



SHADOWSENSE PERFORMANCE
REPORT: OPERATING TEMPERATURES

1.0 Objective

The purpose of this experiment is to measure and evaluate the long term effects of high operating temperatures on the IR LEDs used in a ShadowSense touch frame.

1.1 Equipment

The equipment used during the entire test:

- Baanto SDW656W1 ShadowSense touch frame with firmware version 7.30
- Baanto Dashboard software
- Custom built temperature controlled heat chamber
- PC running Windows 8

1.2 Setup

A custom designed heat chamber was constructed using 2 inch thick foam insulation material to house various sizes of Baanto ShadowSense touch frames. The chamber is shown in Figure 1.

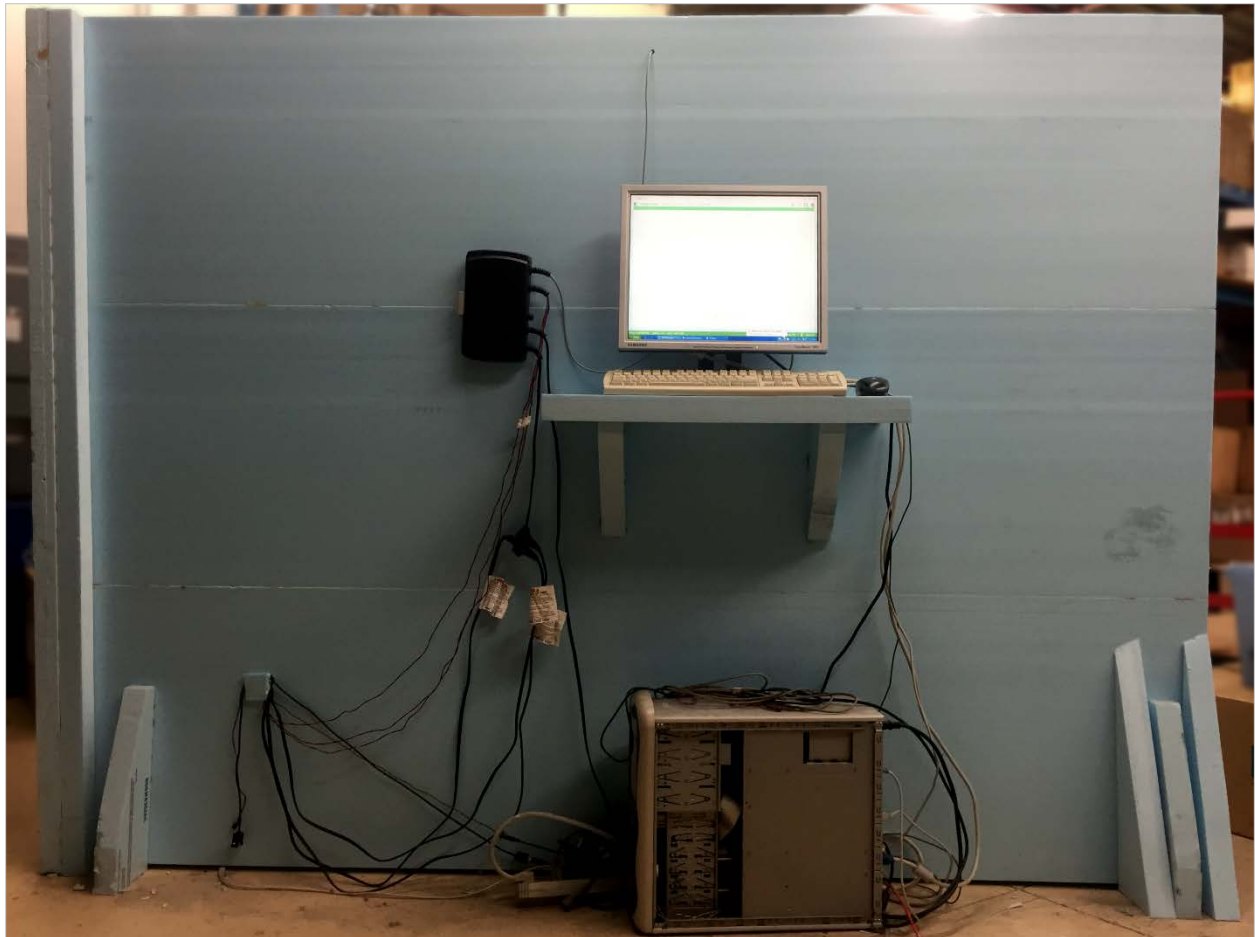


Figure 1: Temperature Controlled Heat Chamber

A temperature controller was then affixed to the chamber and a temperature probe was inserted through the side of the chamber to provide constant temperature readings. The controller was also connected to heaters placed inside the chamber to regulate the internal temperature of the chamber. The temperature controller is shown in Figure 2. The internal temperature of the chamber was maintained at 70° C at all times with minor fluctuations of no more than +/- 0.1° C.



Figure 2: Temperature Controller

Before placing the 65.5" SDW656W1 evaluation frame into the chamber it was tested to ensure that it worked properly. The frame was assembled and connected to the PC through a USB connection and powered with a 12V power supply. Dashboard was used to reset the configuration parameters to their default settings and the LED views were examined to confirm that there were no anomalies with the device under test. This was followed by some basic drawing tests to confirm the system performance.

Once the baseline readings were recorded, the frame was placed inside the chamber and shut tightly. Conduits were provided to allow for power and USB connections to be connected to the frame at all times for the duration of the test. This allowed a computer to be connected to the frame so that Dashboard could be used to interrogate the frame throughout the testing period and to sample the LED data without removing the frame from the heat chamber and compromising the internal temperature.

2.0 Method

A standard ShadowSense frame consists of 6 sensors along the top of the frame and IR LEDs along the left, bottom and right edges. Each of the sensors is able to see each and every LED with the exception of the sensors in the top corners of the frame. The corner sensors cannot see the LEDs that are located directly below them on the sides of the frame.

With the ShadowSense frame isolated in the heat chamber, LED values for several LEDs were collected at random intervals throughout the testing process. The LED values were captured using Dashboard and the LED Data View shown in Figure 3.

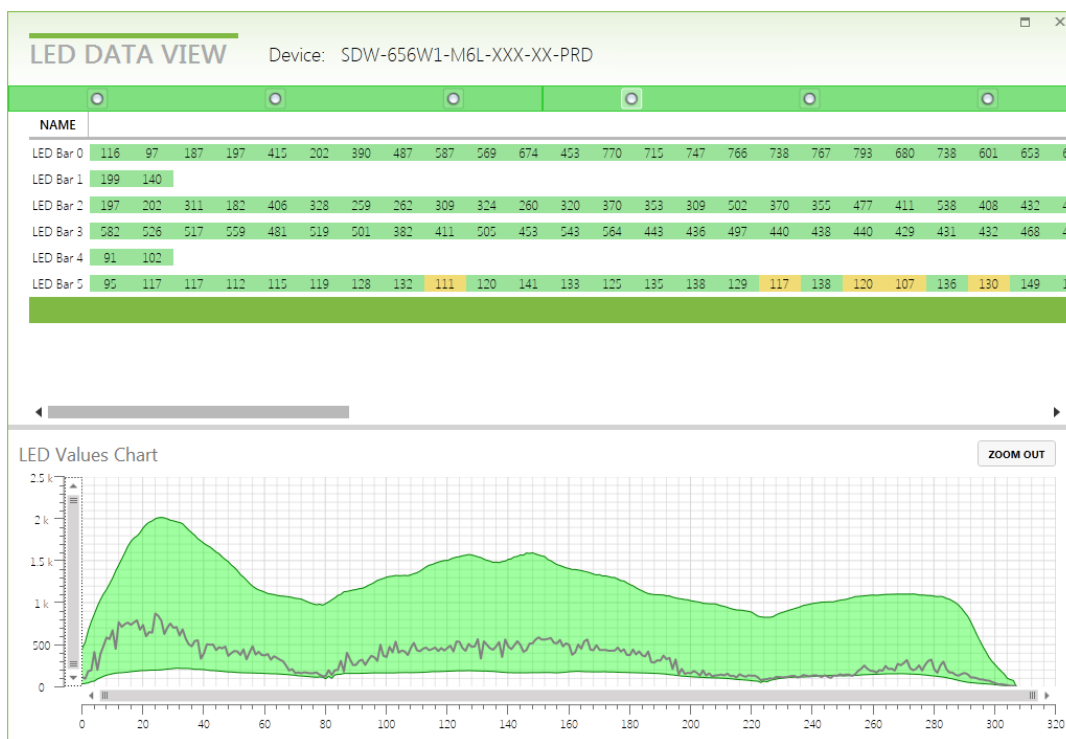


Figure 3: LED Data View from Dashboard

Only LEDs along the bottom edge of the frame were monitored since they are the only ones that are visible by all of the sensors.

This data was continuously collected during a span of over 10,000 hours. Each time, data for all 6 sensors was recorded for all LEDs under test. In the meantime, the internal temperature remained constant at 70° C.

2.1 Results

The LED data for several LEDs were collected for each of the 6 sensors and compiled in a spreadsheet. At the time of writing, over 10,389 hours had elapsed and during this time the frame was interrogated 232 times. Each time, the LED data was recorded and the average of all 6 sensors was calculated. A subset of the collected data taken at approximately 1,000 hour intervals for LED160 is shown in Table 1. For the complete set of results, refer to the table in the Appendix at the end of this document.

Table 1: LED Data Collected at 1,000 Hour Intervals (LED160)

Hours	Average	Sensor0	Sensor1	Sensor2	Sensor3	Sensor4	Sensor5
1	190.50	100	170	248	244	241	140
1014	194.33	98	172	253	250	248	145
2020	191.17	92	168	250	245	246	146
3001	187.50	84	158	246	241	246	150
4068	186.00	83	157	244	238	244	150
5016	184.33	83	155	243	236	240	149
6001	183.33	82	154	242	235	238	149
7007	182.00	82	154	241	233	235	147
8087	179.33	79	152	238	230	231	146
9001	179.00	80	151	238	229	230	146
10181	178.17	79	151	237	228	229	145

The LED data for each sensor and the average was then plotted to visualize the trend. This graph is shown in Figure 4. The line for each sensor is indicated in the legend while the thin black lines represent the best fit trend line for each respective set of data points.

The data obtained by taking the average of all 6 sensors was also used to calculate the exponential fit dimming curve for an LED. This curve along with the actual measured data is shown in Figure 5 for comparison.

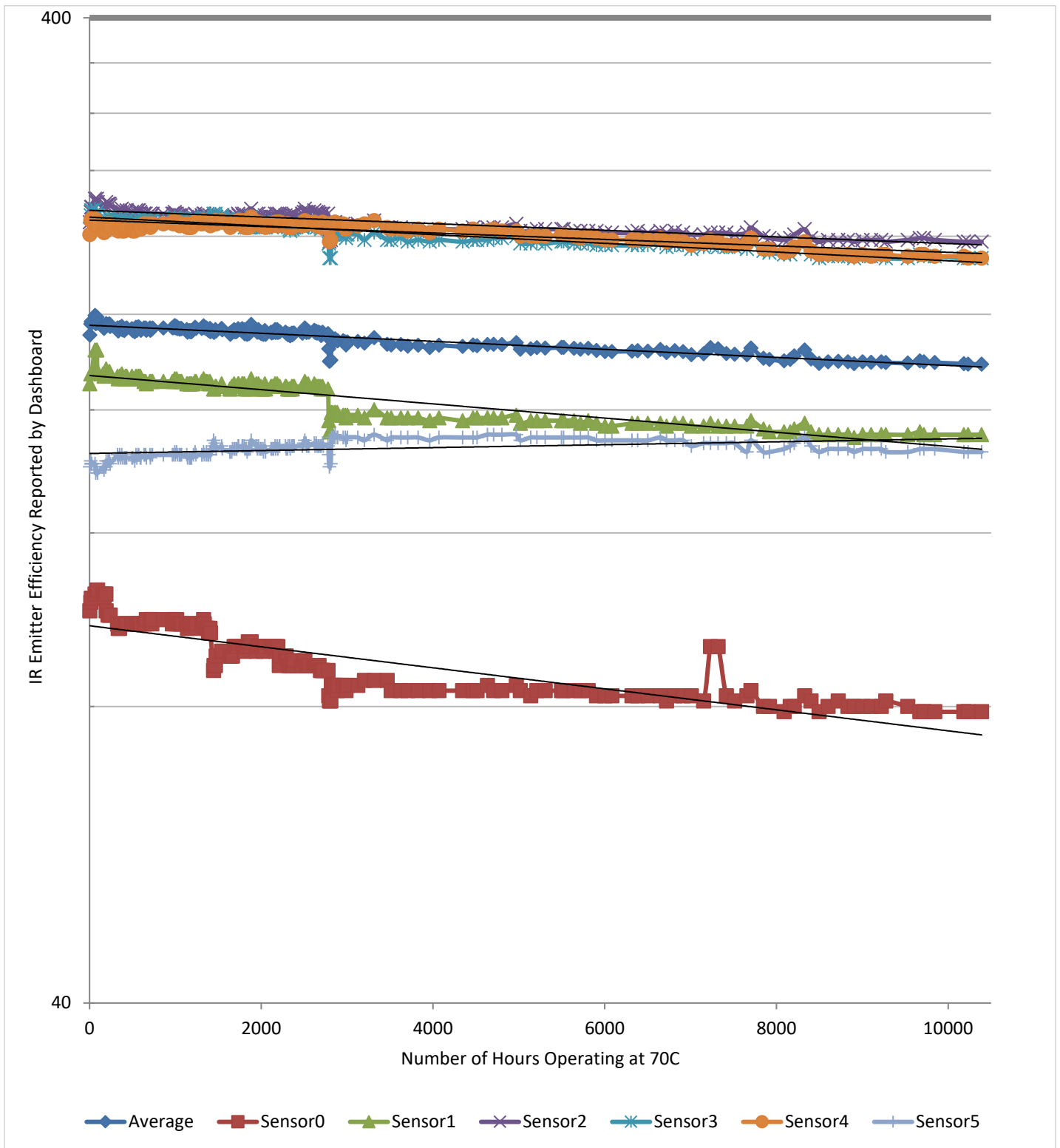


Figure 4: Graph of IR Emitter Efficiency vs. Number of Hours Operating at 70° C

Experimental & Exponential Fit Dimming Curve of IR99-213C IR Emitter at 70°C

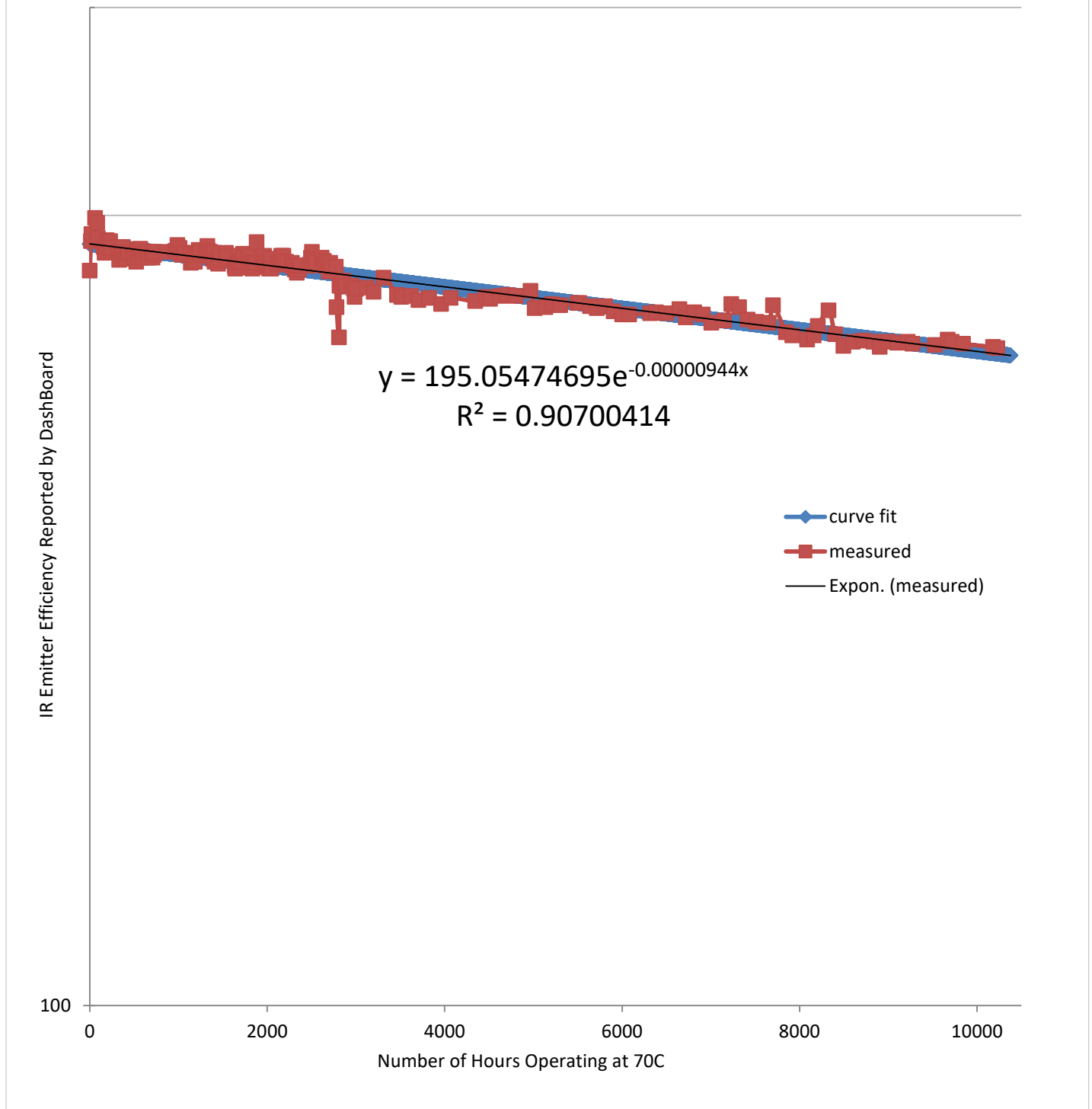


Figure 5: Graph of Experimental and Exponential Fit Dimming Curve

3.0 Conclusion

When subjected to constant operating temperatures of 70° C the IR LEDs in a ShadowSense frame have been shown to perform consistently for over 10,000 hours. During the span of this time, the efficiency of the LEDs only diminished slightly at a rate of 0.00095% per hour on average. More importantly, none of the 308 IR LEDs used within the SDW656 frame under test failed during the experiment.

Using the exponential fit diming curve, the LED life at various diming levels can be predicted when operating at 70° C. The predicted life at L70 (the point in which the LED has dimmed to 70% of its original output) is approximately 38,000 hours while at L20, the predicted life is over 171,000 hours.

Appendix: Complete Results of Temperature Analysis

Column	Hours	Average	Sensor0	Sensor1	Sensor2	Sensor3	Sensor4	Sensor5
5	1	190.5	100	170	248	244	241	140
6	14	195.5	102	174	254	252	249	142
7	20	196.6667	103	174	257	255	250	141
8	23	196.6667	103	174	257	255	250	141
9	24	196.6667	103	174	257	255	250	141
10	62	199.5	104	184	262	256	250	141
11	72	195.6667	104	174	260	252	246	138
12	86	198.6667	105	184	262	254	248	139
13	94	196	105	175	260	252	246	138
14	157	194.5	104	174	258	248	243	140
15	167	193.5	103	173	257	247	242	139
16	184	194.5	104	174	258	248	243	140
17	190	194.5	104	174	258	248	243	140
19	193	195.6667	100	176	260	250	246	142
21	215	195.3333	99	174	259	251	247	142
22	230	195.5	99	175	259	251	247	142
23	238	194.3333	99	174	258	249	245	141
24	325	193.6667	97	173	255	249	244	144
25	334	192.3333	96	172	253	247	243	143
26	349	193.8333	96	173	255	250	245	144
27	357	193.3333	97	173	254	249	244	143
28	374	194.5	97	174	256	250	246	144
29	383	192.8333	97	172	254	248	243	143
30	405	192.5	97	172	253	247	243	143
31	419	193.3333	97	173	254	249	244	143
32	432	193.6667	97	173	255	249	245	143
33	493	193.3333	97	173	254	248	245	143
34	501	192.5	97	172	253	247	243	143
35	525	192	97	172	252	246	243	142
36	540	194	97	173	255	249	246	144
37	550	192.6667	97	172	253	247	244	143
38	564	194.1667	97	173	255	250	246	144
39	572	194.1667	97	173	255	250	246	144
40	590	193.5	97	173	254	249	245	143
41	598	192.6667	97	172	253	247	244	143
43	634	193.6667	97	171	253	250	247	144
44	636	193.5	97	171	253	249	247	144
45	653	193.6667	97	171	253	250	247	144
46	660	192.6667	98	170	251	248	246	143
47	701	193.6667	98	171	253	249	247	144
48	708	192.6667	98	171	251	248	245	143
49	725	193.1667	97	171	252	249	246	144
50	732	193.6667	98	171	253	249	247	144
51	860	193.6667	98	171	253	249	247	144
52	965	193.8333	97	171	253	250	248	144
53	975	193.8333	98	171	253	250	247	144
54	990	194.8333	98	172	254	251	249	145

55	998	193.8333	97	171	253	250	248	144
56	1014	194.3333	98	172	253	250	248	145
57	1022	193.3333	97	171	252	249	247	144
58	1043	193.5	97	171	252	250	247	144
59	1048	193.1667	97	171	252	249	246	144
60	1063	193.5	97	171	252	250	247	144
61	1072	193.3333	97	171	252	249	247	144
62	1133	193	97	170	251	249	247	144
63	1140	191.8333	96	170	250	247	245	143
64	1163	192.5	97	170	251	248	246	143
65	1170	192	97	170	250	247	245	143
66	1181	192.5	97	170	251	248	246	143
67	1188	192	96	170	250	248	245	143
68	1208	193	97	170	251	249	247	144
69	1229	194	97	171	253	250	248	145
70	1238	193.5	97	171	252	250	247	144
71	1306	193.5	97	171	252	250	247	144
72	1311	193.6667	97	171	252	250	248	144
73	1328	194.6667	98	172	253	251	249	145
74	1336	193.8333	97	171	253	250	248	144
75	1359	193.3333	96	171	252	249	248	144
76	1361	193.6667	96	171	252	250	248	145
77	1378	193	96	171	251	249	247	144
78	1384	192.5	95	170	251	248	247	144
79	1401	193.5	96	171	252	249	248	145
80	1408	192	95	170	250	247	246	144
82	1443	192.3333	87	168	249	253	248	149
83	1449	191.6667	88	168	249	251	247	147
84	1464	193	88	169	251	253	249	148
85	1472	192.3333	90	169	251	251	247	146
86	1537	193.5	91	170	252	252	249	147
87	1545	192.8333	91	169	252	251	248	146
88	1634	191.3333	90	168	250	249	246	145
89	1640	190.8333	90	168	249	248	245	145
90	1656	191.8333	90	169	250	250	247	145
91	1663	192.1667	90	169	251	250	247	146
92	1682	193	92	170	252	250	248	146
93	1687	192	92	169	251	247	247	146
94	1705	192	92	169	251	247	247	146
95	1712	192.1667	92	169	251	248	247	146
96	1729	193.3333	92	170	253	249	249	147
97	1735	192.8333	92	170	252	248	248	147
98	1777	193.3333	92	170	253	249	249	147
99	1785	192.8333	92	170	252	248	248	147
100	1800	192.8333	91	170	253	248	248	147
101	1808	191	92	168	250	245	245	146
102	1823	192	92	169	251	247	247	146
103	1834	190.8333	92	168	250	245	245	145
104	1848	191.8333	93	169	251	246	246	146
105	1855	191.1667	93	168	250	245	245	146
106	1871	191.8333	92	169	251	246	247	146

107	1881	195.3333	93	172	256	251	251	149
108	1943	192.8333	91	170	253	248	248	147
109	1952	191.8333	92	169	251	246	247	146
110	1967	193	92	170	253	248	248	147
111	1976	191.8333	92	169	251	246	247	146
112	1993	191.8333	92	169	251	246	247	146
113	1999	191.1667	92	168	250	245	246	146
114	2020	191.1667	92	168	250	245	246	146
115	2023	190.8333	91	168	250	245	246	145
116	2040	192.5	92	170	252	247	247	147
117	2048	190.8333	92	168	250	245	245	145
118	2112	191.8333	92	169	251	246	247	146
119	2121	191.5	92	169	251	245	246	146
120	2135	191.8333	92	169	251	246	247	146
121	2143	191.8333	92	169	251	246	247	146
122	2160	193	92	170	253	248	248	147
123	2168	191.6667	91	169	251	246	247	146
124	2184	193	92	170	253	248	248	147
125	2192	191.6667	92	169	251	246	246	146
126	2208	192	88	169	253	247	248	147
127	2215	192	90	169	252	246	248	147
128	2281	191.8333	90	169	252	246	247	147
129	2289	191.3333	90	169	251	246	246	146
130	2304	191.1667	89	168	251	246	247	146
131	2312	190.6667	88	168	251	245	245	147
132	2329	190.8333	88	168	252	244	246	147
133	2336	190.1667	88	168	251	243	245	146
134	2355	191.3333	89	169	252	245	246	147
135	2360	190.6667	88	168	252	244	245	147
136	2375	191.3333	88	169	253	245	246	147
137	2383	191.3333	89	169	252	245	246	147
138	2476	191.5	88	169	253	245	247	147
139	2480	191.3333	88	169	253	245	246	147
140	2495	192.6667	89	170	254	247	248	148
141	2506	193.6667	89	171	256	248	249	149
142	2519	192.5	88	170	254	247	248	148
143	2526	191.6667	88	169	253	246	247	147
144	2544	192.3333	88	170	254	247	248	147
145	2552	191.8333	88	169	254	246	247	147
146	2616	192.6667	88	170	255	247	248	148
147	2625	191.6667	88	169	253	246	247	147
148	2639	192.1667	88	169	254	247	247	148
149	2648	191.3333	88	169	253	245	246	147
150	2663	191.8333	88	169	254	246	247	147
151	2672	191.6667	88	169	253	246	247	147
152	2687	191.3333	87	169	253	245	247	147
153	2696	190.3333	87	168	251	244	245	147
154	2712	191.8333	87	169	253	246	248	148
155	2722	191.1667	87	168	253	245	247	147
156	2775	191.1667	87	168	253	245	247	147
157	2784	184.5	82	156	245	236	244	144

158	2792.5	179.1667	81	152	237	228	237	140
159	2809	179.6667	81	152	238	228	238	141
160	2816	188	84	159	247	241	247	150
161	2832	188.1667	84	159	247	242	247	150
162	2839	187.8333	84	158	247	241	247	150
163	2855	188.5	84	159	248	242	248	150
164	2859	188.8333	84	159	248	243	248	151
165	2883	188	83	159	247	242	247	150
166	2888	188	84	158	247	242	247	150
167	2952	188	84	158	247	242	247	150
168	2977	187.5	84	158	246	241	246	150
169	2985	186.1667	83	157	245	239	244	149
170	3001	187.5	84	158	246	241	246	150
171	3123	187.6667	84	158	247	241	246	150
172	3201	187	85	157	246	238	247	149
173	3314	189.3333	85	160	249	242	249	151
174	3464	186.5	85	157	245	238	245	149
175	3512	186.1667	83	157	245	238	244	150
176	3624	186.3333	83	157	245	239	244	150
177	3706	185.6667	83	157	244	237	243	150
178	3825	186	83	157	244	238	244	150
179	3960	185	83	156	243	237	242	149
180	4068	186	83	157	244	238	244	150
181	4345	185.5	83	156	244	237	243	150
182	4466	186.1667	83	157	245	238	244	150
183	4512	185.8333	83	157	244	238	243	150
184	4632	186.3333	84	157	245	238	243	151
185	4704	186.5	83	157	245	239	244	151
186	4800	186.3333	83	157	245	239	243	151
187	4968	187.1667	84	158	247	240	243	151
188	5016	184.3333	83	155	243	236	240	149
189	5136	184.5	82	156	243	236	240	150
190	5208	185	83	156	244	237	240	150
191	5304	184.8333	83	156	244	236	240	150
192	5496	185.1667	83	156	244	237	241	150
193	5520	185.1667	83	156	244	237	241	150
194	5640	184.6667	83	156	243	236	240	150
195	5716	184.3333	83	155	243	236	239	150
196	5808	184.6667	83	156	243	236	240	150
197	5904	183.8333	82	155	243	235	239	149
198	6001	183.3333	82	154	242	235	238	149
199	6081	183.3333	82	154	242	235	238	149
200	6317	183.5	82	155	242	235	238	149
201	6382	183.6667	82	155	243	235	238	149
202	6502	183.5	82	155	242	235	238	149
203	6647	184.1667	82	155	243	236	239	150
204	6719	182.8333	81	154	242	234	237	149
205	6814	183.6667	82	155	243	235	238	149
206	6911	183.3333	82	155	242	235	237	149
207	7007	182	82	154	241	233	235	147
208	7150	182.3333	81	154	241	234	236	148

209	7232	185	92	155	242	235	238	148
210	7319	184.5	92	154	242	234	237	148
211	7415	182.5	82	154	242	234	235	148
212	7511	182.1667	81	154	241	234	235	148
213	7654	182	82	154	242	233	236	145
214	7702	184.8333	83	156	245	237	239	149
215	7847	180.5	80	153	240	232	233	145
216	7918	180	80	152	239	231	233	145
217	8087	179.3333	79	152	238	230	231	146
218	8160	180	80	152	239	230	232	147
219	8207	181.5	80	153	241	233	234	148
220	8327	184	82	155	244	236	237	150
221	8401	180.1667	81	152	239	230	232	147
222	8495	178.3333	79	151	237	228	230	145
223	8601	179	80	151	238	229	230	146
224	8719	179.1667	81	151	238	229	230	146
225	8832	179	80	151	238	229	230	146
226	8903	178.1667	80	150	237	228	229	145
227	9001	179	80	151	238	229	230	146
228	9102	178.8333	80	151	238	229	229	146
229	9220	179	80	151	238	229	230	146
230	9272	178.6667	81	151	237	228	230	145
231	9527	178.5	80	151	238	228	229	145
232	9669	179.3333	79	152	239	230	230	146
233	9717	179	79	151	239	229	230	146
234	9842	178.6667	79	151	238	229	229	146
235	10181	178.1667	79	151	237	228	229	145
236	10230	178	79	151	237	228	228	145
237	10389	178	79	151	237	228	228	145