

SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

Quad-Channel, 16-Bit, 1.25 GSPS Digital-to-Analog Converter (DAC)

Check for Samples: DAC34H84

FEATURES

- Very Low Power: 1.4 W at 1.25 GSPS
- Multi-DAC Synchronization
- Selectable 2x, 4x, 8x, 16x Interpolation Filter
 Stop-Band Attenuation > 90 dBc
- Flexible On-chip Complex Mixing
 - Two Independent Fine Mixers with 32-bit NCOs
 - Power Saving Coarse Mixers: ± n×Fs/8
- High Performance, Low Jitter Clock Multiplying PLL
- Digital I and Q Correction
 - Gain, Phase, Offset, and Group Delay Correction
- Digital Inverse Sinc Filters
- 32-Bit DDR Flexible LVDS Input Data Bus
 - 8 Sample Input FIFO
 - Supports Data Rates up to 625 MSPS
 - Data Pattern Checker
 - Parity Check
- Temperature Sensor
- Differential Scalable Output: 10mA to 30mA
- 196-Ball, 12x12mm BGA (GREEN / Pb-Free)

APPLICATIONS

- Cellular Base Stations
- Diversity Transmit
- Wideband Communications

DESCRIPTION

The DAC34H84 is a very low power, high dynamic range, quad-channel, 16-bit digital-to-analog converter (DAC) with a sample rate as high as 1.25 GSPS.

The device includes features that simplify the design of complex transmit architectures: 2x to 16x digital interpolation filters with over 90 dB of stop-band attenuation simplify the data interface and reconstruction filters. Independent complex mixers allow flexible carrier placement. A high-performance low jitter clock multiplier simplifies clocking of the device without significant impact on the dynamic range. The digital Quadrature Modulator Correction (QMC) enables complete IQ compensation for gain, offset, phase and group delay between channels in direct up-conversion applications.

Digital data is input to the device through a 32-bit wide LVDS data bus with on-chip termination. The wide bus allows the processing of very high bandwidth signals. The device includes a FIFO, data pattern checker and parity test to ease the input interface. The interface also allows full synchronization of multiple devices.

The device is characterized for operation over the entire industrial temperature range of -40° C to 85° C and is available in a 196-ball, 12x12mm, 0.8mm pitch BGA package.

The DAC34H84 very low power, high bandwidth support, superior crosstalk, high dynamic range and features are an ideal fit for next generation communication systems.



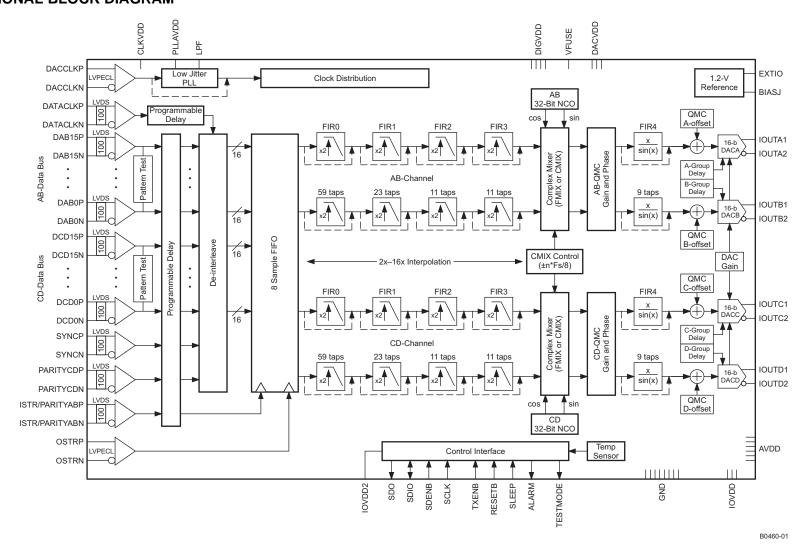
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



FUNCTIONAL BLOCK DIAGRAM





DAC34H84

SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

	(Top View)													
	А	В	С	D	Е	F	G	Н	J	К	L	М	Ν	Р
14	GND	IOUT AP	IOUT AN	GND	IOUT BN	IOUT BP	GND	GND	IOUT CP	IOUT CN	GND	IOUT DN	IOUT DP	GND
13	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND
12	DAC CLKP	GND	CLK VDD	LPF	GND	GND	EXTIO	BIASJ	GND	CLK VDD	IO VDD2	GND	ALARM	SDO
11	DAC CLKN	GND	PLL AVDD	PLL AVDD	AVDD	AVDD	AVDD	AVDD	AVDD	AVDD	TEST MODE	GND	SLEEP	SDIO
10	GND	GND	GND	AVDD	DAC VDD	DAC VDD	DAC VDD	DAC VDD	DAC VDD	DAC VDD	AVDD	GND	RESET B	SDENB
9	OSTR P	OSTR N	GND	DAC VDD	DAC VDD	GND	GND	GND	GND	DAC VDD	DAC VDD	GND	TXENA	SCLK
8	SYNC P	SYNC N	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	PARITY CDP	PARITY CDN
7	DAB 15P	DAB 15N	GND	VFUSE	DIG VDD	GND	GND	GND	GND	DIG VDD	VFUSE	GND	DCD 0P	DCD 0N
6	DAB 14P	DAB 14N	GND	IO VDD	DIG VDD	GND	GND	GND	GND	DIG VDD	IO VDD	GND	DCD 1P	DCD 1N
5	DAB 13P	DAB 13N	GND		DIG VDD	DIG VDD	IO VDD	IO VDD	DIG VDD	DIG VDD	IO VDD	GND	DCD 2P	DCD 2N
4	DAB 12P	DAB 12N	DAB 8P	DAB 6P	DAB 4P	DAB 2P	DAB 0P	DCD 15P	DCD 14P	DCD 12P	DCD 10P	DCD 8P	DCD 3P	DCD 3N
3	DAB 11P	DAB 11N	DAB 8N	DAB 6N	DAB 4N	DAB 2N	DAB 0N	DCD 15N	DCD 14N	DCD 12N	DCD 10N	DCD 8N	DCD 4P	DCD 4N
2	DAB 10P	DAB 10N	DAB 7P	DAB 5P	DAB 3P	DAB 1P	DATA CLKP	ISTR/ PARITY ABP	DCD 13P	DCD 11P	DCD 9P	DCD 7P	DCD 5P	DCD 5N
1	DAB 9P	DAB 9N	DAB 7N	DAB 5N	DAB 3N	DAB 1N	DATA CLKN	ISTR/ PARITY ABN	DCD 13N	DCD 11N	DCD 9N	DCD 7N	DCD 6P	DCD 6N
DAC Output						Da	ta Input			3.3	V Supply			
	Clock Input						CN	IOS Pins				V Supply cept for I		
Sync/Parity Input							Mis	cellaneou	sı		Gro	ound		P0134-01

PINOUT ZAY Package

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PIN FUNCTIONS							
Р	IN	1/0	DESCRIPTION				
NAME	NO.						
AVDD	D10, E11, F11, G11, H11, J11, K11, L10	I	Analog supply voltage. (3.3 V)				
ALARM	N12	ο	CMOS output for ALARM condition. The ALARM output functionality is defined through the <i>config7</i> register. Default polarity is active high, but can be changed to active low via <i>config0 alarm_out_pol</i> control bit.				
BIASJ	H12	0	Full-scale output current bias. For 30mA full-scale output current, connect 1.28k Ω to ground. Change the full-scale output current through <i>coarse_dac(3:0)</i> in <i>config3, bit</i> <15:12>				
CLKVDD	C12, K12	I	Internal clock buffer supply voltage. (1.2 V). It is recommended to isolate this supply from DIGVDD and DACVDD.				
	A7, A6, A5, A4, A3, A2, A1, C4, C2,		LVDS positive input data bits 0 through 15 for the AB-channel path. Internal 100 Ω termination resistor. Data format relative to DATACLKP/N clock is Double Data Rate (DDR).				
DAB[150]P	D4, D2, E4, E2, F4, F2,	I	DAB15P is most significant data bit (MSB) DAB0P is least significant data bit (LSB)				
	G4		The order of the bus can be reversed via <i>config2 revbus</i> bit.				
DAB[150]N	B7, B6, B5, B4, B3, B2, B1, C3, C1, D3, D1, E3, E1, F3, F1, G3	I	LVDS negative input data bits 0 through 15 for the AB-channel path. (See DAB[15:0]P description above)				
	H4, J4, J2, K4, K2, L4,		LVDS positive input data bits 0 through 15 for the CD-channel path. Internal 100 Ω termination resistor. Data format relative to DATACLKP/N clock is Double Data Rate (DDR).				
DCD[150]P	L2, M4, M2, N1, N2, N3, N4, N5, N6,	I	DCD15P is most significant data bit (MSB) DCD0P is least significant data bit (LSB)				
	N7		The order of the bus can be reversed via config2 revbus bit.				
DCD[150]N	H3, J3, J1, K3, K1, L3, L1, M3, M1, P1, P2, P3, P4, P5, P6, P7	I	LVDS negative input data bits 0 through 15 for the CD-channel path. (See DCD[15:0]P description above)				
DACCLKP	A12	I	Positive external LVPECL clock input for DAC core with a self-bias.				
DACCLKN	A11	I	Complementary external LVPECL clock input for DAC core. (see the DACCLKP description)				
DACVDD	D9, E9, E10, F10, G10, H10, J10, K10, K9, L9	I	DAC core supply voltage. (1.2 V). It is recommended to isolate this supply from CLKVDD and DIGVDD.				
DATACLKP	G2	I	LVDS positive input data clock. Internal 100 Ω termination resistor. Input data DAB[15:0]P/N and DCD[15:0]P/N are latched on both edges of DATACLKP/N (Double Data Rate).				
DATACLKN	G1	I	LVDS negative input data clock. (See DATACLKP description)				
DIGVDD	E5, E6, E7, F5, J5, K5, K6, K7	I	Digital supply voltage. (1.2 V). It is recommended to isolate this supply from CLKVDD and DACVDD.				
EXTIO	G12	I/O	Used as external reference input when internal reference is disabled through $config27 extref_ena =$ '1'. Used as internal reference output when $config27 extref_ena =$ '0' (default). Requires a 0.1 µF decoupling capacitor to AGND when used as reference output.				
ISTRP/ PARITYABP	H2	I	LVDS input strobe positive input. Internal 100 Ω termination resistor. The main functions of this input are to sync the FIFO pointer, to provide a sync source to the digital blocks, and/or to act as a parity input for the AB-data bus. These functions are captured with the rising edge of DATACLKP/N. This signal should be edge-aligned with DAB[15:0]P/N and DCD[15:0]P/N. The PARITY, SYNC, and ISTR inputs are rotated to allow complete reversal of the data interface when setting the <i>rev_interface</i> bit in register <i>config1</i> .				
ISTRN/ PARITYABN	H1	I	LVDS input strope negative input. (See the ISTRP/PARITYABP description)				



SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

PIN FUNCTIONS (continued)

Р	IN		DECODIDION				
NAME	NO.	I/O	DESCRIPTION				
GND	A10, A13, A14, B10, B11, B12, B13, C5, C6, C7, C8, C9, C10, C13, D8, D13, D14, E8, E12, E13, F6, F7, F8, F9, F12, F13, G6, G7, G8, G9, G13, G14, H6, H7, H8, H9, H13, H14, J6, J7, J8, J9, J12, J13, K8, K13, L8, L13, L14, M5, M6, M7, M8, M9, M10, M11, M12, M13, N13, P13, P14	I	These pins are ground for all supplies.				
IOUTAP	B14	0	A-Channel DAC current output. Connect directly to ground if unused.				
IOUTAN	C14	0	A-Channel DAC complementary current output. Connect directly to ground if unused.				
IOUTBP	F14	0	B-Channel DAC current output. Connect directly to ground if unused.				
IOUTBN	E14	0	B-Channel DAC complementary current output. Connect directly to ground if unused.				
IOUTCP	J14	0	C-Channel DAC current output. Connect directly to ground if unused.				
IOUTCN	K14	0	C-Channel DAC complementary current output. Connect directly to ground if unused.				
IOUTDP	N14	0	D-Channel DAC current output. Connect directly to ground if unused.				
IOUTDN	M14	0	D-Channel DAC complementary current output. Connect directly to ground if unused.				
IOVDD	D5, D6, G5, H5, L5. L6	I	Supply voltage for all LVDS I/O. (3.3 V)				
IOVDD2	L12	I	Supply voltage for all CMOS I/O. (1.8 to 3.3V) This supply can range from 1.8V to 3.3V to change the input and output level of the CMOS I/O.				
LPF	D12	I/O	PLL loop filter connection. If not using the clock multiplying PLL, the LPF pin can be left unconnected.				
OSTRP	A9	I	Optional LVPECL output strobe positive input. This positive/negative pair is captured with the rising edge of DACCLKP/N. It is used to sync the divided-down clocks and FIFO output pointer in Dual Sync Sources Mode. If unused it can be left unconnected.				
OSTRN	B9	I	Optional LVPECL output strobe negative input. (See the OSTRP description)				
PARITYCDP	N8	I	Optional LVDS positive input parity bit for the CD-data bus. The PARITYCDP/N LVDS pair has an internal 100 Ω termination resistor. If unused it can be left unconnected. The PARITY, SYNC, and ISTR inputs are rotated to allow complete reversal of the data interface when setting the rev_interface bit in register <i>config1</i> .				
PARITYCDN	P8	I	Optional LVDS negative input parity bit for the CD-data bus.				
PLLAVDD	C11, D11	I	PLL analog supply voltage. (3.3 V)				
SCLK	P9	Ι	Serial interface clock. Internal pull-down.				
SDENB	P10	I	Active low serial data enable, always an input to the DAC34H84. Internal pull-up.				
SDIO	P11	1/O	Serial interface data. Bi-directional in 3-pin mode (default) and uni-directional 4-pin mode. Internal pull-down.				
SDO	P12	ο	Uni-directional serial interface data in 4-pin mode. The SDO pin is tri-stated in 3-pin interface mode (default).				
SLEEP	N11	I	Active high asynchronous hardware power-down input. Internal pull-down.				

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PIN FUNCTIONS (continued)

PIN		1/0	DESCRIPTION
NAME	NO.	I/O	DESCRIPTION
SYNCP	A8	I	LVDS SYNC positive input. Internal 100 Ω termination resistor. If unused it can be left unconnected. The PARITY, SYNC, and ISTR inputs are rotated to allow complete reversal of the data interface when setting the <i>rev_interface</i> bit in register <i>config1</i> .
SYNCN	B8	I	LVDS SYNC negative input.
RESETB	N10	I	Active low input for chip RESET. Internal pull-up.
TXENA	N9	I	Transmit enable active high input. Internal pull-down. To enable analog output data transmission, set <i>sif_txenable</i> in register <i>config3</i> to "1" or pull CMOS TXENA pin to high. To disable analog output, set <i>sif_txenable</i> to "0" and pull CMOS TXENA pin to low. The DAC output is forced to midscale.
TESTMODE	L11	I	This pin is used for factory testing. Internal pull-down. Leave unconnected for normal operation.
VFUSE	D7, L7	I	Digital supply voltage. This supply pin is also used for factory fuse programming. Connect to DACVDD or DIGVDD for normal operation.

ORDERING INFORMATION⁽¹⁾

T _A	ORDER CODE	PACKAGE DRAWING/TYPE ⁽²⁾	TRANSPORT MEDIA	QUANTITY
40°C to 95°C	DAC34H84IZAY		Tray	160
–40°C to 85°C	DAC34H84IZAYR	ZAY / 196 NFBGA	Tape and Reel	1000

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or visit the device product folder at www.ti.com.

(2) MSL Peak Temperature: Level-3-260C-168 HR

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		VALUE		
		MIN	UNIT	
	DACVDD, DIGVDD, CLKVDD	-0.5	1.5	V
Supply voltage	VFUSE	-0.5	1.5	V
range ⁽²⁾	IOVDD, IOVDD2	-0.5	4	V
	AVDD, PLLAVDD	-0.5	4	V
	DAB[150]P/N, DCD[150]P/N, DATACLKP/N, ISTRP/N, PARITYCDP/N, SYNCP/N	-0.5	IOVDD + 0.5	V
	DACCLKP/N, OSTRP/N	-0.5	CLKVDD + 0.5	V
Pin voltage range ⁽²⁾	ALARM, SDO, SDIO, SCLK, SDENB, SLEEP, RESETB, TESTMODE, TXENA	-0.5	IOVDD2 + 0.5	V
	IOUTAP/N, IOUTBP/N, IOUTCP/N, IOUTDP/N	-1.0	AVDD + 0.5	V
	EXTIO, BIASJ	-0.5	AVDD + 0.5	V
	LPF	-0.5	PLLAVDD + 0.5	V
Peak input current (an	y input)		20	mA
Peak total input currer	at (all inputs)		-30	mA
Operating free-air tem	Operating free-air temperature range, T _A : DAC34H84		85	°C
Storage temperature r	ange	-65	150	°C

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only and functional operation of these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) Measured with respect to GND.



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THERMAL INFORMATION

		DAC34H84	
	THERMAL METRIC ⁽¹⁾ Maximum junction temperature Junction-to-ambient thermal resistance ⁽²⁾ Junction-to-case (top) thermal resistance ⁽³⁾ Junction-to-case (bottom) thermal resistance ⁽⁴⁾ Junction-to-board thermal resistance ⁽⁵⁾	BGA	UNITS
		(196 ball) PINS	
TJ	Maximum junction temperature	125	°C
θ_{JA}	Junction-to-ambient thermal resistance ⁽²⁾	37.6	
θ _{JCtop}	Junction-to-case (top) thermal resistance ⁽³⁾	6.8	
θ_{JCbot}	Junction-to-case (bottom) thermal resistance ⁽⁴⁾	N/A	°C/W
θ_{JB}	Junction-to-board thermal resistance ⁽⁵⁾	16.8	C/W
ΨJT	Junction-to-top characterization parameter ⁽⁶⁾	0.2	
Ψ_{JB}	Junction-to-board characterization parameter ⁽⁷⁾	16.4	

For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.
 The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as

(2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-k board, as specified in JESD51-7, in an environment described in JESD51-2a.

(3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

(4) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific

JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

(5) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.

(6) The junction-to-top characterization parameter, ψ_{JT} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).

(7) The junction-to-board characterization parameter, ψ_{JB} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).

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ELECTRICAL CHARACTERISTICS – DC SPECIFICATIONS⁽¹⁾

over recommended operating free-air temperature range, nominal supplies, IOUT_{FS} = 20mA (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Resolutio	n		16			Bits
DC ACCU	RACY	· · · ·				
DNL	Differential nonlinearity			±2		LSB
INL	Integral nonlinearity			±4		LSB
ANALOG	OUTPUT					
	Coarse gain linearity			±0.04		LSB
	Offset error	Mid code offset		±0.001		%FSR
	0	With external reference		±2		%FSR
	Gain error	With internal reference		±2		%FSR
	Gain mismatch	With internal reference		±2		%FSR
	Full scale output current		10	20	30	mA
	Output compliance range		-0.5		0.6	V
	Output resistance			300		kΩ
	Output capacitance			5		pF
REFEREN	ICE OUTPUT	<u> </u>				
V _{REF}	Reference output voltage			1.2		V
	Reference output current ⁽²⁾			100		nA
REFEREN	ICE INPUT					
V _{EXTIO}	Input voltage range		0.6	1.2	1.25	V
	Input resistance	External Reference Mode		1		MΩ
	Small signal bandwidth			472		kHz
	Input capacitance			100		pF
TEMPERA	TURE COEFFICIENTS	<u> </u>				
	Offset drift			±1		ppm/°C
		with external reference		±15		ppm/°C
	Gain drift	with internal reference		±30		ppm/°C
	Reference voltage drift			±8		ppm/°C
POWER S	SUPPLY ⁽³⁾					
	AVDD, IOVDD, PLLAVDD		3.14	3.3	3.46	V
	CLKVDD, DACVDD, DIGVDD		1.14	1.2	1.26	V
	IOVDD2		1.71	3.3	3.45	V
PSRR	Power supply rejection ratio	DC tested		±0.25		%FSR/V
POWER C	ONSUMPTION					
I _(AVDD)	Analog supply current ⁽⁴⁾			135	165	mA
I _(DIGVDD)	Digital supply current	MODE 1 ⁽⁵⁾		740	820	mA
I(DACVDD)	DAC supply current	f _{DAC} = 1.25GSPS, 2x interpolation, Mixer on, QMC on, invsinc on, PLL enabled, 20mA FS		40	60	mA
I(CLKVDD)	Clock supply current	output, IF = 200MHz		100	120	mA
P /	Power dissipation			1500	1750	mW

(1) Measured differentially across IOUTP/N with 25 Ω each to GND.

Use an external buffer amplifier with high impedance input to drive any external load. (2)

To ensure power supply accuracy and to account for power supply filter network loss at operating conditions, the use of the ATEST (3) function in register config27 to check the internal power supply nodes is recommended. Includes AVDD, PLLAVDD, and IOVDD

(4)

PLL operation of 1.25GSPS in Mode 1 is used for maximum power consumption measurement only. Please follow the maximum DAC (5) sample rate (F_{DAC}) guideline in the AC Characteristic Table for proper DAC operation.



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ELECTRICAL CHARACTERISTICS – DC SPECIFICATIONS⁽¹⁾ (continued)

over recommended operating free-air temperature range, nominal supplies, IOUT_{FS} = 20mA (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN TYP MAX	UNIT
I _(AVDD)	Analog supply current ⁽⁴⁾		125	mA
I(DIGVDD)	Digital supply current	MODE 2	740	mA
(DACVDD)	DAC supply current	f _{DAC} = 1.25GSPS, 2x interpolation, Mixer on, QMC on, invsinc on, PLL disabled, 20mA FS	45	mA
I(CLKVDD)	Clock supply current	output, IF = 200MHz	75	mA
P	Power dissipation		1440	mW
(AVDD)	Analog supply current ⁽⁴⁾		120	mA
	Digital supply current	MODE 3	370	mA
(DACVDD)	DAC supply current	f _{DAC} = 625MSPS, 2x interpolation, Mixer on, QMC on, invsinc off, PLL disabled, 20mA FS	25	mA
(CLKVDD)	Clock supply current	output, IF = 200MHz	45	mA
D	Power dissipation		925	mW
(AVDD)	Analog supply current ⁽⁴⁾		50	mA
(DIGVDD)	Digital supply current	MODE 4	750	mA
(DACVDD)	DAC supply current	f _{DAC} = 1.25GSPS, 2x interpolation, Mixer on, QMC on, invsinc on, PLL enabled, Channels	40	mA
(CLKVDD)	Clock supply current	A/B/C/D output sleep, IF = 200MHz,	100	mA
P	Power dissipation		1240	mW
(AVDD)	Analog supply current ⁽⁴⁾		40	mA
	Digital supply current	Mode 5 Power-Down mode: No clock, DAC on sleep	10	mA
(DACVDD)	DAC supply current	mode (clock receiver sleep),	5	mA
(CLKVDD)	Clock supply current	Channels A/B/C/D output sleep, static data pattern	15	mA
Р	Power dissipation	pattern	150	mW
(AVDD)	Analog supply current ⁽⁴⁾		140	mA
(DIGVDD)	Digital supply current	Mode 6	360	mA
(DACVDD)	DAC supply current	f _{DAC} = 1GSPS, 2x interpolation, Mixer off, QMC off, invsinc off, PLL enabled, 20mA FS	30	mA
(CLKVDD)	Clock supply current	output, IF = 200MHz	90	mA
P	Power dissipation		1040	mW
(AVDD)	Analog supply current ⁽⁴⁾		120	mA
	Digital supply current	Mode 7	370	mA
(DACVDD)	DAC supply current	f _{DAC} = 1GSPS, 2x interpolation, Mixer off, QMC off, invsinc off, PLL disabled, 20mA FS	30	mA
I _(CLKVDD)	Clock supply current	output, IF = 200MHz	65	mA
P /	Power dissipation		960	mW
Operating	Range		-40 25 85	°C

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ELECTRICAL CHARACTERISTICS – DIGITAL SPECIFICATIONS

over operating free-air temperature range (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
LVDS INF	PUTS: DAB[15:0]P/N, DCD	D[15:0]P/N, DATACLKP/N, ISTRP/N, SYNCP/N, PARITYCDF	P/N ⁽¹⁾			
V _{A,B+}	Logic high differential input voltage threshold		200			mV
V _{A,B-}	Logic low differential input voltage threshold				-200	mV
V _{COM}	Input Common Mode		1.0	1.2	1.6	V
Z _T	Internal termination		85	110	135	Ω
CL	LVDS Input capacitance			2		pF
f _{INTERL}	Interleaved LVDS data transfer rate				1250	MSPS
f _{DATA}	Input data rate				625	MSPS
CLOCK I	NPUT (DACCLKP/N)					
	Duty cycle		40%		60%	
	Differential voltage ⁽²⁾		0.4	1.0		V
	DACCLKP/N Input Frequency				1250	MHz
OUTPUT	STROBE (OSTRP/N)					
f _{OSTR}	Frequency	$f_{OSTR} = f_{DACCLK} / (n x 8 x Interp)$ where n is any positive integer, f_{DACCLK} is DACCLK frequency in MHz			f _{DACCLK} / (8 x interp)	MHz
	Duty cycle			50%	interp)	
	Differential voltage		0.4	1.0		V
CMOS IN	•	SDIO, SCLK, SDENB, SLEEP, RESETB, TXENA				L
V _{IH}	High-level input voltage		0.7 x IOVDD2			V
V _{IL}	Low-level input voltage				0.3 x IOVDD2	V
I _{IH}	High-level input current		-40		40	μA
IIL	Low-level input current		-40		40	μA
CI	CMOS Input capacitance			2		pF
V		$I_{load} = -100 \ \mu A$	IOVDD2 - 0.2			V
V _{OH}	ALARM, SDO, SDIO	$I_{load} = -2 \text{ mA}$	0.8 x IOVDD2			V
M.		I _{load} = 100 μA			0.2	V
V _{OL}	ALARM, SDO, SDIO	I _{load} = 2 mA			0.5	V

See LVDS INPUTS section for terminology.
 Driving the clock input with a differential voltage lower than 1 V may result in degraded performance.



ELECTRICAL CHARACTERISTICS – DIGITAL SPECIFICATIONS (continued)

over operating free-air temperature range (unless otherwise noted)

F	PARAMETER	TEST CONDITIONS			MIN	TYP MAX	UNI
DIGITAL IN	PUT TIMING SPECIFICA	ATIONS					
Fiming LVD	S inputs: DAB[15:0]P/N	N, DCD[15:0]P/N, ISTRP/N, SYNCP/N, P	ARITYCD	P/N, doub	<i>le edge</i> latching	9	
			Config36	6 Setting			
			datadly	clkdly			
			0	0	150		1
			0	1	100		
			0	2	50		
			0	3	0		
	Setup time,		0	4	-50		
	DAB[15:0]P/N, DCD[15:0]P/N,		0	5	-100		1
s(DATA)	ISTRP/N, SYNCP/N,	ISTRP/N and SYNCP/N reset latched	0	6	-150		ps
	and PARITYCDP/N,	only on rising edge of DATACLKP/N	0	7	-200		1 .
	valid to either edge of DATACLKP/N		1	0	200		1
			2	0	250		1
			3	0	300		1
			4	0	350		1
			5	0	400		1
			6	0	450		1
			7	0	500		1
			Config36	6 Setting			
			datadly	clkdly			
			0	0	400		1
			0	1	450		1
			0	2	500		1
			0	3	550		1
	Hold time,		0	4	600		1
	DAB[15:0]P/N,		0	5	650		1
h(DATA)	DCD[15:0]P/N, ISTRP/N, SYNCP/N	ISTRP/N and SYNCP/N reset latched	0	6	700		p
·	and PARITYCDP/N	only on rising edge of DATACLKP/N	0	7	750		1
	valid after either edge of DATACLKP/N		1	0	350		1
			2	0	300		1
			3	0	250		1
			4	0	200		1
			5	0	150		1
			6	0	100		-
			7	0	50		1
t(ISTR_SYNC)	ISTRP/N and SYNCP/N pulse width	f _{DATACLK} is DATACLK frequency in MHz	1		1/2f _{DATACLK}		ns

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ELECTRICAL CHARACTERISTICS – DIGITAL SPECIFICATIONS (continued)

over operating free-air temperature range (unless otherwise noted)

P	ARAMETER	TEST CONDITIONS	MIN	TYP MAX	UNIT
TIMING OU	TPUT STROBE INPUT:	DACCLKP/N rising edge LATCHING ⁽³⁾			
t _{s(OSTR)}	Setup time, OSTRP/N valid to rising edge of DACCLKP/N		-100		ps
t _{h(OSTR)}	Hold time, OSTRP/N valid after rising edge of DACCLKP/N		500		ps
TIMING SYN	NC INPUT: DACCLKP/N	rising edge LATCHING ⁽⁴⁾			
t _{s(SYNC_PLL)}	Setup time, SYNCP/N valid to rising edge of DACCLKP/N			200	ps
$t_{h(SYNC_PLL)}$	Hold time, SYNCP/N valid after rising edge of DACCLKP/N			300	ps
TIMING SEF	RIAL PORT		•		
t _{s(SDENB)}	Setup time, SDENB to rising edge of SCLK		20		ns
t _{s(SDIO)}	Setup time, SDIO valid to rising edge of SCLK		10		ns
t _{h(SDIO)}	Hold time, SDIO valid to rising edge of SCLK		5		ns
		Register config6 read (temperature sensor read)	1		μs
t _(SCLK)	Period of SCLK	All other registers	100		ns
t _{d(Data)}	Data output delay after falling edge of SCLK			10	ns
t _{RESET}	Minimum RESETB pulsewidth			25	ns

(3) OSTR is required in Dual Sync Sources mode. In order to minimize the skew it is recommended to use the same clock distribution device such as Texas Instruments CDCE62005 to provide the DACCLK and OSTR signals to all the DAC34H84 devices in the system. Swap the polarity of the DACCLK outputs with respect to the OSTR ones to establish proper phase relationship.

(4) SYNC is required to synchronize the PLL circuit in mulitple devices. The SYNC signal must meet the timing relationship with respect to the reference clock (DACCLKP/N) of the on-chip PLL circuit.



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ELECTRICAL CHARACTERISTICS – AC SPECIFICATIONS

over recommended operating	g free-air temperature range.	nominal supplies.	$IOUT_{ES} = 20mA$	(unless otherwise noted)
	,			

	PARAMETER	TEST CONDITIONS / COMMENTS	MIN TYP	MAX	UNIT	
ANALOG	OUTPUT ⁽¹⁾				1	
	Maximum DAO anta	PLL OFF	1250		MODO	
f _{DAC}	Maximum DAC rate	PLL ON	1000		MSPS	
t _{s(DAC)}	Output settling time to 0.1%	Transition: Code 0x0000 to 0xFFFF	10		ns	
t _{pd}	Output propagation delay	DAC outputs are updated on the falling edge of DAC clock. Does not include Digital Latency (see below).	2		ns	
t _{r(IOUT)}	Output rise time 10% to 90%		220		ps	
t _{f(IOUT)}	Output fall time 90% to 10%		220		ps	
		No interpolation, FIFO on, Mixer off, QMC off, Inverse sinc off	128			
		2x Interpolation	216			
		4x Interpolation	376			
	Digital Latency	8x Interpolation	726		DAC cloc	
		16x Interpolation	1427		cycles	
		Fine Mixer	24			
		QMC	16			
		Inverse Sinc	20			
Power-up	DAC Wake-up Time	IOUT current settling to 1% of $\mathrm{IOUT}_{\mathrm{FS}}$ from output sleep	2			
Time	DAC Sleep Time	IOUT current settling to less than 1% of $\mathrm{IOUT}_{\mathrm{FS}}$ in output sleep	2		μs	
AC PERFC	DRMANCE ⁽²⁾					
		f_{DAC} = 1.25 GSPS, f_{OUT} = 20 MHz	73			
SFDR	Spurious free dynamic range (0 to f _{DAC} /2) Tone at 0 dBFS	f_{DAC} = 1.25 GSPS, f_{OUT} = 50 MHz	70		dBc	
		f_{DAC} = 1.25 GSPS, f_{OUT} = 70 MHz	66			
	Third-order two-tone intermodulation	f_{DAC} = 1.25 MSPS, f_{OUT} = 30 \pm 0.5 MHz	87			
IMD3	distortion	f_{DAC} = 1.25 GSPS, f_{OUT} = 50 \pm 0.5 MHz	85		dBc	
	Each tone at –12 dBFS	f_{DAC} = 1.25 GSPS, f_{OUT} = 100 ± 0.5 MHz	78			
NSD	Noise Spectral Density ⁽³⁾	f_{DAC} = 1.25 GSPS, f_{OUT} = 10 MHz	160		dBc/Hz	
NOD	Tone at 0dBFS	f_{DAC} = 1.25 GSPS, f_{OUT} = 80 MHz	155		dBc/Hz	
	Adjacent channel leakage ratio, single	f_{DAC} = 1.2288 GSPS, f_{OUT} = 30.72 MHz	77]		
ACLR ⁽³⁾	carrier	f_{DAC} = 1.2288 GSPS, f_{OUT} = 153.6 MHz	74	dBc		
	Alternate channel leakage ratio, single	f_{DAC} = 1.2288 GSPS, f_{OUT} = 30.72 MHz	82		uвс	
	carrier	f_{DAC} = 1.2288 GSPS, f_{OUT} = 153.6 MHz	80		ļ	
	Channel Isolation	f _{DAC} = 1.25 GSPS, f _{OUT} = 10 MHz	95		dBc	

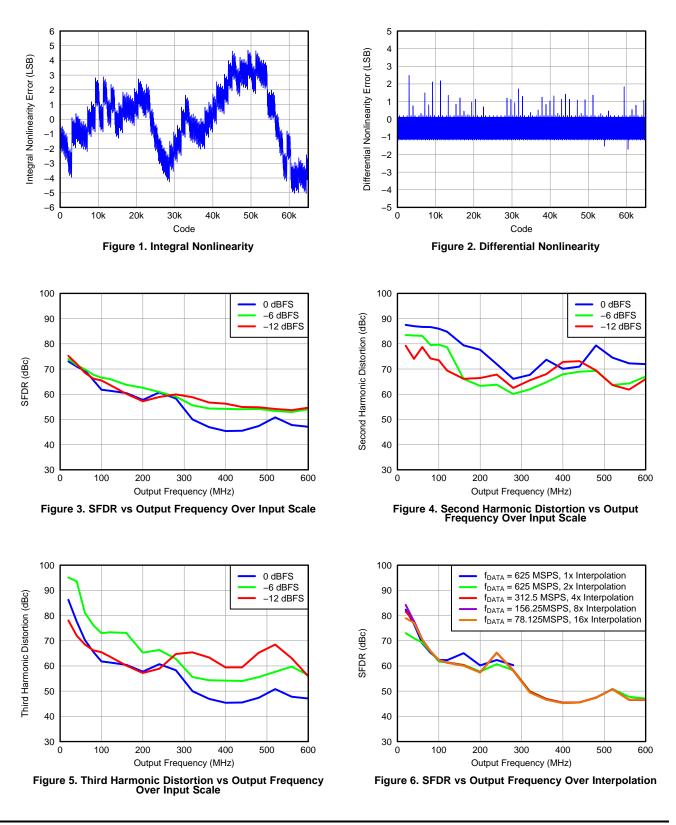
Measured single ended into 50 Ω load.
 4:1 transformer output termination, 50 Ω doubly terminated load
 Single carrier, W-CDMA with 3.84 MHz BW, 5-MHz spacing, centered at IF, PAR = 12dB. TESTMODEL 1, 10 ms



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TYPICAL CHARACTERISTICS

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)

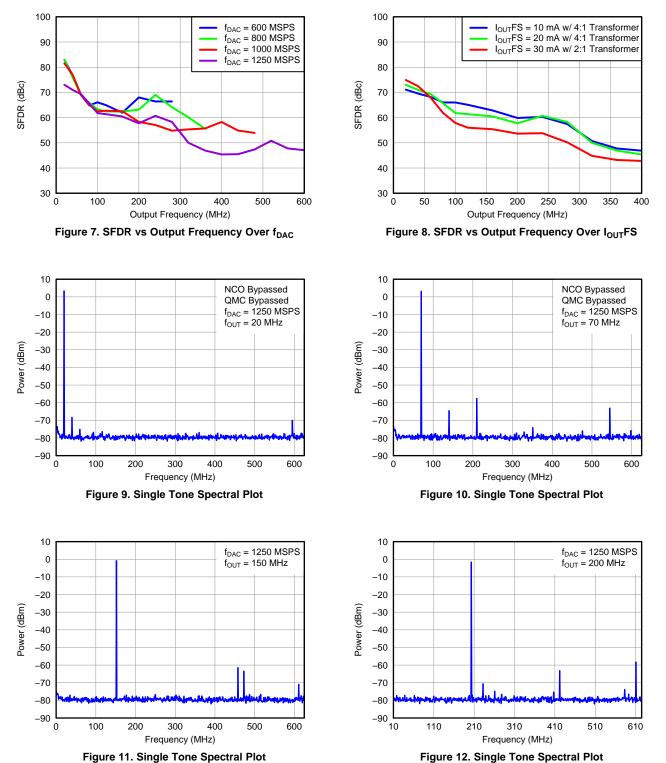




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TYPICAL CHARACTERISTICS (continued)

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)

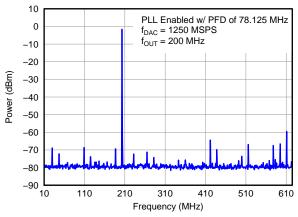


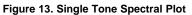
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TYPICAL CHARACTERISTICS (continued)

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)





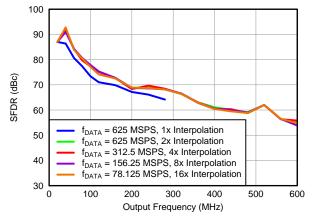


Figure 15. IMD3 vs Output Frequency Over Interpolation

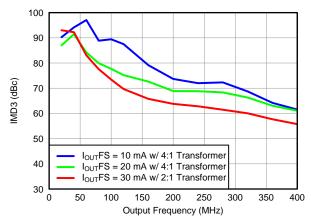


Figure 17. IMD3 vs Output Frequency Over I_{OUT}FS

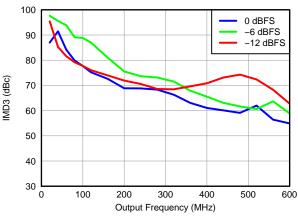


Figure 14. IMD3 vs Output Frequency Over Input Scale

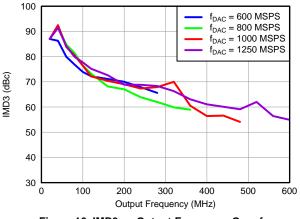


Figure 16. IMD3 vs Output Frequency Over f_{DAC}

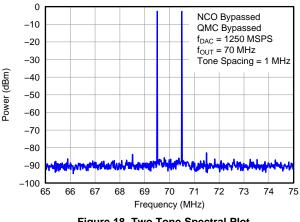
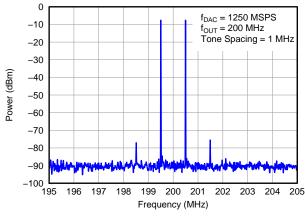


Figure 18. Two Tone Spectral Plot



TYPICAL CHARACTERISTICS (continued)

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)





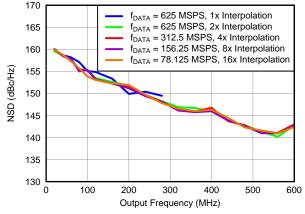


Figure 21. NSD vs Output Frequency Over Interpolation

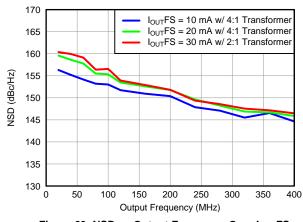
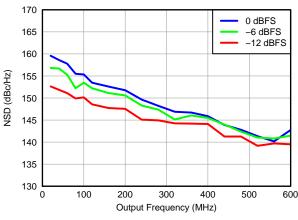


Figure 23. NSD vs Output Frequency Over I_{OUT}FS



SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

Figure 20. NSD vs Output Frequency Over Input Scale

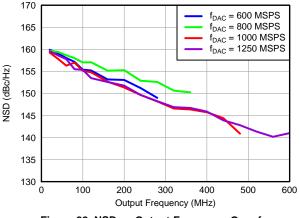


Figure 22. NSD vs Output Frequency Over f_{DAC}

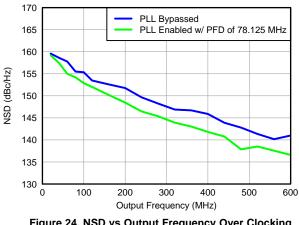


Figure 24. NSD vs Output Frequency Over Clocking Options

DAC34H84

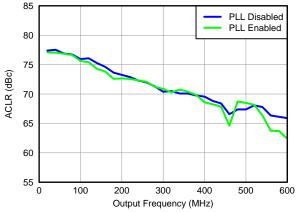
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TYPICAL CHARACTERISTICS (continued)

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)





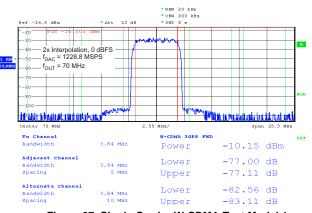
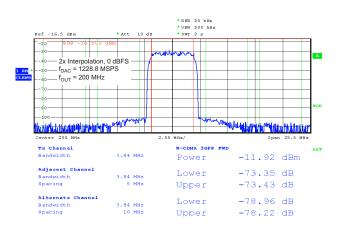


Figure 27. Single Carrier W-CDMA Test Model 1





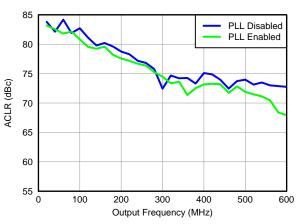
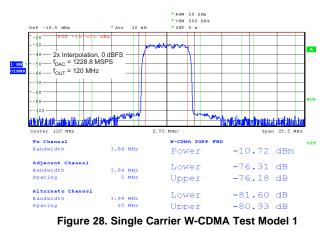
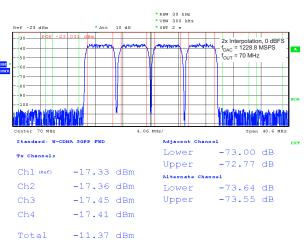


Figure 26. Single Carrier WCDMA ACLR (Alternate) vs Output Frequency Over Clocking Options



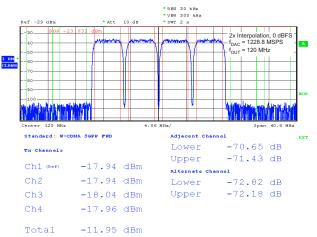




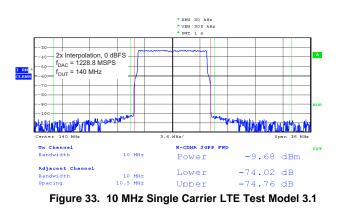


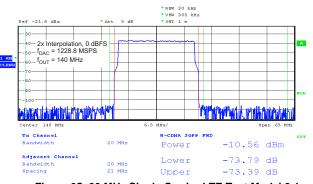
TYPICAL CHARACTERISTICS (continued)

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)

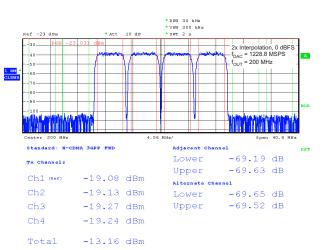






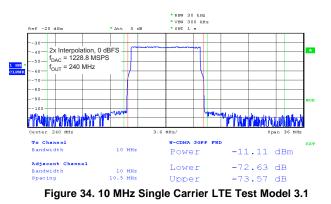


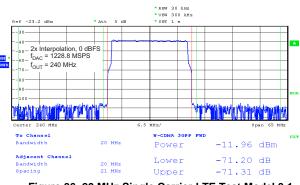




SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

Figure 32. Four Carrier W-CDMA Test Model 1



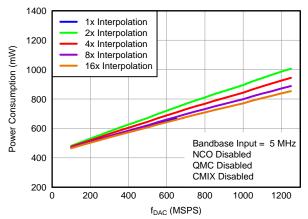


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TYPICAL CHARACTERISTICS (continued)

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)



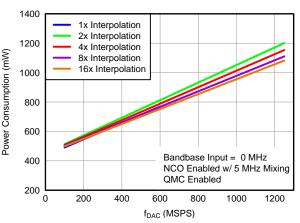


Figure 37. Power Consumption vs f_{DAC} Over Interpolation

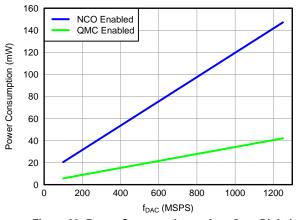
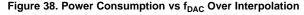


Figure 39. Power Consumption vs f_{DAC} Over Digital Processing Functions



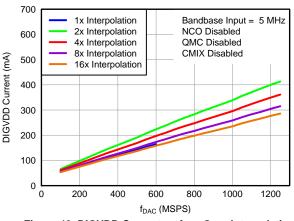
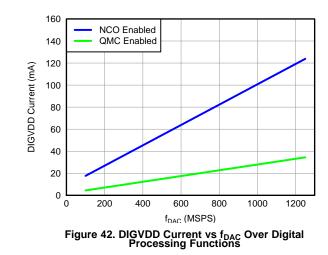
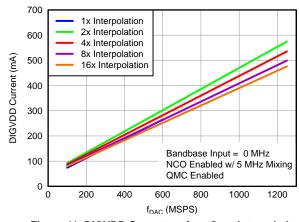


Figure 40. DIGVDD Current vs f_{DAC} Over Interpolation







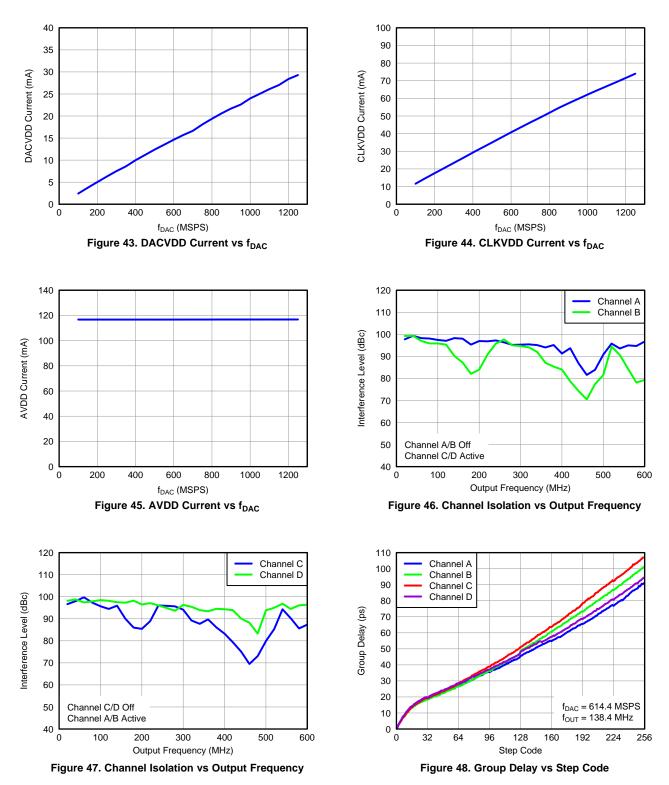
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TYPICAL CHARACTERISTICS (continued)

All plots are at 25°C, nominal supply voltage, f_{DAC} = 1250 MSPS, 2x interpolation, NCO enabled, Mixer Gain disabled, QMC enabled with gain set at 1446 for both I/Q channels, 0 dBFS digital input, 20 mA full-scale output current with 4:1 transformer (unless otherwise noted)



Texas Instruments

DEFINITION OF SPECIFICATIONS

Adjacent Carrier Leakage Ratio (ACLR): Defined for a 3.84Mcps 3GPP W-CDMA input signal measured in a 3.84MHz bandwidth at a 5MHz offset from the carrier with a 12dB peak-to-average ratio.

Analog and Digital Power Supply Rejection Ratio (APSSR, DPSSR): Defined as the percentage error in the ratio of the delta IOUT and delta supply voltage normalized with respect to the ideal IOUT current.

Differential Nonlinearity (DNL): Defined as the variation in analog output associated with an ideal 1 LSB change in the digital input code.

Gain Drift: Defined as the maximum change in gain, in terms of ppm of full-scale range (FSR) per °C, from the value at ambient (25°C) to values over the full operating temperature range.

Gain Error: Defined as the percentage error (in FSR%) for the ratio between the measured full-scale output current and the ideal full-scale output current.

Integral Nonlinearity (INL): Defined as the maximum deviation of the actual analog output from the ideal output, determined by a straight line drawn from zero scale to full scale.

Intermodulation Distortion (IMD3): The two-tone IMD3 is defined as the ratio (in dBc) of the 3rd-order intermodulation distortion product to either fundamental output tone.

Offset Drift: Defined as the maximum change in DC offset, in terms of ppm of full-scale range (FSR) per °C, from the value at ambient (25°C) to values over the full operating temperature range.

Offset Error: Defined as the percentage error (in FSR%) for the ratio between the measured mid-scale output current and the ideal mid-scale output current.

Output Compliance Range: Defined as the minimum and maximum allowable voltage at the output of the current-output DAC. Exceeding this limit may result reduced reliability of the device or adversely affecting distortion performance.

Reference Voltage Drift: Defined as the maximum change of the reference voltage in ppm per degree Celsius from value at ambient (25°C) to values over the full operating temperature range.

Spurious Free Dynamic Range (SFDR): Defined as the difference (in dBc) between the peak amplitude of the output signal and the peak spurious signal within the first Nyquist zone.

Noise Spectral Density (NSD): Defined as the difference of power (in dBc) between the output tone signal power and the noise floor of 1Hz bandwidth within the first Nyquist zone.

SERIAL INTERFACE

The serial port of the DAC34H84 is a flexible serial interface which communicates with industry standard microprocessors and microcontrollers. The interface provides read/write access to all registers used to define the operating modes of DAC34H84. It is compatible with most synchronous transfer formats and can be configured as a 3 or 4 pin interface by *sif4_ena* in register *config2*. In both configurations, SCLK is the serial interface input clock and SDENB is serial interface enable. For 3 pin configuration, SDIO is a bidirectional pin for both data in and data out. For 4 pin configuration, SDIO is data in only and SDO is data out only. Data is input into the device with the rising edge of SCLK.

Each read/write operation is framed by signal SDENB (Serial Data Enable Bar) asserted low. The first frame byte is the instruction cycle which identifies the following data transfer cycle as read or write as well as the 7-bit address to be accessed. Table 1 indicates the function of each bit in the instruction cycle and is followed by a detailed description of each bit. The data transfer cycle consists of two bytes

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Description	R/W	A6	A5	A4	A3	A2	A1	A0

Table 1. Instruction Byte of the Serial Interface



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R/W	Identifies the following data transfer cycle as a read or write operation. A high indicates a read operation from DAC34H84 and a low indicates a write operation to DAC34H84.
[A6 : A0]	Identifies the address of the register to be accessed during the read or write operation.



Figure 49 shows the serial interface timing diagram for a DAC34H84 write operation. SCLK is the serial interface clock input to DAC34H84. Serial data enable SDENB is an active low input to DAC34H84. SDIO is serial data in. Input data to DAC34H84 is clocked on the rising edges of SCLK.

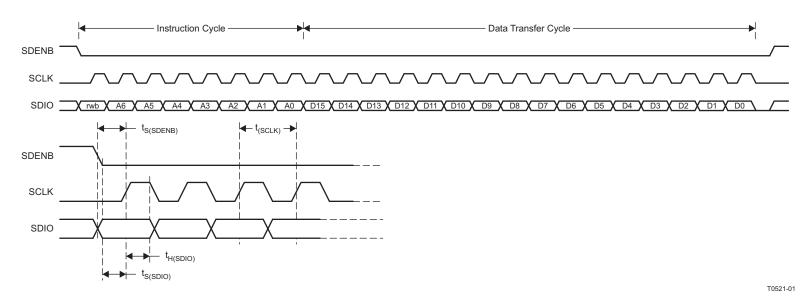


Figure 49. Serial Interface Write Timing Diagram



Figure 50 shows the serial interface timing diagram for a DAC34H84 read operation. SCLK is the serial interface clock input to DAC34H84. Serial data enable SDENB is an active low input to DAC34H84. SDIO is serial data in during the instruction cycle. In 3 pin configuration, SDIO is data out from the DAC34H84 during the data transfer cycle, while SDO is in a high-impedance state. In 4 pin configuration, SDO is data out from the DAC34H84 during the data transfer cycle. At the end of the data transfer, SDIO and SDO will output low on the final falling edge of SCLK until the rising edge of SDENB when it will 3-state.

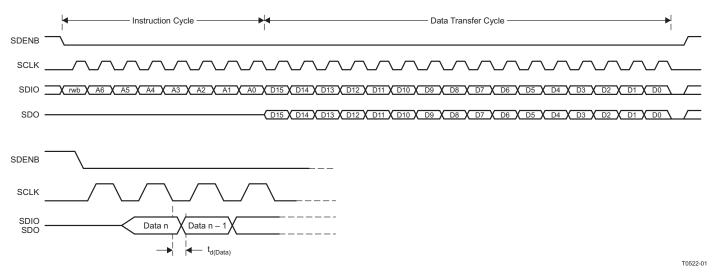


Figure 50. Serial Interface Read Timing Diagram



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Table 2. Register Map⁽¹⁾

										•	•							
Name	Address	Default	(MSB) Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0
config0	0x00	0x049C	qmc_ offsetAB_ ena	qmc_ offsetCD_ ena	qmc_ corrAB_ ena	qmc_ corrCD_ ena		interp	o(3:0)		fifo_ena	reserved	reserved	alarm_out_ ena	alarm_out pol	clkdiv_sync_ ena	invsincAB_ ena	invsincCD_ ena
config1	0x01	0x040E	iotest_ ena	reserved	reserved	64cnt_ ena	oddeven_ parity	single_ parity_ ena	dual_ parity_ ena	rev_ interface	dacA_ complement	dacB_ complement	dacC_ complement	dacD_ complement	alarm_ 2away_ ena	alarm_ 1away_ ena	alarm_ collision_ ena	reserved
config2	0x02	0x7000	reserved	dacclk gone_ena	dataclk gone_ena	collision_ gone_ena	reserved	reserved	reserved	reserved	sif4_ena	mixer_ena	mixer_gain	nco_ena	revbus	reserved	twos	reserved
config3	0x03	0xF000		coarse_	dac(3:0)			rese	erved					reserved				sif_txenable
config4	0x04	NA								i	otest_results(1	5:0)						
config5	0x05	NA	alarm_ from_ zerochk	reserved	aları	ms_from_fifo	(2:0)	alarm_ dacclk_ gone	alarm_ dataclk_ gone	alarm_ output_ gone	alarm_ from_ iotest	reserved	alarm_ from_pll	alarm_ Aparity	alarm_ Bparity	alarm_ Cparity	alarm_ Dparity	reserved
config6	0x06	NA				tempda	ata(7:0)						reser	ved			reserved	reserved
config7	0x07	0xFFFF								i	alarms_mask(1	5:0)						
config8	0x08	0x0000	reserved	reserved	reserved							qmc_offset	A(12:0)					
config9	0x09	0x8000	f	fifo_offset(2:0))							qmc_offset	B(12:0)					
config10	0x0A	0x0000	reserved	reserved	reserved		qmc_offsetC(12:0)											
config11	0x0B	0x0000	reserved	reserved	reserved		qmc_offsetD(12:0)											
config12	0x0C	0x0400	reserved	reserved	reserved	reserved	reserved						qmc_gainA(1	0:0)				
config13	0x0D	0x0400		cmix	(3:0)		reserved						qmc_gainB(1					
config14	0x0E	0x0400	reserved	reserved	reserved	reserved	reserved						qmc_gainC(1	0:0)				
config15	0x0F	0x0400	output_de	layAB(1:0)	output_de	ayCD(1:0)	reserved						qmc_gainD(1	0:0)				
config16	0x10	0x0000	reserved	reserved	reserved	reserved						qmc_j	haseAB(11:0)					
config17	0x11	0x0000	reserved	reserved	reserved	reserved						qmc_p	haseCD(11:0)					
config18	0x12	0x0000			1		1			pl	nase_offsetAB(15:0)						
config19	0x13	0x0000								pł	nase_offsetCD(15:0)						
config20	0x14	0x0000								F	hase_addAB(1	5:0)						
config21	0x15	0x0000								p	hase_addAB(31	1:16)						
config22	0x16	0x0000								p	hase_addCD(1	5:0)						
config23	0x17	0x0000								pl	hase_addCD(3	1:16)						
config24	0x18	NA		reserved		pll_reset	pll_ ndivsync_ ena	pll_ena	rese	rved	pll_c	p(1:0)		pll_p(2:0)			pll_lfvolt(2:0)	
config25	0x19	0x0440				pll_n	n(7:0)					pll_r	n(3:0)		pll_vcc	pitune(2:0)	rese	erved
config26	0x1A	0x0020			pll_vc	o(5:0)			reserved	reserved	bias_ sleep	tsense_ sleep	pll_sleep	clkrecv_ sleep	sleepA	sleepB	sleepC	sleepD
config27	0x1B	0x0000	extref_ ena	reserved	reserved	reserved	fuse_ sleep	reserved	reserved	reserved	reserved	reserved			res	served		
config28	0x1C	0x0000				rese	rved							reser	ved			
config29	0x1D	0x0000				rese	rved							reser	ved			
config30	0x1E	0x1111		syncsel_qm	offsetAB(3:0)			syncsel_qmo	offsetCD(3:0)			syncsel_qn	ncorrAB(3:0)			syncsel_q	mcorrCD(3:0)	

(1) Unless otherwise noted, all reserved registers should be programmed to default values.

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Table 2. Register Map⁽¹⁾ (continued)

Name	Address	Default	(MSB) Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0
config31	0x1F	0x1140		syncsel_m	ixerAB(3:0)			syncsel_mi	ixerCD(3:0)			syncsel	_nco(3:0)		syncsel	_fifo_input	sif_sync	reserved
config32	0x20	0x2400		syncsel_fifoin(3:0) syncsel_fifoout(3:0)										reserved				clkdiv_ sync_sel
config33	0x21	0x0000									reserved							
config34	0x22	0x1B1B	pathA_in	n_set(1:0)	pathB_in	_set(1:0)	pathC_ir	n_set(1:0)	pathD_in	_set(1:0)	DACA_ou	it_set(1:0)	DACB_ou	t_set(1:0)	DACC_o	ut_set(1:0)	DACD_ou	ut_set(1:0)
config35	0x23	0xFFFF									sleep_cntl(15:	0)						
config36	0x24	0x0000		datadly(2:0)			clkdly(2:0)						res	erved				
config37	0x25	0x7A7A									iotest_pattern	0						
config38	0x26	0xB6B6									iotest_pattern	1						
config39	0x27	0xEAEA									iotest_pattern	2						
config40	0x28	0x4545									iotest_pattern	3						
config41	0x29	0x1A1A									iotest_pattern	4						
config42	0x2A	0x1616									iotest_pattern5							
config43	0x2B	0xAAAA									iotest_pattern	6						
config44	0x2C	0xC6C6									iotest_pattern	7						
config45	0x2D	0x0004	reserved	ostrtodig_ sel	ramp_ena							reserved						sifdac_ena
config46	0x2E	0x0000		grp_delayA(7:0)									grp_dela	yB(7:0)				
config47	0x2F	0x0000		grp_delayC(7:0)										grp_dela	yD(7:0)			
config48	0x30	0x0000		sifdac(15:0)														
version	0x7F	0x5409			rese	rved			reserved	res	erved	rese	erved	devicei	d(1:0)		versionid(2:0)	

REGISTER DESCRIPTIONS

Register name: config0 - Address: 0x00, Default: 0x049C

Register Name	Address	Bit	Name	Funct	ion	Default Value
config0	0x00	15	qmc_offsetAB_ena	When set, the digital Quadrature Mo correction for the AB data path is en		0
		14	qmc_offsetCD_ena	When set, the digital Quadrature Mo correction for the CD data path is er		0
		13	qmc_corrAB_ena	When set, the QMC phase and gain data path is enabled.	correction circuitry for the AB	0
		12	qmc_corrCD_ena	When set, the QMC phase and gain data path is enabled.	correction circuitry for the CD	0
		11:8	interp(3:0)	These bits define the interpolation fa	actor	0100
				interp	Interpolation Factor	
				0000	1x	
				0001	2x	
				0010	4x	
				0100	8x	
				1000	16x	
	_	7	fifo_ena	When set, the FIFO is enabled. When the FIFO is disabled DACCCLKP/N and DATACLKP/N must be aligned (not recommended).		1
		6	Reserved	Reserved for factory use.		0
		5	Reserved	Reserved for factory use.		0
		4	alarm_out_ena	When set, the ALARM pin becomes ALARM pin is 3-stated.	an output. When cleared, the	1
		3	alarm_out_pol	This bit changes the polarity of the A 0: Negative logic 1: Positive logic	ALARM signal.	1
		2	clkdiv_sync_ena	When set, enables the syncing of th output pointer using the sync source The internal divided-down clocks wil Refer to the Power-Up Sequence se	e selected by register <i>config3</i> 2. I be phase aligned after syncing.	1
		1	invsincAB_ena	When set, the inverse sinc filter for t	he AB data path is enabled.	0
		0	invsincCD ena	When set, the inverse sinc filter for t	he CD data nath is enabled	0

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SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

Register name: config1 – Address: 0x01, Default: 0x040E

Register Name	Address	Bit	Name	Function	Default Value
config1	0x01	15	iotest_ena	When set, enables the data pattern checker test. The outputs are deactivated regardless of the state of TXENA and sif_txenable.	0
	-	14	Reserved	Reserved for factory use.	0
	-	13	Reserved	Reserved for factory use.	0
		12	64cnt_ena	When set, enables resetting of the alarms after 64 good samples with the goal of removing unnecessary errors. For instance, when checking setup/hold through the pattern checker test, there may initially be errors. Setting this bit removes the need for a SIF write to clear the alarm register.	0
		11	oddeven_parity	Selects between odd and even parity check 0: Even parity 1: Odd parity	0
		10	single_parity_ena	When set, enables parity checking of each input word using the 1 PARITYP/N parity input. It should match the oddeven_parity register setting.	1
		9	dual_parity_ena	When set, enables parity checking using the ISTR signal to 0 source the parity bit. The parity bit should match the oddeven_parity register setting.	0
		8	rev_interface	 When set, the PARITY, SYNC, and ISTR inputs are rotated to allow complete reversal of the data interface when setting the rev_interface bit. When rev_interface = "1", the following changes occurs SYNCP/N becomes ISTRP/N PARITYP/N becomes SYNCP/N ISTRP/N becomes PARITYP/N 	0
		7	dacA_complement	When set, the DACA output is complemented. This allows to effectively change the + and – designations of the LVDS data lines.	0
		6	dacB_complement	When set, the DACB output is complemented. This allows to effectively change the + and – designations of the LVDS data lines.	0
		5	dacC_complement	When set, the DACC output is complemented. This allows to effectively change the + and – designations of the LVDS data lines.	0
		4	dacD_complement	When set, the DACD output is complemented. This allows to effectively change the + and – designations of the LVDS data lines.	0
		3	alarm_2away_ena	When set, the alarm from the FIFO indicating the write and read pointers being 2 away is enabled.	1
		2	alarm_1away_ena	When set, the alarm from the FIFO indicating the write and read pointers being 1 away is enabled.	1
		1	alarm_collision_ena	When set, the alarm from the FIFO indicating a collision between the write and read pointers is enabled.	1
		0	Reserved	Reserved for factory use.	0

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STRUMENTS

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Register name: config2 – Address: 0x02, Default: 0x7000

Register Name	Address	Bit	Name	Function	Default Value
config2	0x02	15	Reserved	Reserved for factory use.	0
		14	dacclkgone_ena	When set, the DACCLK-gone signal from the clock monitor circuit can be used to shut off the DAC outputs. The corresponding alarms, <i>alarm_dacclk_gone</i> and <i>alarm_output_gone</i> , must not be masked (i.e. <i>Config7</i> , bit <10> and bit <8> must set to "0").	1
		13	dataclkgone_ena	When set, the DATACLK-gone signal from the clock monitor circuit can be used to shut off the DAC outputs. The corresponding alarms, <i>alarm_dataclk_gone</i> and <i>alarm_output_gone</i> , must not be masked (i.e.Config7, bit <9> and bit <8> must set to "0").	1
		12	collisiongone_ena	When set, the FIFO collision alarms can be used to shut off the DAC outputs. The corresponding alarms, <i>alarm_fifo_collision</i> and <i>alarm_output_gone</i> , must not be masked (i.e.Config7, bit <13> and bit <8> must set to "0").	1
		11	Reserved	Reserved for factory use.	0
		10	Reserved	Reserved for factory use.	0
		9	Reserved	Reserved for factory use.	0
	-	8	Reserved	Reserved for factory use.	0
		7	sif4_ena	When set, the serial interface (SIF) is a 4 bit interface, otherwise it is a 3 bit interface.	0
	-	6	mixer_ena	When set, the mixer block is enabled.	0
	-	5	mixer_gain	When set, a 6dB gain is added to the mixer output.	0
	-	4	nco_ena	When set, the NCO is enabled. This is not required for coarse mixing.	0
		3	revbus	When set, the input bits for the data bus are reversed. MSB becomes LSB.	0
		2	Reserved	Reserved for factory use.	0
		1	twos	When set, the input data format is expected to be 2's complement. When cleared, the input is expected to be offset-binary.	0
		0	Reserved	Reserved for factory use.	0

Register name: config3 – Address: 0x03, Default: 0xF000

Register Name	Address	Bit	Name	Function	Default Value
config3	0x03	15:12	coarse_dac(3:0)	Scales the output current in 16 equal steps.	1111
				$I_{FS} = \frac{V_{EXTIO}}{R_{BIAS}} \times 2 \times (coarse_dac + 1)$	
		11:8	Reserved	Reserved for factory use.	0000
		7:1	Reserved	Reserved for factory use.	0000000
		0	sif_txenable	When set, the internal value of TXENABLE is set to "1".	0
				To enable analog output data transmission, set <i>sif_txenable</i> to "1" or pull CMOS TXENA pin (N9) to high. To disable analog output, set <i>sif_txenable</i> to "0" and pull CMOS TXENA pin (N9) to low.	



SLAS751B - MARCH 2011 - REVISED SEPTEMBER 2011

Register name: config4 – Address: 0x04, Default: No RESET Value (WRITE TO CLEAR)

Register Name	Address	Bit	Name	Function	Default Value
config4	0x04	15:0	iotest_results(15:0)	Bits in iotest_results with logic value of "1" tell which bit in either DAB[15:0] bus or DCD[15:0] bus failed during the pattern checker test. <i>iotest_results</i> (15:8) correspond to the data bits on both DAB[15:8] and DCD[15:8]. <i>iotest_results</i> (7:0) correspond to the data bits on both DAB[7:0] and DCD[7:0].	No RESET Value

Register name: config5 – Address: 0x05, Default: Setup and Power-Up Conditions Dependent (WRITE TO CLEAR)

Register Name	Address	Bit	Name	Function	Default Value
config5	0x05	15	alarm_from_zerochk	This alarm indicates the 8-bit FIFO write pointer address has an all zeros patterns. Due to pointer address being a shift register, this is not a valid address and will cause the write pointer to be stuck until the next sync. This error is typically caused by timing error or improper power start-up sequence. If this alarm is asserted, resynchronization of FIFO is necessary. Refer to the Power-Up Sequence section for more detail.	NA
		14	Reserved	Reserved for factory use.	NA
		13:11	alarms_from_fifo(2:0)	Alarm indicating FIFO pointer collisions and nearness: 000: All fine 001: Pointers are 2 away 01x: Pointers are 1 away 1xx: FIFO pointer collision If the FIFO pointer collision alarm is set when <i>collisiongone_ena</i> is enabled, the FIFO must be re-synchronized and the bits must be cleared to resume normal operation.	NA
		10	alarm_dacclk_gone	Alarm indicating the DACCLK has been stopped. If the bit is set when <i>dacclkgone_ena</i> is enabled, the DACCLK must resume and the bit must be cleared to resume normal operation.	NA
		9	alarm_dataclk_gone	Alarm indicating the DATACLK has been stopped. If the bit is set when <i>dataclkgone_ena</i> is enabled, the DATACLK must resume and the bit must be cleared to resume normal operation.	NA
		8	alarm_output_gone	Alarm indicating either <i>alarm_dacclk_gone</i> , <i>alarm_dataclk_gone</i> , or <i>alarm_fifo_collision</i> are asserted. It controls the output. When high it will output "0x8000" for each output connected to the DAC. If the bit is set when <i>dacclkgone_ena</i> , <i>dataclkgone_ena</i> , or <i>collisiongone_ena</i> are enabled, then the corresponding errors must be fixed and the bits must be cleared to resume normal operation.	NA
		7	alarm_from_iotest	Alarm indicating the input data pattern does not match the pattern in the iotest_pattern registers. When data pattern checker mode is enabled, this alarm in register config5, bit7 is the only valid alarm. Other alarms in register config5 are not valid and can be disregarded.	NA
		6	Reserved	Reserved for factory use.	NA
		5	alarm_from_pll	Alarm indicating the PLL has lost lock. For version ID "001", <i>alarm_from_PLL</i> may not indicate the correct status of the PLL. Refer to <i>pll_lfvolt(2:0)</i> in register config24 for proper PLL lock indication.	NA
		4	alarm_Aparity	In dual parity mode, alarm indicating a parity error on the A word. In single parity mode, alarm on the 32-bit data captured on the rising edge of DATACLKP/N.	NA
		3	alarm_Bparity	In dual parity mode, alarm indicating a parity error on the B word. In single parity mode, alarm on the 32-bit data captured on the falling edge of DATACLKP/N.	NA
		2	alarm_Cparity	In dual parity mode, alarm indicating a parity error on the C word.	NA
		1	alarm_Dparity	In dual parity mode, alarm indicating a parity error on the D word.	NA
		0	Reserved	Reserved for factory use.	NA

STRUMENTS

FEXAS

Register name: config6 – Address: 0x06, Default: No RESET Value (READ ONLY)

Register Name	Address	Bit	Name	Function	Default Value
config6	0x06	15:8	tempdata(7:0)	This is the output from the chip temperature sensor. The value of this register in two's complement format represents the temperature in degrees Celsius. This register must be read with a minimum SCLK period of $1\mu s$.	No RESET Value
		7:2	Reserved	Reserved for factory use.	000000
		1	Reserved	Reserved for factory use.	0
		0	Reserved	Reserved for factory use.	0

Register name: config7 - Address: 0x07, Default: 0xFFFF

Register Name	Address	Bit	Name	F	unction	Default Value
config7	0x07	15:0	alarms_mask(15:0)	These bits control the masking of the alarr	0xFFFF	
				alarm_mask	Alarm that is Masked	
				15	alarm_from_zerochk	
				14	not used	
				13	alarm_fifo_collision	
				12	alarm_fifo_1away	
				11	alarm_fifo_2away	
				10	alarm_dacclk_gone	
				9	alarm_dataclk_gone	
				8	alarm_output_gone	
				7	alarm_from_iotest	
				6	not used	
				5	alarm_from_pll	
				4	alarm_Aparity	
				3	alarm_Bparity	
				2	alarm_Cparity	
				1	alarm_Dparity	
				0	not used	

Register name: config8 – Address: 0x08, Default: 0x0000 (CAUSES AUTO-SYNC)

Register Name	Address	Bit	Name	Function	Default Value
config8	0x08	15	Reserved	Reserved for factory use.	0
		14	Reserved	Reserved for factory use.	0
		13	Reserved	Reserved for factory use.	0
		12:0	qmc_offsetA(12:0)	DACA offset correction. The offset is measured in DAC LSBs. If enabled in <i>config30</i> writing to this register causes an auto-sync to be generated. This loads the values of the QMC offset registers (<i>config8-config9</i>) into the offset block at the same time. When updating the offset values for the AB channel <i>config8</i> should be written last. Programming <i>config9</i> will not affect the offset setting.	All zeros

Register name: config9 – Address: 0x09, Default: 0x8000

Register Name	Address	Bit	Name	Function	Default Value
config9	0x09	15:13	fifo_offset(2:0)	When the sync to the FIFO occurs, this is the value loaded into the FIFO read pointer. With this value the initial difference between write and read pointers can be controlled. This may be helpful in syncing multiple chips or controlling the delay through the device.	100
		12:0	qmc_offsetB(12:0)	DACB offset correction. The offset is measured in DAC LSBs.	All zeros

Register name: config10 – Address: 0x0A, Default: 0x0000 (CAUSES AUTO-SYNC)

Register Name	Address	Bit	Name	Function	Default Value
config10	0x0A	15	Reserved	Reserved for factory use.	0
		14	Reserved	Reserved for factory use.	0
		13	Reserved	Reserved for factory use.	0
		12:0	qmc_offsetC(12:0)	DACC offset correction. The offset is measured in DAC LSBs. If enabled in <i>config30</i> writing to this register causes an auto-sync to be generated. This loads the values of the CD-channel QMC offset registers (<i>config10-config11</i>) into the offset block at the same time. When updating the offset values for the CD-channel <i>config10</i> should be written last. Programming <i>config11</i> will not affect the offset setting.	All zeros

Register name: config11 – Address: 0x0B, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config11	0x0B	15	Reserved	Reserved for factory use.	0
		14	Reserved	Reserved for factory use.	0
		13	Reserved	Reserved for factory use.	0
		12:0	qmc_offsetD(12:0)	DACD offset correction. The offset is measured in DAC LSBs.	All zeros

Register name: config12 - Address: 0x0C, Default: 0x0400

Register Name	Address	Bit	Name	Function	Default Value
config12	0x0C	15	Reserved	Reserved for factory use.	0
		14	Reserved	Reserved for factory use.	0
		13	Reserved	Reserved for factory use.	0
		12	Reserved	Reserved for factory use.	0
		11	Reserved	Reserved for factory use.	0
		10:0	qmc_gainA(10:0)	QMC gain for DACA. The full 11-bit qmc_gainA(10:0) word is formatted as UNSIGNED with a range of 0 to 1.9990. The implied decimal point for the multiplication is between bit 9 and bit 10.	10000000 000

Register name: config13 – Address: 0x0D, Default: 0x0400

Register Name	Address	Bit	Name	Function	Default Value
config13	0x0D	15	cmix_mode(3:0)	Sets the mixing function of the coarse mixer. Bit 15: Fs/8 mixer Bit 14: Fs/4 mixer Bit 13: Fs/2 mixer Bit 12: -Fs/4 mixer The various mixers can be combined together to obtain a ±n×Fs/8 total mixing factor.	0000
		11	Reserved	Reserved for factory use.	0
		10:0	qmc_gainB(10:0)	QMC gain for DACB. The full 11-bit qmc_gainB(10:0) word is formatted as UNSIGNED with a range of 0 to 1.9990. The implied decimal point for the multiplication is between bit 9 and bit 10.	1000000 000

Register name: config14 – Address: 0x0E, Default: 0x0400

Register Name	Address	Bit	Name	Function	Default Value
config14	0x0E	15	Reserved	Reserved for factory use.	0
		14	Reserved	Reserved for factory use.	0
		13	Reserved	Reserved for factory use.	0
		12	Reserved	Reserved for factory use.	0
		11	Reserved	Reserved for factory use.	0
		10:0	qmc_gainC(10:0)	QMC gain for DACC. The full 11-bit qmc_gainC(10:0) word is formatted as UNSIGNED with a range of 0 to 1.9990. The implied decimal point for the multiplication is between bit 9 and bit 10.	10000000 000

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Register name: config15 - Address: 0x0F, Default: 0x0400

Register Name	Address	Bit	Name	Function	Default Value
config15 (0x0F	15:14	output_ delayAB(1:0)	Delays the AB data path outputs from 0 to 3 DAC clock cycles.	00
		13:12	output_ delayCD(1:0)	Delays the CD data path outputs from 0 to 3 DAC clock cycles.	00
		11	Reserved	Reserved for factory use.	0
		10:0	qmc_gainD(10:0)	QMC gain for DACD. The full 11-bit qmc_gainD(10:0) word is formatted as UNSIGNED with a range of 0 to 1.9990. The implied decimal point for the multiplication is between bit 9 and bit 10.	1000000 000

Register name: config16 – Address: 0x10, Default: 0x0000 (CAUSES AUTO-SYNC)

Register Name	Address	Bit	Name	Function	Default Value
config16	0x10	15	Reserved	Reserved for factory use.	0
		14	Reserved	Reserved for factory use.	0
		13	Reserved	Reserved for factory use.	0
		12	Reserved	Reserved for factory use.	0
		11:0	qmc_phaseAB(11:0)	QMC correction phase for the AB data path. The 12-bit qmc_phaseAB(11:0) word is formatted as two's complement and scaled to occupy a range of -0.5 to 0.49975 and a default phase correction of 0.00. To accomplish QMC phase correction, this value is multiplied by the current B sample, then summed into the A sample. If enabled in <i>config30</i> writing to this register causes an auto-sync to be generated. This loads the values of the QMC offset registers (<i>config12, config13, and config16</i>) into the QMC block at the same time. When updating the QMC values for the AB channel <i>config16</i> should be written last. Programming <i>config12 and config13</i> will not affect the QMC settings.	All zeros

Register name: config17 – Address: 0x11, Default: 0x0000 (CAUSES AUTO-SYNC)

Register Name	Address	Bit	Name	Function	Default Value
config17	0x11	15	Reserved	Reserved for factory use.	0
		14	Reserved	Reserved for factory use.	0
		13	Reserved	Reserved for factory use.	0
		12	Reserved	Reserved for factory use.	0
		11:0	qmc_phaseCD(11:0)	QMC correction phase for the CD data path. The 12-bit qmc_gainCD(11:0) word is formatted as two's complement and scaled to occupy a range of -0.5 to 0.49975 and a default phase correction of 0.00. To accomplish QMC phase correction, this value is multiplied by the current D sample, then summed into the C sample. If enabled in <i>config30</i> writing to this register causes an auto-sync to be generated. This loads the values of the CD-channel QMC block registers (<i>config14, config15 and config17</i>) into the QMC block at the same time. When updating the QMC values for the CD-channel <i>config17</i> should be written last. Programming <i>config14 and config15</i> will not affect the QMC settings.	All zeros

Register name: config18 - Address: 0x12, Default: 0x0000 (CAUSES AUTO-SYNC)

Register Name	Address	Bit	Name	Function	Default Value
config18	0x12	15:0	phase_offsetAB(15:0)	Phase offset added to the AB data path NCO accumulator before the generation of the SIN and COS values. The phase offset is added to the upper 16 bits of the NCO accumulator results and these 16 bits are used in the sin/cos lookup tables. If enabled in <i>config31</i> writing to this register causes an auto-sync to be generated. This loads the values of the fine mixer block registers (<i>config18</i> , <i>config20</i> , and <i>config21</i>) at the same time. When updating the mixer values the <i>config18</i> should be written last. Programming <i>config20</i> and <i>config21</i> will not affect the mixer settings.	0x0000



Register name: config19 – Address: 0x13, Default: 0x0000 (CAUSES AUTO-SYNC)

Register Name	Address	Bit	Name	Function	Default Value
config19	0x13	15:0	phase_offsetCD(15:0)	Phase offset added to the CD data path NCO accumulator before the generation of the SIN and COS values. The phase offset is added to the upper 16 bits of the NCO accumulator results and these 16 bits are used in the sin/cos lookup tables. If enabled in <i>config31</i> writing to this register causes an auto-sync to be generated. This loads the values of the CD-channel fine mixer block registers (<i>config19, config22, and config23</i>) at the same time. When updating the mixer values for the CD-channel <i>config19</i> should be written last. Programming <i>config22 and config23</i> will not affect the mixer settings.	0x0000

Register name: config20 - Address: 0x14, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config20	0x14	15:0	phase_ addAB(15:0)	The phase_addAB(15:0) value is used to determine the NCO frequency. The two's complement formatted value can be positive or negative. Each LSB represents Fs/(2^32) frequency step.	0x0000

Register name: config21 - Address: 0x15, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config21	0x15	15:0	phase_ addAB(31:16)	See config20 above.	0x0000

Register name: config22 – Address: 0x16, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config22	0x16	15:0	phase_ addCD(15:0)	The phase_addCD(15:0) value is used to determine the NCO frequency. The two's complement formatted value can be positive or negative. Each LSB represents Fs/(2^32) frequency step.	0x0000

Register name: config23 – Address: 0x17, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config23	0x17	15:0	phase_ addCD(31:16)	See config22 above.	0x0000

TEXAS INSTRUMENTS

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Register name: config24 - Address: 0x18, Default: NA

Register Name	Address	Bit	Name	Function	Default Value
config24	0x18	15:13	Reserved	Reserved for factory use.	001
		12	pll_reset	When set, the PLL loop filter (LPF) is pulled down to 0V. Toggle from '1' to '0' to restart the PLL if an over-speed lock-up occurs. Over-speed can happen when the process is fast, the supplies are higher than nominal, etc. resulting in the feedback dividers missing a clock.	0
		11	pll_ndivsync_ena	When set, the LVDS SYNC input is used to sync the PLL N dividers.	1
		10	pll_ena	When set, the PLL is enabled. When cleared, the PLL is bypassed.	0
		9:8	Reserved	Reserved for factory use.	00
		7:6	pll_cp(1:0)	PLL pump charge select 00: No charge pump 01: Single pump charge 10: Not used 11: Dual pump charge	00
		5:3	pll_p(2:0)	PLL pre-scaler dividing module control. 010: 2 011: 3 100: 4 101: 5 110: 6 111: 7 000: 8	001
		2:0	pll_lfvolt(2:0)	PLL loop filter voltage. This three bit read-only indicator has step size of 0.4125V. The entire range covers from 0V to 3.3V. The optimal lock range of the PLL will be from 010 to 101 (i.e. 0.825V to 2.063V). Adjust pll_vco(5:0) for optimal lock range.	NA

Register name: config25 - Address: 0x19, Default: 0x0440

Register Name	Address	Bit	Name	Function	Default Value
config25	0x19	15:8	pll_m(7:0)	M portion of the M/N divider of the PLL. If pll_m<7> = 0, the M divider value has the range of pll_m<6:0>, spanning from 4 to 127. (i.e. 0, 1, 2, and 3 are not valid.) If pll_m<7> = 1, the M divider value has the range of 2 × pll_m<6:0>, spanning from 8 to 254. (i.e. 0, 2, 4, and 6 are not valid. M divider has even values only.)	0x04
		7:4	pll_n(3:0)	N portion of the M/N divider of the PLL. 0000: 1 0001: 2 0010: 3 0011: 4 0100: 5 0101: 6 0110: 7 0111: 8 1000: 9 1001: 10 1010: 11 1011: 12 1100: 13 1101: 14 1110: 15 1111: 16	0100
		3:2	pll_vcoitune(1:0)	PLL VCO bias tuning bits. Set to "01" for normal PLL operation	00
		1:0	Reserved	Reserved for factory use.	00



SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

Register name: config26 – Address: 0x1A, Default: 0x0020

Register Name	Address	Bit	Name	Function	Default Value
config26	0x1A	15:10	pll_vco(5:0)	VCO frequency coarse tuning bits.	000000
		9 F	Reserved	Reserved for factory use.	0
	8	Reserved	Reserved for factory use.	0	
		7	bias_sleep	When set, the bias amplifier is put into sleep mode.	0
		6	tsense_sleep	Turns off the temperature sensor when asserted.	0
		5	pll_sleep	When set, the PLL is put into sleep mode.	1
		4	clkrecv_sleep	When asserted the clock input receiver gets put into sleep mode. This affects the OSTR receiver as well.	0
		3	sleepA	When set, the DACA is put into sleep mode.	0
		2	sleepB	When set, the DACB is put into sleep mode.	0
		1	sleepC	When set, the DACC is put into sleep mode.	0
		0	sleepD	When set, the DACD is put into sleep mode.	0

Register name: config27 - Address: 0x1B, Default: 0x0000

Register Name	Address	Bit	Name		Function		Default Value
config27	0x1B	15	extref_ena	Allows the device to use a 0: Internal reference 1: External reference	an external reference or th	e internal reference.	0
	14	Reserved	Reserved for factory use.			0	
		13	Reserved	Reserved for factory use.			0
		12	Reserved	Reserved for factory use.			0
		11	fuse_sleep	Put the fuses to sleep who Note: Default value is '0	•	proper operation	0
		10	Reserved	Reserved for factory use.			0
		9	Reserved	Reserved for factory use.			0
		8	Reserved	Reserved for factory use.			0
		7	Reserved	Reserved for factory use.			0 0
		6 5:0	Reserved	Reserved for factory use.			
			atest	supply voltages are within internal die voltages can b be floating without any pu In ATEST mode, the TXE be active at all time.	h the range. When ATEST be measured at the TXEN III-up or pull-down resistor	hal die voltages to ensure the mode is programmed, the A pin. The TXENA pin (N9) must s. s are bypassed, and output will	000000
				Config27, bit<5:0>	Description	Expected Nominal Voltage	
				001110	DACA AVSS	0V	
				001111	DACA DVDD	1.2V	
				010000	DACA AVDD	3.3V	
				010110	DACB AVSS	0V	
				010111	DACB DVDD	1.2V	
				011000	DACB AVDD	3.3V	
				011110	DACC AVSS	0V	
				011111	DACC DVDD	1.2V	
				100000	DACC AVDD	3.3V	
				100110	DACD AVSS	0V	
				100111	DACD DVDD	1.2V	
				101000	DACD AVDD	3.3V	
				110000	1.2VDIG	1.2V	
				000101	1.2VCLK	1.2V	



Register name: config28 - Address: 0x1C, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config28	0x1C	15:8	Reserved	Reserved for factory use.	0x00
		7:0	Reserved	Reserved for factory use.	0x00

Register name: config29 - Address: 0x1D, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config29	0x1D	15:8	Reserved	Reserved for factory use.	0x00
		7:0	Reserved	Reserved for factory use.	0x00

Register name: config30 – Address: 0x1E, Default: 0x1111

Register Name	Address	Bit	Name	Function	Default Value
config30	0x1E	15:12	syncsel_qmoffsetAB(3:0)	Selects the syncing source(s) of the AB data path double buffered QMC offset registers. A '1' in the bit enables the signal as a sync source. More than one sync source is permitted. Bit 15: sif_sync (via <i>config31</i>) Bit 14: SYNC Bit 13: OSTR Bit 12: Auto-sync from register write	0001
		11:8	syncsel_qmoffsetCD(3:0)	Selects the syncing source(s) of the CD data path double buffered QMC offset registers. A '1' in the bit enables the signal as a sync source. More than one sync source is permitted. Bit 11: sif_sync (via <i>config31</i>) Bit 10: SYNC Bit 9: OSTR Bit 8: Auto-sync from register write	0001
		7:4	syncsel_qmcorrAB(3:0)	Selects the syncing source(s) of the AB data path double buffered QMC offset registers. A '1' in the bit enables the signal as a sync source. More than one sync source is permitted. Bit 7: sif_sync (via <i>config31</i>) Bit 6: SYNC Bit 5: OSTR Bit 4: Auto-sync from register write	0001
		3:0	syncsel_qmcorrCD(3:0)	Selects the syncing source(s) of the CD data path double buffered QMC offset registers. A '1' in the bit enables the signal as a sync source. More than one sync source is permitted. Bit 3: sif_sync (via <i>config31</i>) Bit 2: SYNC Bit 1: OSTR Bit 0: Auto-sync from register write	0001



SLAS751B - MARCH 2011 - REVISED SEPTEMBER 2011

Register name: config31 – Address: 0x1F, Default: 0x1140

Register Name	Address	Bit	Name	Function	Default Value
config31	0x1F	15:12	syncsel_mixerAB(3:0)	Selects the syncing source(s) of the AB data path double buffered mixer registers. A '1' in the bit enables the signal as a sync source. More than one sync source is permitted. Bit 15: sif_sync (via <i>config31</i>) Bit 14: SYNC Bit 13: OSTR Bit 12: Auto-sync from register write	0001
		11:8	syncsel_mixerCD(3:0)	Selects the syncing source(s) of the CD data path double buffered mixer registers. A '1' in the bit enables the signal as a sync source. More than one sync source is permitted. Bit 11: sif_sync (via <i>config31</i>) Bit 10: SYNC Bit 9: OSTR Bit 8: Auto-sync from register write	0001
		7:4	syncsel_nco(3:0)	Selects the syncing source(s) of the two NCO accumulators. A '1' in the bit enables the signal as a sync source. More than one sync source is permitted. Bit 7: sif_sync (via <i>config31</i>) Bit 6: SYNC Bit 5: OSTR Bit 4: ISTR	0100
		3:2	syncsel_fifo_input	Selects either ISTR or SYNC LVDS signal to be routed to the internal FIFO_ISTR path if <i>syncsel_fifoin(3:0)</i> is set to be ISTR (i.e. <i>syncsel_fifoin(3:0)</i> = "0010"). In conjunction with config1 register bit(8), this allows flexibility of external LVDS signal routing to the internal FIFO. The <i>syncsel_fifo_input(1:0)</i> can only have one bit active at a time. 00: external LVDS ISTR signal to internal FIFO_ISTR path 01: external LVDS SYNC signal to internal FIFO_ISTR path 10: external LVDS ISTR signal to internal FIFO_ISTR path 11: external LVDS SYNC signal to internal FIFO_ISTR path	00
		1	sif_sync	SIF created sync signal. Set to '1' to cause a sync and then clear to '0' to remove it.	0
		0	Reserved	Reserved for factory use.	0

Register name: config32 - Address: 0x20, Default: 0x2400

Register Name	Address	Bit	Name		Function	Default Value
config32	0x20	15:12	syncsel_fifoin(3:0)		e(s) of the FIFO input side. A '1' in the bit enables the fore than one sync source is permitted. onfig31)	0010
		11:8	syncsel_fifoout(3:0)	signal as a sync source. N	Sync Sources Mode lync Source mode	0100
		7:1	Reserved	Reserved for factory use.		0000
		0	clkdiv_sync_sel	Selects the signal source t	for clock divider synchronization.	0
				clkdiv_sync_sel	Sync Source	
				0	OSTR	
				1	ISTR, SYNC, or SIF SYNC, based on syncsel_fifoin source selection (config32, bit<15:12>)	

Register name: config33 - Address: 0x21, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config33	0x21	15:0	Reserved	Reserved for factory use.	0x0000

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Register name: config34 - Address: 0x22, Default: 0x1B1B

Register Name	Address	Bit	Name	Function	Default Value
config34	0x22	15:14	pathA_in_sel(1:0)	Selects the word used for the A channel path.	00
		13:12	pathB_in_sel(1:0)	Selects the word used for the B channel path.	01
		11:10	pathC_in_sel(1:0)	Selects the word used for the C channel path.	10
		9:8	pathD_in_sel(1:0)	Selects the word used for the D channel path.	11
		7:6	DACA_out_sel(1:0)	Selects the word used for the DACA output.	00
		5:4	DACB_out_sel(1:0)	Selects the word used for the DACB output.	01
		3:2	DACC_out_sel(1:0)	Selects the word used for the DACC output.	10
		1:0	DACD_out_sel(1:0)	Selects the word used for the DACD output.	11

Register name: config35 - Address: 0x23, Default: 0xFFFF

Register Name	Address	Bit	Name		Function	Default Value
config35	0x23	15:0	sleep_cntl(15:0)	bit in this register is set, the SLEEF	SLEEP signal (pin N11) to different blocks. When a P signal will be sent to the corresponding block. The e SLEEP is logic HIGH and the correspond bit is set	0xFFFF
				These bits do not override SIF bits	in config26 that control the same sleep function.	
				sleep_cntl(bit)	Function	
				15	DACA sleep	
				14	DACB sleep	
				13	DACC sleep	
				12	DACD sleep	
				11	Clock receiver sleep	
				10	PLL sleep	
				9	LVDS data sleep	
				8	LVDS control sleep	
				7	Temp sensor sleep	
				6	reserved	
				5	Bias amplifier sleep	
				All others	not used	

Register name: config36 - Address: 0x24, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config36	0x24	15:13	datadly(2:0)	Controls the delay of the data inputs through the LVDS receivers. Each LSB adds approximately 50 ps 0: Minimum	000
		12:10	clkdly(2:0)	Controls the delay of the data clock through the LVDS receivers. Each LSB adds approximately 50 ps 0: Minimum	000
		9:0	Reserved	Reserved for factory use.	0x000

Register name: config37 - Address: 0x25, Default: 0x7A7A

Register Name	Address	Bit	Name	Function	Default Value
config37	0x25	15:0	iotest_pattern0	Dataword0 in the IO test pattern. It is used with the seven other words to test the input data. At the start of the IO test pattern, this word should be aligned with rising edge of ISTR or SYNC signal to indicate sample 0.	0x7A7A



SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

Register name: config38 – Address: 0x26, Default: 0xB6B6

Register Name	Address		Name	Function	Default Value
config38	0x26	15:0	iotest_pattern1	Dataword1 in the IO test pattern. It is used with the seven other words to test the input data.	0xB6B6

Register name: config39 - Address: 0x27, Default: 0xEAEA

Register Name	Address	Bit	Name	Function	Default Value
config39	0x27	15:0	iotest_pattern2	Dataword2 in the IO test pattern. It is used with the seven other words to test the input data.	0xEAEA

Register name: config40 – Address: 0x28, Default: 0x4545

Register Name	Address	ss Bit Name Function Va	Default Value		
config40	0x28	15:0	iotest_pattern3	Dataword3 in the IO test pattern. It is used with the seven other words to test the input data.	0x4545

Register name: config41 – Address: 0x29, Default: 0x1A1A

Register Name	Address	Bit	Name	Function	Default Value
config41	0x29	15:0	iotest_pattern4	Dataword4 in the IO test pattern. It is used with the seven other words to test the input data.	0x1A1A

Register name: config42 - Address: 0x2A, Default: 0x1616

Register Name	Address	Bit	Name	Function	Default Value	
config42	0x2A	15:0	iotest_pattern5	Dataword5 in the IO test pattern. It is used with the seven other words to test the input data.	0x1616	

Register name: config43 - Address: 0x2B, Default: 0xAAAA

Register Name	Address	Bit	Name	Function	Default Value
config43	0x2B	15:0	iotest_pattern6	Dataword6 in the IO test pattern. It is used with the seven other words to test the input data.	0xAAAA

Register name: config44 – Address: 0x2C, Default: 0xC6C6

Register Name	Address	Bit	Name	Function	Default Value
config44	0x2C	15:0	iotest_pattern7	Dataword7 in the IO test pattern. It is used with the seven other words to test the input data.	0xC6C6

Register name: config45 - Address: 0x2D, Default: 0x0004

Register Name	Address	Bit	Name	Function	Default Value
config45	0x2D	15	Reserved	Reserved for factory use.	0
		14	ostrtodig_sel	When set, the OSTR signal is passed directly to the digital block. This is the signal that is used to clock the dividers.	0
		13	ramp_ena	When set, a ramp signal is inserted in the input data at the FIFO input.	0
		12:1	Reserved	Reserved for factory use.	0000 0000 0010
		0	sifdac_ena	When set, the DAC output is set to the value in <i>sifdac(15:0)</i> in register <i>config48</i> .	0



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Register name: config46 - Address: 0x2E, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config46	0x2E	15:8	grp_delaya(7:0)	Sets the group delay function for DACA. The maximum delay ranges from 30ps to 100ps and is dependent on DAC sample clock. Contact TI for specific application information.	0x00
		7:0	grp_delayB(7:0)	Sets the group delay function for DACB. The maximum delay ranges from 30ps to 100ps and is dependent on DAC sample clock. Contact TI for specific application information.	0x00

Register name: config47 – Address: 0x2F, Default: 0x0000

Register Name	Address	Bit	Name	Function	Default Value
config47	0x2F	15:8	grp_delayC(7:0)	Sets the group delay function for DACC. The maximum delay ranges from 30ps to 100ps and is dependent on DAC sample clock. Contact TI for specific application information.	0x00
		7:0	grp_delayD(7:0)	Sets the group delay function for DACD. The maximum delay ranges from 30ps to 100ps and is dependent on DAC sample clock. Contact TI for specific application information.	0x00

Register name: config48 – Address: 0x30, Default: 0x0000

	Register Name	Address	Bit	Name	Function	Default Value	
ſ	config48	0x30	15:0	sifdac(15:0)	Value sent to the DACs when <i>sifdac_ena</i> is asserted. DATACLK must be running to latch this value into the DACs. The format would be based on twos in register <i>config2</i> .	0x0000	

Register name: version- Address: 0x7F, Default: 0x5409 (READ ONLY)

Register Name	Address	Bit	Name	Function	Default Value
version	0x7F	15:10	Reserved	Reserved for factory use.	010101
		9	Reserved	Reserved for factory use.	0
		8:7	Reserved	Reserved for factory use.	00
		6:5	Reserved	Reserved for factory use.	00
		4:3	deviceid(1:0)	Returns '01' for DAC34H84.	01
		2:0	versionid(2:0)	A hardwired register that contains the version of the chip.	001



DATA INTERFACE

The DAC34H84 has a 32-bit LVDS bus that accepts quad, 16-bit data in word-wide format. The quad-16-bit data can be input to the device using a dual-bus, 16-bit interface. The bus accepts LVDS transfer rates up to 1.25GSPS which corresponds to a maximum data rate of 625MSPS per data channel. The default LVDS bus input assignment is shown in Table 3.

Data Paths	Pins
A and B	DAB[150]
C and D	DCD[150]

Table 3. LVDS Bus Input Assignment

Data is sampled by the LVDS double data rate (DDR) clock DATACLK. Setup and hold requirements must be met for proper sampling. A and C data are captured on the rising edge of DATACLK. B and D data are captured on the falling edge of DATACLK.

For both input bus modes, a sync signal, either ISTR or SYNC, is required to sync the FIFO read and/or write pointers.

The sync signal, either ISTR or SYNC, can be either a pulse or a periodic signal where the sync period corresponds to multiples of 8 samples. ISTR or SYNC is sampled by a rising edge in DATACLK. The pulse-width $t_{(ISTR_SYNC)}$ needs to be at least equal to 1/2 of the DATACLK period.

DATA FORMAT

The 16-bit data for channels A and B is interleaved in the form $A_0[15:0]$, $B_0[15:0]$, $A_1[15:0]$, $B_1[15:0]$, $A_2[15:0]$... into the DAB[15:0]P/N LVDS inputs. Similarly data for channels C and D is interleaved into the DCD[15:0]P/N LVDS inputs. Data into the DAC34H84 is formatted according to the diagram shown in Figure 51 where index 0 is the data LSB and index 15 is the data MSB.

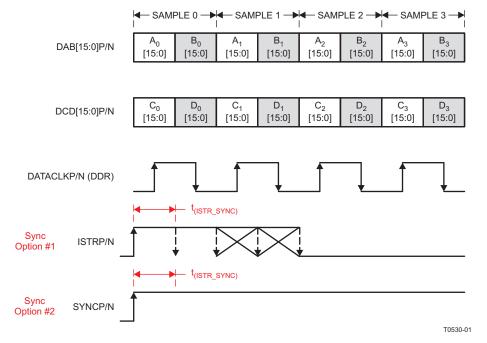


Figure 51. Data Transmission Format

The FIFO read and write pointer can also be synced by SIF SYNC as the third sync option if multi-device synchronization is not needed. In this sync mode, the *syncsel_fifoin(3:0)* and *syncsel_fifoout(3:0)* in register config32 need to be both set to "1000" for the SIF SYNC option.

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INPUT FIFO

The DAC34H84 includes a 4-channel, 16-bits wide and 8-samples deep input FIFO which acts as an elastic buffer. The purpose of the FIFO is to absorb any timing variations between the input data and the internal DAC data rate clock such as the ones resulting from clock-to-data variations from the data source.

Figure 52 shows a simplified block diagram of the FIFO.

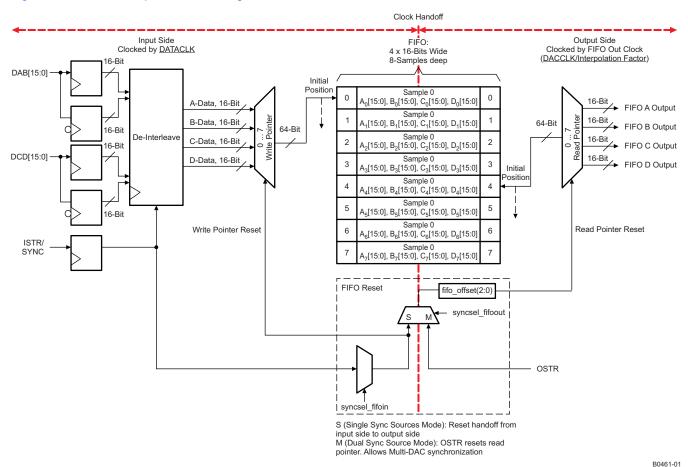


Figure 52. DAC34H84 FIFO Block Diagram

Data is written to the device 32-bits at a time on the rising and falling edges of DATACLK. In order to form a complete 64-bit wide sample (16-bit A-data, 16-bit B-data, 16-bit C-data, and 16-bit D-data) one DATACLK period is required. Each 64-bit wide sample is written into the FIFO at the address indicated by the write pointer. Similarly, data from the FIFO is read by the FIFO Out Clock 64-bits at a time from the address indicated by the read pointer. The FIFO Out Clock is generated internally from the DACCLK signal and its rate is equal to DACCLK/Interpolation. Each time a FIFO write or FIFO read is done the corresponding pointer moves to the next address.

The reset position for the FIFO read and write pointers is set by default to addresses 0 and 4 as shown in Figure 52. This offset gives optimal margin within the FIFO. The default read pointer location can be set to another value using *fifo_offset(2:0)* in register *config3* (address 4 by default). Under normal conditions data is written-to and read-from the FIFO at the same rate and consequently the write and read pointer gap remains constant. If the FIFO write and read rates are different, the corresponding pointers will be cycling at different speeds which could result in pointer collision. Under this condition the FIFO attempts to read and write data from the same address at the same time which will result in errors and thus must be avoided.

The write pointer sync source is selected by *syncsel_fifoin(3:0)* in register *config32*. In most applications either ISTR or SYNC are used to reset the write pointer. Unlike DATA, the sync signal is latched only on the rising edges of DATACLK. A rising edge on the sync signal source causes the pointer to return to its original position.



Similarly, the read pointer sync source is selected by *syncsel_fifoout(3:0)*. The write pointer sync source can be set to reset the read pointer as well. In this case, the FIFO Out clock will recapture the write pointer sync signal to reset the read pointer. This clock domain transfer (DATACLK to FIFO Out Clock) results in phase ambiguity of the sync signal. This limits the precise control of the output timing and makes full synchronization of multiple devices difficult.

To alleviate this, the device offers the alternative of resetting the FIFO read pointer independently of the write pointer by using the OSTR signal. The OSTR signal is sampled by DACCLK and must satisfy the timing requirements in the specifications table. In order to minimize the skew it is recommended to use the same clock distribution device such as Texas Instruments CDCE62005 to provide the DACCLK and OSTR signals to all the DAC34H84 devices in the system. Swapping the polarity of the DACCLK outputs with respect to the OSTR ones establishes proper phase relationship.

The FIFO pointers reset procedure can be done periodically or only once during initialization as the pointers automatically return to the initial position when the FIFO has been filled. To reset the FIFO periodically, it is necessary to have the ISTR, SYNC, and OSTR signals to repeat at multiples of 8 FIFO samples. To disable FIFO reset, set *syncsel_fifoin(3:0)* and *syncsel_fifoout(3:0)* to "0000".

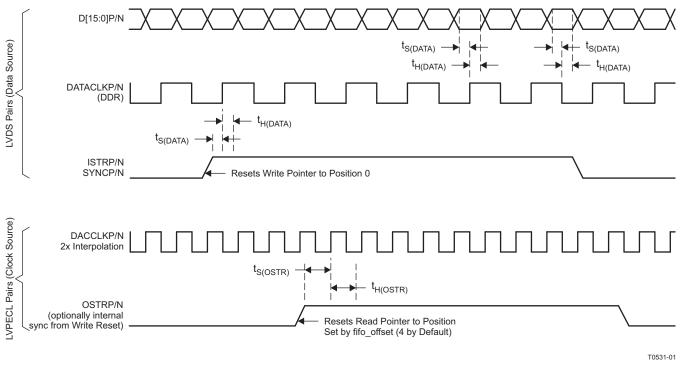
The frequency limitation for ISTR and SYNC signals are the following:

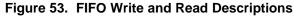
 $f_{sync} = f_{DATACLK}/(n \times 8)$ where n = 1, 2, ...

The frequency limitation for the OSTR signal is the following:

 $f_{OSTR} = f_{DAC}/(n x \text{ interpolation } x 8)$ where n = 1, 2, ...

The frequencies above are at maximum when n = 1. This is when the ISTR, SYNC, or OSTR have a rising edge transition every 8 FIFO samples. The occurrence can be made less frequent by setting n > 1, for example, every $n \times 8$ FIFO samples.





FIFO MODES OF OPERATION

The DAC34H84 input FIFO can be completely bypassed through registers *config0* and *config32*. The register configuration for each mode is described in Table 4.

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Register Control Bits

config0 fifo_ena config32 syncsel fifoout(3:0)

			config0 and co	nfig32 FIFO Bits			
FIFO Mode	fifo_ena	syncsel_fifoout					
		Bit 3: sif_sync	Bit 2: OSTR	Bit 1: ISTR	Bit 0: SYNC		
Dual Sync Sources	1	0	1	0	0		
Single Sync Source	1	0	0	1 or 0 Depends on the sync source	1 or 0 Depends on the sync source		
Bypass	0	Х	Х	X	Х		

Table 4. FIFO Operation Modes

DUAL SYNC SOURCES MODE

This is the recommended mode of operation for those applications that require precise control of the output timing. In Dual Sync Sources mode, the FIFO write and read pointers are reset independently. The FIFO write pointer is reset using the LVDS ISTR or SYNC signal, and the FIFO read pointer is reset using the LVPECL OSTR signal. This allows LVPECL OSTR signal to control the phase of the output for either a single chip or multiple chips. Multiple devices can be fully synchronized in this mode.

SINGLE SYNC SOURCE MODE

In Single Sync Source mode, the FIFO write and read pointers are reset from the same source, either LVDS ISTR or LVDS SYNC signal. This mode has a possibility of up to 2 DAC clocks offset between the multiple DAC outputs. Applications requiring exact output timing control will need Dual Sync Sources mode instead of Single Sync Source Mode. A single rising edge for FIFO and clock divider sync is recommended. Periodic sync signal is not recommended due to the non-deterministic latency of the sync signal through the clock domain transfer.

In this mode, there is a chance for FIFO pointers 2 away alarm (or possibly 1 away alarm) to occur at initial setup/syncing. This is the result of Single Sync Source mode having 0 to 3 address location slip, which is caused by the asynchronous handoff of the sync signal occurring between the DATACLK zone and DACCLK zone. The asynchronous relationship between the clock domains means there could be a slip (from nominal) in the READ and Write pointers at initial syncing. For example, with the default programming of FIFO Offset of 4, the actual FIFO Offset may be 3, 2, or in some instances, 1. Please note that in this mode, the nominal address location slip is 0 with the possibility getting less for each increase in slip amount. Also, the slip does not continue to occur as the device functions, but the READ/WRITE pointers may not be at optimal settings. In situation of alarm occurrence:

- 1. Adjust the FIFO offset accordingly and resynchronize the FIFO, data formatter, etc such that there are no alarm reported or at least only 2 away alarm is reported.
- 2. The FIFO collision alarm is a warning of the system since the read and write processes occur at the same pointer. However, the FIFO 1 away or 2 away alarms are informational for the system designer. The important thing for these two alarms is that the alarm should not get closer to collision during normal operation. If 1 away alarm and alarm collision starts to occur, it is a warning to check for system errors. The system should have an interrupt or algorithm to fix the error and resynchronize the alarm appropriately.

BYPASS MODE

In FIFO bypass mode, the FIFO block is not used. As a result the input data is handed off from the DATACLK to the DACCLK domain without any compensation. In this mode the relationship between DATACLK and DACCLK is critical and used as a synchronizing mechanism for the internal logic. Due to this constraint this mode is **not recommended**. In bypass mode the pointers have no effect on the data path or handoff.



SLAS751B – MARCH 2011 – REVISED SEPTEMBER 2011

CLOCKING MODES

The DAC34H84 has a dual clock setup in which a DAC clock signal is used to clock the DAC cores and internal digital logic and a separate DATA clock is used to clock the input LVDS receivers and FIFO input. The DAC34H84 DAC clock signal can be sourced directly or generated through an on-chip low-jitter phase-locked loop (PLL).

In those applications requiring extremely low noise it is recommended to bypass the PLL and source the DAC clock directly from a high-quality external clock to the DACCLK input. In most applications system clocking can be simplified by using the on-chip PLL to generate the DAC core clock while still satisfying performance requirements. In this case the DACCLK pins are used as the reference frequency input to the PLL.

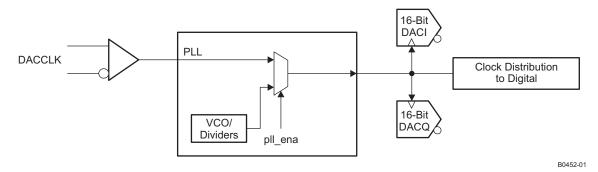


Figure 54. Top Level Clock Diagram

PLL BYPASS MODE

In PLL bypass mode a very high quality clock is sourced to the DACCLK inputs. This clock is used to directly source the DAC34H84 DAC sample rate clock. This mode gives the device best performance and is recommended for extremely demanding applications.

The bypass mode is selected by setting the following:

- 1. *pll_ena* bit in register *config24* to "0" to bypass the PLL circuitry.
- 2. *pll_sleep* bit in register *config*26 to "1" to put the PLL and VCO into sleep mode.

PLL MODE

In this mode the clock at the DACCLKP/N input functions as a reference clock source to the on-chip PLL. The on-chip PLL will then multiply this reference clock to supply a higher frequency DAC sample rate clock. Figure 55 shows the block diagram of the PLL circuit.

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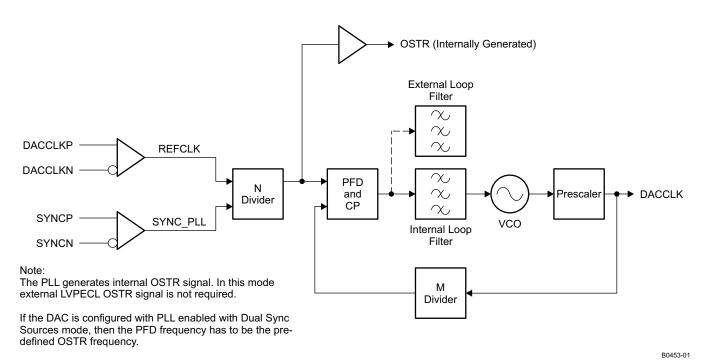


Figure 55. PLL Block Diagram

The DAC34H84 PLL mode is selected by setting the following:

- 1. *pll_ena* bit in register *config24* to "1" to route to the PLL clock path.
- 2. *pll_sleep* bit in register *config26* to "0" to enable the PLL and VCO.

The output frequency of the VCO is designed to be the in the range from 3.3GHz to 4.0GHz. The prescaler value, $pll_p(2:0)$ in register config24, should be chosen such that the product of the prescaler value and DAC sample rate clock is within the VCO range. To maintain optimal PLL loop, the coarse tune bits, $pll_vco(5:0)$ in register config26, can adjust the center frequency of the VCO towards the product of the prescaler value and DAC sample rate clock. Figure 56 shows a typical relationship between coarse tune bits and VCO center frequency.

DAC34H84

SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

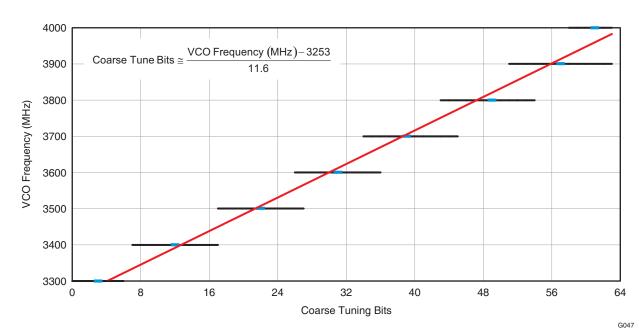


Figure 56. Typical PLL/VCO Lock Range vs Coarse Tuning Bits

Common wireless infrastructure frequencies (614.4MHz, 737.28MHz, 983.04MHz, etc.) are generated from this VCO frequency in conjunction with the pre-scaler setting as shown in Table 5.

Table 5. VCO Opera	ation
--------------------	-------

VCO Frequency (MHz)	Pre-Scale Divider	Desired DACCLK (MHz)	pll_p(2:0)
3932.16	8	491.52	111
3686.4	6	614.4	110
3686.4	5	737.28	101
3932.16	4	983.04	100

The M divider is used to determine the phase-frequency-detector (PFD) and charge-pump (CP) frequency.

Table 6. PFD and CP Operation

DACCLK Frequency (MHz)	M Divider	PDF Update Rate (MHz)	pll_m(7:0)
491.52	4	122.88	00000100
491.52	8	61.44	00001000
491.52	16	30.72	00010000
491.52	32	15.36	00100000

The N divider in the loop allows the PFD to operate at a lower frequency than the reference clock. Both M and N dividers can keep the PFD frequency below 155 MHz for peak operation.

The overall divide ratio inside the loop is the product of the Pre-Scale and M dividers ($P \times M$) and the following guidelines should be followed:

- The overall divide ratio range is from 24 to 480
- When the overall divide ratio is less than 120, the internal loop filter can assure a stable loop
- · When the overall divide ratio is greater than 120, an external loop filter is required to ensure loop stability

The single charge pump current option is selected by setting $pll_cp(1:0)$ in register *config24* to "01". If an external filter is required, the following filter should be connected to the LPF pin (A1):

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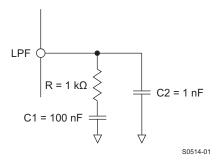


Figure 57. Recommended External Loop Filter

The PLL will generate an internal OSTR signal and does not require the external LVPECL OSTR signal. The OSTR signal is buffered from the N-divider output in the PLL block, and the frequency of the signal is the same as the PFD frequency. Therefore, using PLL with Dual Sync Sources mode would require the PFD frequency to be the pre-defined OSTR frequency. This will allow the FIFO to be synced correctly by the internal OSTR.

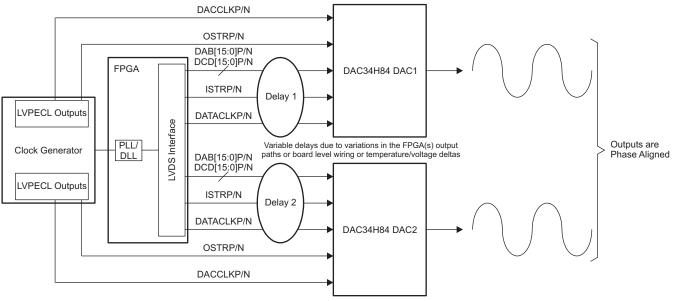
MULTI-DEVICE SYNCHRONIZATION

In various applications, such as multi antenna systems where the various transmit channels information is correlated, it is required that multiple DAC devices are completely synchronized such that their outputs are phase aligned. The DAC34H84 architecture supports this mode of operation.

MULTI-DEVICE SYNCHRONIZATION: PLL BYPASSED WITH DUAL SYNC SOURCES MODE

For single- or multi-device synchronization it is important that delay differences in the data are absorbed by the device so that latency through the device remains the same. Furthermore, to ensure that the outputs from each DAC are phase aligned it is necessary that data is read from the FIFO of each device simultaneously. In the DAC34H84 this is accomplished by operating the multiple devices in Dual Sync Sources mode. In this mode the additional OSTR signal is required by each DAC34H84 to be synchronized.

Data into the device is input as LVDS signals from one or multiple baseband ASICs or FPGAs. Data into multiple DAC devices can experience different delays due to variations in the digital source output paths or board level wiring. These different delays can be effectively absorbed by the DAC34H84 FIFO so that all outputs are phase aligned correctly.



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Figure 58. SynchronizationSystem in Dual Sync Sources Mode with PLL Bypassed



SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

For correct operation both OSTR and DACCLK must be generated from the same clock domain. The OSTR signal is sampled by DACCLK and must satisfy the timing requirements in the specifications table. If the clock generator does not have the ability to delay the DACCLK to meet the OSTR timing requirement, the polarity of the DACCLK outputs can be swapped with respect to the OSTR ones to create 180 degree phase delay of the DACCLK. This may help establish proper setup and hold time requirement of the OSTR signal.

Careful board layout planning must be done to ensure that the DACCLK and OSTR signals are distributed from device to device with the lowest skew possible as this will affect the synchronization process. In order to minimize the skew across devices it is recommended to use the same clock distribution device to provide the DACCLK and OSTR signals to all the DAC devices in the system.

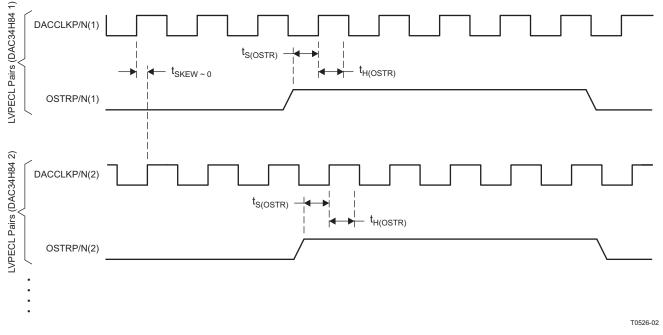


Figure 59. Timing Diagram for LVPECL Synchronization Signals

The following steps are required to ensure the devices are fully synchronized. The procedure assumes all the DAC34H84 devices have a DACCLK and OSTR signal and must be carried out on each device.

- 1. Start-up the device as described in the power-up sequence. Set the DAC34H84 in Dual Sync Sources mode and select OSTR as the clock divider sync source (*clkdiv_sync_sel* in register *config32*).
- 2. Sync the clock divider and FIFO pointers.
- 3. Verify there are no FIFO alarms either through register *config5* or through the ALARM pin.
- 4. Disable clock divider sync by setting *clkdiv_sync_ena* to "0" in register *config0*.

After these steps all the DAC34H84 outputs will be synchronized.

MULTI-DEVICE SYNCHRONIZATION: PLL ENABLED WITH DUAL SYNC SOURCES MODE

The DAC34H84 allows exact phase alignment between multiple devices even when operating with the internal PLL clock multiplier. In PLL clock mode, the PLL generates the DAC clock and an internal OSTR signal from the reference clock applied to the DACCLK inputs so there is no need to supply an additional LVPECL OSTR signal.

For this method to operate properly the SYNC signal should be set to reset the PLL N dividers to a known state by setting *pll_ndivsync_ena* in register *config24* to "1". The SYNC signal resets the PLL N dividers with a rising edge, and the timing relationship $t_{s(SYNC_PLL)}$ and $t_{h(SYNC_PLL)}$ are relative to the reference clock presented on the DACCLK pin.

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SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

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Both SYNC and DACCLK can be set as low frequency signals to greatly simplifying trace routing (SYNC can be just a pulse as a single rising edge is required, if using a periodic signal it is recommended to clear the *pll_ndivsync_ena* bit after resetting the PLL dividers). Besides the $t_{s(SYNC_PLL)}$ and $t_{h(SYNC_PLL)}$ requirement between SYNC and DACCLK, there is no additional required timing relationship between the SYNC and ISTR signals or between DACCLK and DATACLK. The only restriction as in the PLL disabled case is that the DACCLK and SYNC signals are distributed from device to device with the lowest skew possible.

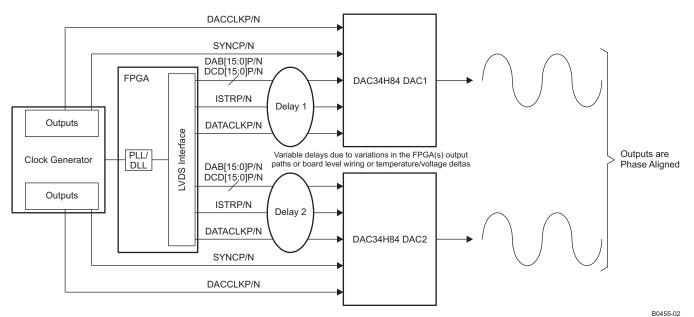


Figure 60. Synchronization System in Dual Sync Sources Mode with PLL Enabled

The following steps are required to ensure the devices are fully synchronized. The procedure assumes all the DAC34H84 devices have a DACCLK and OSTR signal and must be carried out on each device.

- 1. Start-up the device as described in the power-up sequence. Set the DAC34H84 in Dual Sync Sources mode and enable SYNC to reset the PLL dividers (set *pll_ndivsync_ena* in register *config24* to "1").
- 2. Reset the PLL dividers with a rising edge on SYNC.
- 3. Disable PLL dividers resetting.
- 4. Sync the clock divider and FIFO pointers.
- 5. Verify there are no FIFO alarms either through register *config5* or through the ALARM pin.
- 6. Disable clock divider sync by setting *clkdiv_sync_ena* to "0" in register *config0*.

After these steps all the DAC34H84 outputs will be synchronized.

MULTI-DEVICE OPERATION: SINGLE SYNC SOURCE MODE

In Single Sync Source mode, the FIFO write and read pointers are reset from the same sync source, either ISTR or SYNC. Although the FIFO in this mode can still absorb the data delay differences due to variations in the digital source output paths or board level wiring it is impossible to guarantee data will be read from the FIFO of different devices simultaneously thus preventing exact phase alignment.

In Single Sync Source mode the FIFO read pointer reset is handoff between the two clock domains (DATACLK and FIFO OUT CLOCK) by simply re-sampling the write pointer reset. Since the two clocks are asynchronous there is a small but distinct possibility of a meta-stability during the pointer handoff. This meta-stability can cause the outputs of the multiple devices to slip by up to 2 DAC clock cycles.

When the PLL is enabled with Single Sync Source mode, the FIFO read pointer is not synchronized by the OSTR signal. Therefore, there is no restriction on the PLL PFD frequency as described in the previous section.



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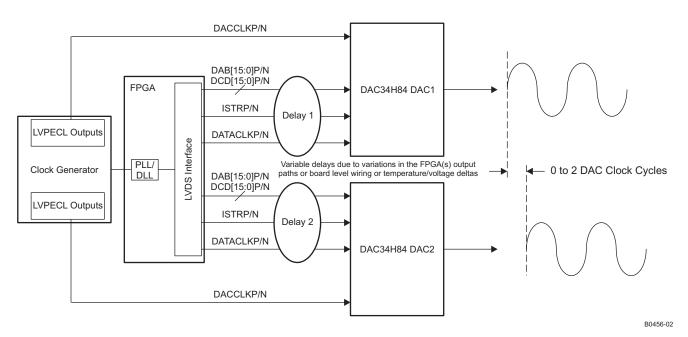


Figure 61. Multi-Device Operation in Single Sync Source Mode

FIR FILTERS

Figure 62 through Figure 65 show the magnitude spectrum response for the FIR0, FIR1, FIR2 and FIR3 interpolating filters where f_{IN} is the input data rate to the FIR filter. Figure 66 to Figure 69 show the composite filter response for 2x, 4x, 8x and 16x interpolation. The transition band for all interpolation settings is from 0.4 to 0.6 x f_{DATA} (the input data rate to the device) with < 0.001dB of pass-band ripple and > 90 dB stop-band attenuation.

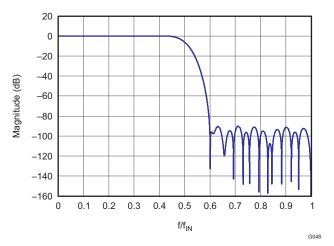
The DAC34H84 also has a 9-tap inverse sinc filter (FIR4) that runs at the DAC update rate (f_{DAC}) that can be used to flatten the frequency response of the sample-and-hold output. The DAC sample-and-hold output sets the output current and holds it constant for one DAC clock cycle until the next sample, resulting in the well-known $\sin(x)/x$ or $\sin(x)$ frequency response (Figure 70, red line). The inverse sinc filter response (Figure 70, blue line) has the opposite frequency response from 0 to 0.4 x Fdac, resulting in the combined response (Figure 70, green line). Between 0 to 0.4 x f_{DAC} , the inverse sinc filter compensates the sample-and-hold roll-off with less than 0.03 dB error.

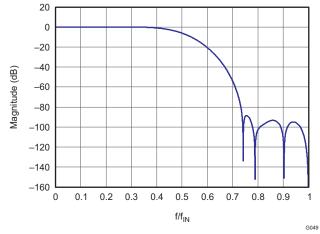
The inverse sinc filter has a gain > 1 at all frequencies. Therefore, the signal input to FIR4 must be reduced from full scale to prevent saturation in the filter. The amount of back-off required depends on the signal frequency, and is set such that at the signal frequencies the combination of the input signal and filter response is less than 1 (0 dB). For example, if the signal input to FIR4 is at 0.25 x f_{DAC} , the response of FIR4 is 0.9 dB, and the signal must be backed off from full scale by 0.9 dB to avoid saturation. The gain function in the QMC blocks can be used to reduce the amplitude of the input signal. The advantage of FIR4 having a positive gain at all frequencies is that the user is then able to optimize the back-off of the signal based on its frequency.

The filter taps for all digital filters are listed in Table 4. Note that the loss of signal amplitude may result in lower SNR due to decrease in signal amplitude.

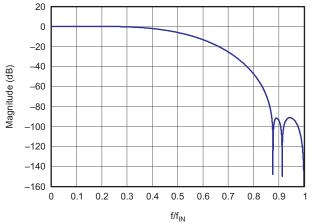
DAC34H84

SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011











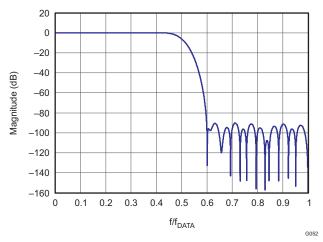


Figure 66. 2x Interpolation Composite Response



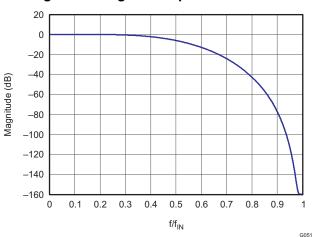


Figure 65. Magnitude Spectrum for FIR3

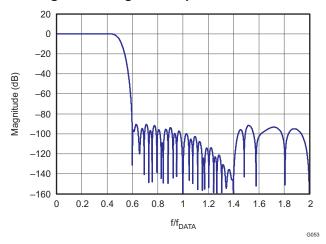


Figure 67. 4x Interpolation Composite Response

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DAC34H84

SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

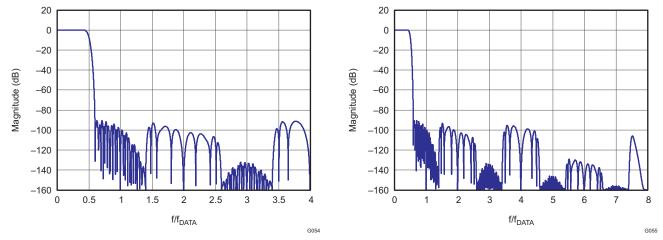


Figure 68. 8x Interpolation Composite Response

Figure 69. 16x Interpolation Composite Response

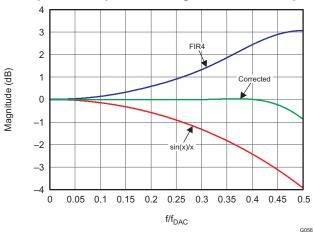


Figure 70. Magnitude Spectrum for Inverse Sinc Filter

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Table 7. FIR Filter Coefficients

	Interpolating Half-band Filters Non-Interpolating Inverse-SINC Filter								
FI	FIR0FIR159 Taps23 Taps		R1 FIR2			FIR3		FIR4	
59 T			aps	11 Taps		11 Taps		9 Taps	
6	6	-12	-12	29	29	3	3	1	1
0	0	0	0	0	0	0	0	-4	-4
-19	-19	84	84	-214	-214	-25	-25	13	13
0	0	0	0	0	0	0	0	-50	-50
47	47	-336	-336	1209	1209	150	150	592 ⁽¹⁾	
0	0	0	0	2048 ⁽¹⁾		256 ⁽¹⁾			
-100	-100	1006	1006						
0	0	0	0						
192	192	-2691	-2691						
0	0	0	0						
-342	-342	10141	10141						
0	0	16384 ⁽¹⁾							
572	572								
0	0								
-914	-914								
0	0								
1409	1409								
0	0								
-2119	-2119								
0	0								
3152	3152								
0	0								
-4729	-4729								
0	0								
7420	7420								
0	0								
-13334	-13334								
0	0								
41527	41527								
65536 ⁽¹⁾									

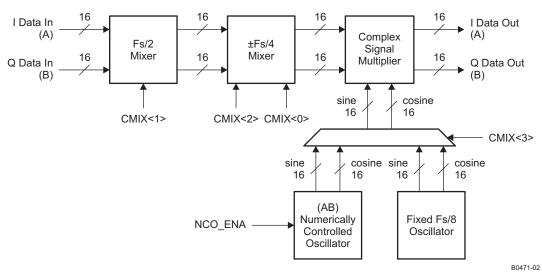
(1) Center taps are highlighted in BOLD



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COMPLEX SIGNAL MIXER

The DAC34H84 has two paths of complex signal mixer blocks that contain two full complex mixer (FMIX) blocks and power saving coarse mixer (CMIX) blocks. The signal path is shown in Figure 71.



Note: Channel CD data path not shown



FULL COMPLEX MIXER

The two FMIX blocks operate with independent Numerically Controlled Oscillators (NCOs) and enable flexible frequency placement without imposing additional limitations in the signal bandwidth. The NCOs have 32-bit frequency registers (*phaseaddAB*(31:0) and *phaseaddCD*(31:0)) and 16-bit phase registers (*phaseoffsetAB*(15:0) and *phaseoffsetCD*(15:0)) that generate the sine and cosine terms for the complex mixing. The NCO block diagram is shown in Figure 72.

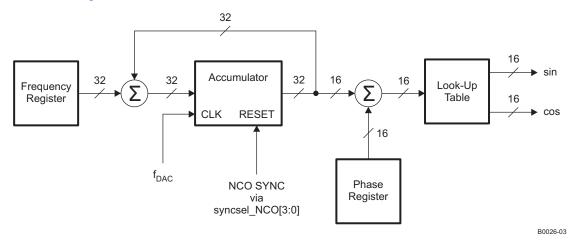


Figure 72. NCO Block Diagram

Synchronization of the NCOs occurs by resetting the NCO accumulators to zero. The synchronization source is selected by $syncsel_NCO(3:0)$ in config31. The frequency word in the phaseaddAB(31:0) and phaseaddCD(31:0) registers is added to the accumulators every clock cycle, f_{DAC} . The output frequency of the NCO is:

$$f_{NCO} = \frac{\text{treq} \times f_{NCO_CLK}}{2^{32}}$$

(1)

DAC34H84

SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

With the complex mixer enabled, the two channels in the mixer path are treated as complex vectors of the form $I_{IN}(t) + j Q_{IN}(t)$. The complex signal multiplier (shown in Figure 73) will multiply the complex channels with the sine and cosine terms generated by the NCO. The resulting output, $I_{OUT}(t) + j Q_{OUT}(t)$, of the complex signal multiplier is:

 $I_{OUT}(t) = (I_{IN}(t)cos(2\pi f_{NCO}t + \delta) - Q_{IN}(t)sin(2\pi f_{NCO}t + \delta)) \times 2^{(mixer_gain - 1)}$ $Q_{OUT}(t) = (I_{IN}(t)sin(2\pi f_{NCO}t + \delta) + Q_{IN}(t)cos(2\pi f_{NCO}t + \delta)) \times 2^{(mixer_gain - 1)}$

where t is the time since the last resetting of the NCO accumulator, δ is the phase offset value and *mixer_gain* is either 0 or 1. δ is given by:

 $\delta = 2\pi \times phase offsetAB/CD(15:0)/2^{16}$

The mixer gain option allows the output signals of the multiplier to reduce by half (6dB). See Mixer Gain section for details.

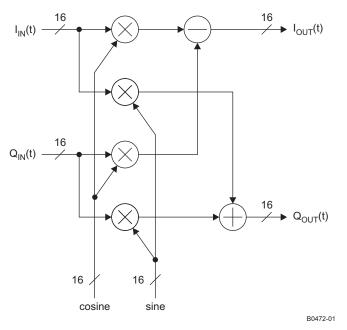


Figure 73. Complex Signal Multiplier

COARSE COMPLEX MIXER

In addition to the full complex mixers, the DAC34H84 also has coarse mixer blocks capable of shifting the input signal spectrum by the fixed mixing frequencies $\pm n \times f_S/8$. Utilizing the coarse mixer instead of the full mixers lowers power consumption.

The output of the fs/2, fs/4, and -fs/4 mixer block is:

 $I_{OUT}(t) = I(t)\cos(2\pi f_{CMIX}t) - Q(t)\sin(2\pi f_{CMIX}t)$

 $Q_{OUT}(t) = I(t)sin(2\pi f_{CMIX}t) + Q(t)cos(2\pi f_{CMIX}t)$

Since the sine and the cosine terms are a function of fs/2, fs/4, or -fs/4 mixing frequencies, the possible resulting value of the terms will only be 1, -1, or 0. The simplified mathematics allows the complex signal multiplier to be bypassed in any one of the modes, thus mixer gain is not available. The fs/2, fs/4, and -fs/4 mixer blocks performs mixing through negating and swapping of I/Q channel on certain sequence of samples. Table 8 shows the algorithm used for those mixer blocks.

MODE	MIXING SEQUENCE
Normal (miyer bynassed)	lout = {+I1, +I2, +I3, +I4}
Normal (mixer bypassed)	Qout = {+Q1, +Q2, +Q3, +Q4}

Table 8. Fs/2, Fs/4, and -Fs/4 Mixing Sequence

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SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

MODE	MIXING SEQUENCE
fs/2	lout = {+I1, -I2, +I3, -I4}
IS/2	Qout = {+Q1, -Q2, +Q3, -Q4}
fs/4	lout = {+11, -Q2, -13, +Q4}
15/4	Qout = {+Q1, +I2, -Q3, -I4}
-fs/4	lout = {+I1, +Q2, -I3, -Q4}
-1S/4	Qout = {+Q1, -I2, -Q3, +I4}

The fs/8 mixer can be enabled along with various combinations of fs/2, fs/4, and –fs/4 mixer. Since the fs/8 mixer uses the complex signal multiplier block with fixed fs/8 sine and cosine term, the output of the multiplier is:

$$\begin{split} I_{\text{OUT}}(t) &= (I_{\text{IN}}(t)\text{cos}(2\pi f_{\text{NCO}}t + \delta) - Q_{\text{IN}}(t)\text{sin}(2\pi f_{\text{NCO}}t + \delta)) \times 2^{(\text{mixer}_gain - 1)} \\ Q_{\text{OUT}}(t) &= (I_{\text{IN}}(t)\text{sin}(2\pi f_{\text{NCO}}t + \delta) + Q_{\text{IN}}(t)\text{cos}(2\pi f_{\text{NCO}}t + \delta)) \times 2^{(\text{mixer}_gain - 1)} \end{split}$$

where f_{CMIX} is the fixed mixing frequency selected by cmix(3:0). The mixing combinations are described in Table 9. The *mixer_gain* option allows the output signals of the multiplier to reduce by half (6dB). See Mixer Gain section for details.

cmix(3:0)	Fs/8 Mixer cmix(3)	Fs/4 Mixer cmix(2)	Fs/2 Mixer cmix(1)	–Fs/4 Mixer cmix(0)	Mixing Mode	
0000	Disabled	Disabled	Disabled	Disabled	No mixing	
0001	Disabled	Disabled	Disabled	Enabled	-Fs/4	
0010	Disabled	Disabled	Enabled	Disabled	Fs/2	
0100	Disabled	Enabled	Disabled	Disabled	+Fs/4	
1000	Enabled	Disabled	Disabled	Disabled	+Fs/8	
1010	Enabled	Disabled	Enabled	Disabled	-3Fs/8	
1100	Enabled	Enabled	Disabled	Disabled	+3Fs/8	
1110	Enabled	Enabled	-Fs/8			
All others	-	_	Not recommende			

Table 9. Coarse Mixer Combinations

MIXER GAIN

The maximum output amplitude out of the complex signal multiplier (i.e., FMIX mode or CMIX mode with fs/8 mixer enabled) occurs if $I_{IN}(t)$ and $Q_{IN}(t)$ are simultaneously full scale amplitude and the sine and cosine arguments are equal to $2\pi \times f_{MIX}t + \delta$ (2N-1) x $\pi/4$, where N = 1, 2, 3, etc....

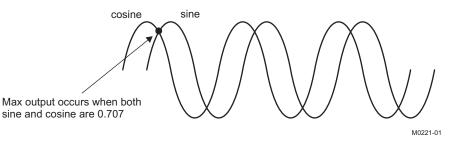


Figure 74. Maximum Output of the Complex Signal Multiplier

With *mixer_gain* = 1 and both $I_{IN}(t)$ and $Q_{IN}(t)$ are simultaneously full scale amplitude, the maximum output possible out of the complex signal multiplier is 0.707 + 0.707 = 1.414 (or 3dB). This configuration can cause clipping of the signal and should therefore be used with caution.

With *mixer_gain* = 0 in *config2*, the maximum output possible out of the complex signal multiplier is $0.5 \times (0.707 + 0.707) = 0.707$ (or -3dB). This loss in signal power is in most cases undesirable, and it is recommended that the gain function of the QMC block be used to increase the signal by 3 dB to compensate.



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REAL CHANNEL UPCONVERSION

The mixer in the DAC34H84 treats the A, B, C, and D inputs are complex input data and produces a complex output for most mixing frequencies. The real input data for each channel can be isolated only when the mixing frequency is set to normal mode or fs/2 mode. Refer to Table 8 for details.

QUADRATURE MODULATION CORRECTION (QMC)

GAIN AND PHASE CORRECTION

The DAC34H84 includes a Quadrature Modulator Correction (QMC) block. The QMC blocks provide a mean for changing the gain and phase of the complex signals to compensate for any I and Q imbalances present in an analog quadrature modulator. The block diagram for the QMC block is shown in Figure 75. The QMC block contains 3 programmable parameters.

Registers *qmc_gainA/B(10:0)* and *qmc_gainC/D(10:0)* controls the I and Q path gains and is an 11-bit unsigned value with a range of 0 to 1.9990 and the default gain is 1.0000. The implied decimal point for the multiplication is between bit 9 and bit 10.

Register *qmc_phaseAB/CD(11:0)* control the phase imbalance between I and Q and are a 12-bit values with a range of –0.5 to approximately 0.49975. The QMC phase term is not a direct phase rotation but a constant that is multiplied by each "Q" sample then summed into the "I" sample path. This is an approximation of a true phase rotation in order to keep the implementation simple.

LO feed-through can be minimized by adjusting the DAC offset feature described below.



DAC34H84

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SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

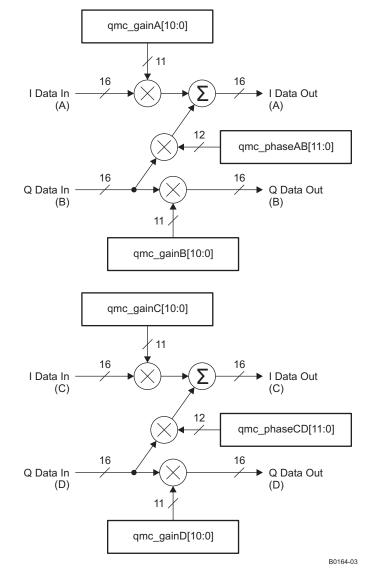


Figure 75. QMC Block Diagram

OFFSET CORRECTION

Registers $qmc_offsetA(12:0)$, $qmc_offsetB(12:0)$, $qmc_offsetC(12:0)$ and $qmc_offsetD(12:0)$ can be used to independently adjust the DC offsets of each channel. The offset values are in represented in 2s-complement format with a range from -4096 to 4095.

The offset value adds a digital offset to the digital data before digital-to-analog conversion. Since the offset is added directly to the data it may be necessary to back off the signal to prevent saturation. Both data and offset values are LSB aligned.

SLAS751B – MARCH 2011 – REVISED SEPTEMBER 2011



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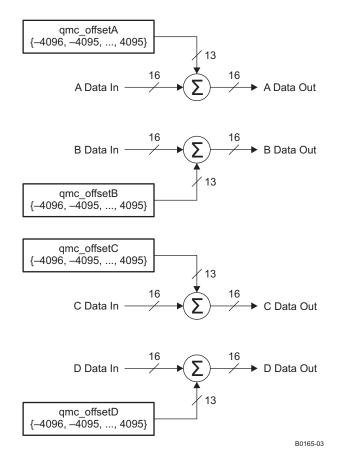


Figure 76. Digital Offset Block Diagram

GROUP DELAY CORRECTION

A complex transmitter system typically is consisted of a DAC, reconstruction filter network, and I/Q modulator. Besides the gain and phase mismatch contribution, there could also be timing mismatch contribution from each components. For instance, the timing mismatch could come from the PCB trace length variation between the I and Q channels and the group delay variation from the reconstruction filter.

This timing mismatch in the complex transmitter system creates phase mismatch that varies linearly with respect to frequency. To compensate for the I/Q imbalances due to this mismatch, the DAC34H84 has group delay correction block for each DAC channel. Each DAC channel can adjust its delay through *grp_delayA(7:0) grp_delayB(7:0) grp_delayC(7:0)* and *grp_delayD(7:0)* in register *config46* and *config47*. The maximum delay ranges from 30ps to 100ps and is dependent on DAC sample clock. Contact TI for specific application information. Refer to the Group Delay vs Step Code plots in the Typical Characteristics section. The group delay correction, along with gain/phase correction, can be useful for correcting imbalances in wide-band transmitter system.

TEMPERATURE SENSOR

The DAC34H84 incorporates a temperature sensor block which monitors the temperature by measuring the voltage across 2 transistors. The voltage is converted to an 8-bit digital word using a successive-approximation (SAR) analog to digital conversion process. The result is scaled, limited and formatted as a twos complement value representing the temperature in degrees Celsius.

The sampling is controlled by the serial interface signals SDENB and SCLK. If the temperature sensor is enabled (*tsense_sleep* = "0" in register *config26*) a conversion takes place each time the serial port is written or read. The



data is only read and sent out by the digital block when the temperature sensor is read in *tempdata*(7:0) in *config6*. The conversion uses the first eight clocks of the serial clock as the capture and conversion clock, the data is valid on the falling eighth SCLK. The data is then clocked out of the chip on the rising edge of the ninth SCLK. No other clocks to the chip are necessary for the temperature sensor operation. As a result the temperature sensor is enabled even when the device is in sleep mode.

In order for the process described above to operate properly, the serial port read from *config6* must be done with an SCLK period of at least 1 µs. If this is not satisfied the temperature sensor accuracy is greatly reduced.

DATA PATTERN CHECKER

The DAC34H84 incorporates a simple pattern checker test in order to determine errors in the data interface. The main cause of failures is setup/hold timing issues. The test mode is enabled by asserting *iotest_ena* in register *config1*. In test mode the analog outputs are deactivated regardless of the state of TXENA or *sif_texnable* in register *config3*.

The data pattern key used for the test is 8 words long and is specified by the contents of *iotest_pattern[0:7]* in registers *config37* through *config44*. The data pattern key can be modified by changing the contents of these registers.

The first word in the test frame is determined by a rising edge transition in ISTR or SYNC, depending on the *syncsel_fifoin(3:0)* setting in *config32*. At this transition, the *pattern0* word should be input to the data DAB[15:0] pins, and *pattern2* should be input to the data DCD[15:0] pins. Patterns 1, 4, and 5 of DAB[15:0] bus and pattern 3, 6, and 7 of DCD[15:0] bus should follow sequentially on each edge of DATACLK (rising and falling). The sequence should be repeated until the pattern checker test is disabled by setting *iotest_ena* back to "0". It is not necessary to have a rising ISTR or SYNC edge aligned with every four DATACLK cycle, just the first one to mark the beginning of the series.

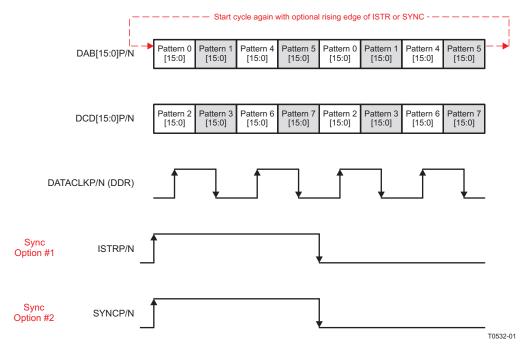


Figure 77. IO Pattern Checker Data Transmission Format

The test mode determines if the all the patterns on the two 16-bit LVDS data buses (DAB[15:0]P/N and DCD[15:0]P/N) were received correctly by comparing the received data against the data pattern key. If any bits in either of the two 16-bit data buses were received incorrectly, the corresponding bits in *iotest_results(15:0)* in register *config4* will be set to "1" to indicate bit error location. The user can check the corresponding bit location on both 16-bit data buses and implement the fix accordingly. Furthermore, the error condition will trigger the *alarm_from_iotest* bit in register *config5* to indicate a general error in the data interface. When data pattern checker mode is enabled, this alarm in register config5, bit7 is the only valid alarm. Other alarms in register config5 are not valid and can be disregarded.

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For instance, *pattern0* is programmed to the default of 0x7A7A. If the received Pattern 0 is 0x7A7B, then bit 0 in *iotest_results(15:0)* will be set to "1" to indicate an error in bit 0 location. The *alarm_from_iotest* will also be set to "1" to report the data transfer error. Note that *iotest_results(15:0)* does not indicate which of the 16-bit buses has the error. The user needs to check both 16-bit buses and then narrow down the error from the bit location information.

The alarms can be cleared by writing 0x0000 to *iotest_results(15:0)* and "0" to *alarm_from_iotest* through the serial interface. The serial interface will read back 0s if there are no errors or if the errors are cleared. The corresponding alarm bit will remain a "1" if the errors remain.

It is recommended to enable the pattern checker and then run the pattern sequence for 100 or more complete cycles before clearing the *iotest_results(15:0)* and *alarm_from_iotest*. This will eliminate the possibility of false alarms generated during the setup sequence.



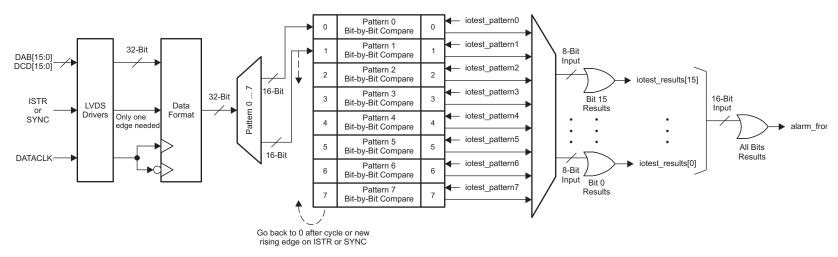


Figure 78. DAC34H84 Pattern Check Block Diagram



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PARITY CHECK TEST

The DAC34H84 has a parity check test that enables continuous validity monitoring of the data received by the DAC. Parity check testing in combination with the data pattern checker offer an excellent solution for detecting board assembly issues due to missing pad connections.

For the parity check test, an extra parity bit is added to the data bits to ensure that the total number of set bits (bits with value 1) is even or odd. This simple scheme is used to detect single or any other odd number of data transfer errors. Parity testing is implemented in the DAC34H84 in two ways: 32-bit parity and dual 16-bit parity.

32-BIT PARITY

In the 32-bit mode the additional parity bit is sourced to the parity input (PARITYP/N) for the 32-bit data transfer into the DAB[15:0]P/N and DCD[15:0]P/N inputs. This mode is enabled by setting the *single_parity_ena* bit in register *config1*. The input parity value is defined to be the total number of logic 1s on the 33-bit data bus – the DAB[15:0]P/N inputs, the DCD[15:0]P/N inputs, and the PARITYP/N input. This value, the total number of logic 1s, must match the parity test selected in the *oddeven_parity* bit in register *config1*.

For example, if the oddeven_parity bit is set to "1" for odd parity, then the number of 1s on the 33-bit data bus should be odd. The DAC will check the data transfer through the parity input. If the data received has odd number of 1s, then the parity is correct. If the data received has even number of 1s, then the parity is incorrect. The corresponding alarm for parity error will be set accordingly.

Figure 79 shows the simple XOR structure used to check word parity. Parity is tested independently for data captured on both rising and falling edges of DATACLK (*alarm_Aparity* and *alarm_Bparity*, respectively). Testing on both edges helps in determining a possible setup/hold issue. Both alarms are captured individually in register *config5*.

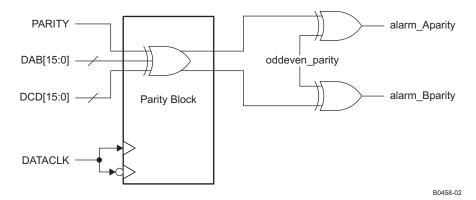


Figure 79. DAC34H84 32-Bit Parity Check

DUAL 16-BIT PARITY

In the dual 16-bit mode, each 16-bit LVDS data bus input will be accompanied by a parity bit for error checking. The DAB[15:0]P/N and ISTRP/N are one 17-bit data path, and the DCD[15:0]P/N and PARITYP/N are another path. This mode is enabled by setting the *dual_parity_ena* bit in register *config1*. The input parity value is defined to be the total number of logic 1s on each 17-bit data bus. This value, the total number of logic 1s, must match the parity test selected in the *oddeven_parity* bit in register *config1*.

For example, if the oddeven_parity bit is set to "1" for odd parity, then the number of 1s on each 17-bit data bus should be odd. The DAC will check the data transfer through the parity input. If the data received has odd number of 1s, then the parity is correct. If the data received has even number of 1s, then the parity is incorrect. The corresponding alarm for parity error will be set accordingly.

Figure 80 shows the simple XOR structure used to check word parity. Parity is tested independently for data captured on both rising and falling edges of DATACLK for each data path (*alarm_Aparity, alarm_Bparity, alarm_Cparity, and alarm_Dparity, respectively*). Testing on both edges and both data buses helps in determining a possible setup/hold issue. All of the alarms are captured individually in register *config5*.



In this mode the ISTR signal functions as a parity signal and cannot be used to sync the FIFO pointer simultaneously. It is recommended to use the SYNC to sync the FIFO pointer. If ISTR has to be used to sync the FIFO pointer, the ISTR sync can only be possible upon start-up when dual 16-bit parity function is disabled. Once the initialization is finished, disable the FIFO pointer sync through ISTR (by configuring *syncsel_fifoin* and *syncsel_fifoout* in *config32*) and enable the dual 16-bit parity function afterwards.

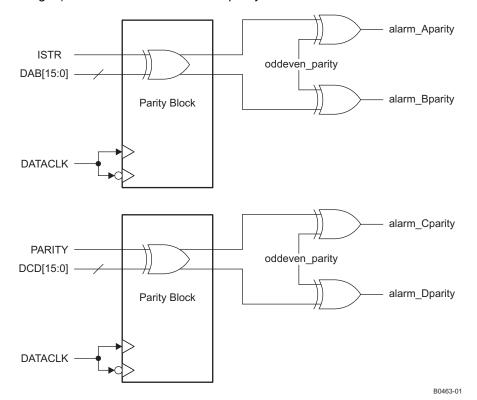


Figure 80. DAC34H84 Dual 16-Bit Parity Check

DAC34H84 ALARM MONITORING

The DAC34H84 includes a flexible set of alarm monitoring that can be used to alert of a possible malfunction scenario. All the alarm events can be accessed either through the *config5* register or through the ALARM pin. Once an alarm is set, the corresponding alarm bit in register *config5* must be reset through the serial interface to allow further testing. The set of alarms includes the following conditions:

Zero check alarm

 Alarm_from_zerochk. Occurs when the FIFO write pointer has an all zeros pattern. Since the write pointer is a shift register, all zeros will cause the input point to be stuck until the next sync event. When this happens a sync to the FIFO block is required.

FIFO alarms

- alarm_from_fifo. Occurs when there is a collision in the FIFO pointers or a collision event is close.
 - alarm_fifo_2away. Pointers are within two addresses of each other.
 - alarm_fifo_1away. Pointers are within one address of each other.
 - alarm_fifo_collision. Pointers are equal to each other.

Clock alarms

- clock_gone. Occurs when either the DACCLK or DATACLOCK have been stopped.
 - alarm_dacclk_gone. Occurs when the DACCLK has been stopped.
 - alarm_dataclk_gone. Occurs when the DATACLK has been stopped.

Pattern checker alarm

DAC34H84

SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011



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• alarm_from_iotest. Occurs when the input data pattern does not match the pattern key.

PLL alarm

• alarm_from_pll. Occurs when the PLL is out of lock.

Parity alarms

- alarm_Aparity: In dual parity mode, alarm indicating a parity error on the A word. In single parity mode, alarm on the 32-bit data captured on the rising edge of DATACLKP/N.
- alarm_Bparity: In dual parity mode, alarm indicating a parity error on the B word. In single parity mode, alarm on the 32-bit data captured on the falling edge of DATACLKP/N.
- alarm_Cparity: In dual parity mode, alarm indicating a parity error on the C word.
- alarm_Dparity: In dual parity mode, alarm indicating a parity error on the D word.

To prevent unexpected DAC outputs from propagating into the transmit channel chain, the clock and alarm_ fifo_collision alarms can be set in *config2* to shut-off the DAC output automatically regardless of the state of TXENA or *sif_txenable*.

Alarm monitoring is implemented as follows:

- Power up the device using the recommended power-up sequence.
- Clear all the alarms in *config5* by setting them to zeros.
- Unmask those alarms that will generate a hardware interrupt through the ALARM pin in config7.
- Enable automatic DAC shut-off in register *config2* if required.
- In the case of an alarm event, the ALARM pin will trigger. If automatic DAC shut-off has been enabled the DAC outputs will be disabled.
- Read registers *config5* to determine which alarm triggered the ALARM pin.
- · Correct the error condition and re-synchronize the FIFO.
- Clear the alarms in *config5*.
- Re-read *config5* to ensure the alarm event has been corrected.
- Keep clearing and reading *config5* until no error is reported.

POWER-UP SEQUENCE

The following startup sequence is recommended to power-up the DAC34H84:

- 1. Set TXENA low
- Supply all 1.2V voltages (DACVDD, DIGVDD, CLKVDD and VFUSE) and all 3.3V voltages (AVDD, IOVDD, and PLLAVDD). The 1.2V and 3.3V supplies can be powered up simultaneously or in any order. There are no specific requirements on the ramp rate for the supplies.
- 3. Provide all LVPECL inputs: DACCLKP/N and the optional OSTRP/N. These inputs can also be provided after the SIF register programming.
- 4. Toggle the RESETB pin for a minimum 25 ns active low pulse width.
- 5. Program the SIF registers.
- 6. Program fuse_sleep (config27, bit<11>) to put the internal fuses to sleep.
- 7. FIFO configuration needed for synchronization:
 - (a) Program *syncsel_fifoin(3:0)* (*config32*, bit<15:12>) to select the FIFO input pointer sync source.
 - (b) Program syncsel_fifoout(3:0) (config32, bit<11:8>) to select the FIFO output pointer sync source.
 - (c) Program syncsel_fifo_input(1:0) (config31, bit<3:2>) to select the FIFO input sync source.
- 8. Clock divider configuration needed for synchronization:
 - (a) Program *clkdiv_sync_sel* (*config32*, bit<0>) to select the clock divider sync source.
 - (b) Program *clkdiv_sync_ena* (*config0*, bit<2>) to "1" to enable clock divider sync.
 - (c) For multi-DAC synchronization in PLL mode, program *pll_ndivsync_ena* (*config24*, bit<11>) to "1" to synchronize the PLL N-divider.
- 9. Provide all LVDS inputs (D[15:0]P/N, DCD[15:0]P/N, DATACLKP/N, ISTRP/N, SYNCP/N and PARITYP/N) simultaneously. Synchronize the FIFO and clock divider by providing the pulse or periodic signals needed.
 - (a) For Single Sync Source Mode where either ISTRP/N or SYNCP/N is used to sync the FIFO, a single



rising edge for FIFO and clock divider sync is recommended. Periodic sync signal is not recommended due to the non-deterministic latency of the sync signal through the clock domain transfer.

- (b) For Dual Sync Sources Mode, both single pulse or periodic sync signals can be used.
- (c) For multi-DAC synchronization in PLL mode, the LVDS SYNCP/N signal is used to sync the PLL N-divider and can be sourced from either the FPGA/ASIC pattern generator or clock distribution circuit as long as the t_(SYNC_PLL) setup and hold timing requirement is met with respect to the reference clock source at DACCLKP/N pins. The LVDS SYNCP/N signal can be provided at this point.
- 10. FIFO and clock divider configurations after all the sync signals have provided the initial sync pulses needed for synchronization:
 - (a) For Single Sync Source Mode where the clock divider sync source is either ISTRP/N or SYNCP/N, clock divider syncing must be disabled after DAC34H84 initialization and before the data transmission by setting *clkdiv_sync_ena* (*config0*, bit 2) to "0".
 - (b) For Dual Sync Sources Mode, where the clock divider sync source is from the OSTR signal (either from external OSTRP/N or internal PLL N divider output), the clock divider syncing may be enabled at all time.
 - (c) Optionally, to prevent accidental syncing of the FIFO when sending the ISTRP/N or SYNCP/N pulse to other digital blocks such as NCO, QMC, etc, disable FIFO syncing by setting syncsel_fifoin(3:0) and syncsel_fifoout(3:0) to "0000" after the FIFO input and output pointers are initialized. If the FIFO and sync remain enabled after initialization, the ISTRP/N or SYNCP/N pulse must occur in ways to not disturb the FIFO operation. Refer to the INPUT FIFO section for detail.
 - (d) Disable PLL N-divider syncing by setting *pll_ndivsync_ena* (*config24*, bit<11>) to "0".
- 11. Enable transmit of data by asserting the TXENA pin or set sif_txenable to "1".
- 12. At any time, if any of the clocks (i.e DATACLK or DACCLK) is lost or a FIFO collision alarm is detected, a complete resynchronization of the DAC is necessary. Set TXENABLE low and repeat steps 7 through 11. Program the FIFO configuration and clock divider configuration per steps 7 and 8 appropriately to accept the new sync pulse or pulses for the synchronization.

EXAMPLE START-UP ROUTINE

DEVICE CONFIGURATION

 $f_{DATA} = 491.52MSPS$ Interpolation = 2x Input data = baseband data $f_{OUT} = 122.88MHz$ PLL = Enabled Full Mixer = Enabled

Dual Sync Sources Mode

PLL CONFIGURATION

 f_{REFCLK} = 491.52MHz at the DACCLKP/N LVPECL pins

 $f_{DACCLK} = f_{DATA} x$ Interpolation = 983.04MHz

 $f_{VCO} = 4 \text{ x} f_{DACCLK} = 3932.16 \text{MHz}$ (keep f_{VCO} between 3.3GHz to 4GHz)

 $PFD = f_{OSTR} = 30.72MHz$

N = 16, M = 32, P = 4, single charge pump

pll_vco(5:0) = "111011" (59)

NCO CONFIGURATION

f_{NCO} = 122.88MHz

 $f_{NCO_{CLK}} = 983.04 MHz$

TEXAS INSTRUMENTS

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freq = f_{NCO} x 2^32 / 983.04 = 536870912 = 0x20000000 phaseaddAB(31:0) or phaseaddCD(31:0) = 0x20000000 NCO SYNC = sif_sync

EXAMPLE START-UP SEQUENCE

Table 10. Example Start-Up Sequence Description

STEP	READ/WRITE	ADDRESS	VALUE	DESCRIPTION
1	N/A	N/A	N/A	Set TXENA Low
2	N/A	N/A	N/A	Power-up the device
3	N/A	N/A	N/A	Apply LVPECL DACCLKP/N for PLL reference clock
4	N/A	N/A	N/A	Toggle RESETB pin
5	Write	0x00	0xF19F	QMC offset and correction enabled, 2x int, FIFO enabled, Alarm enabled, clock divider sync enabled, inverse sinc filter enabled.
6	Write	0x01	0x040E	Single parity enabled, FIFO alarms enabled (2 away, 1 away, and collision)
7	Write	0x02	0x7052	Output shut-off when DACCLK gone, DATACLK gone, and FIFO collision. Mixer block with NCO enabled, twos complement.
8	Write	0x03	0xA000	Output current set to 20mAFS with internal reference and 1.28kohm R_{BIAS} resistor.
9	Write	0x07	0xD8FF	Un-mask FIFO collision, DACCLK-gone, and DATACLK-gone alarms to the Alarm output.
10	Write	0x08	N/A	Program the desired channel A QMC offset value. (Causes Auto-Sync for QMC AB-Channels Offset Block)
11	Write	0x09	N/A	Program the desired FIFO offset value and channel B QMC offset value.
12	Write	0x0A	N/A	Program the desired channel C QMC offset value. (Causes Auto-Sync for QMC CD-Channels Offset Block)
13	Write	0x0B	N/A	Program the desired channel D QMC offset value.
14	Write	0x0C	N/A	Program the desired channel A QMC gain value.
15	Write	0x0D	N/A	Coarse mixer mode not used. Program the desired channel B QMC gain value.
16	Write	0x0E	N/A	Program the desired channel B QMC gain value.
17	Write	0x0F	N/A	Program the desired channel C QMC gain value.
18	Write	0x10	N/A	Program the desired channel AB QMC phase value. (Causes Auto-Sync QMC AB-Channels Correction Block)
19	Write	0x11	N/A	Program the desired channel CD QMC phase value. (Causes Auto-Sync for the QMC CD-Channels Correction Block)
20	Write	0x12	N/A	Program the desired channel AB NCO phase offset value. (Causes Auto-Sync for Channel AB NCO Mixer)
21	Write	0x13	N/A	Program the desired channel CD NCO phase offset value. (Causes Auto-Sync for Channel CD NCO Mixer)
22	Write	0x14	0x2000	Program the desired channel AB NCO frequency value
23	Write	0x15	0x0000	Program the desired channel AB NCO frequency value
24	Write	0x16	0x2000	Program the desired channel CD NCO frequency value
25	Write	0x17	0x0000	Program the desired channel CD NCO frequency value
26	Write	0x18	0x2C67	PLL enabled, PLL N-dividers sync enabled, single charge pump, prescaler 4.
27	Write	0x19	0x20F4	M = 32, N = 16, PLL VCO bias tune = "01"
28	Write	0x1A	0xEC00	PLL VCO coarse tune = 59
29	Write	0x1B	0x0800	Internal reference
30	Write	0x1E	0x9999	QMC offset AB, QMC offset CD, QMC correction AB, and QMC correction CD can be synced by sif_sync or auto-sync from register write
31	Write	0x1F	0x4440	Mixer AB and CD values synced by SYNCP/N. NCO accumulator synced to SYNCP/N.

TEXAS INSTRUMENTS

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SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

STEP	READ/WRITE	ADDRESS	VALUE	DESCRIPTION			
32	Write	0x20	0x2400	FIFO Input Pointer Sync Source = ISTR FIFO Output Pointer Sync Source = OSTR (from PLL N-divider output) Clock Divider Sync Source = OSTR			
33	N/A	N/A	N/A	Provide all the LVDS DATA and DATACLK Provide rising edge ISTRP/N and rising edge SYNCP/N to sync the FIFO input pointer and PLL N-dividers.			
34	Read	0x18	N/A	Read back pll_lfvolt(2:0). If the value is not optimal, adjust pll_vco(5:0) in 0x1A.			
35	Write	0x05	0x0000	Clear all alarms in 0x05.			
36	Read	0x05	N/A	Read back all alarms in 0x05. Check for PLL lock, FIFO collision, DACCLK-gone, DATACLK-gone, etc. Fix the error appropriately. Repeat step 34 and 35 as necessary.			
37	Write	0x1F	0x4442	Sync all the QMC blocks using sif_sync. These blocks can also be synced via auto-sync through appropriate register writes.			
38	Write	0x00	0xF19B	Disable clock divider sync.			
39	Write	0x1F	0x4448	Set sif_sync to "0" for the next sif_sync event.			
40	Write	0x20	0x0000	Disable FIFO input and output pointer sync.			
41	Write	0x18	0x2467	Disable PLL N-dividers sync.			
42	N/A	N/A	N/A	Set TXENA high. Enable data transmission.			

Table 10. Example Start-Up Sequence Description (continued)

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LVPECL INPUTS

Figure 81 shows an equivalent circuit for the DAC input clock (DACCLKP/N) and the output strobe clock (OSTRP/N).

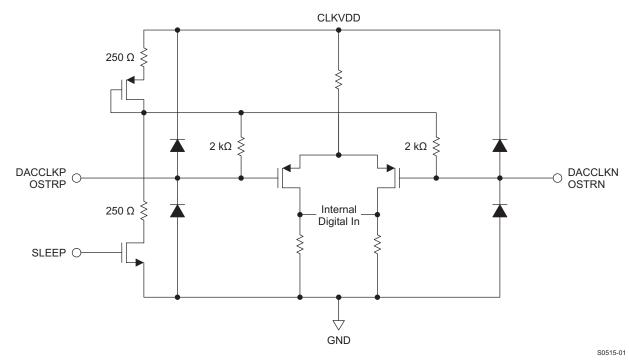


Figure 81. DACCLKP/N and OSTRP/N Equivalent Input Circuit

Figure 82 shows the preferred configuration for driving the CLKIN/CLKINC input clock with a differential ECL/PECL source.

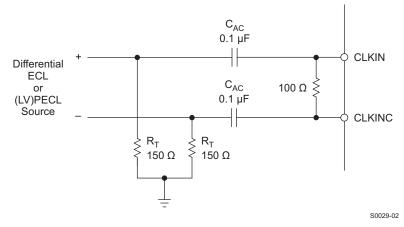


Figure 82. Preferred Clock Input Configuration with a Differential ECL/PECL Clock Source



LVDS INPUTS

The DAB[15:0]P/N, DCD[15:0]P/N, DATACLKP/N, SYNCP/N, PARITYP/N, and ISTRP/N LVDS pairs have the input configuration shown in Figure 83. Figure 84 shows the typical input levels and common-move voltage used to drive these inputs.

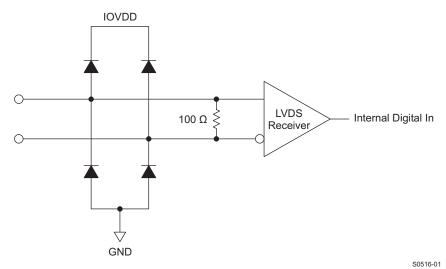


Figure 83. DAB[15:0]P/N, DCD[15:0]P/N, DATACLKP/N, ISTRP/N, SYNCP/N and PARITYP/N LVDS Input Configuration

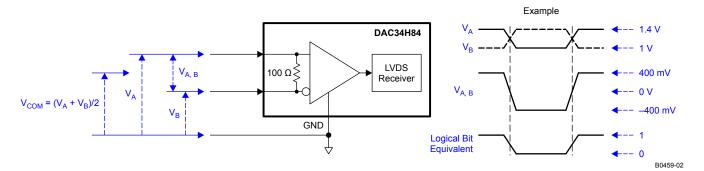


Figure 84. LVDS Data Input Levels

Applied Voltages		Resulting Differential Voltage	Resulting Common-Mode Voltage	Logical Bit Binary Equivalent	
V _A	VB	V _{A,B}	V _{COM}	Equivalent	
1.4 V	1.0 V	400 mV	1.2 V	1	
1.0 V	1.4 V	-400 mV	1.2 V	0	
1.2 V	0.8 V	400 mV	1.0 V	1	
0.8 V	3 V 1.2 V -400 mV		1.0 V	0	



CMOS DIGITAL INPUTS

Figure 85 shows a schematic of the equivalent CMOS digital inputs of the DAC34H84. SDIO, SCLK, SLEEP and TXENA have pull-down resistors while SDENB and RESETB have pull-up resistors internal to the DAC34H84. All the CMOS digital inputs and outputs are referred to the IOVDD2 supply, which can vary from 1.8V to 3.3V. This facilitates the I/O interface and eliminates the need of level translation. See the specification table for logic thresholds. The pull-up and pull-down circuitry is approximately equivalent to $100k\Omega$.

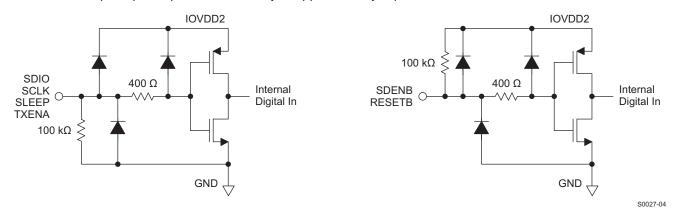


Figure 85. CMOS Digital Equivalent Input

REFERENCE OPERATION

The DAC34H84 uses a bandgap reference and control amplifier for biasing the full-scale output current. The full-scale output current is set by applying an external resistor R_{BIAS} to pin BIASJ. The bias current I_{BIAS} through resistor R_{BIAS} is defined by the on-chip bandgap reference voltage and control amplifier. The default full-scale output current equals 64 times this bias current and can thus be expressed as:

 $IOUT_{FS} = 64 \times I_{BIAS} = 64 \times (V_{EXTIO} / R_{BIAS}) / 2$

The DAC34H84 has a 4-bit coarse gain control *coarse_dac(3:0)* in the *config3* register. Using gain control, the IOUT_{FS} can be expressed as:

 $IOUT_{FS} = (coarse_dac + 1)/16 \times I_{BIAS} \times 64 = (coarse_dac + 1)/16 \times (VEXTIO / RBIAS) / 2 \times 64$

where V_{EXTIO} is the voltage at terminal EXTIO. The bandgap reference voltage delivers an accurate voltage of 1.2V. This reference is active when *extref_ena* = '0' in *config27*. An external decoupling capacitor C_{EXT} of 0.1 µF should be connected externally to terminal EXTIO for compensation. The bandgap reference can additionally be used for external reference operation. In that case, an external buffer with high impedance input should be applied in order to limit the bandgap load current to a maximum of 100 nA. The internal reference can be disabled and overridden by an external reference by setting the *extref_ena* control bit. Capacitor C_{EXT} may hence be omitted. Terminal EXTIO thus serves as either input or output node.

The full-scale output current can be adjusted from 30 mA down to 10 mA by varying resistor R_{BIAS}, programming *coarse_dac(3:0)*, or changing the externally applied reference voltage.

NOTE

With internal reference, the minimum Rbias resistor value is $1.28k\Omega$. Resistor value below $1.28k\Omega$ is not recommended sice it will program the full-scale current to go above 30mA and potentially damages the device.

DAC TRANSFER FUNCTION

The CMOS DACs consist of a segmented array of PMOS current sources, capable of sourcing a full-scale output current up to 30 mA. Differential current switches direct the current to either one of the complementary output nodes IOUTP or IOUTN. Complementary output currents enable differential operation, thus canceling out common mode noise sources (digital feed-through, on-chip and PCB noise), dc offsets, even order distortion components, and increasing signal output power by a factor of two.



The full-scale output current is set using external resistor R_{BIAS} in combination with an on-chip bandgap voltage reference source (+1.2 V) and control amplifier. Current I_{BIAS} through resistor R_{BIAS} is mirrored internally to provide a maximum full-scale output current equal to 64 times I_{BIAS} .

The relation between IOUTP and IOUTN can be expressed as:

 $IOUT_{FS} = IOUTP + IOUTN$

We will denote current flowing into a node as – current and current flowing out of a node as + current. Since the output stage is a current source the current flows from the IOUTP and IOUTN pins. The output current flow in each pin driving a resistive load can be expressed as:

 $\begin{aligned} \text{IOUTP} &= \text{IOUT}_{\text{FS}} \text{ x CODE } / \text{ 65536} \\ \text{IOUTN} &= \text{IOUT}_{\text{FS}} \text{ x (65535 - CODE) } / \text{ 65536} \\ \text{where CODE is the decimal representation of the DAC data input word} \end{aligned}$

For the case where IOUTP and IOUTN drive resistor loads R_L directly, this translates into single ended voltages at IOUTP and IOUTN:

VOUTP = IOUT1 x R_L VOUTN = IOUT2 x R_L

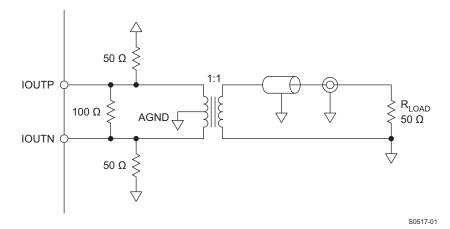
Assuming that the data is full scale (65535 in offset binary notation) and the R_L is 25 Ω , the differential voltage between pins IOUTP and IOUTN can be expressed as:

VOUTP = 20mA x 25 Ω = 0.5 V VOUTN = 0mA x 25 Ω = 0 V VDIFF = VOUTP - VOUTN = 0.5V

Note that care should be taken not to exceed the compliance voltages at node IOUTP and IOUTN, which would lead to increased signal distortion.

ANALOG CURRENT OUTPUTS

The DAC34H84 can be easily configured to drive a doubly terminated 50 Ω cable using a properly selected RF transformer. Figure 86 and Figure 87 show the 50 Ω doubly terminated transformer configuration with 1:1 and 4:1 impedance ratio, respectively. Note that the center tap of the primary input of the transformer has to be grounded to enable a DC current flow. Applying a 20 mA full-scale output current would lead to a 0.5 Vpp for a 1:1 transformer and a 1 Vpp output for a 4:1 transformer. The low dc-impedance between IOUTP or IOUTN and the transformer center tap sets the center of the ac-signal to GND, so the 1 Vpp output for the 4:1 transformer results in an output between -0.5 V and +0.5 V.







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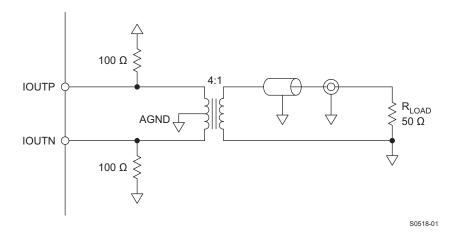


Figure 87. Driving a Doubly Terminated 50 Ω Cable Using a 4:1 Impedance Ratio Transformer

PACKAGE OPTION ADDENDUM

ORDERABLE DEVICE	STATUS	PACKAGE TYPE	PINS	PACKAGE QUANTITY	ECO PLAN	LEAD/BALL FINISH	MSL PEAK TEMPERATURE
DAC34H84IZAY	Active	NFBGA	196	800	Green (RoHS & no Sb/Br)	SNAGCU	MSL3 260C
DAC34H84IZAYR	Active	NFBGA	196	1000	Green (RoHS & no Sb/Br)	SNAGCU	MSL3 260C



SLAS751B-MARCH 2011-REVISED SEPTEMBER 2011

REVISION HISTORY

Cł	nanges from Original (March 2011) to Revision A Pa	age
•	Changed from PRODUCT PREVIEW to PRODUCTION DATA	1
Cł	nanges from Revision A (June 2011) to Revision B	age
•	Changed ALARM description	4
•	Added notes to ELECTRICAL CHARACTERISTICS – DC SPECIFICATIONS	8
•	Deleted t _(align) from ELECTRICAL CHARACTERISTICS – DIGITAL SPECIFICATIONS	. 10
•	Changed DIGITAL INPUT TIMING SPECIFICATIONS in ELECTRICAL CHARACTERISTICS – DIGITAL SPECIFICATIONS	
•	Added f _{DAC} PLL ON MIN of 1000MSPS in ELECTRICAL CHARACTERISTICS – AC SPECIFICATIONS	. 13
•	Changed DAC Wake-up Time in ELECTRICAL CHARACTERISTICS – AC SPECIFICATIONS	. 13
•	Changed register version default value from 0x5408 to 0x5409 in Register Map	. 27
•	Deleted t _(align) from register config0 description	. 28
•	Added SIF SYNC to register config32 description	. 39
•	Changed B40 to N11 in register config35 description	40
•	Changed register config 45 default value	. 41
•	Changed register version default value from 0x5408 to 0x5409	. 42
•	Added information to SINGLE SYNC SOURCE MODE section	
•	Deleted t _(align) from BYPASS MODE section	46
•	Changed 1.2288GHz to 983.04MHz in PLL MODE description	
•	Changed data in Table 5	. 49
•	Deleted 2x in Table 7	56
•	Changed EXAMPLE START-UP ROUTINE information	. 69
•	Changed Table 10	. 70



PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/ Ball Finish	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
DAC34H84IZAY	ACTIVE	NFBGA	ZAY	196	160	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	
DAC34H84IZAYR	ACTIVE	NFBGA	ZAY	196	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	
PDAC34H84IZAY	PREVIEW	NFBGA	ZAY	196		TBD	Call TI	Call TI	

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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PACKAGE MATERIALS INFORMATION

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TAPE AND REEL INFORMATION

REEL DIMENSIONS

TEXAS INSTRUMENTS





NFBGA

TAPE AND REEL INFORMATION

DAC34H84IZAYR

TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

K0

(mm)

2.3

P1

(mm)

16.0

w

(mm)

24.0

Pin1

Quadrant

Q1

*All dimensions are nominal							
Device		Package	SPQ	Reel	Reel	A0	B0
	Туре	Drawing		Diameter		(mm)	(mm)
				(mm)	W1 (mm)		

196

1000

330.0

24.4

12.35

12.35

ZAY

TEXAS INSTRUMENTS

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PACKAGE MATERIALS INFORMATION

12-Apr-2012

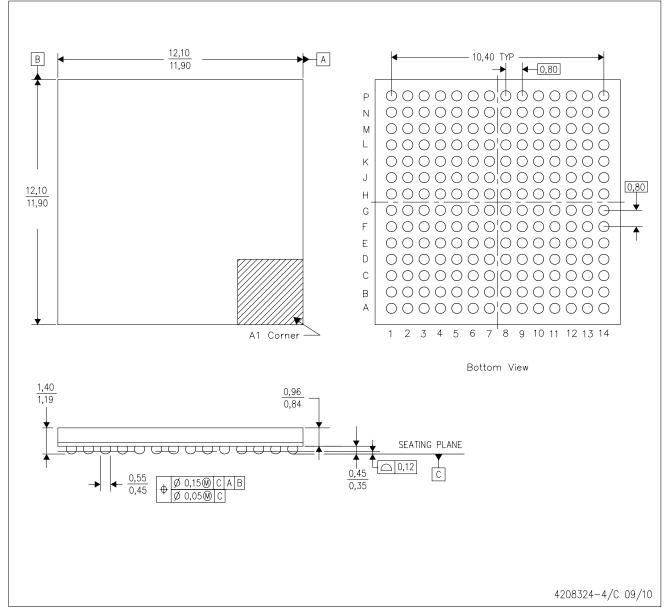


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DAC34H84IZAYR	NFBGA	ZAY	196	1000	341.0	336.6	41.3

ZAY (S-PBGA-N196)

PLASTIC BALL GRID ARRAY



NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.

- B. This drawing is subject to change without notice.
- C. This is a Pb-free solder ball design.



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