Direct RF-Sampling ADCs

July 2011
Breakthrough Direct RF-Sampling ADCs from National Semiconductor Revolutionize Radio Architectures

- Pin-compatible family
  - ADC12D1800RF 3.6 GSPS
  - ADC12D1600RF 3.2 GSPS
  - ADC12D1000RF 2.0 GSPS
  - ADC12D800RF 1.6 GSPS
  - ADC12D500RF 1.0 GSPS

- Industry’s best performance up to 2.7 GHz
- Enables Direct RF-sampling 3G/4G basestations
- Enables sampling into and beyond the 7th Nyquist zone
ADC12D1800/1600/1000/800/500RF
RF-Sampling ADCs Sample Beyond 2.7-GHz Inputs

Features
• Sample beyond 2.7-GHz inputs
• Interleaved or dual-channel mode
• New high-bandwidth interleaved mode
• Pin-compatible with ADC12D1x00 and ADC10D1x00 families
• Autosync for multi-ADC systems

ADC12D1800/1600/1000RF
IMD3 @ 2.7GHz  -64/-70/-69 dBc
Noise floor    -155/-154.6/-154 dBm/Hz
Power         4.4/4.0/3.5 W

ADC12D800/500RF
IMD3 @ 2.7GHz  -71/-69 dBc
Noise floor    -152.2/-150.5 dBm/Hz
Power         2.5/2.0 W

Schedule
ADC12D1800/1600/1000RF
• Samples & Boards          NOW
• Release to Production     Late July 2011

ADC12D800/500RF
• Samples & Board           NOW
• Release to Production     NOW
ADC12Dxx00RF Samples Beyond 2.7-GHz

3.84-MHz channel @ 2.7 GHz
-13 dBFS

ADC12D800RFRF-Sampling Metrics

- Noise Floor -152.2 dBm/Hz
- Wideband IMD3 @ -13 dBFS inputs
  - -60 dBc
- 2-tone IMD3 @ -16 dBFS inputs
  - -71 dBc

-13 dBFS CW blocker @ 2.71 GHz

Wideband IMD3 -73 dBFS

PowerWise
National Semiconductor
Customers Want Integrated Radio Solutions

Customer View

Customer Needs

• Reduced system cost
• Reduced system size and weight
• Simplified design
• More flexible system
• Lower power
• Scalable solution

Don’t Care

DSP
RF-Sampling Eliminates Many Components
Replaces Entire IF-Sampling Subsystem

National’s RF-Sampling Solution

Benefits
- Fewer components
- Smaller board
- Lower power
- Flexible digital mixing & filtering
- Less interference
- 1.8-GHz Nyquist BW

Traditional IF-Sampling
RF-Sampling Eliminates 20+ Components
Replaces Entire ZIF-Sampling Subsystem

National’s RF-Sampling Solution

Benefits
• Fewer components
• Smaller board
• Lower power
• Flexible digital mixing & filtering
• Less interference
• 1.8-GHz Nyquist BW
### ADC12Dxx00RF Apply to Many Applications

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*Image of Motorola, Sony, and National Semiconductor logos.*
Wireless Basestations
Replaces IF-Sampling in Rx and DPD

Old: IF-Sampling
New: RF-Sampling

RF ADC

Cost Area Time
Wireless Basestations
Replaces ZIF-Sampling in Rx and DPD

Old: ZIF-Sampling
New: RF-Sampling
Military Designs
Dramatically Reduces Size, Weight & Power

1.8-GHz Nyquist zone enables
• Combine multiple channels

RF-Sampling enables
• Eliminate freq conv stage
• Digital control of freq

Old Solution

x10 to 100

Analog Ctrl

RF ADC

x100 to 1000

Analog Ctrl

DSP

RF Sampling

CTRL in DSP

DSP

11
Microwave Backhaul
Reduce Size

Old Solution

Outdoor Unit

Indoor Unit

RF-Sampling Solution

Outdoor Unit

RF-Sampling enables
- Eliminate freq conv stage
- Integrate ODU and IDU into single unit
Microwave Backhaul
Increase Data Capacity

Excellent performance beyond 2.7 GHz
- Increase modulation order

Nyquist zone up to 1.8 GHz
- Increase channel bandwidth

Simultaneously Increase Modulation & BW

Increased Channel BW Increases Data Capacity

Traditional band channels
- 28MHz, 56MHz, 112MHz

E-band channels
- 250MHz, 500MHz, 750MHz, 1250MHz

Increased Modulation increases Data Capacity

Modulations:
- DPQPSK
- 16-QAM, 64-QAM, 256-QAM, 1024-QAM, 4096-QAM
Excellent Linearity beyond 2.7 GHz IMD3

-10 dBFS input

-13 dBFS input

-16 dBFS input

Input Frequency
New, Higher-$f_{IN}$ DES Mode
DESCLKIQ for Supporting Higher Input Frequencies

Non-DES

DESI / DESQ

DESIQ

NEW DESCLKIQ

ADC1xD1x00 modes

Improves interleaved $f_{IN}$ range > 100%
Pin-Compatible GSPS ADC Portfolio

Pin-compatible 10-bit, 12-bit, and RF-ADC family allows design reuse for different speeds & resolutions.

New RF ADCs

12-bit ADC

10-bit ADC

500  1000  1500  2000  2500  3000  3600

Sampling Rate (MSPS)

Non-DES

DES
Summary

- National introduces industry’s first ADC for Direct RF-Sampling beyond 2.7 GHz
- Pin-compatible family covers 500-MSPS to 3.6-GSPS and is pin-compatible with existing 10- & 12-bit GSPS ADCs
- Single RF-sampling ADC replaces entire analog subsystem
- Shifts more processing to digital for lower power, better programmability
- New interleaving mode more than doubles usable frequency range
For More Information on National’s Direct RF-Sampling ADCs

Visit

http://www.national.com/rfadc