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Automatic Protection Testing System with RTDS

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- Red Eléctrica de España

HUGM RTDS USER'S GROUP MEETING

2024 EUROPE USER'S GROUP MEETING

DELFT, NETHERLANDS

RTDS Technologies

AMETEK

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Introduction.

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Introduction.

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Electromechanical Protection relays.

~1920

~1960

Analog Electronic Protection relays.

Digital Protection relays.

~1980

~2000

Digital Multiprocessor Protection and Control Relays

Today's Technology.

Introduction. – Testing Needs.

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The Firmware

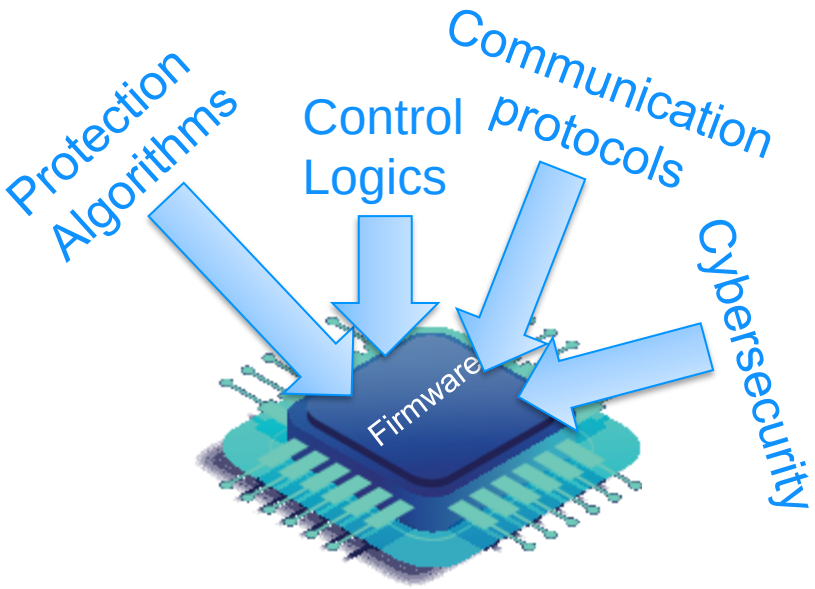
During last 10 years manufacturers are speeding up their firmware releases implementing fixes, new functionalities and cybersecurity patches.

The Tests

- Every new FW version has to be analysed to decided if it Will be implemented.
- It is mandatory to perform Tests to grant a proper performance of the device.

A solution is needed to be agile and secure.

Automate



Some manufacturers release up to 6 Firmwares every year!

Overview.

2

Overview.

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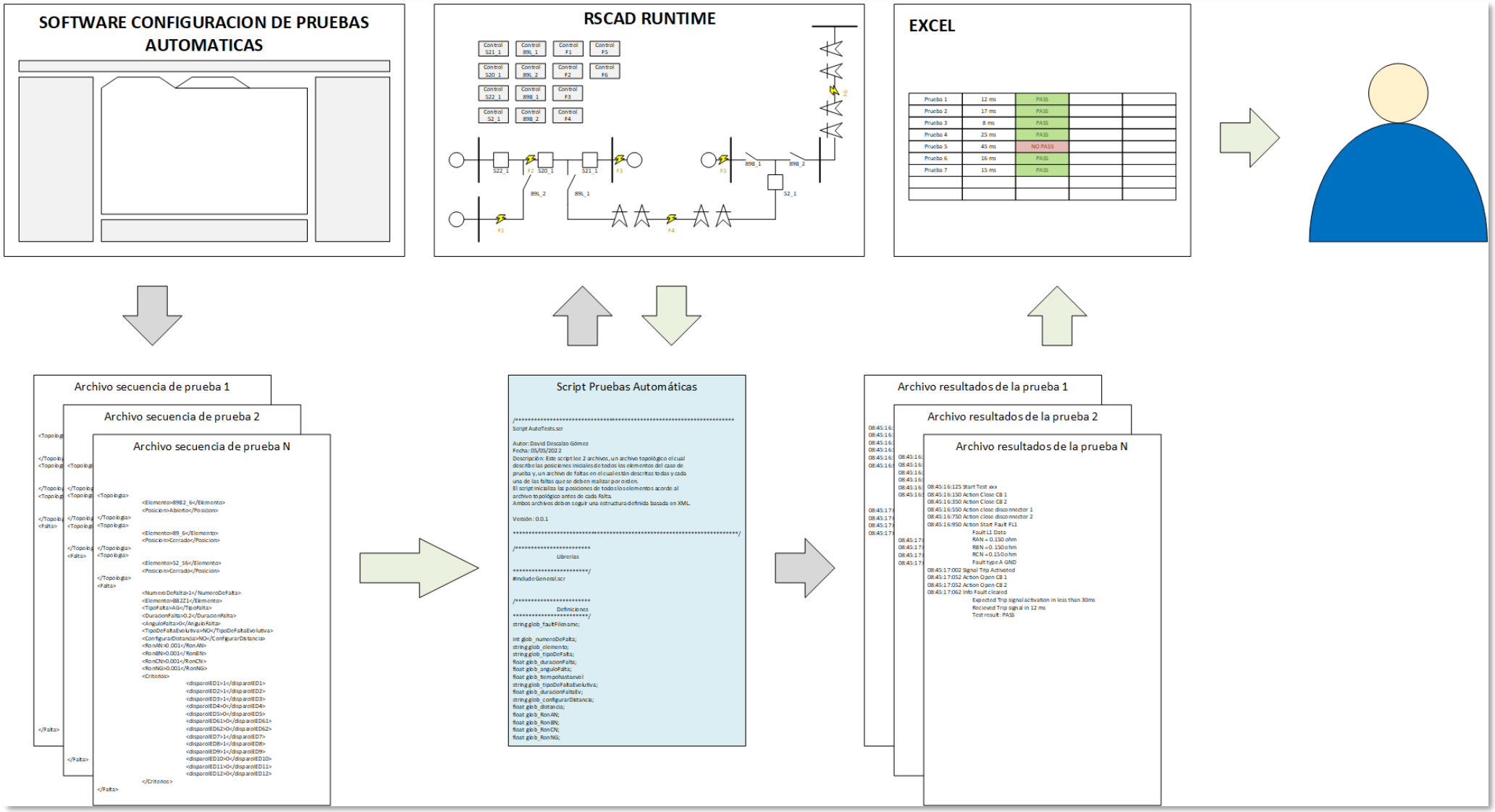
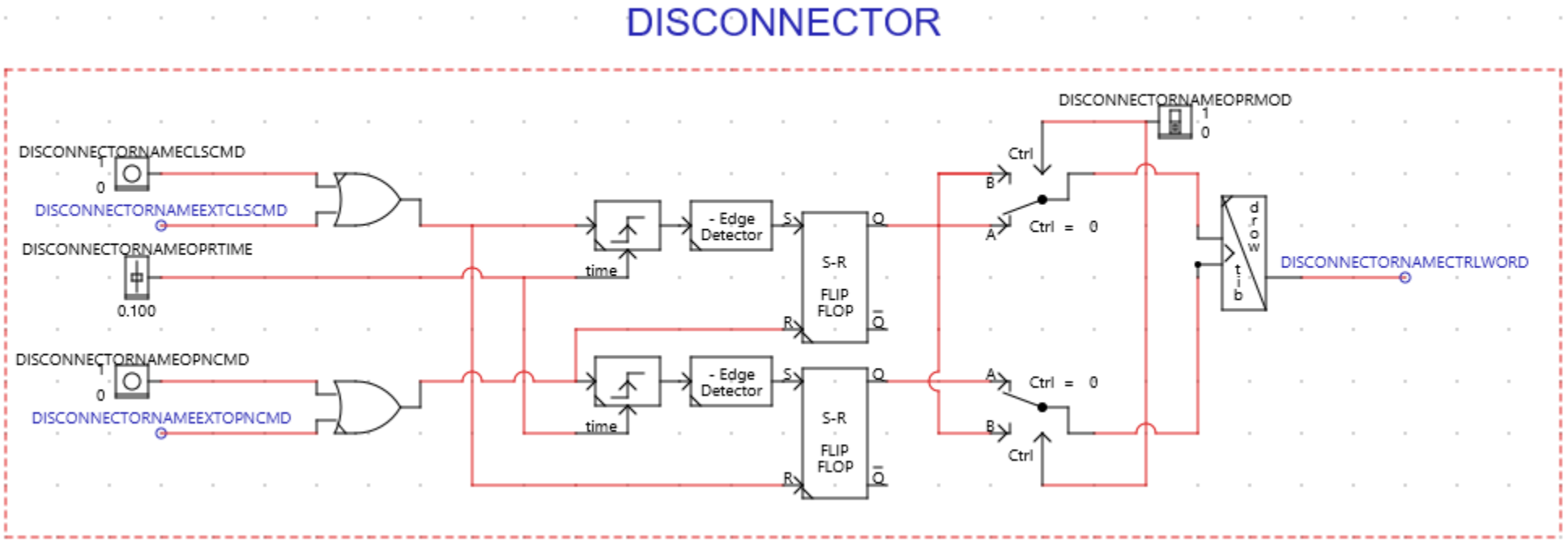


RSCAD Standarization.

3

Every functional element should be standarized

Every circuit breaker, disconnector, Fault, etc, should have a standarized structure and a standarized Namespace.



RSCAD Standarization.

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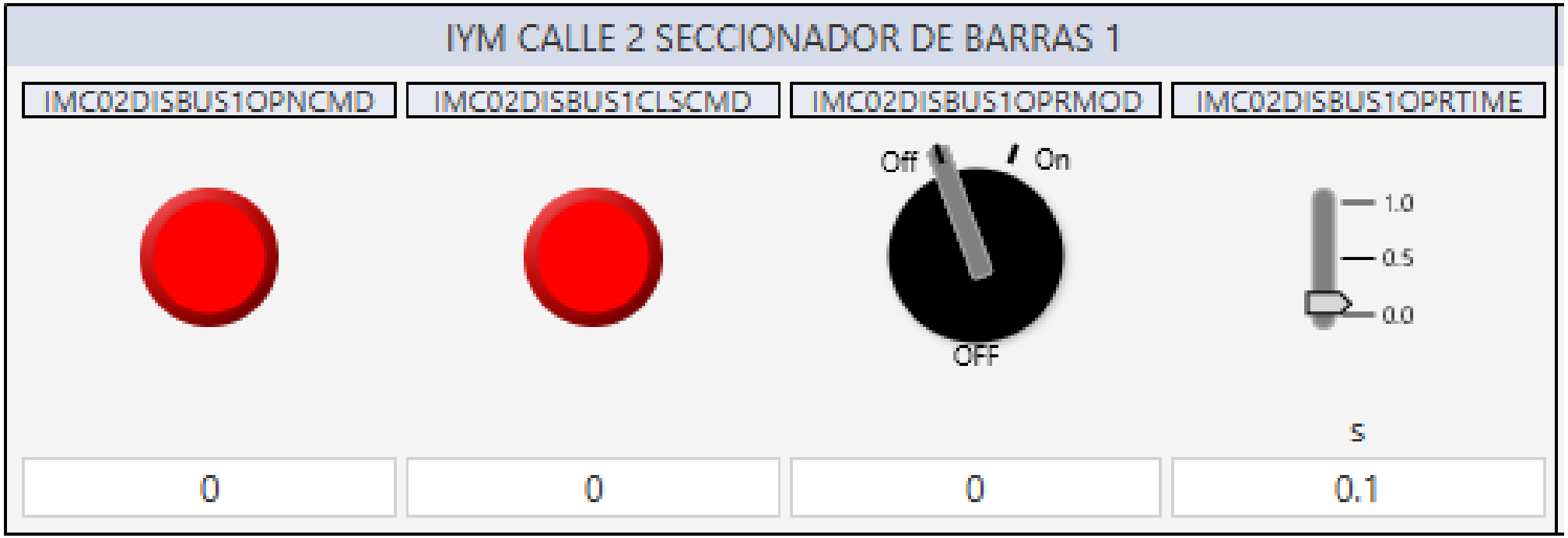
The Runtime Should Also be Standarized

The automation happens on the Runtime window.



RSCAD Standarization.

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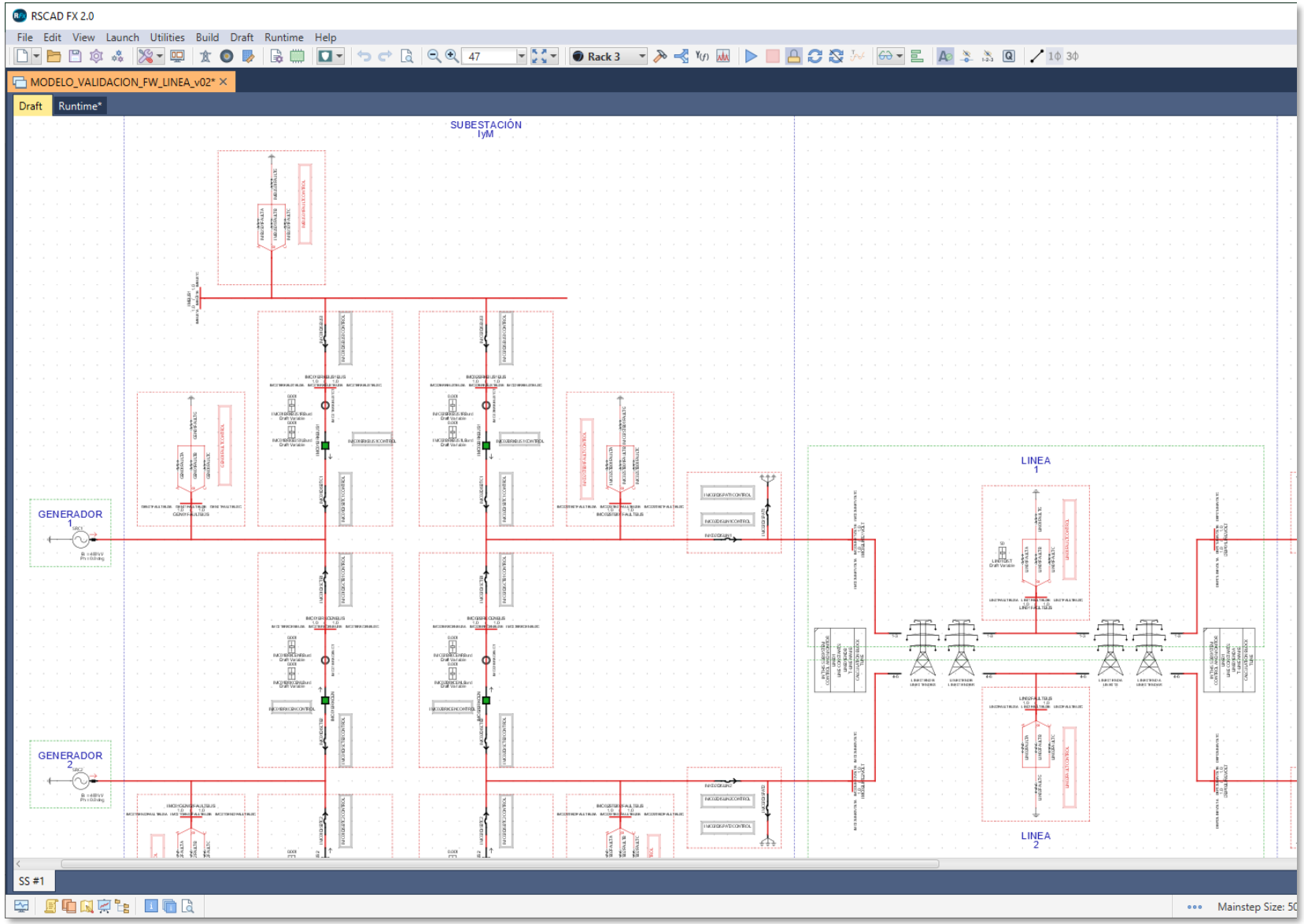

RSCAD Standarization.

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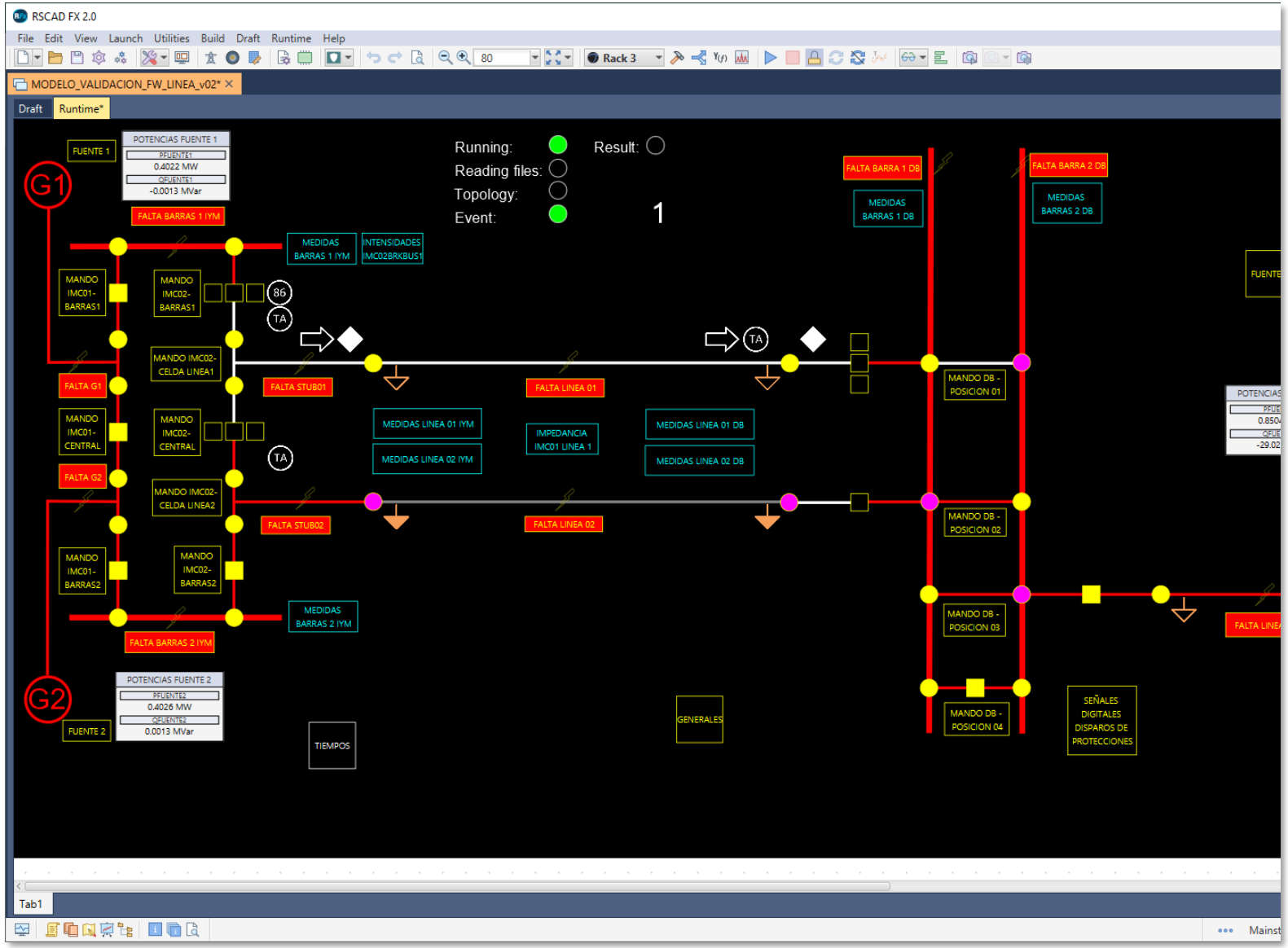

Automatic Test Configuration Tool (ATCT).

4

Automatic Tests Configuration Tool (ATCT).

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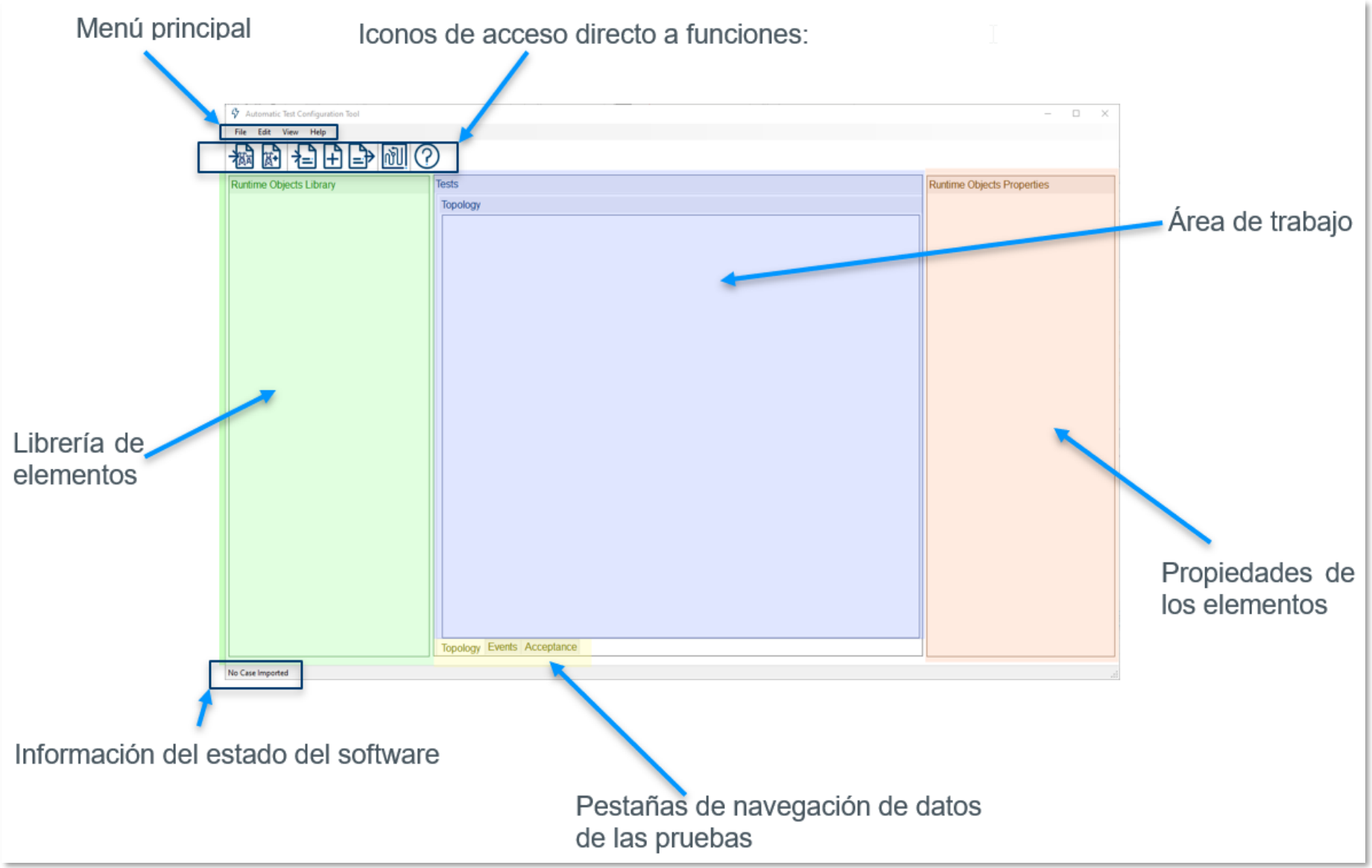

Automatic Tests Configuration Tool (ATCT).

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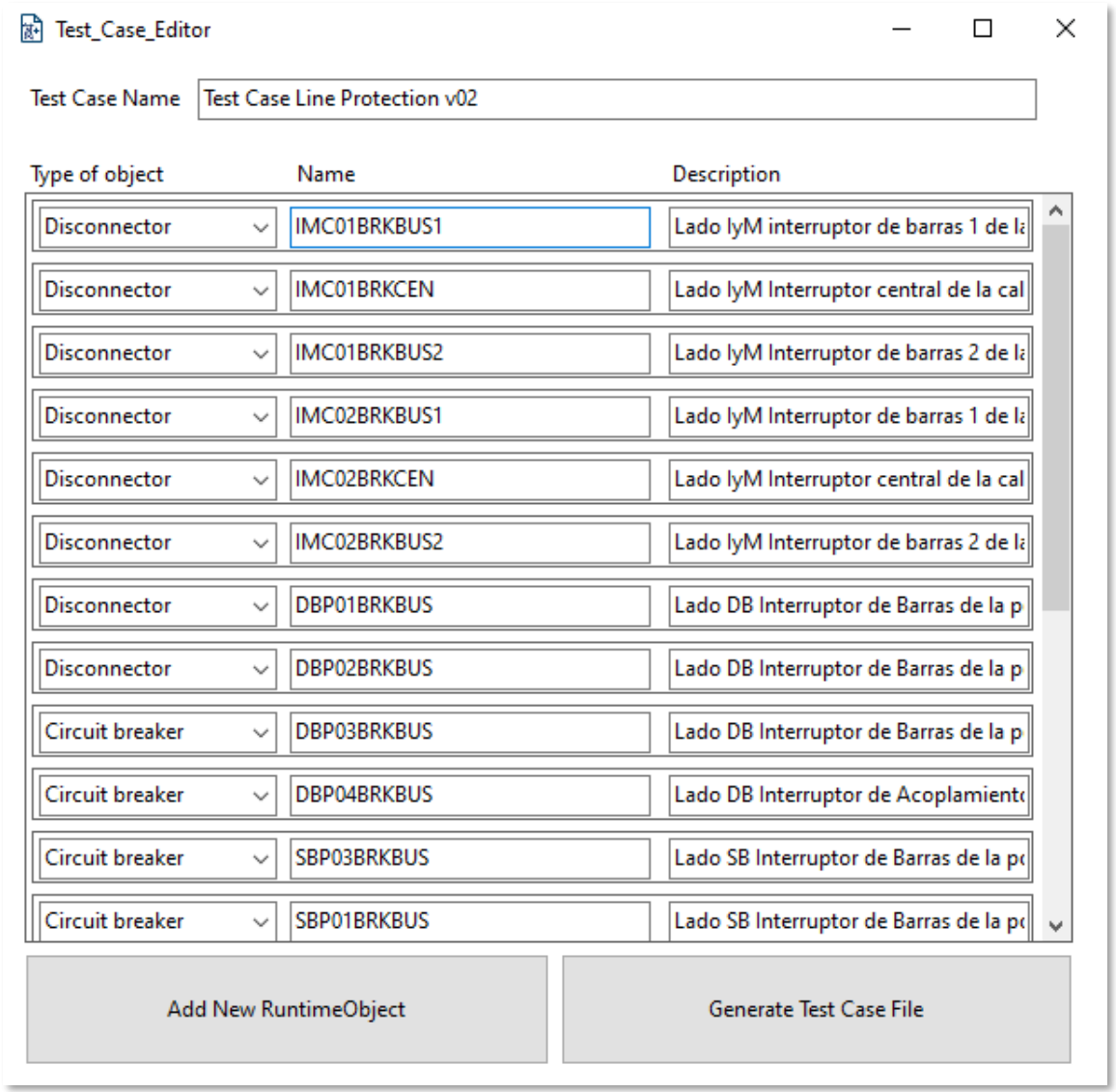

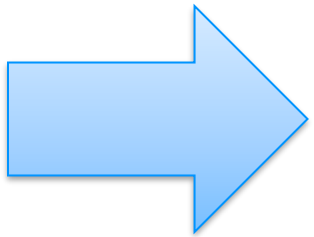

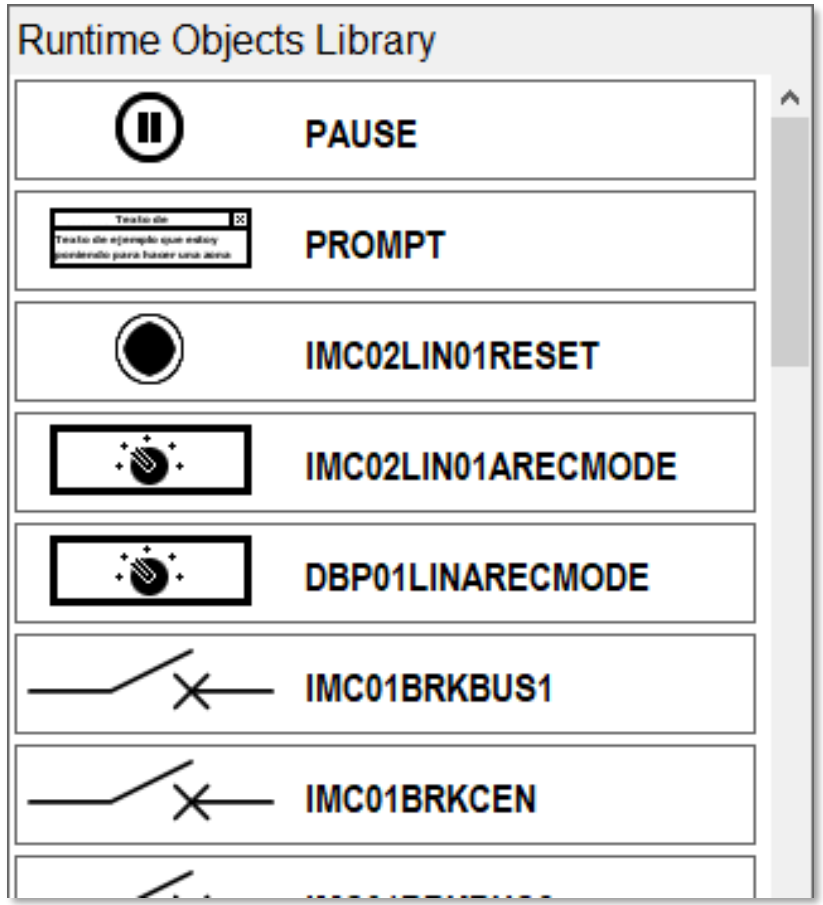

Automatic Tests Configuration Tool (ATCT).

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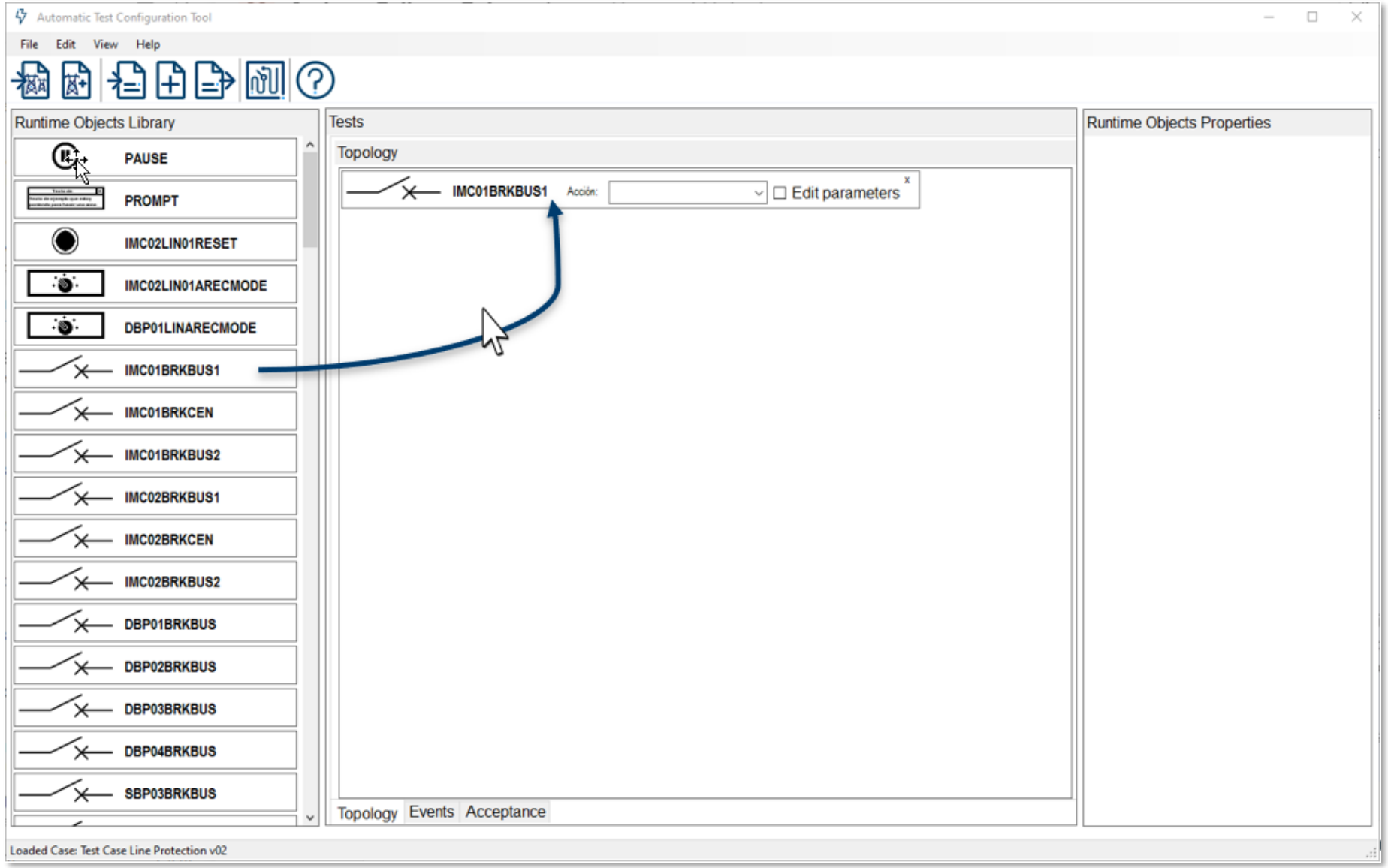

Automatic Tests Configuration Tool (ATCT).

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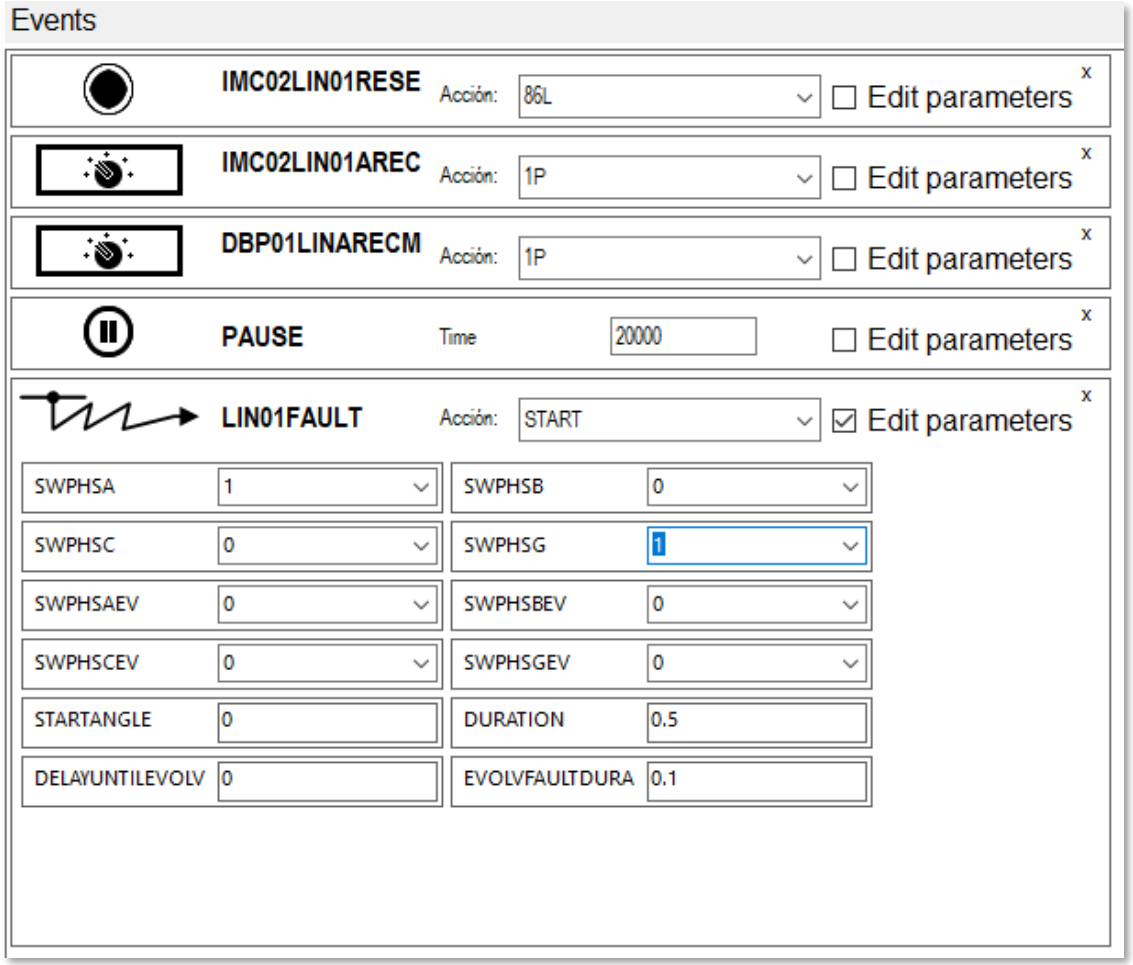
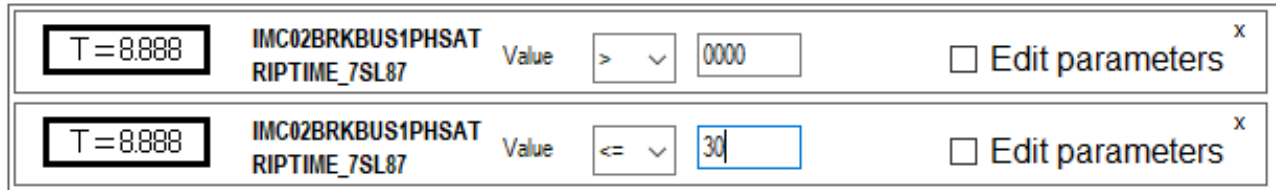
Events



Acceptance Conditions




```
<?xml version="1.0" encoding="utf-8"?>
<Test xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3
  <Event>
    <Element>IMC02LIN01ARECMODE</Element>
    <Dial>IMC02LIN01ARECMODE=2</Dial>
  </Event>
  <Event>
    <Element>DBP01LINARECMODE</Element>
    <Dial>DBP01LINARECMODE=2</Dial>
  </Event>
  <Event>
    <Element>PAUSE</Element>
    <Pausetime>PAUSE=20000</Pausetime>
  </Event>
  <Event>
    <Element>LIN01FAULT</Element>
    <Switch>LIN01FAULTSWPHSA=1</Switch>
    <Switch>LIN01FAULTSWPHSB=0</Switch>
    <Switch>LIN01FAULTSWPHSC=0</Switch>
    <Switch>LIN01FAULTSWPHSG=1</Switch>
    <Switch>LIN01FAULTSWPHSAEV=0</Switch>
    <Switch>LIN01FAULTSWPHSBEV=0</Switch>
    <Switch>LIN01FAULTSWPHSCEV=0</Switch>
    <Switch>LIN01FAULTSWPHSGEV=0</Switch>
    <Button>LIN01FAULTSTART</Button>
  </Event>
</Test>
```

Runtime Script.

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Runtime Script.

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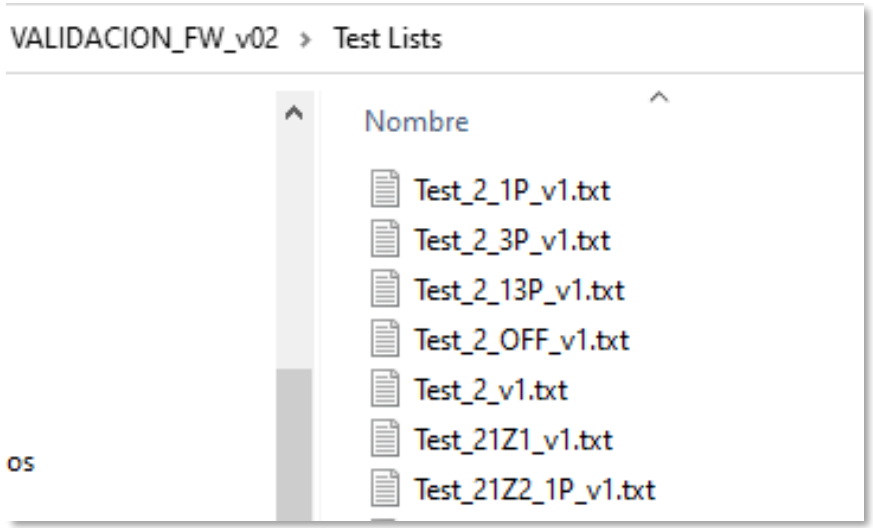
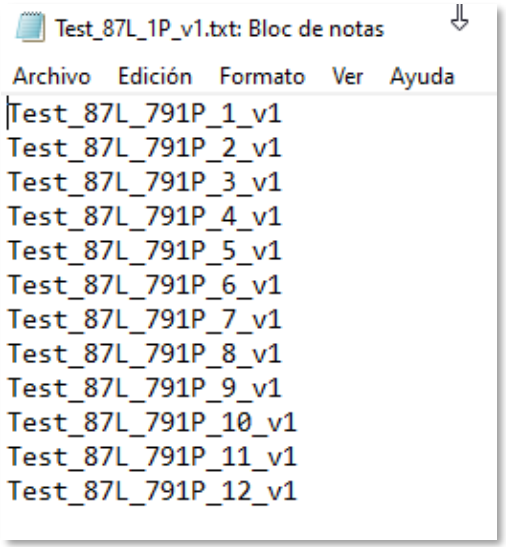
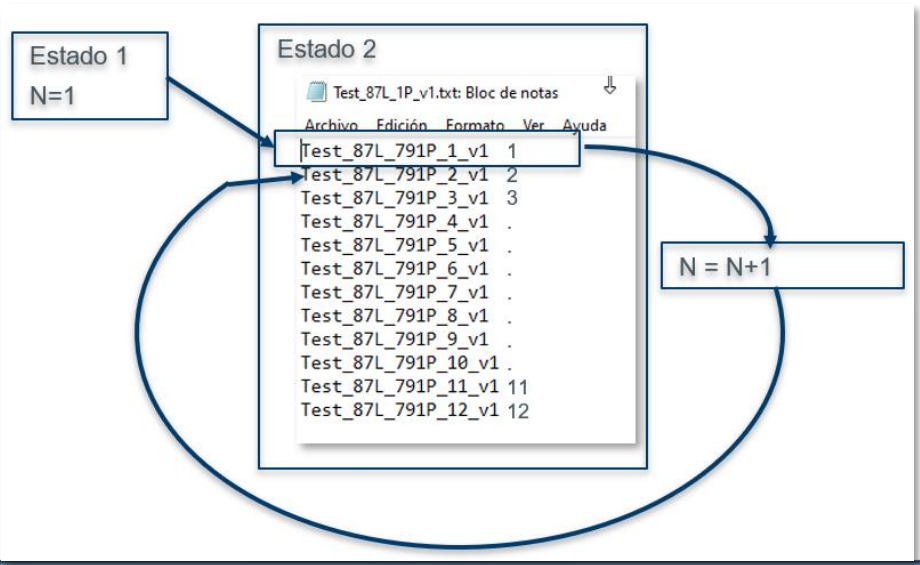
The Runtime script is based on a State Machine and a XML deserializer in C.

```
57  fprintf(stdmsg, "Starting state machine\n");
58  while (!end)
59  {
60      fprintf(stdmsg, "State machine: Entering state [%d]\n", state);
61      if (state == 0)
62      {
63          SetSlider "Subsystem #1 : CTLs : Inputs : PassOrNotPass" = 0.0;
64          // Estado 0: se solicita al usuario que introduzca el nombre del fichero de pruebas.
65          fprintf(stdmsg, "State machine - state [%d]: Asking user the name of the test file\n", state);
66          dialogscanf ("Enter TestList File Name: ","%s",name);
67          if (strcmp(name, "") == 0)
68          {
```







Results.

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Results.

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The Testing system generates both a log file and a CSV file with the results for each test.

Test_87L_v1_191023_1058_Log.txt: Bloc de notas

Archivo Edición Formato Ver Ayuda

```
10/19/2023 10:59:03.188: Starting test: Test_87L_79OFF_1_v1
10/19/2023 10:59:03.283: Setting Topology from file .\Test Files\Test_87L_79OFF_1_v1_topology.xml
10/19/2023 10:59:03.505:        -> Push Button IMC01DISBUS1CLSCMD
10/19/2023 10:59:03.743:        -> Push Button IMC01DISBTC1CLSCMD
10/19/2023 10:59:03.973:        -> Push Button IMC01DISCTB1CLSCMD
10/19/2023 10:59:04.209:        -> Push Button IMC01DISCTB2CLSCMD
10/19/2023 10:59:04.439:        -> Push Button IMC01DISBTC2CLSCMD
10/19/2023 10:59:04.681:        -> Push Button IMC01DISBUS2CLSCMD
10/19/2023 10:59:04.923:        -> Push Button IMC02DISBUS1CLSCMD
10/19/2023 10:59:05.163:        -> Push Button IMC02DISBTC1CLSCMD
10/19/2023 10:59:05.395:        -> Push Button IMC02DISCTB1CLSCMD
10/19/2023 10:59:05.621:        -> Push Button IMC02DISCTB2CLSCMD
10/19/2023 10:59:05.854:        -> Push Button IMC02DISBTC2CLSCMD
10/19/2023 10:59:06.085:        -> Push Button IMC02DISBUS2CLSCMD
10/19/2023 10:59:06.317:        -> Push Button IMC02DISLIN1CLSCMD
10/19/2023 10:59:06.551:        -> Push Button IMC02DISPAT2CLSCMD
10/19/2023 10:59:06.789:        -> Push Button DBP01DISLINCLSCMD
10/19/2023 10:59:07.030:        -> Push Button DBP01DISBUS1CLSCMD
10/19/2023 10:59:07.268:        -> Push Button DBP02DISPATCLSCMD
10/19/2023 10:59:07.499:        -> Push Button DBP02DISBUS2CLSCMD
10/19/2023 10:59:07.729:        -> Push Button DBP03DISLINCLSCMD
10/19/2023 10:59:07.965:        -> Push Button DBP03DISBUS1CLSCMD
10/19/2023 10:59:08.201:        -> Push Button DBP04DISBUS1CLSCMD
10/19/2023 10:59:08.437:        -> Push Button DBP04DISBUS2CLSCMD
10/19/2023 10:59:08.666:        -> Push Button SBP03DISLINCLSCMD
10/19/2023 10:59:08.897:        -> Push Button SBP03DISBUSCLSCMD
10/19/2023 10:59:09.139:        -> Push Button SBP01DISBUSCLSCMD
10/19/2023 10:59:09.382:        -> Push Button IMC01BRKBUS1CLSCMD3PH
10/19/2023 10:59:09.621:        -> Push Button IMC01BRKCENCLSCMD3PH
10/19/2023 10:59:09.857:        -> Push Button IMC01BRKBUS2CLSCMD3PH
10/19/2023 10:59:10.087:        -> Push Button IMC02BRKBUS1CLSCMD3PH
10/19/2023 10:59:10.331:        -> Push Button IMC02BRKCENCLSCMD3PH
10/19/2023 10:59:10.579:        -> Push Button IMC02BRKBUS2CLSCMD3PH
10/19/2023 10:59:10.813:        -> Push Button DBP01BRKBUSCLSCMD3PH
10/19/2023 10:59:11.053:        -> Push Button DBP03BRKBUSCLSCMD3PH
10/19/2023 10:59:11.295:        -> Push Button DBP04BRKBUSCLSCMD3PH
10/19/2023 10:59:11.515:        -> Push Button SBP03BRKBUSCLSCMD3PH
10/19/2023 10:59:11.752:        -> Push Button SBP01BRKBUSCLSCMD3PH
10/19/2023 10:59:11.911: Setting Topology ended
10/19/2023 10:59:11.911: Waiting 5 seconds for case to stabilize
10/19/2023 10:59:19.639:        -> Condition 1 is: IMC02BRKBUS1PHSATRIPTIME_7SL87 Greater than 0.0
10/19/2023 10:59:19.640:        -> Condition 2 is: IMC02BRKBUS1PHSATRIPTIME_7SL87 LowerOrEqual tha
```

Línea 1,

Test_87L_v1_191023_1058.csv - Excel

	A	B	C	D	E	F	G
1	Test File	Event Number	Meter name	Meter value (s)			
2	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017750000000000002	Greater	0.000000	PASS
3	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017750000000000002	LowerOrEqual	0.030000	PASS
4	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHSBTRIPTIME_7SL87	0.017650000000000002	Greater	0.000000	PASS
5	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHSBTRIPTIME_7SL87	0.017650000000000002	LowerOrEqual	0.030000	PASS
6	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHSCTRIPTIME_7SL87	0.017400000000000002	Greater	0.000000	PASS
7	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHSCTRIPTIME_7SL87	0.017400000000000002	LowerOrEqual	0.030000	PASS
8	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHS3CLOSETIME_7SL87	0.0	Equal	0.000000	PASS
9	Test_87L_79OFF_1_v1	1	IMC02BRKBUS1PHS3CLOSETIME_7SL87	0.0	Lower	2.000.000	PASS
10	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHSATRIPTIME_7SL87	0.01695	Greater	0.000000	PASS
11	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHSATRIPTIME_7SL87	0.01695	LowerOrEqual	0.030000	PASS
12	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHSBTRIPTIME_7SL87	0.0171	Greater	0.000000	PASS
13	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHSBTRIPTIME_7SL87	0.0171	LowerOrEqual	0.030000	PASS
14	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHSCTRIPTIME_7SL87	0.0167	Greater	0.000000	PASS
15	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHSCTRIPTIME_7SL87	0.0167	LowerOrEqual	0.030000	PASS
16	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHS3CLOSETIME_7SL87	0.0	Equal	0.000000	PASS
17	Test_87L_79OFF_1_v1	1	IMC02BRKCENPHS3CLOSETIME_7SL87	0.0	Lower	2.000.000	PASS
18	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0164	Greater	0.000000	PASS
19	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0164	LowerOrEqual	0.030000	PASS
20	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHSBTRIPTIME_7SL87	0.0162	Greater	0.000000	PASS
21	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHSBTRIPTIME_7SL87	0.0162	LowerOrEqual	0.030000	PASS
22	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHSCTRIPTIME_7SL87	0.016550000000000002	Greater	0.000000	PASS
23	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHSCTRIPTIME_7SL87	0.016550000000000002	LowerOrEqual	0.030000	PASS
24	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHS3CLOSETIME_7SL87	0.0	Equal	0.000000	PASS
25	Test_87L_79OFF_1_v1	1	DBP01BRKBUSPHS3CLOSETIME_7SL87	0.0	Lower	2.000.000	PASS
26	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.014400000000000001	Greater	0.000000	PASS
27	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.014400000000000001	LowerOrEqual	0.030000	PASS
28	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHSBTRIPTIME_7SL87	0.0143	Greater	0.000000	PASS
29	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHSBTRIPTIME_7SL87	0.0143	LowerOrEqual	0.030000	PASS
30	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHSCTRIPTIME_7SL87	0.014150000000000001	Greater	0.000000	PASS
31	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHSCTRIPTIME_7SL87	0.014150000000000001	LowerOrEqual	0.030000	PASS
32	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHS3CLOSETIME_7SL87	0.0	Equal	0.000000	PASS
33	Test_87L_79OFF_1_v1	2	IMC02BRKBUS1PHS3CLOSETIME_7SL87	0.0	Lower	2.000.000	PASS
34	Test_87L_79OFF_1_v1	2	IMC02BRKCENPHSATRIPTIME_7SL87	0.013600000000000001	Greater	0.000000	PASS
35	Test_87L_79OFF_1_v1	2	IMC02BRKCENPHSATRIPTIME_7SL87	0.013600000000000001	LowerOrEqual	0.030000	PASS
36	Test_87L_79OFF_1_v1	2	IMC02BRKCENPHSBTRIPTIME_7SL87	0.01365	Greater	0.000000	PASS
37	Test_87L_79OFF_1_v1	2	IMC02BRKCENPHSBTRIPTIME_7SL87	0.01365	LowerOrEqual	0.030000	PASS
38	Test_87L_79OFF_1_v1	2	IMC02BRKCENPHSCTRIPTIME_7SL87	0.013250000000000001	Greater	0.000000	PASS

Test_87L_v1_191023_1058

Results.

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This system greatly reduces the time needed to validate new firmware versions and increases the tracebility of the Tests.

For example, in case of validating a new Firmware version of a device previously homologated and already wired to the RTDS we have reduced the time needed to make the validation from months to days, being the raw testing time 13:15 hours (If the device still performs correctly in the new firmware version, if not the testing engineer has to investigate the cause and start conversations with the manufacturer).

Nombre	Numero de pruebas	Numero de ficheros	Tiempo total de ejecución	Resultado
P87STUB	88	43	1:30	PASS
P87L	148	43	2:00	PASS
P21Z1	148	43	2:00	PASS
P21Z2	80	8	1:00	PASS
P67N	40	8	1:00	PASS
P50BF	17	17	1:00	PASS
P59	4	4	0:15	PASS
P27	12	12	0:15	PASS
MANCLS	9	9	0:15	PASS
SYNC	8	8	0:15	PASS
ASYNC	20	20	1:00	PASS
2	72	24	1:15	PASS
SOTF	120	12	1:30	PASS
Total	766	251	13:15	

Video.

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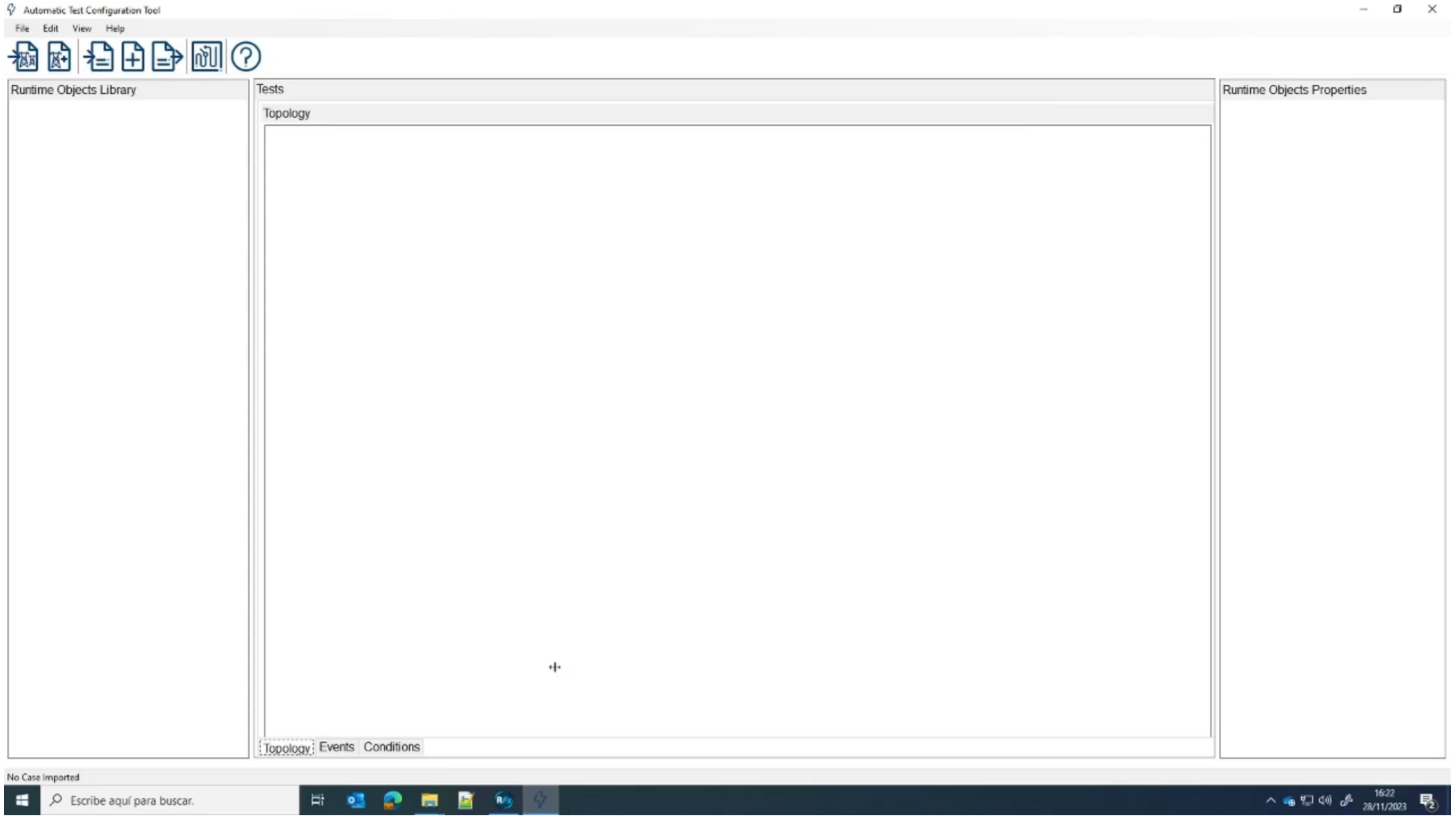

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Valuing the essentials

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