LIT Dataset:
Description of Subsets and Loads

Version 1.1 : June, 2020

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The LIT-Dataset was conceived and engineered to provide data for evaluation of NILM Systems. This document presents how the LIT-Dataset is structured, describing the loads and load composition that make up each Subset.

For more information:

http://www.dainf.ct.utfpr.edu.br/~douglas/LIT_Dataset/

Contents

Chapter 1

What is the LIT-Dataset?

The LIT-Dataset was conceived and engineered to provide data for evaluation of NILM Systems. One such Non-Intrusive Load Monitoring System (NILM) is under development in our Laboratory for Innovation and Technology in Embedded Systems (LIT). The development process behind the LIT-Dataset started by the evaluation of existing datasets, by comparing their features and then by stating the requirements of the recorded waveforms of voltage and current when single and multiple loads were monitored under several conditions.

A distinguished feature of the LIT-dataset is that it is composed of three distinct classes of load monitoring: **Synthetic**, **Natural** and **Simulated**.

Inside each subset there are numbered folders representing the number of concurrent loads in the acquisition. Hence, in folder "2" all the acquisitions correspond to two loads. The lowest level folders are named by acquisition index: number of concurrent loads followed by their identifiers. Hence, acquisition 2A0B0 in the Synthetic subset corresponds to two loads: a microwave (A0) and a LED Lamp (B0). The identifiers of each load are presented in Sections 2 and 3.

This is the acquisition ID of interest. This ID code follows the rule:

$$"Number\_of\_loads" + "load" + "load" + "load" + ... \tag{1.1}$$

For example, to select the acquisition taken with the loads A0 and B0, in this specific order, the user must set the following aqID: '2A0B0'.

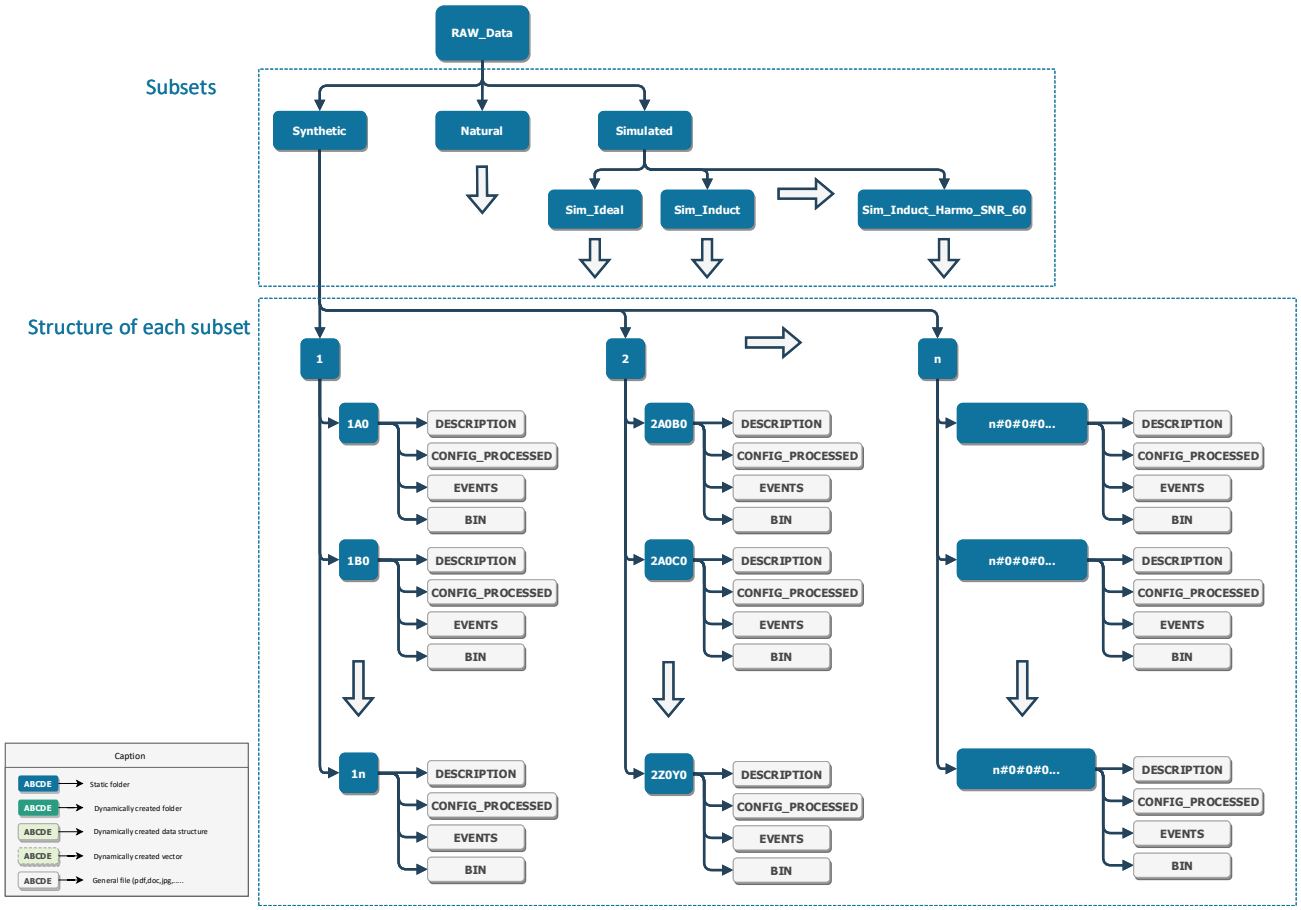

Figure 1.1: Structural Pattern of LIT Database Subsets. structure.

Chapter 2

Synthetic

On this chapter is presented the informations of the Synthetic Subset, compiled as combinations of loads and labels of loads. Tables that follow resume this informations. To make the Synthetic Subset, the LIT laboratory, build and design a embedded prototype, where all the combinations and acquisitions are made. The prototype was designed to support eight loads simultaneously and all the loads attach are powered by 127V at 60Hz, the brazilian power grid pattern.

This Subset count with 26 different loads, see Table 2.1. The Subset have 81 combinations with 16 different trigger angles described in section 2.3.

2.1 Description of Loads and Power

Table 2.1 below features the information of Loads: theirs Identification, Names and Power Consumption.

Table 2.1: Subset Synthetic - Single Loads

ID	Loads	Power(W)
1A0	Microwave Standby	4.5
1B0	LED Lamp	6
1C0	CRT Monitor	10
1D0	LED Panel	13
1E0	Fume Extrator	23
1F0	LED Monitor	26
1G0	Phone Charger Asus	38
1H0	Soldering Station	40
1I0	Phone Charger Motorola	-
1J0	Laptop Lenovo	70
1K0	Fan	80
1L0	Resistor	80
1M0	Laptop Vaio	90
1N0	Incandescent Lamp	100
1O0	Drill Speed 1	165
1P0	Drill Speed 2	350
1Q0	Oil Heater Power 1	520
1R0	Oil Heater Power 2	750
1S0	Microwave On	950
1T0	Air Heater Nilko	1120
1U0	HairDryer Eleganza - Fan1	365
1V0	HairDryer Eleganza - Fan2	500
1W0	HairDryer Super 4.0 - Fan1 - Heater1	660
1X0	HairDryer Super 4.0 - Fan1 - Heater2	1120
1Y0	HairDryer Parlux - Fan1 - Heater1	660
1Z0	HairDryer Parlux - Fan2 - Heater1	885

2.2 Combinations

Tables explain how the acquisitions are made, the first column represent the first load triggered (e.g., 2A0B0: First turn on load A0, in sequence turn on load B0). The first number represent how many load exist in the acquisition, making the identification of the files easier when compact. For more information see Chapter 1.

2.2.1 Dual Loads

Table 2.2, below, presents the combinations of Loads and also their names in triggering order. The single loads are shown individually in Table 2.1.

Table 2.2: Subset Synthetic - Duo Loads

Combination	Loads	
	1	2
2A0B0	Microwave Standby	LED Lamp
2A0H0	Microwave Standby	Soldering Station
2A0L0	Microwave Standby	Resistor
2A0M0	Microwave Standby	Laptop Vaio
2A0N0	Microwave Standby	Incandescent Lamp
2A0Q0	Microwave Standby	Oil Heater Power 1
2B0A0	LED Lamp	Microwave Standby
2B0H0	LED Lamp	Soldering Station
2B0L0	LED Lamp	Resistor
2B0M0	LED Lamp	Laptop Vaio
2B0N0	LED Lamp	Incandescent Lamp
2B0Q0	LED Lamp	Oil Heater Power 1
2H0A0	Soldering Station	Microwave Standby
2H0B0	Soldering Station	LED Lamp
2H0L0	Soldering Station	Resistor
2H0M0	Soldering Station	Laptop Vaio
2H0N0	Soldering Station	Incandescent Lamp
2H0Q0	Soldering Station	Oil Heater Power 1
2L0A0	Resistor	Microwave Standby
2L0B0	Resistor	LED Lamp
2L0H0	Resistor	Soldering Station
2L0M0	Resistor	Laptop Vaio
2L0N0	Resistor	Incandescent Lamp
2L0Q0	Resistor	Oil Heater Power 1
2M0A0	Laptop Vaio	Microwave Standby
2M0B0	Laptop Vaio	LED Lamp
2M0H0	Laptop Vaio	Soldering Station
2M0L0	Laptop Vaio	Resistor
2M0N0	Laptop Vaio	Incandescent Lamp
2M0Q0	Laptop Vaio	Oil Heater Power 1
2N0A0	Incandescent Lamp	Microwave Standby
2N0B0	Incandescent Lamp	LED Lamp
2N0H0	Incandescent Lamp	Soldering Station
2N0L0	Incandescent Lamp	Resistor
2N0M0	Incandescent Lamp	Laptop Vaio
2N0Q0	Incandescent Lamp	Oil Heater Power 1
2Q0A0	Oil Heater Power 1	Microwave Standby
2Q0B0	Oil Heater Power 1	LED Lamp
2Q0H0	Oil Heater Power 1	Soldering Station
2Q0L0	Oil Heater Power 1	Resistor
2Q0M0	Oil Heater Power 1	Laptop Vaio
2Q0N0	Oil Heater Power 1	Incandescent Lamp

2.2.2 Triple Loads

Table 2.3, below, features the combinations of Loads and also their names in triggering order. Single loads are shown individually in Table 2.1.

Table 2.3: Subset Synthetic - Triple Loads

Combination	Loads		
	1	2	3
3Q0X0E0	Oil Heater Power 1	HairDryer Super 4.0 Fan1 - Heater2	Fume Extrator
3Y0T0E0	HairDryer Parlux Fan1 - Heater1	Air Heater Nilko	Fume Extrator
3M0R0X0	Laptop Vaio	Oil Heater Power 2	HairDryer Super 4.0 Fan1 - Heater 2
V0H0X0	HairDryer Eleganza Fan2	Soldering Station	HairDryer Super 4.0 Fan1 - Heater2
3Z0P0V0	HairDryer Parlux Fan2 - Heater1	Drill Speed 2	HairDryer Eleganza Fan2
3H0P0W0	Soldering Station	Drill Speed 2	HairDryer Super 4.0 Fan1 - Heater1
3D0Y0S0	LED Panel	HairDryer Parlux Fan1 - Heater1	Microwave On
3X0D0P0	HairDryer Super 4.0 Fan1 - Heater2	LED Panel	Drill Speed 2
3T0V0M0	Air Heater Nilko	HairDryer Eleganza Fan2	Laptop Vaio
3P0U0Z0	Drill Speed 2	HairDryer Eleganza Fan1	HairDryer Parlux Fan2 - Heater1
3V0D0M0	HairDryer Eleganza Fan2	LED Panel	Laptop Vaio
3W0E0T0	HairDryer Super 4.0 Fan1 - Heater1	Fume Extrator	Air Heater Nilko
3U0N0Z0	HairDryer Eleganza Fan1	Incandescent Lamp	HairDryer Parlux Fan2 - Heater1
3D0Q0N0	LED Panel Power 1	Oil Heater	Incandescent Lamp
3W0E0H0	HairDryer Super 4.0 Fan1 - Heater1	Fume Extrator	Soldering Station
3R0E0S0	Oil Heater Power 2	Fume Extrator	Microwave On
3P0Z0H0	Drill Speed 2	HairDryer Parlux Fan2 - Heater1	Soldering Station
3U0T0H0	HairDryer Eleganza Fan1	Air Heater Nilko	Soldering Station
3D0Q0I0	LED Panel	Oil Heater Power 1	Phone Charger Motorola
3N0S0I0	Incandescent Lamp	Microwave On	Phone Charger Motorola
3V0M0Q0	HairDryer Eleganza Fan2	Laptop Vaio	Oil Heater Power 1
3U0R0Y0	HairDryer Eleganza Fan1	Oil Heater Power 2	HairDryer Parlux Fan1 - Heater1
3S0E0Y0	Microwave On	Fume Extrator	HairDryer Parlux Fan1 - Heater1
3M0W0I0	Laptop Vaio	HairDryer Super 4.0 Fan1 - Heater1	Phone Charger Motorola
3W0I0Z0	HairDryer Super 4.0 Fan1 - Heater1	Phone Charger Motorola	HairDryer Parlux Fan2 - Heater1
3S0I0Y0	Microwave On	Phone Charger Motorola	HairDryer Parlux Fan1 - Heater1
3T0Q0N0	Air Heater Nilko	Oil Heater Power 1	Incandescent Lamp
3X0N0R0	HairDryer Super 4.0 Fan1 - Heater2	Incandescent Lamp	Oil Heater Power 2
3Y0P0U0	HairDryer Parlux Fan1 - Heater1	Drill Speed 2	HairDryer Eleganza Fan1
3M0W0R0	Laptop Vaio	HairDryer Super 4.0 Fan1 - Heater1	Oil Heater Power 2

2.2.3 Eightfold Loads

Table 2.4 below features the combinations of eight Loads and also their names in triggering order. Single loads are shown individually in Table 2.1.

Table 2.4: Subset Synthetic - Eightfold Loads

Combination	Loads							
	1	2	3	4	5	6	7	8
8D0G0P0Q0M0N0H0E0	LED Panel	Phone Charger Asus	Drill Speed2	Oil Heater Power1	Laptop Vaio	Incandescent Lamp	Soldering Station	Fume Extrator
8Q0H0N0M0P0E0I0V0	Oil Heater Power1	Soldering Station	Incandescent Lamp	Laptop Vaio	Drill Speed2	Fume Extrator	Phone Charger Motorola	Eleganza Fan2
8X0E0H0I0M0P0N0D0	Super 4.0 Fan1-Heater2	Fume Extrator	Soldering Station	Phone Charger Motorola	Laptop Vaio	Drill Speed 2	Incandescent Lamp	LED Panel
8E0P0I0M0N0H0W0Y0	Fume Extrator	Drill Speed 2	Phone Charger Motorola	Laptop Vaio	Incandescent Lamp	Soldering Station	Super 4.0 Fan1 - Heater1	Parlux Fan1-Heater1
8I0E0H0D0M0N0U0Z0	Phone Charger Motorola	Fume Extrator	Soldering Station	LED Panel	Laptop Vaio	Incandescent Lamp	Eleganza Fan1	Parlux Fan2-Heater1
8D0M0S0G0H0N0R0E0	LED Panel	Laptop Vaio	Microwave On	Phone Charger Asus	Soldering Station	Incandescent Lamp	Oil Heater Power2	Fume Extrator

2.3 Trigger Angles

All the combinations of the Synthetic Subset have the sequence of triggering shown in Table below 2.5. The angles are the equivalent of the grid waveform, those angles affect directly the loads, making every waveform distinct.

Table 2.5: Subset Synthetic - Angles

ID Angle	Trigger Angle
0	0°
1	22.5°
2	45°
3	67.5°
4	90°
5	112.5°
6	135°
7	157.5°
8	180°
9	202.5°
10	225°
11	247.5°
12	270°
13	292.5°
14	315
15	337.5

Chapter 3

Simulated

Several classes of loads were simulated in a MATLAB/SIMULINK environment, and validated against actual loads. The use of simulated loads allows us to modify the load characteristics so to create scenarios that would be very difficult/complex to create in the real world.

On this Subset exist 6 groups of configurations for the Simulated database where can be see in Table 3.

Table 3.1: Database Settings

Name	Parameters
Sim_Ideal (DB-1)	ideal
Sim_Induct (DB-2)	leakage inductance
Sim_Induct_Harmo (DB-3)	leakage inductance and harmonics
Sim_Induct_Harmo_SNR_60 (DB-4)	leakage inductance harmonics and AWGN with SRN 60dB
Sim_Induct_Harmo_SNR_30 (DB-5)	leakage inductance harmonics and AWGN with SRN 30dB
Sim_Induct_Harmo_SNR_10 (DB-6)	leakage inductance harmonics and AWGN with SRN 10dB

In sections 3.1 and 3.2 we present the Loads Combinations of the groups described in Table 3. Trigger angles are described in section 3.3.

3.1 Description of loads

The loads used in this Subset are described in Table 3.2 with the respective active power. Note that the single IDs below are those who composes the multiple Loads Combinations Simulations. The combinations can be seen on the sections 3.2.1, 3.2.2, 3.2.3 and 3.2.4.

Table 3.2: Subset Simulated - Single Loads

ID	Load	Power (W)
A0	Motor 1	457,1
B0	Motor 2	339,29
C0	Motor 3	261,79
D0	Motor 4	195,19
E0	Full Bridge 1	15,48
F0	Full Bridge 2	29,92
G0	Full Bridge 3	60,6
H0	Full Bridge 4	99,3
I0	Circuit R 1	6775
J0	Circuit R 2	3239
K0	Circuit R 3	2024
L0	Circuit R 4	1620
M0	Circuit RL 1	1418
N0	Circuit RL 2	782,2
O0	Circuit RL 3	531,6
P0	Circuit RL 4	209,4
Q0	Thyristor R 1	440
R0	Thyristor R 2	367,4
S0	Thyristor R 3	294,22
T0	Thyristor R 4	220,72
U0	Thyristor RL 1	432,8
V0	Thyristor RL 2	842,6
W0	Thyristor RL 3	146,8
X0	Thyristor RL 4	42,36
Y0	Diode 1	12200
Z0	Diode 2	5597
A1	Diode 3	2401
B1	Diode 4	640,1

3.2 Load Combinations

On the Simulated Subset there are 5 types of combinations between the loads described in Table 3.2. The combinations chosen balance the amount of simulations done on this Subset.

The select combinations of loads follow a similar approach as the Synthetic Subset. All combinations can be seen on the sections 3.2.1, 3.2.2, 3.2.3 e 3.2.4. Corresponding to the combinations of duo, triple, quadruple and quintuple loads.

3.2.1 Dual Loads

This section feature the combinations between two loads of Table 3.2. Table 3.3 compile which combination was made and the sequence of triggering.

Table 3.3: Subset Simulated - Double Loads

Combination	Loads	
	1	2
2Y0G0	Diode 1	Full Bridge 3
2O0S0	Circuit RL 3	Thyristor R 3
2Y0X0	Diode 1	Thyristor RL 4
2S0D0	Thyristor R 3	Motor 4
2J0G0	Circuit R 2	Full Bridge 3
2K0X0	Circuit R 3	Thyristor RL 4
2Z0G0	Diode 2	Full Bridge 3
2A1J0	Diode 3	Circuit R 2
2F0I0	Full Bridge 2	Circuit R 1
2R0M0	Thyristor R 2	Circuit RL 1
2J0W0	Circuit R 2	Thyristor RL 3
2Q0O0	Thyristor R 1	Circuit RL 3
2Y0E0	Diode 1	Full Bridge 1
2V0U0	Thyristor RL 2	Thyristor RL 1
2K0B0	Circuit R 3	Motor 2
2A0B0	Motor 1	Motor 2
2N0T0	Circuit RL 2	Thyristor R 4
2A1F0	Diode 3	Full Bridge 2
2P0M0	Circuit RL 4	Circuit RL 1
2A0K0	Motor 1	Circuit R 3
2D0V0	Motor 4	Thyristor RL 2
2I0O0	Circuit R 1	Circuit RL 3
2E0Q0	Full Bridge 1	Thyristor R 1
2H0R0	Full Bridge 4	Thyristor R 2
2T0U0	Thyristor R 4	Thyristor RL 1
2N0C0	Circuit RL 2	Motor 3
2F0Y0	Full Bridge 2	Diode 1
2E0W0	Full Bridge 1	Thyristor RL 3
2P0A1	Circuit RL 4	Diode 3
2C0L0	Motor 3	Circuit R 4

3.2.2 Triple loads

This section feature the combination between three loads of Table 3.2. Table 3.4 compile which combination was made and the sequence of triggering.

Table 3.4: Subset Simulated - Triple Loads

Combination	Loads		
	1	2	3
3T0P0W0	Thyristor R 4	Circuit RL 4	Thyristor RL 3
3Y0F0J0	Diode 1	Full Bridge 2	Circuit R 2
3M0A1E0	Circuit RL 1	Diode 3	Full Bridge 1
3X0B0J0	Thyristor RL 4	Motor 2	Circuit R 2
3F0L0Z0	Full Bridge 2	Circuit R 4	Diode 2
3D0Y0G0	Motor 4	Diode 1	Full Bridge 3
3K0P0D0	Circuit R 3	Circuit RL 4	Motor 4
3I0G0Q0	Circuit R 1	Full Bridge 3	Thyristor R 1
3X0A1S0	Thyristor RL 4	Diode 3	Thyristor R 3
3K0O0U0	Circuit R 3	Circuit RL 3	Thyristor RL 1
3Z0X0V0	Diode 2	Thyristor RL 4	Thyristor RL 2
3H0Q0A0	Full Bridge 4	Thyristor R 1	Motor 1
3K0I0E0	Circuit R 3	Circuit R 1	Full Bridge 1
3F0U0C0	Full Bridge 2	Thyristor RL 1	Motor 3
3Q0M0S0	Thyristor R 1	Circuit RL 1	Thyristor R 3
3T0R0A0	Thyristor R 4	Thyristor R 2	Motor 1
3B0I0N0	Motor 2	Circuit R 1	Circuit RL 2
3D0L0V0	Motor 4	Circuit R 4	Thyristor RL 2
3U0A1E0	Thyristor RL 1	Diode 3	Full Bridge 1
3J0C0P0	Circuit R 2	Motor 3	Circuit RL 4
3W0L0C0	Thyristor RL 3	Circuit R 4	Motor 3
3H0N0B1	Full Bridge 4	Circuit RL 2	Diode 4
3M0O0B1	Circuit RL 1	Circuit RL 3	Diode 4
3Y0N0B1	Diode 1	Circuit RL 2	Diode 4
3R0Z0W0	Thyristor R 2	Diode 2	Thyristor RL 3
3S0H0R0	Thyristor R 3	Full Bridge 4	Thyristor R 2
3T0B0G0	Thyristor R 4	Motor 2	Full Bridge 3
3G0O0V0	Full Bridge 3	Circuit RL 3	Thyristor RL 2
3J0V0R0	Circuit R 2	Thyristor RL 2	Thyristor R 2
3A0Q0K0	Motor 1	Thyristor R 1	Circuit R 3

3.2.3 Quadruple loads

This section feature the combination between four loads of Table 3.2. Table 3.5 compile which combination was made and the sequence of triggering.

Table 3.5: Subset Simulated - Quadruple Loads

Combination	Loads			
	1	2	3	4
4Z0A0M0J0	Diode 2	Motor 1	Circuit RL 1	Circuit R 2
4M0X0I0T0	Circuit RL 1	Thyristor RL 4	Circuit R 1	Thyristor R 4
4N0A0E0S0	Circuit RL 2	Motor 1	Full Bridge 1	Thyristor R 3
4A1E0V0P0	Diode 3	Full Bridge 1	Thyristor RL 2	Circuit RL 4
4F0T0G0W0	Full Bridge 2	Thyristor R 4	Full Bridge 3	Thyristor RL 3
4H0X0E0B1	Full Bridge 4	Thyristor RL 4	Full Bridge 1	Diode 4
4C0P0R0N0	Motor 3	Circuit RL 4	Thyristor R 2	Circuit RL 2
4L0B0Q0Z0	Circuit R 4	Motor 2	Thyristor R 1	Diode 2
4V0Z0F0B1	Thyristor RL 2	Diode 2	Full Bridge 2	Diode 4
4G0D0O0L0	Full Bridge 3	Motor 4	Circuit RL 3	Circuit R 4
4M0Y0W0I0	Circuit RL 1	Diode 1	Thyristor RL 3	Circuit R 1
4S0B1V0U0	Thyristor R 3	Diode 4	Thyristor RL 2	Thyristor RL 1
4H0Q0P0N0	Full Bridge 4	Thyristor R 1	Circuit RL 4	Circuit RL 2
4Y0H0I0C0	Diode 1	Full Bridge 4	Circuit R 1	Motor 3
4X0R0M0P0	Thyristor RL 4	Thyristor R 2	Circuit RL 1	Circuit RL 4
4B0R0O0S0	Motor 2	Thyristor R 2	Circuit RL 3	Thyristor R 3
4O0A1F0C0	Circuit RL 3	Diode 3	Full Bridge 2	Motor 3
4D0B0W0L0	Motor 4	Motor 2	Thyristor RL 3	Circuit R 4
4G0X0Q0T0	Full Bridge 3	Thyristor RL 4	Thyristor R 1	Thyristor R 4
4A1B1E0D0	Diode 3	Diode 4	Full Bridge 1	Motor 4
4A0C0N0Z0	Motor 1	Motor 3	Circuit RL 2	Diode 2
4Y0N0A1Q0	Diode 1	Circuit RL 2	Diode 3	Thyristor R 1
4U0O0J0D0	Thyristor RL 1	Circuit RL 3	Circuit R 2	Motor 4
4Q0H0B0S0	Thyristor R 1	Full Bridge 4	Motor 2	Thyristor R 3
4G0L0R0I0	Full Bridge 3	Circuit R 4	Thyristor R 2	Circuit R 1
4U0K0R0Z0	Thyristor RL 1	Circuit R 3	Thyristor R 2	Diode 2
4M0A0I0K0	Circuit RL 1	Motor 1	Circuit R 1	Circuit R 3
4Y0F0V0K0	Diode 1	Full Bridge 2	Thyristor RL 2	Circuit R 3
4H0K0T0J0	Full Bridge 4	Circuit R 3	Thyristor R 4	Circuit R 2
4W0U0J0F0	Thyristor RL 3	Thyristor RL 1	Circuit R 2	Full Bridge 2

3.2.4 Fivefold Loads

This section feature the combination between five loads of Table 3.2. Table 3.3 compile which combination was made and the sequence of triggering.

Table 3.6: Subset Simulated - Fivefold Loads

Combination	Loads				
	1	2	3	4	5
5W0Z0I0Q0K0	Thyristor RL 3	Diode 2	Circuit R 1	Thyristor R 1	Circuit R 3
5H0U0K0V0B1	Full Bridge 4	Thyristor RL 1	Circuit R 3	Thyristor RL 2	Diode 4
5O0Z0E0D0P0	Circuit RL 3	Diode 2	Full Bridge 1	Motor 4	Circuit RL 4
5L0U0V0T0H0	Circuit R 4	Thyristor RL 1	Thyristor RL 2	Thyristor R 4	Full Bridge 4
5O0C0A1D0Q0	Circuit RL 3	Motor 3	Diode 3	Motor 4	Thyristor R 1
5N0F0M0J0B0	Circuit RL 2	Full Bridge 2	Circuit RL 1	Circuit R 2	Motor 2
5A1H0I0R0N0	Diode 3	Full Bridge 4	Circuit R 1	Thyristor R 2	Circuit RL 2
5W0X0Z0A0U0	Thyristor RL 3	Thyristor RL 4	Diode 2	Motor 1	Thyristor RL 1
5R0A1N0L0T0	Thyristor R 2	Diode 3	Circuit RL 2	Circuit R 4	Thyristor R 4
5G0N0X0O0U0	Full Bridge 3	Circuit RL 2	Thyristor RL 4	Circuit RL 3	Thyristor RL 1
5A1G0H0Q0C0	Diode 3	Full Bridge 3	Full Bridge 4	Thyristor R 1	Motor 3
5R0B1S0W0X0	Thyristor R 2	Diode 4	Thyristor R 3	Thyristor RL 3	Thyristor RL 4
5V0T0Y0O0A0	Thyristor RL 2	Thyristor R 4	Diode 1	Circuit RL 3	Motor 1
5D0Z0M0L0F0	Motor 4	Diode 2	Circuit RL 1	Circuit R 4	Full Bridge 2
5P0R0A0B1I0	Circuit RL 4	Thyristor R 2	Motor 1	Diode 4	Circuit R 1
5B0S0F0D0E0	Motor 2	Thyristor R 3	Full Bridge 2	Motor 4	Full Bridge 1
5E0F0B0P0G0	Full Bridge 1	Full Bridge 2	Motor 2	Circuit RL 4	Full Bridge 3
5P0S0M0N0K0	Circuit RL 4	Thyristor R 3	Circuit RL 1	Circuit RL 2	Circuit R 3
5D0J0G0V0W0	Motor 4	Circuit R 2	Full Bridge 3	Thyristor RL 2	Thyristor RL 3
5F0I0Q0K0E0	Full Bridge 2	Circuit R 1	Thyristor R 1	Circuit R 3	Full Bridge 1
5A1C0B1K0Y0	Diode 3	Motor 3	Diode 4	Circuit R 3	Diode 1
5R0P0B0T0B1	Thyristor R 2	Circuit RL 4	Motor 2	Thyristor R 4	Diode 4
5S0B0W0X0Y0	Thyristor R 3	Motor 2	Thyristor RL 3	Thyristor RL 4	Diode 1
5Y0V0N0E0J0	Diode 1	Thyristor RL 2	Circuit RL 2	Full Bridge 1	Circuit R 2
5D0A0Y0H0Z0	Motor 4	Motor 1	Diode 1	Full Bridge 4	Diode 2
5J0M0Q0A0U0	Circuit R 2	Circuit RL 1	Thyristor R 1	Motor 1	Thyristor RL 1
5P0X0J0L0B0	Circuit RL 4	Thyristor RL 4	Circuit R 2	Circuit R 4	Motor 2
5W0R0I0E0C0	Thyristor RL 3	Thyristor R 2	Circuit R 1	Full Bridge 1	Motor 3
5B1O0S0Y0G0	Diode 4	Circuit RL 3	Thyristor R 3	Diode 1	Full Bridge 3
5L0M0T0U0C0	Circuit R 4	Circuit RL 1	Thyristor R 4	Thyristor RL 1	Motor 3

3.3 Trigger Angles

All the angles explained in this section has been powered by simulated alternative current source, attach on the loads. Triggering angles can be seen in Table 3.7, with the special attention for the thyristor circuits.

Table 3.7: Subset Simuladed - Angles and Circuits

Angle ID	Trigger Angle	Circuits
0	0° (*)	Motor, Full bridge, Circuits R and RL, Thyristor R and RL, Diode
1	45°	Motor, Full brigde, Circuits R and RL, Diode
2	90°	Motor, Full brigde, Circuits R and RL, Diode

(*) The circuits with thyristor have different angle, because of the delay in the component response. In the simulations the trigger angle after the thyristor are 60°.

Diferent from de Synthetic Subset, the Simulated used a especific angle for each trigger. Tables 3.8, 3.9, 3.10 and 3.11 represent the sequence of action for each combination on this Subset.

Table 3.8: Subset Simuladed - Duo Loads - Angles in order of trigger

Sequence	Trigger Angle 1	Trigger Angle 2
0	0°	0°
1	0°	45°
2	0°	90°
3	45°	0°
4	45°	45°
5	45°	90°
6	90°	0°
7	90°	45°
8	90°	90°

Table 3.9: Subset Simuladed - Triple Loads - Angles in order of trigger

Sequence	Trigger Angle 1	Trigger Angle 2	Trigger Angle 3
0	0°	0°	0°
1	0°	45°	0°
2	45°	90°	0°
3	90°	90°	45°
4	0°	0°	90°

Table 3.10: Subset Simuladed - Quadruple - Angles in order of trigger

Sequence	Trigger Angle 1	Trigger Angle 2	Trigger Angle 3	¨Trigger Angle 4
0	0°	0°	0°	0°
1	0°	0°	0°	45°
2	45°	90°	45°	90°
3	45°	90°	90°	0°
4	0°	45°	45°	45°

Table 3.11: Subset Simuladed - Quintuple - Angles in order of trigger

Sequence	Trigger Ang 1	Trigger Ang 2	Trigger Ang 3	¨Trigger Ang 4	Trigger Ang 5
0	0°	0°	0°	0°	0°
1	90°	45°	0°	0°	0°
2	45°	45°	45°	90°	90°
3	90°	45°	0°	0°	45°
4	90°	45°	0°	0°	0°