Smart IRt/c™

EXERGEN CORPORATION

Infrared Temperature Sensor

	0-5V	0-10V	4-20mA	RS232
Sensing Range	Standard Ranges 0-250 °C, 0-100 °C other Ranges Factory Selectable			0-250 °C
Ambient Temperature Range	0 °C to 70 °C (internal case temperature)			
Storage Temperature Range	-10 °C to 70 °C			
Field of View of Sensing Element	3:1 (distance:spot) approx. 17°, 5:1 (11°), 20:1 (3°), and 40:1 (1.5°)			
Minimum Spot size	3 mm (0.12") on 3:1 and 5:1 models and 15.9 mm (0.625") on 20:1 and 40:1's			
Dominant Spectral Response	5 to 14 µ			
Impedance	Less than 1 Kohms		50 ohm max	NA
Emissivity Setting (ε)	0.90 can be factory adjusted			
Measurement Type	Thermopile			
Resolution	10 bit***			4 Digit w/ floating decimal
Update Time	Less than 250ms after first reading**			
Response Time (95% of step change)	Less than 650 ms**			
Bandwidth	Typically 5Hz			
First Reading in	Less than 2 seconds			
Accuracy (Includes Repeatability and Interchangeability)	Typically: ±1 °C (±1.8 °F) or 1% of reading at ε 0.9			
Recommended Power Supply	12 ± 10% V DC or 24 ± 10% V DC; depending on model			
Power Accepted*	Shuts off when voltage is functionally low*			
Power Consumption	12V power less then 400mW 24V Power less than 800 mW			
Dimensions	Contact Exergen for Drawing			
Housing	Zinc-Aluminum Alloy Z-12 (ISO/DIS 301)			
Sensor Connection	3 foot pigtail			DB9 and loose power wires
Recommended Air Purge Pressure	3 PSI - Contact Exergen for Pressure\Flow\Error Graphs			
Maximum Air Pressure	20 PSI - may cause reading errors			
Air Cleanliness	Instrument Air is Recommended, ANSI/ISA-7.0.01-1996			
Humidity	Non-Condensing - ISA-71.01-1985 Environment Class C Severity X			
Shock	100G			
Weight	Approximately 200 grams (7oz.)			
LED	Constantly on for normal operation			

* The unit will not give an error message if the input voltage exceeds recommended high limit, but functionality or accuracy is not guaranteed when exceeding the Recommended Power Supply voltage.

** At room temperature

*** Current Output 10bit 0-20mA

Note: Specifications contained herein are preliminary. For additional or updated specifications please contact Exergen Corporation.

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ERROR MESSAGES						
Condition	**Priority**	**LED Display**	**0-5V**	**0-10V**	**4-20mA**	**RS-232**
Low Power	**1**	**OFF**	**Under 0.1V**	**Under 0.1V**	**Under 4mA**	**Not Implemented**
Hardware Internal Errors	**2, 13**	**Uniform Flash**	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
Vsig-Offset High	**3**	**Uniform Flash**	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
Vsig-Offset Low	**4**	**Uniform Flash**	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
EMI	**5**	**Uniform Flash**	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
Range Error	**6**	**Uniform Flash**	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
High Ambient	**7**	**Long Flash****	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
Low Ambient	**8**	**Short Flash***	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
Too Much Heat Flow	**9**	**Long Flash****	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
Too Little Heat Flow	**10**	**Short Flash***	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
High Target	**11**	**Long Flash****	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**
Low Target	**12**	**Short Flash***	**Over 4.9V**	**Over 9.8V**	**Over 19.7mA**	**Not Implemented**

*Six counts off one count on
**Six counts on one count off

PIN OUT Carol C074 Series/Belden 953 Series/Alpha 630 Series					
Pin	**Color**	**Function**	**Pin**	**Color**	**Function**
1	**White**	**Positive Output Signal**	**6**	**Brown**	**TA Pull Down Pin / IO option**
2	**Green**	**Reference Output Signal**	**7**	**Yellow**	**RS232_TXD / IO option**
3	**Red**	**Positive Power**	**8**	**Violet**	**RS232_RXD / IO option**
4	**Black**	**Ground**	**9**	**Blue**	**RS232_RTD (READY_TO_SEND)**
5	**Bare**	**Shield**	**10**	**Orange**	**RS232_CTS (CLEAR_TO_SEND)**

MODEL KEY SmartIRt/c.F-P-O-T		
CODE	**FEATURE**	**PART #**
F-3	3:1 field of view	SmartIRt/c.3-P-O-T
F-5	5:1 field of view	SmartIRt/c.5-P-O-T
F-20	20:1 field of view	SmartIRt/c.20-P-O-T
F-40	40:1 field of view	SmartIRt/c.40-P-O-T
P-12V	12VDC power supplied	SmartIRt/c.F-12V-O-T
P-24V	24VDC power supplied	SmartIRt/c.F-24V-O-T
O-05	0-5V Output	SmartIRt/c.F-P-05-T
O-010	0-10V Output	SmartIRt/c.F-P-010-T
O-420	4-20 mA Output	SmartIRt/c.F-P-420-T
O-232	RS232 Output	SmartIRt/c.F-P-232
T-70C	Temperature Range -30-70C	SmartIRt/c.F-P-O-70C
T-100C	Temperature Range 0-100C	SmartIRt/c.F-P-O-100C
T-250C	Temperature Range 0-250C	SmartIRt/c.F-P-O-250C
T-500C	Temperature Range 0-500C	SmartIRt/c.F-P-O-500C
T-1000C	Temperature Range 0-1000C	SmartIRt/c.F-P-O-1000C

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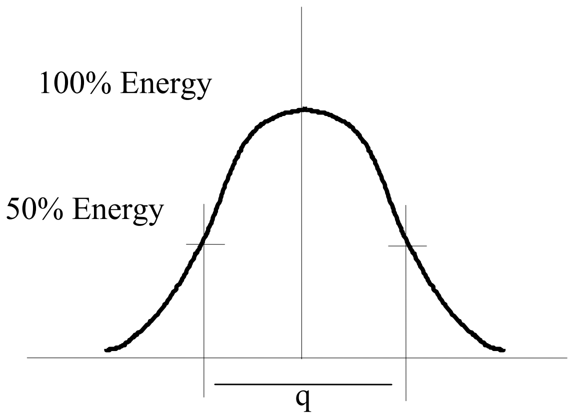
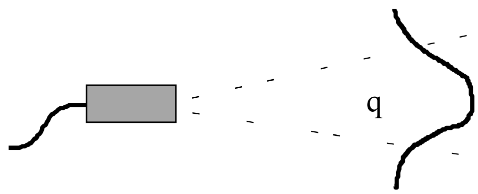
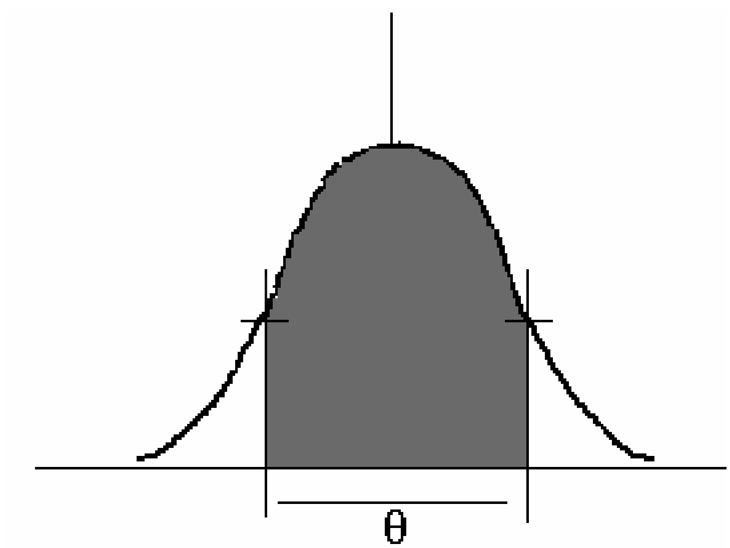
FIELD OF VIEW

There are two typical methods of defining Field of View for IR devices. A common convention in infrared thermometry, and the one used to verify the optical performance of IRt/c's, is to define the field-of-view by the "1/2 energy points" in an optical rotational experiment. The resultant data looks like a "Bell Curve." The field-of-view is simply the angle between the 50% energy points, also defined as U. See drawing:





The other popular definition of Field of View is the "90% of Energy." This definition is more common in non-IR devices, but has been growing in its acceptance over the past ten years. This method defines the Field of View as the angle where 90% of the integrated energy of the bell curve found from an optical rotation experiment. See drawing:



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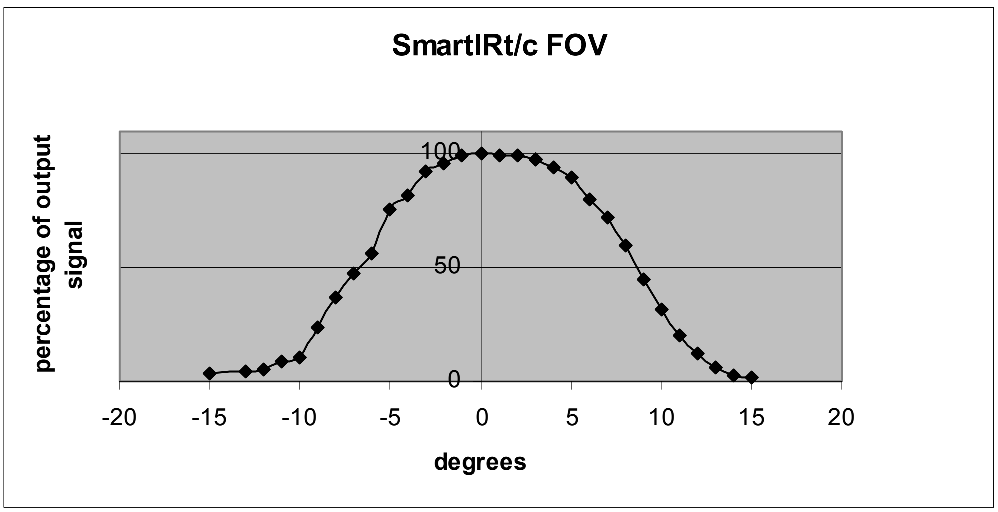
SmartIRt/c.3™ Field of View

The SmartIRt/c.3™ was designed to have a 3:1 FOV with either definition. Results below are from our FOV test. This is of course a random unit, so results may vary. Additionally this data is just of the IR sensing element, not of the SmartIRt/c™. Thus, measuring a SmartIRt/c one will get different values, since the output of the SmartIRt/c™ is a combination of the ambient temperature and the IR signal.



From this data we get the following chart:

Unit Type 3:1	FOV Ratio	Approximated Integrated Energy
50% Energy Point	3.7:1	85%
90% Integrated Energy	3.3:1	90%

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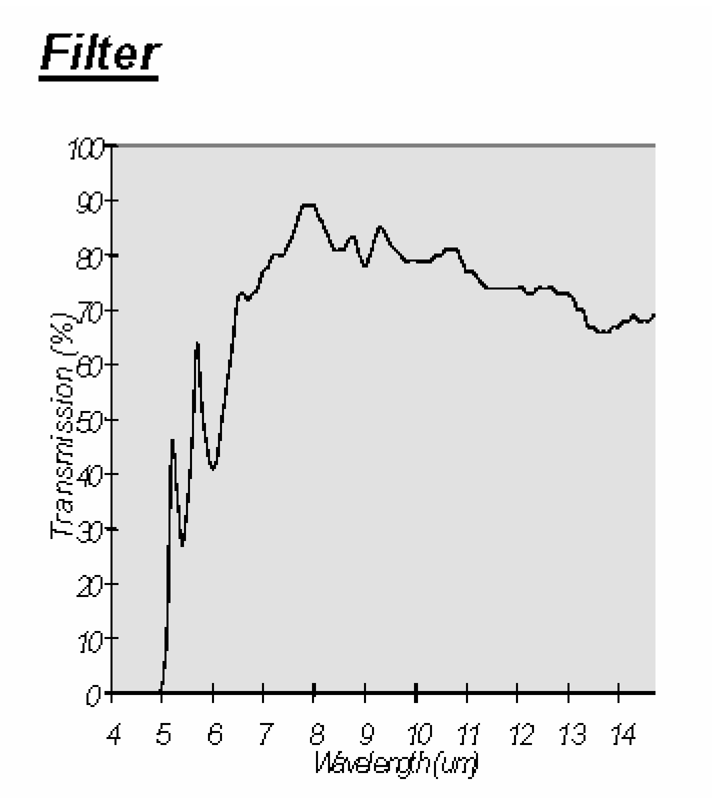
Filter Properties

This is the manufacturer's specified filter. We have notice that there are slight differences between each units filter. So the graph should be used as a guide only.



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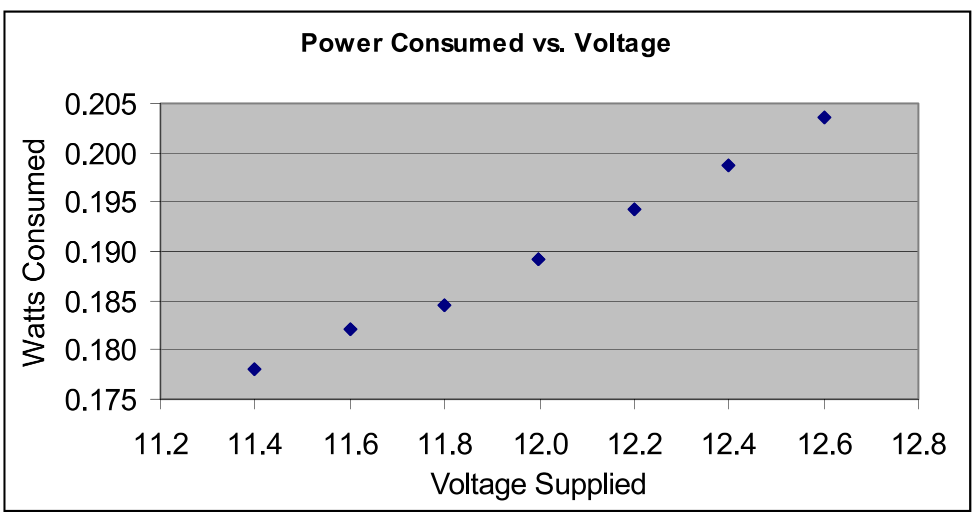
Power Consumption

The Power consumption varies from power supplied, output type, and even ambient temperature. Make sure that the information you review is appropriate to your model.

Power Consumption with Supply Voltage Change
Data was taken for a SmartIRt/c 12V supply, 0-5V output model. The unit was at room temperature looking at a room temperature target. Target temperature should have little or no affect on power consumption. It has also been noticed that other units have high power consumption rates.

The reason for high and low power consumption is that this changes during a period of Autozero

		Current mA		Calculated power W	
Sample	Voltage V	Low	High	Low	High
Unit A	Supplied				
1	11.4	14.58	15.61	0.166	0.178
2	11.6	14.66	15.69	0.170	0.182
3	11.8	14.76	15.64	0.174	0.185
4	12.0	14.84	15.77	0.178	0.189
5	12.2	14.94	15.92	0.182	0.194
6	12.4	15.01	16.02	0.186	0.199
7	12.6	15.11	16.15	0.190	0.203



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For the same unit type (12V supply, 0-5V output) we also measure the power consumption vs. ambient temperature. Two temperature measurements were taken. One external with an Exergen's D501 and the internal sensor temperature. The unit was taken out of a freezer and powered on for this test. This is clearly shown by the internal temperature starting lower than the external, since the "skin" surface heated up quickly. The internal temperature then becomes greater then the skin temperature. This occurs due to self heating of the unit.

Measured Amb. Temp (C) (D501)	Unit's Calculated Amb. Temp (C)	Supply Power (V)	Supply Current (mA)	Power * Current (mW)
4.7	1.0	12.02	19.57	235
7.6	2.6	12.02	19.40	233
8.2	4.7	12.02	19.63	236
9.2	6.1	12.02	19.49	234
10.1	7.2	12.02	19.59	235
11.8	9.1	12.02	19.69	237
13.0	10.4	12.02	19.48	234
13.8	11.8	12.02	19.72	237
15.0	13.1	12.02	19.54	235
15.3	13.9	12.02	19.75	237
16.3	14.6	12.02	19.72	237
16.6	15.5	12.02	19.73	237
17.7	16.4	12.02	19.57	235
18.3	17.5	12.02	19.83	238
18.9	18.2	12.02	19.59	235
19.6	19.2	12.02	19.72	237
20.2	19.9	12.02	19.73	237
21.0	20.6	12.02	19.88	239
21.6	21.4	12.02	19.75	237
22.5	22.5	12.02	19.74	237
27.6	28.2	12.01	19.89	239
32.1	32.6	12.01	20.06	241
35.4	36.8	12.01	20.21	243
39.5	41.5	12.01	20.29	244
45.2	47.3	12.01	20.31	244
47.3	49.9	12.01	20.52	246
52.8	55.1	12.01	20.44	245
56.0	59.2	12.01	20.65	248
58.6	62.1	12.01	20.73	249
59.5	63.2	12.01	20.62	248
61.6	65.6	12.01	20.57	247

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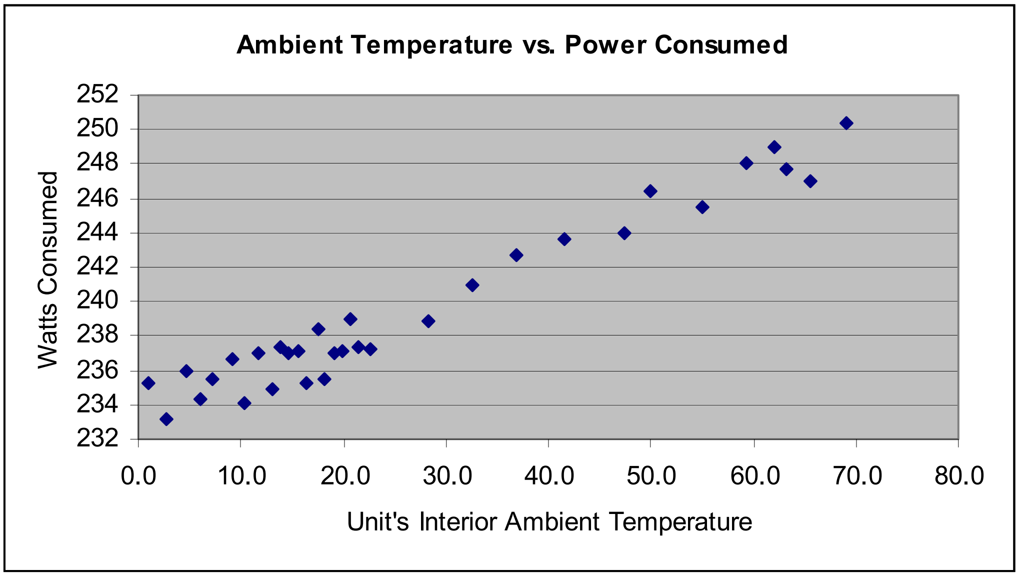
64.8	69.0	12.01	20.85	250



We have determined some average power consumption for SmartIRt/c™ model types. These averages were determined using a very small sample size. Additionally, component batches have a big effect on the power consumed, so many units produced in a year might not have the same average. Always follow the maximum consumed power specification.

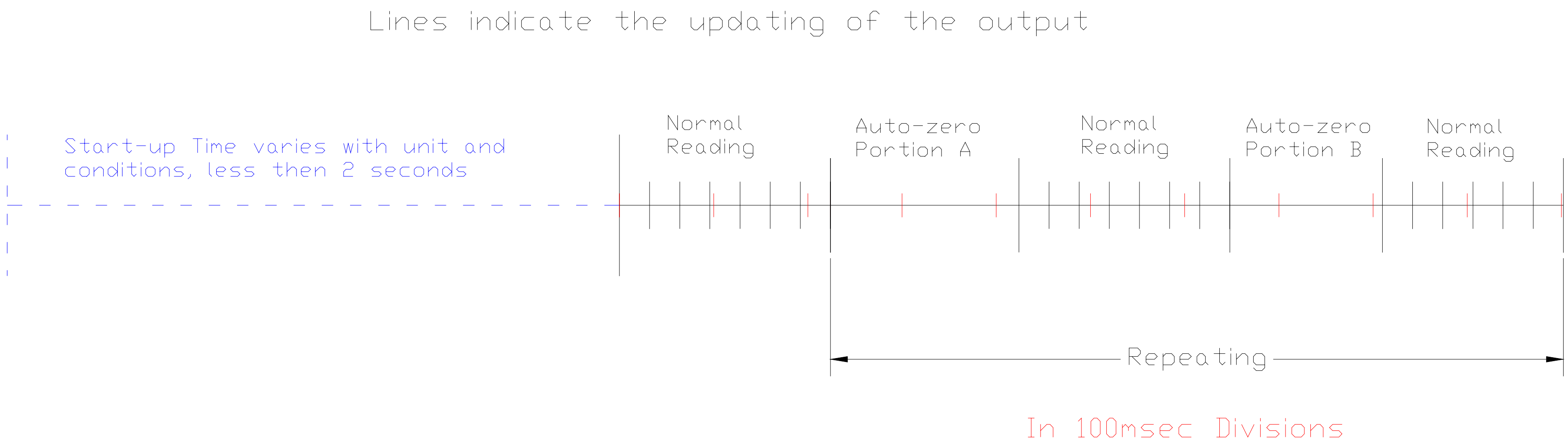
Power Consumption for Model Type				
Model	Exergen P/N	Average Power Consumed at 25C	Standard Deviation	Sample Size
12V Supply, 0-5V Output	150014, 150017, 150018, 150019	237	1	6
24V Supply, 0-10V Output	150001, 150020, 150021, 150021	516	26	10
12V Supply, 4-20mA Output	150013, 150023, 150024, 150025	316	14	19

Timing

The SmartIRt/c™ is a microprocessor based unit. The processor requires a clock in order to operate. This clock is composed of a resistor and capacitor. Due to the variation in value of capacitors this can have an effect on the clock speed. This will have a direct corrolation to the timing of the SmartIRt/c™ device. The StartUp, Update, and Response will all be affected.

The SmartIRt/c™ has an Autozero which calibrates for circuit and temperature drift. This process has been divided into two sections, Auto-zero Portion A and Auto-zero Portion B. These periods take considerably longer then a normal reading, which can also affect the response time.

Update Timing Diagram (The below time line assumes a 3.6 MHz operating frequency)



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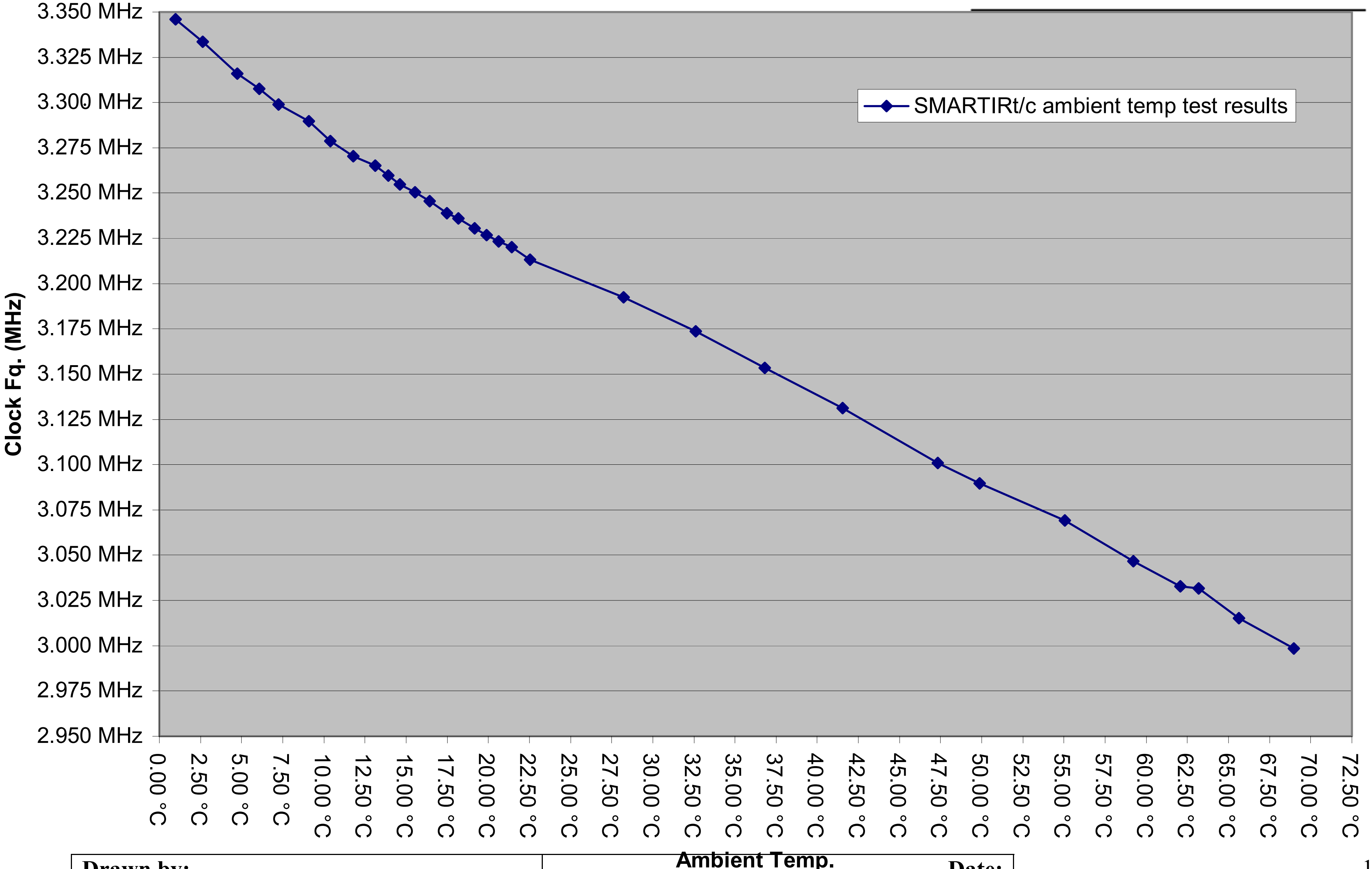
Average Frequency

Number	Unit Type	Frequency KHz
88	10V	3159.6
98	10V	3194.4
107	10V	3173.2
111	10V	3157.2
148	10V	3188
149	10V	3213.6
203	10V	3188.8
207	10V	3282.8
209	10V	3177.6
210	10V	3243.2
58	4-20mA	3180.4
61	4-20mA	3140.4
100	4-20mA	3119.2
120	4-20mA	3132
121	4-20mA	3177.2
122	4-20mA	3129.2
142	4-20mA	3178.8
144	4-20mA	3180
157	4-20mA	3125.2
159	4-20mA	3150.4
164	4-20mA	3133.6
165	4-20mA	3182.4
171	4-20mA	3098.8
172	4-20mA	3193.6
175	4-20mA	3116.8
176	4-20mA	3137.2
177	4-20mA	3132.8
182	4-20mA	3122.4
A	4-20mA	3145.6
69	5V	3115.2
192	5V	3159.6
195	5V	3218.8
196	5V	3128.4
198	5V	3243.6
199	5V	3153.2
	Average	3164.9
	STD	41.4
	Sample Size	35

SMARTIRt/c ambient temp test results



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Output Impedance

This test was performed on a 12V supply and 0-5V output. However, it should also apply to 0-10V output units.

From the circuit below, one can expect that the output impedance would be 750 ohms. This was confirmed experimentally by measuring the output with constant ambient and target, then placing a 750-ohm resistor across the output and the voltage drops approximately in half.

Impact Test

Test #1

The unit was clamped in a vise, a hammer was used to impact one corner closest to the sensor. This impact caused a dent in the corner (marked "one hit"). After the impact the unit was tested and worked. The area of the dent was approximated to be 0.429 square inches.

Test #2

The unit was set on a hard metal surface and a hammer was used to impact the top corner closest to the sensor. The unit was struck several times (marked "multiple hits"). After this test the epoxy around the sensor had cracked and the unit was operational but did not output the correct temperature. The impact caused the two screw heads nearest the sensor to pop off.

Moving surface test

For this test a SMART IRt/c unit was placed with the aperture close to a rotating sanding wheel. A tube of approx. 8' with a .17" dia. was hooked to the purge port. The unit had the plug port sealed off using hot glue. The end of the tubing was lit and allowed to burn to produce smoke. A barely noticeable amount of smoke was sucked into the tube. When the sanding wheel was stopped no smoke was sucked into the tube. By shortening the tube to about 1'6" the flow increased slightly. The ratio of the area of the tube to the area of the aperture is 3.66:1

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Voltage Variation Test

This test was conducted on a 12V supply, 0-5V output unit. It should not be considered for other model types.

Voltage Variation Test				
Sample	Input voltage(V)	Output voltage(V)	LED state	Notes
1	0.0	0.000	off	
2	1.0	0.000	off	
3	2.0	0.000	off	
4	3.0	0.000	off	
5	4.0	0.000	dim lit	
6	4.5	0.000	dim lit	
7	5.0	0.364	dim lit	Output value is very unstable, and with small changes in input voltage varies a lot
8	5.3	0.412	dim lit	
9	5.5	0.305	dim lit	Unit acting very erratic
10	6.0	0.375	dim lit	It takes a moment for the output power to come up.
11	6.5	0.220	dim lit	
12	7.0	0.322	dim lit	
13	7.5	0.327	dim lit	Flick at 1.4 V first an then went down
14	8.0	0.331	medium lit	
15	8.5	0.385	medium lit	
16	9.0	0.385	lit	
17	9.5	0.380	lit	
18	10.0	0.380	lit	
19	10.5	0.380	lit	
20	11.0	0.380	lit	
21	11.5	0.380	lit	
22	12.0	0.380	lit	
23	12.5	0.375	lit	
24	13.0	0.375	lit	
25	13.5	0.370	lit	
26	14.0	0.375	lit	
27	14.5	0.375	lit	
28	15.0	0.370	lit	
29	15.5	0.370	lit	
30	16.0	0.370	lit	

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31	16.5	0.370	lit	
32	17.0	0.370	lit	
33	17.5	0.370	lit	
34	18.0	0.370	lit	
35	18.5	0.375	lit	
36	19.0	0.370	lit	
37	19.5	0.370	lit	
38	20.0	0.370	lit	
39	20.5	0.370	lit	
40	21.0	0.370	lit	
41	21.5	0.370	lit	
42	22.0	0.365	lit	
43	22.5	0.365	lit	
44	23.0	0.370	lit	
45	23.5	0.370	lit	
46	24.0	0.365	lit	
47	24.5	0.370	lit	
48	25.0	0.365	lit	
49	25.5	0.365	lit	
50	26.0	0.365	lit	
51	26.5	0.365	lit	
52	27.0	0.365	lit	
53	27.5	0.365	lit	
54	28.0	0.365	lit	
55	28.5	0.365	lit	
56	29.0	0.365	lit	
57	29.5	0.360	lit	
58	30.0	0.360	lit	
59	30.5	0.365	lit	
60	31.0	0.360	lit	

As you can see the unit can actually take a much higher voltage than we recommend. This is useful for applications where 16 or 18 volts might be easily available. However, we do not guarantee the accuracy of the unit under these conditions. It is possible that the self heating effects of the extra energy dissipated within the unit will cause the unit be inaccurate. We recommend extensive testing for customers who operate with supply powers greater than the specification.

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