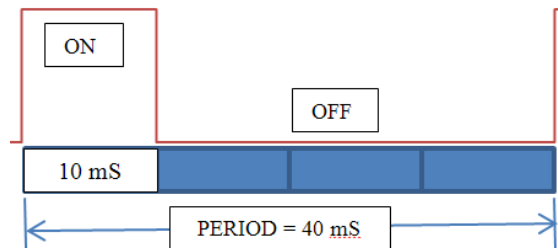# Simplified Pulsed Current
(Duty Cycle) Guidelines

SCOPE: The goal of this paper is to provide a basic method to estimate the pulsed current carrying capacity of an interconnect system. (Please see the definitions on page 3 for clarification.)

NOTE: These guidelines are only estimates as each application is unique and ultimately must be tested.

For this paper we will assume that this is a repetitive pulse stream into a resistive load thus eliminating many of the more complex issues. We will also base this on a 30°C temperature rise above ambient as our current carrying limit.

In order to assess the connector/cable system compatibility with a particular Pulsed Current application some questions will have to be answered:

- What is the Pulse Width? Example in Figure 1 = 10 mS
- What is the Period time? Example in Figure 1 = 40 mS, (Max Period = 1 second)
- What is the Duty Cycle (Pulse Width/Period; 10/40)? Example in Figure 1 = 25%

(Red line = Current Pulse)
Figure 1

Table 1 gives examples of typical duty cycles and rated current values resulting in the associated pulsed current ratings. Simply look up the **Rated Current** of the product of interest (far left column of table) and match up the **Duty Cycle** (three columns on the right, 10%, 25%, or 50%) and this will result in a **Pulsed Current Rating** (Max Period = 1 second).

Rated Current (amps)	Pulsed Current Rating (amps) Maximum Period = 1s		
	10% Duty Cycle	25% Duty Cycle	50% Duty Cycle
1	3.16	2.00	1.41
2	6.32	4.00	2.83
3	9.49	6.00	4.24
4	12.65	8.00	5.66
5	15.81	10.00	7.07
6	18.97	12.00	8.49
7	22.14	14.00	9.90
8	25.30	16.00	11.31
9	28.46	18.00	12.73
10	31.62	20.00	14.14
15	47.43	30.00	21.21
20	63.25	40.00	28.28
25	79.06	50.00	35.36
30	94.87	60.00	42.43
40	126.49	80.00	56.57
50	158.11	100.00	70.71

Table 1
This chart is based on the RMS power formula: (100/%duty cycle)* (rated current).
We start with the basic power formula; P = I²(current squared) * R(resistance),
but R is assumed constant in this case so we are able to drop that variable from the calculation
and just deal with the current² and the time.

EXAMPLE: The following example is based on the use of the Chart and Table in **Figure 3**. In order to estimate the duty cycle conditions you must:

1. Select the contact that you are going to evaluate from Samtec's catalog.
2. Locate the CCC (Current Carrying Capacity) data within the test reports online and establish the rated current for your application. Samtec's SS5 contact @ a 30°C rise will be used for this example:
   http://www.samtec.com/Documents/WebFiles/TestRpt/237836_report_rev_3_qua.pdf
3. The current rating for this example is 2 adjacent contacts powered and is 1.5 Amps found on the table in the linked report (see **Figure 2**).

Temperature Rise, CCC at a 20% de-rating
- CCC for a 30°C Temperature Rise-------------------1.5A per contact with 2 adjacent contacts powered
- CCC for a 30°C Temperature Rise-------------------1.2A per contact with 4 adjacent contacts powered
- CCC for a 30°C Temperature Rise-------------------1.0A per contact with 6 adjacent contacts powered
- CCC for a 30°C Temperature Rise-------------------0.9A per contact with 8 adjacent contacts powered
- CCC for a 30°C Temperature Rise-------------------0.6A per contact with 40 adjacent contacts powered
- CCC for a 30°C Temperature Rise-------------------0.4A per contact with all adjacent contacts powered

Figure 2

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4. Then, choose the duty cycle you are expecting. We will use 50% for our example.
5. From the chart and table in **Figure 3** look at the 50% data point which indicates that the **Current Multiplier** of 1.41 is to be used. This means that you will be able to pulse approximately 2.12A (1.5A x 1.41 multiplier) Amps through two adjacent contacts for 50% of the time (Max Period = 1 second).

The following chart (and table) can be used to estimate the pulsed current/duty cycle characteristics of contact/cable systems. These guidelines are only estimates as each application is unique and ultimately must be tested.
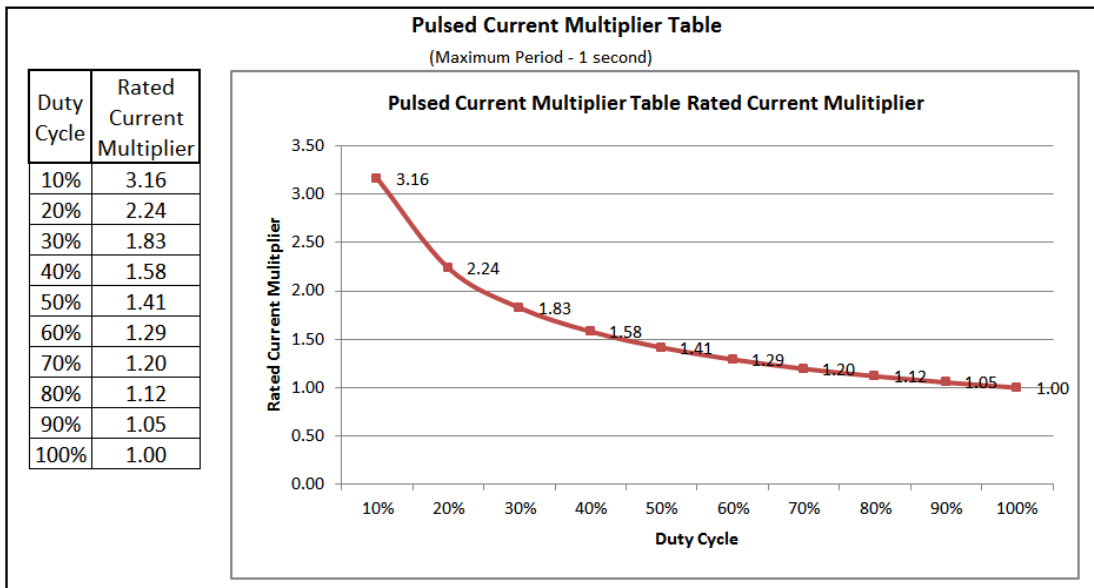
Pulsed Current Multiplier Table
(Maximum Period - 1 second)

Duty Cycle	Rated Current Multiplier
10%	3.16
20%	2.24
30%	1.83
40%	1.58
50%	1.41
60%	1.29
70%	1.20
80%	1.12
90%	1.05
100%	1.00

Pulsed Current Multiplier Table Rated Current Mulitiplier

Data points (Duty Cycle vs Rated Current Multiplier): 10% = 3.16, 20% = 2.24, 30% = 1.83, 40% = 1.58, 50% = 1.41, 60% = 1.29, 70% = 1.20, 80% = 1.12, 90% = 1.05, 100% = 1.00

Figure 3

DEFINITIONS:

General application definitions – These definitions cover the typical repetitive (more or less) even types of pulses such as "one pulse 10 mS wide, every second" or the like.

Pulsed Current: When the Electrical Current (Amperage) in a circuit/device is not a steady or virtually steady amount and is cycled on and off at some defined interval, we call that a pulsed current application.

Period: The entire cycle time between turn on edges (or turn off edges) of the cycles as shown in Figure 1 is the cycle period.

Duty Cycle: The ratio of ON time vs. Period or Cycle time is the duty cycle as shown in Figure 1, representing a 25% duty cycle.

Pulse Width: The duration or width of the ON time of the cycle is the pulse width

Load: The final "destination" where the power is dissipated is called the load. This is your populated circuit board or cooling fan or fluorescent bulbs, etc., whatever the current is powering. Resistive loads need no further compensation, but inductive or capacitive loads will be sensitive to the speed of the pules edge transition times.

Pulse Edge: Either transition from ON to OFF (also called Fall Time) or from OFF to ON (also called Rise Time) is called a cycle edge, pulse edge, transition time, etc. At high speeds (short times) this factor may need to be considered since the contact system under evaluation can act as a capacitive or inductive load at high speeds.

Power factor: The ultimate Inductive (L) and capacitive (C) reactance (X_L and X_C) of the load will react with the power supply causing the voltage and current to be phase shifted. This condition can cause the apparent (reactive) load to be different from the DC or steady state condition. *Example: It takes more power to start your refrigerator than it does to keep it running once it starts due to the reactance of the compressor*.

High speed application definitions

NOTE: It is impossible for a "square" pulse to actually be square since it takes time for the current to flow just as you cannot turn on a water pipe without some time elapsing from zero flow to full flow.

Rise Time: The amount of time it takes the current to go from the OFF state to the ON state is called the Rise Time; conversely the amount of time it takes the current to go from the ON state to the OFF state is called the Fall Time. Shown in Figure 2; notice the theoretical dotted square wave in the background. The rise and fall times are affected by the Power Factor of the load as well as the reactance of the contact/cable system. Faster rise and fall times require less reactive loads and contact/cable systems.

Rise Time