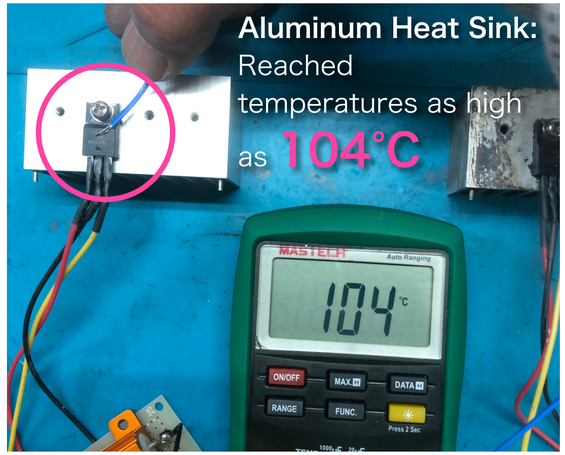
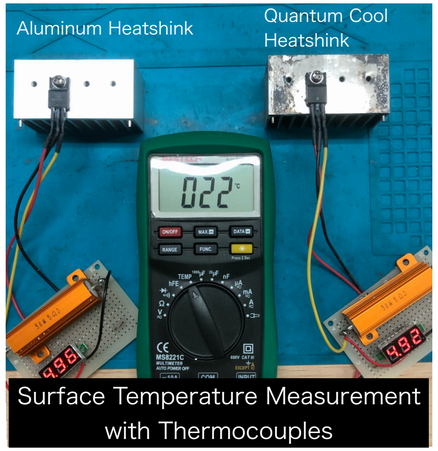
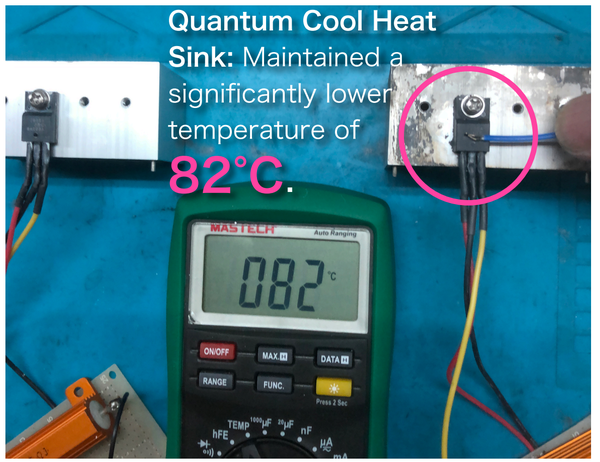
Quamtum Cooling™ Device

Demonstration Experiment Using Quantum Cool Heat Sink Technology

Cooling a Three-Terminal Regulator







The innovative **Quantum Cool** heat sink technology substantially reduces thermal resistance

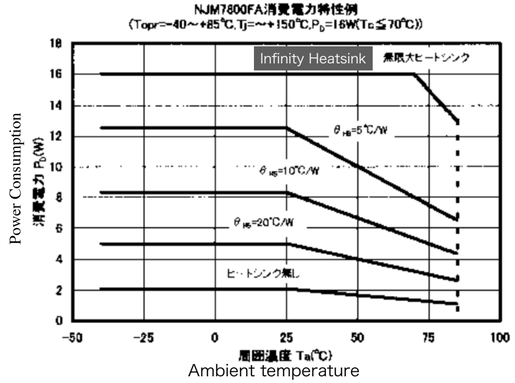
Specifications of the NJM7805 Regulator

■ **電気的特性** (C_I = 0.33μF, C_O = 0.1μF, Tj = 25°C) Electrical Characteristics

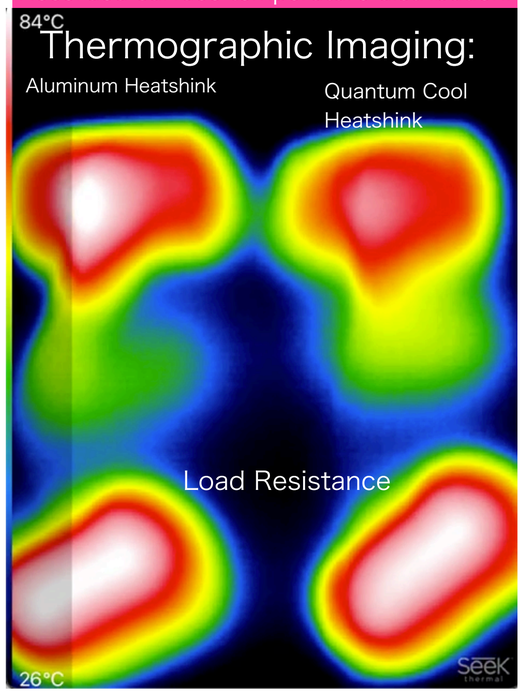
測定はパルス試験とする

項目	記号	条件	TO-220F 最小	TO-220F 標準	TO-220F 最大	TO-252 最小	TO-252 標準	TO-252 最大	単位
NJM7805FA/DL1A									
出力電圧	V_O	V_{IN}=10V, I_O=0.5A	4.8	5.0	5.2	4.8	5.0	5.2	V
ラインレギュレーション	ΔV_O-V_{IN}	V_{IN}=7~25V, I_O=0.5A	-	3	50	-	3	100	mV
ロードレギュレーション	ΔV_O-I_O	V_{IN}=10V, I_O=0.005~1.5A	-	15	50	-	15	100	mV
無効電流	I_Q	V_{IN}=10V, I_O=0mA	-	4.2	6.0	-	4.2	6.0	mA
出力電圧温度係数	$\Delta V_O/\Delta T$	V_{IN}=10V, I_O=5mA	-	-0.5	-	-	-0.5	-	mV/°C
リップル除去比	RR	V_{IN}=10V, I_O=0.5A, e_{IN}=$2V_{P-P}$, f=120Hz	68	78	-	68	78	-	dB
出力雑音電圧	V_{NO}	V_{IN}=10V, BW=10Hz~100kHz, I_O=0.5A	-	45	-	-	45	-	μV

Power Consumption Characteristics (example provided in supplementary materials)



Recorded surface temperature distribution.



This experiment utilized a well-known three-terminal regulator, the **NJM7805**. These regulators typically operate by converting part of the input voltage into heat while stabilizing the output voltage, using a linear circuitry method (also referred to as a step-down regulator). Consequently, dissipating heat generated by the power transistor's voltage differential between its input and output terminals is essential. Heat sinks are a necessity in most applications.

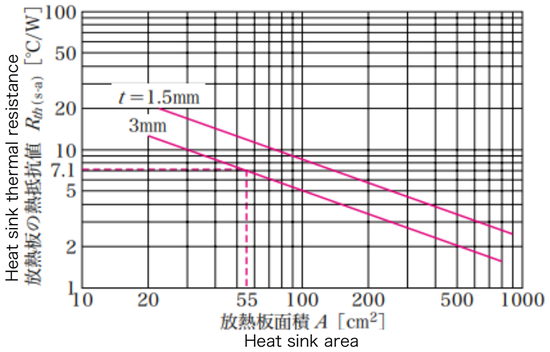
Design Considerations: The relationship between power loss and the surface area of the heat sink is critical. For instance, the following equation illustrates the relationship between junction temperature (Tj) and the heat sink's thermal resistance (Rth(s-a)):

$$R_{th(s-a)} = \frac{T_J - T_A}{P_D} - R_{th(j-c)} - R_{th(c-s)}$$

Experimental Example:

- For a load resistance conducting **0.6A**, the regulator dissipates **3.6W** of heat.
- For **1A**, **7W** of heat must be dissipated.

This requires aluminum heat sinks with thermal resistances ranging from **7.1°C/W to 2.6°C/W**, corresponding to considerable surface areas. The results demonstrate that the new **Quantum Cool** heat sink technology achieves significant thermal resistance reduction, effectively replicating an expansion of the flat surface area of aluminum heat sinks



Relationship Between Aluminum Plate Surface Area and Thermal Resistance