Load Bank Optimization

Mohamad Fares El Hajj Chehade

July 2022

1 The Aim of the Work

The purpose of this work is to determine the load requirements for the PEARL labs H-Bridge circuit at the **minimum cost**.

2 Problem Statement

The H-bridge inverter at PEARL labs should be tested with a resistor bank. The resistors belong to the TE1500B1R0J brand and can consume a **maximum power of 1500 W**. The load should be tested using a **900 V DC supply** at **80% duty ratio**, and the overall circuit should consume a **minimum power of 100 kW**. The requirements should be met at the **least possible cost**.

3 Methodology

The resistors are the only components to be purchased, so the cost of the experiment can be minimized by **minimizing the number of resistors** used. As a result, an optimization problem can be formulated as follows:

- minimize the number of resistors

subject to:

- a minimum power of 100 kW in the circuit
- a maximum power of 1500 W for each resistor

4 Optimization Problem

For the purpose of solving the above problem, a linear program was established as follows:

$$\min_{x_i} \sum_{i=1}^{7} i * x_i$$

subject to:

$$x_i \geq 0 \ \forall i \in \{1, 2, ..., 7\}$$

$$1 - x_i \leq M z_i \ \forall i \in \{1, 2, ..., 7\}$$

$$x_i - 1 \leq M(1 - z_i) - \epsilon \ \forall i \in \{1, 2, ..., 7\}$$

$$\frac{V_{rms}}{i\sqrt{P_{rated}}} - \sum_{i=1}^{7} \frac{1}{i} x_i \leq M(z_i + \sum_{j=1}^{i-1}(1 - z_j)) \ \forall i \in \{1, 2, ..., 7\}$$

$$\sum_{i=1}^{7} \frac{1}{i} x_i \leq \frac{V_{rms}^2}{P_{circuit}} \ \forall i \in \{1, 2, ..., 7\}$$

$$\sum_{i=1}^{7} i * x_i \geq 1$$

where:

- x_i represents the number of i parallel combinations
- z_i is a Boolean slack variable
- M and ϵ are very large and small constants respectively

5 Solution

The solution is **optimal**, and the optimal load bank is a resistor bank made up of **21 combinations of 4 parallel resistors**. Hence, the **total number of resistors needed is 84**.

6 Verification of Results

The solution above was verified through computing the required circuit quantities:

1. The active power dissipated in the circuit is 123.4 kW.
2. The power consumed by each resistor is 1467 W.