



Cost effective Concurrent Test Solution for an Audio Subsystem IC with class-D output

Testing an Audio Sub-System with Class-D output

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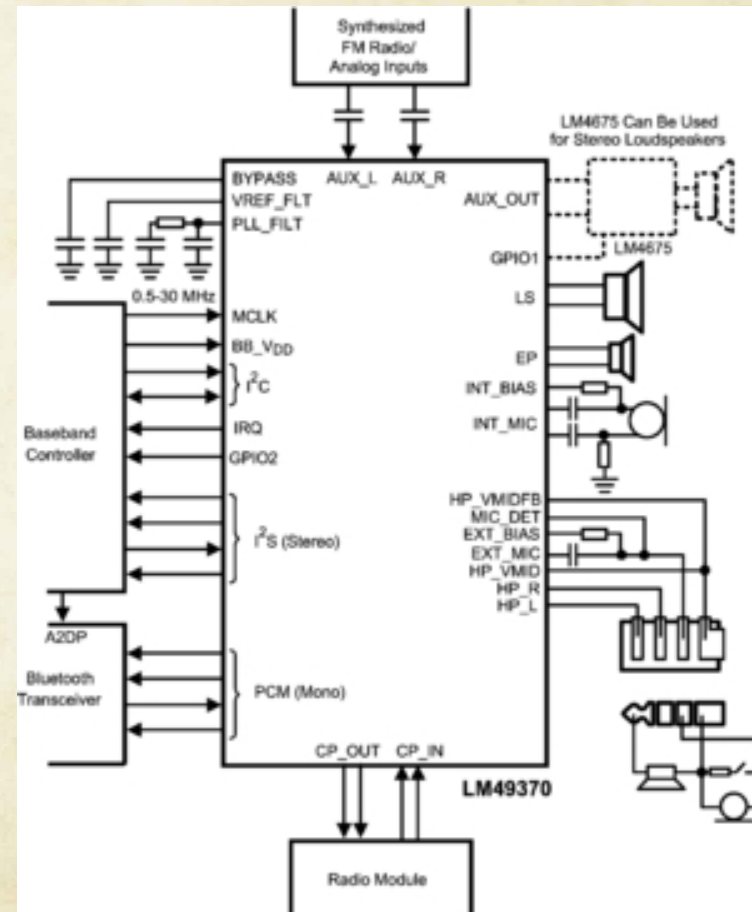


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- Introduction (Description of test challenge)
- Current setup
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- HDACTO solution
- Conversion
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- Summary & Conclusions
- Questions???

Introduction

- LM49370 audio subsystem
 - Many Analog I/O
 - LS, HP, Cellphone, MIC
 - High Performance
 - SNR 98dB
 - THD 0.04%
 - Cell phone
- Pressure on COT
 - Testtime ↓
 - Sitecount ↑





Current setup

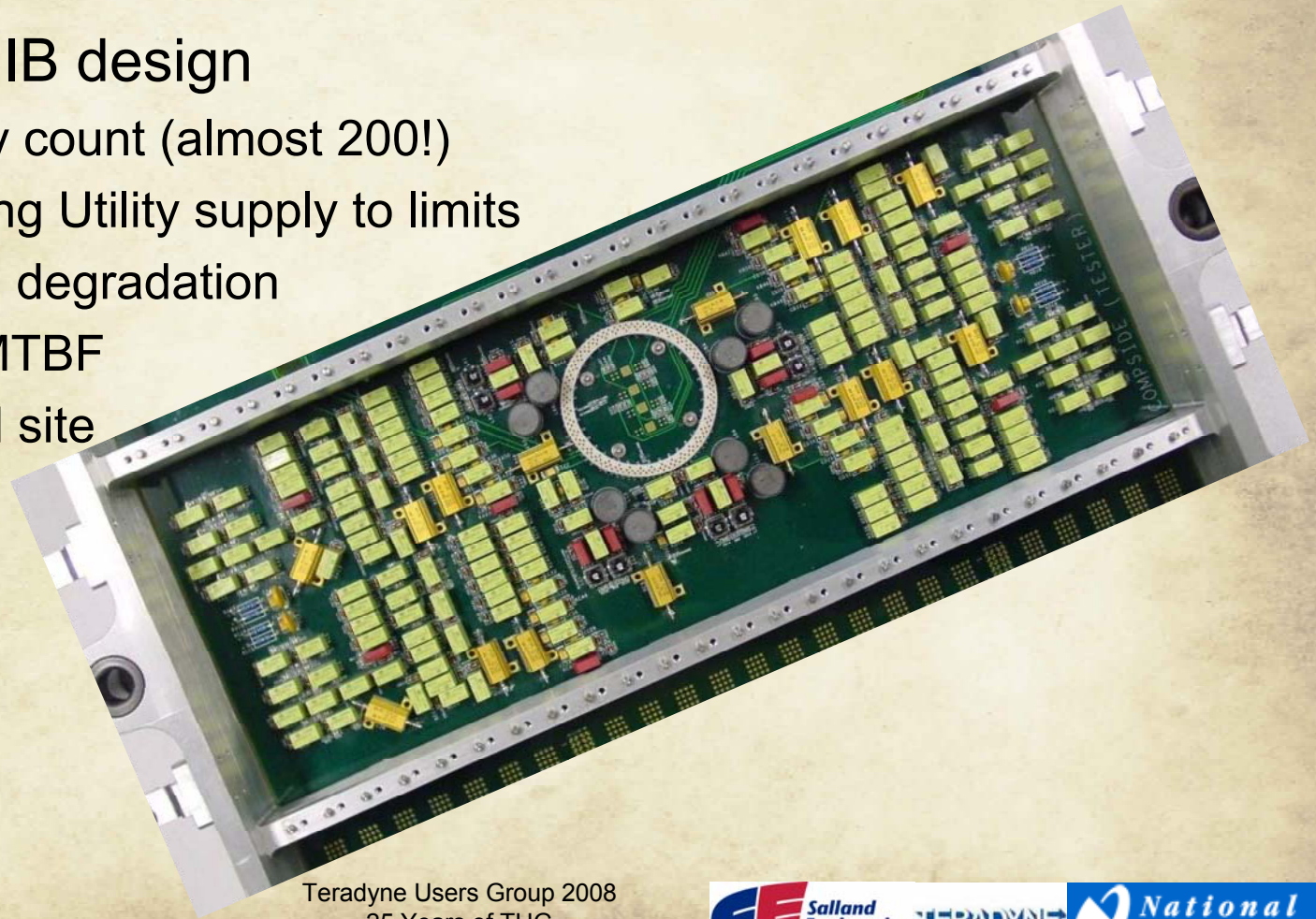
- Tested on uFlex platform
- Quad site
- 2 * BBAC
- 3 * DC-30 (continuity, power, etc.)
- 1 * POOL (continuity)
- 2 * HSD200
- 1 * DC-90 (high current)
- = 9 instrument slots occupied from 12 available





Issues with current setup

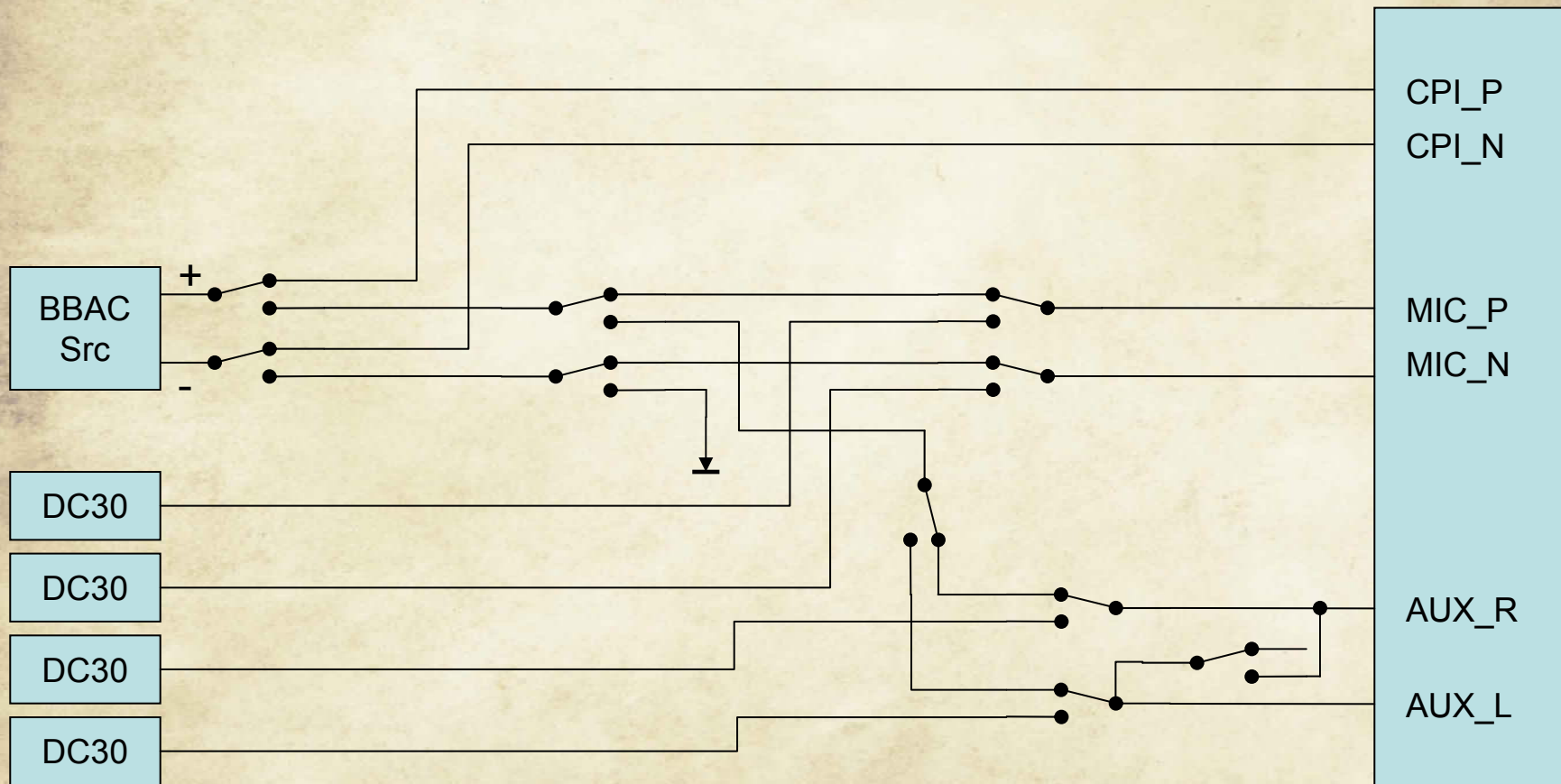
- Complex DIB design
 - High relay count (almost 200!)
 - Pushing Utility supply to limits
 - Signal degradation
 - Low MTBF
 - Max quad site





LM49370 Analog Inputs using BBAC

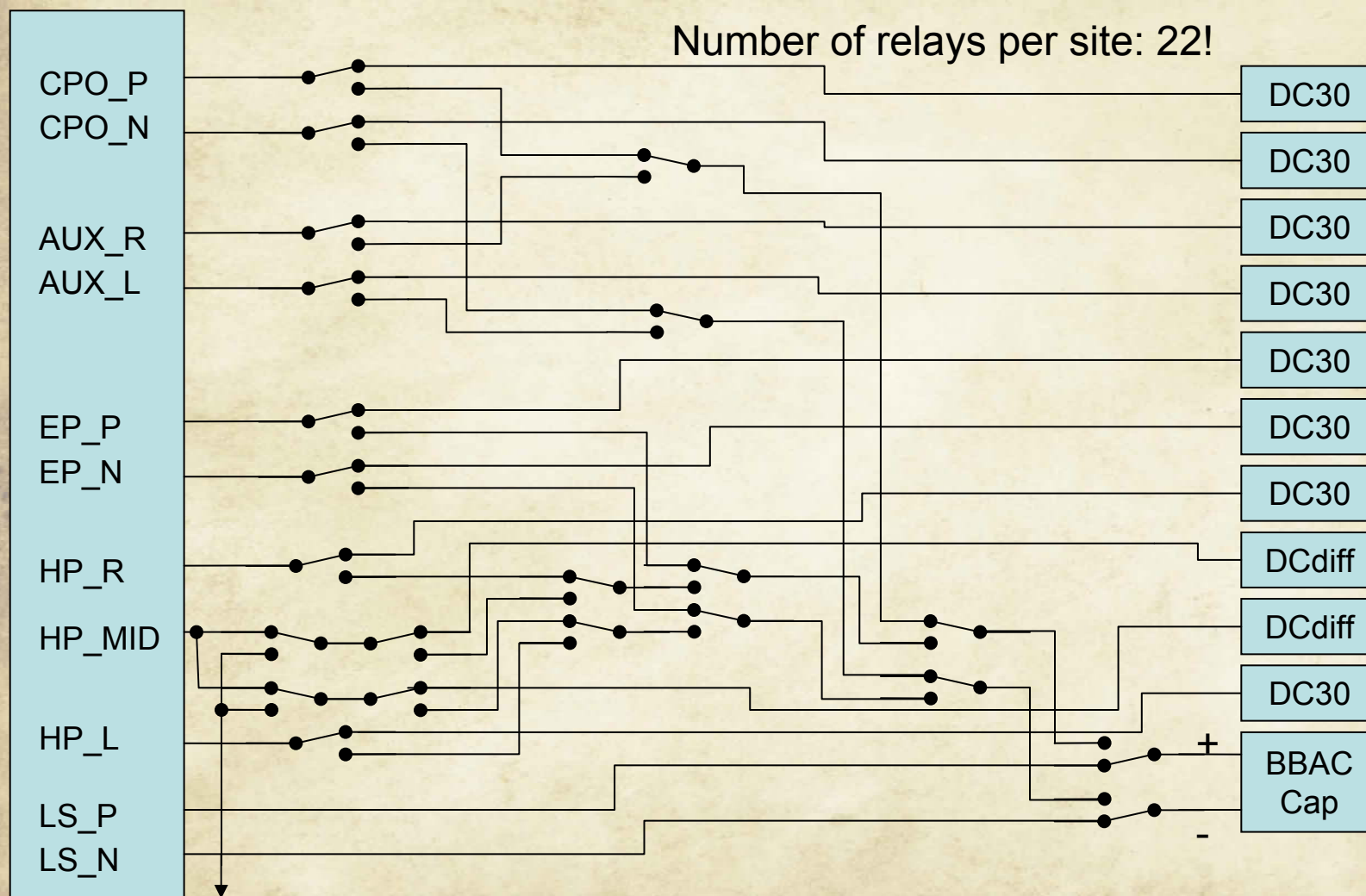
Number of relays per site: 10!





LM49370 Analog Outputs using BBAC

Number of relays per site: 22!



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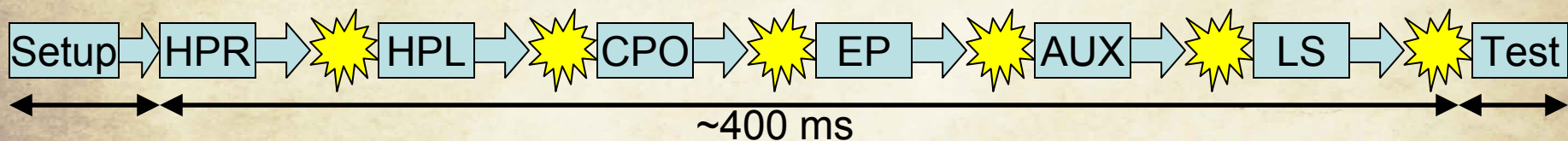
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Issues with current setup

- High cost of test
 - High testtime due to serial testing
 - E.g. THD test

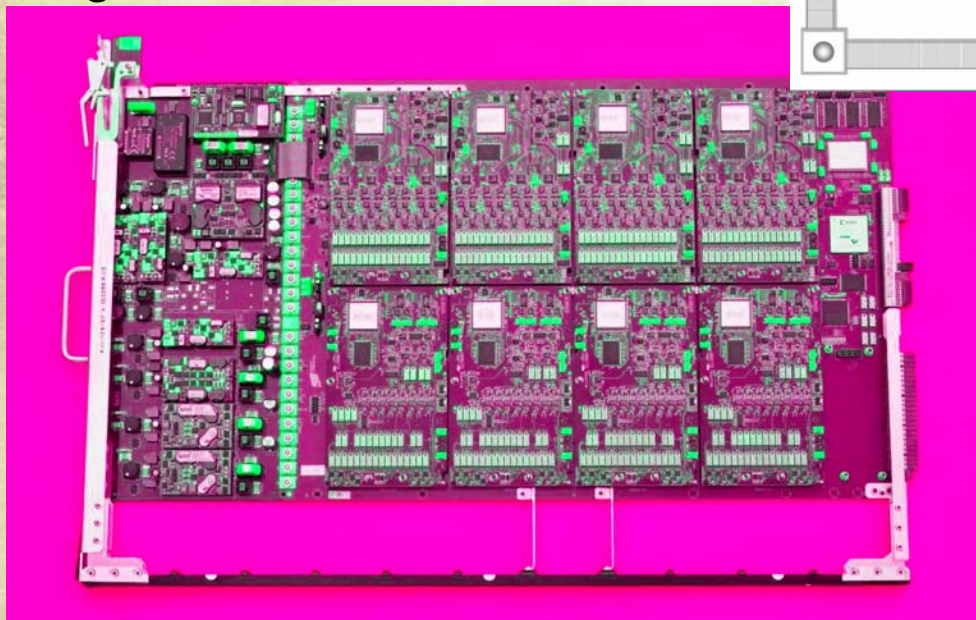


- Total testtime (dual site) ~4.1 sec
- High number of instruments/channels needed
 - 2 * BBAC (1 channel/site)
 - 3 * DC-30 (1 used for dps, 2 others for continuity)



HDACTO overview

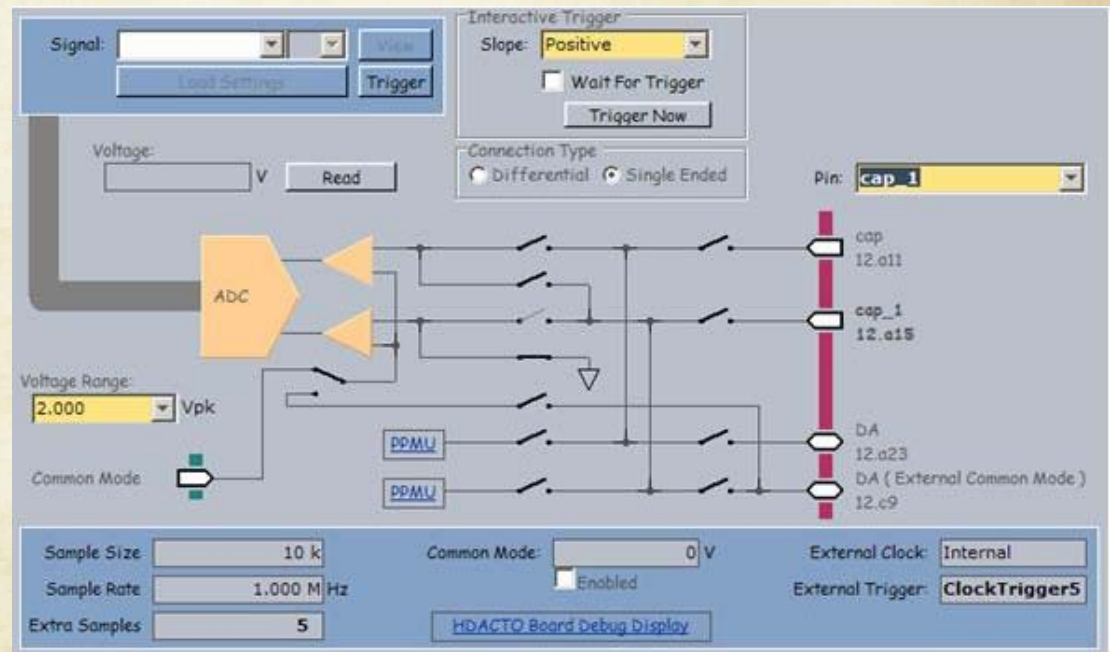
- Salland Engineering's 2nd OpenFlex instrument
- **High Density AC Test Option**
- Modular, Scalable Concept
- Source & Capture
- High Performance





HDACTO Features

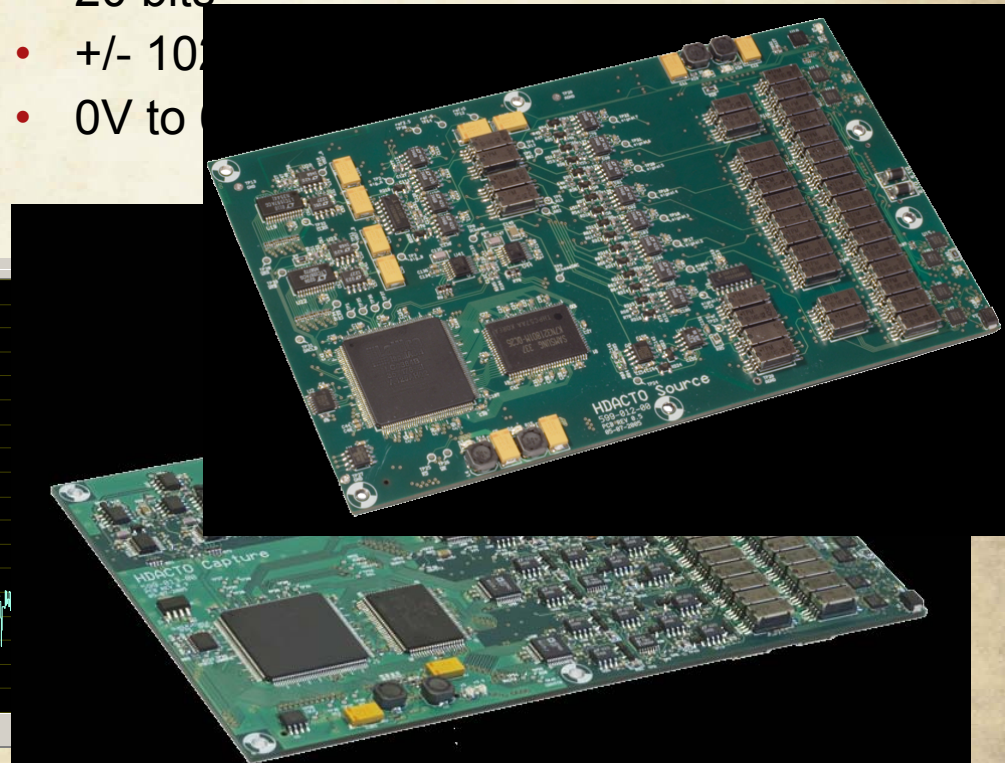
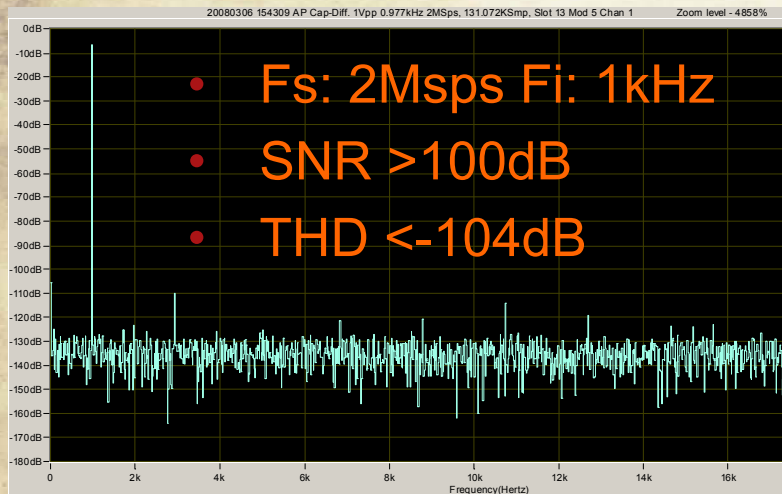
- Capture: 32 Differential channels
- Source: 64 SE / 32 Differential
- Mix and match source and capture modules (any combination possible)
- 8 modules
- PPMU per channel (total of 72)
- Supports FLEX G4 DSP background processing
- 20-bit Vref on each module





HDACTO Source & Capture

- Capture
 - 4 Diff/SE Channels
 - 2Msps
 - 1M memory/channel
- Source
 - 4 Diff/8 SE Channels
 - 2Msps
 - 1M memory / DAC
- PPMU (4 Quadrant)
 - +/- 32uA to +/- 32mA
 - -1.0V to 6.5V
- VREF
 - 20 bits
 - +/- 10V
 - 0V to 10V



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Conversion (Channelmap)

- Before

	A	B	C	D	E	F	G	H	I
1	Channel Map						TERADYNE		
2									
3	DIB ID: <input type="text"/>			View Mode: <input type="text" value="Pogo"/>					
4									
5	Device Under Test		Tester Channel						
6	Pin Name	Package Pin	Type	Site 0	Comment				
16	IMICP		DCVI	10.a2.a34	DC30				
17	IMICN		DCVI	10.a6.a34	DC30				
18	AUXINR		DCVI	10.a22.a34	DC30				
19	AUXINL		DCVI	10.d18.a34	DC30				
20	CPOUTP		DCVI	10.a4.a34	DC30				
21	CPOUTN		DCVI	10.d22.a34	DC30				
22	HPL		DCVI	10.a18.a34	DC30				
23	HPR		DCVI	10.d2.a34	DC30				

- After

	A	B	C	D	E	F	G	H	I
1	Channel Map						TERADYNE		
2									
3	DIB ID: <input type="text"/>			View Mode: <input type="text" value="Signal"/>					
4									
5	Device Under Test		Tester Channel						
6	Pin Name	Package Pin	Type	Site 0	Comment				
16	IMICP		SE_ACTOSrc	25.Src6A	DC30 -> HDACTO				
17	IMICN		SE_ACTOSrc	25.Src6B	DC30 -> HDACTO				
18	AUXINR		SE_ACTOSrc	25.Src8A	DC30 -> HDACTO				
19	AUXINL		SE_ACTOSrc	25.Src7A	DC30 -> HDACTO				
20	CPOUTP		SE_ACTOCap	25.Cap15A	DC30 -> HDACTO				
21	CPOUTN		SE_ACTOCap	25.Cap15B	DC30 -> HDACTO				
22	HPL		SE_ACTOCap	25.Cap10A	DC30 -> HDACTO				
23	HPR		SE_ACTOCap	25.Cap10B	DC30 -> HDACTO				



Conversion (Continuity)

- Before

```
'For Analog Pins
With thehdw.DCVI.Pins("Cont_DCVI") 'INTMICP,INTMICN,AUX_R,AUX_L,CPO_P,CPO_N,HP_L,HP_R,HPVMIND
    .mode = tlDCVIModeCurrent
    .Meter.mode = tlDCVIMeterVoltage
    .Current = Analog_FI
    .Voltage = -3
    .Connect
    .Gate = True
End With
With thehdw.PPMU.Pins("BBAC_srcP,BBAC_srcN,BBAC_capP,BBAC_capN,HPMIDFB,VREF,MICDET,IMICBIAS,EMIC,EMICBIAS,BYPASS")
    .ForceI Analog_FI
    .Connect
    .Gate = tlOn
End With
thehdw.Wait (0.001)
Cont_Analog1 = thehdw.DCVI("Cont_DCVI").Meter.Read(tlStrobe, 10, 10000)
Cont_Analog2 = thehdw.PPMU("BBAC_srcP,BBAC_srcN,BBAC_capP,BBAC_capN,HPMIDFB,VREF,MICDET,IMICBIAS,EMIC,EMICBIAS,BYPASS").Read(tlP
```

- After

```
'For Analog Pins
With thehdw.PPMU.Pins("LSP,LSN,CPINP,CPINN,HPMIDFB,VREF,MICDET,IMICBIAS,EMIC,EMICBIAS,BYPASS,Cont_HDACTO")
    .ForceI Analog_FI
    .Connect
    .Gate = tlOn
End With
'For Digital Pins (18pins)

thehdw.Wait (0.001)
Cont_Analog2 = thehdw.PPMU("BBAC_srcP,BBAC_srcN,BBAC_capP,BBAC_capN,HPMIDFB,VREF,MICDET,IMICBIAS,EMIC,EMICBIAS,BYPASS,Cont_HDACTO").Read(tlP
```



Conversion (Source example)

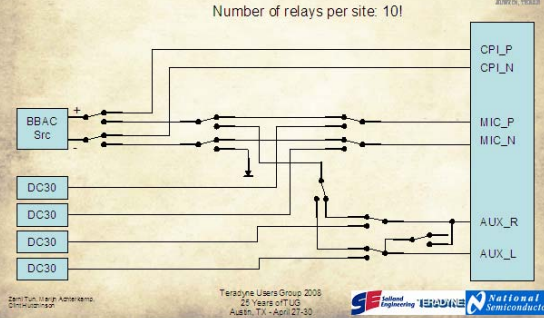
- BBAC

```
With thehdw.BBACSource.Pins("BBAC_srcP").Signals(pinname + "_signal")
  If connectiontype = differential_src Then
    .connectiontype = tlBBACSourceConnectionTypeDifferential
  Else
    .connectiontype = tlBBACSourceConnectionTypeSingleEndedRef
  End If
  .VoltageRange.mode = tlCSignalModeUseValue
  .SampleRate = SampleRate
  .samplesize = samplesize
  .cyclecount = cyclecount
  .amplitude = amplitude
  .offset = offset
  .phase = phase
  .LoadSamples
  .LoadSettings
End With
```

```
'setup Src for CPIN
thehdw.Wait (0.002)
With HDACTOSource
  .Pins("IMICP").Signals.Add ("IMICinDigCheckSignal")
  .Pins("IMICP").connectiontype = seACTOSrcConnectionTypeDifferential
  With .Pins("IMICP").Signals("IMICinDigCheckSignal")
    .Reinitialize
    .amplitude = 0.1
    .VoltageRange = 1.8
    .offset = 1.5
    .WaveDefinitionName = "aSine"
    .cyclecount = 20
    .SampleRate = 1000000
    .samplesize = 10000
    .LoadSamples
    .LoadSettings
  End With
  .Pins("IMICP, IMICN").Connect seACTOSrcSourceFromInst
End With
HDACTOSource.Pins("IMICP").Signals("IMICinDigCheckSignal").Start tlStartImmediately
```

- HDACTO

LM49370 Analog Inputs using BBAC



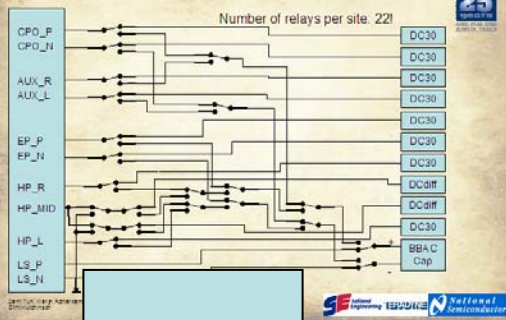
LM49370 Analog Inputs using HDACTO



Number of relays per site: 0!



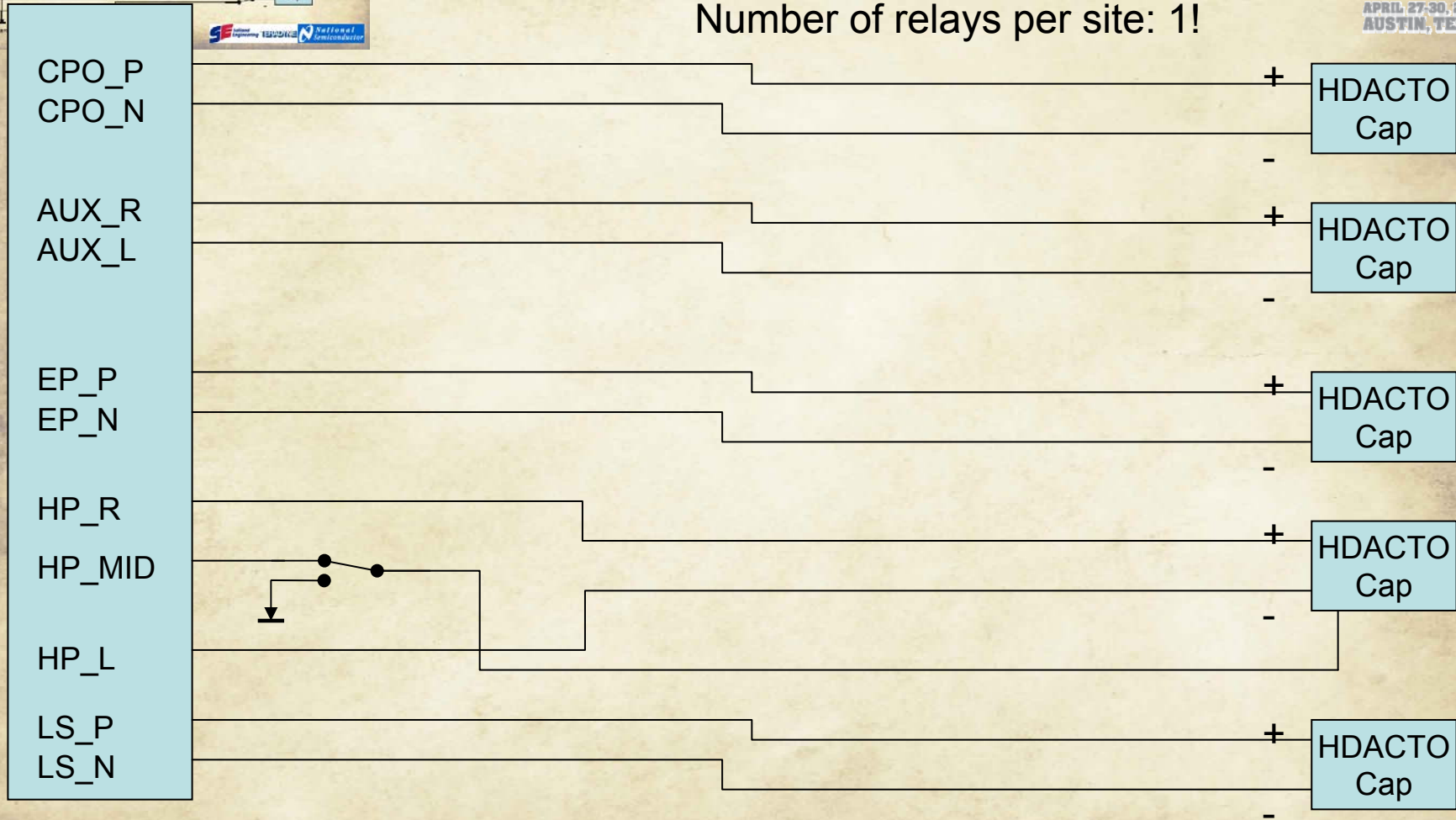
LM49370 Analog Outputs using BBAC



LM49370 Analog Outputs using HDACTO



Number of relays per site: 1!





Saving testtime (1)

- Continuity test (BBAC)
 - Connect BBAC
 - Measure
 - Disconnect
 - Connect DCVI
 - Measure
 - Disconnect
 - Connect POOL
 - Measure
 - Disconnect
- Testtime ~180 ms (Quad site)
- Continuity test (HDACTO)
 - Connect all PPMU's
 - Measure
 - Disconnect
- Testtime ~55 ms (Quad site)



Saving testtime (2)

- PSRR test (BBAC)
 - Connect BBAC
 - Measure
 - Disconnect
 - Connect DCVI
 - Measure
 - Disconnect
 - Connect POOL
 - Measure
 - Disconnect
- Testtime ~370 ms (Quad site)
- PSRR test (HDACTO)
 - Connect all PPMU's
 - Measure
 - Disconnect
- Testtime ~176 ms (Quad site)



Testtime

Testtime Profile

	BBAC			HDACTO				Testtime
	1 site	2 sites	4 sites (approx)	1 site	2 sites (approx)	4 sites (approx)		gain (ms)
Continuity		176.35	185.17	50.40	52.92	55.57	ms	123.43
V_offset		179.05	188.00	123.37	130.54	158.07	ms	48.51
T_swing		409.62	430.10	371.18	389.74	409.23	ms	39.87
PSRR		352.50	370.13	159.66	167.64	176.03	ms	204.86
SNR		408.06	428.46	297.99	312.89	328.53	ms	95.17
THD_Power		547.66	575.04	355.45	373.23	391.89	ms	174.43
Vol_Cntl		667.50	700.88	521.19	547.25	574.61	ms	200.25
Dig_Check		538.29	565.20	532.32	558.93	586.88	ms	100.65
Total		3279.02	3442.97		2273.14	2386.80	ms	1005.88
						30.68%		Total Analog reduction (dual site)



Saving Capital Cost

microFlex Configuration

- Only 1 DC30 Needed (power supply)
- No BBAC needed
- No POOL needed

BBAC

Tester			
Slot	Description	Slot	Description
1	BBAC #1	1	
		2	BBAC #1
2	DC90 #1	3	
		4	DC90 #1
3	DC30 #1	5	DC30 #1
		6	
4		7	
		8	Support Board
5	DC30 #2	9	
		10	DC30 #2
6	HSD200 #1	11	HSD #1
		12	
7	Support Board	13	
		14	POOL2
8	POOL2	15	HSD #2
		16	
9	HSD200 #2	17	
		18	
10		19	
		20	Support Board
11	DC30 #3	21	
		22	
12		23	DC30 #3
		24	
13	BBAC #1	25	BBAC #2

HDACTO

Salland			
TEST HEAD SLOT	Instrument	DIB SLOT	DIB Pogo Description
1		1	
		2	
2	DC90 #1	3	
		4	DC90 #1
3		5	
		6	
4		7	
		8	Support Board
5	DC30 #1	9	
		10	DC30 #1
6	HSD200 #1	11	HSD200 #1
		12	
7	Support Board	13	
		14	
8	HSD200 #2	15	HSD200 #2
		16	
9		17	
		18	
10		19	
		20	Support Board
11		21	
		22	
12		23	
		24	HDACTO-J1
13	HDACTO #1	25	HDACTO-J2



Benefits with HDACTO

- Reducing DIB complexity
 - Direct connections
 - Reducing relay count
- Saving Testtime (>30%)
 - Concurrent testing
 - Enabling Octal site
- Saving capital cost
 - Only 1 DC-30 needed
 - No BBAC needed

Total nr. of relays	Single Site	Dual Site	Quad Site	Octal Site
BBAC	49	98	196	392
HDACTO	18	36	72	144
Saving	31	62	124	248



Questions???

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