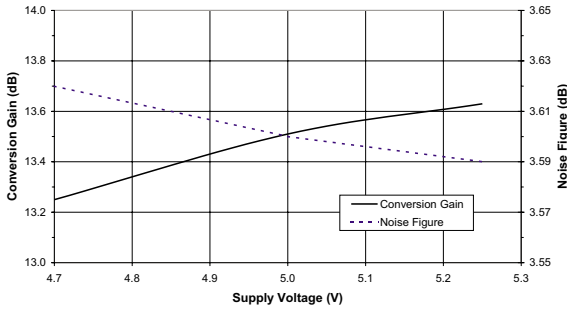
3. All timing values are referred to minimum  $V_H$  and maximum  $V_L$  levels.



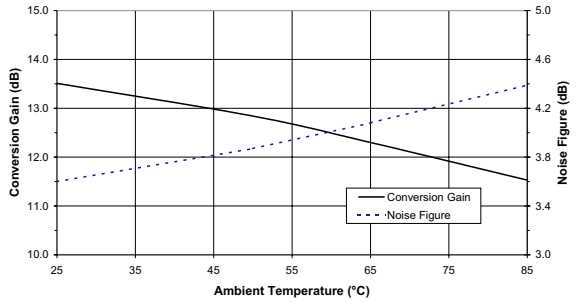
**Figure 4: Serial 2-Wire Data Input Timing**

PERFORMANCE DATA

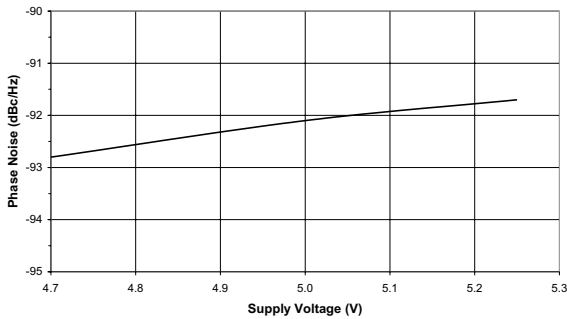
**Figure 5: Typical Conversion Gain and Noise Figure vs. Supply Voltage**  
 (T<sub>A</sub> = +25 °C, f<sub>LO2</sub> = 1042 MHz)



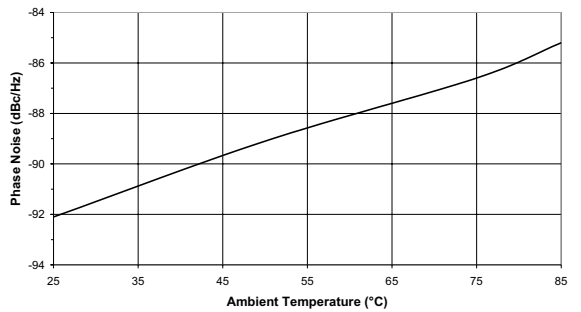
**Figure 6: Typical Conversion Gain and Noise Figure vs. Ambient Temperature**  
 (V<sub>DD</sub> = +5 V, f<sub>LO2</sub> = 1042 MHz)



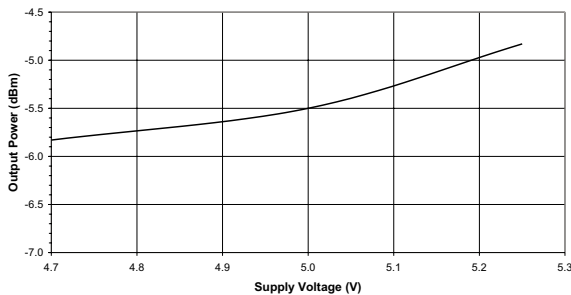
**Figure 7: Typical Phase Noise at 10 kHz Offset vs. Supply Voltage**  
 (T<sub>A</sub> = +25 °C, f<sub>LO2</sub> = 1042 MHz)



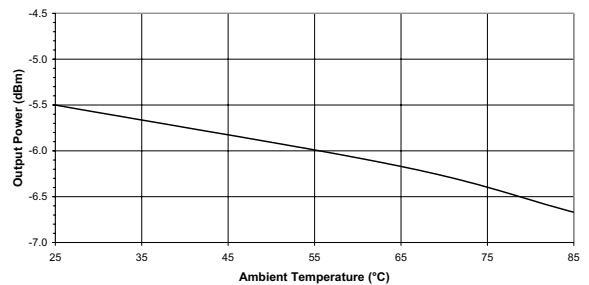
**Figure 8: Typical Phase Noise at 10 kHz Offset vs. Ambient Temperature**  
 (V<sub>DD</sub> = +5 V, f<sub>LO2</sub> = 1042 MHz)



**Figure 9: Typical Local Oscillator Output Power vs. Supply Voltage**  
 (T<sub>A</sub> = +25 °C, f<sub>LO2</sub> = 1042 MHz)

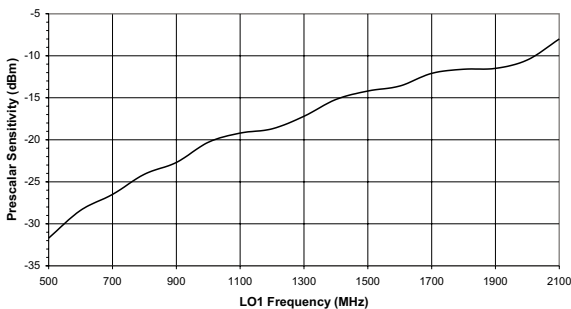


**Figure 10: Typical Local Oscillator Output Power vs. Ambient Temperature**  
 (V<sub>DD</sub> = +5 V, f<sub>LO2</sub> = 1042 MHz)

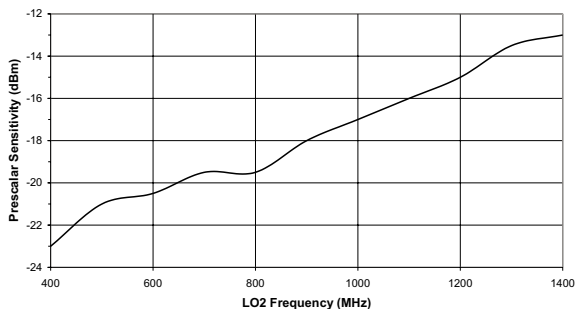




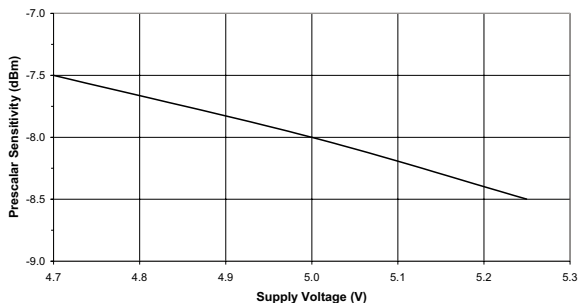
**Figure 11: Typical Upconverter Prescaler Sensitivity vs. Local Oscillator Frequency**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ )



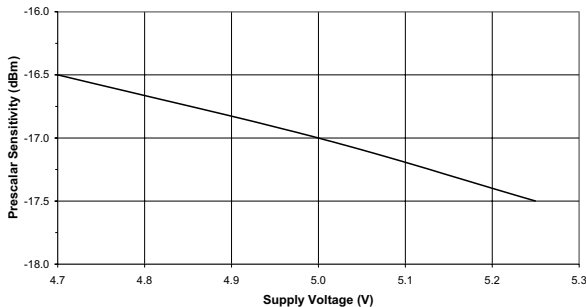
**Figure 12: Typical Downconverter Prescaler Sensitivity vs. Local Oscillator Frequency**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ )



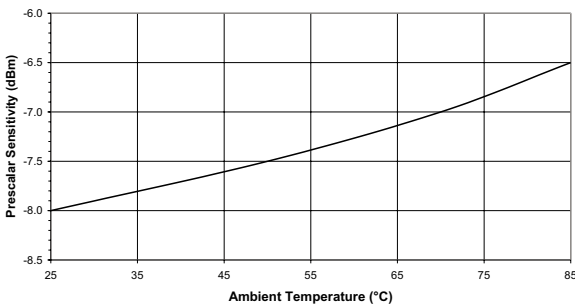
**Figure 13: Typical Upconverter Prescaler Sensitivity vs. Supply Voltage**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $f_{LO1} = 2100\text{ MHz}$ )



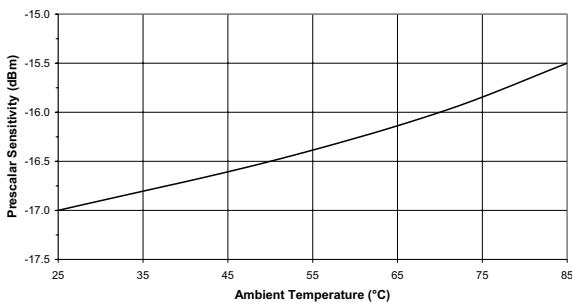
**Figure 14: Typical Downconverter Prescaler Sensitivity vs. Supply Voltage**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $f_{LO2} = 1000\text{ MHz}$ )



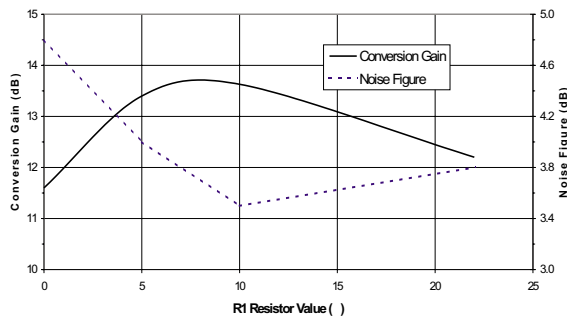
**Figure 15: Typical Upconverter Prescaler Sensitivity vs. Ambient Temperature**  
 ( $V_{DD} = +5\text{ V}$ ,  $f_{LO1} = 2100\text{ MHz}$ )



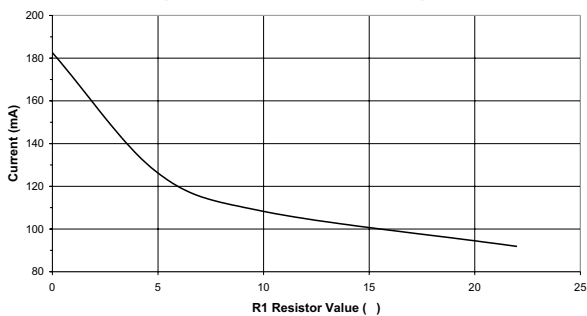
**Figure 16: Typical Downconverter Prescaler Sensitivity vs. Ambient Temperature**  
 ( $V_{DD} = +5\text{ V}$ ,  $f_{LO2} = 1000\text{ MHz}$ )



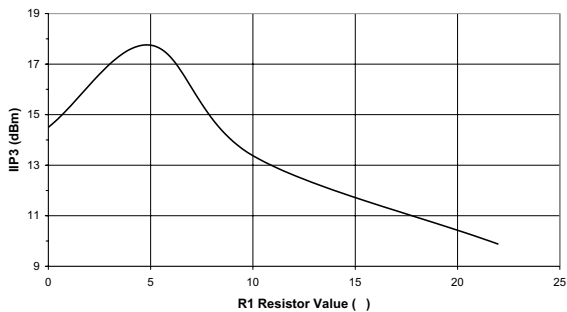
**Figure 17: Typical Conversion Gain and Noise Figure vs. LNA/Mixer Current Control Resistor R1**  
 (T<sub>A</sub> = +25 °C, V<sub>DD</sub> = +5 V, f<sub>L02</sub> = 1042 MHz)



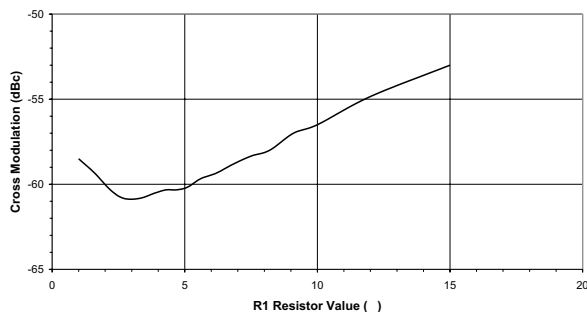
**Figure 18: Typical Total Current Consumption vs. LNA/Mixer Current Control Resistor R1**  
 (T<sub>A</sub> = +25 °C, V<sub>DD</sub> = +5 V)



**Figure 19: Typical Input IP3 vs. LNA/Mixer Current Control Resistor R1**  
 (T<sub>A</sub> = +25 °C, V<sub>DD</sub> = +5 V)



**Figure 20: Typical Cross Modulation vs. LNA/Mixer Current Control Resistor R1**  
 (T<sub>A</sub> = +25 °C, V<sub>DD</sub> = +5 V)



## LOGIC PROGRAMMING

The ACD2203 includes an interface for a two-wire serial data control bus that ANADIGICS has developed for use with its dual PLL synthesizers. This interface saves one connection between the host and the dual synthesizer, compared to a standard CLOCK-DATA-ENABLE three-wire interface. The interface is optimized for applications in which the dual synthesizer is a slave receiver device. Hosts that conform to the I<sup>2</sup>C-Bus Specification standard can be used to program a dual PLL that uses this interface.

### Physical Interface

The two-wire interface consists of two digital signal lines, CLOCK and DATA. The speed of the interface is nominally 400 kbits/sec. For data transmission, the signal on the DATA line must be stable when the CLOCK signal is high, and the state of the data must change only while the CLOCK signal is low. A logic level transition on the DATA line during a high CLOCK signal indicates the beginning or end of a data transmission, as specified in the following sections and shown in Figure 21.

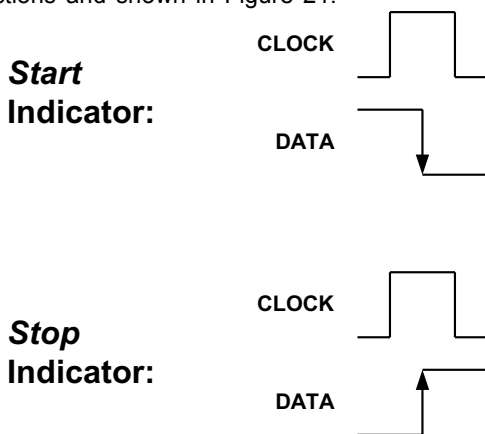


Figure 21: Transmission Indicators

### Addressing The Dual PLL

The dual PLL monitors the CLOCK and DATA signals for a *Start* indication from the host. A *Start* is indicated by a high-to-low transition of the DATA signal while the CLOCK signal is high. Immediately following the *Start* indicator, the host sends an 8-bit address word to the dual PLL. The 8-bit word required to address the dual PLL is programmable via a DC voltage level applied to the address select pin. For example, a voltage of  $4V < AS < 5V$  corresponds to a value of C6h, or 1100110b. (The MSB is sent first, LSB last.) The Address Select pin

(10) decodes an analog voltage input into two digital logic output bits AS1 and AS2. The level of a DC voltage applied to this pin determines the two-bit logic state, AS2 and AS1 to address the synthesizer. The software must be programmed with the corresponding decimal equivalent of the 8b word selected, as shown in Table 7. Once the dual PLL has recognized the *Start* indicator and the correct address word, it sends an address acknowledgement to the host by pulling the DATA line low for one clock pulse. The host can then begin to send data to program the dual PLL.

### Sending Data

After receiving the address byte acknowledgement from the dual PLL, the host begins sending programming data in 8-bit words. The MSB is sent first, and the LSB last. Following the receipt of each 8-bit data word, the dual PLL acknowledges receipt by pulling the DATA line low for one clock pulse. The data acknowledgement tells the host it may send the next data word. For the dual PLL, each group of three data words (24 bits total) is a significant block of information used to program one of four registers, as described in "Programming the Dual PLL."

### Completing Data Transmissions

After sending the final data word, the host sends a *Stop* indicator to mark the end of data transmission. A *Stop* is indicated by a low-to-high transition of the DATA signal while the CLOCK signal is held high. After receiving the *Stop* indicator, the dual PLL ceases to send further acknowledgements and begins to monitor the CLOCK and DATA signals for the next *Start* indicator.

*Note: The Stop indicator does not directly control when the programming data is latched or takes effect; the data takes effect immediately following the receipt of each three-word block of data, which represents a complete 24-bit divider register.*

### Resending Data

If, for some reason, the data transmission fails or is interrupted, and the dual PLL fails to send an address word or data word acknowledgement to the host, the host can resend the data. To resend data, a new *Start* indicator and address word must be sent prior to any data words.

### Programming The Dual PLL

Each synthesizer in the dual PLL contains programmable Reference and Main dividers, which

**Table 7: Address Select Decoding**  
(T<sub>A</sub> = +25 °C <sup>(1)</sup>, V<sub>DD</sub> = +5 VDC)

| VOLTAGE ON PIN<br>10, AS    | C (BINARY 12) |    |    |    | AS2 AS1 |    |    |    | HEX | DECIMAL |
|-----------------------------|---------------|----|----|----|---------|----|----|----|-----|---------|
|                             | B7            | B6 | B5 | B4 | B3      | B2 | B1 | B0 |     |         |
| V <sub>SS</sub> < AS < 0.8V | 1             | 1  | 0  | 0  | 0       | 0  | 1  | 0  | C2  | 194     |
| 1.1V < AS < 1.7V            | 1             | 1  | 0  | 0  | 0       | 0  | 0  | 0  | C0  | 192     |
| 2.1V < AS < 2.7V            | 1             | 1  | 0  | 0  | 0       | 1  | 0  | 0  | C4  | 196     |
| 3.15V < AS < 3.65V          | 1             | 1  | 0  | 0  | 0       | 0  | 0  | 0  | C0  | 192     |
| 4.2V < AS < V <sub>DD</sub> | 1             | 1  | 0  | 0  | 0       | 1  | 1  | 0  | C6  | 198     |

Notes:

(1) Case Temperature is 15 °C higher than Ambient Temperature, when Ambient Temperature is +25 °C, using the PC Board Layout shown in Figures 24-26.

allow a wide range of output frequencies. The 24-bit registers that control the dividers and other functions are each segmented into three 8-bit data words, and are programmed via the two-wire interface.

### Register Select Bits

The two least significant bits of each register are register select bits that determine which register is programmed during a particular data entry cycle. Table 8 indicates the register select bit settings used to program each of the available registers.

**Table 8: Register Select Bits**

| SELECT BITS |        | DESTINATION REGISTER FOR SERIAL DATA |
|-------------|--------|--------------------------------------|
| S<br>2      | S<br>1 |                                      |
| 0           | 0      | Reference Divider Register for PLL2  |
| 0           | 1      | Main Divider Register for PLL2       |
| 1           | 0      | Reference Divider Register for PLL1  |
| 1           | 1      | Main Divider Register for PLL1       |

### Reference Divider Programming

The reference divider register for each synthesizer consists of fifteen divider bits, five program mode bits and the two register select bits, as shown in Table 9. The fifteen divider bits allow a divide ratio from 3 to 32767, inclusive, as shown in Table 10.

### Main Divider Programming

The main divider register for each synthesizer consists of seven A counter bits, eleven B counter bits, two program mode bits and the two register select bits, as shown in Table 11. The main divider divide ratio, N, is determined by the values in the A and B counters. The eleven B Counter bits and allowed values are shown in Table 12, and the seven A Counter bits and allowed values are shown in Table 13. Note that there are some limitations on the ranges of the values for each counter.

### Pulse Swallow Function

The VCO output frequency for the local oscillator is computed using the following equation; the variables are defined in Table 14:

$$f_{VCO} = N \times f_{osc}/R, \text{ where } N = [(P \times B) + A]$$

where:

$$N = [(P \times B) + A]$$

f<sub>VCO</sub> is the desired output frequency

B is the divide ratio of the B counter (3 to 2047)

A is the divide ratio of the A counter (0 < A < P, A < B)

f<sub>osc</sub> is the frequency of the reference oscillator

R is the divide ratio of the R counter (3 to 32767)

P is the preset modulus of the prescaler (P=64).

Table 9: Reference Divider Registers

|              |                 | MSB |              |    |    |    |    |                                   |    |    |    |    |    |    |                 |   |   | LSB |   |   |   |   |   |        |   |
|--------------|-----------------|-----|--------------|----|----|----|----|-----------------------------------|----|----|----|----|----|----|-----------------|---|---|-----|---|---|---|---|---|--------|---|
| Data Word    | FIRST DATA WORD |     |              |    |    |    |    | SECOND DATA WORD                  |    |    |    |    |    |    | THIRD DATA WORD |   |   |     |   |   |   |   |   |        |   |
| Register Bit | 24              | 23  | 22           | 21 | 20 | 19 | 18 | 17                                | 16 | 15 | 14 | 13 | 12 | 11 | 10              | 9 | 8 | 7   | 6 | 5 | 4 | 3 | 2 | 1      |   |
| Function     | Dummy/Spacer    |     | Program Mode |    |    |    |    | Reference Divider Divide Ratio, R |    |    |    |    |    |    |                 |   |   |     |   |   |   |   |   | Select |   |
| Data         | X               | X   | D            | D  | D  | D  | D  | R                                 | R  | R  | R  | R  | R  | R  | R               | R | R | R   | R | R | R | R | R | S      | S |
|              | 2               | 1   | 5            | 4  | 3  | 2  | 1  | 15                                | 14 | 13 | 12 | 11 | 10 | 9  | 8               | 7 | 6 | 5   | 4 | 3 | 2 | 1 | 2 | 1      |   |

Table 10: Reference Divider R Counter Bits

| DIVIDE RATIO R | R 15 | R 14 | R 13 | R 12 | R 11 | R 10 | R 9 | R 8 | R 7 | R 6 | R 5 | R 4 | R 3 | R 2 | R 1 |
|----------------|------|------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 3              | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   |
| 4              | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   |
| -              | -    | -    | -    | -    | -    | -    | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| 32767          | 1    | 1    | 1    | 1    | 1    | 1    | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |

Notes:

Divide ratios less than 3 are prohibited.

Table 11: Main Divider Registers

|              |                 | MSB |              |    |           |    |    |                  |    |    |    |    |    |    |                 |           |   | LSB |   |   |        |   |   |   |
|--------------|-----------------|-----|--------------|----|-----------|----|----|------------------|----|----|----|----|----|----|-----------------|-----------|---|-----|---|---|--------|---|---|---|
| Data Word    | FIRST DATA WORD |     |              |    |           |    |    | SECOND DATA WORD |    |    |    |    |    |    | THIRD DATA WORD |           |   |     |   |   |        |   |   |   |
| Register Bit | 24              | 23  | 22           | 21 | 20        | 19 | 18 | 17               | 16 | 15 | 14 | 13 | 12 | 11 | 10              | 9         | 8 | 7   | 6 | 5 | 4      | 3 | 2 | 1 |
| Function     | Dummy/Spacer    |     | Program Mode |    | B Counter |    |    |                  |    |    |    |    |    |    |                 | A Counter |   |     |   |   | Select |   |   |   |
| Data         | X               | X   | C            | C  | B         | B  | B  | B                | B  | B  | B  | B  | B  | B  | B               | A         | A | A   | A | A | A      | A | S | S |
|              | 2               | 1   | 2            | 1  | 11        | 10 | 9  | 8                | 7  | 6  | 5  | 4  | 3  | 2  | 1               | 7         | 6 | 5   | 4 | 3 | 2      | 1 | 2 | 1 |

Table 12: Main Divider B Counter Bits

| VALUE OF B COUNTER | B 11 | B 10 | B 9 | B 8 | B 7 | B 6 | B 5 | B 4 | B 3 | B 2 | B 1 |
|--------------------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 3                  | 0    | 0    | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   |
| 4                  | 0    | 0    | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   |
| -                  | -    | -    | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| 2047               | 1    | 1    | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |

Notes:

B &gt; A, Divide ratios less than 3 are prohibited.

**Table 13: Main Divider A Counter Bits**

| VALUE OF A COUNTER | A 7 | A 6 | A 5 | A 4 | A 3 | A 2 | A 1 |
|--------------------|-----|-----|-----|-----|-----|-----|-----|
| 0                  | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 1                  | 0   | 0   | 0   | 0   | 0   | 0   | 1   |
| -                  | -   | -   | -   | -   | -   | -   | -   |
| 127                | 1   | 1   | 1   | 1   | 1   | 1   | 1   |

Notes:

 $B > A, A < P$ **Table 14: Phase Detector Polarity Bit**

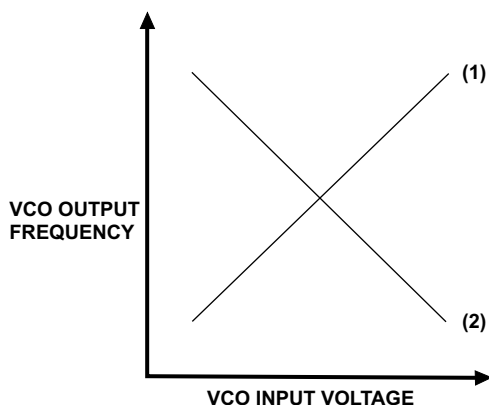
| S 2 | S 1 | D 1                          |
|-----|-----|------------------------------|
| 0   | 0   | PLL2 Phase Detector Polarity |
| 1   | 0   | PLL1 Phase Detector Polarity |

**Programmable Modes**

Each register contains bits set aside for programming different modes of operation in the synthesizers. Bit D1 in each reference divider register controls the phase detector polarity. Table 14 shows how this bit controls the polarity, and the correct setting is determined by using Table 15 and Figure 22.

**Table 15: Phase Detector Polarity Selection**

| D 1 | POLARITY | VCO CHARACTERISTICS |
|-----|----------|---------------------|
| 0   | Negative | curve (2)           |
| 1   | Positive | curve (1)           |

**Figure 22: VCO Characteristics**

Bit C1 in each main divider register sets the prescaler mode. Table 16 indicates the appropriate settings. (Currently, there is only one prescaler mode available for use.)

**Table 16: Prescaler Mode**

| C 1 | PRESCALAR MODE            |
|-----|---------------------------|
| 0   | 64/65                     |
| 1   | (reserved for future use) |

Bit C2 in the main divider registers, bits D2 through D5 in the reference divider registers, and bits X1 and X2 in all registers are reserved for future use, and have no current function. They can be set either high or low without affecting synthesizer performance.

### Synthesizer Programming Example

The following example for programming the two synthesizers in the dual PLL details the calculations used to determine the required value of each bit in all four registers:

#### Requirements

Desired CATV input channel: "HHH" - 499.25 MHz picture carrier (501 MHz digital channel center frequency)

(Second) IF picture carrier output frequency: 45.75 MHz (44 MHz digital channel center frequency)

First IF frequency: 1087.75 MHz (recommended)

Phase detector comparison frequency for down converter (also tuning increment): 62.5 KHz

Phase detector comparison frequency for up converter: 250 KHz

Crystal reference oscillator frequency: 4 MHz

#### Calculation of Reference Divider Values

The value for each reference divider is calculated by dividing the reference oscillator frequency by the desired phase detector comparison frequency:

$$R = f_{OSC} / f_{PD}$$

For the down converter, the 4 MHz crystal oscillator frequency and the 62.5 KHz phase detector comparison frequency are used to yield  $R_{PLL2} = 4 \text{ MHz} / 62.5 \text{ KHz} = 64$ , and so the bit values for the down converter R counter are  $R_{PLL2} = 000000001000000$ .

For the up converter, the 4 MHz crystal oscillator frequency and the 250 KHz phase detector comparison frequency are used to yield  $R_{PLL1} = 4 \text{ MHz} / 250 \text{ KHz} = 16$ , and so the bit values for the up converter R counter are  $R_{PLL1} = 00000000010000$ .

#### Calculation of Main Divider Values

The values for the A and B counters are determined by the desired VCO output frequency for the local oscillator and the phase detector comparison frequency:

$$N = f_{VCO} / f_{PD}$$

$$B = \text{trunc}(N / P)$$

$$A = N - (B \times P)$$

The down converter local oscillator frequency will be  $1087.75 \text{ MHz} - 45.75 \text{ MHz} = 1042 \text{ MHz}$  in this example. The main divider ratio for the down converter, then, is  $N_{PLL2} = 1042 \text{ MHz} / 62.5 \text{ KHz} = 16672$ . Since  $P = 64$  in the ACD2203,  $B_{PLL2} = \text{trunc}(16672 / 64) = 260$ , and  $A_{PLL2} = 16672 - (260 \times 64) = 32$ . These results give bit values of  $B_{PLL2} = 00100000100$  and  $A_{PLL2} = 0100000$  for the B and A counters.

The up converter local oscillator frequency will be  $499.25 \text{ MHz} + 1087.75 \text{ MHz} = 1587 \text{ MHz}$  in this example. Therefore,  $N_{PLL1} = 1587 \text{ MHz} / 250 \text{ KHz} = 6348$ ,  $B_{PLL1} = \text{trunc}(6348 / 64) = 99$ , and  $A_{PLL1} = 6348 - (99 \times 64) = 12$ . These results give bit values of  $B_{PLL1} = 00001100011$  and  $A_{PLL1} = 0001100$  for the B and A counters.

#### Phase Detector Polarity

If the VCO for the up converter has a negative slope, the phase detector polarity for PLL1 should be negative, and  $D1_{PLL1} = 1$ . If the VCO for the down converter has a positive slope, the phase detector polarity for PLL2 should be positive, and  $D1_{PLL2} = 0$ .

In summary, for this example, the four register programming words are shown in Tables 17 and 18 on the following page.

**Table 17: PLL1 and PLL2 Reference Divider Register Bits  
for Synthesizer Programming Example**

|              |                  | MSB          |    |    |    |    |                                   |                  |    |    |    |    |    |    |                 |   |   | LSB |   |   |   |        |   |   |
|--------------|------------------|--------------|----|----|----|----|-----------------------------------|------------------|----|----|----|----|----|----|-----------------|---|---|-----|---|---|---|--------|---|---|
| Data Word    | FIRST DATA WORD  |              |    |    |    |    |                                   | SECOND DATA WORD |    |    |    |    |    |    | THIRD DATA WORD |   |   |     |   |   |   |        |   |   |
| Register Bit | 24               | 23           | 22 | 21 | 20 | 19 | 18                                | 17               | 16 | 15 | 14 | 13 | 12 | 11 | 10              | 9 | 8 | 7   | 6 | 5 | 4 | 3      | 2 | 1 |
| Function     | Dummy/<br>Spacer | Program Mode |    |    |    |    | Reference Divider Divide Ratio, R |                  |    |    |    |    |    |    |                 |   |   |     |   |   |   | Select |   |   |
| Data         | X                | X            | D  | D  | D  | D  | D                                 | R                | R  | R  | R  | R  | R  | R  | R               | R | R | R   | R | R | R | R      | S | S |
| PLL2         | 0                | 0            | 0  | 0  | 0  | 0  | 1                                 | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0               | 0 | 1 | 0   | 0 | 0 | 0 | 0      | 0 | 0 |
| PLL1         | 0                | 0            | 0  | 0  | 0  | 0  | 0                                 | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0               | 0 | 0 | 1   | 0 | 0 | 0 | 0      | 1 | 0 |

**Table 18: PLL1 and PLL2 Main Divider Register Bits  
for Synthesizer Programming Example**

|              |                  | MSB             |           |    |    |    |    |                  |    |    |    |    |    |           |                 |   |   | LSB |        |   |   |   |   |   |
|--------------|------------------|-----------------|-----------|----|----|----|----|------------------|----|----|----|----|----|-----------|-----------------|---|---|-----|--------|---|---|---|---|---|
| Data Word    | FIRST DATA WORD  |                 |           |    |    |    |    | SECOND DATA WORD |    |    |    |    |    |           | THIRD DATA WORD |   |   |     |        |   |   |   |   |   |
| Register Bit | 24               | 23              | 22        | 21 | 20 | 19 | 18 | 17               | 16 | 15 | 14 | 13 | 12 | 11        | 10              | 9 | 8 | 7   | 6      | 5 | 4 | 3 | 2 | 1 |
| Function     | Dummy/<br>Spacer | Program<br>Mode | B Counter |    |    |    |    |                  |    |    |    |    |    | A Counter |                 |   |   |     | Select |   |   |   |   |   |
| Data         | X                | X               | C         | C  | B  | B  | B  | B                | B  | B  | B  | B  | B  | B         | B               | A | A | A   | A      | A | A | S | S |   |
| PLL2         | 0                | 0               | 0         | 0  | 0  | 0  | 1  | 0                | 0  | 0  | 0  | 0  | 1  | 0         | 0               | 0 | 1 | 0   | 0      | 0 | 0 | 0 | 0 | 1 |
| PLL1         | 0                | 0               | 0         | 0  | 0  | 0  | 0  | 0                | 1  | 1  | 0  | 0  | 0  | 1         | 1               | 0 | 0 | 0   | 1      | 1 | 0 | 0 | 1 | 1 |



APPLICATION INFORMATION

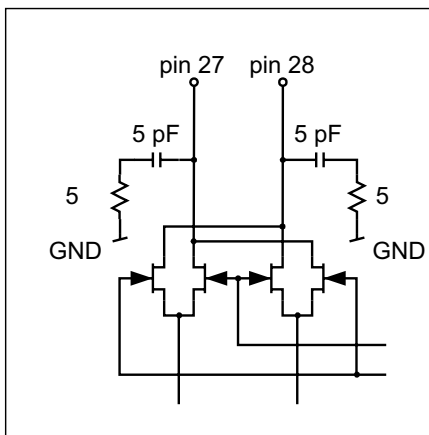
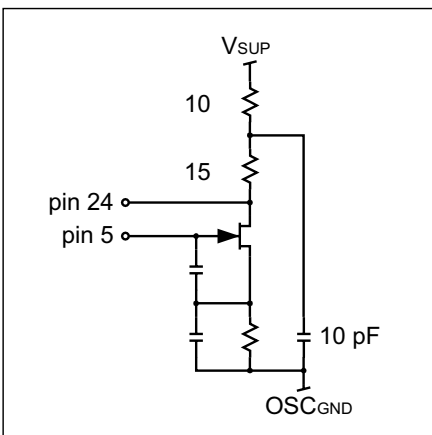
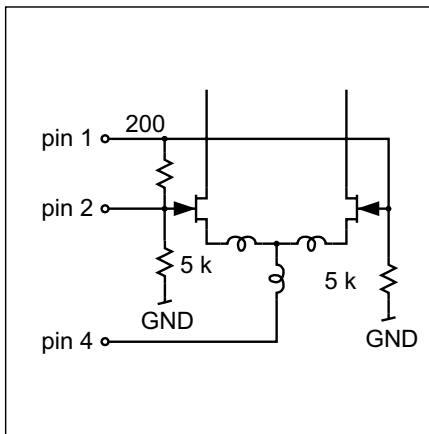
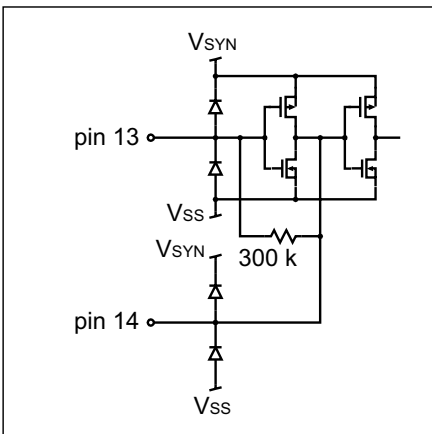
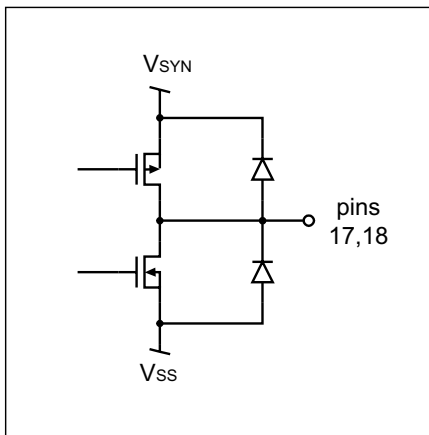
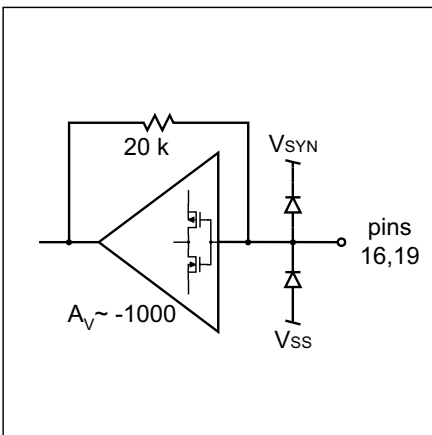


Figure 23: Equivalent Circuits

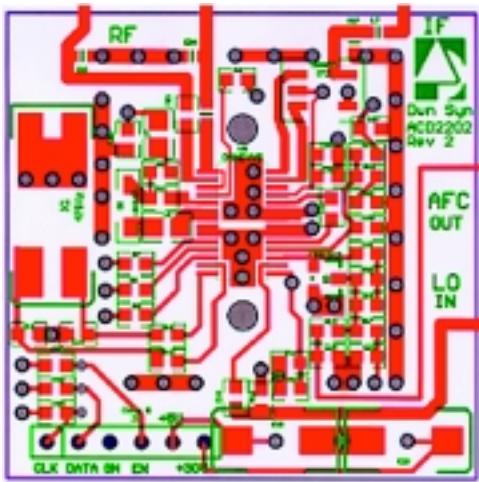


Figure 24: PC Board Layout Top View

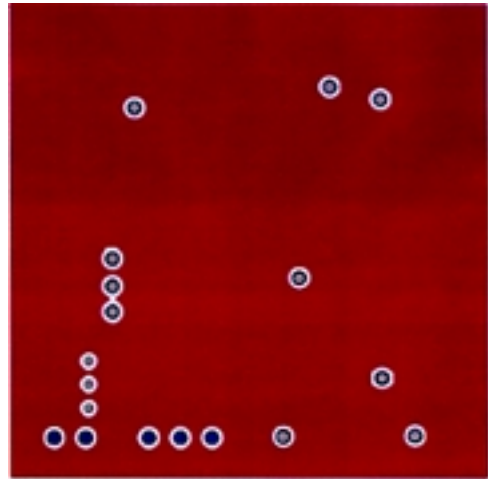


Figure 25: PC Board Layout Mid View

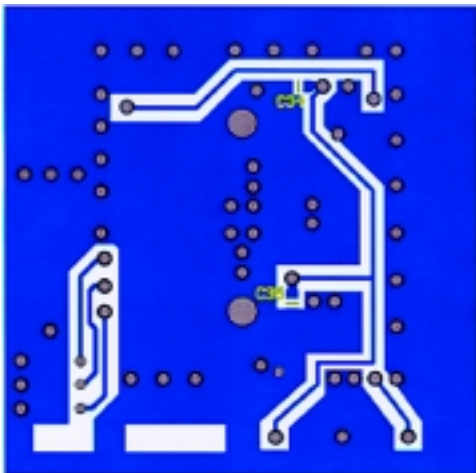


Figure 26: PC Board Layout Bottom View

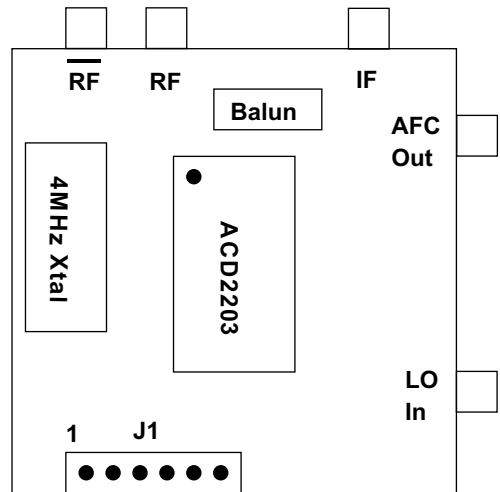


Figure 27: Evaluation Fixture

Table 19: J1 Header Pinout

| PIN | FUNCTION |
|-----|----------|
| 1   | Clock    |
| 2   | Data     |
| 3   | Ground   |
| 4   | AS       |
| 5   | +5 VDC   |
| 6   | +30 VDC  |

Table 20: Fixture Pinout

| PIN                    | FUNCTION                                   |
|------------------------|--|
| $\overline{\text{RF}}$ | Downconverter $\overline{\text{RF}}$ Input |
| RF                     | Downconverter RF Input                     |
| IF                     | IF Output (Single Ended)                   |
| AFC Out                | To Upconverter Oscillator Tuning Circuit   |
| LO In                  | Synthesizer $\text{RF}_u$ LO Input         |

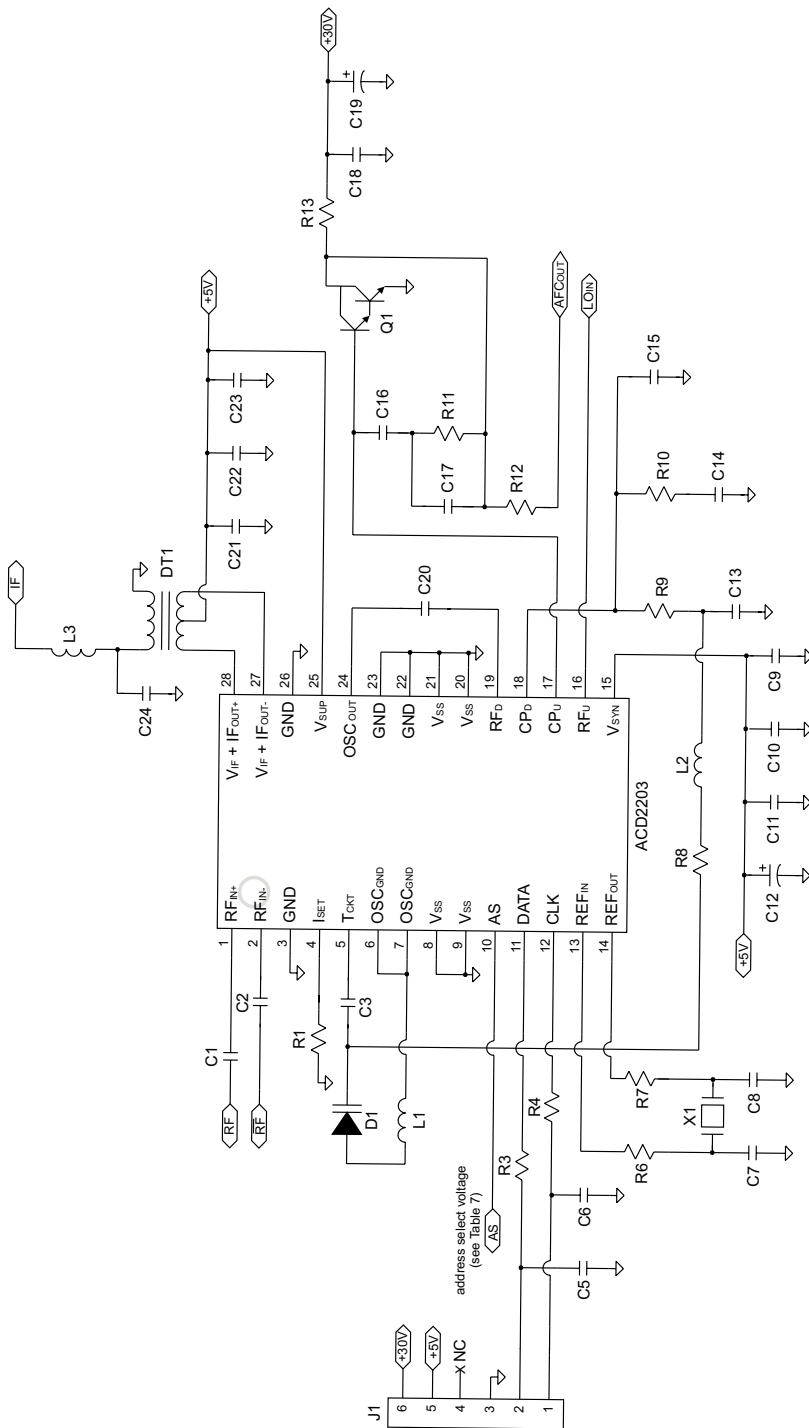


Figure 28: Evaluation Fixture Schematic

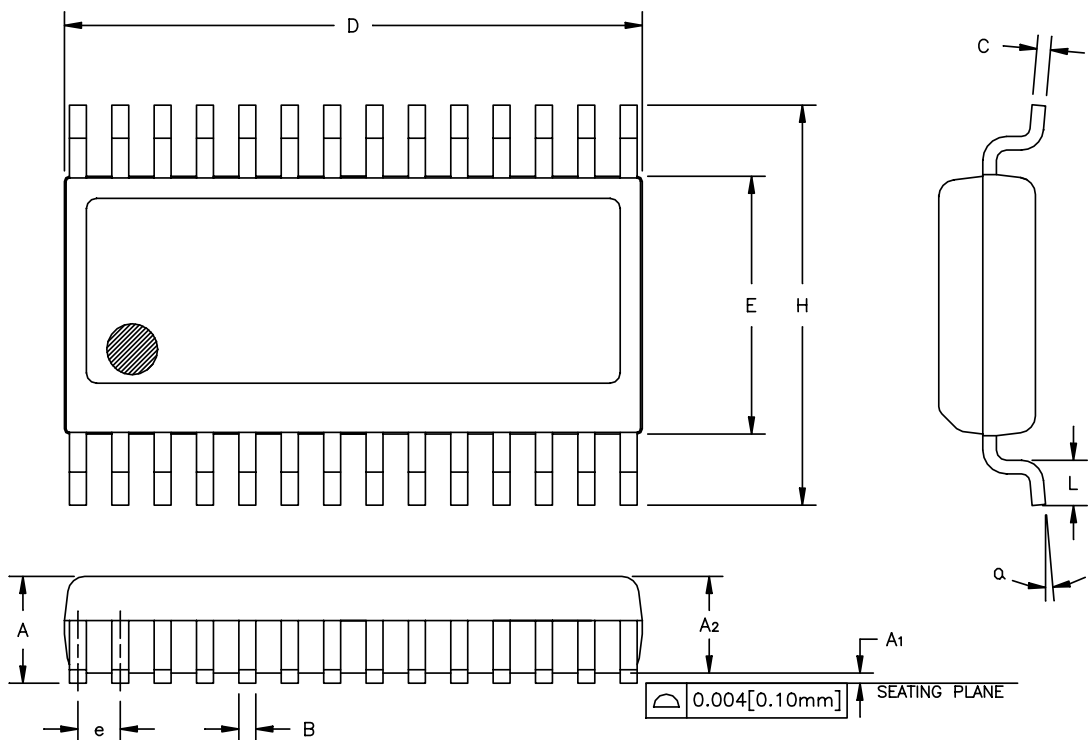
Table 21: Evaluation Fixture Parts List

| ITEM #                 | VALUE  | SIZE          | DESCRIPTION                | PART #               | QTY | VENDOR    |
|------------------------|--------|---------------|----------------------------|----------------------|-----|-----------|
| C1, C2, C20            | 100pF  | 0603          | Chip-capacitor             | GRM39COG101J50V      | 3   | Murata    |
| C3                     | 5pF    | 0603          | Chip-capacitor             | GRM39COG050C50V      | 1   | Murata    |
| C7, C8                 | 30pF   | 0603          | Chip-capacitor             | GRM39COG300J50V      | 2   | Murata    |
| C12                    | 220uF  | 10V VA Series | Capacitor                  | PCE2040CT-ND         | 1   | DIGI-KEY  |
| C9, C11, C14, C21, C22 | .1uF   | 0603          | Chip-capacitor             | GRM39Y5V104Z16V      | 5   | Murata    |
| C10, C23               | 1000pF | 0603          | Chip-capacitor             | GRM39X7R102K50V      | 2   | Murata    |
| C15, C17               | 4700pF | 0603          | Chip-capacitor             | GRM39X7R472K25V      | 2   | Murata    |
| C16                    | 1uF    | 0603          | Radial-lead Chip-capacitor | RPE113-X7R-105-K-050 | 1   | Murata    |
| C18                    | .01uF  | 0603          | Chip-capacitor             | GRM39X7R103K25V      | 1   | Murata    |
| C19                    | 10uF   | 35 V TANT     | TE Series Cap.             | PCS6106CT-ND         | 1   | DIGI-KEY  |
| C24                    | 15pF   | 0603          | Chip-capacitor             | GRM39COG150J50V      | 1   | Murata    |
| C13                    | 5600pF | 0603          | Chip-capacitor             | GRM39X7R562K50V      | 1   | Murata    |
| C5, C6                 | 33pF   | 0603          | Chip-capacitor             | GRM39COG330J50V      | 2   | Murata    |
| R8                     | 51     | 0603          | Chip Resistor              | ERJ-3GSYJ510         | 1   | Panasonic |
| R1                     | 10     | 0603          | Chip Resistor              | ERJ-3GSYJ100         | 1   | Panasonic |
| R3, R4                 | 2K     | 0603          | Chip Resistor              | ERJ-3GSYJ202         | 2   | Panasonic |
| R12                    | 1K     | 0603          | Chip Resistor              | ERJ-3GSYJ102         | 1   | Panasonic |
| R11                    | 2.7K   | 0603          | Chip Resistor              | ERJ-3GSYJ272         | 1   | Panasonic |
| R7                     | 3K     | 0603          | Chip Resistor              | ERJ-3GSYJ302         | 1   | Panasonic |
| R13                    | 22K    | 0603          | Chip Resistor              | ERJ-3GSYJ223         | 1   | Panasonic |
| R10                    | 8.2K   | 0603          | Chip Resistor              | ERJ-3GSYJ822         | 1   | Panasonic |
| R6, R9                 | 0      | 0603          | Chip Resistor              | ZC0603               | 2   | RCD       |
| L1                     | 6.8nH  | 0805          | Inductor                   | 0805CS-060X-BC       | 1   | Coilcraft |

Table 21: Evaluation Fixture Parts List continued

| ITEM # | VALUE      | SIZE   | DESCRIPTION             | PART #         | QTY | VENDOR                         |
|--------|------------|--------|-------------------------|----------------|-----|--------------------------------|
| L2     | 68nH       | 0805   | Inductor                | 0805CS-680X-BC | 1   | Coilcraft                      |
| L3     | 270nH      | 0805   | Inductor                | 0805CS-271X-BC | 1   | Coilcraft                      |
| D1     | 1SV245     |        | Varactor diode          | 1SV245         | 1   | Toshiba                        |
| DT1    | 4:1        |        | Transformer             | ETC4-1-2       | 1   | M/A-COM, Inc.<br>North America |
| Q1     | 30V<br>SMD | SOT-23 | Transistor NPN<br>Darl. | FMMTA13CT-ND   | 1   | DIGI-KEY                       |
| X1     | 4MHZ       |        | Crystal                 | SE2618CT-ND    | 1   | DIGI-KEY                       |

PACKAGE OUTLINE



| SYMBOL         | INCHES |       | MILLIMETERS |       | NOTE |
|----------------|--------|-------|-------------|-------|------|
|                | MIN.   | MAX.  | MIN.        | MAX.  |      |
| A              | 0.053  | 0.069 | 1.35        | 1.75  |      |
| A <sub>1</sub> | 0.004  | 0.010 | 0.10        | 0.25  |      |
| A <sub>2</sub> | —      | 0.059 | —           | 1.50  |      |
| B              | 0.008  | 0.012 | 0.20        | 0.30  |      |
| C              | 0.007  | 0.010 | 0.18        | 0.25  |      |
| D              | 0.386  | 0.394 | 9.80        | 10.00 | 2    |
| E              | 0.150  | 0.157 | 3.81        | 3.98  | 3    |
| e              | 0.025  | BSC   | 0.64        | BSC   | 4    |
| H              | 0.228  | 0.244 | 5.79        | 6.19  |      |
| L              | 0.016  | 0.050 | 0.40        | 1.27  |      |
| α              | 0°     | 8°    | 0°          | 8°    |      |

NOTES:

1. CONTROLLING DIMENSION: INCHES
2. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.006 [0.15mm] PER SIDE.
3. DIMENSION "E" DOES NOT INCLUDE INTER-LEAD FLASH OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED 0.010 [0.25mm] PER SIDE.
4. MAXIMUM LEAD TWIST/SKEW TO BE ±0.0035 [0.089mm].
5. REFERENCE JEDEC MO-137 AF.

Figure 29: S8 Package Outline - 28 Pin SSOP

NOTES

## ORDERING INFORMATION

| ORDER NUMBER | TEMPERATURE RANGE | PACKAGE DESCRIPTION      | COMPONENT PACKAGING               |
|--------------|-------------------|--------------------------|-----------------------------------|
| ACD2203S8P1  | -40°C to +85°C    | 28 Pin SSOP              | Tape & Reel, 3500 pieces per reel |
| ACD2203S8P0  | -40°C to +85°C    | 28 Pin SSOP              | Tubes, 50 pieces per tube         |
| ACD2203S8GP1 | -40°C to +85°C    | Lead-free<br>28 Pin SSOP | Tape & Reel, 3500 pieces per reel |
| ACD2203S8GP0 | -40°C to +85°C    | Lead-free<br>28 Pin SSOP | Tubes, 50 pieces per tube         |



**ANADIGICS, Inc.**

141 Mount Bethel Road

Warren, New Jersey 07059, U.S.A

Tel: +1 (908) 668-5000

Fax: +1 (908) 668-5132

URL: <http://www.anadigics.com>

E-mail: [Mktg@anadigics.com](mailto:Mktg@anadigics.com)

#### IMPORTANT NOTICE

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