Hittite Microwave Corporation

Your
Number One Provider of
Analog Mixed Signal Solutions

April 2012

Hittite - Growing Global Presence

HMC Corporate Headquarters
Boston (1985)

HMC Europe., LTD.
London, (2001)

HMC International HQ
Cork, Ireland

HMC Deutschland GmbH
Munich, (2001)

HMC Asia Co., LTD.
Seoul, (2002)

HMC Co., LTD.
Shanghai, (2003)

HMC Co., LTD.
Shenzhen, (2004)

HMC East
Philadelphia (2005)

HMC Design Center Turkey
Istanbul (2005)

HMC Design Center
Colorado Springs (2005)

HMC India
Hyderabad (2009)
Bangalore (2005)

HMC Nordic AB
Stockholm (2006)

HMC Canada, Inc.
Ottawa (2006)

HMC ADC
Trondheim (2011)

HMC Central
Dallas (2006)

HMC West
San Diego (2007)

HMC Japan
Tokyo (2008)

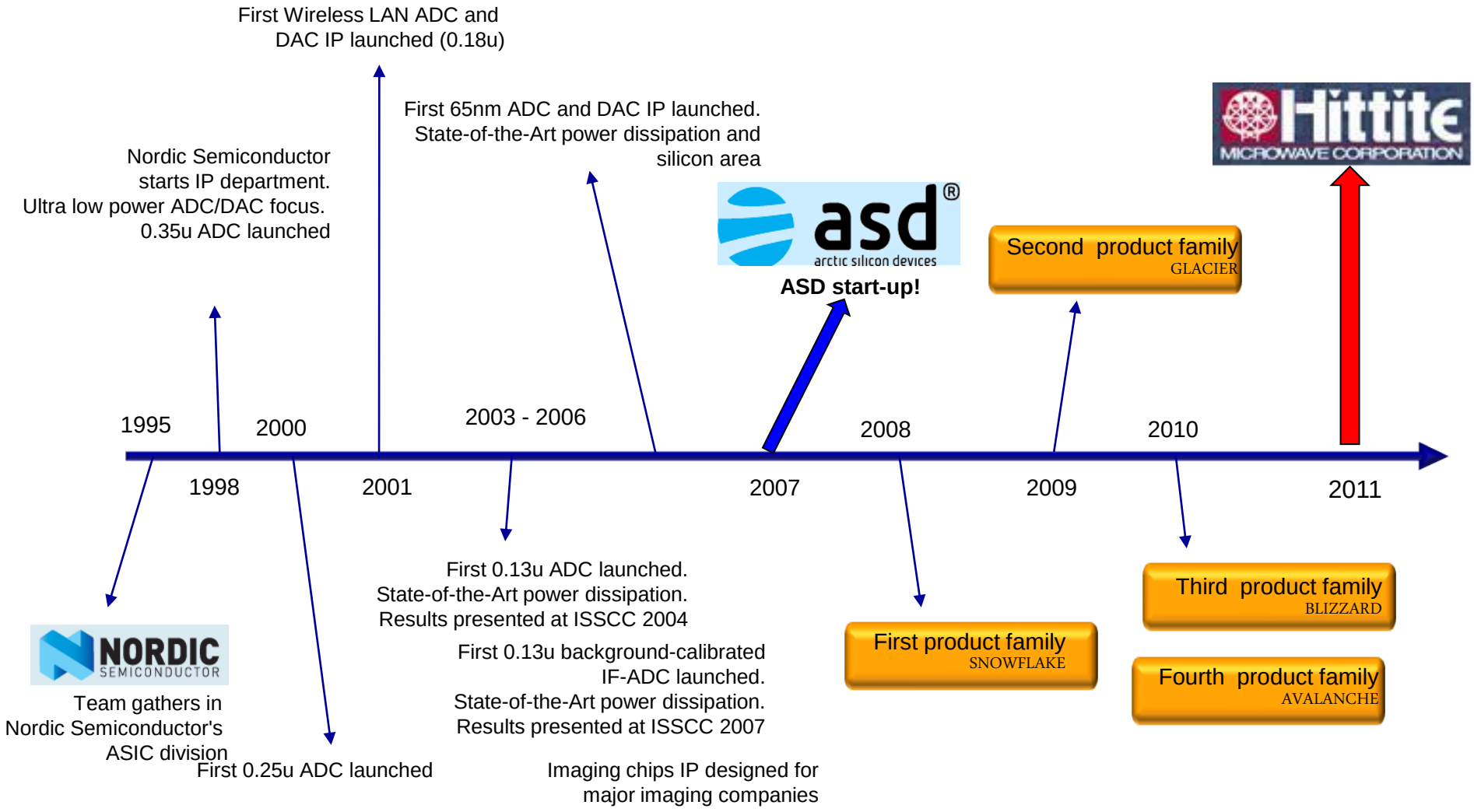
Hittite Microwave Corporation

High sampling speed, high resolution and low power dissipation A/D Converter Solutions

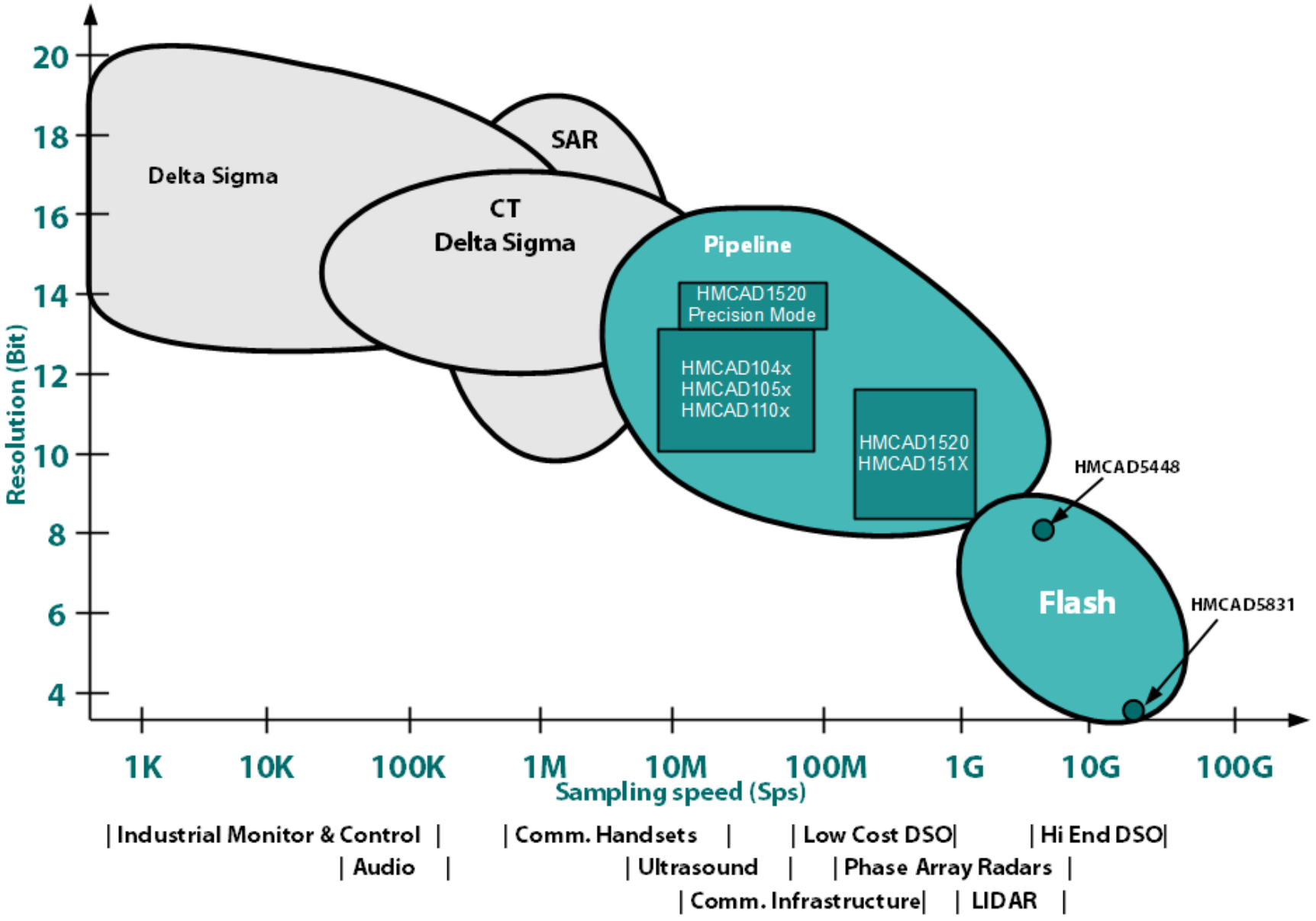
Hittite Microwave Confidential

March 2012

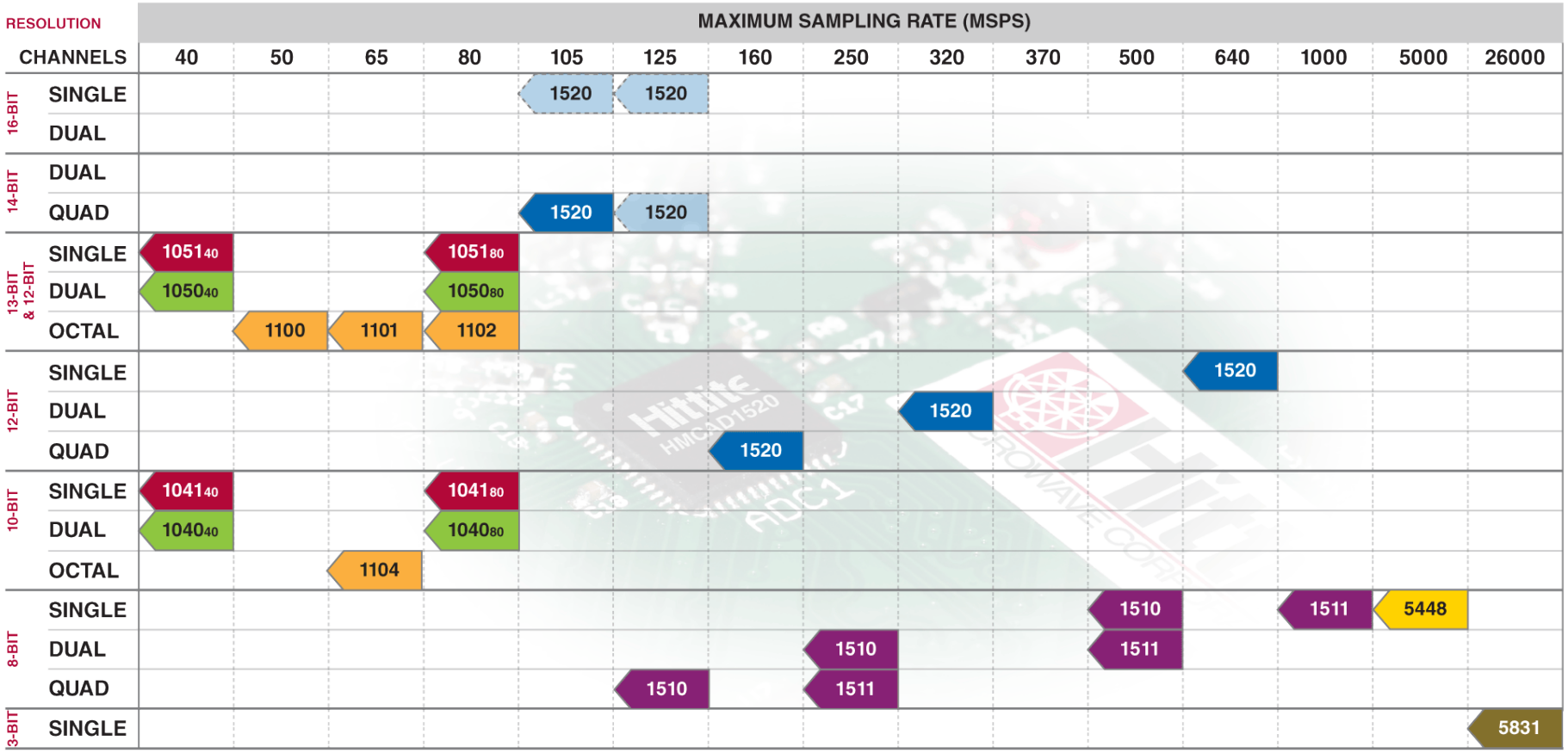
Arctic Design Center – Brief History



ADC Architectures - Speed and resolution



High Speed, Low Power ADCs - Introduction



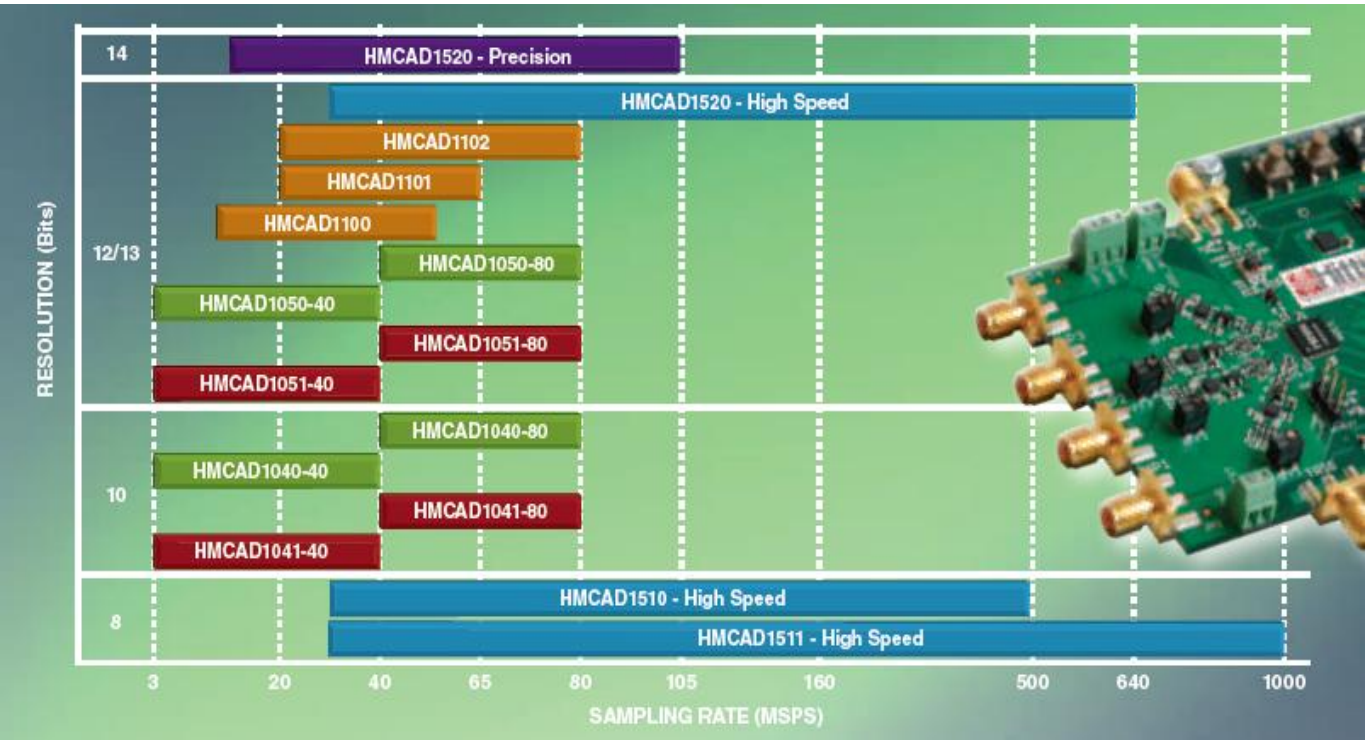
COLOR LEGEND

Red	1041 & 1051 - Parallel (CMOS) Output LP6
Green	1040 & 1050 - Parallel Output LP9
Orange	1100, 1101, 1102 & 1104 - Serial (LVDS) Output LP9
Purple	1510 & 1511 - Serial (LVDS) Output LP7
Lt. Blue	1520 - See Hittite for Details
Blue	1520 @ Serial (LVDS) Output LP7
Yellow	5448 - Serial (LVDS Demux) 256 BGA
Gold	5831 - Serial (CML) LP9
Teal	106X & 107X

High Speed, Low Power ADCs - Introduction

High Speed, Low Power Analog-to-Digital Converters (ADC)

- ✓ *Sample Rates: 3 to 1000 MSPS*
- ✓ *Resolution: 8 to 16 bits*
- ✓ *CMOS & LVDS output*
- ✓ *Configurable Power Consumption & Functionality with SPI settings*
- ✓ *Integrated Instrumentation Functionality*



Cellular & Microwave Infrastructure

- ✓ *Diversity Receivers*
- ✓ *Direct Conversion Receivers*
- ✓ *Digital Pre Distortion (DPD) Loops*
- ✓ *Remote Radio Heads (RRH)*

Test & Instrumentation

- ✓ *Digital Oscilloscopes*
- ✓ *Spectrum Analyzers*
- ✓ *High Definition Video Digitizing*
- ✓ *Non Destructive Testing (NDT)*

Industrial & Medical

- ✓ *Ultrasound*

Magnetic Resonance Imaging (MRI)

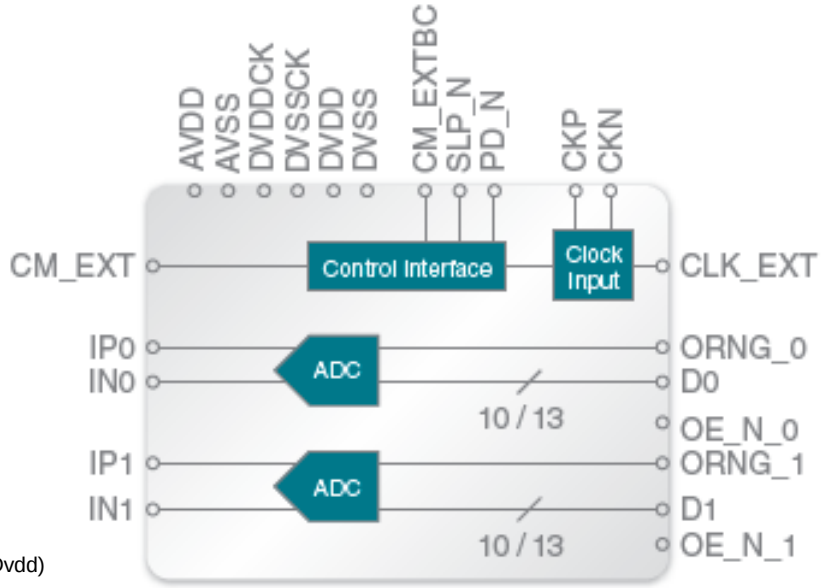
- ✓ *Environment & Patient Monitoring*

10 & 13-Bit Dual ADCs, up to 80 MSPS

Part Number	Function / Mode	Resolution (bits)	Sample Rate (MSPS)	Power Dissipation[2][3]	SNR (dBFS)	SFDR (dBc)	Package
HMCAD1050-80	Dual Channel	13 / 12	80	102 mW	72	77	LP9E
	Dual Channel	13 / 12	65	85 mW	72.6	81	
HMCAD1050-40	Dual Channel	13 / 12	40	55 mW	72.7	81	LP9E
	Dual Channel	13 / 12	20	30 mW	72.2	85	
HMCAD1040-80	Dual Channel	10	80	78 mW	61.6	75	LP9E
	Dual Channel	10	65	65 mW	61.6	77	
HMCAD1040-40	Dual Channel	10	40	43 mW	61.6	81	LP9E
	Dual Channel	10	20	24 mW	61.6	81	

Features

- ✓ *Selectable 20/40/65/80 MSPS*
- ✓ *Ultra Low Power Dissipation*
  - ✓ *Dynamic power vs sample rate scaling*
- ✓ *72 dB SNR at 80 MSPS & 8MHz Fin*
- ✓ *Internal Reference Circuitry*
- ✓ *Parallel CMOS Output*
- ✓ *64 Pin QFN Package*
- ✓ *Pin Compatible*

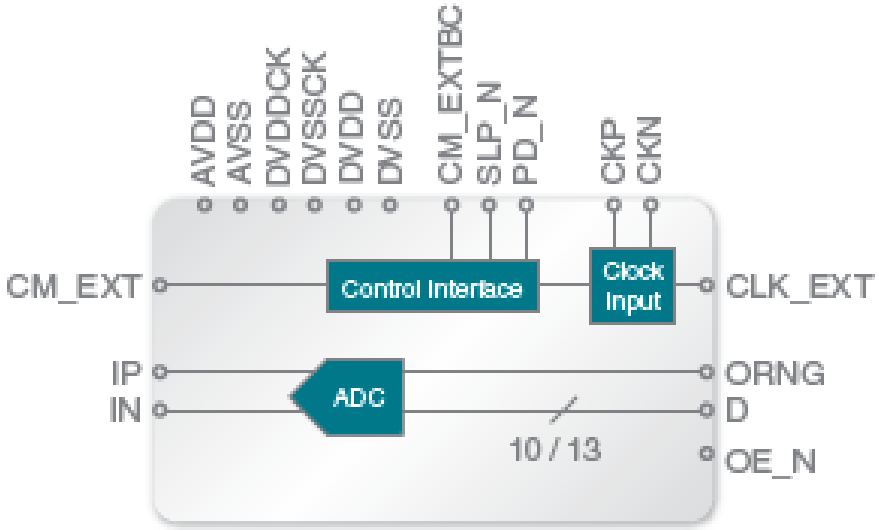


[2] Supply Voltage (Vdd) +1.8 Vdc Analog Supply (Avdd) and +1.8Vdc Digital Supply (Dvdd)
[3] Output Supply Voltage (OVdd) +1.7 to +3.6 Vdc

Part Number	Function / Mode	Resolution (bits)	Sample Rate (MSPS)	Power Dissipation[2][3]	SNR (dBFS)	SFDR (dBc)	Package
HMCAD1051-80	Single Channel	13 / 12	80	60 mW	72	77	LP6HE
	Single Channel	13 / 12	65	50 mW	72.6	81	
HMCAD1051-40	Single Channel	13 / 12	40	53 mW	72.7	81	LP6HE
	Single Channel	13 / 12	20	19 mW	72.2	85	
HMCAD1041-80	Single Channel	10	80	46 mW	61.6	75	LP6HE
	Single Channel	10	65	38 mW	61.6	77	
HMCAD1041-40	Single Channel	10	40	25mW	61.6	81	LP6HE
	Single Channel	10	20	15 mW	61.6	81	

Features

- ✓ *Selectable 20/40/65/80 MSPS*
- ✓ *Ultra Low Power Dissipation*
  - ✓ *Dynamic power vs sample rate scaling*
- ✓ *72 dB SNR at 80 MSPS & 8MHz Fin*
- ✓ *Internal Reference Circuitry*
- ✓ *Parallel CMOS Output*
- ✓ *40 Pin QFN Package*
- ✓ *Pin Compatible*



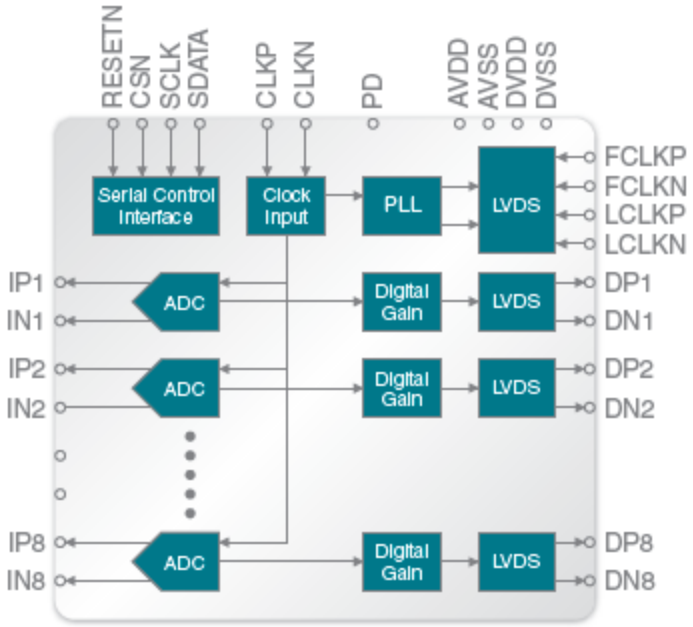
[2] Supply Voltage (Vdd) +1.8 Vdc Analog Supply (Avdd) and +1.8Vdc Digital Supply (Dvdd)
[3] Output Supply Voltage (OVdd) +1.7 to +3.6 Vdc

12 & 13-Bit Octal ADCs, up to 80 MSPS

Part Number	Function / Mode	Resolution (bits)	Sample Rate (MSPS)	Power Dissipation[2][3]	SNR (dBFS)	SFDR (dBc)	Package
HMCAD1102	Octal Channel	12	80	59 mW / Channel	70.1	77	LP9E
HMCAD1101	Octal Channel	13 / 12	65	51 mW / Channel	72.2	82	LP9E
HMCAD1100	Octal Channel	13 / 12	50	41 mW / Channel	72.2	82	LP9E
	Octal Channel	13 / 12	40	35 mW / Channel	72.2	82	
	Octal Channel	13 / 12	20	23 mW / Channel	72.2	82	

Features

- ✓ *Selectable 20/40/50/65/80 MSPS*
- ✓ *Ultra Low Power Dissipation*
  - ✓ *Dynamic power vs sample rate scaling*
- ✓ *72.2 dB SNR @ 65 MSPS & 8MHz Fin*
- ✓ *Internal Reference Circuitry*
- ✓ *15µs Start Up Time from Power Down*
- ✓ *Coarse and Fine Gain Control*
- ✓ *SPI Configuration*
- ✓ *64 Pin QFN Package*



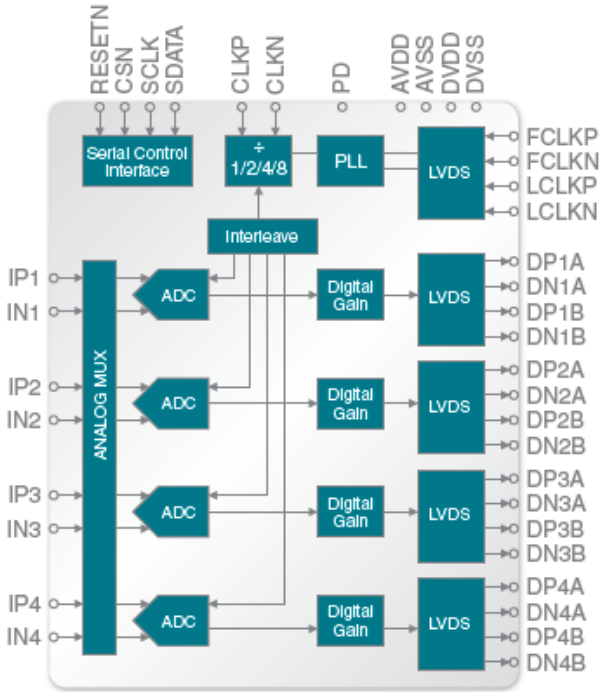
[2] Supply Voltage (Vdd) +1.8 Vdc Analog Supply (Avdd) and +1.8Vdc Digital Supply (Dvdd)
[3] Output Supply Voltage (OVdd) +1.7 to +3.6 Vdc

HMCAD1520 – Multi-Mode ADC w/ Integrated Cross Point Switch

Part Number	Function / Mode	Resolution (bits)	Sample Rate (MSPS)	Power Dissipation[2][3]	SNR (dBFS)	SFDR (dBc)	Package
HMCAD1520	High Speed Single Channel	12	640	490 mW	70	60 / 75 [1]	LP7DE
	High Speed Dual Channel	12	320	490 mW	70	60 / 78 [1]	
	High Speed Quad Channel	12	160	490 mW	70	60 / 78 [1]	
	Precision Quad Channel	14	105	603 mW	74	83	
	Precision Quad Channel	14	80	530 mW	75	85	

Features

- ✓ *Multiple Modes*
  - ✓ *Single channel 12-bit up to 640 MSPS*
  - ✓ *Dual channel 12-bit up to 320 MSPS*
  - ✓ *Quad channel 12-bit up to 160 MSPS*
  - ✓ *Quad channel 14-bit up to 105 MSPS*
- ✓ *SPI Configurable Operational Modes*
- ✓ *SPI Configurable Number of Channels*
- ✓ *1µs Switching Time Between Configurations*
- ✓ *Internal 1X to 8X Clock Divider*
- ✓ *LVDS output*
  - ✓ *Full robustness inn RSDS (Low Current) Mode*
- ✓ *Ultra Low Power Dissipation*
  - ✓ *Dynamic power vs sample rate scaling*
- ✓ *Coarse & Fine Gain Control*
- ✓ *48 Pin QFN Package*



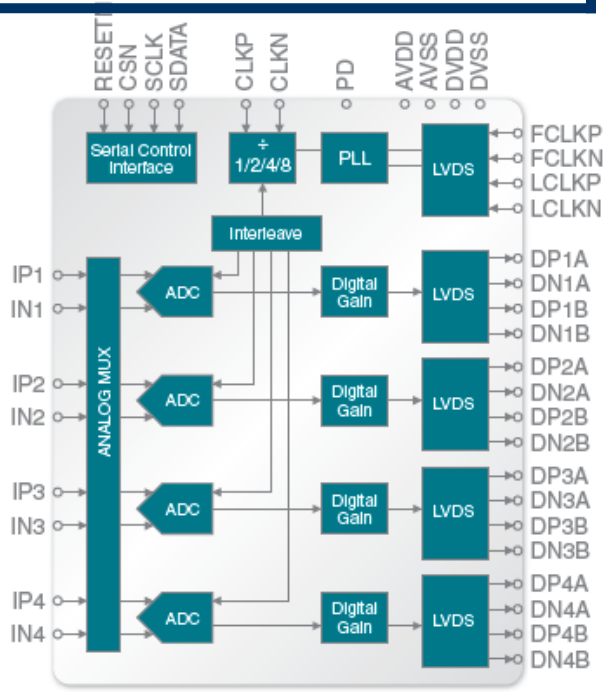
[1] Excluding Interleaving Spurs
[2] Supply Voltage (Vdd) +1.8 Vdc Analog Supply (Avdd) and +1.8Vdc Digital Supply (Dvdd)
[3] Output Supply Voltage (OVdd) +1.7 to +3.6 Vdc

8-bit up to 1000 MSPS ADCs w/ Integrated Cross Point Switch

Part Number	Function / Mode	Resolution (bits)	Sample Rate (MSPS)	Power Dissipation[2][3]	SNR (dBFS)	SFDR (dBc)	Package
HMCAD1511	Single Channel	8	1000	710 mW	49.8	49 / 64 [1]	LP7DE
	Dual Channel	8	500	710 mW	49.8	44 / 63 [1]	
	Quad Channel	8	250	710 mW	49.8	57 / 70 [1]	
HMCAD1510	Single Channel	8	500	295 mW	49.8	49 / 65 [1]	LP7DE
	Dual Channel	8	250	295 mW	49.8	59 / 69[1]	
	Quad Channel	8	125	295 mW	49.7	60 / 69 [1]	

Features

- ✓ *Multiple Modes*
  - ✓ *Single channel 8-bit up to 1000 / 500 MSPS*
  - ✓ *Dual channel 8-bit up to 500 / 250 MSPS*
  - ✓ *Quad channel 8-bit up to 250 / 125 MSPS*
- ✓ *SPI Configurable Operational Modes*
- ✓ *SPI Configurable Number of Channels*
- ✓ *1µs Switching Time Between Configurations*
- ✓ *Internal 1X to 8X Clock Divider*
- ✓ *Wide Range Digital Gain*
- ✓ *LVDS output*
  - ✓ *Full robustness inn RSDS (Low Current) Mode*
- ✓ *Ultra Low Power Dissipation*
  - ✓ *Dynamic power vs sample rate scaling*
- ✓ *Coarse & Fine Gain Control*
- ✓ *48 Pin QFN Package*



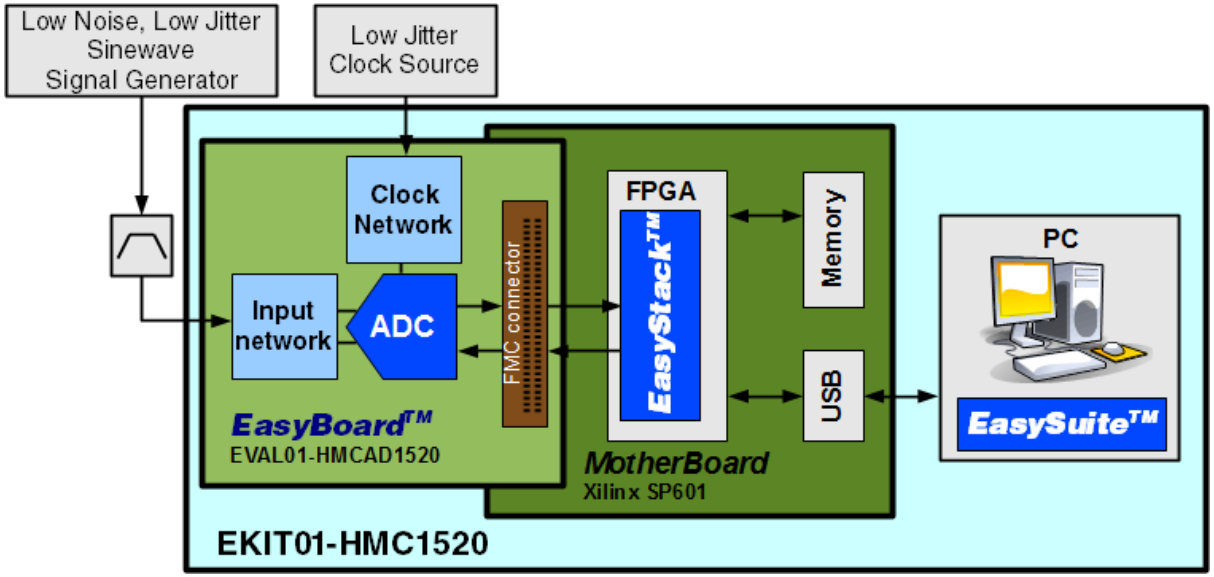
[1] Excluding Interleaving Spurs
[2] Supply Voltage (Vdd) +1.8 Vdc Analog Supply (Avdd) and +1.8Vdc Digital Supply (Dvdd)
[3] Output Supply Voltage (OVdd) +1.7 to +3.6 Vdc

EasySuite™

ADC Evaluation and Prototyping Platform

Analog Made Easy™

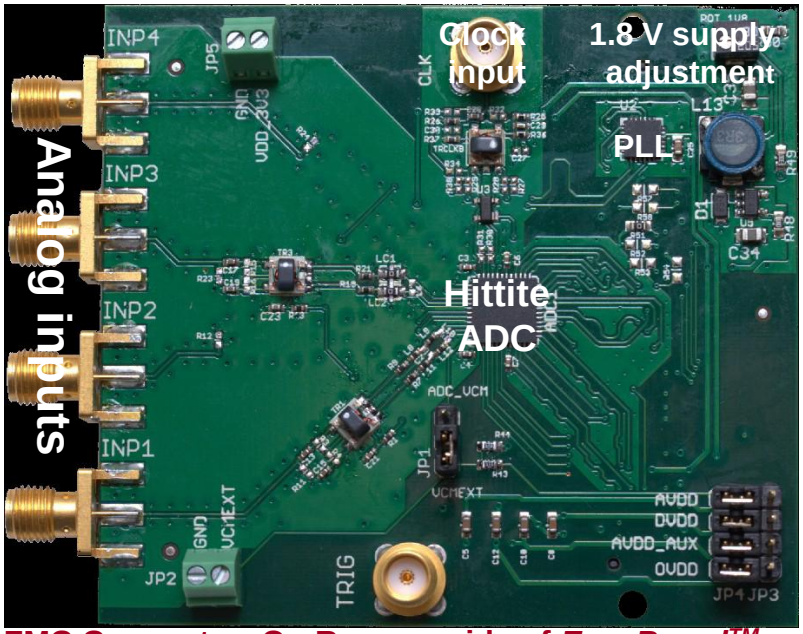
- ✓ ***EasySuite™:*** *Evaluation and Prototyping Platform Environment*
  - ✓ *The EasySuite™ PC tool handles ADC configuration and ADC data analysis. With EasySuite™, the user can easily configure the ADC through the SPI port, perform measurements and analyze the result.*
  - ✓ *EasySuite™ includes Time-Interleave post processing, for Time-Interleave artifact analysis*
- ✓ ***EasyBoard™:*** *Supplied Evaluation Board Connected to Xilinx© Standard FMC Board*
- ✓ ***EasyStack™:*** *Firmware Code Stack, Currently Available for Xilinx©*
  - ✓ *EasyStack handles data transport over LVDS from the ADC to the FPGA, and from the FPGA to the PC.*
  - ✓ *EasyStack includes an ADC data processing API*



EasySuite™ ADC Evaluation and Prototyping Tool
EasyBoard™ and Measurement setup

EasyBoard™

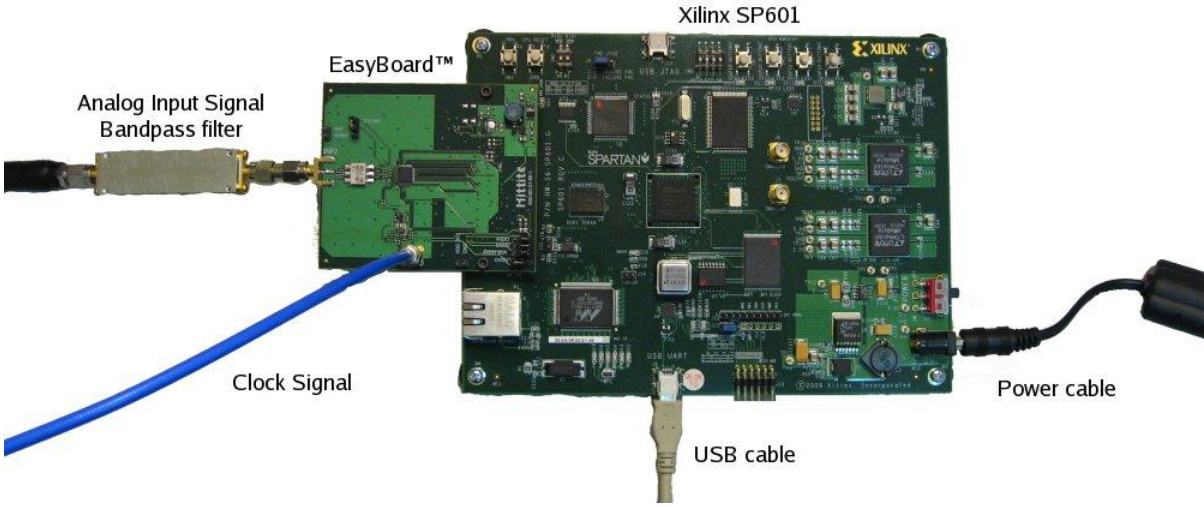
- ✓ *Connected to Xilinx standard Evaluation board through FMC Connector*
- ✓ *FMC: FPGA Mezzanine Card*
- ✓ *The Low-Pin Count FMC connector variant is utilized*
- ✓ *Xilinx SP601, SP605 and ML605 are supported*
  - ✓ *SP601 is included in the EKIT delivery*
- ✓ *EasyBoard is available for all Hittite ADCs*



FMC Connector: On Reverse side of *EasyBoard™*

Hardware setup

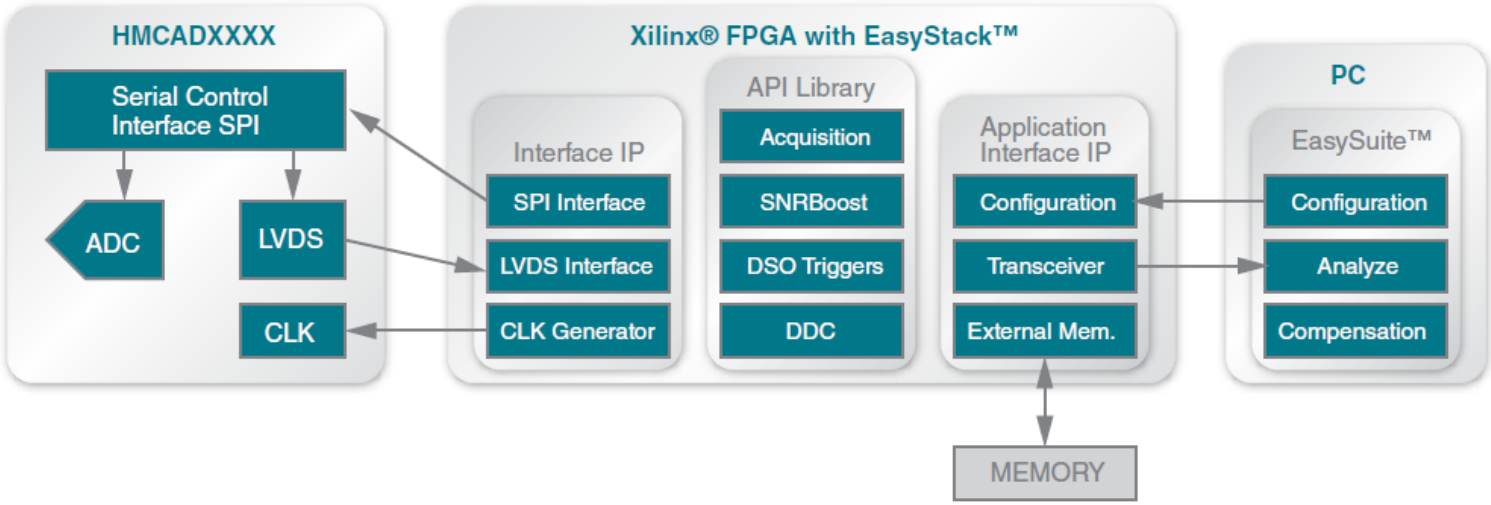
- ✓ *Analog input from signal generator*
  - ✓ *Filter needed to eliminate Signal generator noise*
- ✓ *EasyBoard™ with Hittite ADC connected to Xilinx FMX board through FMC connector*
- ✓ *Xilinx SP601 FMC board with uploaded Hittite EasyStack™ FPGA Firmware*



Analog Made Easy™

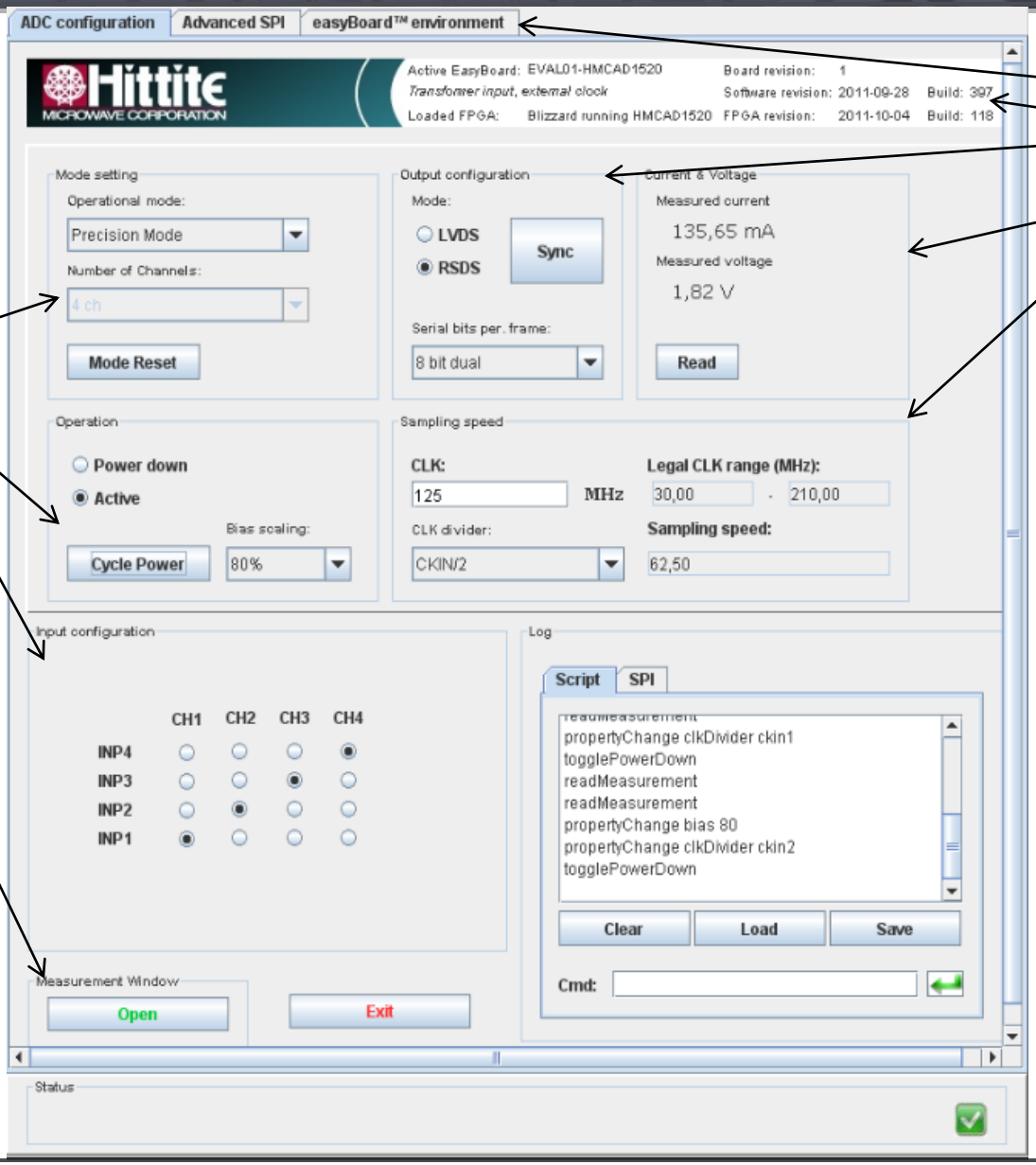
- *EasySuite™: Evaluation and Prototyping Software Environment*
- *EasyBoard™: Supplied Evaluation Board Connected to Xilinx© Standard FMC Board*
- *EasyStack™: Firmware Code Stack, Currently Available for Xilinx©*

ADC Evaluation Kit Functional Diagram



Set up

- ✓ *Set mode and # channels*
- ✓ *Set ADC current*
- ✓ *Cycle power if red*
- ✓ *Set up Cross Point Switch Array*
- ✓ *Open Measurement Window*



Set up

- ✓ *Supply Voltage*
- ✓ *Board Info*
- ✓ *Set LVDS output configuration*
- ✓ *Check supply voltage and current consumption*
- ✓ *Set clock frequency and clock divider*

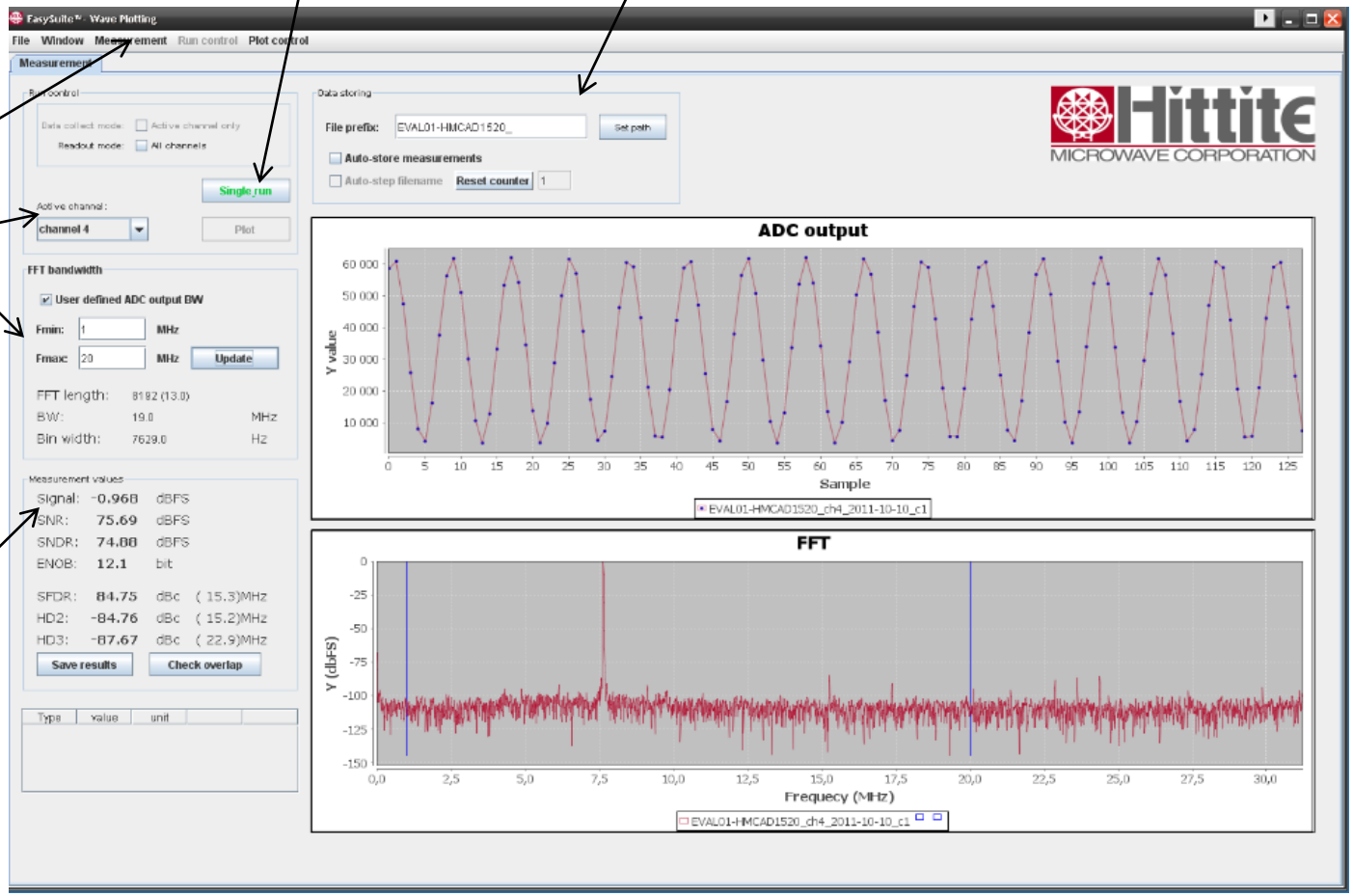
EasySuite™ Measurement Window (1 of 2)

Run
- ✓ *Capture data*

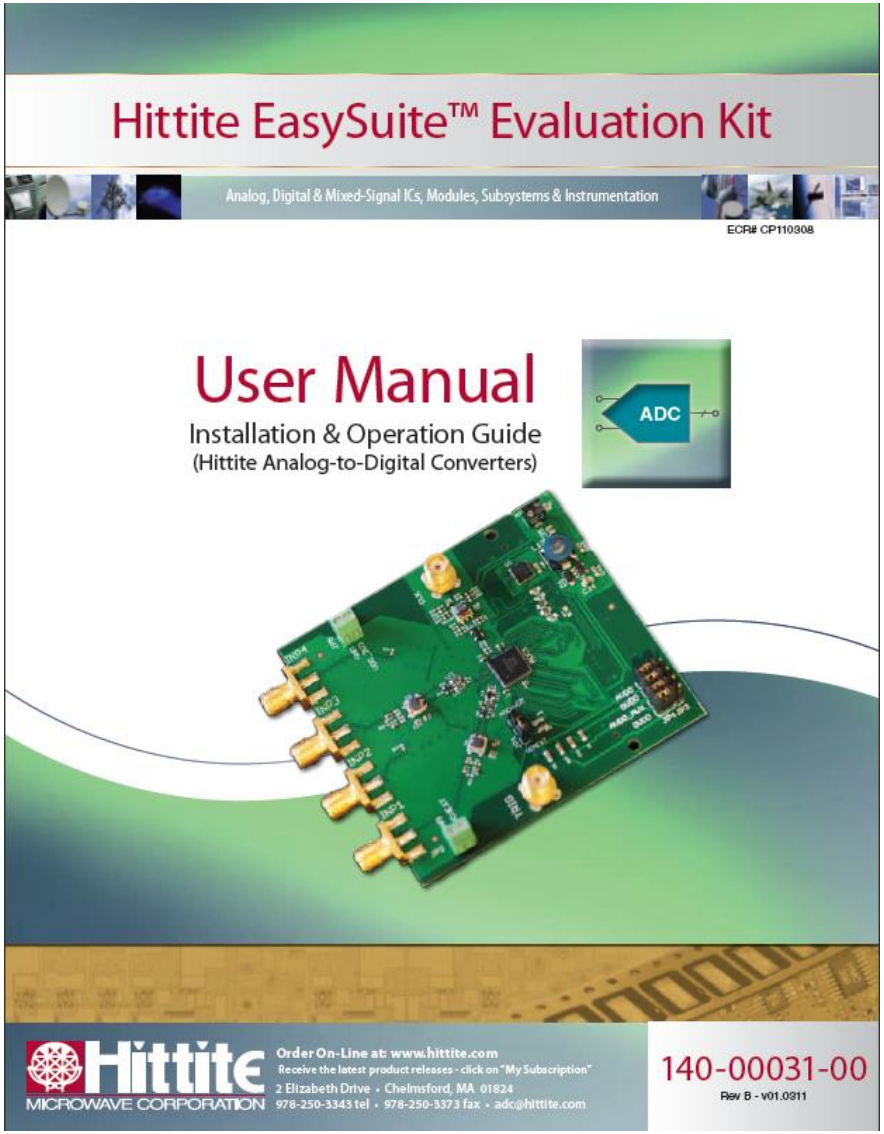
Store
- ✓ *Store data*

Set up
- ✓ *FFT length*
- ✓ *Active channel*
- ✓ *ADC output frequency band*

Evaluate
- ✓ *Read ADC performance parameters*



EasySuite™ – User Manual



Hittite Microwave Corporation

Ultra high speed A/D Converter Solutions

January 2012

Ultra High Speed A/D Converters - Overview

Part Number	Function/ Mode	Resolution (Bits)	Sample Rate	Demux	RF Bandwidth	Power Dissipation	ENOB	SFDR (dBc)
HMC5448-256BGA	8-bit, 5Gsps, with integrated 1:4 Demux	8	5 Gsps	1:4 to LVDS	9 GHz	8.5 W	5.8	41
HMC5448-256BGA	8-bit, 5Gsps, with integrated 1:8 Demux	8	5 Gsps	1:8 to LVDS	9 GHz	9.2 W	5.8	41
HMC5401LC5	26Gsps 3-bit + OVR	3	26 Gsps	None	20 GHz	3.3 W	2.9	25
HMC5831LP9	26Gsps 3-bit + OVR with integrated 1:2 Demux	3	26 Gsps	1:2 with ADC encoder	20 GHz	4.2 W	2.9	25

Roadmap

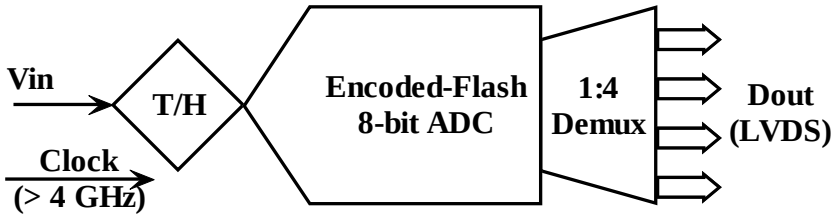
Part Number	Function/ Mode	Resolution (Bits)	Sample Rate	Demux	RF Bandwidth	Power Dissipation	ENOB	SFDR (dBc)
	8-bit, 5Gsps, with integrated 1:4 Demux	8	5 Gsps	1:4 to LVDS	9 GHz	4.2 W	5.8	41
	6-bit, 10Gsps, with integrated 1:8 Demux	6	10 Gsps	1:8 to LVDS	14 GHz	4.5 W	4.2	>32
	52Gsps 3-bit + OVR	3	52 Gsps	1:4 CML	26 GHz	5 W	2.9	25
	40Gsps 2-bit + OVR with integrated 1:2 Demux	2	40 Gsps	1:2 with ADC encoder	20 GHz	4.2 W	1.9	18
	26Gsps 5-bit + OVR	5	26 Gsps	1:2 with ADC encoder	26 GHz	4.5 W	4	29

HMC5448 8-bit @ 5 GS/s ADC

Applications

- ✓ *RADAR, LIDAR, EW, ELINT Systems*
- ✓ *Broadband Spectrometers*
- ✓ *Radio Astronomy*
- ✓ *Software-Defined Radio*
- ✓ *UWB Systems*
- ✓ *Broadband Test & Measurement Equipment*

Functional Diagram



Key Measured Specifications

Parameter	Typ. Performance	Units
Resolution	**8**	**bits**
Signal Input Bandwidth	**9**	**GHz**
Sampling rate	**5**	**GS/s**
ENOB (4 GS/s*)	**5.8 @100MHz 5.5 @ 2.0GHz 5.4 @ 6.0GHz**	**bits**
SFDR to Nyquist (4 GS/s*)	**41 @ 100 MHz 38 @ 2.5 GHz 39 @ 6.0 GHz**	**dBc**
Supply Voltages	**-5.0 ± 5% (Core) +2.0, variable +1 to 2 -2.0, 0.9 to 1.8 (Outputs)**	**V**
Total Power	**8.5 (1:4 demux, HMC5448) 9.7 (1:8 demux, HMC5447)**	**W**

** Sampling rate limited by test system*
Unless otherwise specified, T = +25°

Product ECCN Code:3A001.a.5.a

Features

- ✓ *Extremely broadband data conversion*
- ✓ *Supports sub-sampling into X-band*
- ✓ *On-chip T/H improves performance, bandwidth*
- ✓ *Differential signal and clock inputs (50 Ω)*
- ✓ *On-chip 1:4 or 1: 8 demux*
- ✓ *LVDS-compatible data, demux clock, over-range outputs*
- ✓ *-40 to 85°C operating temperature range*
- ✓ *Radiation-tolerant by design and technology*
- ✓ *Signal and clock inputs are differential*
- ✓ *Technology is SiGe HBT*

HMC5448 8-bit @ 5 GS/s ADC

EVALUATION BOARD PART NO. 127097-1

SYNPLICITY HAPS311040 MOTHER BOARD

- ***TEST BOARD MATES WITH SYNPLICITY HAPS311040 MOTHER BOARD WITH XILINX VIRTEX-4 FPG.***
- ***SYNPLICITY H_ETH_USB_1X1_P7 PROVIDES USB INTERFACE TO PC.***
- ***DATA IS PROCESSED IN THE PC USING HMC CUSTOM MATLAB AND EXCEL ROUTINES.***
- ***PART IS OPERATED WITH HEATSINK OF 5 SQ IN SURFACE AREA (1.1 IN L x1.1 IN W X 0.5 IN H) AND AIR FLOW OF 10 CFM.***
- ***ADC PACKAGE CONFORMS TO JEDEC 256 BGA (17 mm SQUARE X 4.0mm MAXIMUM HEIGHT)***

Bill of Materials 2007056 8bit ADC

Component	Description	MFG Name	MFG Part #	Quantity per Board
U1	ADC	HMC	HMC5448	1
U2	T flip-flop	HMC	HMC749LC3C	1
C1-C10	CAP TANT 4.7UF 10V 20% 0603 SMD	AVX	TACL475M010XTA	10
C11-C12,C14,C17-C37	100 nF capacitor	ATC	530L104KT 16 T	24
L4	FERRITE 10A 56 OHM 1612 SMD	Steward	HI1612X560R-10	1
L1, L2, L3, L11, L12	FERRITE 1A 19 OHMS 1206 SMD	Steward	HF1206J150R-10	5
L5,L7-L10, L13-L17	FERRITE CHIP SIGNAL 30 OHM SMD	Steward	LI0402E300R-10	10
R1-R2	RES 1.0K OHM 1/10W 5% 0603 SMD	Vishay/Dale	CRCW06031K00JNEA	2
A1-A2	CONN RCPT HI-SPD .5MM 120POS DL	Samtec	QSH-060-01-L-D-A	2
J1-J9	SMP male, Thru Mount, Full Detent, "T"=0.14	Astrolab	29474-ST2	9
J10-J11	CONN RECPT ULTRA-MINI COAX SMD	Hirose	U.FL-R-SMT(01)	2
J12-J15	CONN HEADER 2POS .100 VERT TIN	Molex	90120-0122	4
J17-J18	CONN HEADER 4POS .100 VERT TIN	Molex	90120-0124	2
J19	CONN HEADER 6POS .100" STR TIN	Molex	90131-0123	1
J20	CONN HEADER 10POS .100" STR TIN	Molex	90131-0125	1
J21	CONN HEADER 2POS 3MM R/A GOLD	Molex	43045-0202	1
J22	CONN HEADER 4POS 3MM R/A GOLD	Molex	43045-0402	1
J23	CONN HEADER 6POS 3MM R/A GOLD	Molex	43045-0602	1
J21 off board mate	CONN RECEPT 2POS 3MM VERT DUAL	Molex	43025-0200	1
J22 off board mate	CONN RECEPT 4POS 3MM VERT DUAL	Molex	43025-0400	1
J23 off board mate	CONN RECEPT 6POS 3MM VERT DUAL	Molex	43025-0600	1
J21-J32 mate female conn.	CONN TERM FEMALE 20-24AWG GOLD	Molex	43030-0009	12

HMC5831LP9 3-Bit @ 20GS/s ADC

Applications

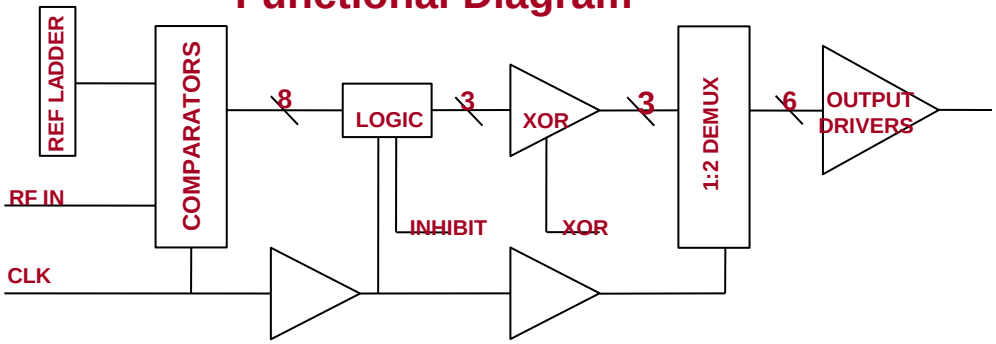
- ✓ *Serial data links*
- ✓ *Test equipment for link diagnostics*
- ✓ *Clock and data recovery*
- ✓ *Spectrometers*
- ✓ *Ultra wideband phased arrays*
- ✓ *Radio Astronomy*

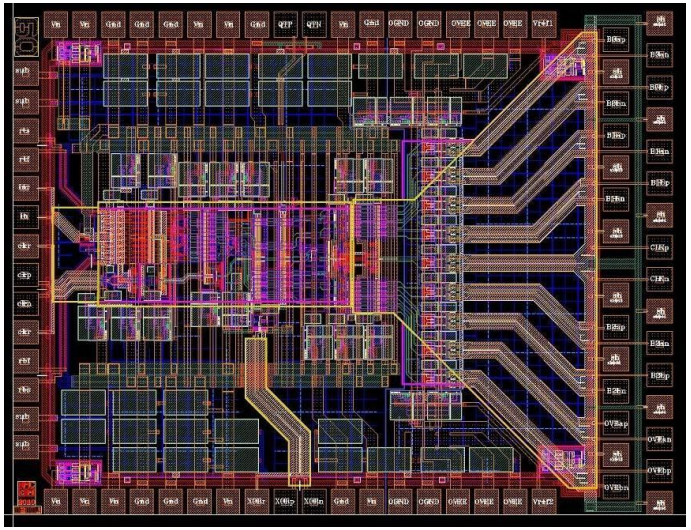
Features

- ✓ *Full Flash Architecture*
- ✓ *1:2 Demux on-chip*
- ✓ *Over/Under Range Bit*
- ✓ *Output Data Inhibit control*
- ✓ *XOR input for data paths*
- ✓ *DC Power < 4.2W*
- ✓ *RF input level 256mVpp single ended*
- ✓ *CML Outputs*
- ✓ *Sinewave Clock input level 0 dBm differential at -3dB*
- ✓ *9mm x 9mm 64 lead QFN plastic package*

Parameter	Typical	Units
Full Power Bandwidth	10	GHz
Sampling Rate	20	Gsps
Resolution	3	Bits
ENOB to Nyquist	2.9	Bits
SFDR to Nyquist	26	dBc
Clock Rate	20	GHz
Data Output Rate	10	Gsps

Functional Diagram





Unless otherwise specified, T = +25°C, 50ς

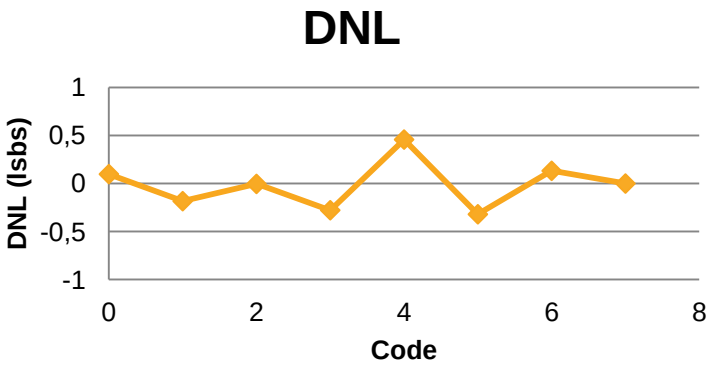
Typical Test Data from Packaged Die Evaluation - Decimated 2:1

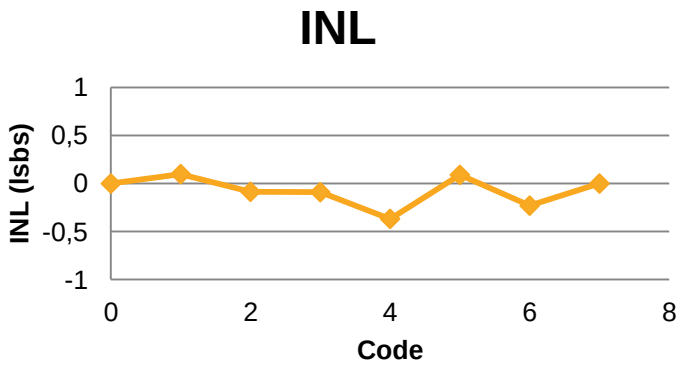
Clock Rate	20GHz	20GHz	20GHz	26GHz
Input Frequency	312.5MHz	9.6875GHz	19.6875GHz	406.25MHz
ENOB*	2.97	2.9	2.8	2.9
SINAD* (dB)	19.6	19.2	18.7	19.4
SFDR (dB)	26.8	25.9	27.5	26.4
DNL (lsbs)	0.45	0.45	0.2	0.41
INL (lsbs)	-0.37	-0.36	-0.2	-0.35

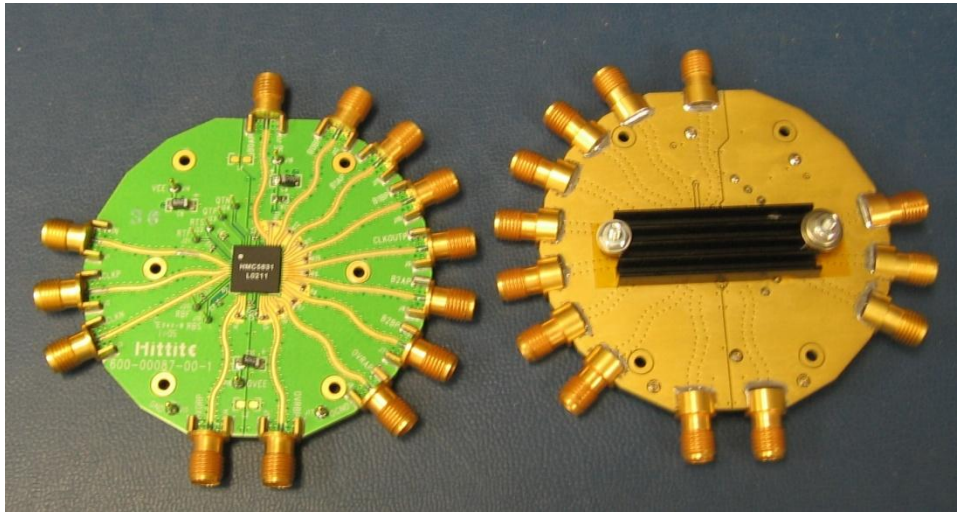
*Using IEEE std 1241

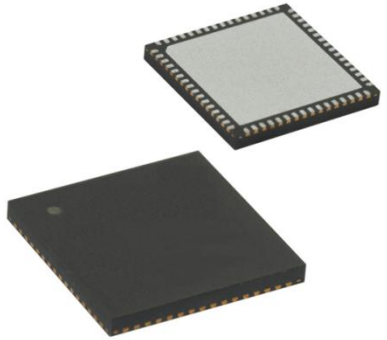
HMC5831LP9 3-Bit @ 20GS/s ADC

Preliminary Test Data









9mm x 9mm 64 Lead QFN

Hittite Microwave Corporation

Ultra Wide Band T/H Amplifiers

January 2012

T/H Amplifiers Product Overview

- **Precise Input Signal Sampling and Holding of the Sampled Input Voltage**
- **Key Application: Front End Sampler for High Speed ADCs**

  Can be used with both conventional and interleaved ADCs

  Extends bandwidth & linearity beyond that normally provided by ADC

  Provides low jitter sampling, eliminates impact of ADC clock jitter and timing skew in interleaved devices.

  Can operate at input frequencies much greater than the sample rate (sub sampling): sampling process can naturally provide frequency down conversion

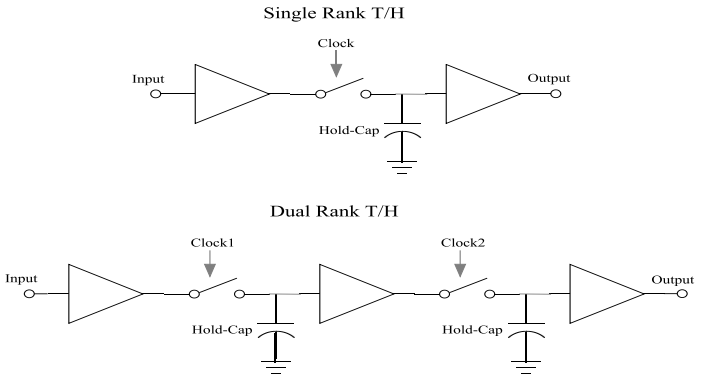
- **The difference between T/H and S/H**

  ***Sample&Hold** - The main function of S/H circuit is to take the samples of its input signal and hold this samples in its output for some period of time*

  ***Track& Hold** - If in sample mode the output tracks the input then it is called T/H circuit (or functionality)*

T/H Amplifiers – Basic Types

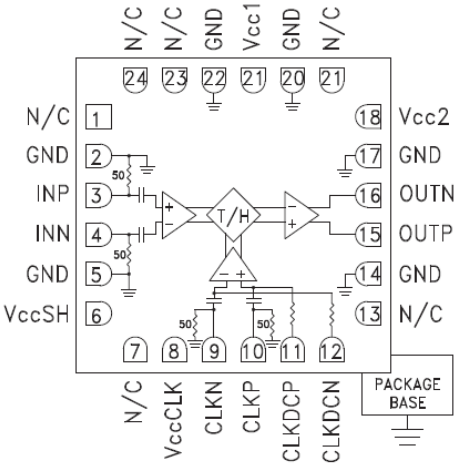
- **Single Rank T/H (Single T/H Device)**
  - ✓ *Output: Track-mode for ½ clock cycle, Hold-mode for ½ clock cycle*
  - ✓ *ADC is timed to only sample the T/H hold-interval*
  - ✓ *Optimizes dynamic range (SFDR and noise)*
  - ✓ *Most useful with high speed ADCs operating at 0.5 – 3 GS/s sample rate*



- **Dual Rank T/H (Integration of two T/Hs in cascade)**
  - ✓ *T/H1 and T/H2 clocked 180 degrees out of phase*
  - ✓ *T/H2 samples the output of T/H1 hold interval*
  - ✓ *Can be viewed as the analog equivalent of a master-slave D-flip flop*
  - ✓ *Output: T/H1 holds for ½ clock cycle (while T/H2 tracks), T/H2 holds for ½ clock cycle (while T/H1 tracks)*
  - ✓ *Output is constant at held sample value over the entire clock period*
  - ✓ *Somewhat less dynamic range but useful for lower performance ADCs (long acquisition times) or high speed ADCS at very high clock rates where ADC acquisition time limits the achievable clock rate.*

T/H Amplifiers Product Overview

Functional Diagram



HMC660LC4B

0.02 – 4.5 GHz Bandwidth

Fs = 3 GS/s

N EW!

HMC5640BLC4B

DC – 18 GHz Ultra Wideband

Fs = 4 GS/s

N EW!

HMC5641BLC4B

DC – 5 GHz Ultra Wideband

Fs = 4 GS/s

Electrical Specifications T_A = +25C, See Test Conditions on following page herein.

Parameter	Conditions	Test Level	Min.	Typ.	Max.	Units
Analog Inputs (INP, INN)						
Differential Full Scale Range				1		Vpp
AC Coupling Low Frequency Corner				16		MHz
Input Resistance	Each lead to ground			50		Ω
Return Loss	0 to 5 GHz			12		dB
DC Clock Inputs (CLKDCP, CLKDCN)						
Common Mode Voltage			2	2.5	3	V
Differential Clock High Voltage (Track Mode)			20	40	2000	mV
Differential Clock Low Voltage (T/H Mode)			-20	-40	-2000	mV
Differential Input Current				10		µA
Common Mode Input Current	CLKDCP, CLKDCN @ 2.5V			6		µA
AC Clock Inputs (CLKP, CLKN)						
Amplitude (Sinusoidal Input)	Per input terminal		-10	0	10	dBm

T/H Amplifiers Product Overview

Part number	Description	Max BW (GHz)	Max sampling rate	Evaluation Boards
HMC660	Single Rank, AC-Coupled I/O	4.5 GHz	3 GSPS	available
HMC5641B (HMC760)	Single Rank DC-Coupled I/O	5 GHz	4 GSPS	available
HMC5640B (HMC661)	Single Rank DC-Coupled I/O	18 GHz	4 GSPS	available
*HMC6054	Dual Rank DC-Coupled I/O	5 GHz	tbd	
HMC6053	Dual Rank DC-Coupled I/O	18 GHz	4 GSPS	available

* This device is presently in the engineering test

HMC5640BLC4B 18 GHz T/H amplifier

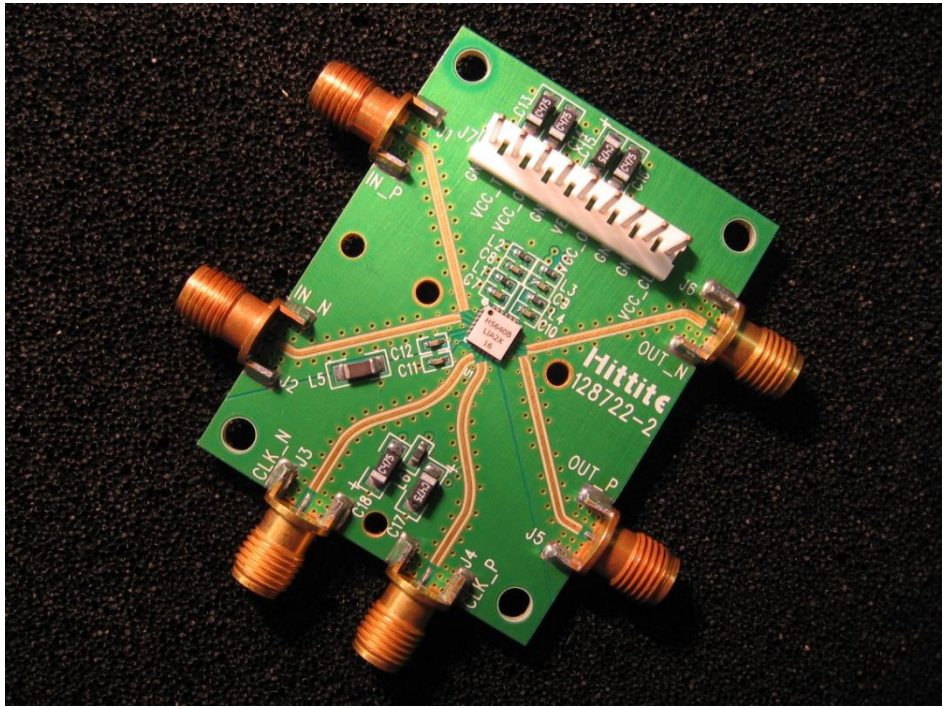
Features

- ✓ **18 GHz Input Sampling Bandwidth @ Full Scale Input**
- ✓ Up to 4 GS/s Sampling Rate
- ✓ DC Coupled, Differential Signal I/O and Clock
- ✓ Excellent High Frequency Linearity
- ✓ Clean Output Waveform, Minimal Glitching
- ✓ Single Rank Device for Low Noise in A/D applications
- ✓ 4x4mm SMT Ceramic RoHS Compliant Package

Applications

- ✓ RF ATE Applications
- ✓ Digital Sampling Oscilloscopes
- ✓ Digital Receiver Systems
- ✓ High Speed Peak Detectors
- ✓ Software Defined Radio
- ✓ Military Radar and ECM

Parameter	Typ.	Units
Input Sampling BW (T/H Mode)	18	GHz
Gain	1	V/V
Maximum Sampling Rate	4	GS/s
Full Scale Differential Input Level	**1**	**Vpp**
Single Tone SFDR (Fin = 1 GHz)[1]	56/67	dB
Single Tone SFDR (Fin = 2 GHz)[1]	56/65	dB
Single Tone SFDR (Fin = 4 GHz)[1]	57/68	dB
Single Tone SFDR (Fin = 8 GHz)[1]	43/55	dB
Sampling Aperture Jitter	< 70	fs
Hold-mode Sample Output Noise[2]	1.05	mV rms
DC Power Dissipation	1.59	W



Notes:

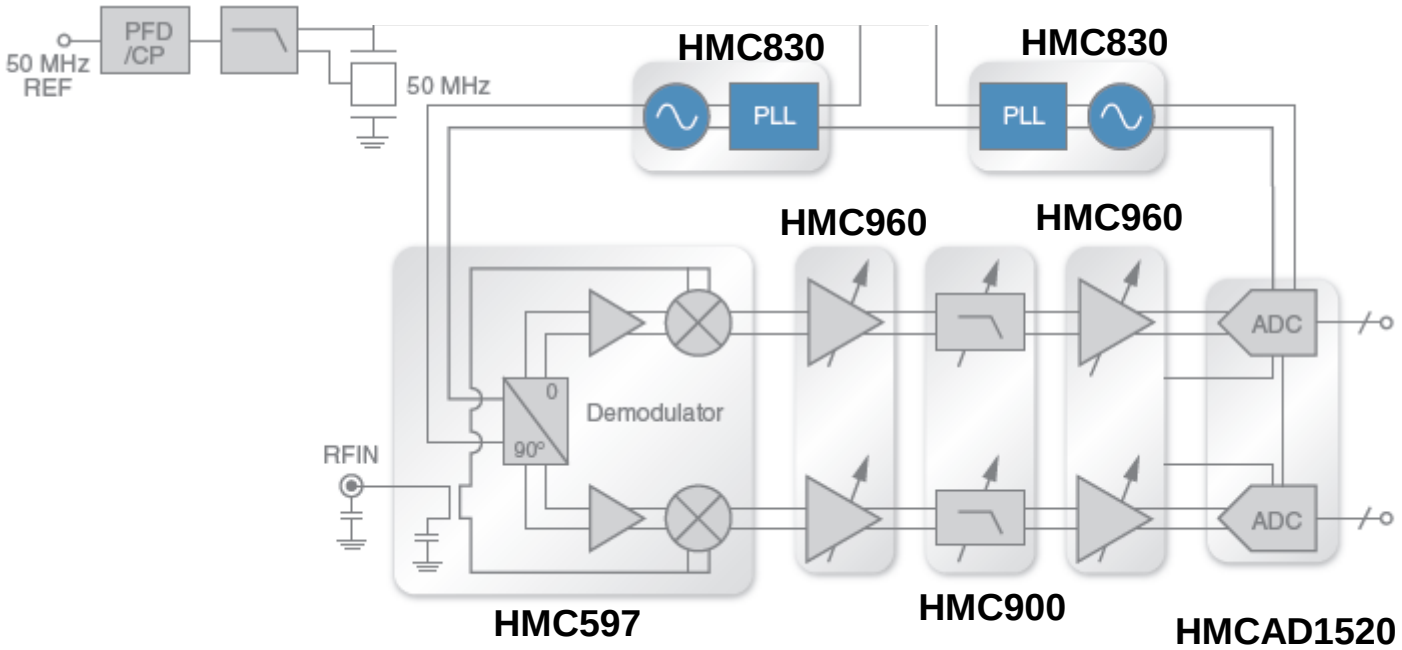
1) Clock rate = 1 GHz, input signal @ full scale/half-full scale level

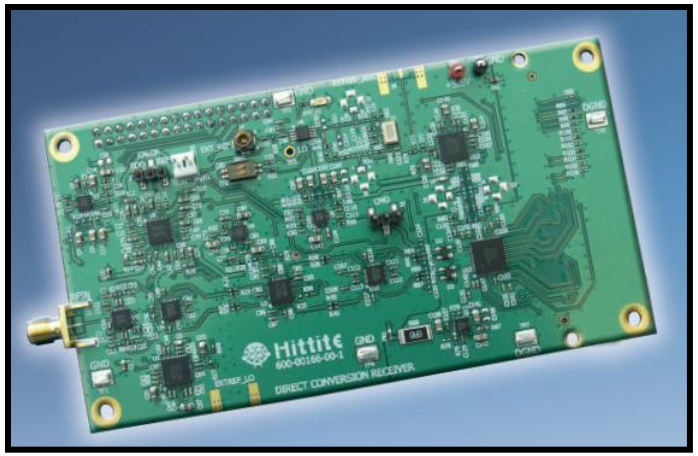
2) Measured with no output filtering (On-chip output amplifier bandwidth ~ 7 GHz), lower noise achievable with filtering

Complete Analog Mixed Signal Solutions

From RF to Bits

HMC6383 Programmable Direct Conversion Receiver



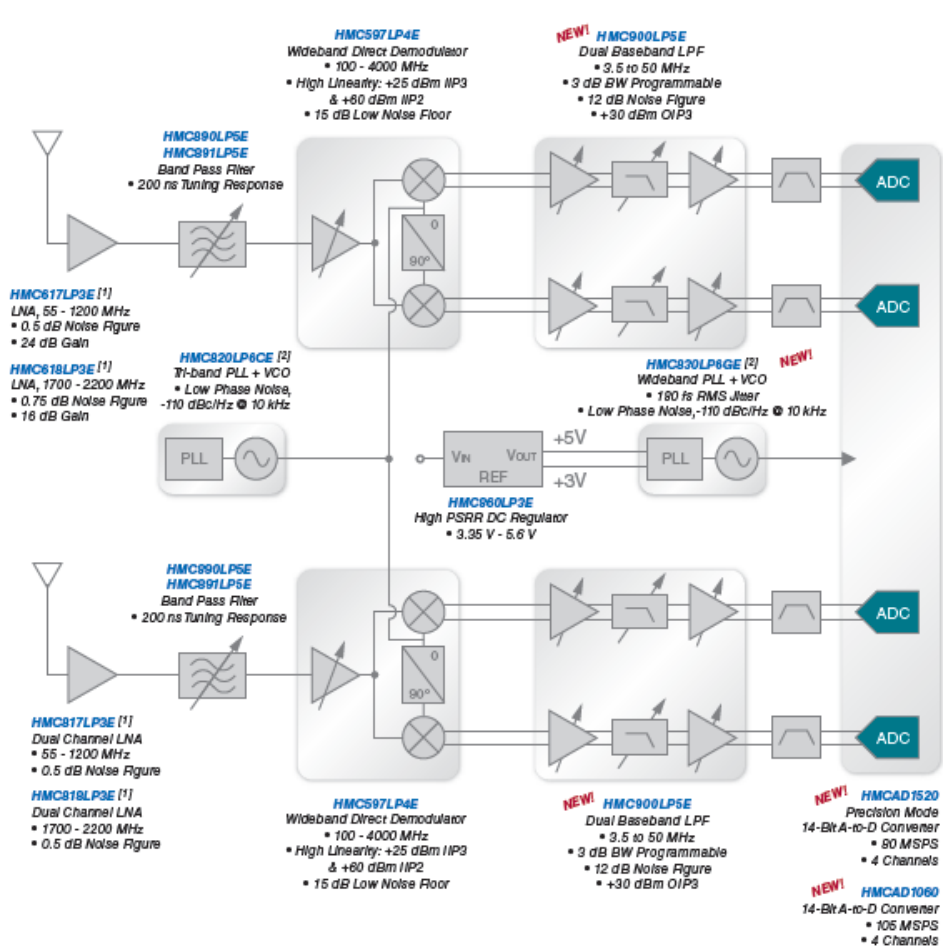


Direct Conversion Receiver Eval. Platform

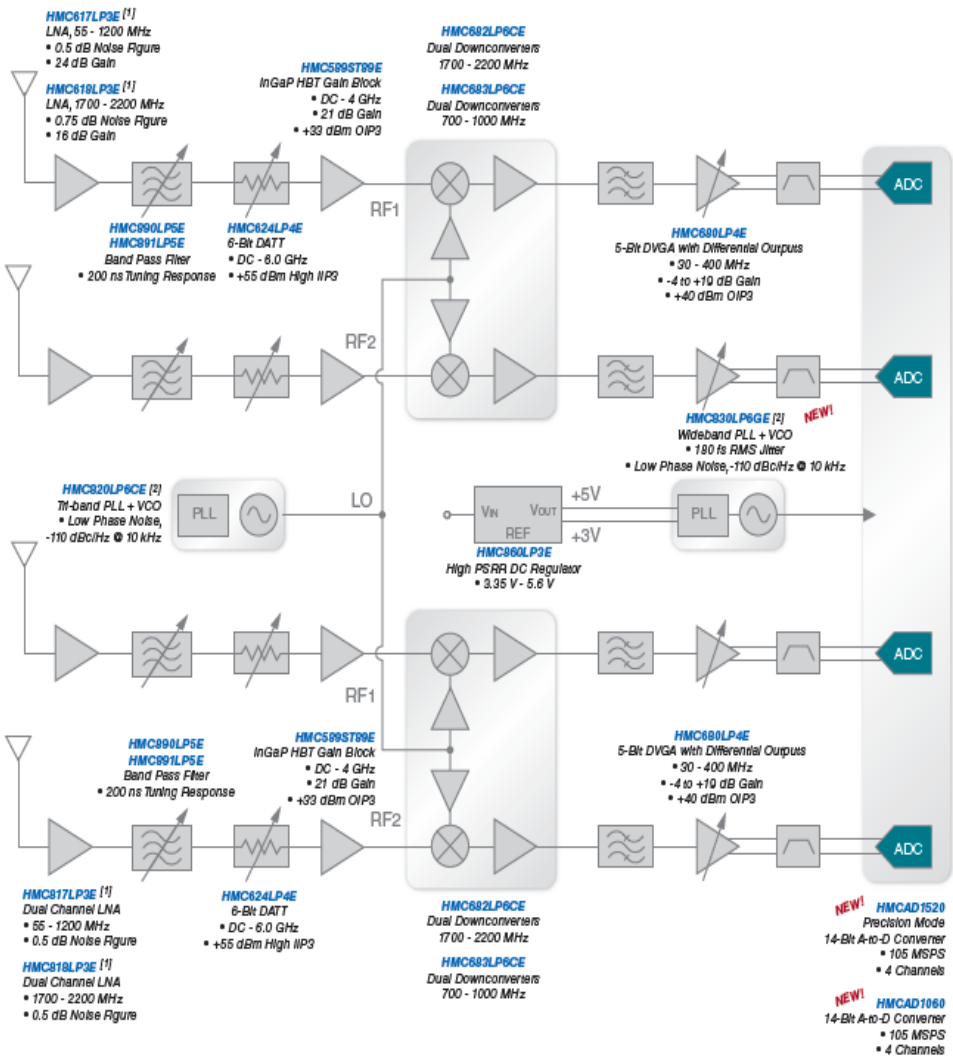
- Wideband, high linearity,
- Multi-carrier Multi-standard
- Adaptive IF for Microwave Radios
- Software defined Radios
-1 to 3GHz operation
- high performance HMC830 LO and ADC clocks
- high performance 160Msps ADCs
- Programmable baseband Filtering
- 40dB Differential VGAs

Application examples: Diversity receivers

Direct Conversion Receiver with Diversity

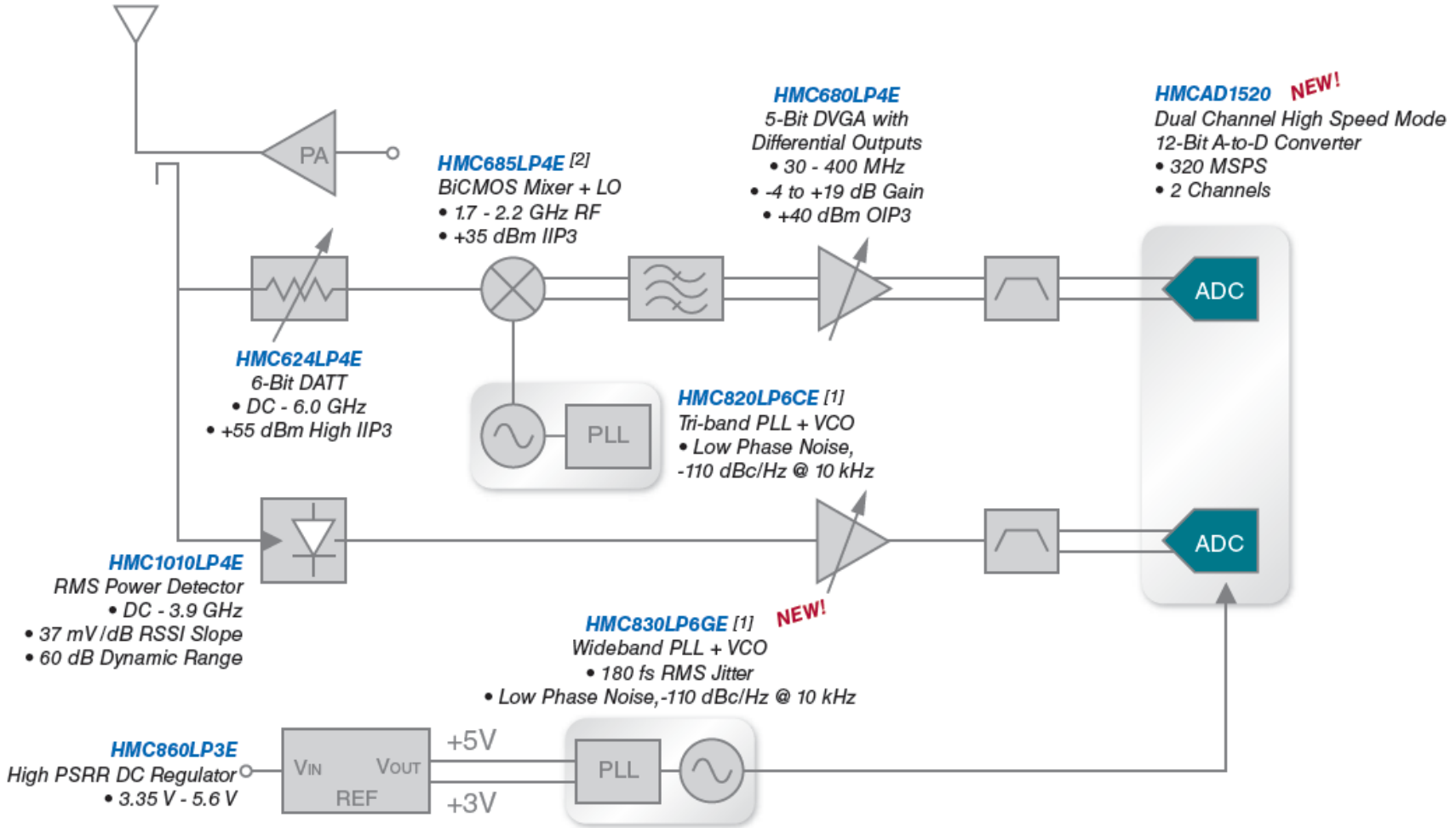


Heterodyne Receiver with MIMO



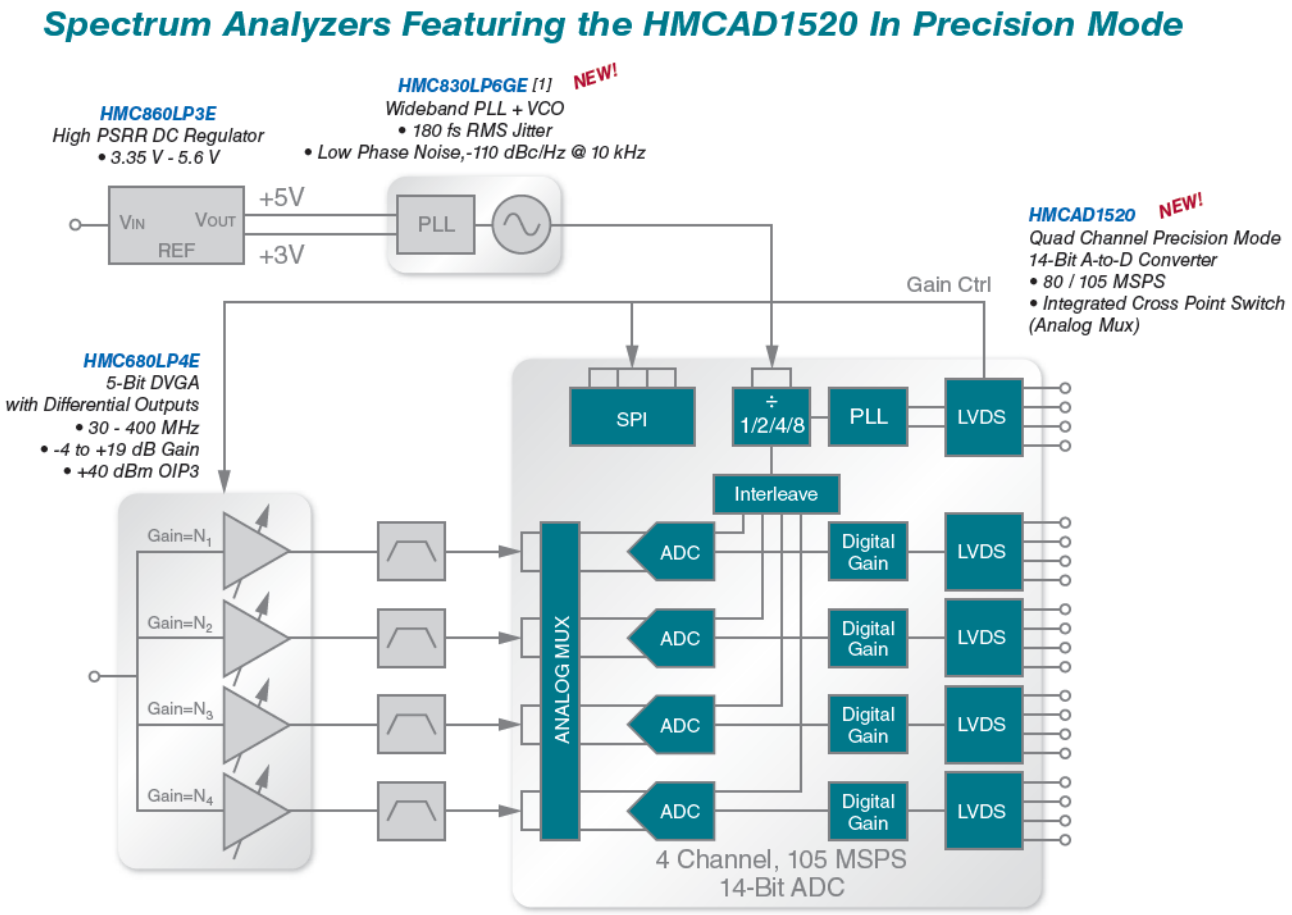
Application example: Digital Pre-Distortion Featuring HMCAD1520

Digital Pre-Distortion (DPD) Receiver Subsystem Featuring the HMCAD1520



HMCAD1520 in Spectrum Analyzer

- ✓ *Integrated Cross Point switch (analog mux) gives unique functionality for Spectrum Analyzers*
  - ✓ *The analog mux can switch ADCs to input of interest.*
  - ✓ *Gives up to 6dB SNR increase (By assigning all 4 ADCs to one input)*
  - ✓ *Analog mux switch delay: 1µs*



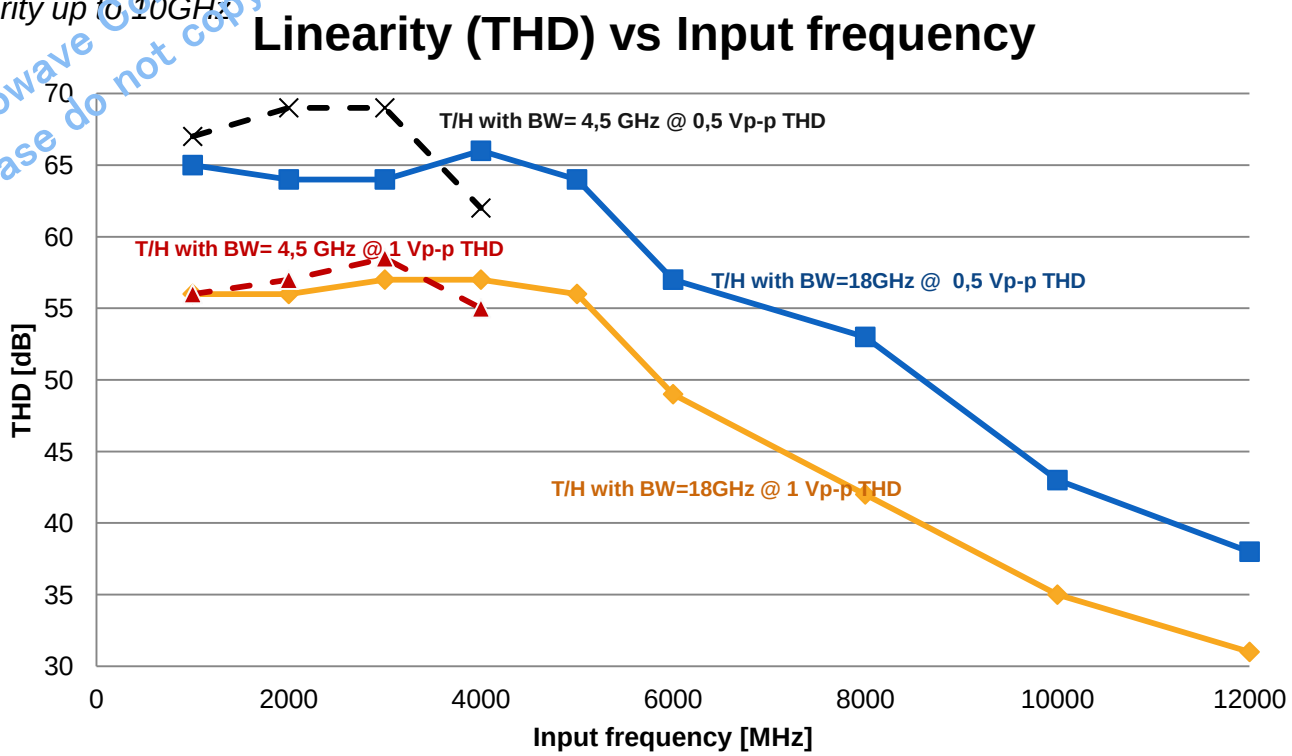
Hittite Microwave Corporation

Multi GHz Quantizer

Proposed solution

Ultra Wide Band or Narrow Band based Quantizer: Unique linearity for Microwave frequencies!

- ✓ *T/H with BW = 4,5 GHz offers*
  - ✓ *AC coupling required: Fin minimum: 20MHz*
  - ✓ *69dB linearity for 2-3GHz input frequencies*
- ✓ *T/H with BW = 18 GHz offers*
  - ✓ *DC coupling*
  - ✓ *>55dB linearity up to 6GHz*
  - ✓ *>40dB linearity up to 10GHz*



Multi GHz Quantizer

AEB306 - Single ADC solution and Single Rank T/H

Features

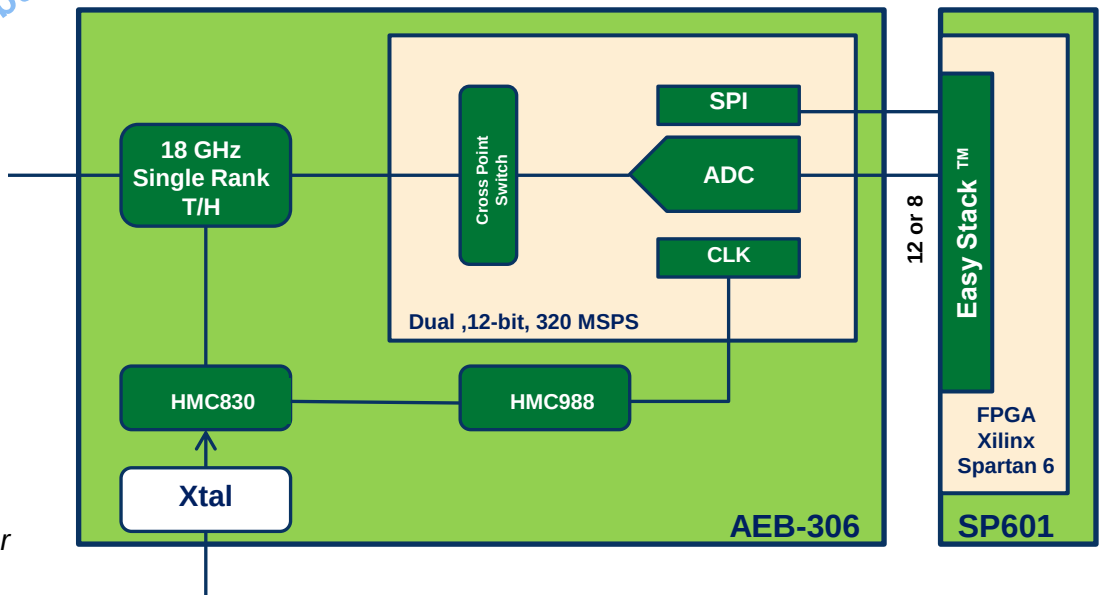
- ✓ *Input frequency range:*
  - ✓ *DC to 12GHz*
- ✓ *Instantaneous bandwidth Up to 500MHz*
  - ✓ *ADC FS=1100MSPS => Fnyq=550MHz*
  - ✓ *10% Transition bands => Instantaneous BW=500MHz*
- ✓ *Lowest sample rate*
  - ✓ *100MSPS*

ADC

- ✓ *ADC #1*
  - ✓ *12-bit Up to 640MSPS at Vsup=1.8*
- ✓ *ADC #2*
  - ✓ *8-bit Up to 1000MSPS at Vsup=1.8*

Trade-offs

- ✓ *T/H input signal amplitude (Noise vs. Linearity)*
- ✓ *ADC input amplitude*
  - ✓ *Settling BW / Noise trade-off*
  - ✓ *ADC digital gain could be utilized to enable lower magnitude at ADC input*



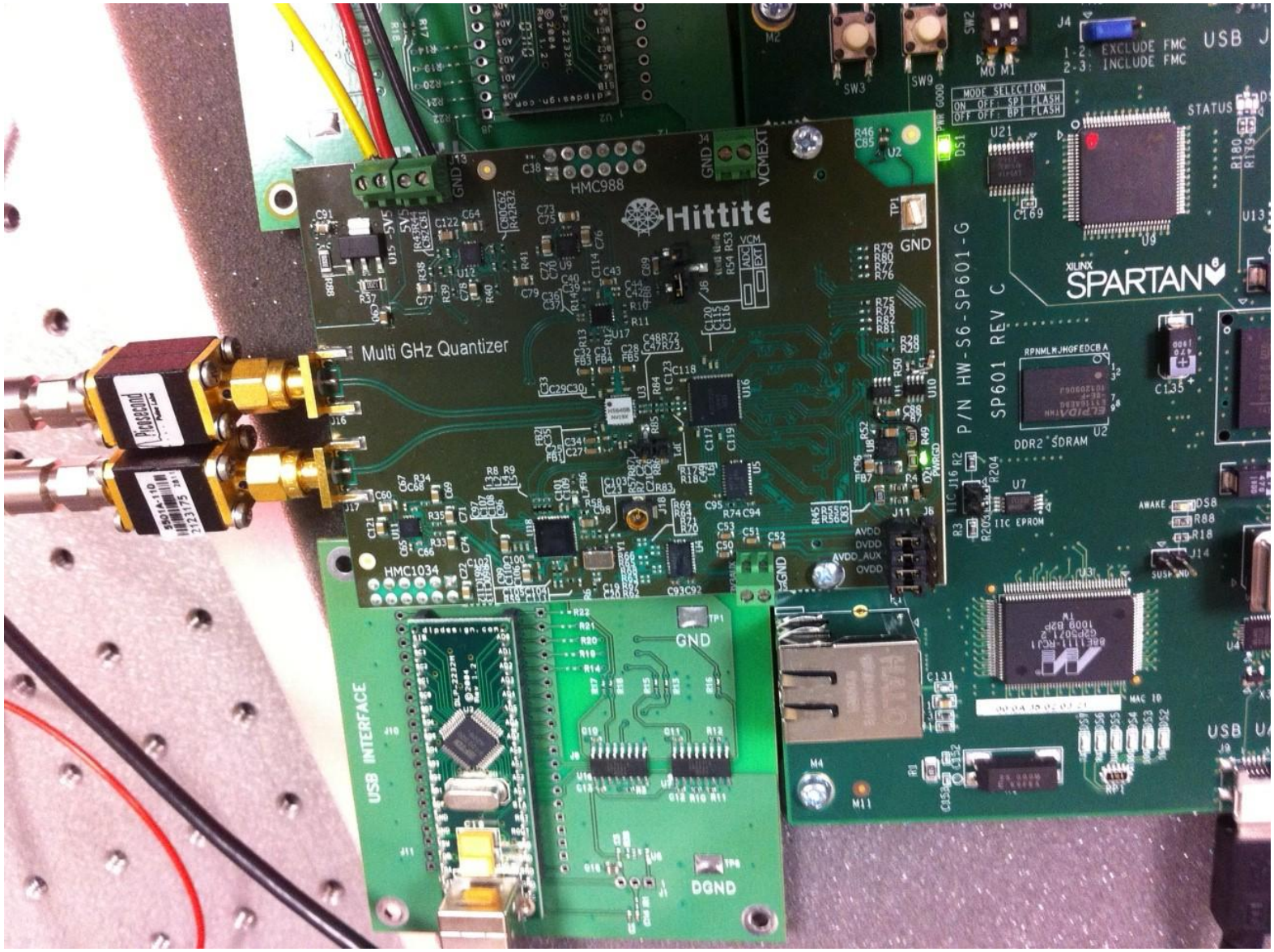
Clock control

- ✓ *PLL + VCO*
  - ✓ *HMC1034 (125 MHz – 3GHz)*
  - ✓ *HMC830 (25 MHz – 3 GHz)*
- ✓ *Programmable clock delay (divider) line*
  - ✓ *HMC988*
- ✓ *T/H input signal amplitude*
  - ✓ *Noise vs linearity*

Available in Q2 / 2012

Multi GHz Quantizer

AEB-306 reference design board



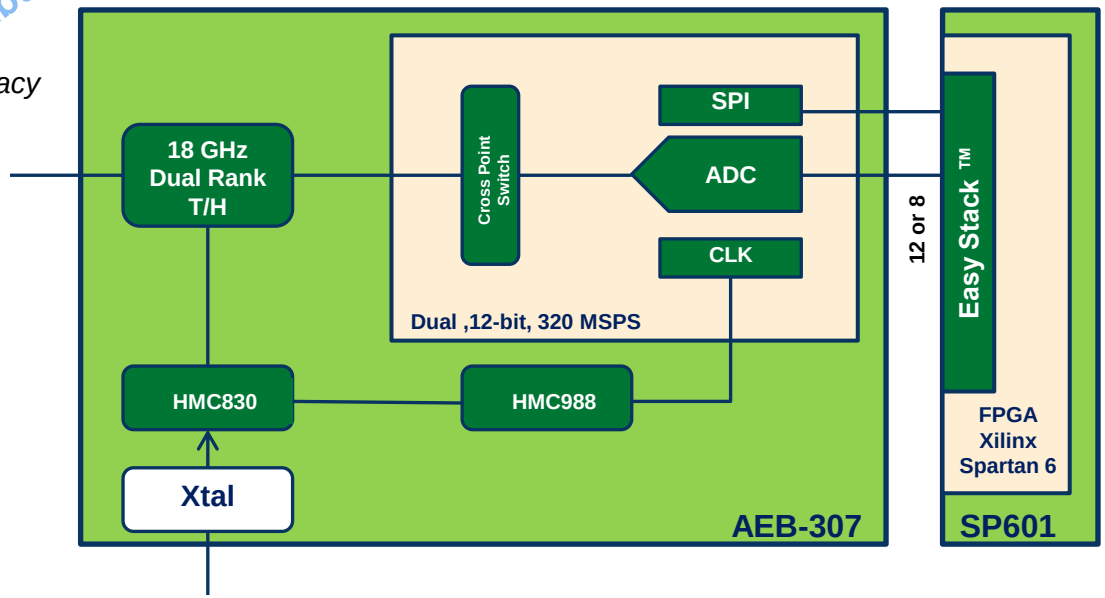
Features: identical to AEB-306

Benefits compared to AEB-306

- ✓ *Doubled ADC settling time*
- ✓ *Improved settling accuracy*
- ✓ *Reduced Settling bandwidth for given settling accuracy*
- ✓ *Reduced clock delay accuracy requirement*

Disadvantage compared to AEB-306

- ✓ *Increased power consumption*
- ✓ *Increased noise level*



Available in Q2 / 2012

Features

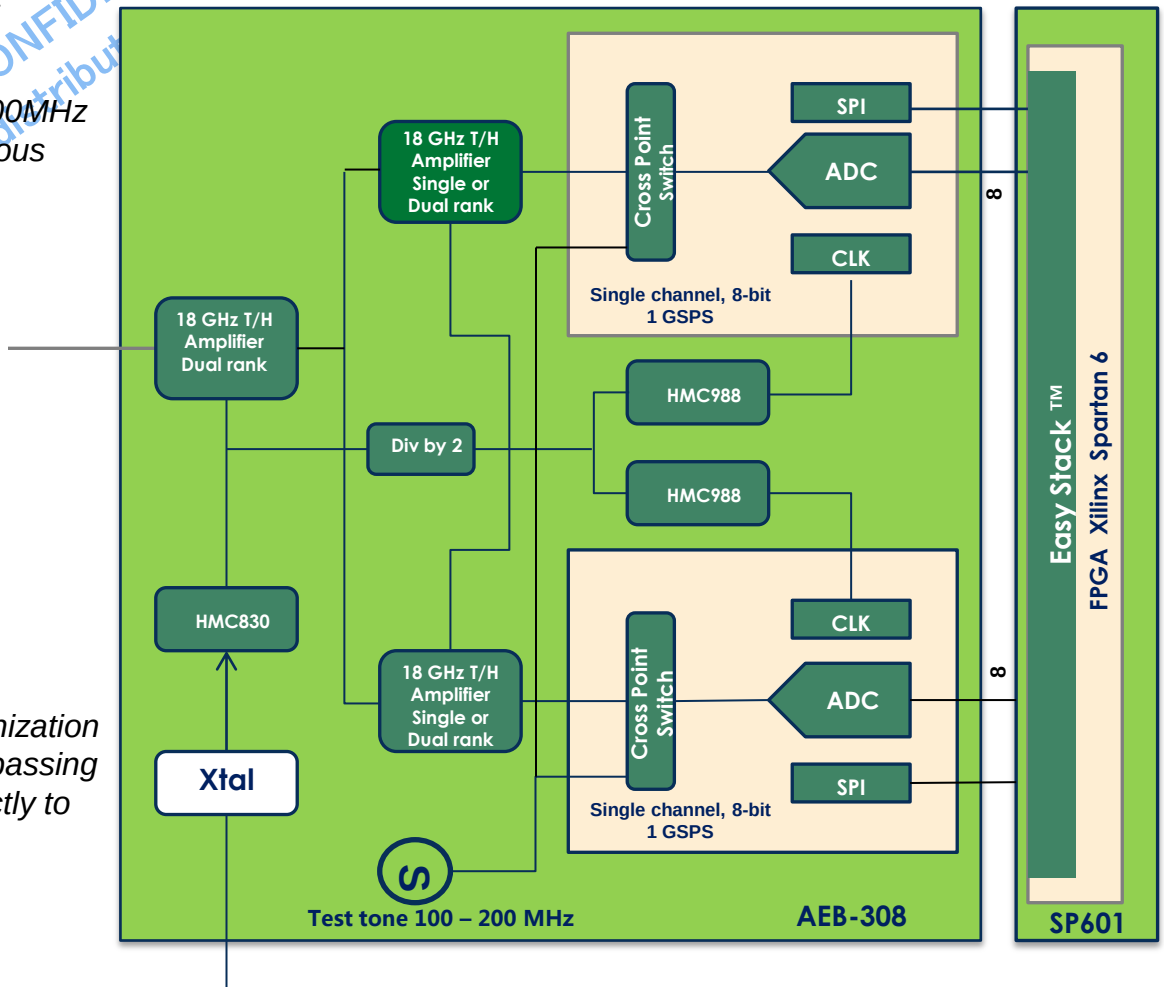
- ✓ *Input frequency range:*
  - ✓ *Narrow-Band T/H: 20 MHz to 4 GHz*
  - ✓ *Ultra Wide-Band T/H: DC to 12GHz*
- ✓ *Instantaneous bandwidth Up to 1GHz*
  - ✓ *ADC FS=2*1100MSPS => Fnyq=1100MHz*
  - ✓ *10% Transition bands => Instantaneous BW=1000MHz*

Advantage over AEB306/AEB307

- ✓ *Doubled instantaneous BW*

Comments

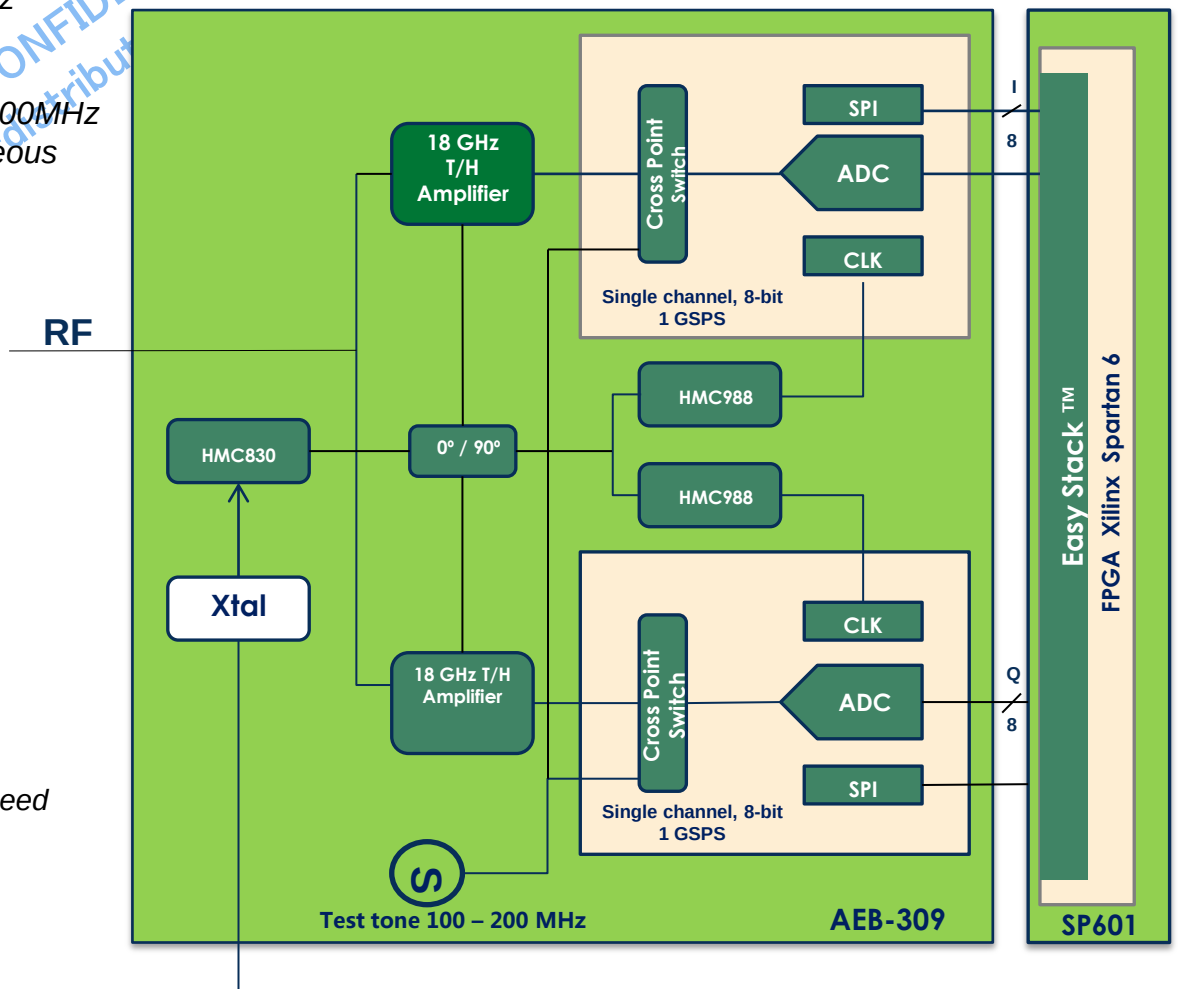
- ✓ *ADC test tone is required to ensure synchronization*
- ✓ *Direct interleaving could be evaluated by bypassing the 2nd T/H line and connect the 1st T/H directly to an unused ADC input*



Available in Q3 / 2012

Features

- ✓ *Input frequency range:*
  - ✓ *Narrow-Band T/H: 20 MHz to 4 GHz*
  - ✓ *Ultra Wide-Band T/H: DC to 12GHz*
- ✓ *Instantaneous bandwidth Up to 1GHz*
  - ✓ *ADC FS=2*1100MSPS => Fnyq=1100MHz*
  - ✓ *10% Transition bands => Instantaneous BW=1000MHz*



Advantage over AEB306/AEB307

- ✓ *Doubled instantaneous BW*

Advantage over AEB308

- ✓ *T/H amplifier and ADC operate at the same speed*

Available in Q3 / 2012

Hittite Microwave Corporation

Your Number One
Mixed Analog Signal Solutions Provider

THANK YOU FOR YOUR ATTENTION!