First Design-In Experiences of Xilinx's, 20 nm, Kintex UltraScale KU060 for Space Applications and 16 nm UltraScale+ RFSoC for Ground Segment

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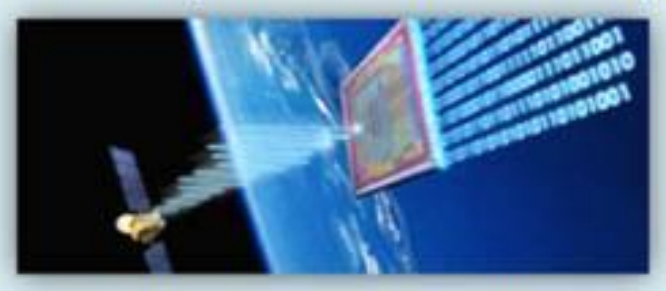

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Space-Grade/COTS FPGAs

	Xilinx V5QV	NanoXplore NG-ULTRA	NanoXplore NG-LARGE	Xilinx KU060	Microsemi RTG4	Microsemi IGLOO2/SF2
Core Voltage (V)	1.0	TBD (< 1V)	1.2	0.9	1.2	1.2
Speed (MHz)	450	TBD	TBD	1000	300	300
Memory (Mb)	10.9	32	9.8	38	5	0.7 to 5
No. of LUTs (k)	87.9	TBD	137	331	151	6 to 146
No. of Flip Flops (k)	87.9	TBD	129	663	151	6 to 146
Transceivers	18 at 3.125 Gbps	? at 12.5 Gbps	24 at 6.25 Gbps	32 at 12.5 Gbps	24 at 3.125 Gbps	0 to 16 at 5 Gbps
User I/O	836	TBD	TBD	624	720	209 to 574

20 nm Fabrication Technology Advantages

- *20 nm delivers higher bandwidth, more logic resources at lower power.*
- *Power Consumption Advantages*
  - *Lower power operation due to a core voltage of 0.9 V and smaller capacitive loads:*
  - *Pdynamic α CV^2* *25% lower than equivalent 1.0/1.2 V FPGAs*

$$P_{dynamic} = \left[\frac{1}{2}CV^2 + Q_{ShortCircuit}V\right]f \cdot activity$$

Capacitance charging

Short circuit charge during switching

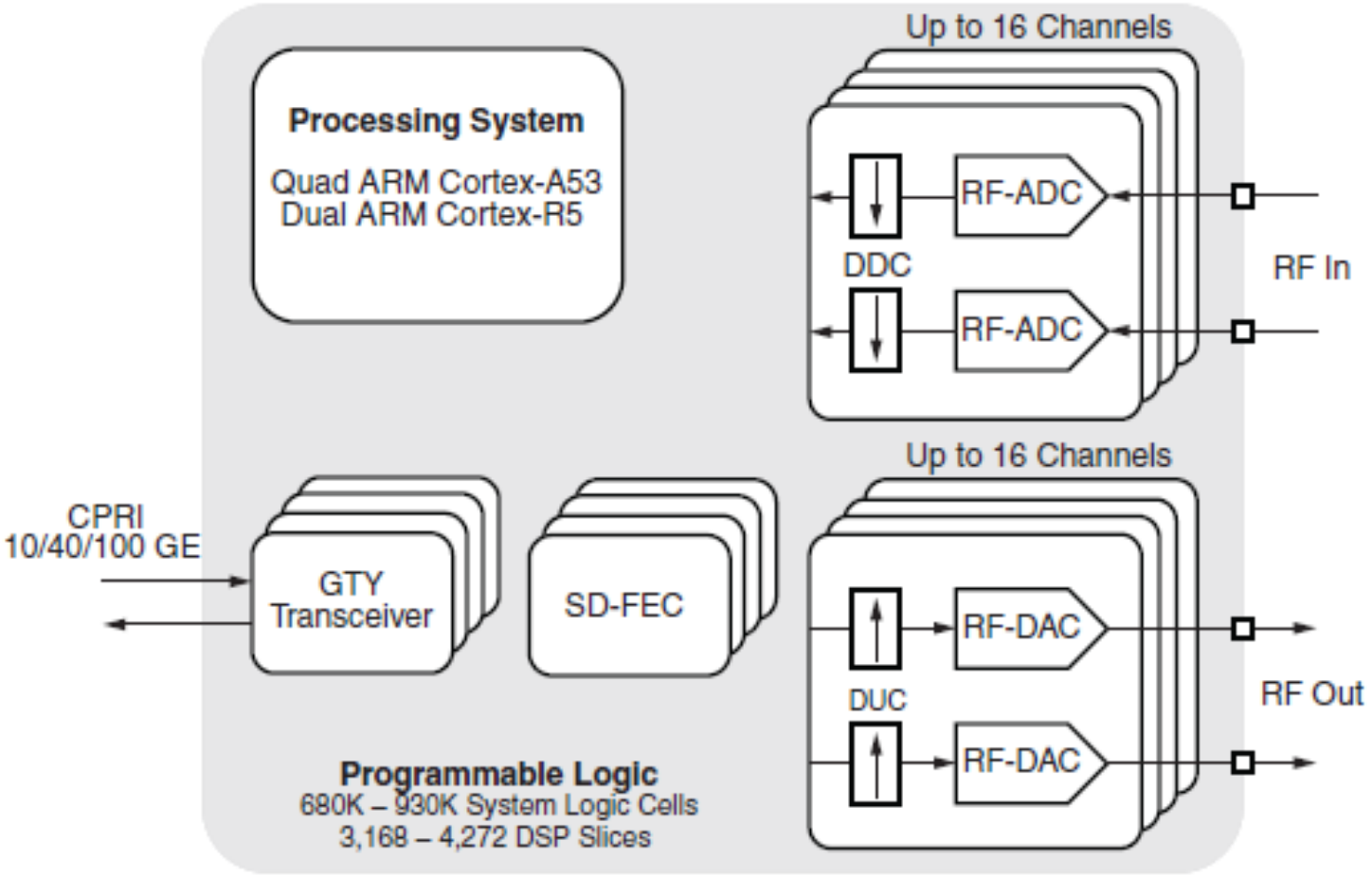
Percent of circuit that switches each cycle

  - *Pstatic α V^3* *> 30% lower than equivalent 1.0/1.2 V FPGAs*

Radiation Hardness

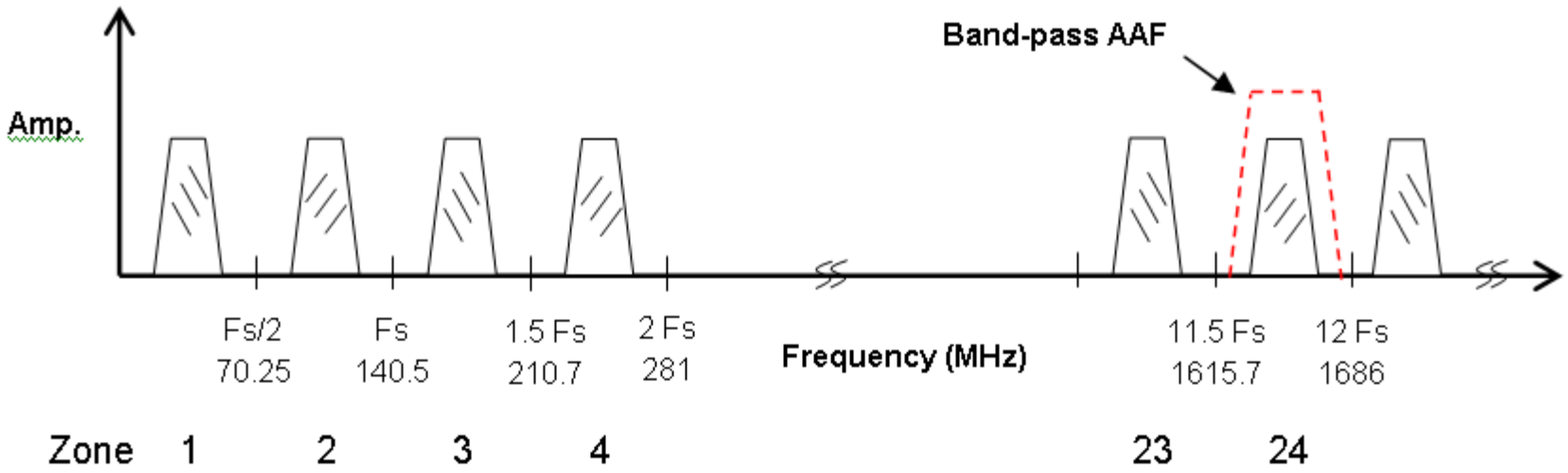
- *Same silicon as commercial version*
- *Scaling benefits*
- *SEL (Sandia) = 79.2 MeV-cm^2/mg*
- *TID = 100 Krad (Si)*
- *TMR FT MicroBlaze, 32-bit RISC CPU*
- *CRAM is interleaved, SEM IP for mitigation*
- *User triplication, EDAC and scrubbing*

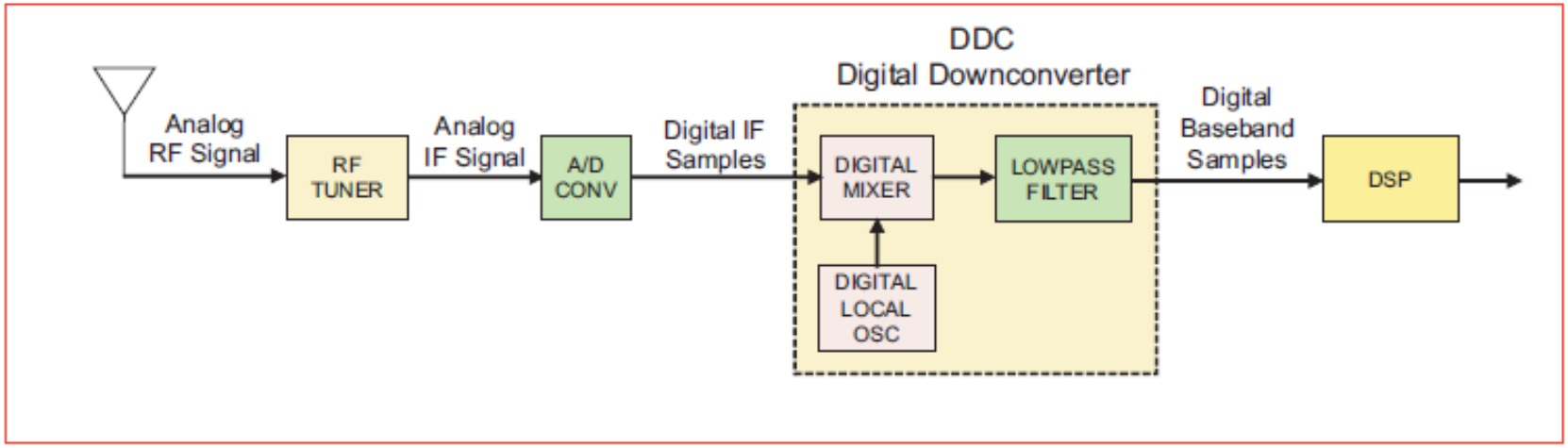
16 nm MPSoC

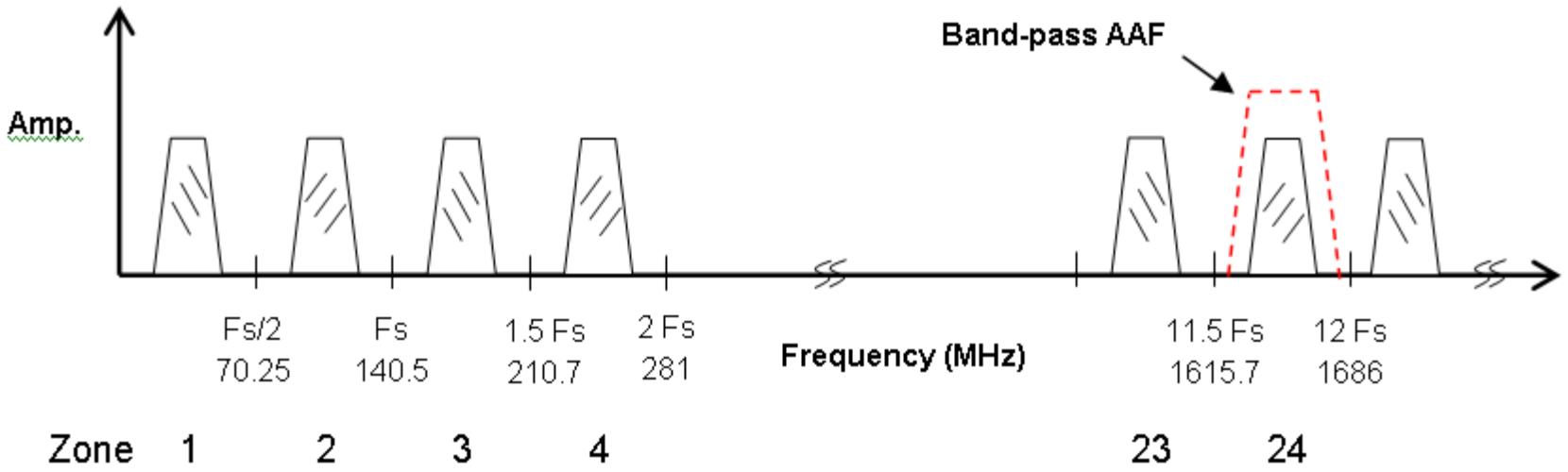

Up to 16 Channels
Processing System
Quad ARM Cortex-A53
Dual ARM Cortex-R5
RF-ADC
DDC
RF-ADC
RF In
Up to 16 Channels
CPRI
10/40/100 GE
GTY
Transceiver
SD-FEC
RF-DAC
DUC
RF-DAC
RF Out
Programmable Logic
680K – 930K System Logic Cells
3,168 – 4,272 DSP Slices

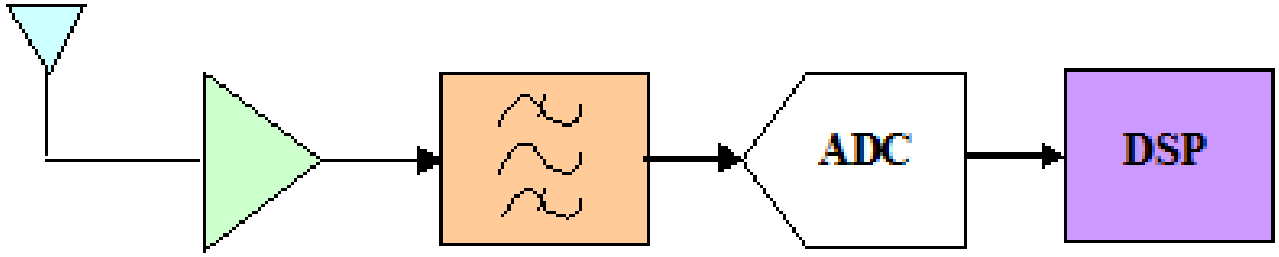
	XCZU21DR	XCZU25DR	XCZU27DR	XCZU28DR	XCZU29DR
12-bit, 4GSPS RF-ADC w/ DDC	0	8	8	8	0
12-bit, 2GSPS RF-ADC w/ DDC	0	0	0	0	16
14-bit, 6.4GSPS RF-DAC w/ DUC	0	8	8	8	16
SD-FEC	8	0	0	8	0
Application Processing Unit	Quad-core ARM Cortex-A53 MPCore with CoreSight™; NEON and Single/Double Precision Floating Point; 32KB/32KB L1 Cache, 1MB L2 Cache				
Real-Time Processing Unit	Dual-core ARM Cortex-R5 with CoreSight; Single/Double Precision Floating Point; 32KB/32KB L1 Cache, and TCM				
Embedded and External Memory	256KB On-Chip Memory w/ECC; External DDR4; DDR3; DDR3L; LPDDR4; LPDDR3; External Quad-SPI; NAND; eMMC				
General Connectivity	214 PS I/O; UART; CAN; USB 2.0; I2C; SPI; 32b GPIO; Real Time Clock; Watchdog Timers; Triple Timer Counters				
High-Speed Connectivity	4 PS-GTR; PCIe® Gen1/2; Serial ATA 3.1; DisplayPort 1.2a; USB 3.0; SGMII				
System Logic Cells	930,300	678,318	930,300	930,300	930,300
CLB Flip-Flops	850,560	620,176	850,560	850,560	850,560
CLB LUTs	425,280	310,088	425,280	425,280	425,280
Distributed RAM (Mb)	13.0	9.6	13.0	13.0	13.0
Block RAM Blocks	1,080	792	1,080	1,080	1,080
Block RAM (Mb)	38.0	27.8	38.0	38.0	38.0
UltraRAM Blocks	80	48	80	80	80
UltraRAM (Mb)	22.5	13.5	22.5	22.5	22.5
DSP Slices	4,272	3,145	4,272	4,272	4,272

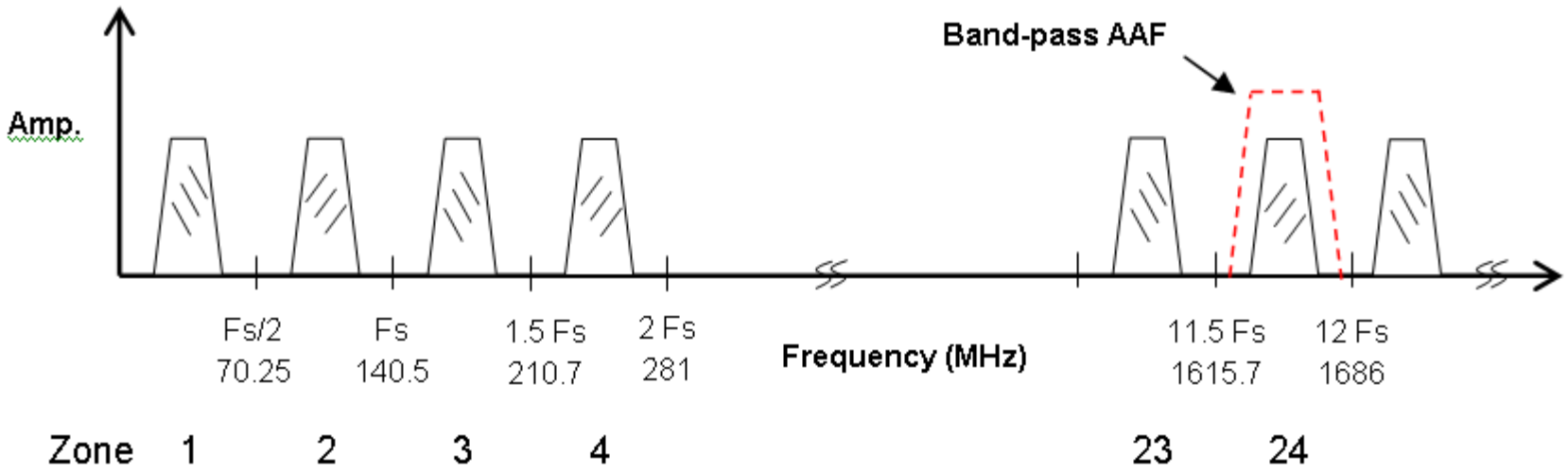
70% utilisation = 13W

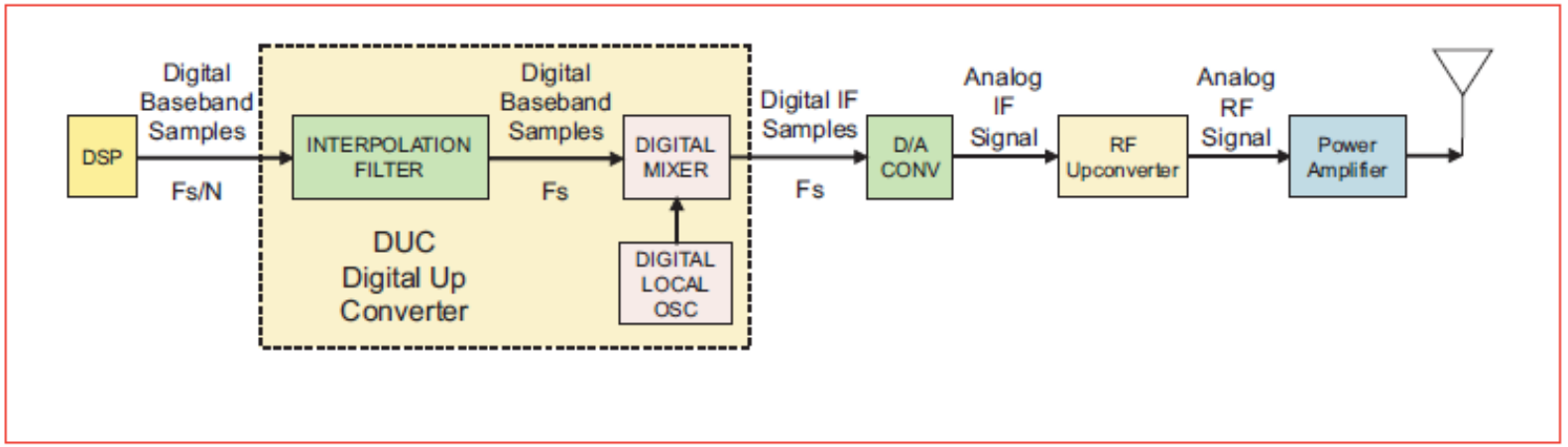


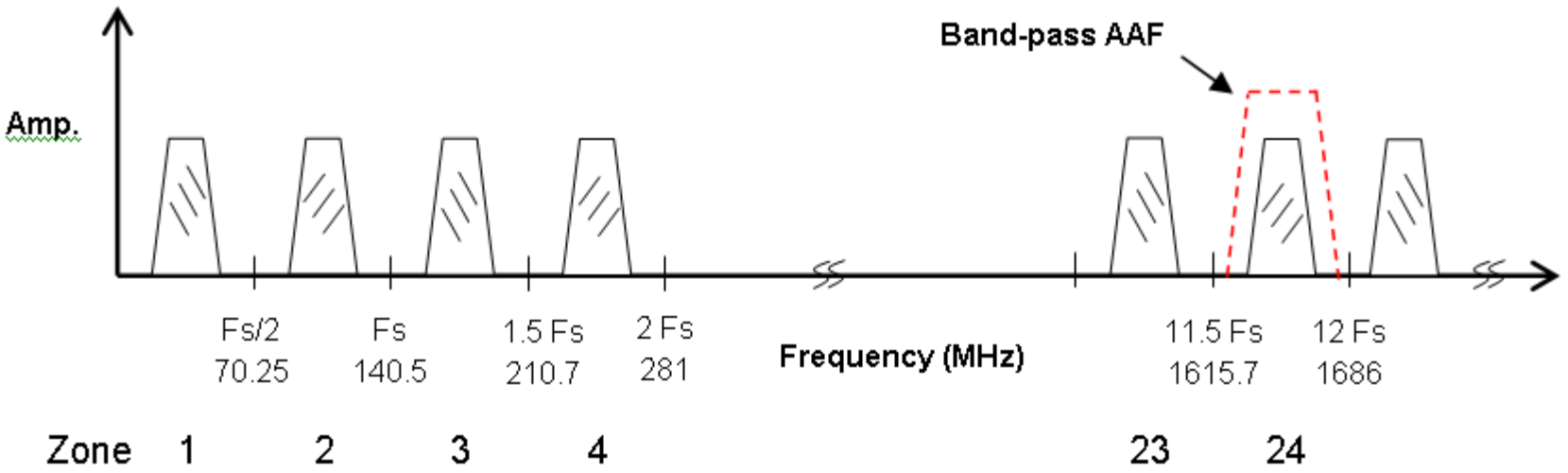


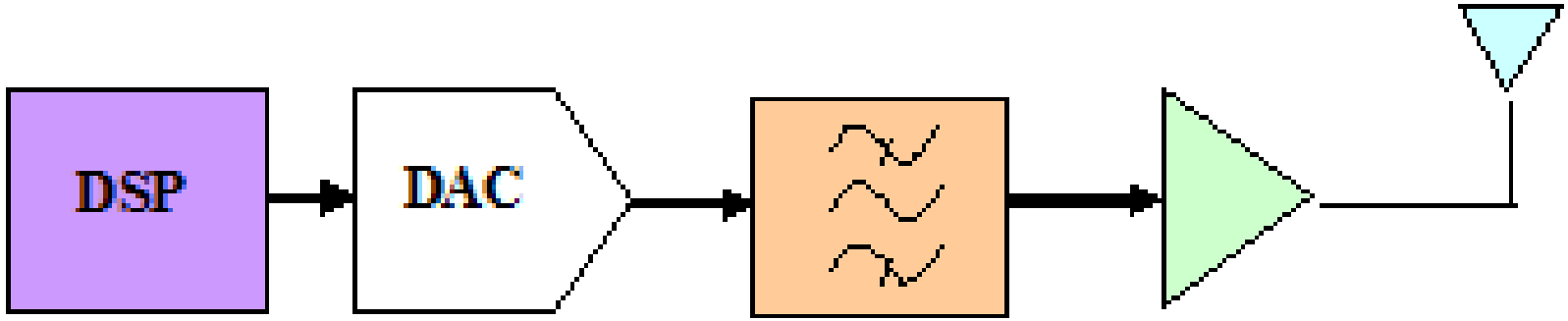


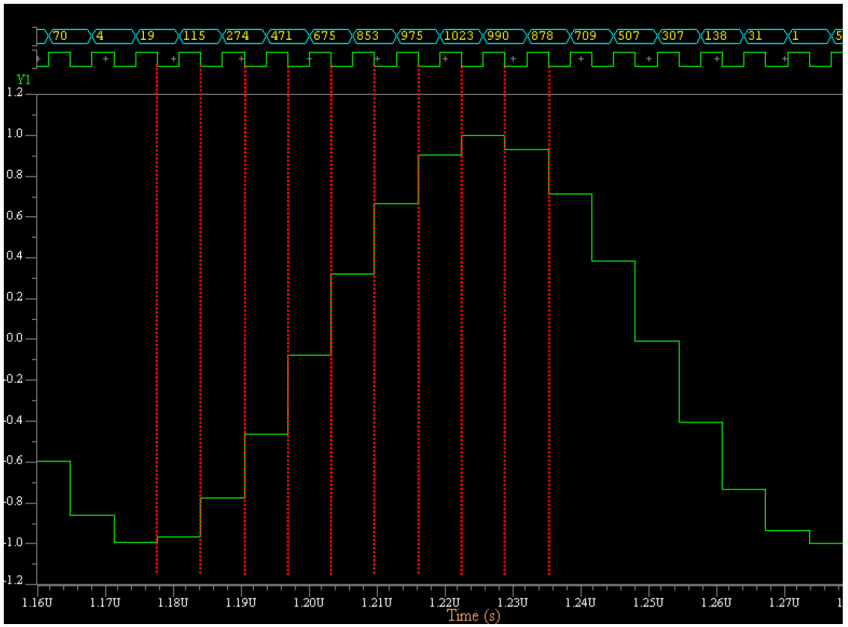


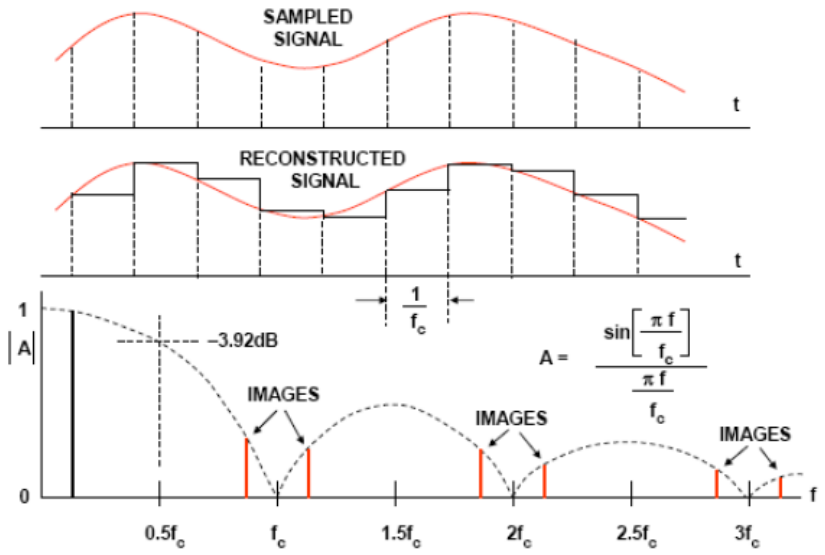












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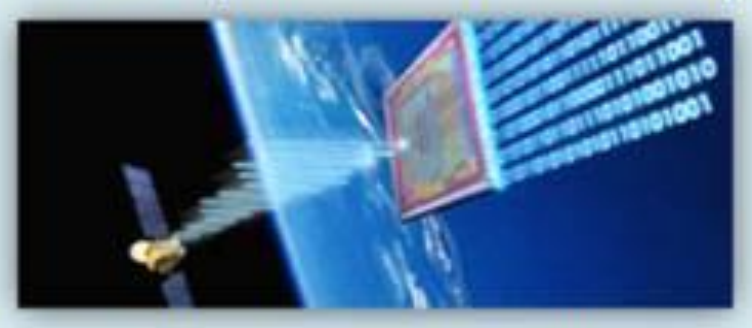

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