PLL Frequency Synthesizer

Preliminary Technical Data ADF4116/ADF4117/ADF4118

FEATURES

ADF4116: 550 MHz
ADF4117: 1.2 GHz
ADF4118: 2.8 GHz
+2.7 V to +5.5 V Power Supply
Dual Modulus Prescaler
ADF4116: 8/9
ADF4117/ADF4118: 32/33
3-Wire Serial Interface
Digital Lock Detect
Power Down Mode
Fastlock Mode

APPLICATIONS

Base Stations for Mobile Radio (GSM, PCS, DCS, WCDMA)
Wireless Handsets (GSM, PCS, DCS, WCDMA)
Wireless Local Area Networks (WLANs)
Communications Test Equipment
Cable TV Tuners (CATV)

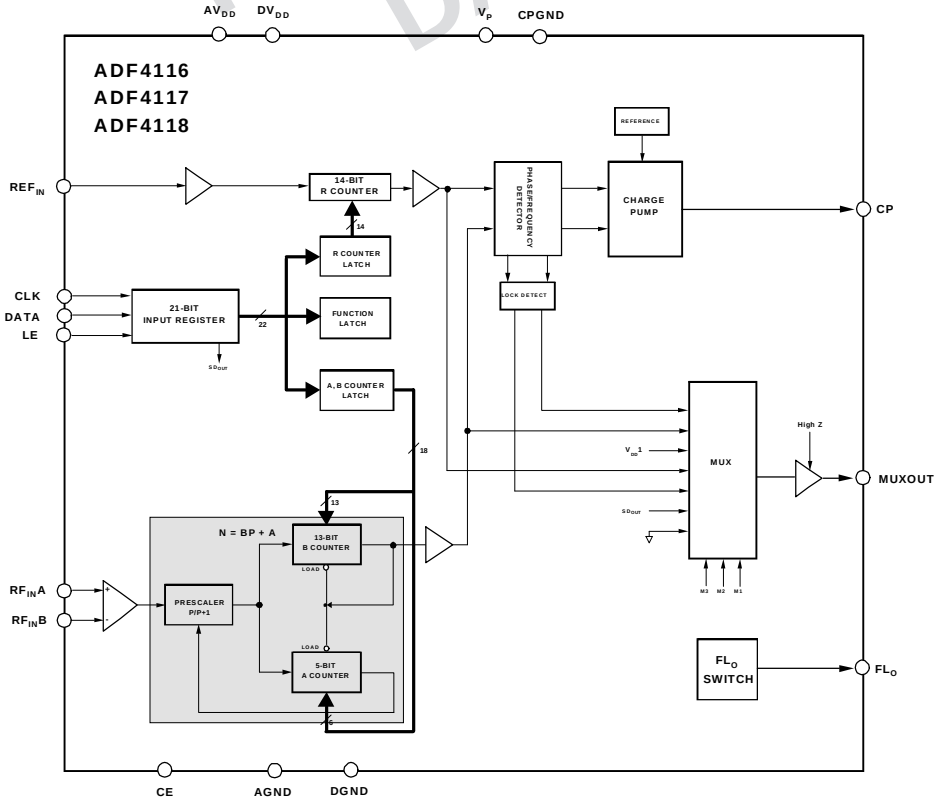
GENERAL DESCRIPTION

The ADF4116/ADF4117/ADF4118 are frequency synthesizers which can be used to implement local oscillators in the up-conversion and down-conversion sections of wireless receivers and transmitters. They consist of a low-noise digital PFD (Phase Frequency Detector), a precision charge pump, a programmable reference divider, programmable A and B counters and a dual-modulus prescaler (P/P+1). The A (5-bit) and B (13-bit) counters, in conjunction with the dual modulus prescaler (P/P+1), implement an N divider (N= BP+A). In addition, the 14-bit reference counter (R Counter), allows selectable REFIN frequencies at the PFD input. A complete PLL (Phase-Locked Loop) can be implemented if the synthesizer is used with an external loop filter and VCO (Voltage Controlled Oscillator)

Control of all the on-chip registers is via a simple 3-wire interface.

The devices operate with a 2.7V (± 10%) or 5V(± 10%) power supply and can be powered down when not in use.

FUNCTIONAL BLOCK DIAGRAM



REV.PrG 10/99

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ADF4116/7/8 – SPECIFICATIONS[1]

(V_{DD}, V_P = +5 V ± 10%, +3 V ± 10%; GND = 0 V; T_A = T_{MIN} to T_{MAX} unless otherwise noted)

Parameter	B Version	BChips	Units	Test Conditions/Comments
RF CHARACTERISTICS				
RF Input Frequency				See Figure 3 for input circuit.
ADF4116	25/550	25/550	MHz min/max	
ADF4117	0.1/1.2	0.1/1.2	GHz min/max	
ADF4118	0.1/2.8	0.1/2.8	GHz min/max	
Reference Input Frequency	0/150	0/150	MHz min/max	
Phase Detector Frequency	55	55	MHz max	
RF Input Sensitivity	-15/0	-15/0	dBm min/max	3V Power Supply
	-10/0	-10/0	dBm min/max	5V Power Supply
Reference Input Sensitivity	-5	-5	dBm min	DC Coupled Max: 0 to V_{DD}
CHARGE PUMP				
I_{CP} sink/source				
High Value	1	1	mA typ	
Low Value	250	250	µA typ	
Absolute Accurcay	2	2	% typ	
	5	5	% max	
I_{CP} Three State Current	1	1	nA max	
Sink and Source Current Matching	2	2	% typ	$0.5V < V_{CP} < V_P - 0.5$
I_{CP} vs. V_{CP}	2	2	% typ	$0.5V < V_{CP} < V_P - 0.5$
I_{CP} vs. Temperature	2	2	% typ	$V_{CP} = V_P/2$
LOGIC INPUTS				
V_{INH}, Input High Voltage	$0.8*V_{DD}$	$0.8*V_{DD}$	V min	
V_{INL}, Input Low Voltage	$0.2*V_{DD}$	$0.2*V_{DD}$	V max	
I_{INH}/I_{INL}, Input Current	±1	±1	µA max	
C_{IN}, Input Capacitance	10	10	pF max	
Oscillator Input Current	±100	±100	µA max	
LOGIC OUTPUTS				
V_{OH}, Output High Voltage	V_{DD} - 0.4	V_{DD} - 0.4	V min	I_{OH} = 1mA
V_{OL}, Output Low Voltage	0.4	0.4	V max	I_{OL} = 1mA
POWER SUPPLIES				
AV_{DD}	2.7/5.5	2.7/5.5	V min/V max	
DV_{DD}	AV_{DD}	AV_{DD}		
V_P	AV_{DD}/5.5	AV_{DD}/5.5	V min/V max	
I_{DD} (AI_{DD} + DI_{DD})				
ADF4116	2.0	2.0	mA max	
ADF4117	4.2	4.2	mA max	
ADF4118	6.5	6.5	mA max	
Low Power Sleep Mode	1	1	µA typ	

NOTES
1. Operating temperature range is as follows: B Version: –40°C to +85°C.
2. The BChip specifications are given as typical values.
3. Guaranteed by deign. Sample tested to ensure compliance.

ADF4116/7/8 – SPECIFICATIONS[1]

(V_{DD}, V_P = +5 V ± 10%, +3 V ± 10%; GND = 0 V; T_A = T_{MIN} to T_{MAX} unless otherwise noted)

Parameter	B Version	BChips	Units	Test Conditions/Comments
NOISE CHARACTERISTICS				
Phase Noise Floor	-171	-171	dBc/Hz typ	@ 25kHz PFD Frequency
	-163	-163	dBc/Hz typ	@ 200kHz PFD Frequency
Phase Noise Performance[2]				@ VCO Output
ADF4116[3]	-94	-94	dBc/Hz typ	
ADF4117[4]	-90	-90	dBc/Hz typ	
ADF4117[5]	-82	-82	dBc/Hz typ	
ADF4118[6]	-83	-83	dBc/Hz typ	
ADF4118[7]	-68	-68	dBc/Hz typ	
ADF4118[8]	-83	-83	dBc/Hz typ	
Spurious Signals				Measured at offset of $f_{PFD}/2f_{PFD}$
ADF4116[3]	-80/-84	-80/-84	dB typ	
ADF4117[4]	-80/-84	-80/-84	dB typ	
ADF4117[5]	-80/-84	-80/-84	dB typ	
ADF4118[6]	-80/-84	-80/-84	dB typ	
ADF4118[7]	-78/-82	-78/-82	dB typ	
ADF4118[8]	-78/-82	-78/-82	dB typ	

NOTES

1 Operating temperature range is as follows: B Version: –40°C to +85°C.

2 The synthesizer phase noise floor is estimated by measuring the in-band phase noise at the output of the VCO and subtracting 20logN (where N is the divider value). The phase nois is measured with the EVAL-ADF411XEB Evaluation Board and the HP8562E Spectrum Analyzer. The spectrum analyzer provides the REFIN for the synthesizer. (f_{REFOUT} = 10MHz @ 0dBm)

3. f_{REFIN} = 10 MHz; f_{PFD} = 200 kHz; Offset frequency = 1 kHz; f_{RF} = 540MHz; N = 2700; Loop B/W = 20kHz
4. f_{REFIN} = 10 MHz; f_{PFD} = 200 kHz; Offset frequency = 1 kHz; f_{RF} = 900MHz; N = 4500; Loop B/W = 20kHz
5. f_{REFIN} = 10 MHz; f_{PFD} = 30kHz; Offset frequency = 300 Hz; f_{RF} = 836MHz; N = 27867; Loop B/W = 3kHz
6. f_{REFIN} = 10 MHz; f_{PFD} = 200kHz; Offset frequency = 1 kHz; f_{RF} = 1750MHz; N = 8750; Loop B/W = 20kHz
7. f_{REFIN} = 10 MHz; f_{PFD} = 10kHz; Offset frequency = 200 Hz; f_{RF} = 1750MHz; N = 175000; Loop B/W = 1kHz
8. f_{REFIN} = 10 MHz; f_{PFD} = 200kHz; Offset frequency = 1 kHz; f_{RF} = 1960MHz; N = 9800; Loop B/W = 20kHz

Specifications subject to change without notice.

ORDERING GUIDE

Model	Temperature Range	Package Option*
ADF4116BRU	–40°C to +85°C	RU-16
ADF4116BCP	–40°C to +85°C	CP-24
ADF4117BRU	–40°C to +85°C	RU-16
ADF4117BCP	–40°C to +85°C	CP-24
ADF4118BRU	–40°C to +85°C	RU-16
ADF4118BCP	–40°C to +85°C	CP-24

* RU = Thin Shrink Small Outline Package (TSSOP)
CP = Chip Scale Package
Contact the factory for chip availability

TIMING CHARACTERISTICS (V_{DD} = +5 V 10%, +3 V ± 10%; GND = 0 V, unless otherwise noted)

Parameter	Limit at T_{MIN} to T_{MAX} (B Version)	Units	Test Conditions/Comments
t_1	10	ns min	DATA to CLOCK Set Up Time
t_2	10	ns min	DATA to CLOCK Hold Time
t_3	25	ns min	CLOCK High Duration
t_4	25	ns min	CLOCK Low Duration
t_5	10	ns min	CLOCK to LE Set Up Time
t_6	20	ns min	LE Pulse Width

NOTE
Guaranteed by Design but not Production Tested.

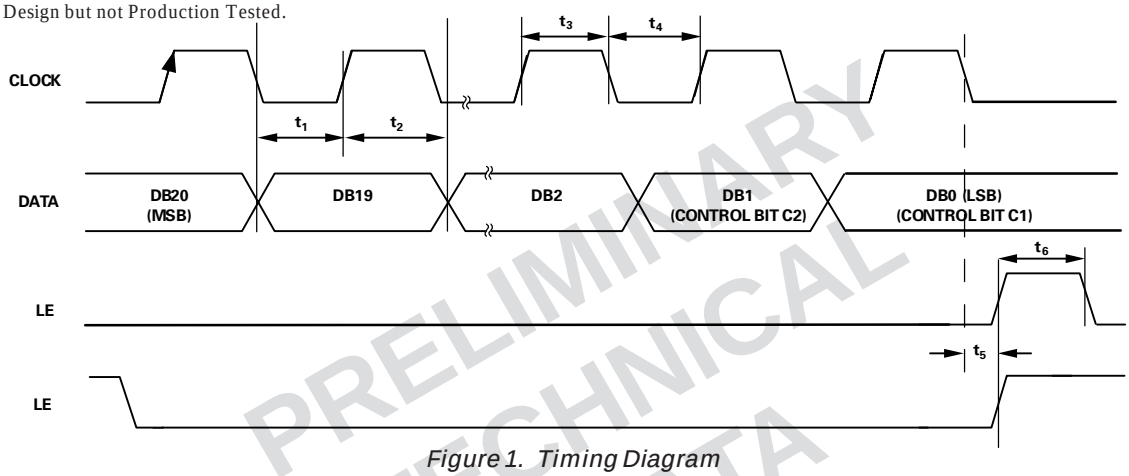


Figure 1. Timing Diagram

ABSOLUTE MAXIMUM RATINGS[1, 2]
(T_A = +25°C unless otherwise noted)

AV_{DD} to GND ..... –0.3 V to +7 V
AV_{DD} to DV_{DD} ..... –0.3 V to +0.3 V
V_P to GND ..... –0.3 V to +7 V
V_P to V_{DD} ..... –0.3 V to +5.5 V
Digital I/O Voltage to GND ..... –0.3 V to V_{DD} + 0.3 V
Analog I/O Voltage to GND ..... –0.3 V to V_p + 0.3 V
Operating Temperature Range
Industrial (B Version) ..... –40°C to +85°C
Storage Temperature Range ..... –65°C to +150°C
Maximum Junction Temperature ..... +150°C
TSSOP θ_{JA} Thermal Impedance ..... 150.4°C/W
CSP θ_{JA} Thermal Impedance ..... TBD°C/W
Lead Temperature, Soldering
Vapor Phase (60 sec) ..... +215°C
Infrared (15 sec) ..... +220°C

1. Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. This device is a high-performance RF integrated circuit with an ESD rating of < 2kV and it is ESD sensitive. Proper precautions should be taken for handling and assembly.

CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this device features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

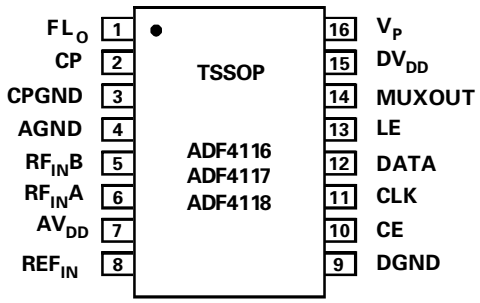
PIN DESCRIPTION

Mnemonic	Function
FL_O	Fast Lock Switch Output. This can be used to switch an external resistor to change the loop filter bandwidth. This will speed up locking of the PLL.
CP	Charge Pump Output. This is normally connected to a loop filter which drives the input to an external VCO.
CPGND	Charge Pump Ground
AGND	Analog Ground
$RF_{IN}B$	Complementary Input to the RF Prescaler. This point should be decoupled to the ground plane with a small bypass capacitor. If this is not done then there will be some degradation in RF sensitivity.
$RF_{IN}A$	Input to the RF Prescaler. This small signal input is normally taken from the VCO.
AV_{DD}	Analog Power Supply. This may range from 2.7V to 5.5V. Decoupling capacitors to the analog ground plane should be placed as close as possible to this pin. AV_{DD} must be the same value as DV_{DD}.
REF_{IN}	Reference Input. This is a CMOS input with a nominal threshold of $AV_{DD}/2$ and an equivalent input resistance of 100kΩ. See Figure 2. The oscillator input can be driven from a TTL or CMOS crystal oscillator.
DGND	Digital Ground.
CE	Chip Enable. A logic low on this pin powers down the device and puts the charge pump output into three-state mode. Taking the pin high will power up the device depending on the status of the power-down bit F2.
CLK	Serial Clock Input. This serial clock is used to clock in the serial data to the registers. The data is latched into the 21-bit shift register on the CLK rising edge. This input is a high impedance CMOS input.
DATA	Serial Data Input. The serial data is loaded MSB first with the two LSBs being the control bits. This input is a high impedance CMOS input.
LE	Load Enable, CMOS Input. When LE goes high, the data stored in the shift registers is loaded into one of the four latches, the latch being selected using the control bits.
MUXOUT[1]	This multiplexer output allows either the Lock Detect, the scaled RF or the scaled Reference Frequency to be accessed externally.
DV_{DD}	Digital Power Supply. This may range from 2.7V to 5.5V. Decoupling capacitors to the digital ground plane should be placed as close as possible to this pin. DV_{DD} must be the same value as AV_{DD}.
V_P	Charge Pump Power Supply. This should be greater than or equal to V_{DD}. In systems where V_{DD} is 3V, it can be set to 5V and used to drive a VCO with a tuning range of up to 5V

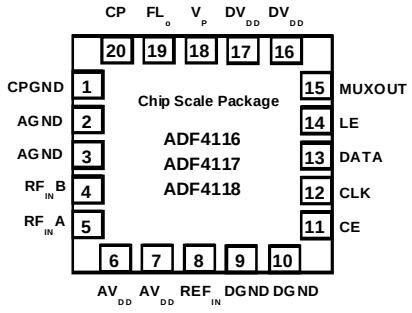
NOTES
1. MUXOUT is also used for Test Modes on the devices. These Test modes will be detailed in TNXXX available from Analog Devices Inc.

PIN CONFIGURATION

TOP VIEW



TOP VIEW



TRANSISTOR COUNT: 6425 (CMOS) and 303 (Bipolar).

CIRCUIT DESCRIPTION

REFERENCE INPUT SECTION

The Reference Input stage is shown below in Figure 2. SW1 and SW2 are normally-closed switches. SW3 is

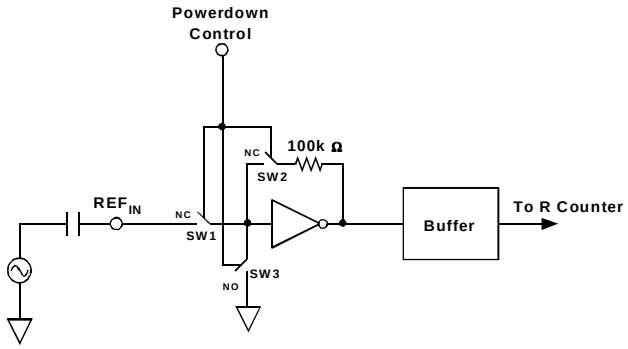


Figure 2. Reference Input Stage

normally-open. When Powerdown is initiated, SW3 is closed and SW1 and SW2 are opened. This ensures that there is no loading of the REF_{IN} pin on powerdown.

RF INPUT STAGE

The RF input stage is shown in Figure 3. It is followed by a 2-stage limiting amplifier to generate the CML clock levels needed for the prescaler.

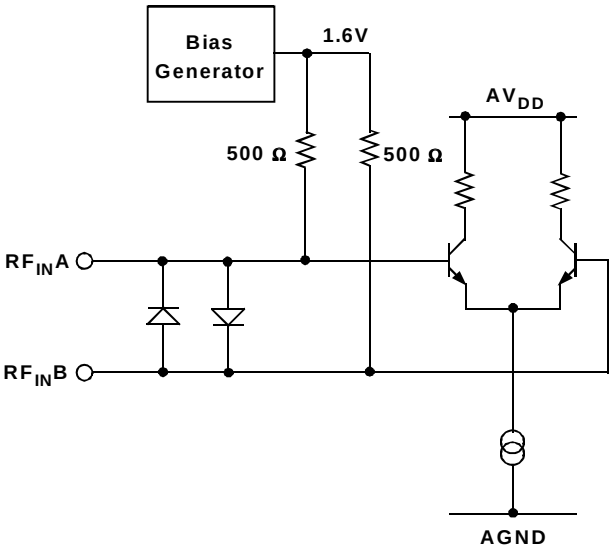


Figure 3. RF Input Stage

PRESCALER

The dual-modulus prescaler takes the CML clock from the RF input stage and divides it down to a manageable frequency for the CMOS A and B counters. The prescaler is set to 8/9 for the ADF4116, and set to 32/33 for the ADF4117 & ADF4118. It is based on a synchronous 4/5 core.

A AND B COUNTERS

The A and B CMOS counters combine with the dual modulus prescaler to allow a wide ranging division ratio in the PLL feedback counter. Prescaler values should be chosen so that the prescaler output frequency (input frequency to the CMOS counters) is always less than or equal to 125MHz. Thus, with an RF input frequency of 2GHz, a prescaler value of 16/17 is valid but a value of 8/9 is not valid.

Pulse Swallow Function

The Prescaler and A & B Counters are shown in Figure 4. The A and B counters, in conjunction with the dual modulus prescaler make it possible to generate output frequencies which are spaced only by the Reference Frequency divided by R . The equation for the VCO frequency is as follows:

$$f_{VCO} = [(P \times B) + A] \times f_{REFIN}/R$$

f_{VCO}: Ouput Frequency of external voltage controlled oscillator (VCO).

P: Preset modulus of dual modulus prescaler.

B: Preset Divide Ratio of binary 13-bit counter (1 to 8191).

A: Preset Divide Ratio of binary 5-bit swallow counter.

f_{REFIN}: Ouput frequency of the external reference frequency oscillator.

R: Preset divide ratio of binary 14-bit programmable reference counter (1 to 16383).5

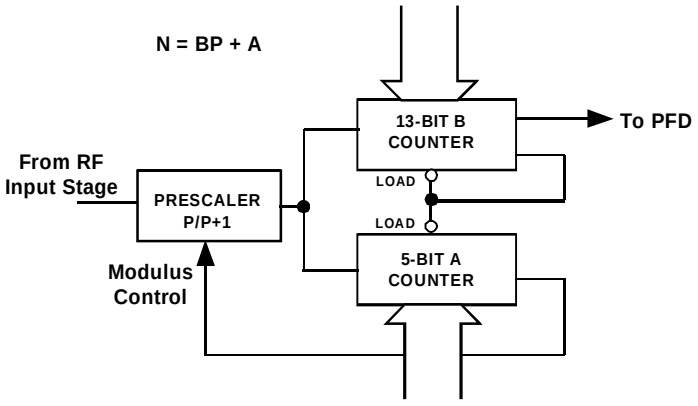


Figure 4. A and B Counters

R COUNTER

The 14-bit R counter allows the input reference frequency to be divided down to produce the input clock to the phase frequency detector (PFD). Division ratios from 1 to 16,383 are allowed.

PHASE FREQUENCY DETECTOR (PFD) AND CHARGE PUMP

The PFD takes inputs from the R counter and N counter and produces an output proportional to the phase and frequency difference between them. Figure 4 is a simplified schematic. The PFD includes a fixed delay element

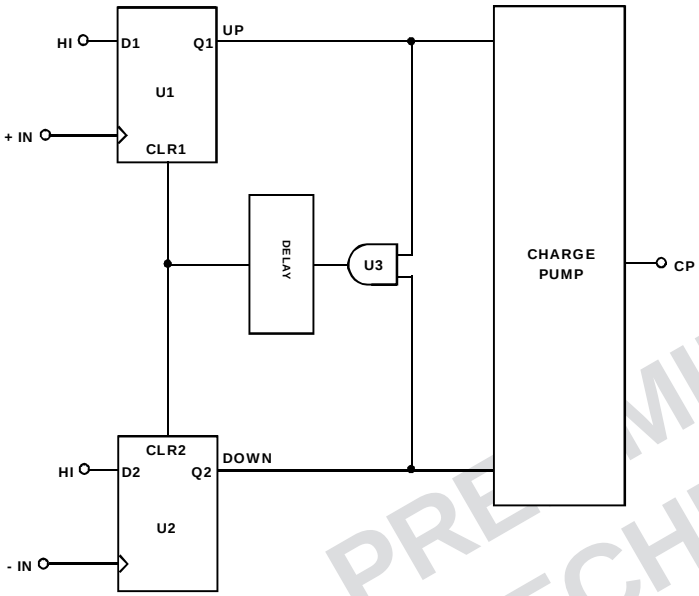


Figure 5. PFD Simplified Schematic

which sets the width of the anti-backlash pulse. This is typically 2.9ns. This pulse ensures that there is no deadzone in the PFD transfer function and gives a consistent reference spur level.

INPUT SHIFT REGISTER

The ADF4116 family digital section includes a 21-bit input shift register, a 14-bit R counter and a 18-bit N counter, comprising a 5-bit A counter and a 13-bit B counter. Data is clocked into the 21-bit shift register on each rising edge of CLK. The data is clocked in MSB first. Data is transferred from the shift register to one of four latches on the rising edge of LE. The destination latch is determined by the state of the two control bits (C2, C1) in the shift register. These are the two lsb's DB1, DB0 as shown in the timing diagram of Figure 1. The truth table for these bits is shown in Table 6. Table 1 shows a summary of how the latches are programmed.

Table 1. C2, C1 Truth Table

Control Bits C2	C1	Data Latch
0	0	R Counter
0	1	N Counter (A and B)
1	0	Function Latch
1	1	Initialization Latch

Table 2. ADF4116 Family Latch Summary

Reference Counter Latch

Lock Detect Precision	Test Mode Bits				14-Bit Reference Counter													Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
LDP	T4	T3	T2	T1	R14	R13	R12	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1	C2 (0)	C1 (0)

N Counter Latch

CP Gain	13-Bit B Counter													5-Bit A Counter					Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
G1	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	A5	A4	A3	A2	A1	C2 (0)	C1 (1)

Function Latch

	Power Down 2				Timer Counter Control				FastLock Mode		Fastlock Enable	CP 3-State	PD Polarity	MUXOUT Control			Power Down 1	Counter Reset	Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
	PD2				TC4	TC3	TC2	TC1	F6	F5	F4	F3	F2	M3	M2	M1	PD1	F1	C2 (1)	C1 (0)

Initialization Latch

	Power Down 2				Timer Counter Control				FastLock Mode		Fastlock Enable	CP 3-State	PD Polarity	MUXOUT Control			Power Down 1	Counter Reset	Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
	PD2				TC4	TC3	TC2	TC1	F6	F5	F4	F3	F2	M3	M2	M1	PD1	F1	C2 (1)	C1 (1)

REFERENCE COUNTER LATCH

Table 3. Reference Counter Latch Map

Lock Detect Precision	Test Mode Bits				14-Bit Reference Counter														Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
LDP	T4	T3	T2	T1	R14	R13	R12	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1	C2 (0)	C1 (0)

R14	R13	R12	.....	R3	R2	R1	Divide Ratio
0	0	0	.....	0	0	1	1
0	0	0	.....	0	1	0	2
0	0	0	.....	0	1	1	3
0	0	0	.....	1	0	0	4
.	.	.	.....	.	.	.	.
.	.	.	.....	.	.	.	.
.	.	.	.....	.	.	.	.
1	1	1	.....	1	0	0	16380
1	1	1	.....	1	0	1	16381
1	1	1	.....	1	1	0	16382
1	1	1	.....	1	1	1	16383

Test Mode Bits should be set to 0000 for Normal Operation

LDP	Operation
0	3 consecutive cycles of phase delay less than 15ns must occur before lock detect is set.
1	5 consecutive cycles of phase delay less than 15ns must occur before lock detect is set.

N COUNTER LATCH

Table 4. N Counter Latch Map

CP Gain	13-Bit B Counter													5-Bit A Counter					Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
G1	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	A5	A4	A3	A2	A1	C2 (0)	C1 (1)

ADF4116

A5	A4	A3	A2	A1	A Counter Divide Ratio
X	X	0	0	0	0
X	X	0	0	1	1
.	.	.	.	.	.
.	.	.	.	.	.
X	X	1	1	0	6
X	X	1	1	1	7

ADF4117 / ADF4118

A5	A4	A3	A2	A1	A Counter Divide Ratio
0	0	0	0	0	0
0	0	0	0	1	1
0	0	0	1	0	2
.	.	.	.	.	.
.	.	.	.	.	.
1	1	1	0	1	29
1	1	1	1	0	30
1	1	1	1	1	31

B13	B12	B11	.....	B3	B2	B1	B Counter Divide Ratio
0	0	0	.....	0	0	1	1
0	0	0	.....	0	1	0	2
0	0	0	.....	0	1	1	3
0	0	0	.....	1	0	0	4
.	.	.	.....	.	.	.	.
.	.	.	.....	.	.	.	.
.	.	.	.....	.	.	.	.
1	1	1	.....	1	0	0	8188
1	1	1	.....	1	0	1	8189
1	1	1	.....	1	1	0	8190
1	1	1	.....	1	1	1	8191

G1	Current Setting
0	250uA
1	1mA

N = BP + A, P is prescaler value set in the Function Latch
B must be greater than or equal to A
For contiguous values of N, N_{MIN} is $(P^2 - P)$

FUNCTION LATCH

Table 5. Function Latch Map

	Power Down 2				Timer Counter Control				FastLock Mode		Fastlock Enable	CP 3-State	PD Polarity	MUXOUT Control			Power Down 1	Counter Reset	Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
	PD2				TC4	TC3	TC2	TC1	F6	F5	F4	F3	F2	M3	M2	M1	PD1	F1	C2 (1)	C1 (0)

CE Pin	PD2	PD1	Mode
0	X	X	Asynchronous Power-Down
1	X	0	Normal Operation
1	0	1	Asynchronous Power-Down
1	1	1	Synchronous Power-Down

F1	Counter Operation
0	Normal
1	R, A, B Counters Held in Reset

M3	M2	M1	Output
0	0	0	3-State Output
0	0	1	Digital Lock Detect
0	1	0	N Divider Output
0	1	1	AV_{DD}
1	0	0	R Divider Output
1	0	1	N-Channel Open-Drain Lock Detect
1	1	0	Serial Data Output
1	1	1	DGND

F3	PD Polarity
0	Negative
1	Positive

F3	Charge Pump Output
0	Normal
1	3-State

F4	F6	Fastlock Mode
0	X	Fastlock Disabled
1	0	Fastlock Mode 1
1	1	Fastlock Mode 2

TC4	TC3	TC2	TC1	Timeout (PFD Cycles)
0	0	0	0	3
0	0	0	1	7
0	0	1	0	11
0	0	1	1	15
0	1	0	0	19
0	1	0	1	23
0	1	1	0	27
0	1	1	1	31
1	0	0	0	35
1	0	0	1	39
1	0	1	0	43
1	0	1	1	47
1	1	0	0	51
1	1	0	1	55
1	1	1	0	59
1	1	1	1	63

INITIALIZATION LATCH

Table 6. Initialization Latch Map

	Power Down 2				Timer Counter Control				FastLoc Mod		Fastlock Enable	CP 3-State	PD Polarity	MUXOUT Control			Power Down 1	Counter Reset	Control Bits	
DB20	DB19	DB18	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
	PD2				TC4	TC3	TC2	TC1	F6	F5	F4	F3	F2	M3	M2	M1	PD1	F1	C2 (1)	C1 (1)

CE Pin	PD2	PD1	Mode
0	X	X	Asynchronous Power-Down
1	X	0	Normal Operation
1	0	1	Asynchronous Power-Down
1	1	1	Synchronous Power-Down

F1	Counter Operation
0	Normal
1	R, A, B Counters Held in Reset

M3	M2	M1	Output
0	0	0	3-State Output
0	0	1	Digital Lock Detect
0	1	0	N Divider Output
0	1	1	AV_{DD}
1	0	0	R Divider Output
1	0	1	N-Channel Open-Drain Lock Detect
1	1	0	Serial Data Output
1	1	1	DGND

F3	PD Polarity
0	Negative
1	Positive

F3	Charge Pump Output
0	Normal
1	3-State

F4	F6	Fastlock Mode
0	X	Fastlock Disabled
1	0	Fastlock Mode
1	1	Fastlock Mode

TC4	TC3	TC2	TC1	Timeout (PFD Cycles)
0	0	0	0	3
0	0	0	1	7
0	0	1	0	11
0	0	1	1	15
0	1	0	0	19
0	1	0	1	23
0	1	1	0	27
0	1	1	1	31
1	0	0	0	35
1	0	0	1	39
1	0	1	0	43
1	0	1	1	47
1	1	0	0	51
1	1	0	1	55
1	1	1	0	59
1	1	1	1	63

THE FUNCTION LATCH

With C2, C1 set to 1,0, the on-chip function latch will be programmed. Table 5 shows the input data format for programming the Function Latch.

Counter Reset

DB2 is the counter reset bit for the ADF4116 family . When this is "1", the R counter and the A,B counters are reset. For normal operation this bit should be "0". *Upon powering up, the F1 bit needs to be disabled, the N counter resumes counting in "close" alignment with the R counter. (The maximum error is one prescaler cycle).*

Power Down

F2 and F18 on the ADF4116, provide programmable power-down modes. They are enabled by the CE pin. When the CE pin is low, the device is immediately disabled regardless of the states of PD2, PD1.

In the programmed asynchronous power-down, the device powers down immediately after latching a "1" into bit PD1, with the condition that PD2 has been loaded with a "0".

In the programmed synchronous power-down, the device power down is gated by the charge pump to prevent unwanted frequency jumps. Once the power-down is enabled by writing a "1" into bit PD1 (on condition that a "1" has also been loaded to PD2), then the device will go into power-down after the first successive charge pump event.

When a power down is activated (either synchronous or asynchronous mode including CE-pin-activated power down), the following events occur:

All active DC current paths are removed.

The R, N and timeout counters are forced to their load state conditions.

The charge pump is forced into three-state mode.

The digital clock detect circuitry is reset.

The RF_{IN} input is debiased to a high impedance state.

The oscillator input buffer circuitry is disabled.

The input register remains active and capable of loading and latching data.

MUXOUT Control

The on-chip multiplexer is controlled by F5, F4 and F3 on the an ADF4116 family. Table 5 shows the truth table.

Phase Detector Polarity

F6 in the ADF4116 sets the Phase Detector Polarity. When the VCO characteristics are positive this should be set to "1". When they are negative it should be set to "0".

Charge Pump Three-State

This bit puts the charge pump into three-state mode when programmed to a "1". It should be set to "0" for normal operation.

Fastlock Enable Bit

DB9 of the Function Latch in the ADF4116 familiy is the Fastlock Enable Bit. Only when this is "1" is Fastlock enabled.

Fastlock Mode Bit

DB11 of the Function Latch in the ADF4116 family is the Fastlock Mode bit. When Fastlock is enabled, this bit determines which Fastlock Mode is used. If the Fastlock Mode bit is "0" then Fastlock Mode 1 is selected and if the Fastlock Mode bit is "1", then Fastlock Mode 2 is selected.

If Fastlock is not enabled (DB9 = "0"), then DB11 (ADF4116) determines the state of the FL_O output. FL_O state will be the same as that programmed to DB11.

Fastlock Mode 1

In the ADF4116 family, the output level of FL_O is programmed to a low state and the charge pump current is switched to the high value (1mA). FL_O is used to switch a resistor in the loop filter and ensure stability while in Fastlock by altering the loop bandwidth.

The device enters Fastlock by having a "1" written to the CP Gain bit in the N register. The device exits Fastlock by having a "0" written to the CP Gain bit in the N register.

Fastlock Mode 2

In the ADF4116 family, the output level of FL_O is programmed to a low state and the charge pump current is switched to the high value (1mA). FL_O is used to switch a resistor in the loop filter and ensure stability while in Fastlock by altering the loop bandwidth.

The device enters Fastlock by having a "1" written to the CP Gain bit in the N register. The device exits Fastlock under the control of the Timer Counter. After the timeout period determined by the value in TC4 - TC1, the CP Gain bit in the N register is automatically reset to "0" and the device reverts to normal mode instead of Fastlock.

Timer Counter Control
In the ADF4116 family, the user has the option of switching between two charge pump current values to speed up locking to a new frequency.

When using the Fastlock feature with the ADF4116 family, the normal sequence of events is as follows:

The user must make sure that Fastlock is enabled. Set DB9 of the ADF4116 family to "1". The user must also choose which Fastlock Mode to use. As discussed in the previous section, Fastlock Mode 2 uses the values in the Timer Counter to determine the timeout period before reverting to normal mode operation after Fastlock. Fastlock Mode 2 is chosen by setting DB11 of the ADF4116 family to "1".

The user must also decide how long they want the high current (1mA) to stay active before reverting to low current (250uA). This is controlled by the Timer Counter Control Bits DB14 to DB11 (TC4 - TC1) in the Function Latch. The truth table is given in Table 5.

Now, when the user wishes to program a new output frequency, they can simply program the A,B counter latch with new values for A and B. At the same time they can set the CP Gain bit to a "1" ,which sets the charge pump 1mA for a period of time determined by TC4 - TC1. When this time is up, the charge pump current reverts to 250uA. At the same time the CP Gain Bit in the A, B Counter latch is reset to 0 and is now ready for the next time that the user wishes to change the frequency again.

The Initialization Latch
When C2, C1 = 1, 1 then the Initialization Latch is programmed. This is essentially the same as the Function Latch (programmed when C2, C1 = 1, 0).

However, when the Initialization Latch is programmed there is a additional internal reset pulse applied to the R and N counters. This pulse ensures that the N counter is at load point when the N counter data is latched and the device will begin counting in close phase alignment.

If the Latch is programmed for synchronous powerdown (CE pin is High; PD1 bit is High; PD2 bit is Low), the internal pulse also triggers this powerdown. The prescaler reference and the oscillator input buffer are unaffected by the internal reset pulse and so close phase alignment is maintained when counting resumes.

When the first N counter data is latched after initialisation, the internal reset pulse is again activated. However, successive N counter loads after this will not trigger the internal reset pulse.

Device Programming After Initial Power-Up.
After initially powering up the device, there are three ways to program the device.

Initialisation Latch Method.

Apply V_{DD}.
Program the Initialisation Latch ("11" in 2 lsb's of input word). Make sure that F1bit is programmed to "0".
Then do an R load ("00" in 2 lsb's).
Then do an N load ("01" in 2 lsb's).
When the Initialisation Latch is loaded, the following occurs:

1. The function latch contents are loaded.
2. An internal pulse resets the R, N and timeout counters to load state conditions and also tri-states the charge pump. Note that the prescaler bandgpap reference and the oscillator input buffer are unaffected by the internal reset pulse, allowing close phase alignment when counting resumes.
3. Latching the first N counter data after the initialisation word will activate the same internal reset pulse. Successive N loads will not trigger the internal reset pulse unless there is another initialisation.

The CE pin Method.
Apply V_{DD}.

Bring CE low to put the device into power-down. This is an asychronous power-down in that it happens immediately.
Program the Function Latch (10).
Program the R Counter Latch (00).
Program the N Counter Latch (01).
Bring CE high to take the device out of power-down.
The R and N counter will now resume counting in close alignment.
Note that after CE goes high, a duration of 1us may be required for the prescaler bandgap voltage and oscillator input buffer bias to reach steady state.
CE can be used to power the device up and down in order to check for channel activity. The input register does not need to be reprogrammed each time the device is disabled and enabled as long as it has been programmed at least once after Vcc was initially applied.

The Counter Reset Method
Apply V_{DD}.

Do a Function Latch Load ("10" in 2 lsb's). As part of this, load "1" to the F1 bit. This enables the counter reset.
Do an R Counter Load ("00" in 2 lsb's).
Do an N Counter Load ("01" in 2 lsb's).
Do a Function Latch Load ("10" in 2 lsb's). As part of this, load "0" to the F1 bit. This disables the counter reset.
This sequence provides the same close alignment as the initialisation method. It offers direct control over the internal reset. Note that counter reset holds the counters at load point and tri-states the charge pump, but does not trigger synchronous power-down. The counter reset method requires an extra function latch load compared to the initialisation latch method.

Programmable Reference (R) Counter
If control bits C2, C1 are 0,0 then the data is transferred from the input shift register to the R counter. Table 2 below shows the input shift register data format for programming the R counter and Table 3 shows the divide ratios possible.

Programmable Divider (N Counter)
The N counter consists of a 5-bit A counter (swallow counter) and a 13-bit B counter (B counter). If C2, C1 are 0,1 the N counter is selected. Table 4 shows the input register data format for programming the N counter. Table 4 is the A and B Counter truth table.

Charge Pump Currents
In the ADF4116, when Fastlock is not enabled (F4 = "0" in the Function Latch) the CP Gain bit will switch the charge pump current between two values. With CP Gain bit = "0" the current is 250uA, and with the CP Gain bit = "1" the current is 1mA. See Table 4.