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# Automatic Protection Testing System with RTDS

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2024 EUROPE USER'S GROUP MEETING  
DELFT, NETHERLANDS



1. Introduction.
2. Overview.
3. RSCAD Standarization.
4. Automatic Test Configuration Tool (ATCT).
5. Runtime Script.
6. Results.



# Introduction.

1

Electromechanical  
Protection relays.

~1920

Digital Protection  
relays.

~1980

~1960

Analog Electronic  
Protection relays.

~2000

Digital  
Multiprocessor  
Protection and  
Control Relays  
Today's Technology.





## The Firmware

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

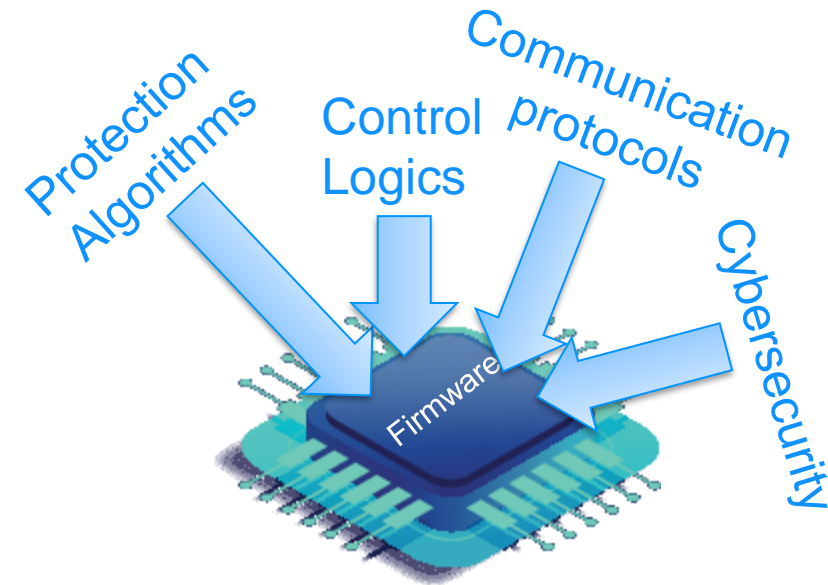
## The Tests

- 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**

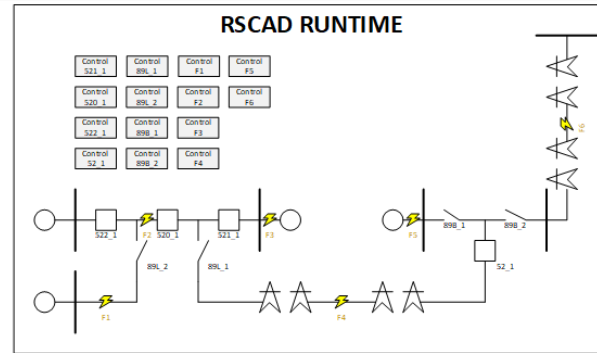
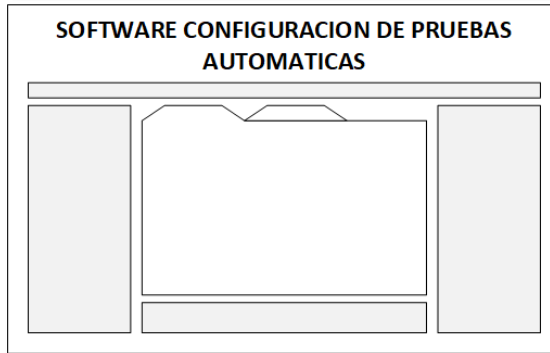


Some manufacturers release up to 6 Firmwares every year!

# Overview.

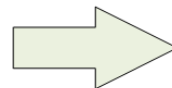
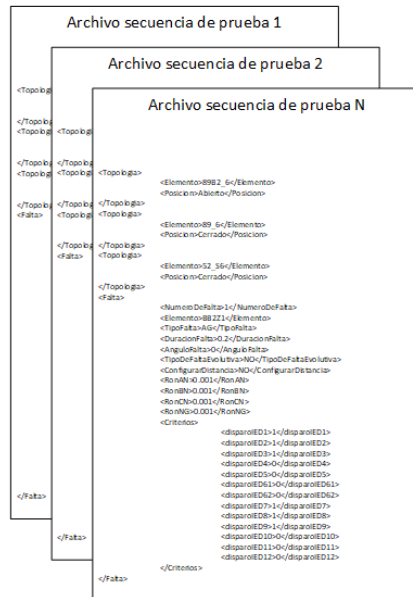
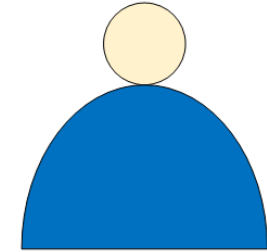
2





### EXCEL

Prueba 1	12 ms	PASS		
Prueba 2	17 ms	PASS		
Prueba 3	8 ms	PASS		
Prueba 4	25 ms	PASS		
Prueba 5	45 ms	NO PASS		
Prueba 6	16 ms	PASS		
Prueba 7	15 ms	PASS		



### Script Pruebas Automáticas

```

/*****
Script AutoTests.scr
Autor: David Descalzo Gómez
Fecha: 05/05/2022
Descripción: Este script lee 2 archivos, un archivo topológico el cual describe las posiciones iniciales de todos los elementos del caso de prueba y, un archivo de fallos en el cual están descritas todas y cada una de las fallos que se deben realizar por orden.
El script inicializa las posiciones de todos los elementos a acorde al archivo topológico antes de cada Run.
Ambos archivos deben seguir una estructura definida basada en XML.
Versión: 0.0.1
*****/

Librerías
*****
#include Gen.rsc

/*****
Definiciones
*****/
string glob_faltasName;
int glob_numeroDefaltas;
string glob_elemento;
string glob_tipoDefaltas;
float glob_duracionFalta;
float glob_anguloFalta;
float glob_temphastaevel;
string glob_tipoDefaltasVelutiva;
float glob_duracionActiv;
string glob_configuracionDistancia;
float glob_distancia;
float glob_RomAN;
float glob_RomBN;
float glob_RomCN;
float glob_RomW;
  
```



### Archivo resultados de la prueba 1

### Archivo resultados de la prueba N

```

08:45:16 08:45:16: Start Test xxx
08:45:16 08:45:16: Action Close CB 1
08:45:16 08:45:16: Action Close CB 2
08:45:17 08:45:16:550 Action Close discomector 1
08:45:17 08:45:16:750 Action Close discomector 2
08:45:17 08:45:16:950 Action State Fault F11
08:45:17 08:45:17: Fault1 Data
08:45:17 08:45:17: RAN = 0.150 ohm
08:45:17 08:45:17: REN = 0.150 ohm
08:45:17 08:45:17: RCN = 0.150 ohm
08:45:17 08:45:17: Fault type A_GND
08:45:17 08:45:17:002 Signal Trip Activated
08:45:17 08:45:17:052 Action Open CB 1
08:45:17 08:45:17:052 Action Open CB 2
08:45:17 08:45:17:062 Info Fault cleared
08:45:17 08:45:17:062 Info Trip signal activation in less than 30ms
08:45:17 08:45:17:062 Info Received Trip signal in 12 ms
08:45:17 08:45:17:062 Test result: PASS
  
```





# RSCAD Standardization.

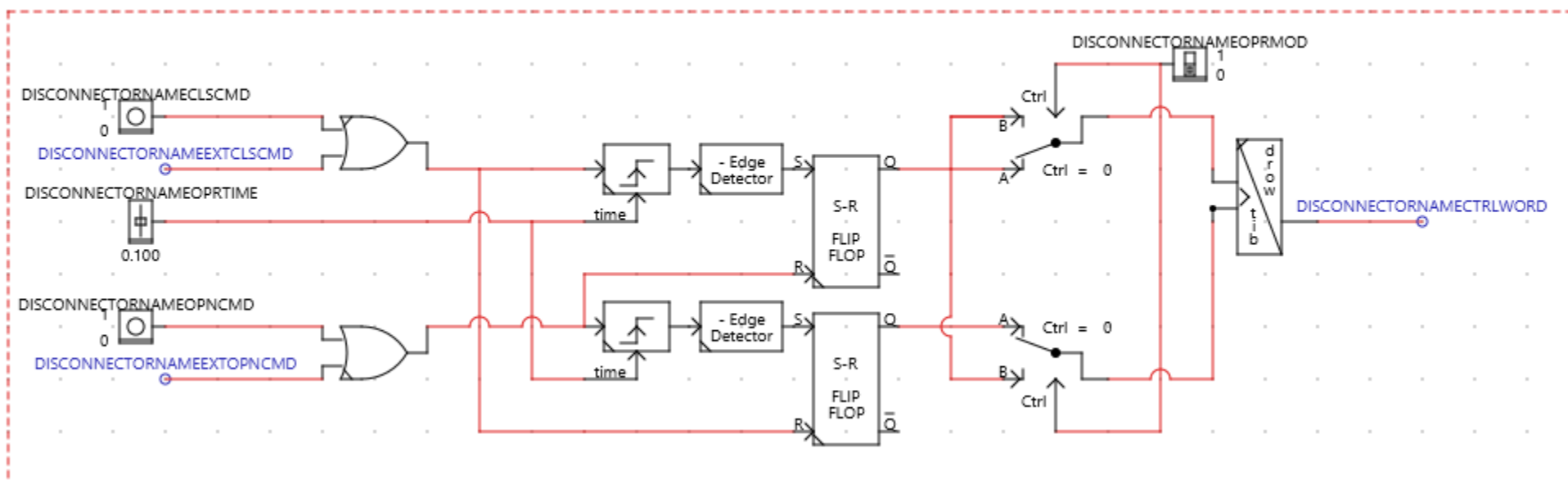
3



## Every functional element should be standardized

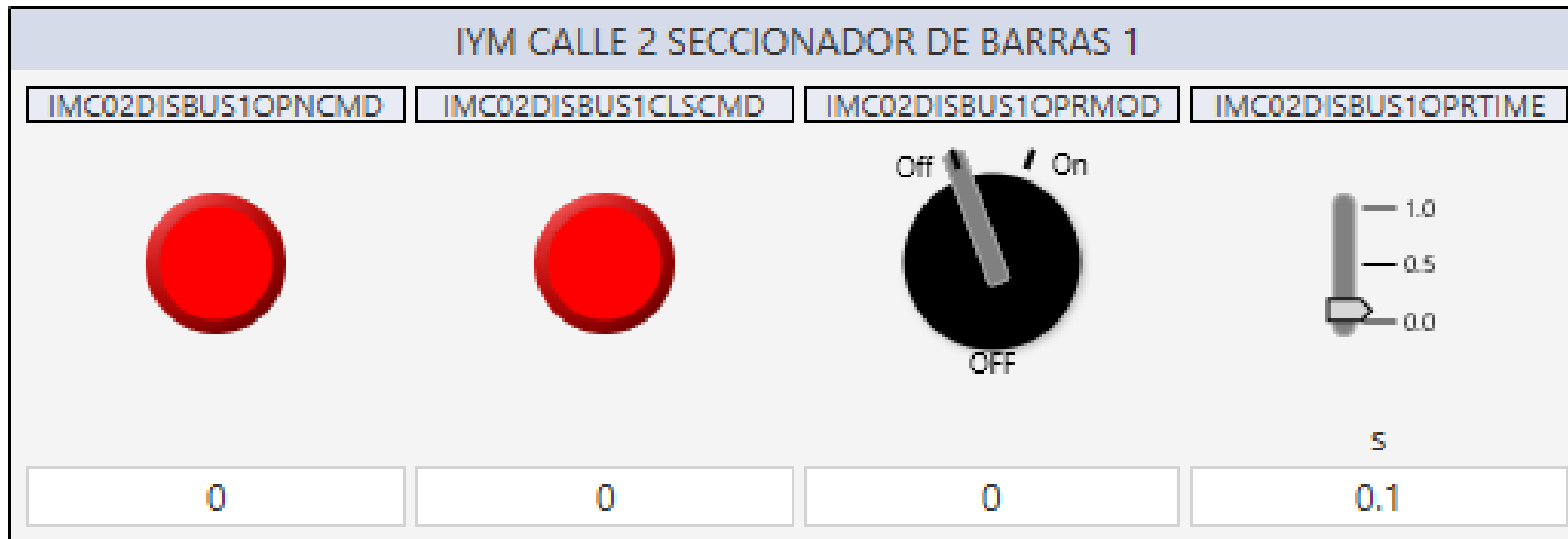
Every circuit breaker, disconnector, Fault, etc, should have a standardized structure and a standardized Namespace.

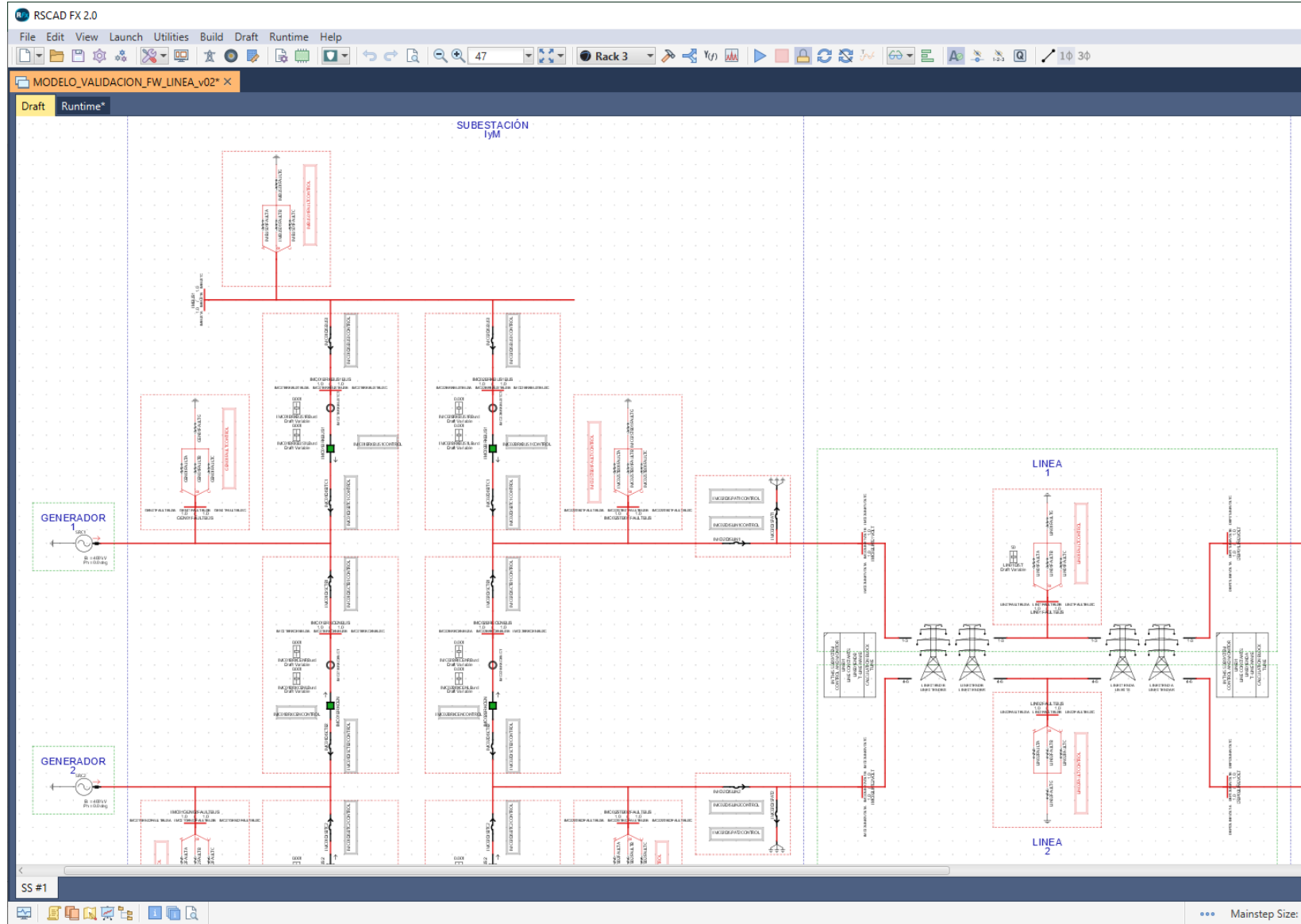
### DISCONNECTOR



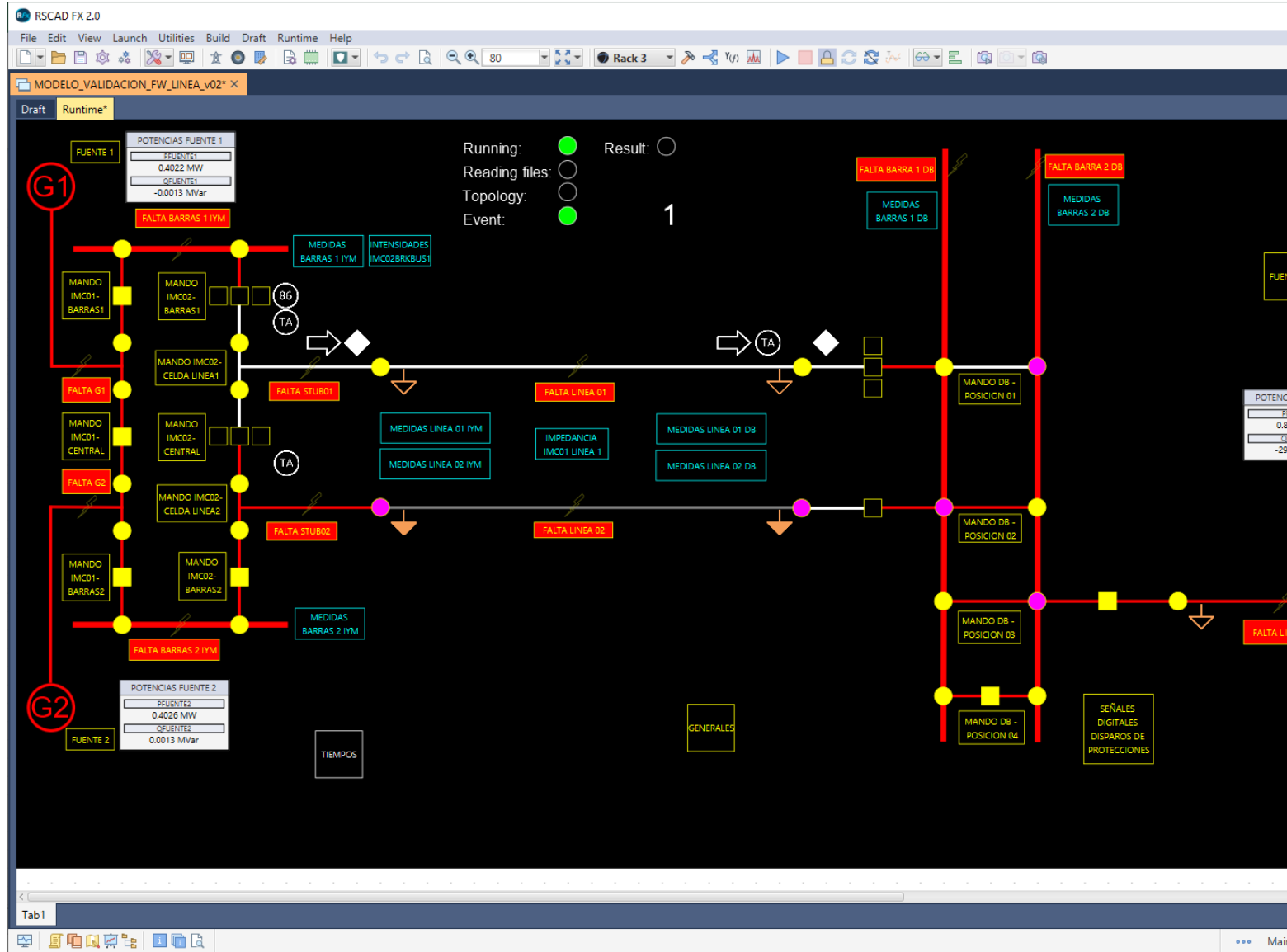
### The Runtime Should Also be Standardized

The automation happens on the Runtime window.





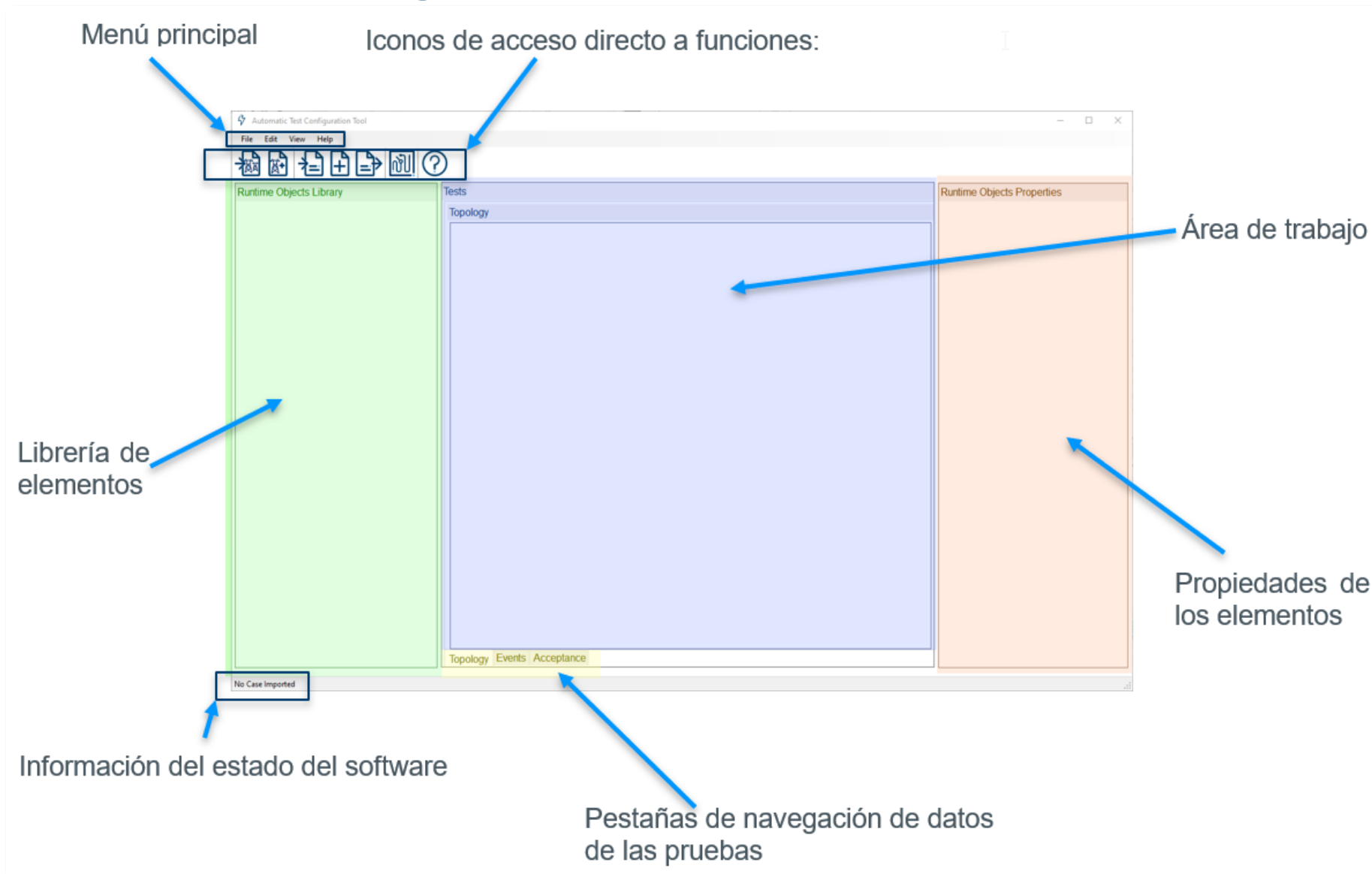




# Automatic Test Configuration Tool (ATCT).

4





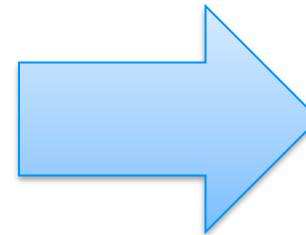


Test Case Editor

Test Case Name: Test Case Line Protection v02

Type of object	Name	Description
Disconnecter	IMC01BRKBUS1	Lado lyM interruptor de barras 1 de la
Disconnecter	IMC01BRKCEN	Lado lyM Interruptor central de la cal
Disconnecter	IMC01BRKBUS2	Lado lyM Interruptor de barras 2 de la
Disconnecter	IMC02BRKBUS1	Lado lyM Interruptor de barras 1 de la
Disconnecter	IMC02BRKCEN	Lado lyM Interruptor central de la cal
Disconnecter	IMC02BRKBUS2	Lado lyM Interruptor de barras 2 de la
Disconnecter	DBP01BRKBUS	Lado DB Interruptor de Barras de la p
Disconnecter	DBP02BRKBUS	Lado DB Interruptor de Barras de la p
Circuit breaker	DBP03BRKBUS	Lado DB Interruptor de Barras de la p
Circuit breaker	DBP04BRKBUS	Lado DB Interruptor de Acoplamiento
Circuit breaker	SBP03BRKBUS	Lado SB Interruptor de Barras de la p
Circuit breaker	SBP01BRKBUS	Lado SB Interruptor de Barras de la p

Add New RuntimeObject      Generate Test Case File

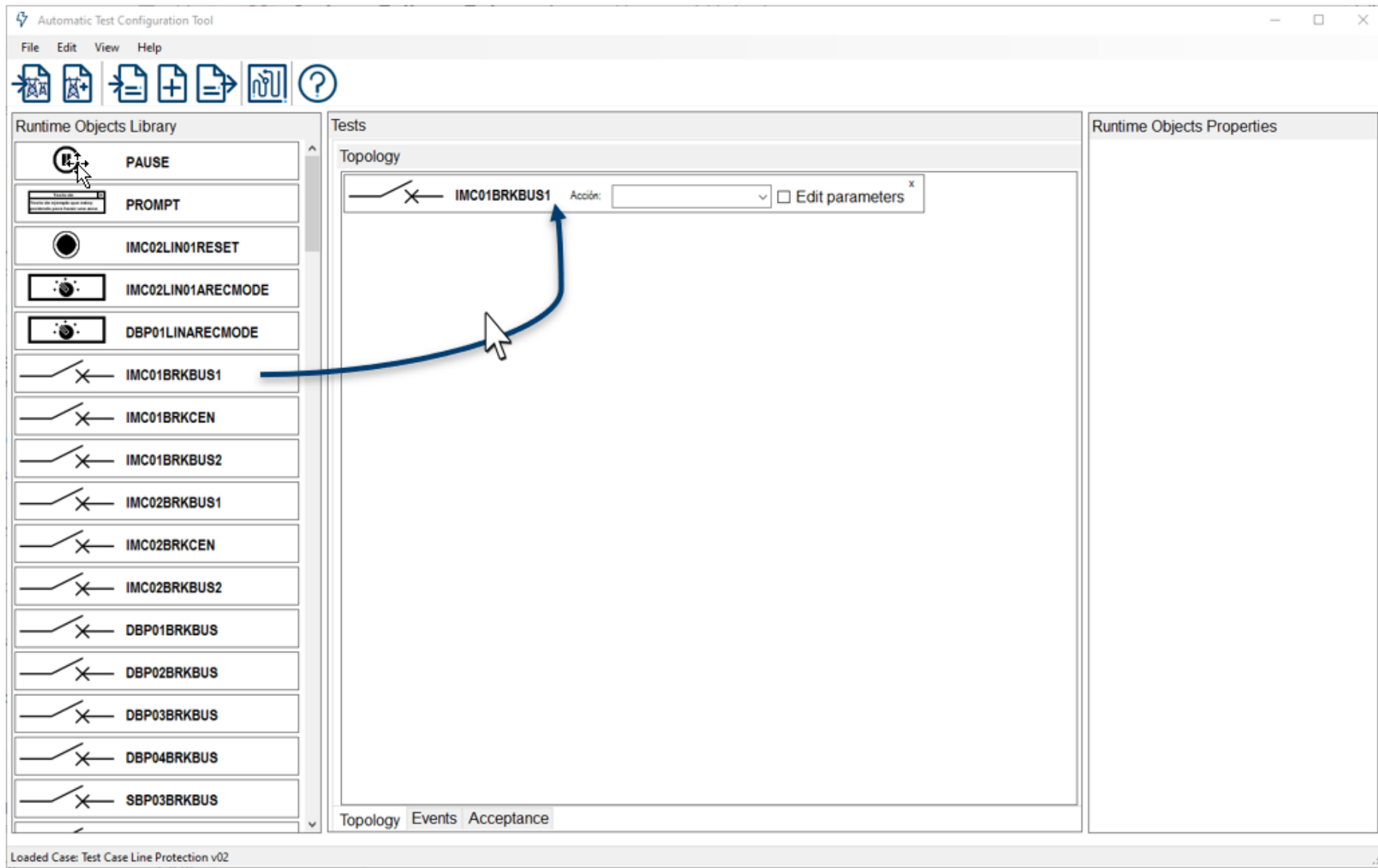


Runtime Objects Library

- PAUSE
- PROMPT
- IMC02LIN01RESET
- IMC02LIN01ARECMODE
- DBP01LINARECMODE
- IMC01BRKBUS1
- IMC01BRKCEN

# Automatic Tests Configuration Tool (ATCT).

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## Events

	<b>IMC02LIN01RESE</b>	Acción: 86L	<input type="checkbox"/> Edit parameters
	<b>IMC02LIN01AREC</b>	Acción: 1P	<input type="checkbox"/> Edit parameters
	<b>DBP01LINARECM</b>	Acción: 1P	<input type="checkbox"/> Edit parameters
	<b>PAUSE</b>	Time: 20000	<input type="checkbox"/> Edit parameters
	<b>LIN01FAULT</b>	Acción: START	<input checked="" type="checkbox"/> Edit parameters

SWPHSA	1	SWPHSB	0
SWPHSC	0	SWPHSG	1
SWPHSAEV	0	SWPHSBEV	0
SWPHSCEV	0	SWPHSGEV	0
STARTANGLE	0	DURATION	0.5
DELAYUNTILEVOLV	0	EVOLVFAULTDURA	0.1

## Acceptance Conditions

T=8.888	IMC02BRKBUS1PHSAT RIPTIME_7SL87	Value >	0000	<input type="checkbox"/> Edit parameters
T=8.888	IMC02BRKBUS1PHSAT RIPTIME_7SL87	Value <=	30	<input type="checkbox"/> Edit parameters

```
<?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.

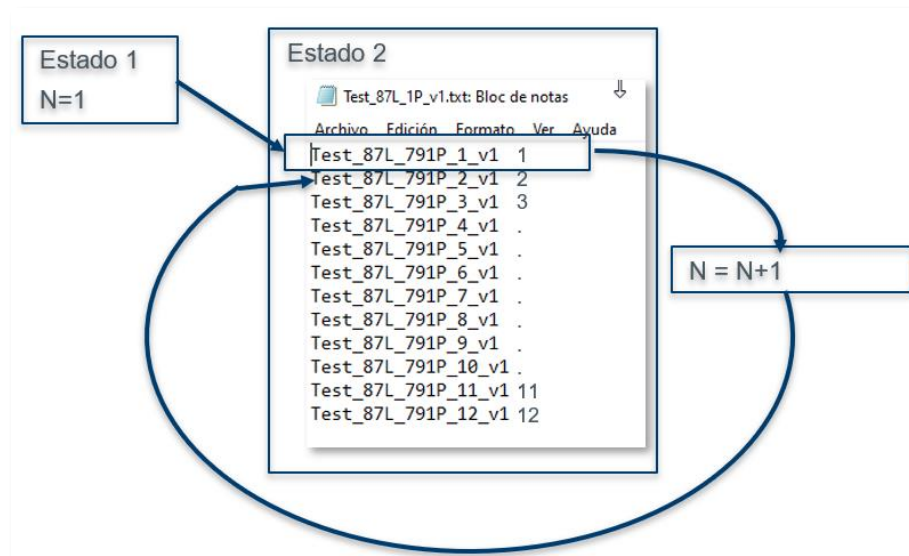
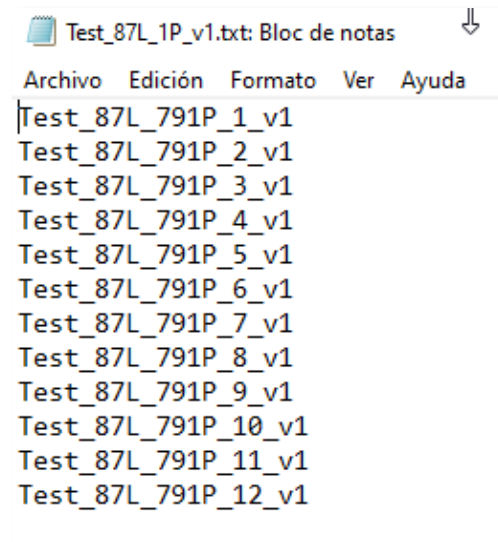
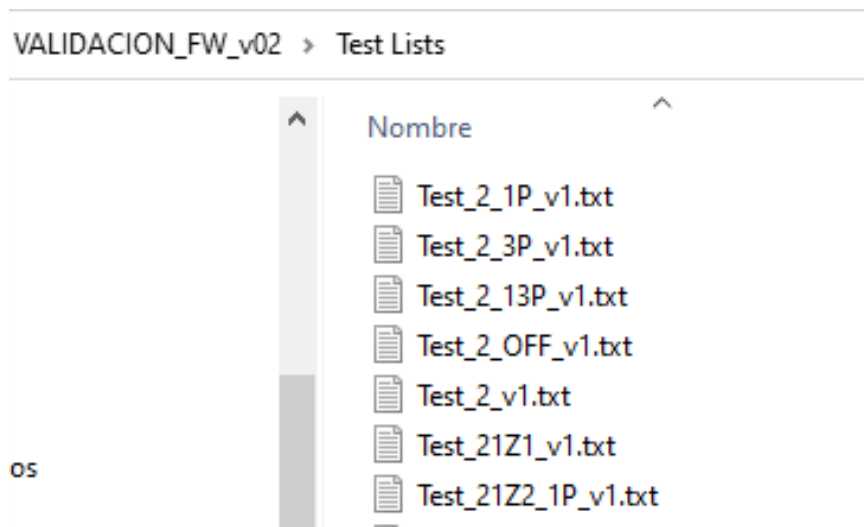
5

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.

5



## 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_790FF_1_v1
10/19/2023 10:59:03.283: Setting Topology from file .\Test Files\Test_87L_790FF_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 IMC01BRKCNCLSCMD3PH
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 IMC02BRKCNCLSCMD3PH
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 0.00
10/19/2023 10:59:19.640: -> Condition 2 is: IMC02BRKBUS1PHSATRIPTIME_7SL87 LowerOrEqual than
    
```

Test File	Event Number	Meter name	Meter value (s)			
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017750000000000002	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017750000000000002	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017650000000000002	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017650000000000002	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017400000000000002	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.017400000000000002	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.0	Equal	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.0	Lower	2.000.000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.01695	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.01695	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.0171	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.0171	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.0167	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.0167	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.0	Equal	0.000000	PASS
Test_87L_790FF_1_v1	1	IMC02BRKCNPHSATRIPTIME_7SL87	0.0	Lower	2.000.000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0164	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0164	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0162	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0162	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.016550000000000002	Greater	0.000000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.016550000000000002	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0	Equal	0.000000	PASS
Test_87L_790FF_1_v1	1	DBP01BRKBUSPHSATRIPTIME_7SL87	0.0	Lower	2.000.000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.014400000000000001	Greater	0.000000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.014400000000000001	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.0143	Greater	0.000000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.0143	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.014150000000000001	Greater	0.000000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.014150000000000001	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.0	Equal	0.000000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKBUS1PHSATRIPTIME_7SL87	0.0	Lower	2.000.000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKCNPHSATRIPTIME_7SL87	0.013600000000000001	Greater	0.000000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKCNPHSATRIPTIME_7SL87	0.013600000000000001	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKCNPHSATRIPTIME_7SL87	0.01365	Greater	0.000000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKCNPHSATRIPTIME_7SL87	0.01365	LowerOrEqual	0.030000	PASS
Test_87L_790FF_1_v1	2	IMC02BRKCNPHSATRIPTIME_7SL87	0.013250000000000001	Greater	0.000000	PASS

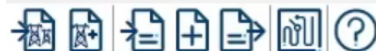


**This system greatly reduces the time needed to validate new firmware versions and increases the traceability of the Tests.**

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	





Runtime Objects Library

Tests

Runtime Objects Properties

Topology

Topology: Events Conditions

No Case Imported

Escribe aquí para buscar.



16:22  
28/11/2023



# redeia

Valuing the essentials

---

red eléctrica

reintel

hispasat

redinter

elewit

