

# A Pad Description

A reference number has been assigned to each pad. The numbering starts in the upper left corner of the die (with the analogue input pads left) and runs counter-clockwise (cf. figure 17 for *Beetle1.3 / 1.4* or figure 18 for *Beetle1.5*). The following tables summarise the signals and explain them. The pad coordinates refer to the lower left corner of the pad opening, which is  $120\ \mu\text{m} \times 95\ \mu\text{m}$  in case of the front pads and  $95\ \mu\text{m} \times 95\ \mu\text{m}$  for all others with exception of the backside power pads. Their enlarged pad windows are listed in section A.3. The origin of the coordinate system is defined by the lower left chip corner (0, 0). The dimensions of the chip die are  $5\ 400\ \mu\text{m} \times 6\ 100\ \mu\text{m}$ <sup>4</sup>. The analogue input pads have a pitch of  $40.24\ \mu\text{m}$ , all others  $115\ \mu\text{m}$ .

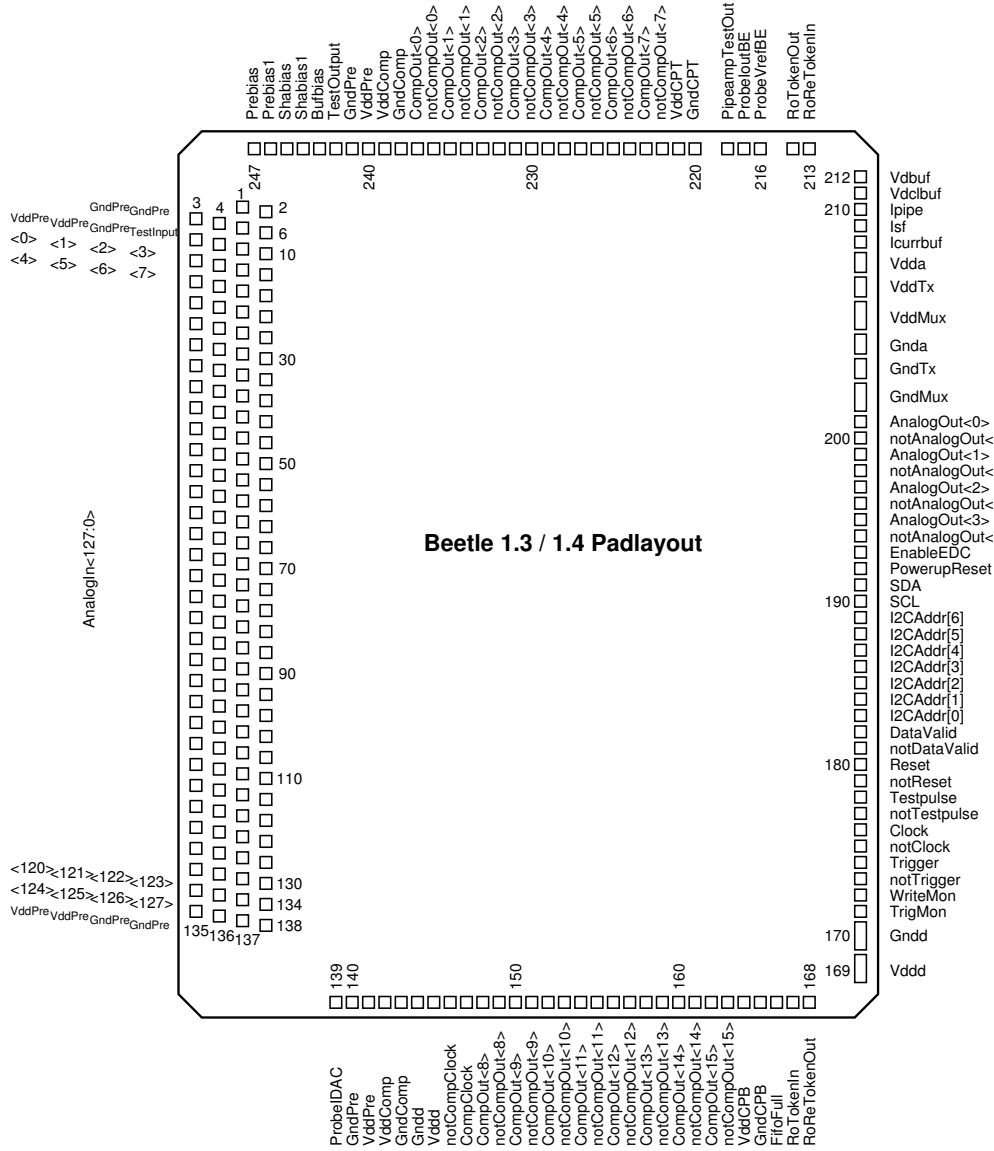


Figure 17: Pad layout of *Beetle1.3* and *Beetle1.4*. The die size is  $(5.4 \times 6.1)\ \text{mm}^2$ .

<sup>4</sup>Note, that this are the dimensions of the chip's scribe line, i.e. not including cutting margins. They could add some  $100\ \mu\text{m}$  to the chip dimensions.

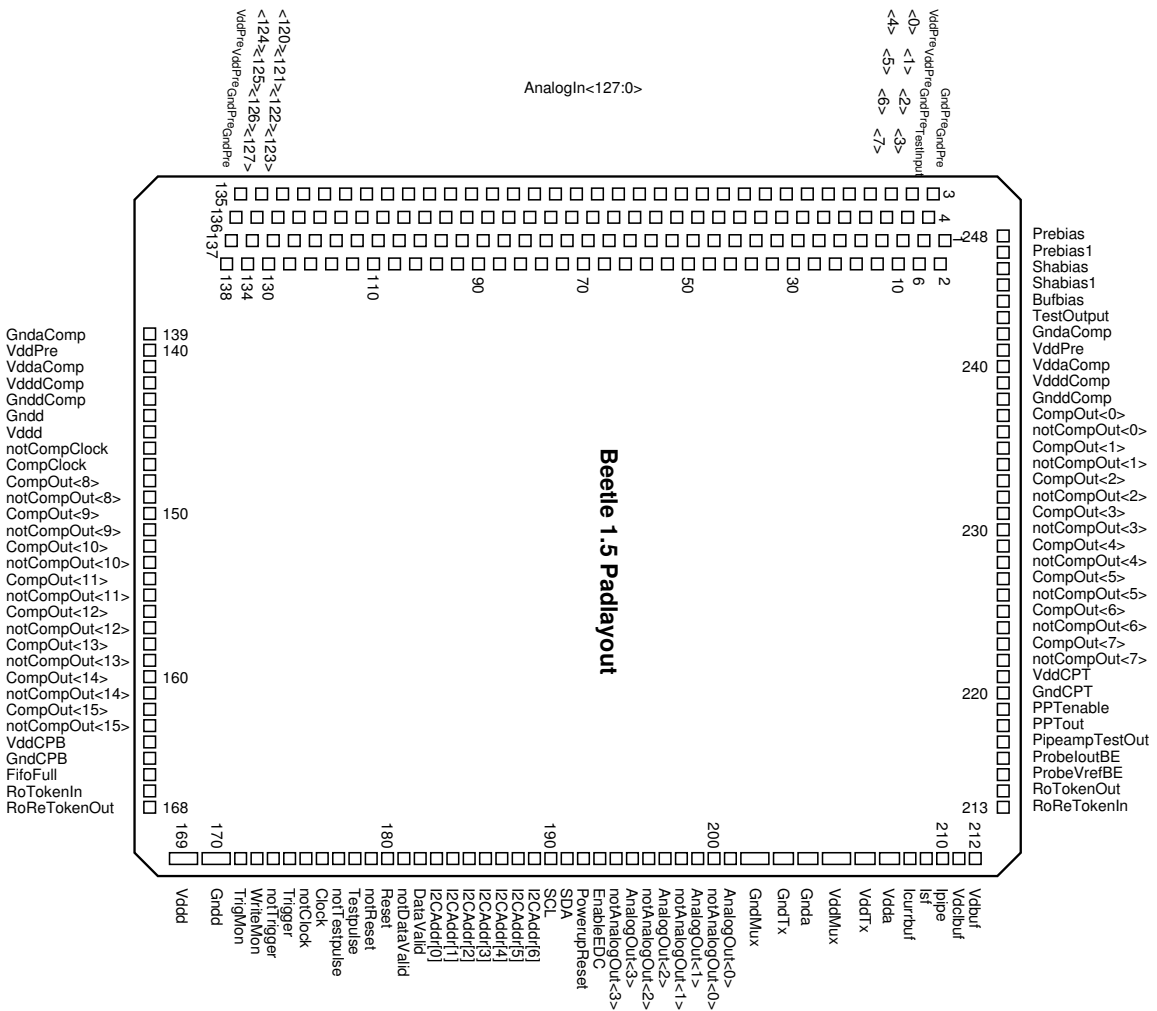


Figure 18: Pad layout of *Beetle 1.5*. The die size is  $(5.4 \times 6.1)$  mm<sup>2</sup>.

## A.1 Front Pads

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
1	GndPre	335.00	5876.54	power input	neg. analogue preamplifier supply (detector gnd)
2	GndPre	490.00	5836.30	power input	neg. analogue preamplifier supply (detector gnd)
3	VddPre	25.00	5796.06	power input	pos. analogue preamplifier supply
4	VddPre	180.00	5755.82	power input	pos. analogue preamplifier supply
5	GndPre	335.00	5715.58	power input	neg. analogue preamplifier supply (detector gnd)
6	TestInput	490.00	5675.34	input	input of test channel
7	AnalogIn<0>	25.00	5635.10	input	input of channel 0
8	AnalogIn<1>	180.00	5594.86	input	input of channel 1
9	AnalogIn<2>	335.00	5554.62	input	input of channel 2
10	AnalogIn<3>	490.00	5514.38	input	input of channel 3
11	AnalogIn<4>	25.00	5474.14	input	input of channel 4
12	AnalogIn<5>	180.00	5433.90	input	input of channel 5
13	AnalogIn<6>	335.00	5393.66	input	input of channel 6
14	AnalogIn<7>	490.00	5353.42	input	input of channel 7
15	AnalogIn<8>	25.00	5313.18	input	input of channel 8
16	AnalogIn<9>	180.00	5272.94	input	input of channel 9
17	AnalogIn<10>	335.00	5232.70	input	input of channel 10
18	AnalogIn<11>	490.00	5192.46	input	input of channel 11
19	AnalogIn<12>	25.00	5152.22	input	input of channel 12
20	AnalogIn<13>	180.00	5111.98	input	input of channel 13
21	AnalogIn<14>	335.00	5071.74	input	input of channel 14
22	AnalogIn<15>	490.00	5031.50	input	input of channel 15
23	AnalogIn<16>	25.00	4991.26	input	input of channel 16
24	AnalogIn<17>	180.00	4951.02	input	input of channel 17
25	AnalogIn<18>	335.00	4910.78	input	input of channel 18
26	AnalogIn<19>	490.00	4870.54	input	input of channel 19
27	AnalogIn<20>	25.00	4830.30	input	input of channel 20
28	AnalogIn<21>	180.00	4790.06	input	input of channel 21
29	AnalogIn<22>	335.00	4749.82	input	input of channel 22
30	AnalogIn<23>	490.00	4709.58	input	input of channel 23
31	AnalogIn<24>	25.00	4669.34	input	input of channel 24
32	AnalogIn<25>	180.00	4629.10	input	input of channel 25
33	AnalogIn<26>	335.00	4588.86	input	input of channel 26
34	AnalogIn<27>	490.00	4548.62	input	input of channel 27
35	AnalogIn<28>	25.00	4508.38	input	input of channel 28
36	AnalogIn<29>	180.00	4468.14	input	input of channel 29
37	AnalogIn<30>	335.00	4427.90	input	input of channel 30
38	AnalogIn<31>	490.00	4387.66	input	input of channel 31
39	AnalogIn<32>	25.00	4347.42	input	input of channel 32
40	AnalogIn<33>	180.00	4307.18	input	input of channel 33
41	AnalogIn<34>	335.00	4266.94	input	input of channel 34
42	AnalogIn<35>	490.00	4226.70	input	input of channel 35
43	AnalogIn<36>	25.00	4186.46	input	input of channel 36
44	AnalogIn<37>	180.00	4146.22	input	input of channel 37
45	AnalogIn<38>	335.00	4105.98	input	input of channel 38
46	AnalogIn<39>	490.00	4065.74	input	input of channel 39
47	AnalogIn<40>	25.00	4025.50	input	input of channel 40
48	AnalogIn<41>	180.00	3985.26	input	input of channel 41

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
49	AnalogIn<42>	335.00	3945.02	input	input of channel 42
50	AnalogIn<43>	490.00	3904.78	input	input of channel 43
51	AnalogIn<44>	25.00	3864.54	input	input of channel 44
52	AnalogIn<45>	180.00	3824.30	input	input of channel 45
53	AnalogIn<46>	335.00	3784.06	input	input of channel 46
54	AnalogIn<47>	490.00	3743.82	input	input of channel 47
55	AnalogIn<48>	25.00	3703.58	input	input of channel 48
56	AnalogIn<49>	180.00	3663.34	input	input of channel 49
57	AnalogIn<50>	335.00	3623.10	input	input of channel 50
58	AnalogIn<51>	490.00	3582.86	input	input of channel 51
59	AnalogIn<52>	25.00	3542.62	input	input of channel 52
60	AnalogIn<53>	180.00	3502.38	input	input of channel 53
61	AnalogIn<54>	335.00	3462.14	input	input of channel 54
62	AnalogIn<55>	490.00	3421.90	input	input of channel 55
63	AnalogIn<56>	25.00	3381.66	input	input of channel 56
64	AnalogIn<57>	180.00	3341.42	input	input of channel 57
65	AnalogIn<58>	335.00	3301.18	input	input of channel 58
66	AnalogIn<59>	490.00	3260.94	input	input of channel 59
67	AnalogIn<60>	25.00	3220.70	input	input of channel 60
68	AnalogIn<61>	180.00	3180.46	input	input of channel 61
69	AnalogIn<62>	335.00	3140.22	input	input of channel 62
70	AnalogIn<63>	490.00	3099.98	input	input of channel 63
71	AnalogIn<64>	25.00	3059.74	input	input of channel 64
72	AnalogIn<65>	180.00	3019.50	input	input of channel 65
73	AnalogIn<66>	335.00	2979.26	input	input of channel 66
74	AnalogIn<67>	490.00	2939.02	input	input of channel 67
75	AnalogIn<68>	25.00	2898.78	input	input of channel 68
76	AnalogIn<69>	180.00	2858.54	input	input of channel 69
77	AnalogIn<70>	335.00	2818.30	input	input of channel 70
78	AnalogIn<71>	490.00	2778.06	input	input of channel 71
79	AnalogIn<72>	25.00	2737.82	input	input of channel 72
80	AnalogIn<73>	180.00	2697.58	input	input of channel 73
81	AnalogIn<74>	335.00	2657.34	input	input of channel 74
82	AnalogIn<75>	490.00	2617.10	input	input of channel 75
83	AnalogIn<76>	25.00	2576.86	input	input of channel 76
84	AnalogIn<77>	180.00	2536.62	input	input of channel 77
85	AnalogIn<78>	335.00	2496.38	input	input of channel 78
86	AnalogIn<79>	490.00	2456.14	input	input of channel 79
87	AnalogIn<80>	25.00	2415.90	input	input of channel 80
88	AnalogIn<81>	180.00	2375.66	input	input of channel 81
89	AnalogIn<82>	335.00	2335.42	input	input of channel 82
90	AnalogIn<83>	490.00	2295.18	input	input of channel 83
91	AnalogIn<84>	25.00	2254.94	input	input of channel 84
92	AnalogIn<85>	180.00	2214.70	input	input of channel 85
93	AnalogIn<86>	335.00	2174.46	input	input of channel 86
94	AnalogIn<87>	490.00	2134.22	input	input of channel 87
95	AnalogIn<88>	25.00	2093.98	input	input of channel 88
96	AnalogIn<89>	180.00	2053.74	input	input of channel 89
97	AnalogIn<90>	335.00	2013.50	input	input of channel 90
98	AnalogIn<91>	490.00	1973.26	input	input of channel 91
99	AnalogIn<92>	25.00	1933.02	input	input of channel 92
100	AnalogIn<93>	180.00	1892.78	input	input of channel 93
101	AnalogIn<94>	335.00	1852.54	input	input of channel 94

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
102	AnalogIn<95>	490.00	1812.30	input	input of channel 95
103	AnalogIn<96>	25.00	1772.06	input	input of channel 96
104	AnalogIn<97>	180.00	1731.82	input	input of channel 97
105	AnalogIn<98>	335.00	1691.58	input	input of channel 98
106	AnalogIn<99>	490.00	1651.34	input	input of channel 99
107	AnalogIn<100>	25.00	1611.10	input	input of channel 100
108	AnalogIn<101>	180.00	1570.86	input	input of channel 101
109	AnalogIn<102>	335.00	1530.62	input	input of channel 102
110	AnalogIn<103>	490.00	1490.38	input	input of channel 103
111	AnalogIn<104>	25.00	1450.14	input	input of channel 104
112	AnalogIn<105>	180.00	1409.90	input	input of channel 105
113	AnalogIn<106>	335.00	1369.66	input	input of channel 106
114	AnalogIn<107>	490.00	1329.42	input	input of channel 107
115	AnalogIn<108>	25.00	1289.18	input	input of channel 108
116	AnalogIn<109>	180.00	1248.94	input	input of channel 109
117	AnalogIn<110>	335.00	1208.70	input	input of channel 110
118	AnalogIn<111>	490.00	1168.46	input	input of channel 111
119	AnalogIn<112>	25.00	1128.22	input	input of channel 112
120	AnalogIn<113>	180.00	1087.98	input	input of channel 113
121	AnalogIn<114>	335.00	1047.74	input	input of channel 114
122	AnalogIn<115>	490.00	1007.50	input	input of channel 115
123	AnalogIn<116>	25.00	967.26	input	input of channel 116
124	AnalogIn<117>	180.00	927.02	input	input of channel 117
125	AnalogIn<118>	335.00	886.78	input	input of channel 118
126	AnalogIn<119>	490.00	846.54	input	input of channel 119
127	AnalogIn<120>	25.00	806.30	input	input of channel 120
128	AnalogIn<121>	180.00	766.06	input	input of channel 121
129	AnalogIn<122>	335.00	725.82	input	input of channel 122
130	AnalogIn<123>	490.00	685.58	input	input of channel 123
131	AnalogIn<124>	25.00	645.34	input	input of channel 124
132	AnalogIn<125>	180.00	605.10	input	input of channel 125
133	AnalogIn<126>	335.00	564.86	input	input of channel 126
134	AnalogIn<127>	490.00	524.62	input	input of channel 127
135	VddPre	25.00	484.38	power input	pos. analogue preamplifier supply
136	VddPre	180.00	444.14	power input	pos. analogue preamplifier supply
137	GndPre	335.00	403.90	power input	neg. analogue preamplifier supply (detector gnd)
138	GndPre	490.00	363.66	power input	neg. analogue preamplifier supply (detector gnd)

## A.2 Bottom Pads

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
139	ProbeIDAC	1824.12	37.50	output	current DAC ( <i>Ibuf</i> ) probe pad
1.3/1.4	GndaComp	1824.12	37.50	power input	neg. analogue comparator supply
140	GndPre	1939.12	37.50	power input	neg. analogue preamplifier (detector gnd) and comparator supply
1.5	VddPre	1939.12	37.50	power input	pos. analogue preamplifier supply
141	VddPre	2054.12	37.50	power input	pos. analogue preamplifier and comparator supply
1.5	VddaComp	2054.12	37.50	power input	pos. analogue comparator supply
142	VdddComp	2169.12	37.50	power input	pos. digital comparator supply
143	GnddComp	2284.12	37.50	power input	neg. digital comparator supply
144	Gndd	2399.12	37.50	power input	neg. digital supply
145	Vddd	2514.12	37.50	power input	pos. digital supply
146	notCompClock	2629.12	37.50	LVDS input	comparator clock
147	CompClock	2744.12	37.50	LVDS input	comparator clock
148	CompOut<8>	2859.12	37.50	LVDS output	comparator output channel 8
149	notCompOut<8>	2974.12	37.50	LVDS output	comparator output channel 8
150	CompOut<9>	3089.12	37.50	LVDS output	comparator output channel 9
151	notCompOut<9>	3204.12	37.50	LVDS output	comparator output channel 9
152	CompOut<10>	3319.12	37.50	LVDS output	comparator output channel 10
153	notCompOut<10>	3434.12	37.50	LVDS output	comparator output channel 10
154	CompOut<11>	3549.12	37.50	LVDS output	comparator output channel 11
155	notCompOut<11>	3664.12	37.50	LVDS output	comparator output channel 11
156	CompOut<12>	3779.12	37.50	LVDS output	comparator output channel 12
157	notCompOut<12>	3894.12	37.50	LVDS output	comparator output channel 12
158	CompOut<13>	4009.12	37.50	LVDS output	comparator output channel 13
159	notCompOut<13>	4124.12	37.50	LVDS output	comparator output channel 13
160	CompOut<14>	4239.12	37.50	LVDS output	comparator output channel 14
161	notCompOut<14>	4354.12	37.50	LVDS output	comparator output channel 14
162	CompOut<15>	4469.12	37.50	LVDS output	comparator output channel 15
163	notCompOut<15>	4584.12	37.50	LVDS output	comparator output channel 15
164	VddCPB	4699.12	37.50	power input	pos. comparator LVFS supply
165	GndCPB	4814.12	37.50	power input	neg. comparator LVDS supply
166	FifoFull	4929.12	37.50	CMOS output	indicates a full derandomising buffer
167	RoTokenIn	5044.12	37.50	CMOS input (pull-down)	readout start token in daisy-chain mode
168	RoReTokenOut	5159.12	37.50	CMOS output	return token in daisy-chain mode

### A.3 Backside Pads

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
169	Vddd	5274.62	184.72	power input	pos. digital supply (pad window: $(95 \times 210) \mu\text{m}^2$ )
170	Gnnd	5274.62	414.72	power input	neg. digital supply (pad window: $(95 \times 210) \mu\text{m}^2$ )
171	TrigMon	5274.62	644.72	CMOS output	indicates if trigger pointer passes column 0
172	WriteMon	5274.62	759.72	CMOS output	indicates if write pointer passes column 0
173	notTrigger	5274.62	874.72	LVDS input	trigger
174	Trigger	5274.62	989.72	LVDS input	trigger
175	notClock	5274.62	1104.72	LVDS input	system clock
176	Clock	5274.62	1219.72	LVDS input	system clock
177	notTestpulse	5274.62	1334.72	LVDS input	test pulse
178	Testpulse	5274.62	1449.72	LVDS input	test pulse
179	notReset	5274.62	1564.72	LVDS input	system reset
180	Reset	5274.62	1679.72	LVDS input	system reset
181	notDataValid	5274.62	1794.72	LVDS output	indicates presence of valid data
182	DataValid	5274.62	1909.72	LVDS output	indicates presence of valid data
183	I2CAddr<0>	5274.62	2024.72	CMOS input (pull-down)	<i>Beetle</i> chip id. bit 0
184	I2CAddr<1>	5274.62	2139.72	CMOS input (pull-down)	<i>Beetle</i> chip id. bit 1
185	I2CAddr<2>	5274.62	2254.72	CMOS input (pull-down)	<i>Beetle</i> chip id. bit 2
186	I2CAddr<3>	5274.62	2369.72	CMOS input (pull-down)	<i>Beetle</i> chip id. bit 3
187	I2CAddr<4>	5274.62	2484.72	CMOS input (pull-down)	<i>Beetle</i> chip id. bit 4
188	I2CAddr<5>	5274.62	2599.72	CMOS input (pull-down)	<i>Beetle</i> chip id. bit 5
189	I2CAddr<6>	5274.62	2714.72	CMOS input (pull-down)	<i>Beetle</i> chip id. bit 6
190	SCL	5274.62	2829.72	CMOS input (5V)	I <sup>2</sup> C-bus clock port
191	SDA	5274.62	2944.72	CMOS inout (5V)	I <sup>2</sup> C-bus data port
192	PowerupReset	5274.62	3059.72	block output	block pad for powerup Reset
193	EnableEDC	5274.62	3174.72	CMOS input (pull-up)	enable Error Detection and Correction
194	notAnalogOut<3>	5274.62	3289.72	output	analogue output channel 3
195	AnalogOut<3>	5274.62	3404.72	output	analogue output channel 3
196	notAnalogOut<2>	5274.62	3519.72	output	analogue output channel 2
197	AnalogOut<2>	5274.62	3634.72	output	analogue output channel 2
198	notAnalogOut<1>	5274.62	3749.72	output	analogue output channel 1
199	AnalogOut<1>	5274.62	3864.72	output	analogue output channel 1
200	notAnalogOut<0>	5274.62	3979.72	output	analogue output channel 0
201	AnalogOut<0>	5274.62	4094.72	output	analogue output channel 0
202	GnndMux	5274.62	4209.72	power input	neg. digital MUX supply (pad window: $(95 \times 210) \mu\text{m}^2$ )
203	GndaTx	5274.62	4439.72	power input	neg. supply output driver (pad window: $(95 \times 152.5) \mu\text{m}^2$ )

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
204	Gnda	5274.62	4612.22	power input	neg. analogue supply (pad window: $(95 \times 152.5) \mu\text{m}^2$ )
205	VdddMux	5274.62	4784.72	power input	pos. digital MUX supply (pad window: $(95 \times 210) \mu\text{m}^2$ )
206	VddaTx	5274.62	5014.72	power input	pos. supply output driver (pad window: $(95 \times 152.5) \mu\text{m}^2$ )
207	Vdda	5274.62	5187.22	power input	pos. analogue supply (pad window: $(95 \times 152.5) \mu\text{m}^2$ )
208	Icurrbuf	5274.62	5359.72	block output	analogue probe pad (to be blocked)
209	Isf	5274.62	5474.72	block output	analogue probe pad (to be blocked)
210	Ipipe	5274.62	5589.72	block output	analogue probe pad (to be blocked)
211	Vdclbuf	5274.62	5704.72	block output	analogue probe pad (to be blocked)
212	Vdbuf	5274.62	5819.72	block output	analogue probe pad (to be blocked)



## A.4 Top Pads

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
213	RoReTokenIn	5159.12	5967.52	CMOS input (pull-down)	return token in daisy-chain mode
214	RoTokenOut	5044.12	5967.52	CMOS output	readout start token in daisy-chain mode
215 1.3/1.4 1.5	— ProbeVrefBE	— 4929.12	— 5967.52	— output	— current source BE probe pad
216 1.3/1.4 1.5	ProbeVrefBE ProbeIoutBE	4814.12 4814.12	5967.52 5967.52	output output	current source BE probe pad current source BE probe pad
217 1.3/1.4 1.5	ProbeIoutBE PipeampTestOut	4699.12 4699.12	5967.52 5967.52	output output	current source BE probe pad pipeline-amplifier probe pad
218 1.3/1.4 1.5	PipeampTestOut PPTout	4584.12 4584.12	5967.52 5967.52	output output	pipeline-amplifier probe pad digital PPT test structure probe pad
219 1.3/1.4 1.5	— PPTenable	— 4469.12	— 5967.52	— CMOS input (pull-down)	— enable pad for PPT test structure
220	GndCPT	4354.12	5967.52	power input	neg. comparator LVDS supply
221	VddCPT	4239.12	5967.52	power input	pos. comparator LVDS supply
222	notCompOut<7>	4124.12	5967.52	LVDS output	comparator output channel 7
223	CompOut<7>	4009.12	5967.52	LVDS output	comparator output channel 7
224	notCompOut<6>	3894.12	5967.52	LVDS output	comparator output channel 6
225	CompOut<6>	3779.12	5967.52	LVDS output	comparator output channel 6
226	notCompOut<5>	3664.12	5967.52	LVDS output	comparator output channel 5
227	CompOut<5>	3549.12	5967.52	LVDS output	comparator output channel 5
228	notCompOut<4>	3434.12	5967.52	LVDS output	comparator output channel 4
229	CompOut<4>	3319.12	5967.52	LVDS output	comparator output channel 4
230	notCompOut<3>	3204.12	5967.52	LVDS output	comparator output channel 3
231	CompOut<3>	3089.12	5967.52	LVDS output	comparator output channel 3
232	notCompOut<2>	2974.12	5967.52	LVDS output	comparator output channel 2
233	CompOut<2>	2859.12	5967.52	LVDS output	comparator output channel 2
234	notCompOut<1>	2744.12	5967.52	LVDS output	comparator output channel 1
235	CompOut<1>	2629.12	5967.52	LVDS output	comparator output channel 1
236	notCompOut<0>	2514.12	5967.52	LVDS output	comparator output channel 0
237	CompOut<0>	2399.12	5967.52	LVDS output	comparator output channel 0
238	GnddComp	2284.12	5967.52	power input	neg. digital comparator supply
239	VdddComp	2169.12	5967.52	power input	pos. digital comparator supply
240 1.3/1.4 1.5	VddPre VddaComp	2054.12 2054.12	5967.52 5967.52	power input power input	pos. analogue preamplifier and com- parator supply pos. analogue comparator
241 1.3/1.4 1.5	GndPre VddPre	1939.12 1939.12	5967.52 5967.52	power input power input	neg. analogue preamplifier (detector gnd) and comparator supply pos. analogue preamplifier
242 1.3/1.4 1.5	TestOutput GndaComp	1824.12 1824.12	5967.52 5967.52	output power input	front-end output of test channel neg. analogue comparator supply

Ref. no	Pin name	Coordinates		Type	Description
		x [ $\mu\text{m}$ ]	y [ $\mu\text{m}$ ]		
243 <i>1.3/1.4</i> <i>1.5</i>	Bufbias TestOutput	1709.12 1709.12	5967.52 5967.52	output output	analogue probe pad front-end output of test channel
244 <i>1.3/1.4</i> <i>1.5</i>	Shabias1 Bufbias	1594.12 1594.12	5967.52 5967.52	output output	analogue probe pad analogue probe pad
245 <i>1.3/1.4</i> <i>1.5</i>	Shabias Shabias1	1479.12 1479.12	5967.52 5967.52	output output	analogue probe pad analogue probe pad
246 <i>1.3/1.4</i> <i>1.5</i>	Prebias1 Shabias	1364.12 1364.12	5967.52 5967.52	output output	analogue probe pad analogue probe pad
247 <i>1.3/1.4</i> <i>1.5</i>	Prebias Prebias1	1249.12 1249.12	5967.52 5967.52	output output	analogue probe pad analogue probe pad
248 <i>1.3/1.4</i> <i>1.5</i>	— Prebias	— 1134.12	— 5967.52	— output	— analogue probe pad