FloTHERM Simulation vs Actual Test

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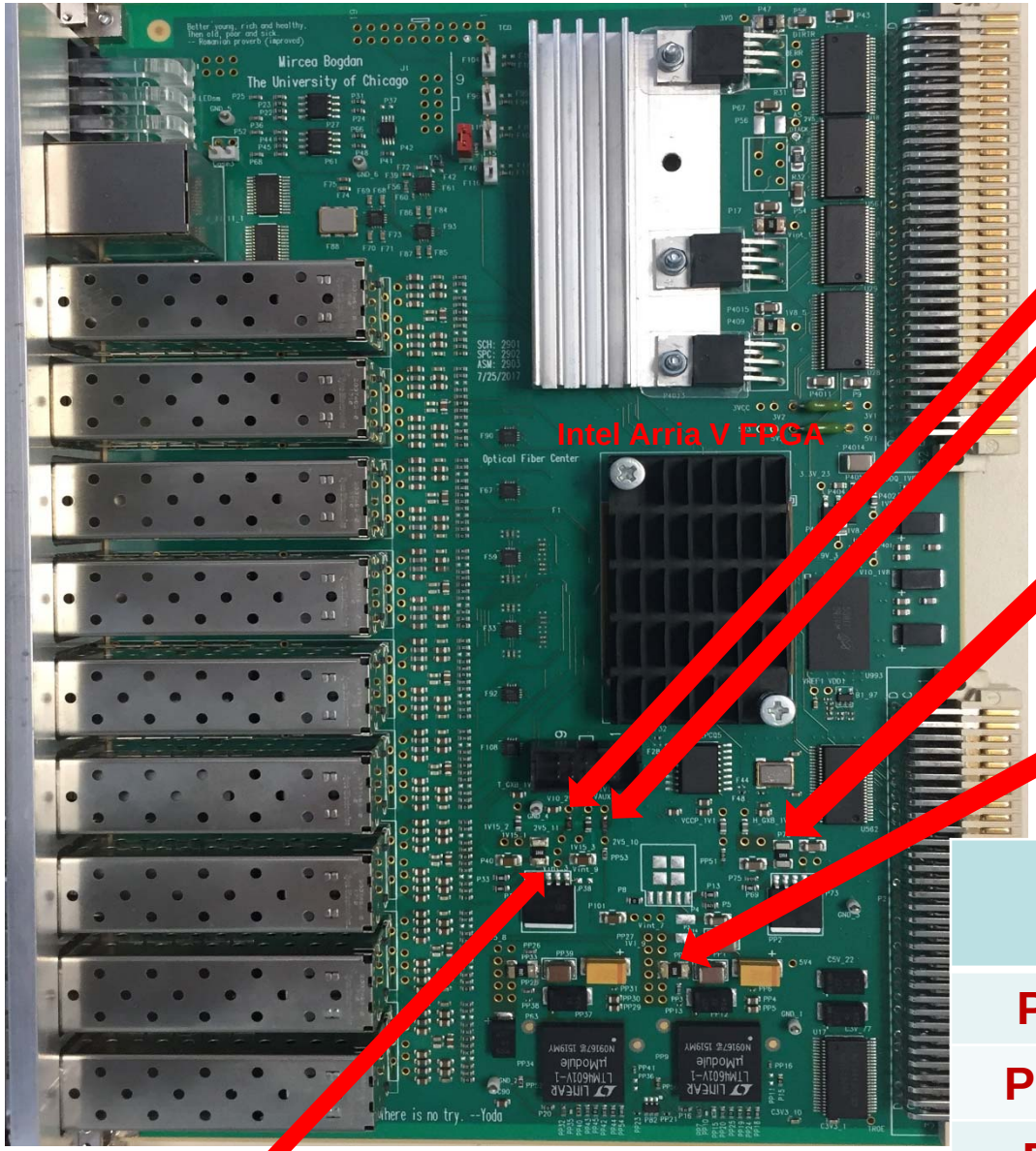
Module under Test



R_{SENSE} for V_{CCAUX} = 2.5V

R_{SENSE} for V_{CCIO} = 2.5V

R_{SENSE} for V_{CCH} = 1.5V

R_{SENSE} for V_{CC} = 1.1V

R_{SENSE} for V_{GX} = 1.15V

FPGA Power changed with a VME command

FPGA Measured Power

	Logic Inactive	Logic Active
P – 2.5V	2 W	2 W
P – 1.15V	0.64 W	0.64 W
P - 1.5V	0.05 W	0.05 W
P – 1.1V	3.78 W	11.6W
Total Power	6.47 W	14. 24W

Junction Temperature Sense

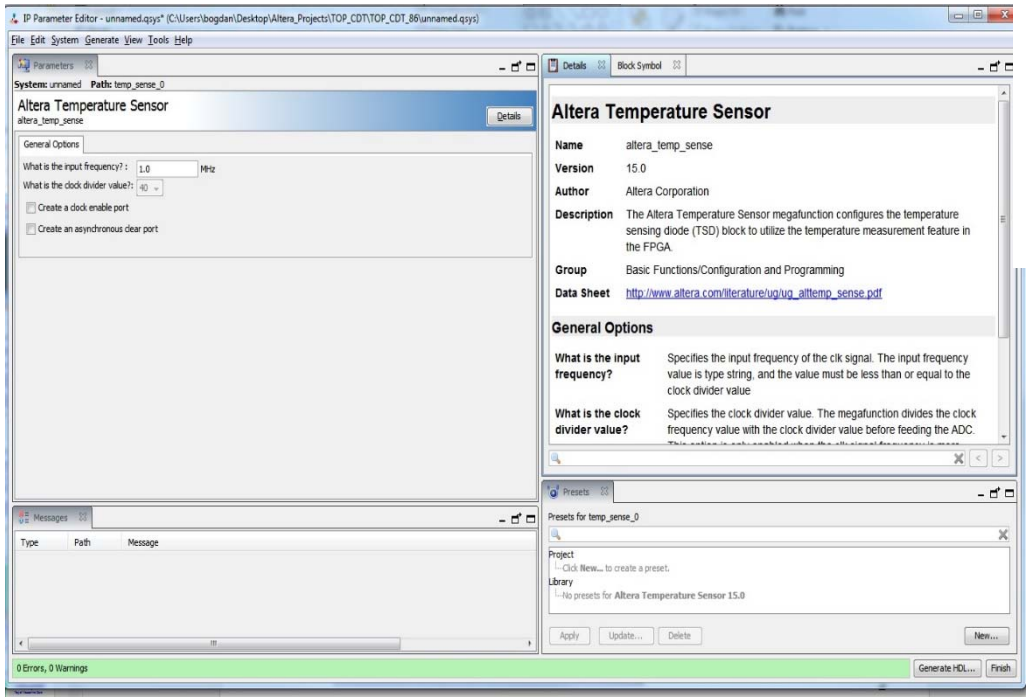


Table 6. The Mapping of tsdcalo[7..0] Value to Arria V, Arria V GZ, Stratix V, and Stratix IV Devices Temperature

This table shows the value of tsdcalo[7:0] that corresponds to the device temperature range. The temperature specification ranges from -70° C to 127° C.

Value of tsdcalo[7:0] in Hexadecimal	Temperature in Degree Celsius (°C)
FF	127
...	...
E4	100
...	...
D5	85
...	...

continued...

Value of tsdcalo[7:0] in Hexadecimal	Temperature in Degree Celsius (°C)
D0	80
...	...
B2	50
...	...
9E	30
...	...
8A	5
...	...
8C	0
...	...
76	-10
...	...
6C	-20
...	...
62	-30
...	...
4E	-50
...	...

Junction Temperature was recorded using the Intel FPGA Temperature Sensor IP Core.
This block generates an 8-bit word that can be read out via the VME interface.

Junction Temperature vs Time

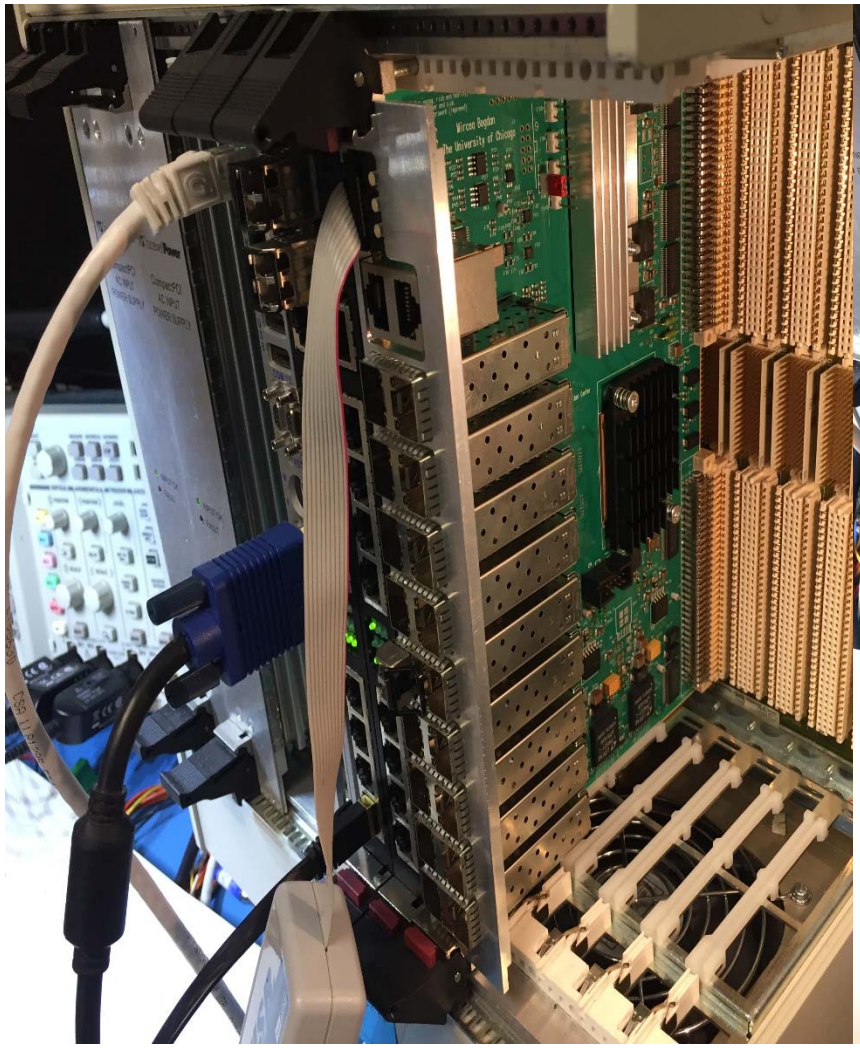
minutes	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Temp[C]	18	35	36	37	38	39	39	39	54	57	59	60	60	60	60	49	44	42	41	40	39

Load Firmware 6.5W

Activate Logic 14.25W

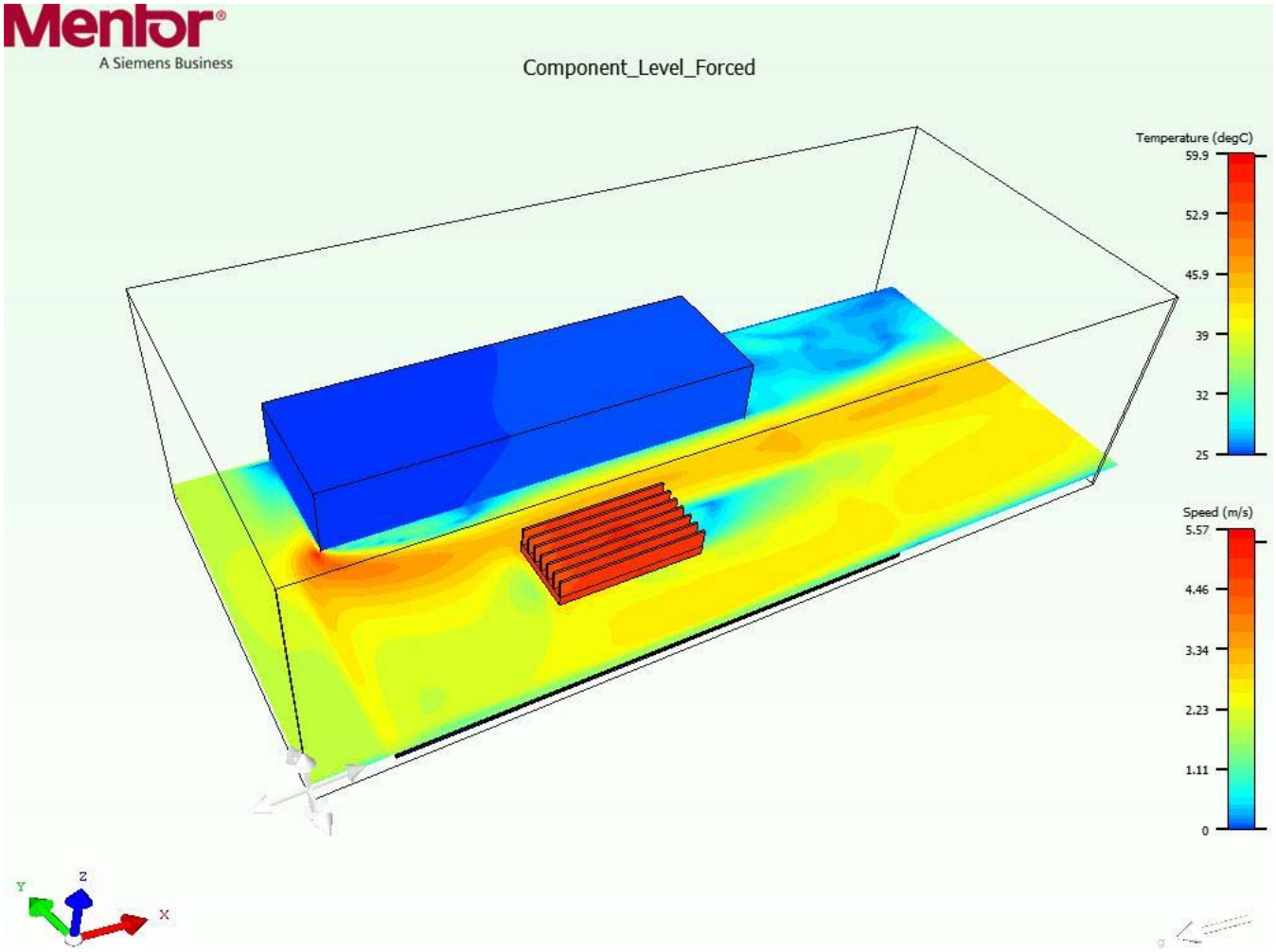
Stop Logic 6.5W

Air Speed and Temperature Measurement



Module before testing

Module during test



FloTHERM Simulation

2-Resistor Model:
T_{JC} = 0.02 K/W
T_{JB} = 3.3 K/W

Heat Sink (7 fins):
base - 32x64x4mm
fins - 1x8x64mm

Fixed Flow Air:
2m/s, 25C

Simulation Results:
FPGA Power = 6.47W => T_J = 39.85C
FPGA Power = 14.24W => T_J = 59.89C

VME Measured Junction Temperature:
FPGA Power = 6.47W => T_J = 39C
FPGA Power = 14.24W => T_J = 60C

Conclusions

Simulation results are very close the actual measured values.

Possible simulation error sources:

Air speed: Measurement changed between 1.9 - 2.3m/s during the 60 minute test.
- In simulation, if air speed changes from 2m/s to 2.3m/s, T_j changes from 59.86C to 57.85C
- In simulation, if air speed changes from 2m/s to 1.9m/s, T_j changes from 59.86C to 60.67C

FPGA Power: In this test, power was measured within 3-5%
- In simulation, if power changes from 14.24W to 13.53W, T_j changes from 59.86C to 58.16C.
- In simulation, if power changes from 14.24W to 14.95W, T_j changes from 59.86C to 61.63C.

How precise are T_{JC} and T_{JB} taken from Arria V data sheet? Probably conservative.

FloTHERM simulation itself is within 1C.