YJSP Component Derating Guide

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1 Contents

2 Why De-rate Components?

Derating is the process of reducing component ratings by a set fraction of their manufacturer-rated value in order to provide an extra margin of safety for components in operation, and to extend component lifespans. On YJSP, we de-rate components in a relatively simple fashion in order to give us extra breathing room for the harsh environments that our parts will end up in.

2.1 Considerations

Most of the derating information presented here has been determined by NASA regarding mil-spec components, which are usually hardier than the standard components we use. At the same time, these cited documents were written at a time when commercial component manufacturing was nowhere near as good as it is today. Furthermore, these requirements were written with the intent to build spacecraft capable of spending years upon years in space, while our boards will only be in space or a space-like environment for lengths on the order of minutes at a time.

More reliable components can also be found in the automotive industry, which has created a large market for reliable components that will last for years in potentially punishing vehicular applications. Where reasonable, preference should be made to components with an AEC rating, though this should not be the sole qualifier or disqualifier of a part in a design. In the end, it’s up to the designer to select a part that best fulfills their needs, and to rigorously test their board to ensure that when it flies, ***they are completely certain it will not fail.*** Move fast and break things, until you find a solution that you have **complete** confidence in. This is the only way that we can ensure success in our team mission.

3 Universal Ratings

These ratings apply to *all parts,* regardless of type. If a critical part does not meet these ratings, the responsible engineer should speak with the avionics team lead to evaluate alternatives, and if none are found, to approve a deviation.

3.1 Universal Ratings Chart

Rating	Value	Notes
Maximum Operating Temperature	≥105°C	≥125°C is desirable
Minimum Operating Temperature	≤-40°C	
Minimum Operating Pressure	0 Pa	

3.2 Unacceptable Component Types

Component Type	Justification
Liquid Electrolytic Capacitors	Electrolyte may boil off at low temperatures in a vacuum. Not suitable for space applications.
Single-Use Fuses	Fuses cannot be replaced in flight. Consider PTC fuses, which increase resistance with temp, limiting current.
Screw Terminals	Screw terminals are prone to loosening with flight loads.
Non-Locking Connectors	All connectors for flight must have some locking mechanical connection to avoid wires coming undone. This includes servo connectors, .1" headers (should be soldered), and thermocouple connectors. XT60/80s should be zip-tied.
Mechanical Relays	Mechanical relays may open/close inadvertently due to flight vibrations.

4 Component Derating Values

Multiple a component's manufacturer-provided rating by its multiplier to get its maximum acceptable design rating. For example, a 50V-rated capacitor can only be used in circuits of .60*50V = 30V or less.

4.1 Table

Component Type	Derating Level

Resistors	≤60% of rated power
Capacitors	≤60% of rated voltage
Inductors	≤50% of rated voltage ≤60% of rated temperature
Diodes: General Purpose, LED, and Schottky	≤70% power, voltage, and current ≤50% surge current
Diodes: Zener and TVS	≤50% steady-state power dissipation and surge current ≤80% max junction temperature
General Semiconductor Devices (Transistors, MOSFETs, etc.)	≤50% of rated power ≤75% of rated voltage ≤75% of rated current ≤110°C junction temperature
Power MOSFETs	≤60% of rated power ≤75% of rated current ≤60% Vgs,max ≤75% Vsd,max ≤80% of max junction temperature
Microcontrollers and ICs	≤80% of maximum clock speed (Hz) ≤80% of rated maximum supply voltage (unless required, such as a 3V3 device with a 4V maximum) ≤100°C junction temperature ≤75% of rated output power
Solid State Relays	≤50% of rated current
Connectors	≤50% of rated current
All Other Devices	Use your best judgment. Be conservative. Test the hell out of anything you're not sure about.

4.2 Wire Current Limits

Wire Gauge (AWG)	Single Wire (A)	Bundled Wire/Cable (A)
30	1.3	0.7
28	1.8	1.0

26	2.5	1.4
24	3.3	2.0
22	4.5	2.5
20	6.5	3.7
18	9.2	5.0
16	13.0	6.5
14	19.0	8.5
12	25.0	11.5
10	33.0	16.5
8	44.6	23.0
6	60.0	30.0

Our wire is often, shall we say, not the highest quality out there *(Please stop buying from Harbor Freight!)*. It is therefore doubly important to make sure we don't overload the wire, lest it overheat and melt, causing a short and possibly a fire.

5 Sources

Simple deratings were taken from NASA document PD-ED-1201.
Some deratings were modified from NASA document EEE-INST-002.