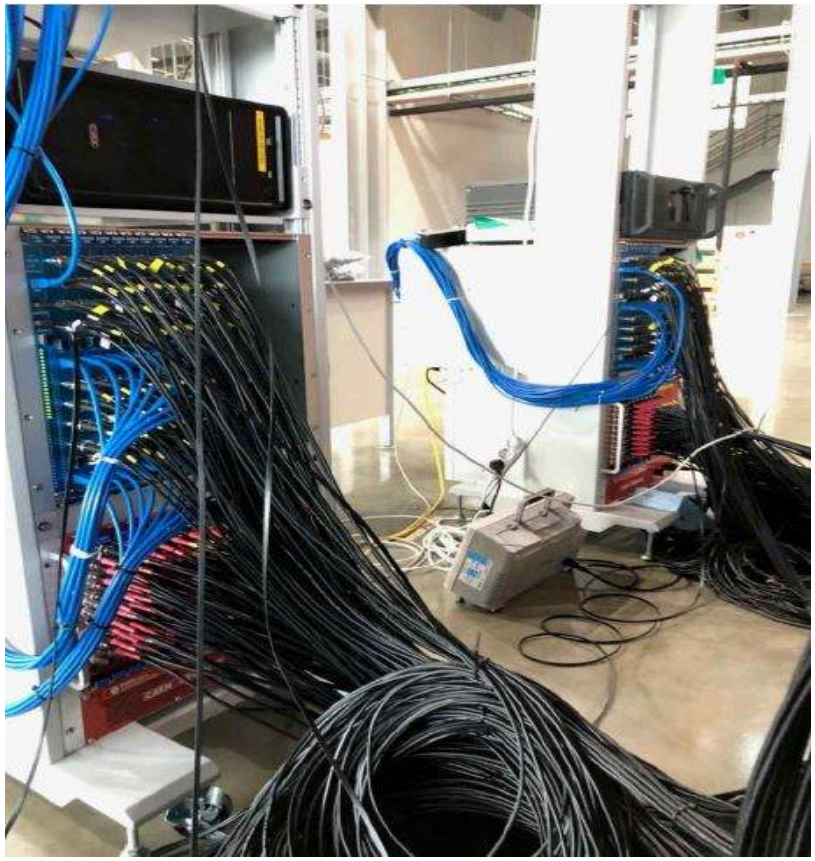
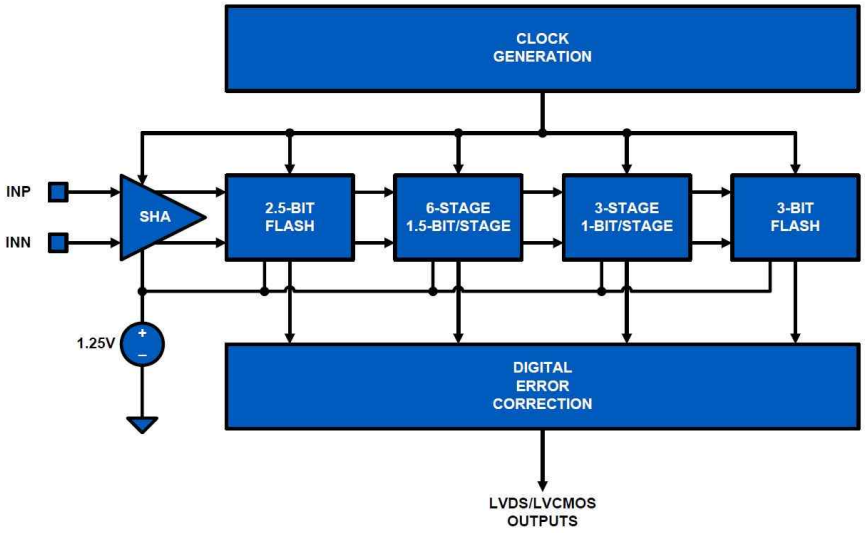
2026 검출기 워크샵
Flash ADC Data AQuisition



김상열

NOTICE (주)노티스

Flash ADC



- We call Flash ADC(FADC) when ADC has sampling rate more than 10 MHz.

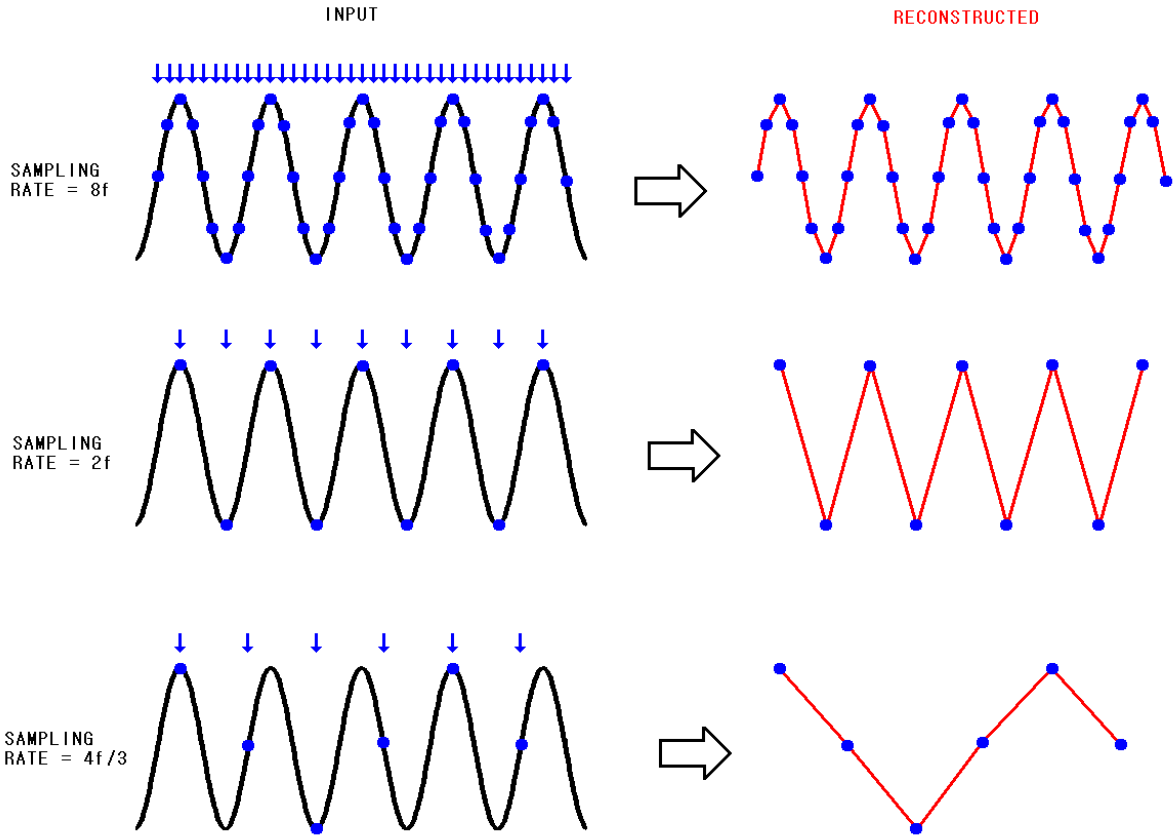
But most of them are pipelined ADC.

Beside complex structure inside ADC IC, using it is very simple.

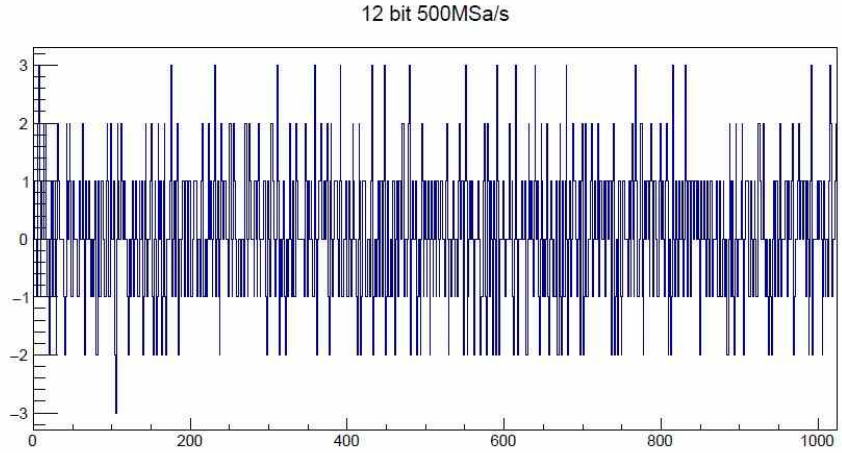
Applying analog input and sampling clock then we get digital data every clock cycle.

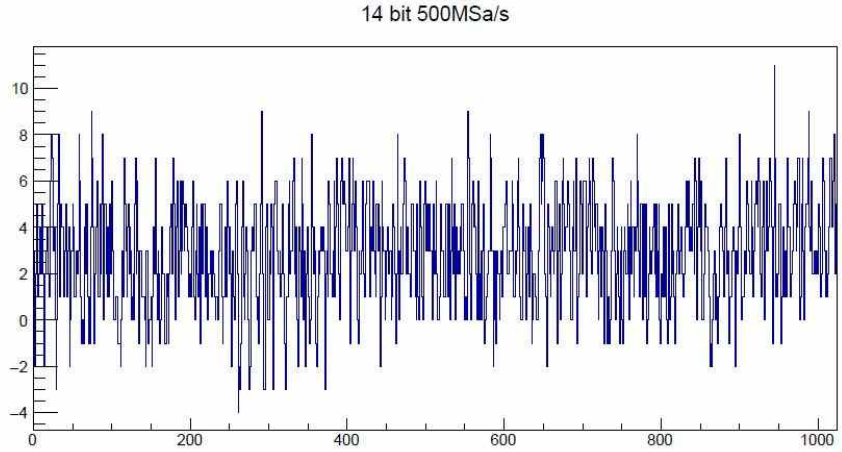
Flash ADC specification 1

Sampling rate



Resolution (# of bits)

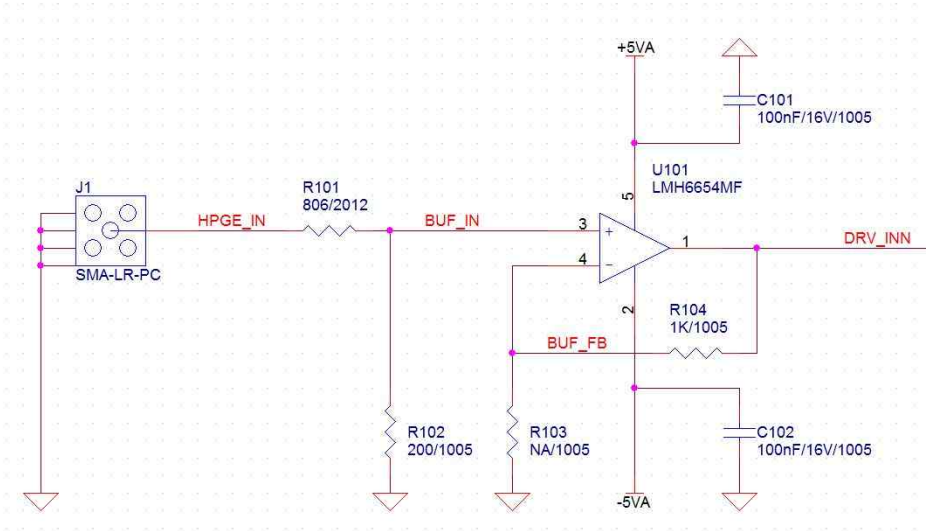




Real resolution = Effective # of bits(ENOB)
SNR(Signal/Noise) = 6.02 x ENOB + 1.76

Flash ADC specification 2

Input voltage range



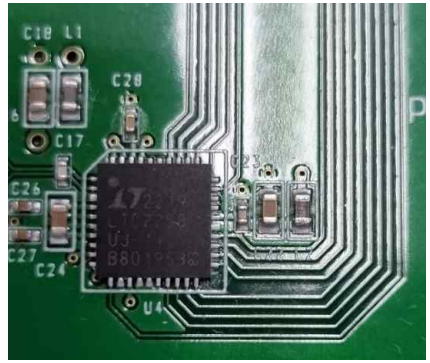
Usually 2Vp-p.
We attenuate or amplify input signal for ADC.

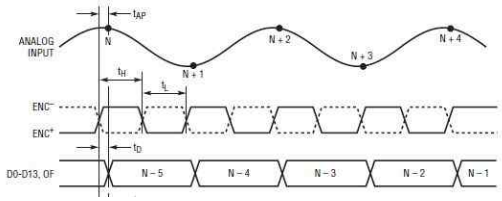
?? T better than A ??

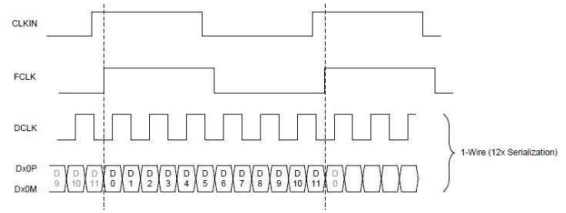
- Input Analog Bandwidth
  Most ADC has larger bandwidth than ½ of maximum sampling rate.
  Okay except special design such as interleaving.

- Power consumption
  Newer = lower
  Low power supply voltage = lower

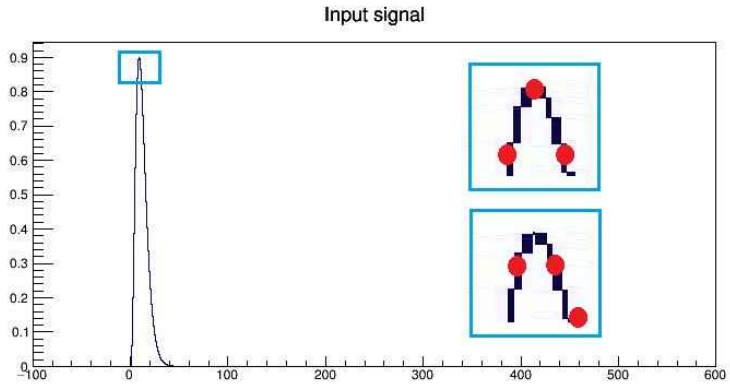
- # of channels = more the better

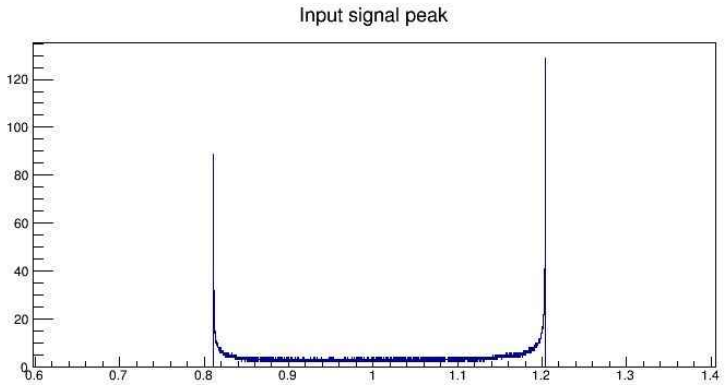




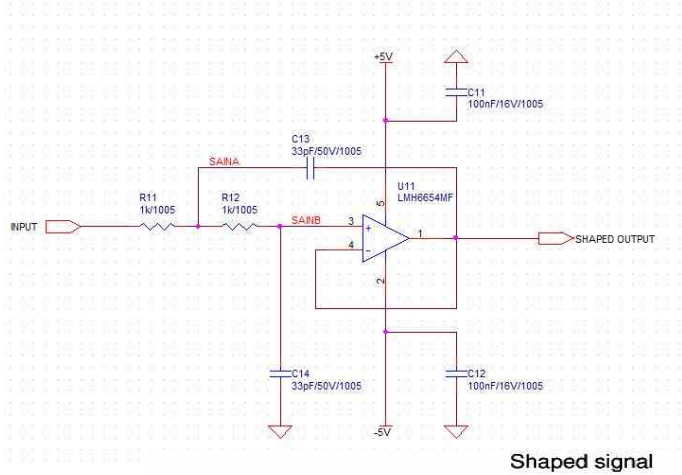


Lowering ADC Sampling rate!

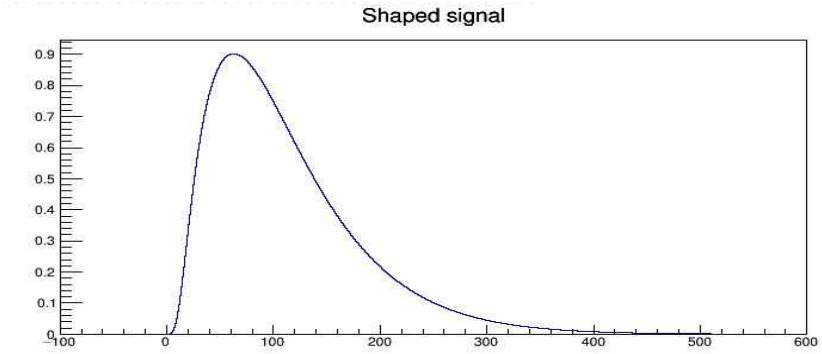


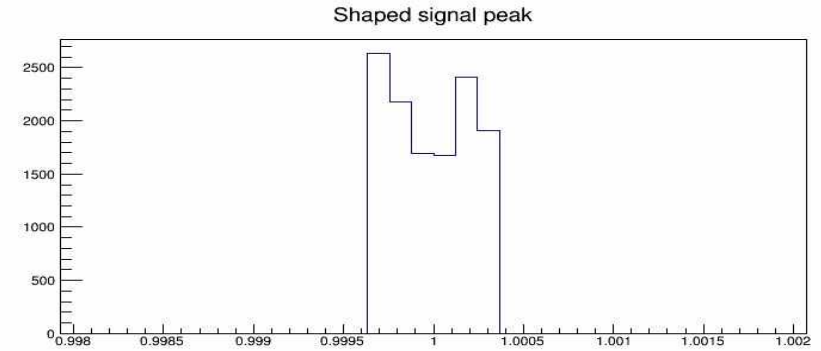


Problem with lower sampling rate
(Input and ADC sampling is asynchronous)

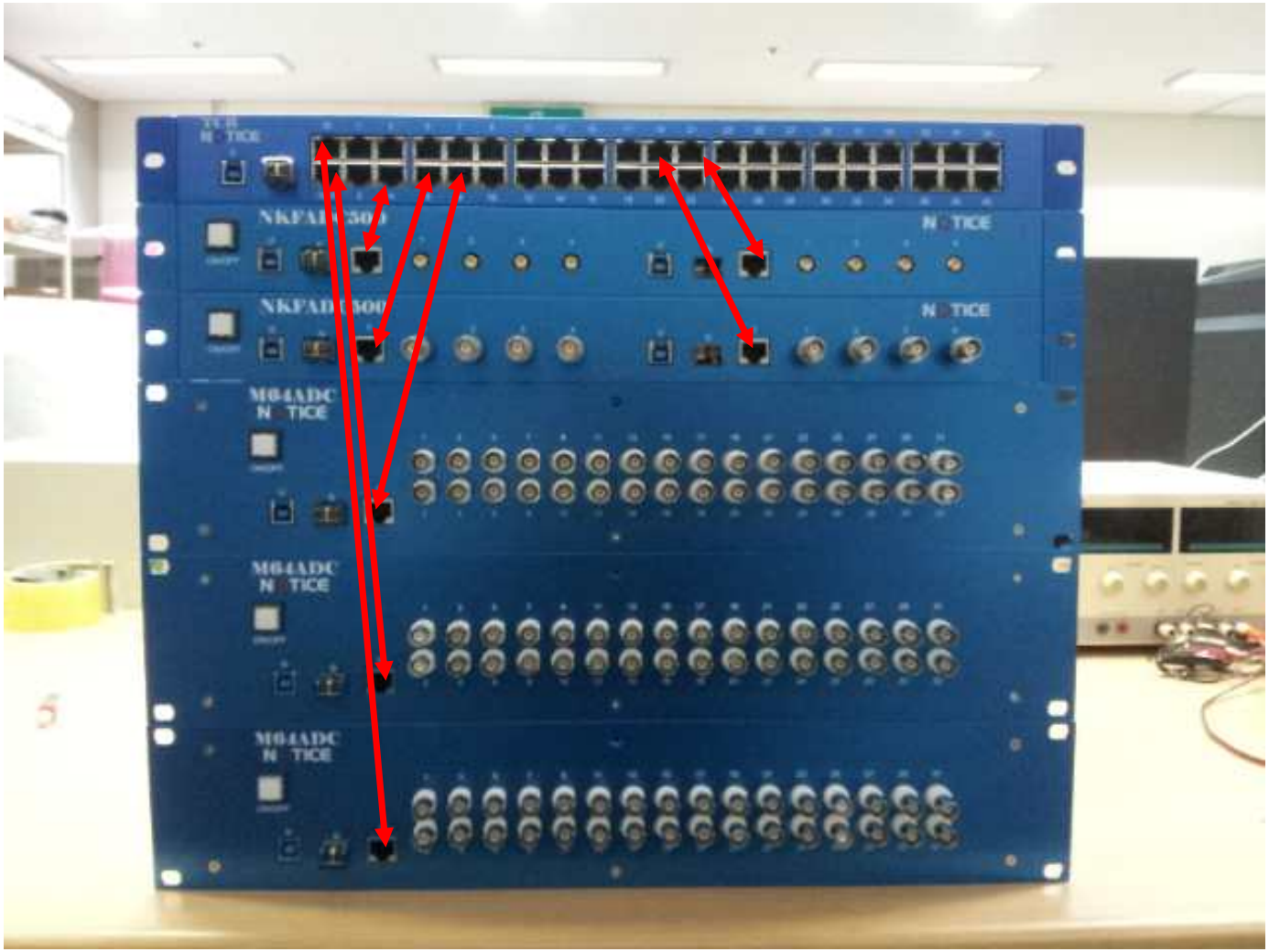


Use low pass filter



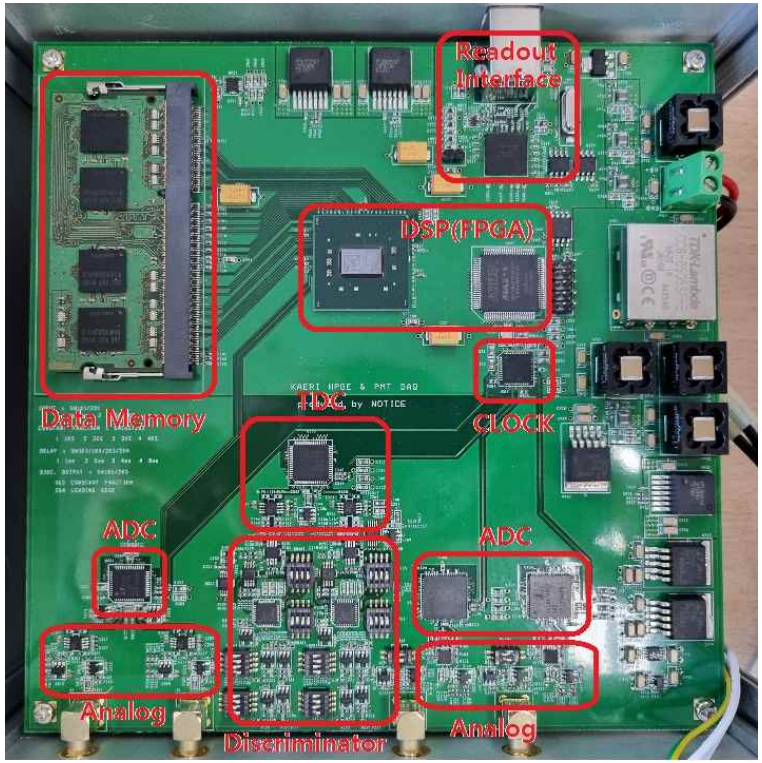


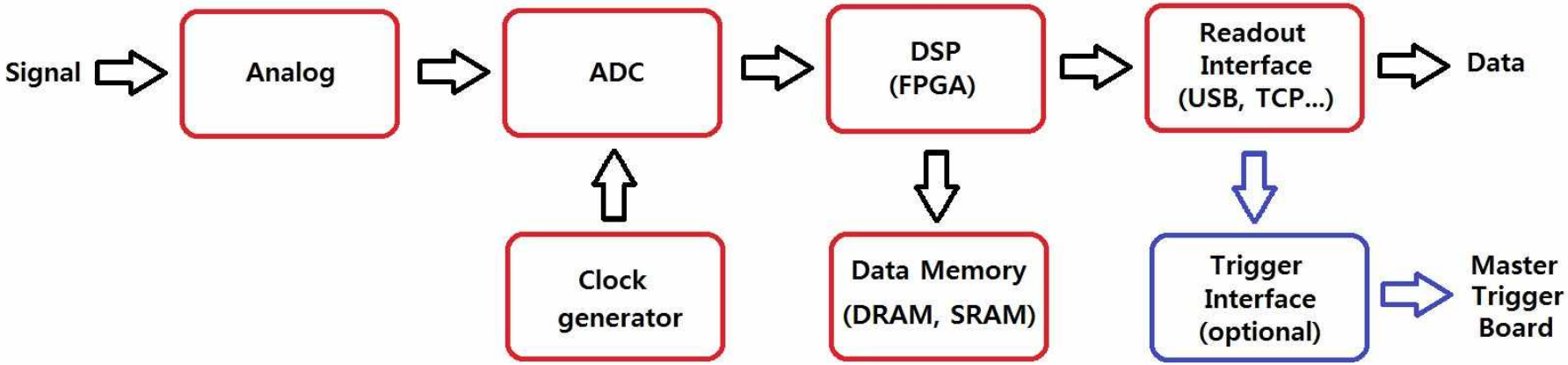
Flash ADC trigger



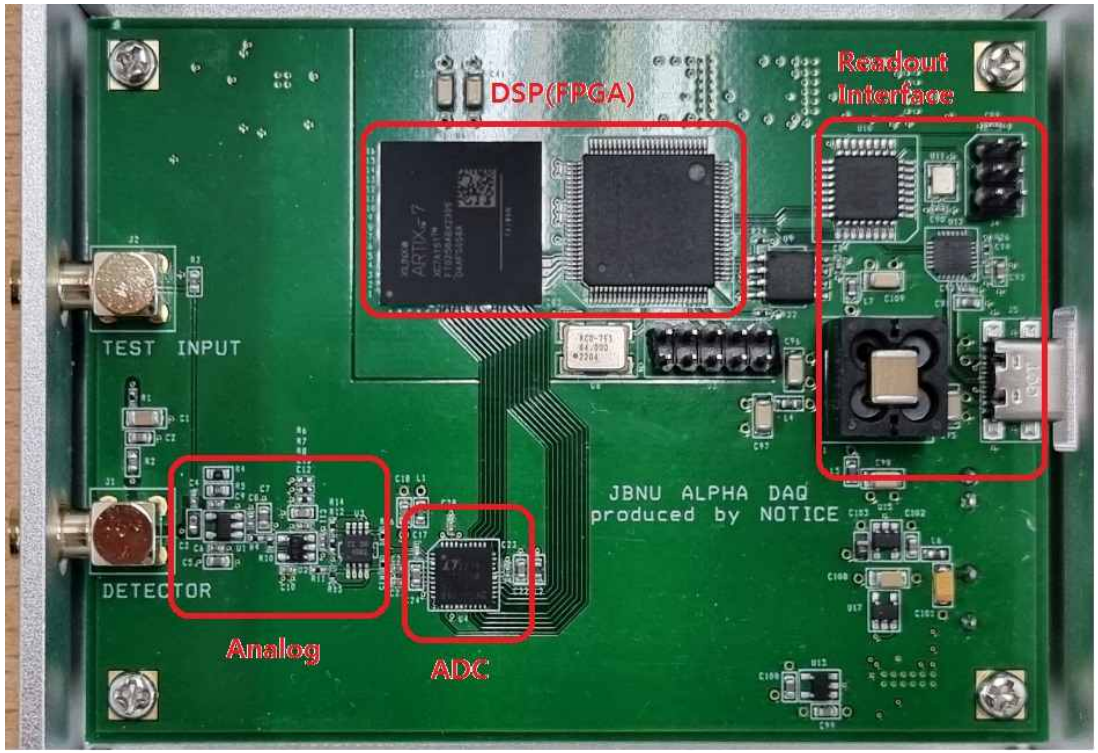
- ADC -> Trigger board
  Local trigger information
  (such as # of hit ch…)
- Trigger board -> ADC
  Global trigger information
  -> ADC stores data
- ADC should have enough FIFO memory that storing ADC data for trigger latency time.
  (Trigger latency can be sometimes more than 10 us)
- Trigger decision logic is designed in pipe-lined style to avoid dead-time.

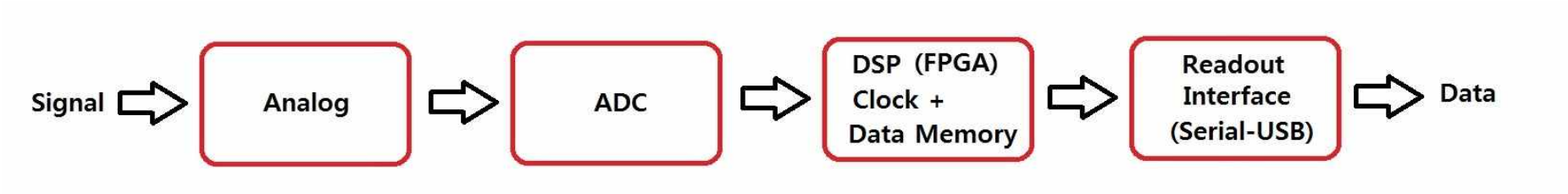
Structure of typical Flash ADC board



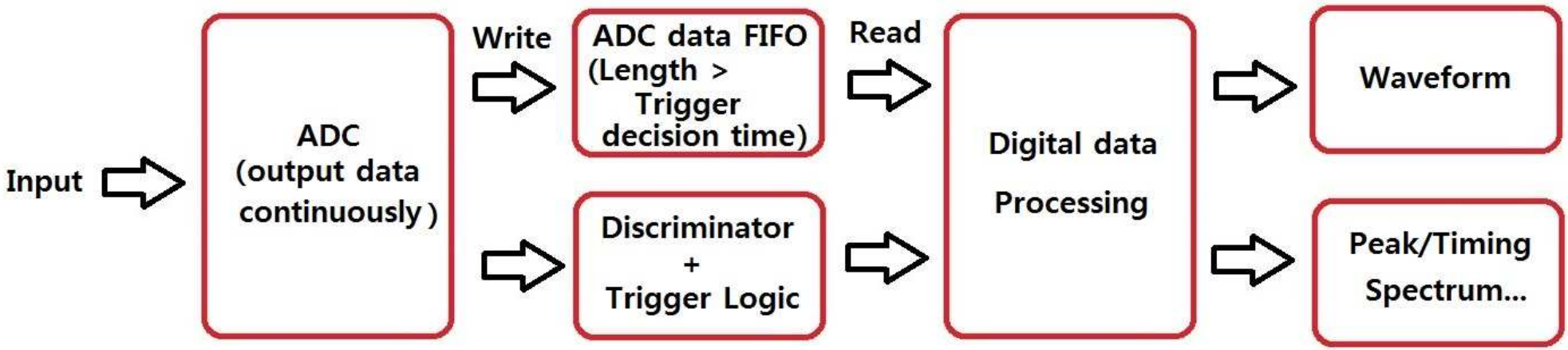


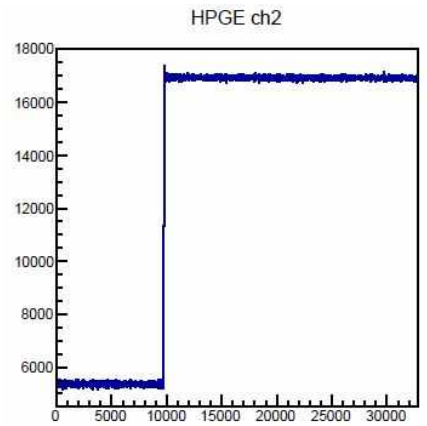
Structure of simpler Flash ADC board

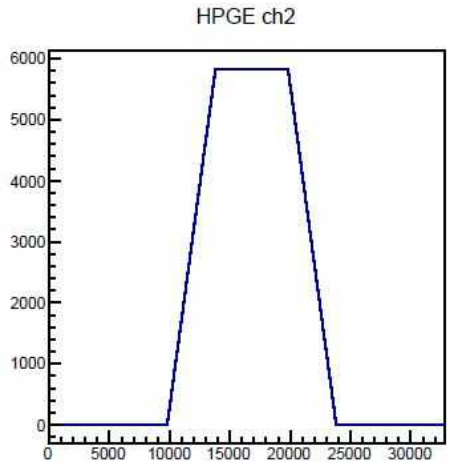


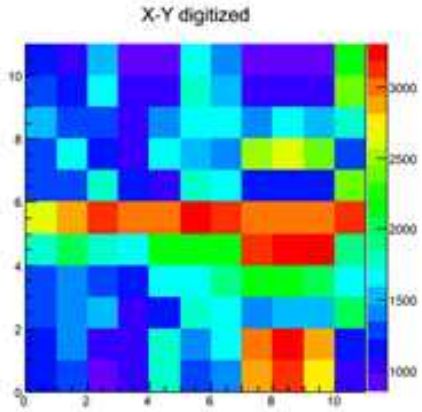


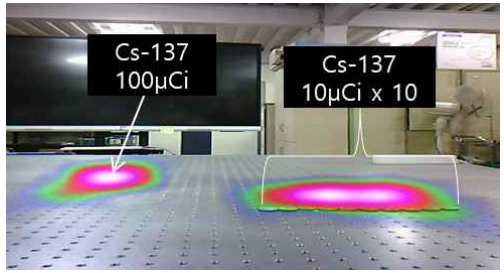
Data processing in Flash ADC board



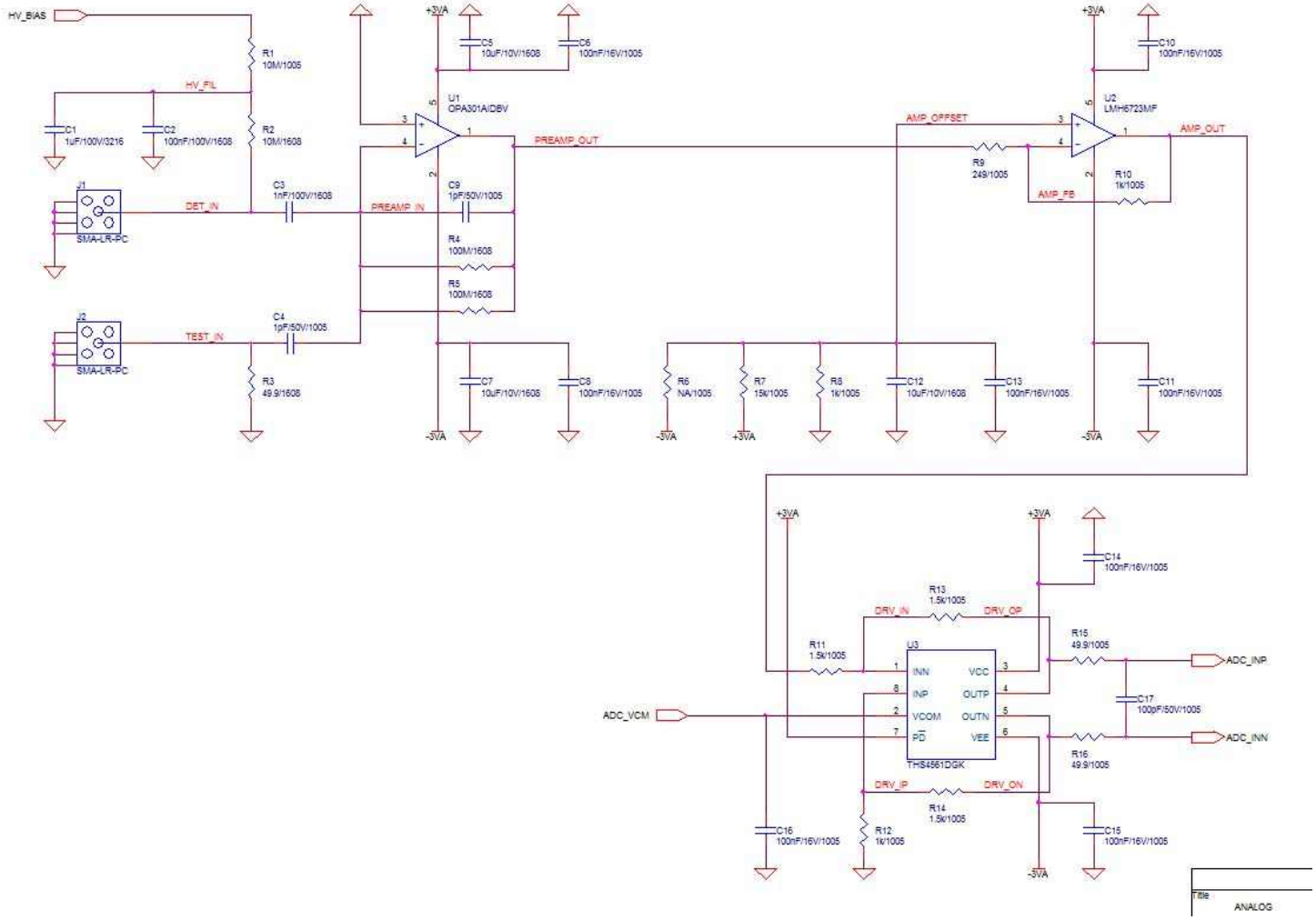




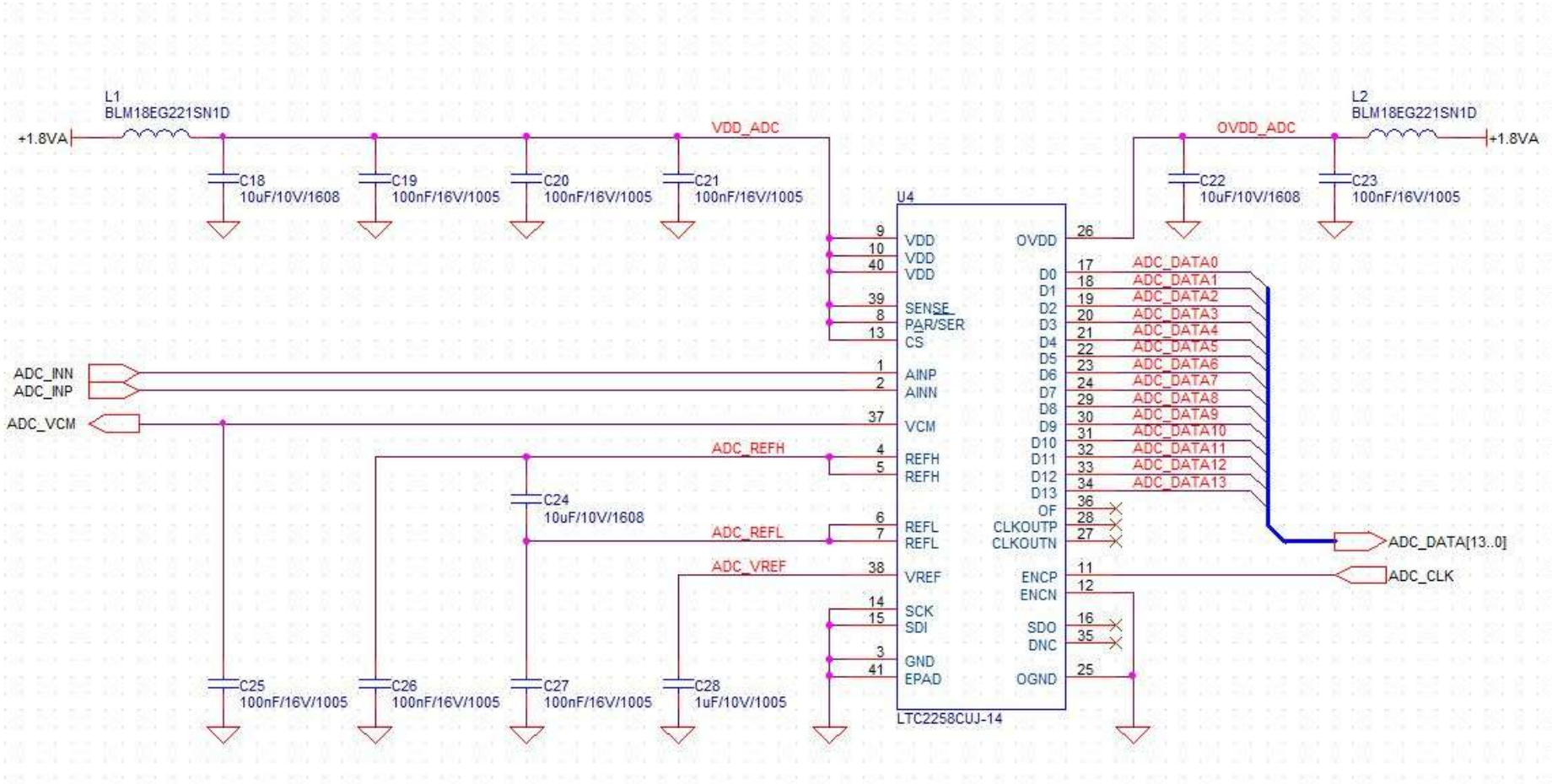




Flash ADC board analog circuits example



Flash ADC board ADC circuits example



Choosing FPGA(Field Programmable Gate Array)

Table 1: **7 Series Families Comparison**

Maximum Capability	Artix-7 Family	Kintex-7 Family	Virtex-7 Family
Logic Cells	215K	478K	1,955K
Block RAM[1]	[illegible]	34 Mb	68 Mb
DSP Slices	740	1,920	3,600
Peak DSP Performance[2]	929 GMAC/s	2,845 GMAC/s	5,335 GMAC/s
Transceivers	16	32	96
Peak Transceiver Speed	6.6 Gb/s	12.5 Gb/s	28.05 Gb/s
Peak Serial Bandwidth (Full Duplex)	211 Gb/s	800 Gb/s	2,784 Gb/s
PCIe Interface	x4 Gen2	x8 Gen2	x8 Gen3
Memory Interface	1,066 Mb/s	1,866 Mb/s	1,866 Mb/s
I/O Pins	500	500	1,200
I/O Voltage	1.2V, 1.35V, 1.5V, 1.8V, 2.5V, 3.3V	1.2V, 1.35V, 1.5V, 1.8V, 2.5V, 3.3V	1.2V, 1.35V, 1.5V, 1.8V, 2.5V, 3.3V
Package Options	Low-Cost, Wire-Bond, Lidless Flip-Chip	Low-Cost, Lidless Flip-Chip and High-Performance Flip-Chip	Highest Performance Flip-Chip

Table 5: **Kintex-7 FPGA Feature Summary by Device**

Device	Logic Cells	Configurable Logic Blocks (CLBs)		DSP Slices[2]	Block RAM Blocks[3]			CMTs[4]	PCIe[5]	GTXs	XADC Blocks	Total I/O Banks[6]	Max User I/O[7]
		Slices[1]	Max Distributed RAM (Kb)		18 Kb	36 Kb	Max (Kb)						
XC7K70T	65,600	10,250	838	240	270	135	4,860	6	1	8	1	6	300
XC7K160T	162,240	25,350	2,188	600	650	325	11,700	8	1	8	1	8	400
XC7K325T	326,080	50,950	4,000	840	890	445	16,020	10	1	16	1	10	500
XC7K355T	356,160	55,650	5,088	1,440	1,430	715	25,740	6	1	24	1	6	300
XC7K410T	406,720	63,550	5,663	1,540	1,590	795	28,620	10	1	16	1	10	500
XC7K420T	416,960	65,150	5,938	1,680	1,670	835	30,060	8	1	32	1	8	400
XC7K480T	477,760	74,650	6,788	1,920	1,910	955	34,380	8	1	32	1	8	400

Table 6: **Kintex-7 FPGA Device-Package Combinations and Maximum I/Os**

Package[1]	FBG484			FBG676[2]			FFG676[2]			FBG900[3]			FFG900[3]			FFG901			FFG1156		
Size (mm)	23 x 23			27 x 27			27 x 27			31 x 31			31 x 31			31 x 31			35 x 35		
Ball Pitch (mm)	1.0			1.0			1.0			1.0			1.0			1.0			1.0		
Device	GTX	I/O		GTX	I/O		GTX	I/O		GTX	I/O		GTX	I/O		GTX	I/O		GTX	I/O	
		HR[4]	HP[5]		HR[4]	HP[5]		HR[4]	HP[5]		HR[4]	HP[5]		HR[4]	HP[5]		HR[4]	HP[5]		HR[4]	HP[5]
XC7K70T	4	185	100	8	200	100															
XC7K160T	4	185	100	8	250	150	8	250	150												
XC7K325T				8	250	150	8	250	150	16	350	150	16	350	150						
XC7K355T																24	300	0			
XC7K410T				8	250	150	8	250	150	16	350	150	16	350	150						
XC7K420T																28	380	0	32	400	0
XC7K480T																28	380	0	32	400	0