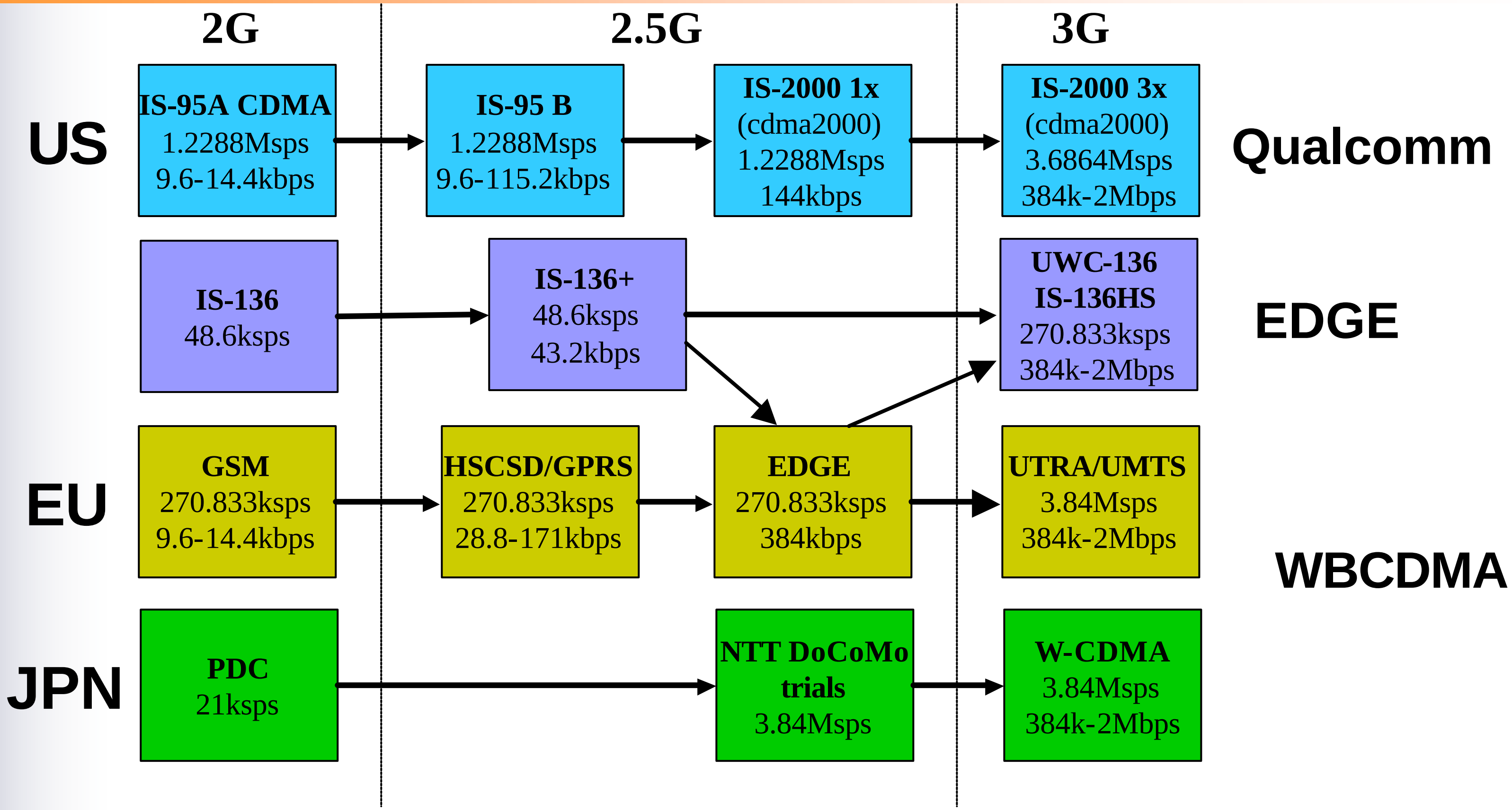
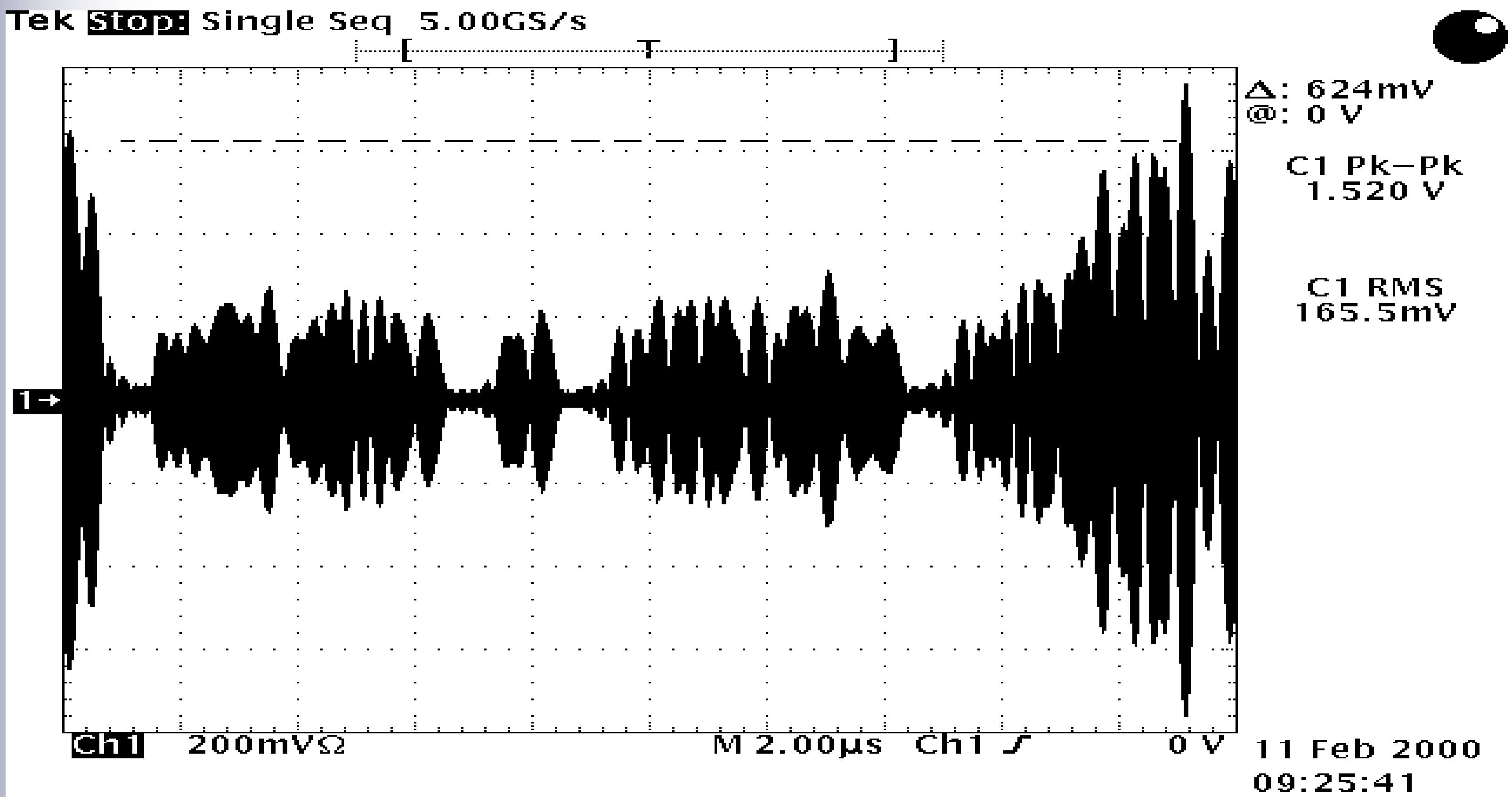
Analog Devices
Radio Solutions
for Wireless Infrastructure

Capacity and increased data services drive the evolution from 2G to 3G



3G Waveforms - Challenging to maintain linearity

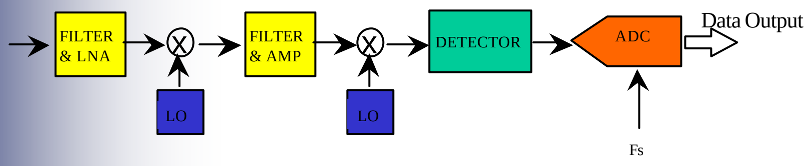
Time Domain Waveform



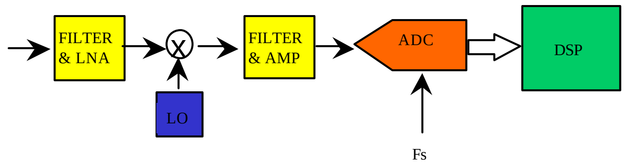
W-CDMA Forward Link, 4 Channels

Receiver Architectures

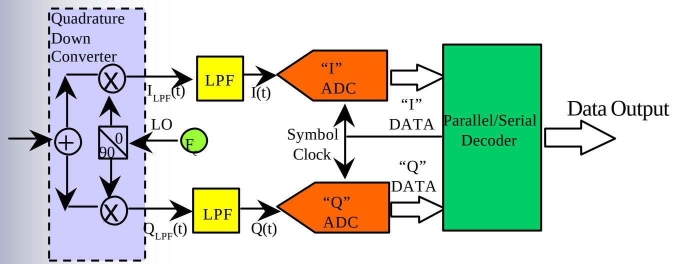
Baseband Sampling (Superheterodyne)



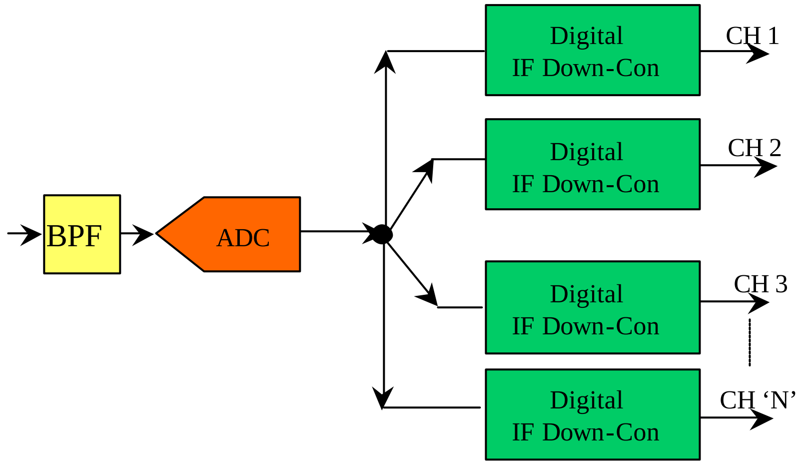
IF Under-Sampling (Direct IF)



Baseband, Analog Down-conversion

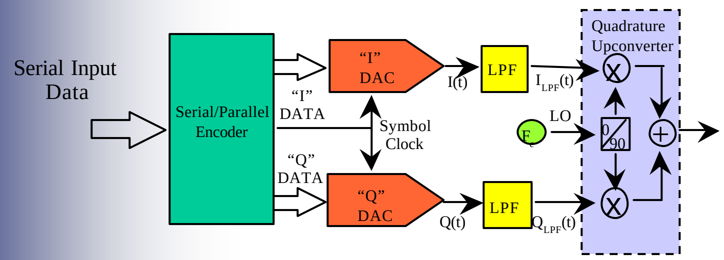


Multi-carrier RX, Digital Demod

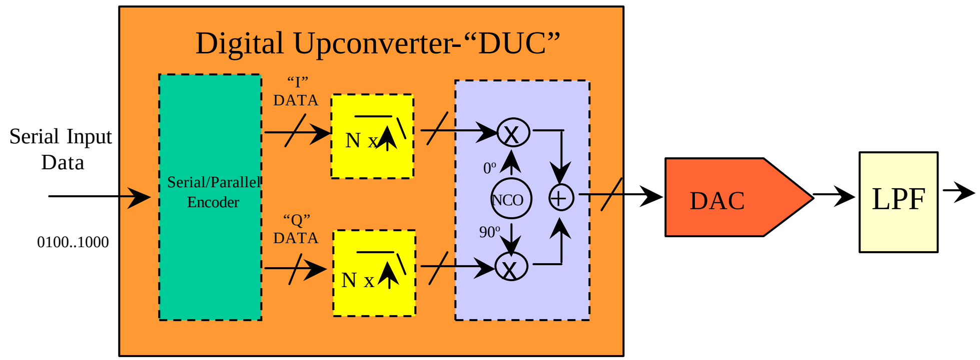


Transmitter Architectures

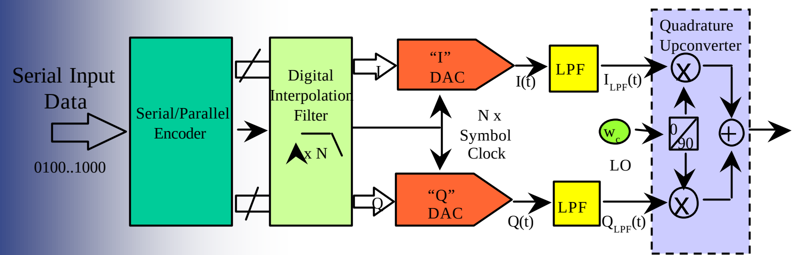
Nyquist Baseband



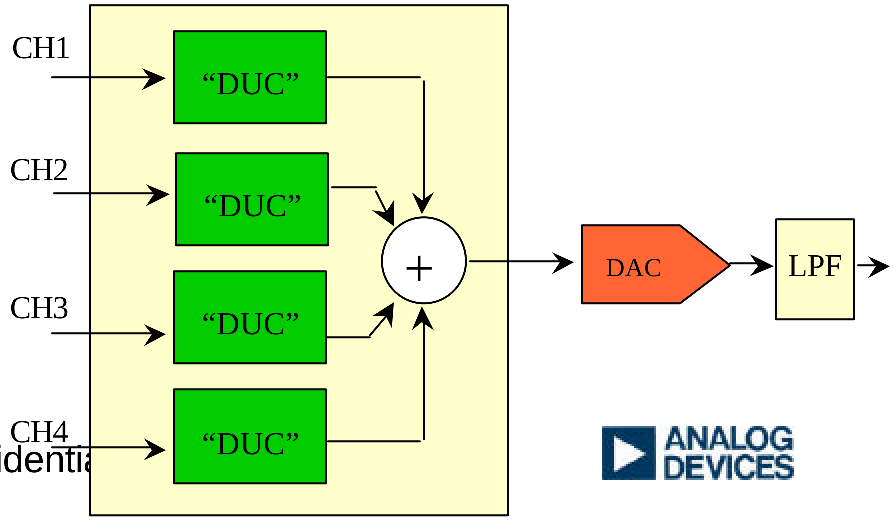
Direct Digital IF



Nyquist Baseband with Digital Interpolation



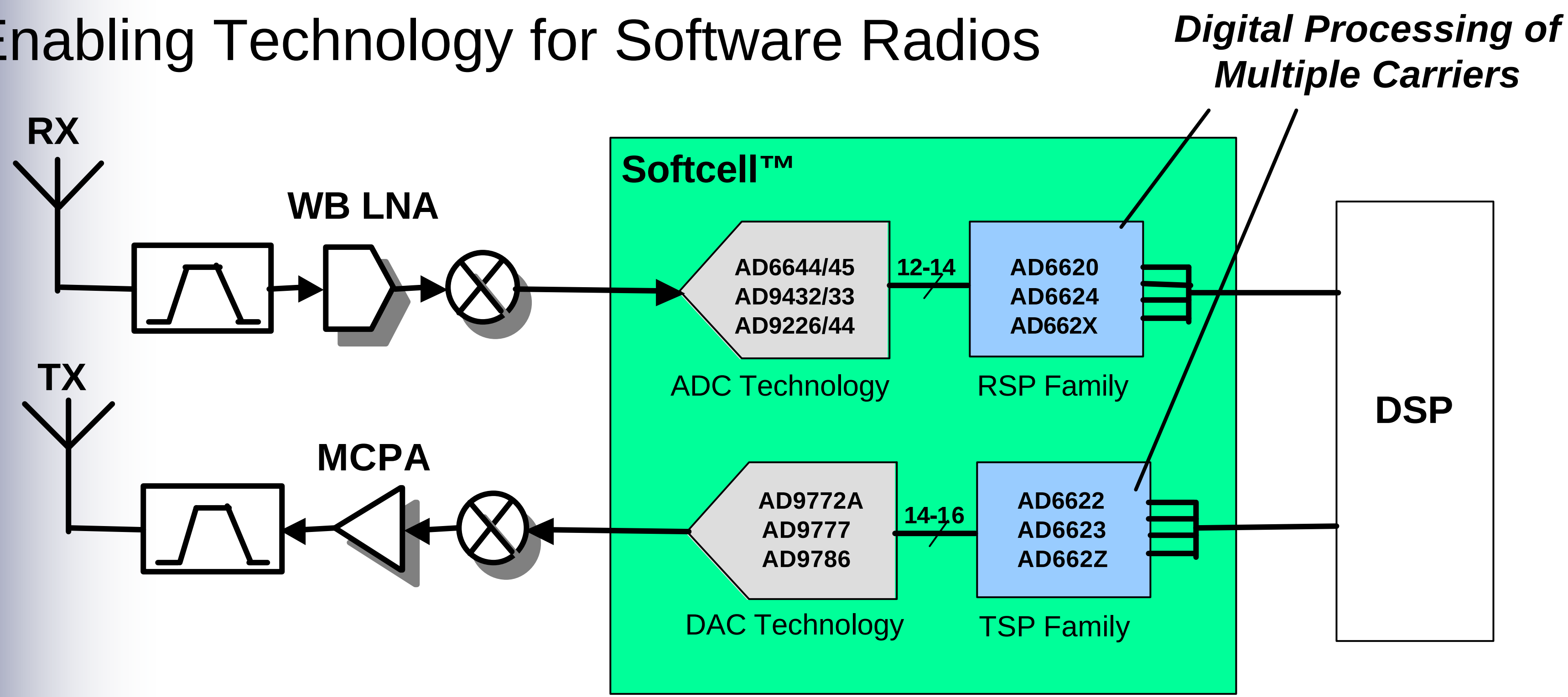
Multi-Carrier Architecture



ANALOG DEVICES

SoftCell™ Multicarrier Transceiver

Enabling Technology for Software Radios

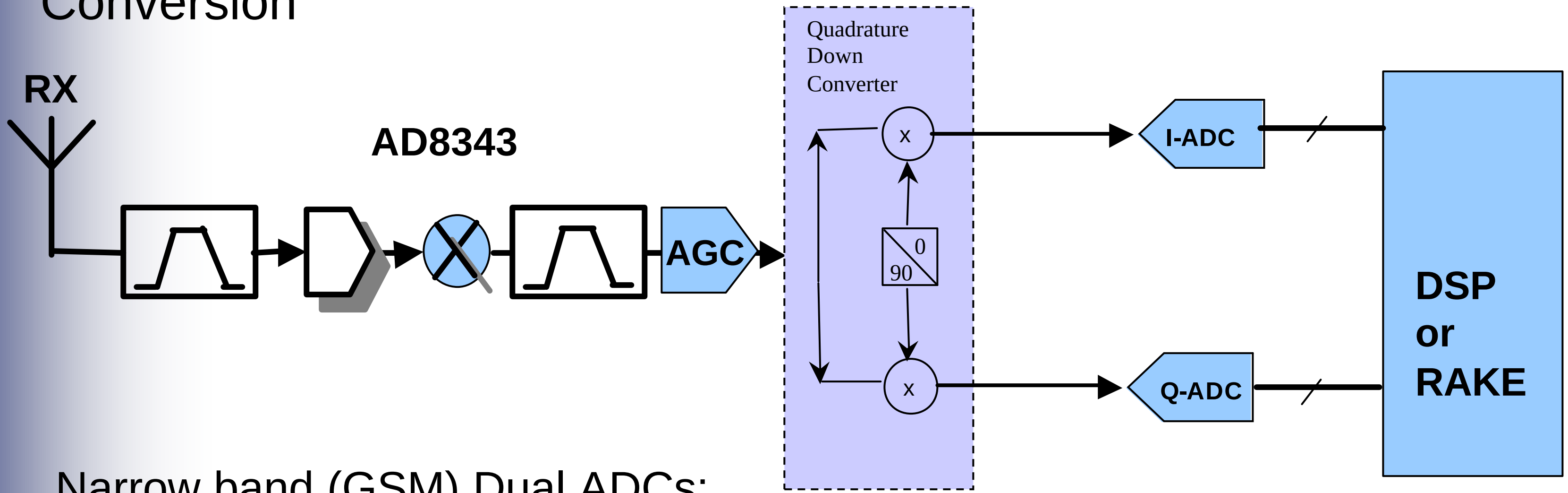


<u>Receive Specifications</u>
>100 MSPS Sampling
100+dB Dynamic Range

<u>Transmit Specifications</u>
>100 MSPS Sampling
85+dB Dynamic Range

Base Station Receiver
Analog Base Band I and Q Architecture

One or Two IF stages….radio dynamic range doesn't permit Direct Conversion



Narrow band (GSM) Dual ADCs:

AD7724 (ΣΔ modulator), AD7729 ΣΔ ADC 16-bit

Wide Band (CDMA) Dual ADCs

AD9066 6-bit

AD9058/59 8-bit

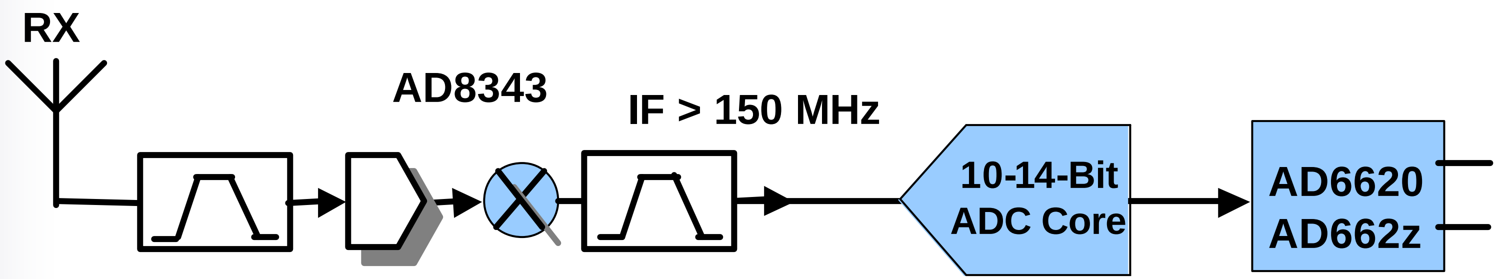
AD9288 8-bit

AD9218 10-bit (pin compatible to 9288)

AD9238 12-bit

Base Station Receiver
Single Carrier Direct IF Sampling

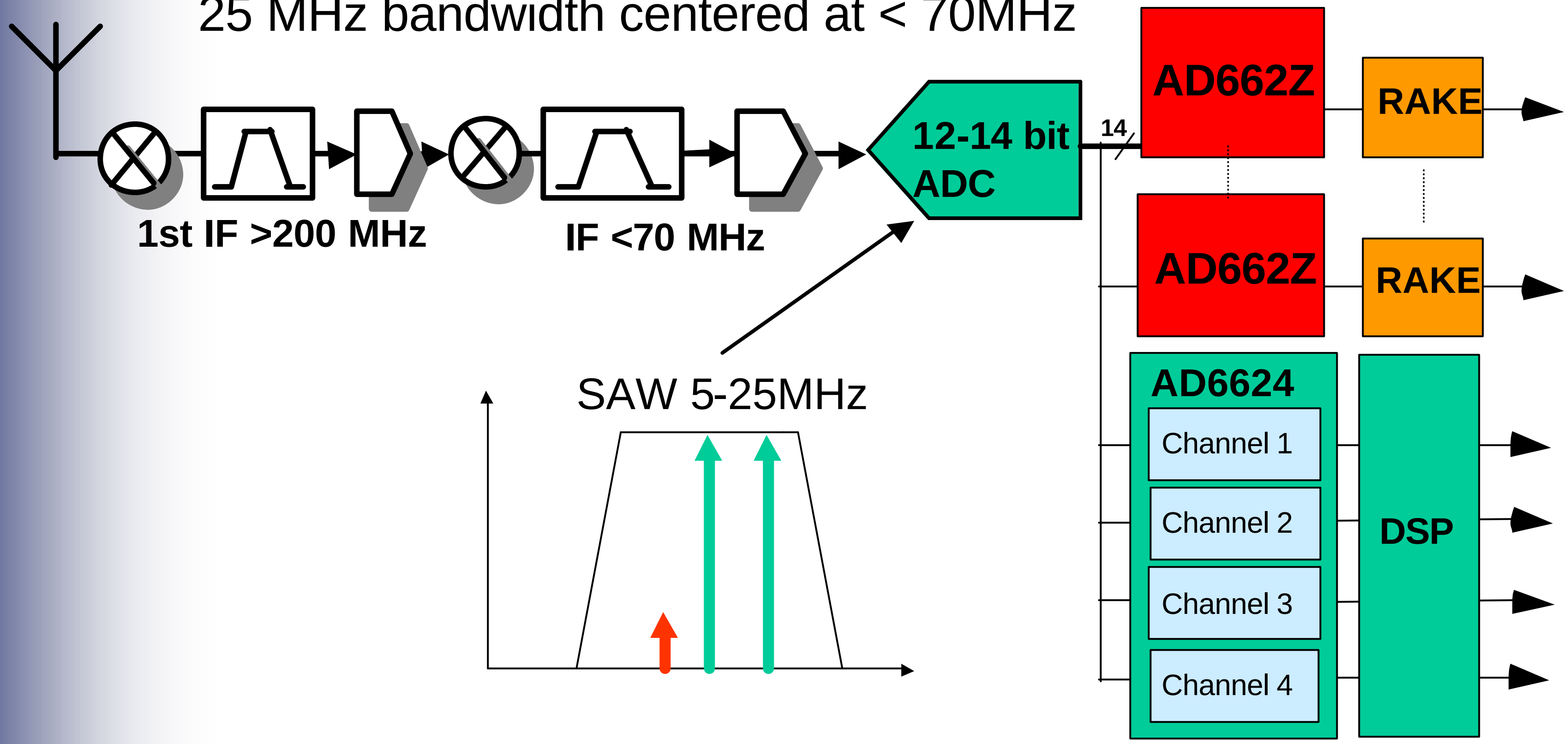
- Single conversion radio design (WBCDMA shown) reduces radio part count and complexity
- Digital Filtering adds flexibility and reliability



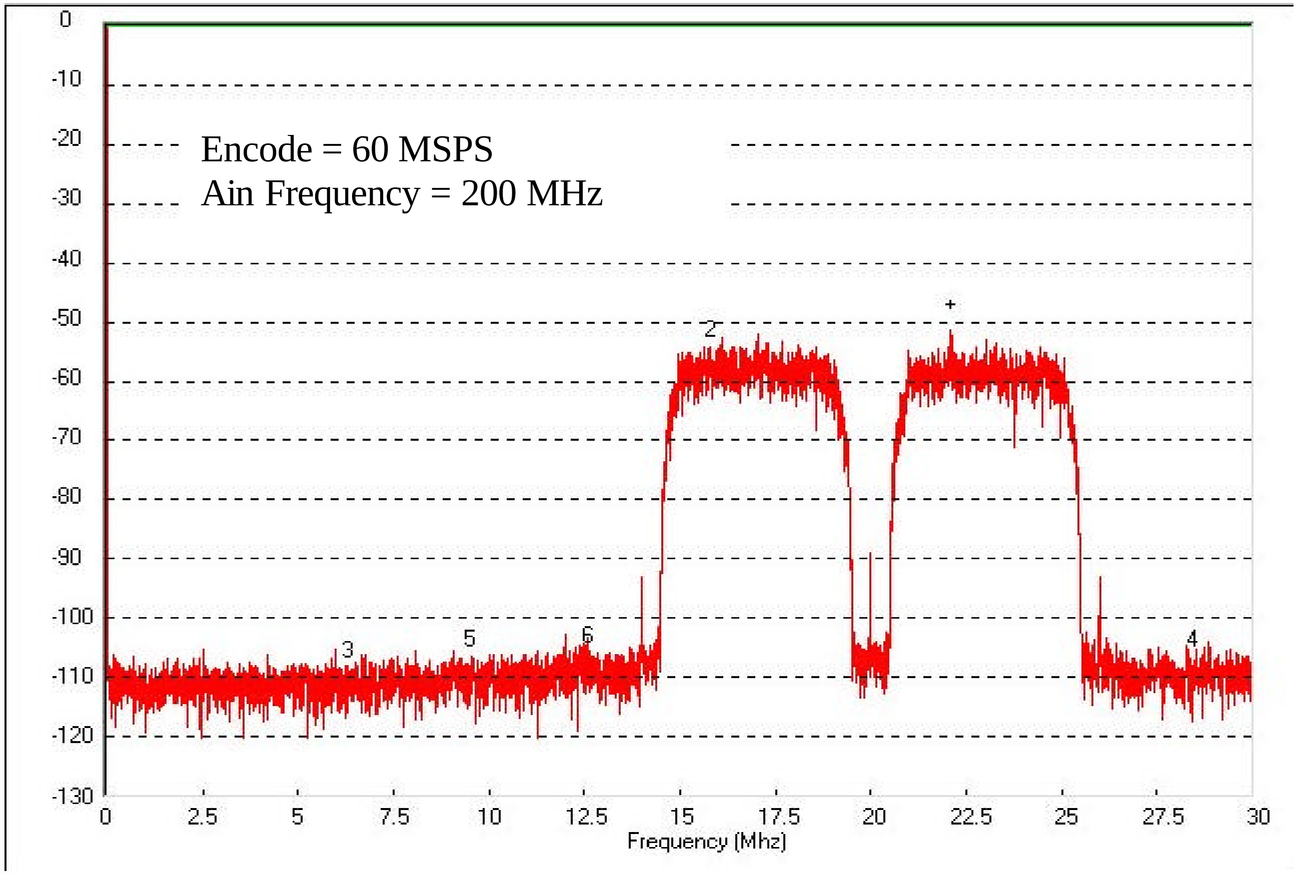
- High Freq. Analog Input ADCs
  - 10-bit: AD9410
  - AD6600 Diversity Receiver (GSM, IS95 CDMA)
  - 12-bit: AD6640, AD9432/33, AD9226, AD9235/38
  - 14-bit: AD6644

Multi-carrier SoftCell™ Low IF Sampling

- Double conversion radio, multi-carrier digitizer
- High Dynamic range requires Low IF Frequency 5MHz to 25 MHz bandwidth centered at < 70MHz



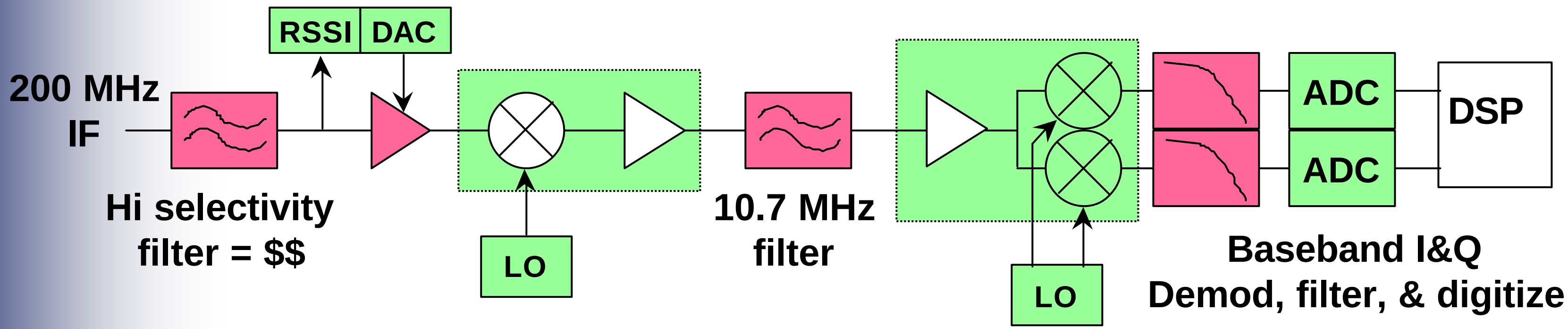
AD6644 IF Sampling a WCDMA Multicarrier Signal @ 200 MHz

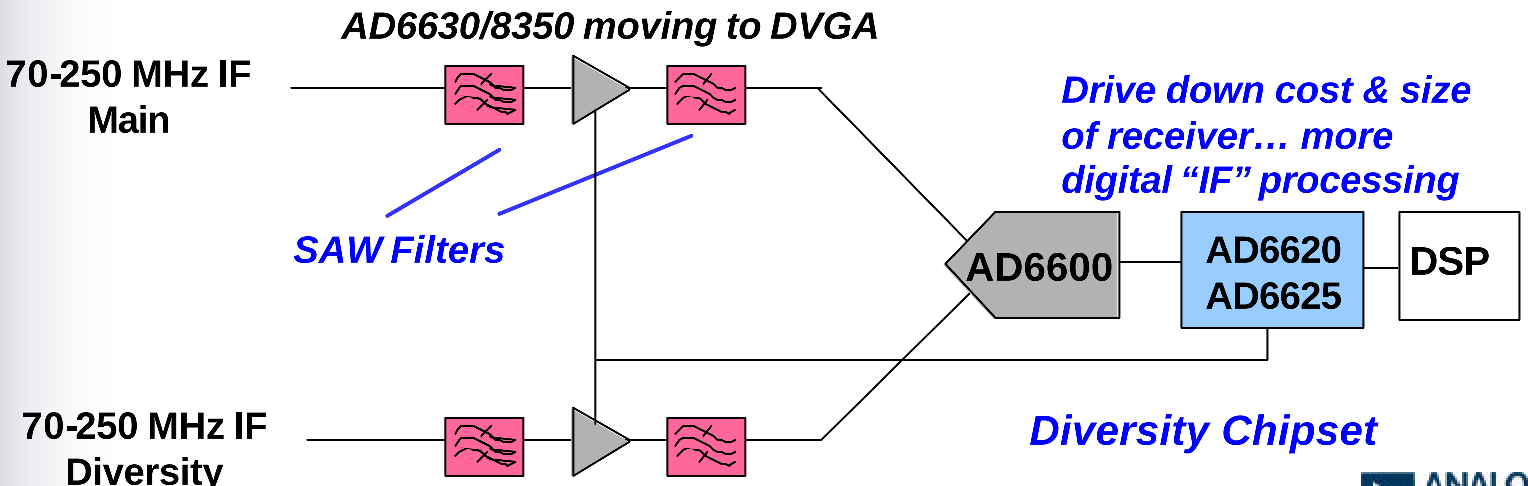


GSM Chipset for Single Carrier Diversity

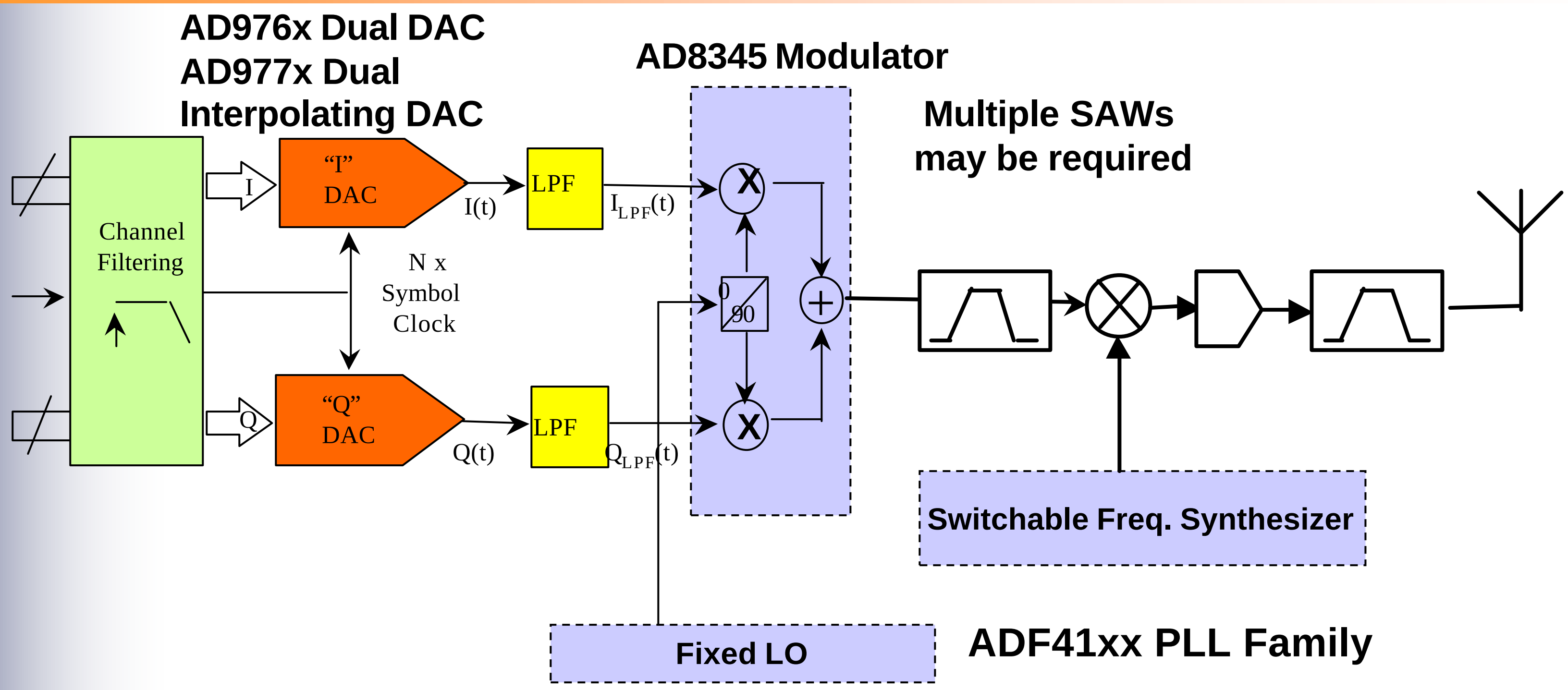
ADI Innovation

Traditional: Two channels required for diversity



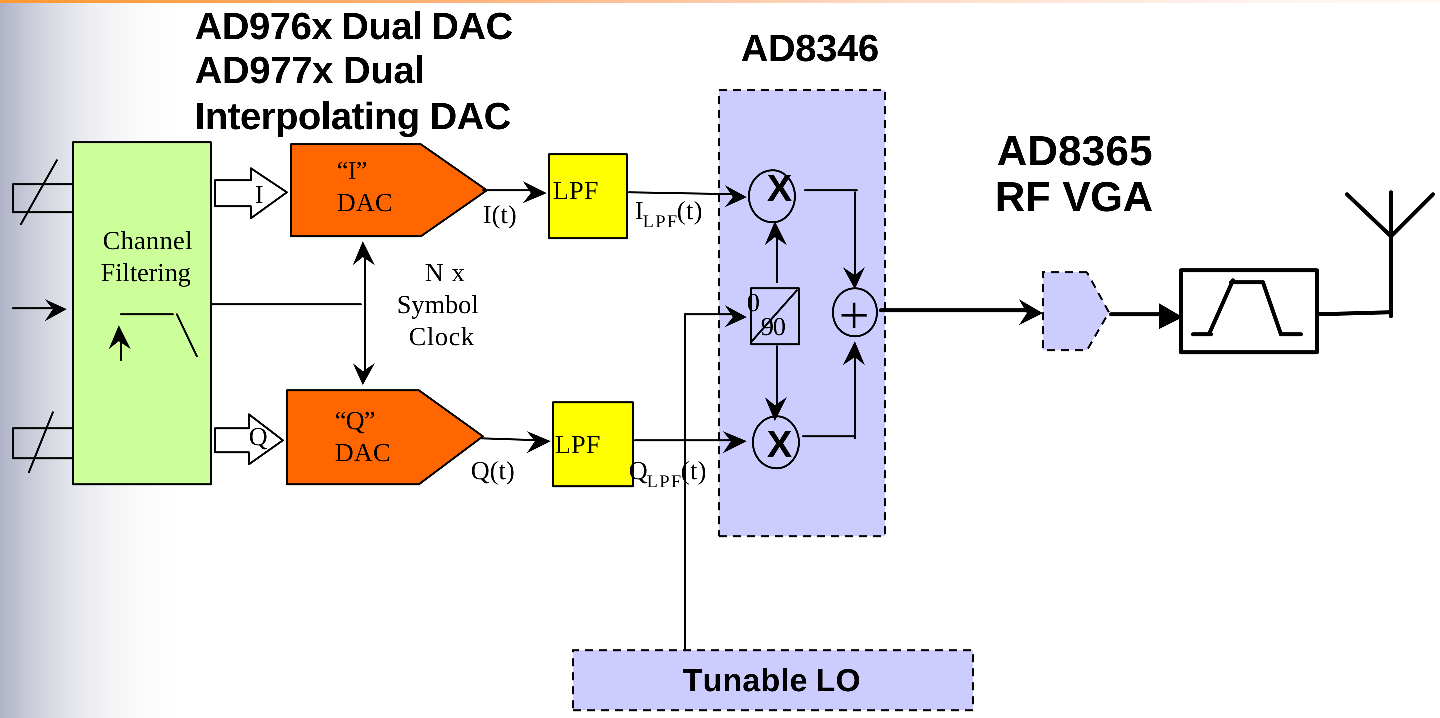


Analog Baseband I and Q
Classic IF Upconversion - ALL air standards



- Quadrature matching is important in all components
  - Dual DACs are perfect, Interpolation eases LPF design
  - AD8345 works well at fixed frequency
- ADI's new line of PLLs work great in both fixed and tunable synthesizers

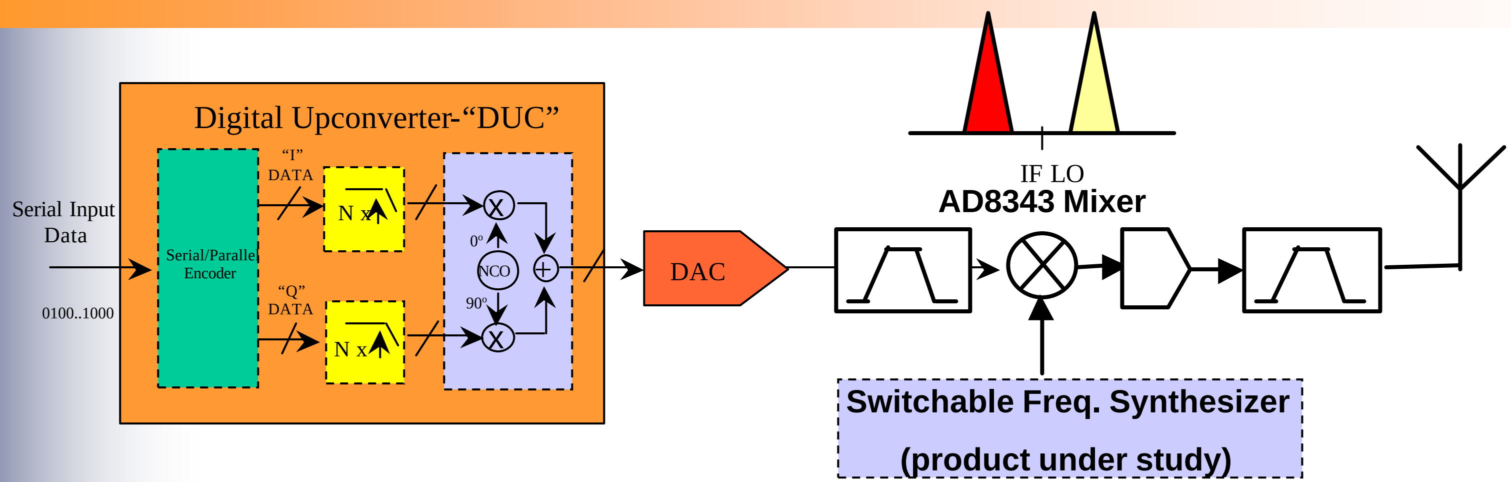
Direct Conversion to RF works for CDMA



- Quadrature matching is critical BUT DIFFICULT AT RF
- 3G can employ direct conversion transmitters
- GSM needs fast LO (AD9858 development)

Direct Digital IF Tx Architecture

Feasibility work underway



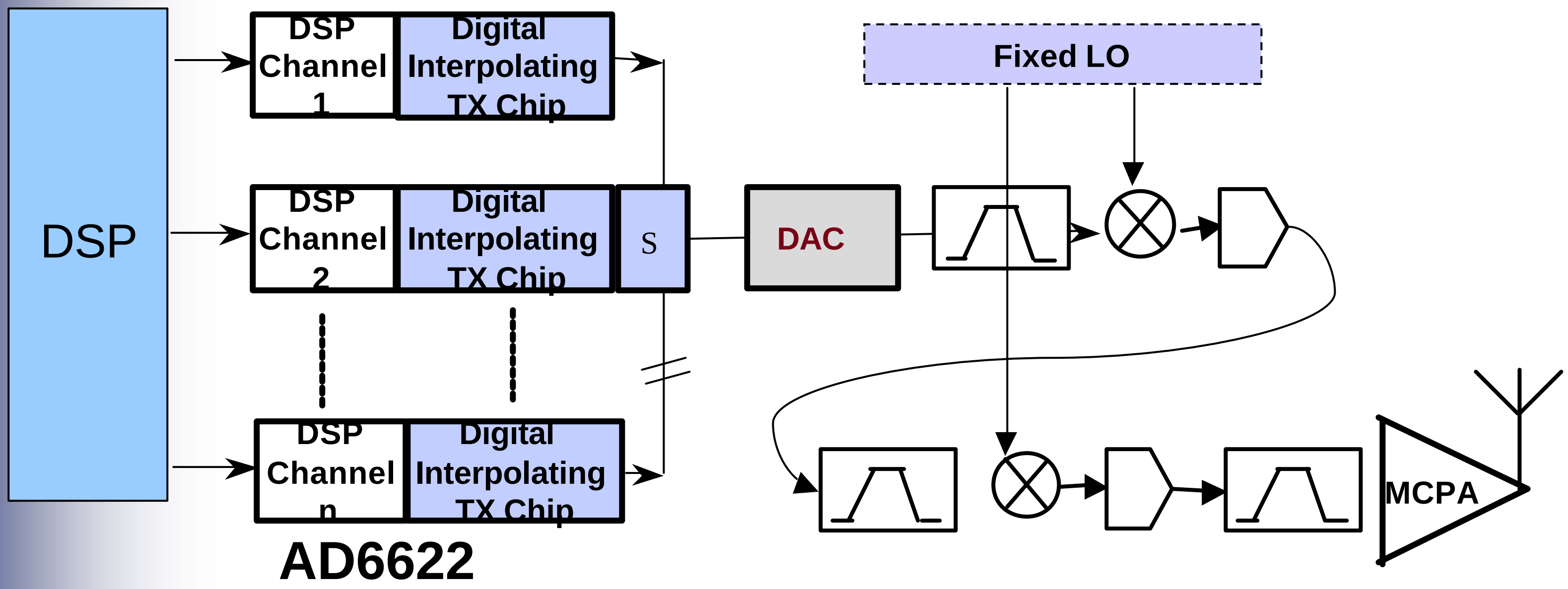
- Modulation Performed Digitally hence Near "Perfect" Accuracy
- DAC's Dynamic Range within Specified "Window" determining 1st IF Passband Tuning Range. Insufficient Tuning Range Will Require a Second Tunable Synthesizer
- Low IF hence requires 2nd IF and tunable analog synthesizer
- LPF must have flat passband and group delay over 1st IF Passband
- Possible to Use "Higher Image" of DAC Output for 1st IF BUT Sinx/x Effect on Passband flatness, and CNR must be evaluated

SAW Filter Requirements For Direct Digital IF Tx Architecture

- Image Problem of 1st Mixing Stage Often Requires 2 SAW's to Reduce LO Feedthrough and Image by >80 dBc
- IF Amplifier(s) required to compensate for SAW Filter(s) Losses (I.e. 7-20 dB per SAW filter)
- SAW Filter Losses Combined with Mixer NF Affects Overall Tx Noise Figure and IF Amp Requirements
- SAW filters Passband Amplitude Ripple and Group Delay Variation Affect EVM of Signal.
- Asymmetrical Passband of SAW filter which is sensitive to Matching Network Affects EVM of Signal. Complex Equalizer May be Required for High Level QAM

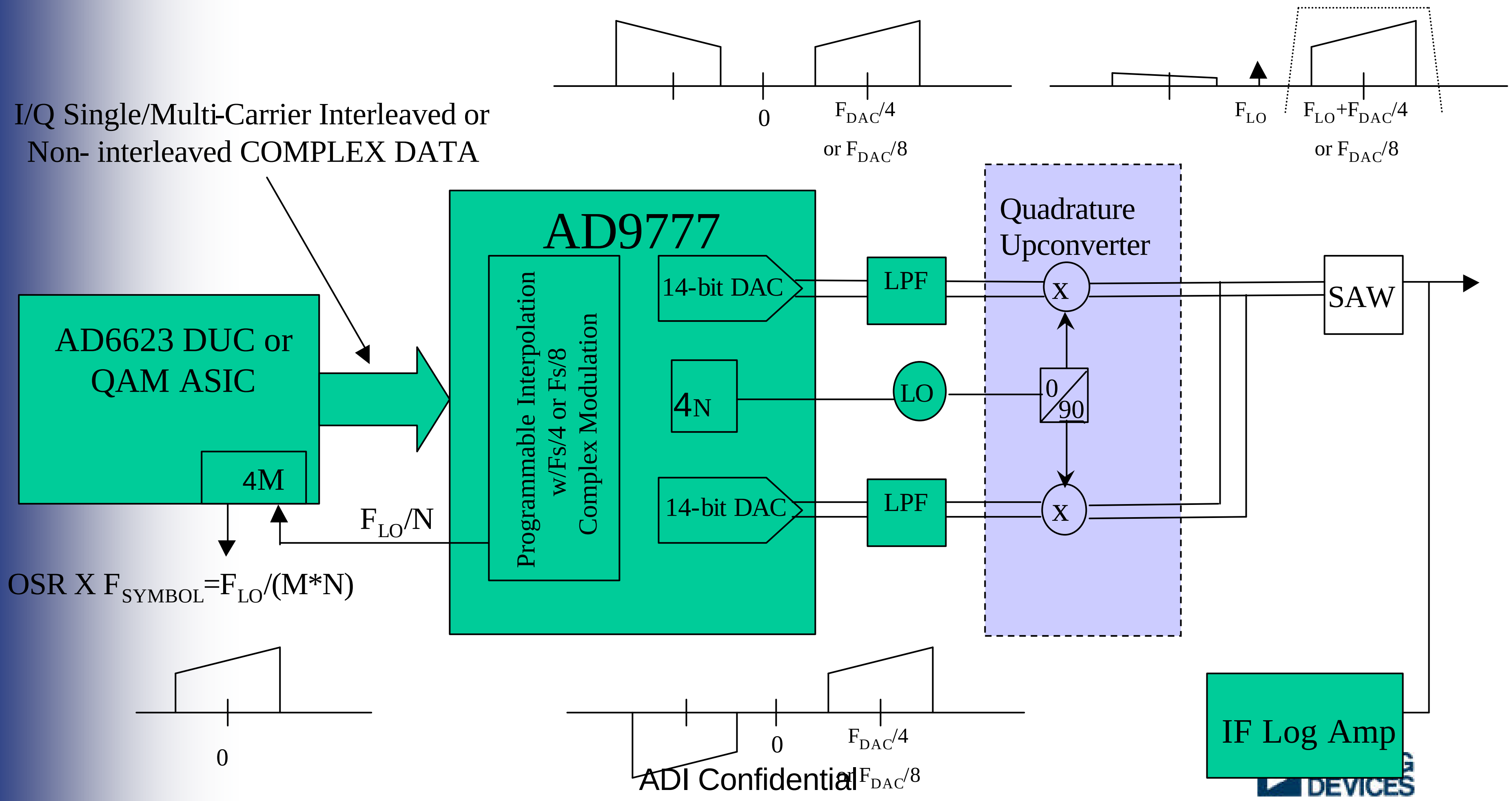
Multicarrier Tx Challenges SoftCell

- AD6622 supports 4 narrowband carriers (GSM/EDGE)
- IS136/ EDGE (N.America) is market driver
- CDMA can also be supported from same platform



DAC (AD9772A) and Multi-Carrier Power Amp (MCPA) are limitations on performance

IF Image-Rejection Tx Architecture for Single or Multi-Carrier Applications



IF Image-Rejection Tx Architecture

- Benefits
  - Requires Single SAW Filter
  - Improves Tx Noise Figure and and IF Gain Stage Requirements
  - Provides Theoretical 3 dB Improvement in CNR and ACP Performance
  - Modulation Still Performed Digitally
  - LO Suppression and Image Rejection Can be Calibrated
- Drawbacks
  - Requires Additional DAC to represent Digital IF as Complex Signal and a High Performance Analog Quadrature Modulator