



# **Advanced Methodology for High-Level System Test Design**

IEC TC91 WG15 JNC

1 Sept 2023

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# Background

1. At the IEC TC91 WG15 meeting in 2022, extending the scope of the Bird's Eye View (BVAS) project for the ATS standards was proposed and positively agreed by IEC members.
2. Based on the studies after that, we are ready to propose a draft standard for the methodology of the high-level design for system test at WG15 international meeting to be held in fall this year
3. Analysis of the experimental studies using prototype system products confirms that this method is useful for efficient and accurate testing of system products.
4. We are looking forward to hearing the opinions of system test experts of SCC20 and to your support on our development of the standard for the high level system test methodology.

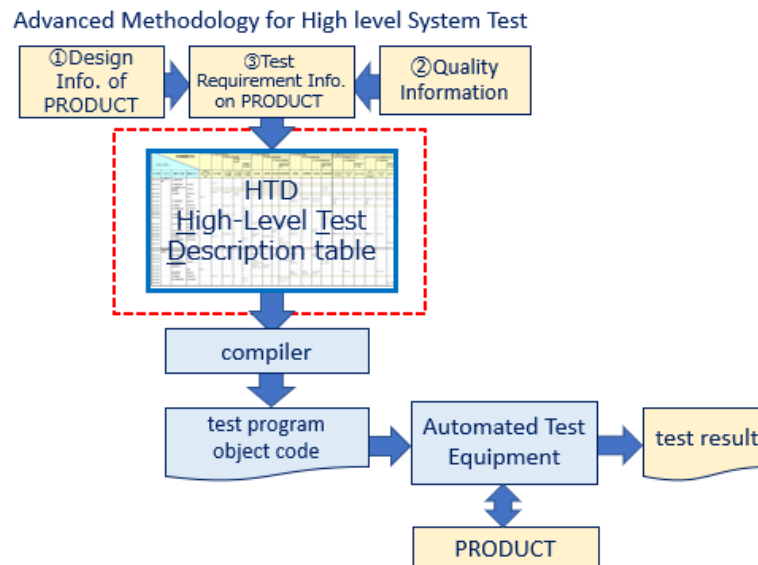
# Objectives of Advanced Methodology for High-Level System Test Design

The high-level design process of the system test is a complex process involving all phases of testing and is considered as one of the most important processes in the verification of system products, but the current methods employed in the industries are not of high quality.

**This methodology is developed to achieve high-quality process for high-level test design by using a common platform that allows simple break-down structures of test requirements (technical information for system products and existing quality and diagnostic information) in a unified manner.**

# Scope of the Standard

- This methodology for high-level system test design put together the following three information about Unit-Under-Test (UUT) into one single standardized table:
  - ① Design information
  - ② Quality information (diagnostic information)
  - ③ Test requirement information
- The table format that serves as the basic information for the test program is called the High-level Test Description (HTD) table.
- The Standard provides definitions and usage of the HTD table.



# Information Required for HTD Table

## ① Design information of Product

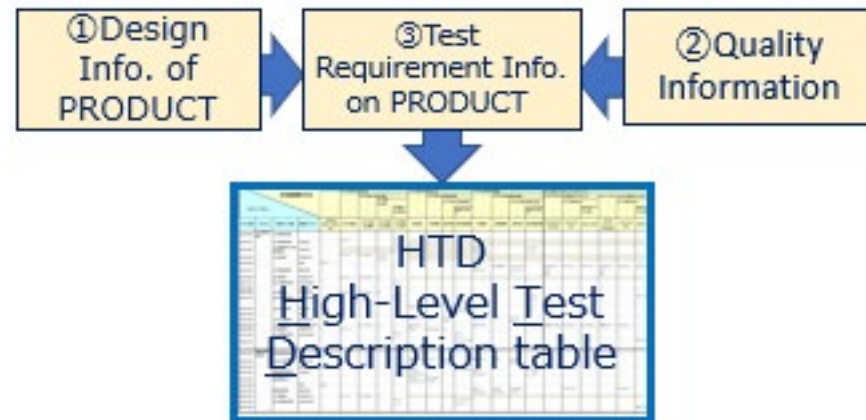
- Sources of test requirements provided by the product developer

## ② Quality (Diagnostic) Information

- Requests for quality/diagnostic information collected and maintained by the product developer and relevant parties which contains past failure information and additional test items to prevent such failures and so on.

## ③ Test Requirement Information. on PRODUCT

- Test requirement specification including ① and ② and customer requirements for the test



# Benefits of Standardization of Advanced Methodology for High-Level System Test Design

## <Current Issues>

- The high-level design process in the system test development has not been well standardized, so that there have been cases where the quality of the test programs is not good enough.
- Therefore, even in large companies, who put great amount of money as well as resources in the high-level test design process, quality of the test may not be guaranteed
- Small or medium-sized companies, who could afford neither money nor resources, have been facing quality issues about test.

## <Effect>

- Standardization of this advanced methodology also enables test program designers not only with large companies but with small companies to employ an efficient high-level design process to achieve high-quality system with lower test development cost

## <Effectiveness in the Market>

- Contributes to an earlier time to market of new products
- Maintains quality level of test through sharing HTD tables among related departments as well as companies.

# Structure of HTD Table

In the standard, HTD system has a hierarchical structure, which breaks down test requirements to more detailed test items, described in the same table format. Definitions of the three constituents of an HTD table are as follows:

1. Horizontal elements (frames/columns) in the table of test requirements
  - Means the contents of the test. The test conditions/settings are described from left to right in the table of test requirements. This frame is common and fixed for all tests. The columns corresponding to its sub-columns are also fixed.
2. Vertical elements of the table of test requirements (rows)
  - Means the flow of the test. The test flow/procedure progresses from the top row to the bottom row of the table of test requirements.
3. Cell
  - Is the smallest unit of data storage area that exists at the intersection of rows and columns. Cells are used to input data such as numbers, text, formulas, etc.

# Example of HTD Table

Frame

Test Flow					Power Supply Setup				Signal/Stimulus Setup				Measurement Instrument Setup				Processing of Test Results																									
																	PASS			FAIL			out of range																			
Test No.					Power Supply Name				Signal Category Name				Instrument Category/Name				Message for operator			Message for operator			Message for operator																			
↓	Test Name		Test Description		↓	PS Type			↓	Signal Type			↓	Measured Signal Type			↓	Storage for Test Results		↓	Storage for Test Results		↓	Storage for Test Results		↓	Storage for Test Results															
	↓	↓	↓	↓		↓	↓	↓		↓	↓	↓		↓	↓	↓		↓	↓		↓	↓		↓	↓		↓	↓	↓	↓	↓	↓										
																																	Test Command		Test Timing		Next Step		Next Step		Next Step	
																																	↓		↓		↓		↓		↓	
Test ID	Test Name	Test Description	Test Command	Test Timing	PS Name	PS Type	PS Spec	Input Terminal	Signal Name	Signal Type	Signal Spec	Input Terminal	Instrument Name	Instrument Type	Measurement Spec	Measurement Terminal	message	save test data	NEXT STEP	message	save test data	NEXT STEP	message	save test data	NEXT STEP																	
0100-0000	Power Supply Check																																									
0100-0010		Connect Power Supply to UUT	CONNECT		DC PS #1			H: J2-2 L: J2-1																																		
0100-0020		Connect UUT PS Signal Monitor	CONNECT										Digital Multimeter-1			H: J2-2R L: J2-1R																										
0100-0060		Power OFF UUT	POWER OFF	Cell	DC PS #1	DC Voltage-1	0V																																			
0100-0100			END														POWER ON TEST	file X1001	0200-0000	POWER ON TEST	file Q1001	9000-1000																				

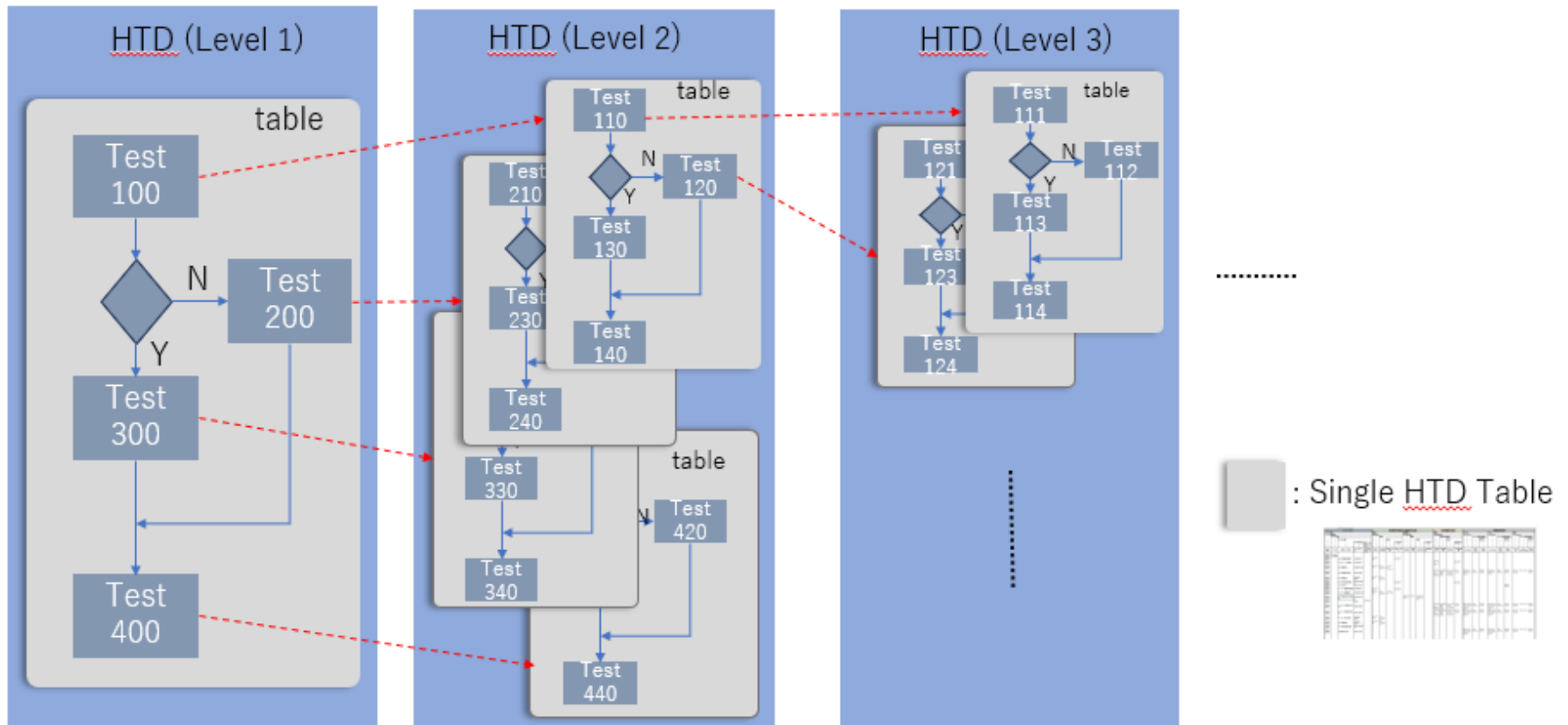
Frame

Test Flow					Power Supply Setup				Signal/Stimulus Setup				Measurement	
Test No.					Power Supply Name				Signal Category Name				Instrument Category	
↓ ↓ ↓ ↓	Test Name				↓ ↓ ↓ ↓	PS Type			↓ ↓ ↓ ↓	Signal Type			↓ ↓ ↓ ↓	Measur
	↓ ↓ ↓	Test Description				↓ ↓ ↓	PS	↓ ↓ ↓		Signal Spec				
		↓ ↓	Test Command	↓ ↓			Input Terminal			↓ ↓	Input Terminal			
												Test Timing		
Test ID	Test Name	Test Description	Test Command	Test Timing	Test ID	Test Name	Test Description	Test Command	Test Timing	PS Name	Test Timing	PS Name	Test Timing	
0100-0000	Power Supply				0100-0000	Power Supply	Check			DC PS #1		DC PS #1		
							Connect Power Supply to UUT	CONNE CT						
							Connect UUT PS Signal Monitor	CONNE CT						
							Power OFF UUT	POWER OFF	Cell	DC PS #1		DC PS #1	DC Vd 1	
								END TEST						
							UUT Initial Setup							
							Connect Power Supply to UUT	CONNE CT				DC PS #1		
							Connect UUT PS Signal Monitor	CONNE CT						



# Hierarchal Structure of HTD

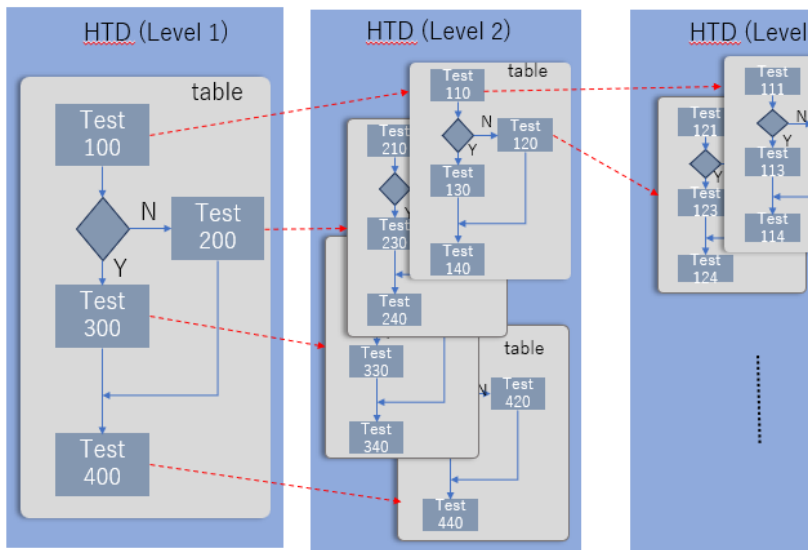
## Hierarchical Structure of HTD



# Example of 1st & 2nd Layers of HTD Hierarchy

Test Flow					Power Supply Setup				Signal/Stimulus Setup				Measurement Instrument Setup				Processing of Test					
																	PASS			FAIL		
Test No.					Power Supply Name				Signal Category Name				Instrument Category/Name				Message for operator			Message for operator		
																	Storage for Test Results			Storage for Test Results		
																	Next Step			Next Step		
																	Next Step			Next Step		
																	Next Step			Next Step		
↓	↓	Test Description	Test Command		↓	↓	PS Spec	Input Terminal	↓	↓	Signal Spec	Input Terminal	↓	↓	Measurement Spec	Measreueumnt Terminal	↓	↓	Next Step	↓	↓	Next Step
↓	↓	↓	↓	Test Timing	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Test ID	Test Name	Test Description	Test Command	Test Timing	PS Name	PS Type	PS Spec	Input Terminal	Signal Name	Signal Type	Signal Spec	Input Terminal	Instrument Name	Instrument Type	Measurement Spec	Measurement Terminal	message	save test data	NEXT STEP	message	save test data	NEXT STEP
0010	Rewrite Firmware																					
0020	Motor output check High																					
0030	Motor output check Low																					
0040	3.3V output check																					
0050	CPU frequency check																					
0060	SPI frequency check																					
0070	PWM frequency check																					
0080	Rotation encoder check																					
0090	Strain gauge detection range check																					
0100	Thermocouple temperature range check																					
0110	Rewrite firmware of the																					

	Test Flow				Power Supply Setup				Signal/Stimulus Setup				Measure				
Test No.					Power Supply Name				Signal	Category Name			Instrument C				
	Test Name				PS Type					Signal Type							
	↓	↓	Test Description	Test Command	↓	↓	PS Spec	Input Terminal		↓	↓	Signal Spec					
														↓	↓	↓	Input Terminal
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							
Test ID	Test Name	Test Description	Test Command	Test Timing	PS Name	PS Type	PS Spec	Input Terminal	Signal Name	Signal Type	Signal Spec	Input Terminal	Instrument Name				
0010-0000	Power Supply Check																
0010-0010		Connect Power Supply to UUT	CONNECT		DC PS #1			H: J2-2 L: J2-1									
0010-0020		Connect UUT PS Signal Monitor	CONNECT										Digital Multimeter-1				
0010-0030		Power ON UUT	POWER ON		DC PS #1	DC Voltage-	+5V DC /500mA										
0010-0040		Measure UUT PS Voltage	MEASURE										Digital Multimeter-1				
0010-0050		Power OFF UUT	POWER OFF		DC PS #1	DC Voltage-											
0010-0060		Disconnect All Signals	DISCONNECT					H: J4-2 L: J4-1									
0010-0070			END TEST														
0010-0080	Rewrite Firmware	Connect to UUT	END TEST														
0010-0090		Rewrite Firmware of UUT for TEST	CONNECT						Debug Uart 1	Uart	Uart Settings A	COM 11					
0010-0100		Send Test Command	STIMULATE						Debug Uart 1	Firmware Data	Test FirmwareV						
0010-0110		Check Success of Rewriting	STIMULATE						Debug Uart 1		test_command		Debug Uart 1				
0010-0120			COMPARE						Debug		Resp_code		Debug Uart 1				



# Horizontal (frame and column) configuration

- It means the contents of the test. (Columns represent detailed contents.)

The number is assigned sequentially starting with the first frame and defining up to the fifth. This is fixed.

- ① Contents of test process
- ② Power setting information of the UUT(Unit under Test)
- ③ Signal source setting information of the UUT
- ④ Equipment used, setting method, and measurement method formeasuring UUT
- ⑤ Process of the test result

# Frame 1: Test Flow

Frame

Test Flow					Power Supply Setup				Signal/Stimulus Setup				Measurement Instrument Setup				Processing of Test Results								
																	PASS			FAIL			out of range		
Test No.					Power Supply Name				Signal Category Name				Instrument Category/Name				Message for operator			Message for operator			Message for operator		
↓ ↓ ↓ ↓	Test Name ↓ ↓ ↓	Test Description ↓<																							

- Describe information on test processing details required for the SUT test.

① Test number e.g.: 001234, 0123-4567, etc.

② Test name e.g.: Power-on confirmation test, outgoing frequency test, VCC-1 voltage measurement, etc,

③ Detailed test items

The following items ④ and ⑤ are described in the test requirements table, which is hierarchized for detailed testing.

④ Test command name: Specify as necessary. Defining macro processing for settings and measurements described in the second and subsequent frames here makes it easier to understand the measurement procedures required for detailed tests.

Example: CONNECT, POWER-ON, MEASURE WAIT, etc.

⑤ Test timing: Describe the execution timing of the macro processing specified by the test command. e.g.: Enter "500ms" in the right column of the test command "WAIT".

## Frame 2 & Frame 3: Power & Signal Source Settings for UUT

Frame																																
Test Flow					Power Supply Setup				Signal/Stimulus Setup				Measurement Instrument Setup				Processing of Test Results															
																	PASS			FAIL			out of range									
Test No.					Power Supply Name				Signal Category Name				Instrument Category/Name				Message for operator			Message for operator			Message for operator									
Test Name		Test Description			Test Command		Test Timing		PS Type		PS Spec		Input Terminal		Signal Type		Signal Spec		Input Terminal		Measured Signal Type		Measurement Spec		Measreumnt		Storage for Test Results		Storage for Test Results		Storage for Test Results	
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Test ID	Test Name	Test Description	Test Command	Test Timing	PS Name	PS Type	PS Spec	Input Terminal	Signal Name	Signal Type	Signal Spec	Input Terminal	Instrument Name	Instrument Type	Measurement Spec	Measurement Terminal	message	save test data	NEXT STEP	message	save test data	NEXT STEP	message	save test data	NEXT STEP							
0100-0000	Power Supply Check		CONNECT		DC PS #1			H: J2-2 L: J2-1																								
0100-0010		Connect Power Supply to UUT	CONNECT																													
0100-0020		Connect UUT P S Signal Monitor	CONNECT										Digital Multimeter-1			H: J2-2R L: J2-1R																
0100-0060		Power OFF UUT	POWER OFF	Cell	DC PS #1	DC Voltage-1	0V																									
0100-0100			END														POWER ON TEST	file X1001	0200-0000	POWER ON TEST	file Q1001	9000-1000										

- Frame 2: Describes the power supply information for setting UUT.

- ① Description of the name of the power supply
- ② Description of power supply type
- ③ Description of power supply specifications
- ④ Description of input terminal information of UUT

Describe power supply required to set up UUT in ATS.

- Frame 3: Describes the signal source information for setting UUT

- ① Description of the type of signal source
- ② Description of the type of signal source
- ③ Description of signal source specifications
- ④ Description of input terminal information of UUT

Describe all signal sources required to set up UUT in ATS

# Frame 4 & Frame 5: UUT Measurement Information & Test Result Information

Frame

Test Flow					Power Supply Setup				Signal/Stimulus Setup				Measurement Instrument Setup				Processing of Test Results								
Test No.  Test Name Test Desription  Test Command  Test Timing  Column					Power Supply Name				Signal Category Name				Instrument Category/Name				PASS			FAIL			out of range		
					PS Type				Signal Type				Measured Signal Type				Message for operator			Message for operator			Message for operator		
					PS Spec				Signal Spec				Measurement Spec				Storage for Test Results			Storage for Test Results			Storage for Test Results		
					Input Terminal				Input Terminal				Measreue mnt				Next Step			Next Step			Next Step		
Test ID	Test Name	Test Description	Test Comma nd	Test Timing	PS Name	PS Type	PS Spec	Input Terminal	Signal Name	Signal Type	Signal Spec	Input Terminal	Instrumnt Name	Instrument Type	Measurement Spec	Measurment Terminal	message	save test data	NEXT STEP	message	save test data	NEXT STEP	messag e	save test data	NEXT STEP
0100-0000	Power Supply Check																								
0100-0010		Connect Power Supply to UUT	CONNE CT		DC PS #1			H: J2-2 L: J2-1																	
0100-0020		Connect UUT PS Signal Monitor	CONNE CT										Digital Multimeter-1			H: J2-2R L: J2-1R									
0100-0060		Power OFF UUT	POWER OFF	Cell	DC PS #1	DC Voltage-1	0V																		
0100-0100		END															POWER ON TEST	file X1001	0200-0000	POWER ON TEST	file Q1001	9000-1000			

- Frame 4: Describing the UUT measurement information

- Measurement description for UUT in ATS
- Instrument name
- Measurement signal type.
- Specifications of measurement
- Measuring terminal

Describe all instrumentation information required for testing in the ATS.

- Frame 5: Describe test result information (PASS/FAIL/abnormal) information

- Description of test results in the ATS: The test results are used to make a judgment (PASS/FAIL/abnormal) by the test result, and the storage destination of the test result and the next step are specifically described.
- Test result PASS/FAIL/abnormal message
- Destination of test results: No description method is specified. Data collection of test results are stored in SAVE TEST DATA as the delivery destination.
- Next Steps:

# Vertical (row) configuration

- Vertical elements of the test requirement table (rows)

It means the flow of the test.

①The test flow/procedure progresses from the top row to the bottom row of the test requirements table.

②Rows are vertically arranged elements, and the test flow (test items, steps) information is a component of the test specification to be described.

- The descriptive information on the line

It is a Name of the test (Power/Stimuli Short Test, Performance Test, etc.) and various information required for the test (Test Description, Input Power, etc.), etc.

Test ID	Test Name	Test Description	Test Command	Test Timing	P S Name	P S Type	P S Spec	Input Terminal	Signal Name	Signal Type	Signal Spec	Input Terminal	Instrument Name	Instrument Type	Measurement Spec	Measurement Terminal	message	save test data	NEXT STEP
0100-0000	Power Supply Check																		
0100-0010		Connect Power Supply to UUT	CONNECT		DC PS #1			H: J2-2 L: J2-1											
0100-0020		Connect UUT P S Signal Monitor	CONNECT										Digital Multimeter-1			H: J2-2R L: J2-1R			
0100-0080		Power OFF UUT	POWER OFF	Cell	DC PS #1	DC Voltage-1	0V												
0100-0100			END TEST														POWER ON TEST PASS	file X1001	0200-0000
0200-0000	UUT Initial Setup																		
0200-0010		Connect Power Supply to UUT	CONNECT		DC PS #1			H: J2-2 L: J2-1											
0200-0020		Connect UUT P S Signal Monitor	CONNECT										Digital Multimeter-1			H: J2-2R L: J2-1R			

Row

# summary

- Advance methodology is proposed to achieve high-quality process for high-level test design by using a common platform, High-Level Test Description (HTD) table
- HTD table is a breakdown of information about product design, quality/diagnostic and test requirements, serving as a basic tool for sharing technical information on test program among parties relevant to test program development
- Hierarchal structure, definitions of the constituents and usage of HTD table are provided in detail
- Standardization of this advanced methodology enables test program designers not only with large companies but with small companies to employ high-level design process in order to achieve high-quality system test development efficiently and cost-effectively





**Thank you**