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NRW-FPGA-Based I&C System Qualification Project

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Title: Software Validation Test Plan

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1. Purpose

The purpose of this Software Validation Test Plan (SVTP) is to prescribe test requirements, conditions, and methodologies for the software validation test conducted in the system validation testing of the Oscillation Power Range Monitor (OPRM) for the NRW-FPGA-Based I&C System Qualification Project.

Test requirements, conditions, and methodologies for the hardware test conducted in the system validation testing are described in the System Test Specification (Reference (6)). The purpose of the system validation testing is to demonstrate that the OPRM unit performs its intended functions specified in the Equipment Design Specification (EDS) (Reference (4)) and the Unit Detailed Design Specification (Unit DDS) (Reference (5)).

The Nuclear Instrumentation & Control Systems Department (NICSD) Independent Verification and Validation (IV&V) Team prepared this plan in accordance with test documentation requirements prescribed in the NICSD V&V Plan (Reference (1)), Master Test Plan (Reference (2)), and Software Test Plan (Reference (3)) using NQ-2019 (Reference(8)) and NQ-3016 (Reference (11)) as guides.

2. Scope

The scope of the test specimen subject to the system validation testing is the OPRM unit and two Power Factor Correction modules (PFCs), which is enclosed by the bold and dotted line in Figure 2-1 that is a copy of Figure 4-1 of the EDS (Reference (4)).

The NICSD Independent Verification and Validation (IV&V) Team is responsible for determining the acceptance methods and criteria for the software validation test conducted in the system validation testing. The software validation test requirements are documented in this document.

This plan is used with System Test Specification (Reference (6)). Section 12 of the System Test Specification refers to this SVTP as test item of software validation test for the OPRM unit. Test items for software validation test in this plan were determined based on the OPRM unit functional requirements prescribed in the EDS, and the Unit DDS (Reference (5)). Test items and features to be tested through the software validation test are listed in Table 9-1.

The hold points, witness points and review points by Nuclear Energy Systems & Services Division (NED) are described in Section 3 of the System Test Specification. The software validation test as a performance test is subject to review by NED

The test specimen which passed the system validation testing is used as test specimen for the Equipment Qualification (EQ) Test and Electromagnetic Compatibility (EMC) Test.

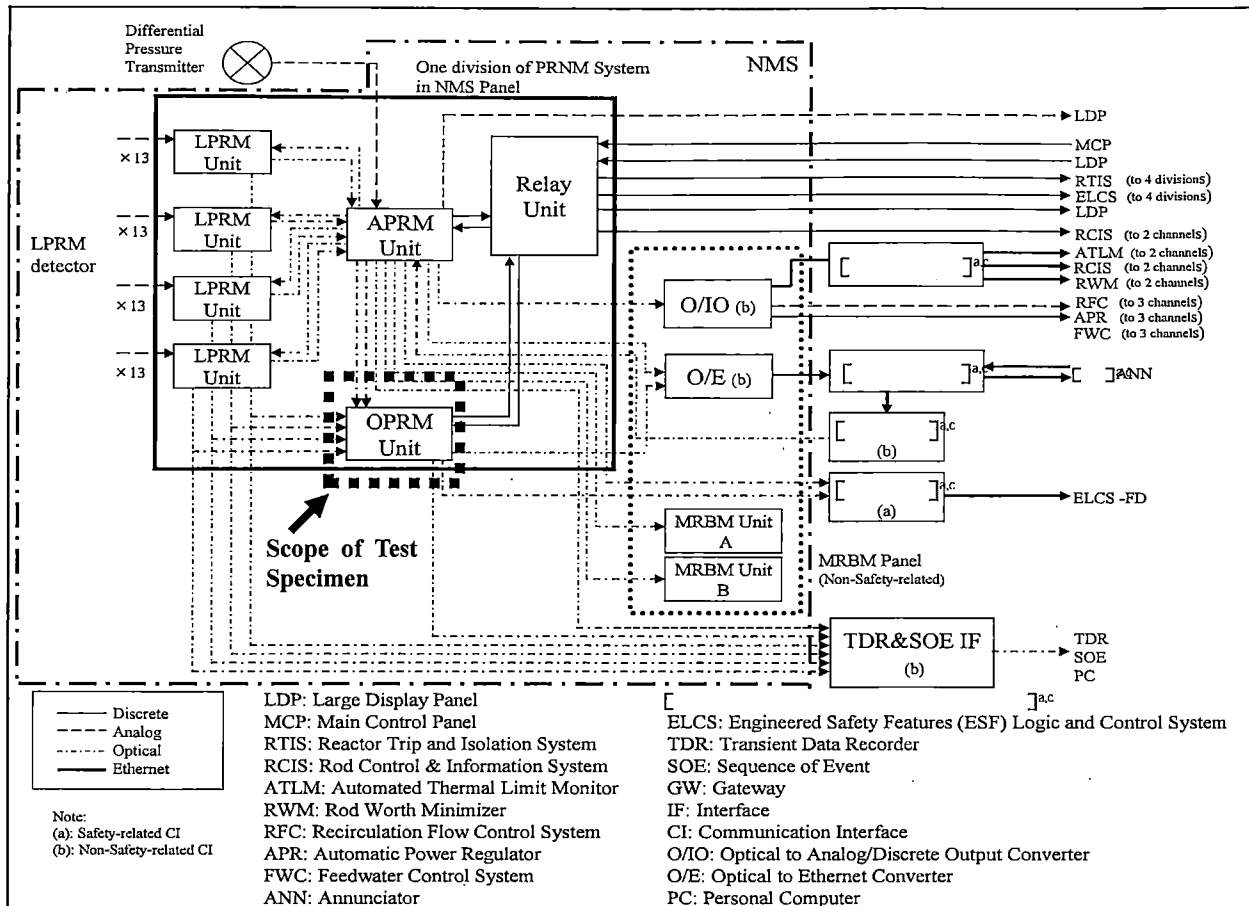


Figure 4-1 System Configuration

Figure 2-1 Scope of Test Specimen

3. Applicable Documents

- (1) Toshiba Project Document Number FA32-3709-1000
“Nuclear Instrumentation & Control Systems Department Verification and Validation Plan for FPGA-based Safety-Related Systems” Rev.4
- (2) Toshiba Project Document Number FC51-7021-1000
“Master Test Plan for NRW-FPGA-Based I&C System Qualification Project” Rev.0
- (3) Toshiba Project Document Number FA32-3705-1000
“Software Test Plan for FPGA-based Safety-Related Systems” Rev.0
- (4) Toshiba Project Document Number FC51-3002-1000
“Equipment Design Specification for Power Range Neutron Monitor” Rev.1
- (5) Toshiba Project Document Number FC51-3702-1000
“OPRM Unit Detailed Design Specification for Power Range Neutron Monitor” Rev.2
- (6) Toshiba Project Document Number FC51-7101-1001
“Nuclear Instrumentation & Control Systems Department System Test Specification for Safety-Related Oscillation Power Range Monitor (OPRM)” Rev.6
- (7) Toshiba Project Document Number FC51-8001-1000
“OPRM Unit User’s Manual” Rev.2
- (8) Toshiba Nuclear Instrumentation & Control Systems Department NQ-2019
“Preparation Procedure for Test Specification” Rev.4
- (9) Toshiba Nuclear Instrumentation & Control Systems Department NQ-3011
“Qualification Procedure of Test Personnel and QC Inspector” Rev.5
- (10) Toshiba Nuclear Instrumentation & Control Systems Department NQ-3015
“Test Control Procedure” Rev.4
- (11) Toshiba Nuclear Instrumentation & Control Systems Department NQ-3016
“Software Test” Rev.4

4. Abbreviations

ABA	Amplitude Based detection Algorithm
AC	Alternate Current
ANN	Annunciator
APRM	Average Power Range Monitor
BSL	Back Slot
CI	Communication Interface
DDS	Detailed Design Specification
EDS	Equipment Design Specification
ELCS	Engineered Safety Features Logic & Control System
EMC	Electromagnetic Compatibility
EQ	Equipment Qualification
ESF	Engineered Safety Features
FD	Flat Display
FPGA	Field Programmable Gate Array
GRA	Growth Rate detection Algorithm
HMI	Human-Machine Interface
I&C	Instrumentation and Control
IV&V	Independent Verification and Validation
LED	Light Emitting Diode
LPRM	Local Power Range Monitor
M&TE	Measuring and Test Equipment
NED	Nuclear Energy Systems & Services Division
NICSD	Nuclear Instrumentation & Control Systems Department
NICS-QC	Quality Control Group for Nuclear Instrumentation & Control Systems
NQ	Nuclear Quality
NRW	Non-Rewritable
OPRM	Oscillation Power Range Monitor
PBDA	Period Based Detection Algorithm
PFC	Power Factor Correction module
[]ac
QC	
RPS	Reactor Protection System
SOE	Sequence of Event
SVTP	Software Validation Test Plan
TDR	Transient Data Recorder

5. Test System

The same test system configuration is used for software validation testing. Refer to Section 6.2 of the System Test Specification (Reference (6)) for test system used for software validation testing. Refer to Section 6.3 of the System Test Specification for test specimen to be validated through the software validation testing. Refer to Section 6.4 of the System Test Specification for test support equipment and Measuring and Test Equipment (M&TE) used for the software validation testing. Figure 5-1 shows the test system configuration which is a copy of Figure 6-1 of the System Test Specification.

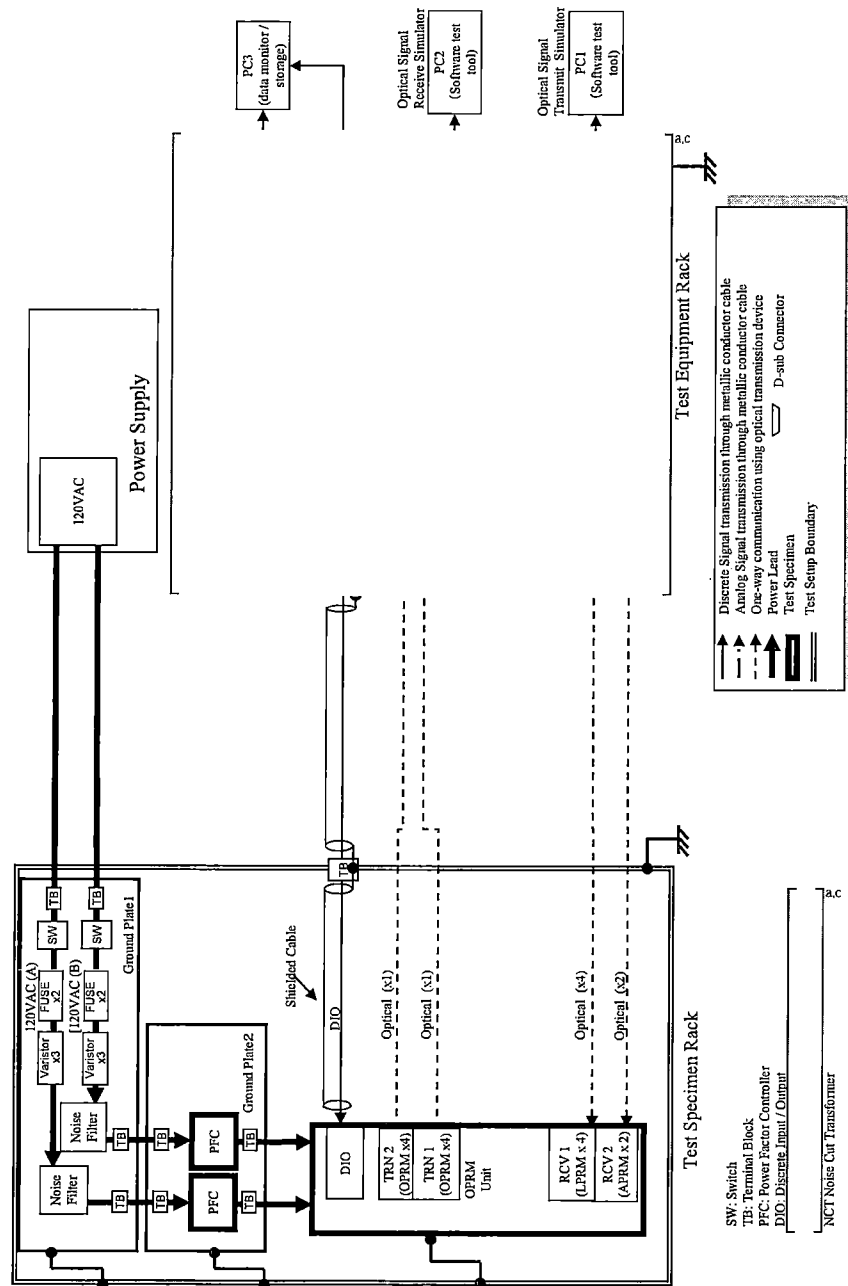


Figure 5-1 Test System

6. Prerequisites

6.1 Standard Settings of OPRM Unit

The same parameter setting for TRN modules and RCV modules, and jumper pin setting are used as “Standard Settings” for software validation testing. Refer to Section 7.1 of the System Test Specification (Reference (6)) for detailed parameter settings for TRN modules and RCV modules, and detailed parameter setting procedure for each module in the OPRM unit. Refer to Section 7.2 of the System Test Specification for detailed jumper pin settings. The following tables show the “Standard Settings” of OPRM unit parameters and setpoints for the software validation testing. If specific parameters for each test item are not specified, the test is performed using the following “Standard Settings.”

Table 6.1-1 Standard Settings for CELL Module

7 Segment LED		Range	Initial Setpoint
PARAMETER1	PARAMETER2		
1	Time Average Filter Cut-off Frequency Setpoint	0.100 to 1.500Hz	0.167
2	LPRM Lower-limit Setpoint	0.0 to 99.9%	5.0
3	Conditioning Filter Cut-off Frequency Setpoint	0.000 to 9.999Hz (effective range: 0.500 to 3.500Hz)	1.000
4	Minimum Number of Active OPRM Cell Setpoint	0 to 99 (effective range: 0 to 44)	32
5	OPRM Region APRM Level Setpoint	0.0 to 99.9%	30.0
6	OPRM Region Core Flow Level Setpoint	0.0 to 99.9%	60.0
7	OPRM Region APRM Level Hysteresis Setpoint	0 to 9%FS	1
8	OPRM Region Core Flow Level Hysteresis Setpoint	0 to 9%FS	1
9	Minimum Number of Active LPRMs	0 to 9 (effective range: 1 to 3)	2

Table 6.1-2 Standard Settings for AGRD Module

7 Segment LED		Range	Initial Setpoint
PARAMETER1	PARAMETER2		
1	Threshold Setpoint (S1)	1.00 to 1.99	1.10
2	Minimum Threshold Setpoint (S2)	0.50 to 1.99	0.92
3	Growth Rate Factor (DR3)	1.00 to 1.99	1.30
4	Maximum Amplitude Trip Setpoint (Smax)	1.00 to 1.99	1.30
5	Growth Rate Amplitude Setpoint (S3)	1.00 to 1.99	N/A (Calculated value)
6	Time Window for Minimum Threshold Setpoint (TI)	0.00 to 0.99s	0.31
7	Time Window for Trip Setpoint (Th)	0.00 to 9.99s	2.20
8	ABA and GRA Trip Hold Time Setpoint (Ttph)	0.0 to 9.9s	[] ^{a,c}
9	Peak and Valley Detection Width Setpoint (a)	0.001 to 0.010 (Note 1)	0.003

Note 1: This parameter is shown as 1 to 10 on the numerical display of the AGRD module.

Table 6.1-3 Standard Settings for PBD Module

7 Segment LED		Range	Initial Setpoint
PARAMETER1	PARAMETER2		
1	Period Minimum Setpoint (Tmin)	0.00 to 9.99s	1.00
2	Period Maximum Setpoint (Tmax)	0.00 to 9.99s	3.50
3	Period Tolerance Setpoint (Te)	0.000 to 0.999s	0.150
4	Confirmation Count Trip Setpoint (Np)	0 to 99	10
5	PBDA Amplitude Setpoint (Sp)	1.00 to 1.99	1.10
6	PBDA Trip Hold Time Setpoint (Ttph)	0.0 to 9.9s	[] ^{a,c}
7	Peak and Valley Detection Width Setpoint (a)	0.001 to 0.010 (Note 1)	0.003

Note 1: This parameter is shown as 1 to 10 on the numerical display of the PBD module.

6.2 Environmental Conditions

The same environmental conditions specified in Section 8.1 of the System Test Specification (Reference (6)) are applied to the software validation testing.

6.3 AC Power Source

AC power sources applied to the test specimen are specified in Section 8.2 of the System Test Specification (Reference (6)).

6.4 Test Sequence

The software validation test should be performed after the hardware test specified in Section 11 of the System Test Specification (Reference (6)). The software validation test as a performance test is subject to review by NED as determined in Section 3 of the System Test Specification.

The software validation test shall be performed in accordance with Section 10 of this SVTP.

After the software validation test is finished, return to the test sequence specified in the Table 2-1 of the System Test Specification.

6.5 Test Tool Identification

The following test tools are used for this software validation test.

Tool Type	Software Tool Registration Application Form Number	Version	Remarks
OPRM Test Tool (Optical Signal Receive Simulator, Optical Signal Transmit Simulator)	FDTR-12-0001-KM	NYP134 • 01-001-C	-
OPRM Test Pattern Files	FDTR-12-0002-KM	NZH002 • 00-001-C	-

Test pattern files used for the software validation test are listed in Attachment A. The Optical Signal Receive

Simulator has two "Transmission Pattern Setting" to transmit LPRM data; that is "Continuous Output" and "Single Output."

Use the "Continuous Output" unless otherwise instructed in each test item.

The description of each Transmission Pattern Setting is as follows.

Continuous Output

- In this Transmission Pattern Setting, the Optical Signal Transmit Simulator starts transmission of selected test patterns when "Start" for each LPRM or "All Start" for LPRM 1 to 4 is clicked.
- In this Transmission Pattern Setting, the Optical Signal Transmit Simulator transmits selected test patterns continuously until "Stop" for each LPRM or "All Stop" for LPRM 1 to 4 is clicked.
- When "All Stop" for LPRM 1 to 4 is clicked during data transmission, the Optical Signal Transmit Simulator transmits 0% LPRM levels for LPRM CH1 through CH52, and the number of active OPRM Cells becomes "0." Thus, the CELL module generates an OPRM Inoperative signal.

Single Output

- In this Transmission Pattern Setting, the Optical Signal Transmit Simulator transmits selected test patterns once when "Start" for each LPRM or "All Start" for LPRM 1 to 4 is clicked. Click "All Start" for LPRM 1 to 4 to transmit LPRM 1 to 4 data synchronously.
- After "Single Output" of selected test patterns is finished, the Optical Signal Transmit Simulator transmits 0% LPRM levels for LPRM CH1 through CH52 automatically, and the number of active OPRM Cells becomes "0." Thus, the CELL module generates an OPRM Inoperative signal.
- When "All Stop" for LPRM 1 to 4 is clicked during data transmission, the Optical Signal Transmit Simulator transmits 0% LPRM levels for LPRM CH1 through CH52, and the number of active OPRM Cells becomes "0." Thus, the CELL module generates an OPRM Inoperative signal.

6.6 Definition of "Normal Status" of Test System

The "Normal Status" used to show the initial status of the test system. In this document, the "Normal Status" of Test System means the following status. It is not necessarily to check all the following items in each step of test where the "Normal Status" is referenced. Check items at "Normal Status" in each step of test should be determined in test procedure as necessary.

- Configure the hardware and cable connections of test system specified in Section 6.2 of the System Test Specification (Reference (6)) are configured.
- Set the OPRM unit to "Standard Settings" as specified in Section 6.1.
- Turn off the APRM Bypass signal (Aux-Relay Plate).
- Supply the power to the OPRM unit.
- Start up the Optical Signal Transmit Simulator and Optical Signal Receive Simulator.
- Set the key switches of the CELL module, AGRD module, and PBD module to "OP" position.
- Run the following test pattern files on the Optical Signal Transmit Simulator.
 - LPRM 1: LPRM_50_R0_LPRM1.csv
 - LPRM 2: LPRM_50_R0_LPRM2.csv
 - LPRM 3: LPRM_50_R0_LPRM3.csv

LPRM 4: LPRM_50_R0_LPRM4.csv

APRM 1: AP_50.0_FL_50.0_R0_Aprm1.csv

APRM 2: AP_50.0_FL_50.0_R0_Aprm2.csv

- Clear the all “FAIL” LEDs and “INOP” LEDs on the CELL module, AGRD module, PBD module, and DAT/ST module by pushing the “RESET” buttons on these modules.

The following table shows the status of displays on the OPRM unit and the Aux-Relay Plate which shows the discrete input and output status of the DIO module.

Table 6.6-1 Normal Status of OPRM Unit

LEDs on CELL Module							
INOP	FAIL	BYP	OPRM REGION	St	APRM	FLOW	CELL Count
Off	Off	Off	On	On	Off	Off	Off
Filtered Flux							
UL BYP		UR BYP		LL BYP		LR BYP	
Off		Off		Off		Off	
MODE							
OP	STANDBY	CAL	TEST St	TEST Filtered FLUX	TEST APRM/FLOW	fa	PARAMETER
On	Off	Off	Off	Off	Off	Off	Off

LEDs on AGRD Module									
TRIP	INOP	FAIL	ABA TRIP	GRA TRIP	MODE				
					OP	STANDBY	CAL	Smax	PARAMETER
Off	Off	Off	Off	Off	On	Off	Off	Off	Off

LEDs on PBD Module									
TRIP	INOP	FAIL	PBDA TRIP	MODE					
				OP	STANDBY	CAL	Terror	Np	PARAMETER
Off	Off	Off	Off	On	Off	Off	Off	Off	Off

LEDs on DAT/ST Module											
FAIL	LVPS ALARM		LINE STATUS								
			SEL		FAIL						
	LVPS1	LVPS2	APRM1	APRM2	APRM1	APRM2	LPRM1	LPRM2	LPRM3	LPRM4	
Off	Off	Off	On	Off	Off	Off	Off	Off	Off	Off	Off

LEDs on TRN Module (BSL 7: for ELCS[] ^{a,c})					LEDs on TRN Module (BSL 8: TDR/SOE)			
LINE STATUS					LINE STATUS			
OUT1	OUT2	OUT3	OUT4		OUT1	OUT2	OUT3	OUT4
On	On	On	On		On	On	On	On

LEDs on RCV Module (BSL 5: LPRM unit 1 to 4 data)				LEDs on RCV Module (BSL 6: APRM data 1, 2)			
LINE STATUS				LINE STATUS			
IN1	IN2	IN3	IN4	IN1	IN2	IN3	IN4
On	On	On	On	On	On	Off	Off

LED on LVPS Module (PSSL 1)	LED on LVPS Module (PSSL 2)
POWER	POWER
On	On

LEDs on Aux-Relay Plate (Discrete Output and Input of DIO Module)					
SCRAM (Pin A)	PBDA_TRIP (Pin B)	COUNT_ST (Pin D)	OPRM_INOP (Pin M)	OPRM_FAIL (Pin N)	
Not generated	Not generated	Not generated	Not generated	Not generated	
Off	Off	Off	Off	Off	
OPRM_AT_BYP (Pin P)	ABA_TRIP (Pin R)	GRA_TRIP (Pin S)	AMP_JUDGE1 (Pin T)	AMP_JUDGE2 (Pin U)	APRM_BYP (Pin JJ)
Not generated	Not generated	Not generated	Not generated	Not generated	Disable
Off	Off	Off	Off	Off	Off

6.7 Documentation and Test Data Storage

The Quality Control Group for Nuclear Instrumentation & Control Systems (NICS-QC) is responsible for preparing a test process schedule, a System Validation Test Procedure which is based on this System Test Specification (Reference (6)) and the SVTP. The NICS-QC is responsible for executing the system validation testing and issuing a System Validation Test Record in accordance with NQ-3015 (Reference (10)). A Test personnel assigned by the Manager of NICS-QC in accordance with NQ-3011 (Reference (9)) executes the system validation testing as a test engineer of the NICSD IV&V team. The NICSD IV&V team is responsible for preparing a Software Validation Test Report after the system validation testing.

Test data during test for each test item shall be obtained using following test equipment.

- Scope Corder (DL850) for discrete input/output signals
- Optical Signal Receive Simulator for ELCS[]data from Back Slot (BSL) 7 of TRN module and PC data from BSL8 of TRN module.

Store the test data files in write-once media after the testing.

7. Test System Overview

7.1 OPRM Function Overview

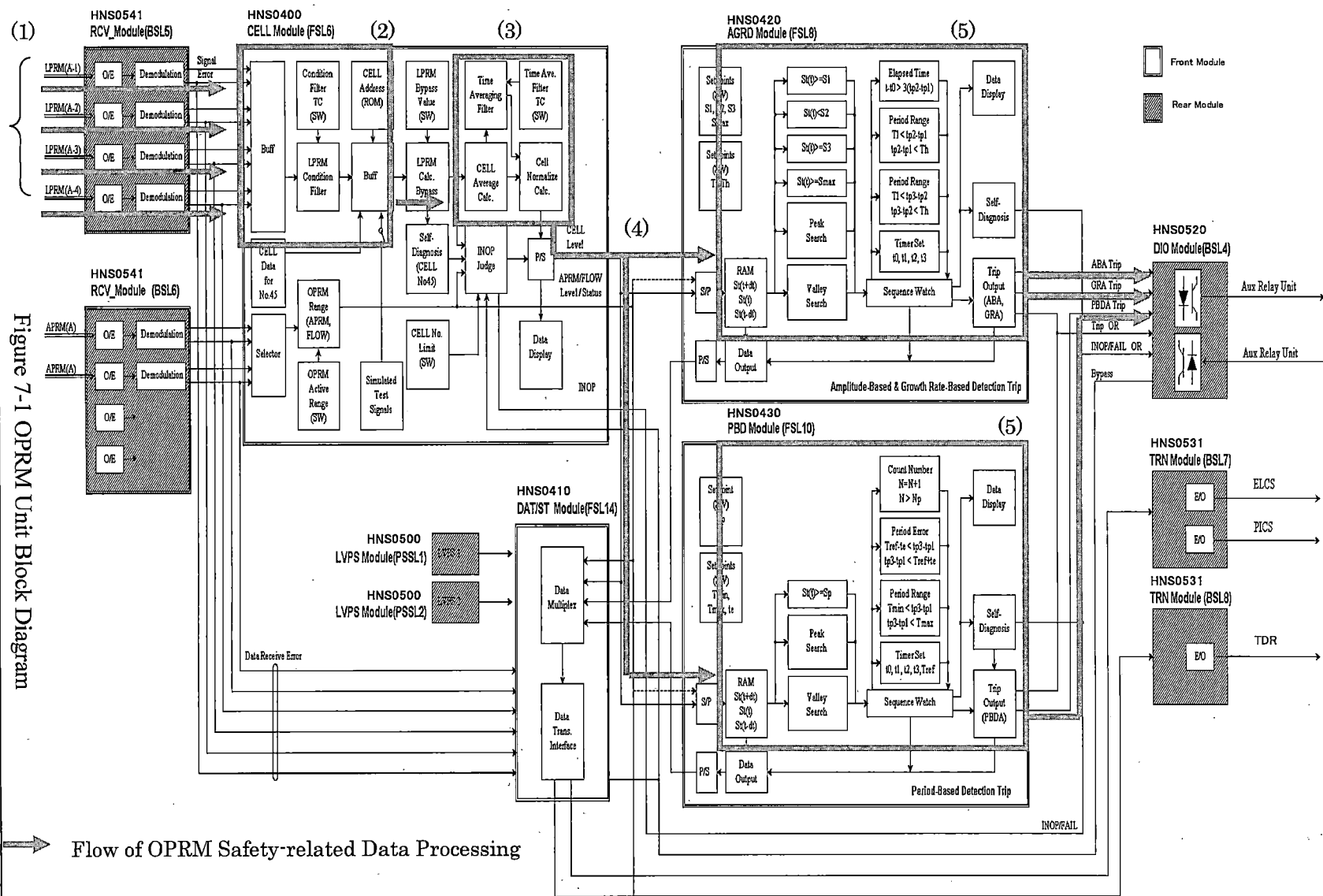
The OPRM unit receives 52 Local Power Range Monitor (LPRM) Levels from four LPRM units and forms 44 OPRM Cell configurations to monitor the neutron flux oscillation behavior of all regions of the core. Each OPRM Cell represents a combination of four LPRM signals selected from the LPRM strings at the four corners of a four-by-four fuel bundle square region. The OPRM unit generates the alarms and trip signals. The OPRM trip algorithm consists of trip logics depending on signal oscillation amplitude, a signal oscillation period, and signal oscillation growth rate. For each cell, the peak to average value of the Normalized Oscillation Signal is determined to evaluate the amplitude of oscillation and to be used in the setpoint algorithm. The OPRM is a functional subsystem of the Average Power Range Monitor (APRM). There are four OPRM units and each of those units is assigned to a corresponding APRM unit. Bypass of one APRM unit also bypass its corresponding OPRM unit. The OPRM unit also receives the APRM Level and the Core Flow Level from the APRM unit and the trip algorithms are automatically bypassed if APRM Level is less than 30% (Initial setpoint) or Core Flow Level is greater than 60% (Initial setpoint). The OPRM unit provides the trip signals to the (Reactor Protection System) RPS via the Relay unit. The OPRM unit provides the signals to Engineered Safety Features Logic & Control System (ELCS) Flat Display (FD) via Safety-related Communication Interface (CI). Also, the OPRM unit provides the signals to [] Annunciator (ANN), Transient Data Recorder (TDR), Sequence of Event (SOE) and PC via Non-Safety-related CI. OPRM Data including internal calculations before 15 minutes and after 5 minutes of OPRM trips are recorded by TDR.

7.2 Signal Processing Flow of OPRM Unit

There are no specific requirements for response time of trip generation for OPRM. The OPRM unit generates trip signals with the following steps (See also Figure 7-1, which is a copy of the Figure 5-1 of the OPRM Unit DDS (Reference (5))).

- (1) After one of the RCV modules in the OPRM unit receives the optical transmission signals including the 52 LPRM levels by a transmission cycle of 1.016ms from each LPRM unit, the RCV module converts the received optical signals to digital data, and provides the digital data of 52 LPRM levels to the CELL module with a transmission cycle of 1.016ms.
- (2) The CELL module selects three or four LPRM levels corresponding to each OPRM Cell from the received digital signals.
- (3) The CELL module performs sequential calculation to obtain a Normalized Oscillation Signal for CELL 1 thorough 44 per a processing cycle of $\frac{1}{f_{osc}}$ (i.e. the CELL module has 25 ms sampling interval).
- (4) The obtained Normalized Oscillation Signal is provided to the AGRD module and the PBD module via the same serial bus.
- (5) The AGRD module sequentially determines a trip generation for CELL 1 thorough 44 per a processing cycle of $\frac{1}{f_{osc}}$ using the Amplitude Based detection Algorithm (ABA) and Growth Rate detection Algorithm (GRA). In parallel with processing in the AGRD module, the PBD module sequentially determines a trip generation for CELL 1 thorough 44 per a processing cycle of $\frac{1}{f_{osc}}$ using the Period Based Detection Algorithm (PBDA).

These sequential processing and parallel processing features in the OPRM unit were taken into account when deciding test patterns and acceptance criteria for software validation test.



8. Validation Approach

This section describes approaches to determine input test patterns and expected outputs.

8.1 Generation of LPRM Levels for Input Test Pattern

A LPRM level input is simulated with the following equation.

$$\left[\begin{array}{c} \\ \\ \\ \end{array} \right]_{a,c}$$

The NICSD IV&V Team generated input test patterns of LPRM levels using above equation with test pattern generation tool. This equation can simulate various types of oscillation signals by changing the parameters. The input test pattern files used for software validation test are listed in Attachment A.

8.2 Determination of Expected Output

If all the LPRM levels in a Cell synchronize, the Normalized Oscillation Signal (S_t) simulated by the theoretical formula may be simplified with a filtered single LPRM level except noise as follows.

Normalized Oscillation Signal (S_t):

$$\left[\begin{array}{c} \\ \\ \\ \end{array} \right]_{a,c}$$

Transfer function ($H_i(j\omega)$):

$$\left[\begin{array}{c} \\ \\ \\ \end{array} \right]_{a,c}$$

Phase ($\Phi_i(\omega)$):

$$\left[\begin{array}{c} \\ \\ \\ \end{array} \right]_{a,c}$$

The NICSD IV&V Team simulated the Normalized Oscillation Signal (S_t) based on above theoretical formula. The NICSD IV&V Team compared the simulated Normalized Oscillation Signal (S_t) with Normalized Oscillation Signal (S_t) output from the OPRM unit, and checked that the input test patterns generated by test pattern were acceptable for use in software validation test. Based on the functionality of the OPRM unit, the NICSD IV&V Team determined expected output for each input test pattern as responses of OPRM unit to the simulated Normalized Oscillation Signal (S_t) and other input parameter conditions.

9. Features to be Tested

Software validation testing for OPRM is performed to ensure that the integrated software meets the requirements stated in the EDS (Reference (4)) and Unit DDS (Reference (5)).

The OPRM unit has the following safety-related functions (Excerpt from Section 5.1.1 of Unit DDS):

(1) Generate the following signals:

Neutron flux oscillation

(2) Generate the following trip signals, as the OPRM functions and provide to the Relay unit:

Growth Rate-Based Trip (GRA Trip)

Amplitude-Based Maximum Trip (ABA Trip)

Period-Based Trip (PBDA Trip)

OPRM Inoperative

(3) Provide the data signals, bypass state, trip state, annunciator, and operation state to the ELCS FD.

Test items are configured based on these safety functions of OPRM. The NICSD IV&V Team determined features to be tested and test items by reviewing the EDS and Unit DDS. Table 9-1 shows a list of test items showing relationship between test items and related EDS section, and Unit DDS section.

The functionality of the OPRM unit specified in the EDS and the Unit DDS is verified as features to be tested through the software validation test. Although the EDS and the Unit DDS also specify hardware specifications and electrical safety requirements to which the software functions of the OPRM unit are not related, those specifications and requirements are to be tested in the hardware test in accordance with the System Test Specification (Reference (6)), and thus are treated as features not to be tested in the software validation test. Of these 2 separate tests, which one was used to verify a certain requirement for the OPRM unit specified in the EDS and the Unit DDS can be checked with requirements traceability.

The NICSD IV&V Team provides a description of the basic concepts to determine test items and test patterns for this software validation test as below.

This software validation test is intended to prove the functionality of the OPRM unit specified in the EDS and the Unit DDS in terms of a unit that consists of modules and a unit chassis as a whole. It is not, however, intended to iteratively and comprehensively test the functions that have already been proved at the module and FPGA levels.

For example, when a certain variable parameter is examined in a test item, its variation range is to be determined from the standpoint of whether the functionality as a whole unit can be proved. In other words, as long as the functions have been proved through the testing at the module or FPGA level, such verification that testing is repeated with changing the parameter in accordance with the least input increment (i.e., by 1 digit) is neither to be performed nor to be intended in the software validation test.

The NICSD IV&V Team has determined in principle that those default values specified in the EDS and the Unit DDS are used as "Standard Settings" for parameters of each test case, and that test patterns are to be set so that OPRM functions for those default values can be evaluated.

As delineated in Section 6.1, the OPRM unit has variety of parameters (i.e., setpoint). For parameters of particular significance which are related to safety functions and may be adjusted by users according to plant-specific setpoint analyses and operating experiences, the NICSD IV&V Team has considered to include a test item to check those parameters by changing them as needed in the software validation test. For example, the NICSD IV&V Team has considered variations of parameters and test patterns that allows users to increase or decrease the value of a parameter (e.g., "Smax" of the ABA algorithm and "Np" of the PBDA algorithm) from its default value, and to check whether the

algorithm operates to output an expected value as intended in accordance with the setpoint variation.

The NICSD IV&V Team has performed reviews with the NICSD Software Safety Team and experts for examining test items and test pattern, and has considered whether there is a certain parameter which functionality should be verified at the unit level as well for operation purpose. The "Peak and Valley Detection Width Setpoint" used for the peak detection and valley detection functions in the PBDA Trip algorithm is a parameter to prevent the Confirmation Count (N) from unnecessarily counting up and being reset due to the effect that LPRM noise makes on Normalized Oscillation Signals. The NICSD IV&V Team has determined that it is important to verify the response of the OPRM unit after making a change to this parameter and thus incorporated this verification in the test item of the PBDA trip.

The OPRM unit has optical transmission inputs from safety system. The OPRM unit also has optical transmission outputs to safety system and non-safety system. Each test item in this SVTP includes checking correct operations of optical transmission signals under normal state. The integrity of optical transmission signals under abnormal conditions is separately evaluated by the test item called Optical Transmission Integrity Test.

Table 9-1 List of Test Items

Test Item		Remarks	Related EDS Section	Related Unit DDS Section
Section No. of SVTP	Title			
10.1	Standard Setting Check (Initial Setpoint)	-	5.1.3 5.2.2.3.9 5.12	5.1.8 5.2.1 5.2.2 5.2.3
10.2	Normalized Oscillation Signal Processing	Section title only	-	-
10.2.1	Normalized Oscillation Signal Processing (without LPRM bypass)	-	5.2.2.3.2	5.1.3-1
10.2.2	Normalized Oscillation Signal Processing (with LPRM bypass)	-	5.2.2.3.3 5.2.2.3.7	5.2.1
10.3	OPRM Region Determination (OPRM Automatic Bypass)	-	5.2.2.3.6 5.2.2.3.7	5.1.3-8 5.2.1
10.4	Trip Determination Functions	Section title only	-	-
10.4.1	Amplitude-Based Maximum Trip (ABA Trip) Determination	-	5.2.2.3.5 5.2.2.3.5.3	5.1.3-3 5.1.3-6 5.1.5 5.2.2
10.4.2	Growth Rate-Based Trip (GRA Trip) Determination	-	5.2.2.3.5 5.2.2.3.5.3	5.1.3-4 5.1.3-6 5.1.5 5.2.2
10.4.3	Period-Based Trip (PBDA Trip) Determination	-	5.2.2.3.5 5.2.2.3.5.3	5.1.3-5 5.1.3-6 5.1.5 5.2.3
10.4.4	Trip Algorithm Initialization	-	5.2.2.3.5 5.2.2.3.5.1 5.2.2.3.5.2 5.2.2.3.5.3 5.2.2.3.7	5.1.6 5.2.2 5.2.3
10.5	Failure Detection and Self Diagnosis Functions	Section title only	-	-

Section No. of SVTP	Test Item	Remarks	Related EDS Section	Related Unit DDS Section
	Title			
10.5.1	OPRM Inoperative	-	5.1.8 5.1.10 5.2.2.3.5	5.1.3-8 5.2.1 5.2.2 5.2.3 8.0 9.0
10.5.2	OPRM Minor Failure	-	5.1.8 5.1.10 5.2.2.3.5	5.1.3-8 5.2.1 5.2.2 5.2.3 5.2.4 5.2.5 5.2.6 5.2.8 9.0
10.6	Other Functions	Section title only	-	-
10.6.1	Test Functions	-	5.1.10 5.2.2.3.7 5.2.2.3.10 5.6	5.1.7 5.2.1
10.6.2	Discrete Input Signal Toggling	-	5.2.1 5.2.1.3	5.1.3-8 6.1.3
10.6.3	Optical Transmission Integrity Test	-	5.2.1 5.2.1.3 5.2.2.3.1	5.1.3-1 5.1.3-7 5.1.3-13 6.1.1 6.1.2 6.2.1 6.2.2
10.6.4	Random HMI Operation	-	5.2.2.3.8	5.1.7 5.2.1 5.2.2 5.2.3 5.2.4 5.2.5 5.2.6
10.6.5	Initialization	-	5.1.2. 5.1.8	7.3. 8.0

Section No. of SVTP	Test Item	Remarks	Related EDS Section	Related Unit DDS Section
	Title			
-	Processing Cycle	There are no specific requirements for response time of trip generation. Processing cycle of 25ms was taken into account when determining acceptance criteria.	5.2.2.3.3	7.1
-	Operation Mode	Mode change operations of each module are included in test item of Section 10.1.4.2. Setpoint change operations under "CAL" mode are included in each test item as necessary. Test functions under "CAL" mode are tested in test item of Section 10.6.1.	5.2.2.3.4	5.1.4 5.2.1 5.2.2 5.2.3
-	Discrete Input Signal APRM Bypass	Discrete input signal check is included in each test item as necessary. Discrete input signal toggling test is included in test item of Section 10.6.2.	5.2.1 5.2.1.3	5.1.3-8 6.1.3
-	Discrete Output Signals OPRM Trip (Scram) OPRM Inoperative OPRM Minor failure	Discrete output signal check is included in each test item as necessary.	5.2.1 5.2.1.3	5.1.3-12 6.2.3
-	Optical Input Signals From LPRM Unit From APRM Unit	Optical input signal check is included in each test item as necessary. Optical transmission integrity test is included in test item of Section 10.6.3.	5.2.1 5.2.1.3 5.2.2.3.1	5.1.3-1 5.1.3-7 6.1.1 6.1.2
-	Optical Output Signals To ELCS/ To TDR/SOE	Optical output signal check is included in each test item as necessary. Optical transmission integrity test is included in test item of Section 10.6.3.	5.2.1 5.2.1.3	5.1.3-13 6.2.1 6.2.2
-	HMI Numerical Display Alarm Display Status Display Mode Display Display Reset Function	Visual check of displays and manual operation of switches and buttons are included in each test item as necessary.	5.2.2.3.8	5.1.7 5.2.1 5.2.2 5.2.3 5.2.4 5.2.5 5.2.6

10. Software Validation Test

The following subsections specify test specifications and conditions for each test item.

10.1 Standard Setting Check (Initial Setpoint)

The same parameter setting and jumper pin setting specified in Section 7 of the System Test Specification (Reference (6)) are used as “Standard Settings” for software validation testing. In this check, check that the parameters displayed on the module front panel are consistent with the values specified in “Standard Settings.”

In this test, correct indication of parameters is checked only. In the subsequent test items, parameters specified in each test item will be varied to demonstrated functionality subject to test as necessary.

(1) Test Patterns and Procedures

- Check that setting of digital switches on the CELL module in accordance with Table 7-1 of System Test Specification was finished.
- Check that setting of digital switches on the AGRD module in accordance with Table 7-2 of System Test Specification was finished.
- Set the “Peak and Valley Detection Width Setpoint (a)” of the AGRD module to 0.003.
- Check that setting of digital switches on the PBD module in accordance with Table 7-3 of System Test Specification was finished.
- Set the “Peak and Valley Detection Width Setpoint (a)” of the PBD module to 0.003.
- Check that setting of digital switches on the TRN modules in accordance with Table 7-4 of System Test Specification was finished.
- Check that setting of digital switches on the RCV modules in accordance with Table 7-5 of System Test Specification was finished.
- Check that setting of jumper pins on the modules in accordance with Table 7-6 of System Test Specification was finished.
- Turn the power of the OPRM unit on.
- Set the “Time Average Filter Cut-off Frequency Setpoint” of CELL module to “0.167” in accordance with the procedures described in Note 1 of Table 7-1 of System Test Specification.
- Set the “Maximum Amplitude Trip Setpoint” of AGRD module to “1.30” in accordance with the procedures described in Note 1 of Table 7-2 of System Test Specification.
- Set the “Period Tolerance Setpoint (Te)” of PBD module to “0.150” in accordance with the procedures described in Note 1 of Table 7-3 of System Test Specification.
- Set the “Confirmation Count Trip Setpoint (Np)” of PBD module to “10” in accordance with the procedures described in Note 1 of Table 7-3 of System Test Specification.
- Set the OPRM unit to the “Normal Status” as described in Section 6.6.

(2) Acceptance Criteria

- Check that the status of displays on the OPRM unit and the Aux-Relay Plate is consistent with Table 6.6-1.
- Check that displayed setpoints on the front panel of CELL module are consistent with the “Initial Setpoint” values

specified in Table 6.1-1.

- Check that displayed setpoints on the front panel of AGRD module are consistent with the “Initial Setpoint” values specified in Table 6.1-2.
- Check that displayed setpoints on the front panel of PBD module are consistent with the “Initial Setpoint” values specified in Table 6.1-3.
- Check the numerical display “Amp/%/Count” of CELL module. Select “St” to show the Normalized Oscillation Signal values. The displayed Normalization Oscillation Signal (St) values for CELL 1 through 45 on the numerical display of the CELL module are as follows.

After 60 seconds elapsed from being set to “Normal Status,” Normalized Oscillation Signal values for CELL 1 to 45 are within[]^{a,c}

- Check the numerical display “Amp/%/Count” of CELL module. Select “CELL Count” to show the Number of Active OPRM Cells. The displayed Number of Active OPRM Cells “CELL Count” on the numerical display of the CELL module is 44.

10.2 Normalized Oscillation Signal Processing

In the following test items, functionality of Normalized Oscillation Signal Processing depending on parameters and conditions specified in each test item is tested.

10.2.1 Normalized Oscillation Signal Processing (without LPRM Bypass)

The purpose of this test item is to check that the Normalized Oscillation Signal calculation is performed under normal state (i.e., calculation is performed with no LPRM Levels bypassed) by inputting a simulated signal of LPRM units in the OPRM unit.

(1) Test Patterns and Procedures

1. Test Pattern 1

This test pattern inputs a sine curve as LPRM Levels of 52ch that make up 44 Cells. This test pattern checks that filtering process, time average process, and normalization are executed for each cell and Normalized Oscillation Signals are calculated as expected.

- Set the OPRM unit to the "Normal Status."
Click "All Stop" for LPRM 1 to 4.
Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
 After "Single Output" of selected test patterns is finished, the Optical Signal Transmit Simulator transmits 0% LPRM levels for LPRM CH1 through CH52 automatically, and the number of active OPRM Cells becomes "0." Thus, the CELL module generates an OPRM Inoperative signal.
- Check that status of module display and PC data output on Optical Signal Receive Simulator is as expected in Table 10.2.1-1.

2. Test Pattern 2

In this test pattern CELL 9 is selected, and the values of 4 LPRMs included in CELL9 are set to a constant in order. Check that Normalized Oscillation Signal change as expected by averaging process.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of module display and ELCS[]^{ac} data output on Optical Receive Simulator is as expected in Table 10.2.1-1.

3. Test Pattern 3

Input constant LPRM values as LPRM Levels of 52ch that make up 44 Cells. After the elapse of a certain period of time, check that Normalized Oscillation Signals in the CELL module indication turns to 1 and that Filtered Flux has the value expected.

- Set the OPRM unit to the "Normal Status."
- Check that status of module display and ELCS[]^adata output on Optical Signal Receive Simulator is as expected in Table 10.2.1-1.

4. Test Pattern 4

In this test pattern, CELL 10 is selected as a representative to check the filtering initialization function (i.e., Normalized Oscillation Signal value becomes 1.) when the Number of Active LPRMs changes (i.e., LPRM bypass occurs.) due to the following conditions.

- LPRM Level is less than the LPRM Lower-limit Setpoint.
- When inoperative (bypass) occurs in the LPRM unit.
- When a transmission error occurs in the LPRM unit.

This test pattern has following features:

- Step 1: LPRM Level under the LPRM Lower-limit Setpoint.
Input the oscillating 4 LPRM Levels data of LPRM CH5, 15, 28 and 44 included in CELL10. After the lapse of a certain period of time, lower the LPRM Level of LPRM CH5 below the LPRM Lower-limit Setpoint.
- Step 2: LPRM Inoperative
Turn on the flag of LPRM Inoperative in LPRM CH15 in LPRM Unit2.
- Step 3: Data Update Error
Change the transmission data from LPRM Unit3 from normal state to a state simulating Data Update Error of LPRM CH 28.
- Step 4: Parity Error
Change the transmission data from LPRM Unit4 from normal state to a state simulating parity error of LPRM CH44.

Procedural steps are as follows.

- Click "All Stop" for LPRM 1 to 4.
Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)
- Check that status of ELCS[]^adata output on Optical Signal Receive Simulator is as expected in Table 10.2.1-1.

5. Test Pattern 5

In this test pattern, CELL 11 is selected as a representative to check that the Levels meeting the following conditions (i.e. LPRM bypass occurs.) are excluded from the calculation of Averaged Flux.

- LPRM Level is less than the LPRM Lower-limit Setpoint.

- When inoperative (bypass) occurs in the LPRM unit.
- When a transmission error occurs in the LPRM unit.

This test pattern has following features:

- Step 1: LPRM Level under the LPRM Lower-limit Setpoint.
Input the oscillating 4 LPRM Levels data of LPRM CH4, 15, 31 and 44 included in CELL11. After the lapse of a certain period of time, lower the LPRM Level of LPRM CH4 below the LPRM Lower-limit Setpoint for a certain period of time.
- Step 2: LPRM Inoperative
Input the oscillating 4 LPRM Levels data of LPRM CH4, 15, 31 and 44 included in CELL11. After the lapse of a certain period of time, turn on the flag of LPRM Inoperative in LPRM CH4 for a certain period of time.
- Step 3: Data Update Error
Input the oscillating 4 LPRM Levels data of LPRM CH4, 15, 31 and 44 included in CELL11. After the lapse of a certain period of time, change the transmission data from LPRM Unit1 from normal state to a state simulating Data Update Error of LPRM CH 4 for a certain period of time.
- Step 4: Parity Error
Input the oscillating 4 LPRM Levels data of LPRM CH4, 15, 31 and 44 included in CELL11. After the lapse of a certain period of time, change the transmission data from LPRM Unit1 from normal state to a state simulating parity error of LPRM CH4 for a certain period of time.

Procedural steps are as follows.

- Click "All Stop" for LPRM 1 to 4.
Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

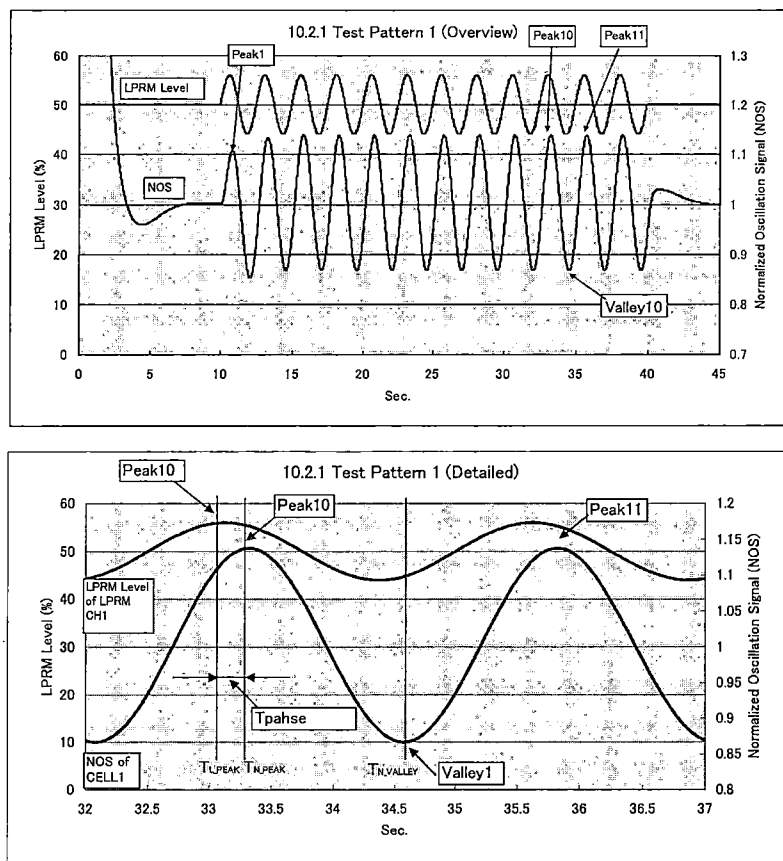
LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)
- Check that status of ELCS[] data output on Optical Signal Receive Simulator is as expected in Table 10.2.1-1.

(2) Acceptance Criteria

- Check that status of module display and ELCS[] data output on Optical Signal Receive Simulator is as expected in Table 10.2.1-1.

Table 10.2.1-1 Test Pattern and Expected Output

Test Pattern No.	Items to be checked		Acceptance Criteria
	Type of signal/display	Signal name/displayed item	
Test Pattern 1	Optical Signal Receive Simulator (PC data)	Normalized Oscillation Signals	Shape of Normalized Oscillation Signals conforms to the expected shape specified in Figure 10.2.1-1.
Test Pattern 2	Optical Signal Receive Simulator (ELCS[] ^{a,f} data)	Normalized Oscillation Signal for CELL 9	Shape of Normalized Oscillation Signal conforms to the expected shape specified in Figure 10.2.1-2.
Test Pattern 3	Numerical display "Amp/%/Count" of CELL module. Select "St" to show the Normalized Oscillation Signal values.	Normalized Oscillation Signal values for CELL 1 to 44	After 60 seconds elapsed, Normalized Oscillation Signal values for CELL 1 to 44 are within[] ^{a,c} [] ^{a,c}
	UL,LL,UR,LR displays of Filtered Flux on CELL module	UL,LL,UR,LR displays of Filtered Flux for CELL 1 to 44.	After 60 seconds elapsed, Filtered Fluxes for CELL 1 to CELL 1 to 44 are within[] ^{a,c}
Test Pattern 4	Optical Signal Receive Simulator (ELCS[] ^{a,f} data)	Normalized Oscillation Signal for CELL 10	[] ^{a,f} times of the filtering initialization (i.e. Normalized Oscillation Signal value becomes 1) are observed as expected in Figure 10.2.1-3.
Test Pattern 5	Optical Signal Receive Simulator (ELCS[] ^{a,f} data)	Normalized Oscillation Signal for CELL 11	[] ^{a,f} times of the change of wave height of Normalized Oscillation Signal due to exclusion of bypassed LPRM from calculation of Averaged Flux are observed as expected in Figure 10.2.1-4.



Note: Details of Acceptance Criteria

Select CELL 1, and display Normalization Oscillation Signal (St) of CELL1 and LPRM Level 1 (LPRM CH1) on the Optical Signal Receive Simulator. Determine peak and valley positions by cursor operation as follows.

When the same values continue at the Peak (Valley) area, the Peak (Valley) position is to be determined by visually picking up a central point of those continuous values in the line graph.

(A) T_{PHASE}

Determine peak position of Peak 10 of LPRM Level 1 (T_{L_PEAK}).

Determine peak position of Peak 10 of Normalization Oscillation Signal (St) of CELL1 (T_{N_PEAK}).

Calculate the $T_{PHASE} = T_{N_PEAK} - T_{L_PEAK}$

Acceptance Criteria: T_{PHASE} is within []^{a,c}sec.

(B) Normalization Oscillation Signals (St) of CELL 1 through CELL44 (Peak)

Determine peak value of Peak 10 of Normalization Oscillation Signals (St) of CELL 1 through CELL44 at the T_{N_PEAK}

Acceptance Criteria:

Normalization Oscillation Signals (St) of CELL 1 through CELL44 at the T_{N_PEAK} are within []^{a,c}

(C) Normalization Oscillation Signals (St) of CELL 1 through CELL44 (Valley)

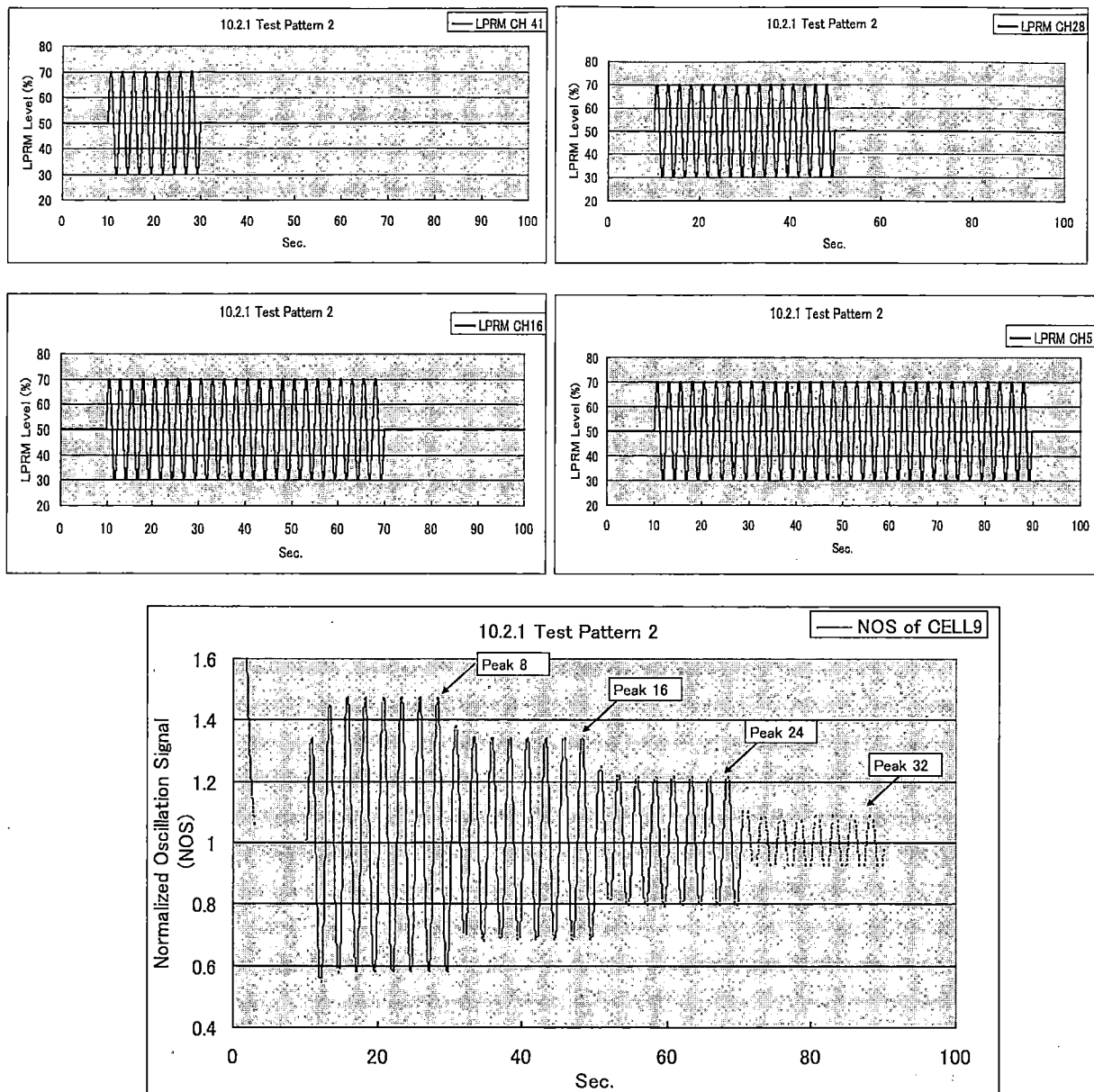
Determine valley position of Valley 10 of Normalization Oscillation Signal (St) of CELL1 (T_{N_VALLEY}).

Determine valley value of Valley 10 of Normalization Oscillation Signals (St) of CELL 1 through CELL44 at the T_{N_VALLEY}

Acceptance Criteria:

Normalization Oscillation Signals (St) of CELL 1 through CELL44 at the T_{N_VALLEY} are within []^{a,c}

Figure 10.2.1-1 Acceptance Criteria for Test Pattern 1



Acceptance Criteria

- Normalization Oscillation Signals (St) of CELL 9 at Peak 8 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 9 at Peak 16 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 9 at Peak 24 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 9 at Peak 32 is within[]^{a,c}

Figure 10.2.1-2 Acceptance Criteria for Test Pattern 2

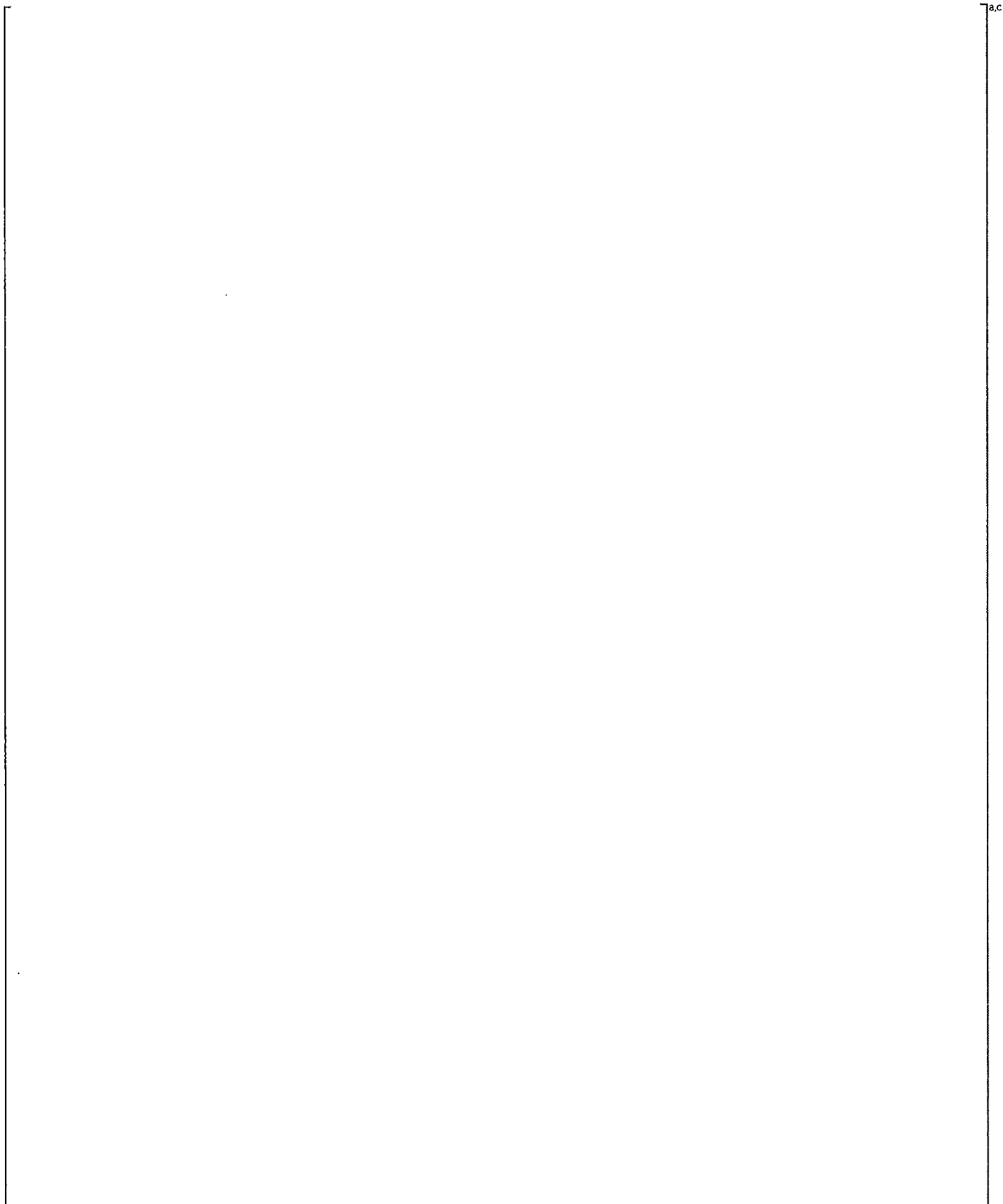


Figure 10.2.1-3 Acceptance Criteria for Test Pattern 4 (1/2)



Acceptance Criteria

- Normalization Oscillation Signals (St) of CELL 10 in the period of Peak 8 once resets to []^{a,c} and oscillates again.
- Normalization Oscillation Signals (St) of CELL 10 in the period of Peak 16 once resets to []^{a,c} and oscillates again.
- Normalization Oscillation Signals (St) of CELL 10 in the period of Peak 24 once resets to []^{a,c} and oscillates again.
- Normalization Oscillation Signals (St) of CELL 10 in the period of Peak 32 once resets to []^{a,c} and oscillates again.

Figure 10.2.1-3 Acceptance Criteria for Test Pattern 4 (2/2)

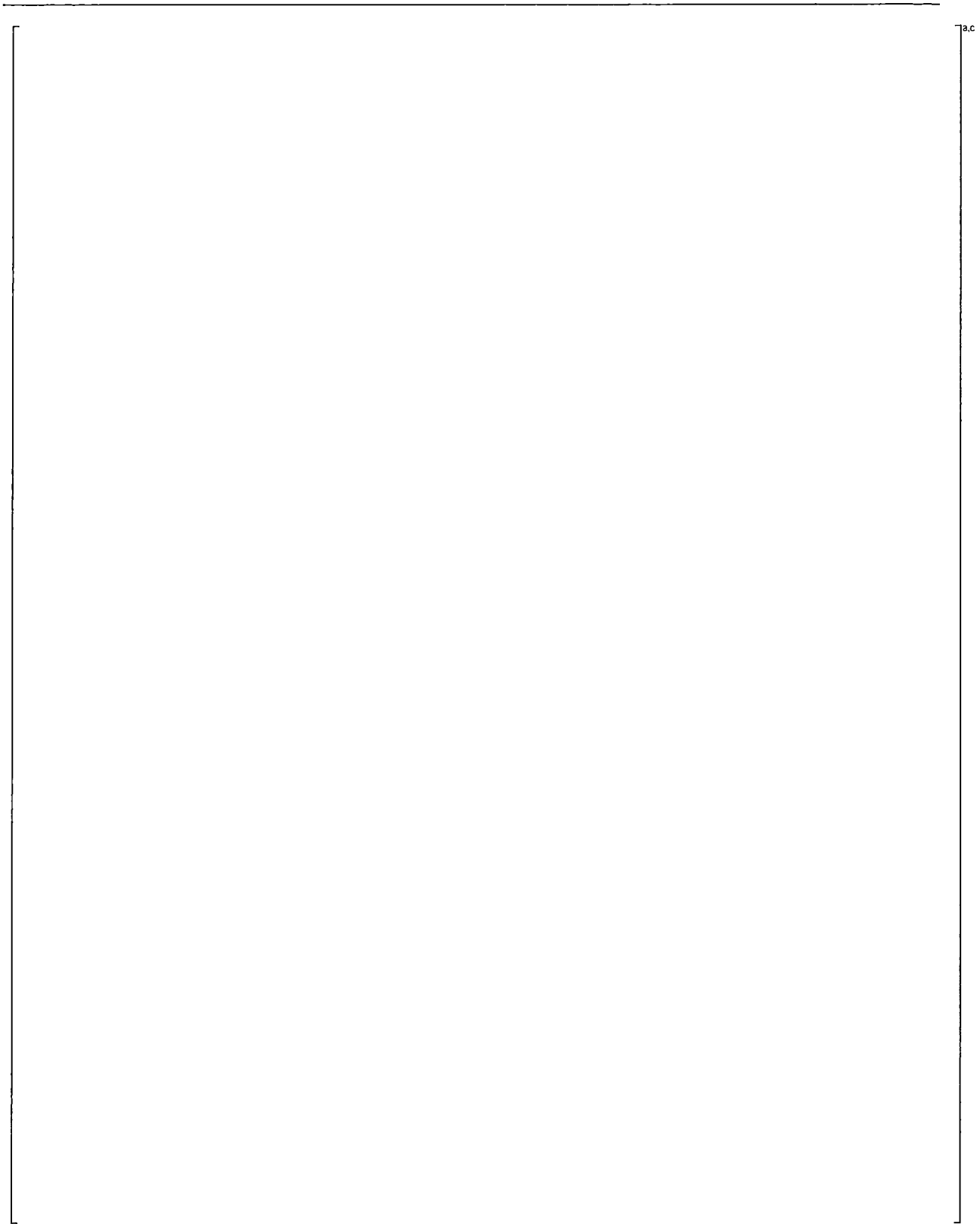


Figure 10.2.1-4 Acceptance Criteria for Test Pattern 5 (1/2)

Acceptance Criteria

- Normalization Oscillation Signals (St) of CELL 11 at Peak 8 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 11 at Peak 16 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 11 at Peak 24 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 11 at Peak 32 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 11 at Peak 40 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 11 at Peak 48 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 11 at Peak 56 is within[]^{a,c}
- Normalization Oscillation Signals (St) of CELL 11 at Peak 64 is within[]^{a,c}

Figure 10.2.1-4 Acceptance Criteria for Test Pattern 5 (2/2)

10.2.2 Normalized Oscillation Signal Processing (with LPRM bypass)

The purpose of this test item is to check that the Normalized Oscillation Signal calculation is performed under abnormal state (i.e., calculation is performed with certain number of LPRM Levels bypassed) by inputting a simulated signal of LPRM units in the OPRM unit.

(1) Test Patterns and Procedures

The test pattern used for this test item has following features:

- Step 1 => Step 2
Input the LPRM Levels data of LPRM CH1 to 13 in LPRM Unit1 at the value equal to or more than the LPRM Lower-limit Setpoint. After the lapse of a certain period of time, lower these LPRM Levels below the LPRM Lower-limit Setpoint.
- Step 2 => Step 3
Turn on the flag of LPRM Inoperative in LPRM CH14 to 26 in LPRM Unit2.
- Step 3 => Step 4
Change the transmission data from LPRM Unit3 from normal state to a state simulating Data Update Error (i.e., simulating exclusion of the data in LPRM CH27 to 39 from LPRM Unit 3).
- Step 4 => Step 5
Change the transmission data from LPRM Unit4 from normal state to a state simulating parity error (i.e., simulating exclusion of the data in LPRM CH40 to 52 from LPRM Unit 4).
- Step 5 => Step 6
Turn the state of LPRM Unit 1 to LPRM Unit 4 back from abnormal to normal.

Table 10.2.2-1 Overview of Test Pattern

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
LPRM1 (normal)	LPRM1 (abnormal)	LPRM1 (abnormal)	LPRM1 (abnormal)	LPRM1 (abnormal)	LPRM1 (normal)
LPRM2 (normal)	LPRM2 (normal)	LPRM2 (abnormal)	LPRM2 (abnormal)	LPRM2 (abnormal)	LPRM2 (normal)
LPRM3 (normal)	LPRM3 (normal)	LPRM3 (normal)	LPRM3 (abnormal)	LPRM3 (abnormal)	LPRM3 (normal)
LPRM4 (normal)	LPRM4 (normal)	LPRM4 (normal)	LPRM4 (normal)	LPRM4 (abnormal)	LPRM4 (normal)

Procedural steps are as follows.

- Step1:
Set the OPRM unit to the "Normal Status."

- Step2:
Run the following test pattern files on the Optical Signal Transmit Simulator.
LPRM 1:[]^{a,c}
- Step3:
Run the following test pattern files on the Optical Signal Transmit Simulator.
LPRM 2:[]^{a,c}
- Step4:
Run the following test pattern files on the Optical Signal Transmit Simulator.
LPRM 3:[]^{a,c}
- Step5:
Run the following test pattern files on the Optical Signal Transmit Simulator.
LPRM 4:[]^{a,c}
- Step6:
Run the following test pattern files on the Optical Signal Transmit Simulator.
LPRM 1:[]^{a,c}
LPRM 2:[]
LPRM 3:[]
LPRM 4:[]
- In each step, check that status of module display is as expected in Table 10.2.2-2.

(2) Acceptance Criteria

- Check that status of module display is as expected in Table 10.2.2-2.

Table 10.2.2-2 Test Pattern and Expected Output

Step	Test Pattern	Acceptance Criteria (Expected Output)			Remarks
		CELL module display		Module display (Others)	
	Optical Signal Transmit Simulator	"BYP" (LPRM Bypass) LEDs corresponding to UL,LL,UR,LR displays of Filtered Flux	Numerical display "Amp%/Count." Select "CELL Count" to show the Number of Active OPRM Cells.		
1	Normal Status	All BYP LEDs for CELL1 to CELL 44 turn OFF.	"CELL Count" is 44.	N/A	
2	Run the following test pattern files. LPRM 1: [] ^{a,c}	Status of BYP LEDs is as expected in Table 10.2.2-3	"CELL Count" is [] ^{a,c}	N/A	Refer to Table 10.2.2-3 for bypassed Cell No.
3	Run the following test pattern files. LPRM 2: [] ^{a,c}	Status of BYP LEDs is as expected in Table 10.2.2-4	"CELL Count" is [] ^{a,c}	N/A	Refer to Table 10.2.2-4 for bypassed Cell No.
4	Run the following test pattern files. LPRM 3: [] ^{a,c}	Status of BYP LEDs is as expected in Table 10.2.2-5	"CELL Count" is [] ^{a,c}	"INOP" LED on CELL module turns ON.	Refer to Table 10.2.2-5 for bypassed Cell No.
5	Run the following test pattern files. LPRM 4: [] ^{a,c}	Status of BYP LEDs is as expected in Table 10.2.2-6	"CELL Count" is [] ^{a,c}	"LPRM4" LED of "LINE STATUS" on DAT/ST module. (LPRM Unit 4 Data transmission failure) turns ON. "INOP" LED on CELL module turns ON.	Refer to Table 10.2.2-6 for bypassed Cell No.
6	Run the following test pattern files. LPRM 1: [] ^{a,c} LPRM 2: [] ^{a,c} LPRM 3: [] ^{a,c} LPRM 4: [] ^{a,c}	All BYP LEDs for CELL1 to CELL 44 turn OFF.	"CELL Count" is 44.	N/A	

Table 10.2.2-3 Expected Output of BYP LEDs on CELL Module (LPRM Unit 1 is Abnormal)

Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)	Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)
LPRM CH in Division					LPRM CH in Division				
1					23				
2					24				
3					25				
4					26				
5					27				
6					28				
7					29				
8					30				
9					31				
10					32				
11					33				
12					34				
13					35				
14					36				
15					37				
16					38				
17					39				
18					40				
19					41				
20					42				
21					43				
22					44				

Hatched portion "■" of "BYP (UL)," "BYP (UR)," "BYP (LL)," and "BYP (LR)" columns means that corresponding LED turns ON. Hatched portion "■" of "Cell No. column means that corresponding CELL is bypassed.

Table 10.2.2-4 Expected Output of BYP LEDs on CELL Module (LPRM Unit 1 and 2 are Abnormal)

Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)	Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)
LPRM CH in Division					LPRM CH in Division				
1					23				
2					24				
3					25				
4					26				
5					27				
6					28				
7					29				
8					30				
9					31				
10					32				
11					33				
12					34				
13					35				
14					36				
15					37				
16					38				
17					39				
18					40				
19					41				
20					42				
21					43				
22					44				

Hatched portion "■" of "BYP (UL)," "BYP (UR)," "BYP (LL)," and "BYP (LR)" columns means that corresponding LED turns ON. Hatched portion "■" of "Cell No. column means that corresponding CELL is bypassed.

Table 10.2.2-5 Expected Output of BYP LEDs on CELL Module (LPRM Units 1, 2, and 3 are Abnormal)

Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)	Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)
	LPRM CH in Division					LPRM CH in Division			
1					23				
2					24				
3					25				
4					26				
5					27				
6					28				
7					29				
8					30				
9					31				
10					32				
11					33				
12					34				
13					35				
14					36				
15					37				
16					38				
17					39				
18					40				
19					41				
20					42				
21					43				
22					44				

Hatched portion "■" of "BYP (UL)," "BYP (UR)," "BYP (LL)," and "BYP (LR)" columns means that corresponding LED turns ON. Hatched portion "■" of "Cell No. column means that corresponding CELL is bypassed.

Table 10.2.2-6 Expected Output of BYP LEDs on CELL Module (All LPRM Units are Abnormal)

Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)	Cell No.	BYP (UL)	BYP (UR)	BYP (LL)	BYP (LR)
	LPRM CH in Division					LPRM CH in Division			
1					23				
2					24				
3					25				
4					26				
5					27				
6					28				
7					29				
8					30				
9					31				
10					32				
11					33				
12					34				
13					35				
14					36				
15					37				
16					38				
17					39				
18					40				
19					41				
20					42				
21					43				
22					44				

Hatched portion "■" of "BYP (UL)," "BYP (UR)," "BYP (LL)," and "BYP (LR)" columns means that corresponding LED turns ON. Hatched portion "■" of "Cell No. column means that corresponding CELL is bypassed.

10.3 OPRM Region Determination (OPRM Automatic Bypass)

The purpose of this test item is to check that the OPRM region determination is performed in the correct manner in accordance with APRM level and Core Flow level variations.

(1) Test Patterns and Procedures

- STEP 1: APRM Level:[\bar{P}_0^{ac} , Core Flow Level:[\bar{P}_0^{ac}
 Set the OPRM unit to the "Normal Status."
 Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	\bar{P}_0^{ac}
APRM 2:	\bar{P}_0^{ac}
- STEP 2: APRM Level:[\bar{P}_0^{ac} , Core Flow Level:[\bar{P}_0^{ac}
 Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	\bar{P}_0^{ac}
APRM 2:	\bar{P}_0^{ac}
- STEP 3: APRM Level:[\bar{P}_0^{ac} , Core Flow Level:[\bar{P}_0^{ac} (OPRM Region)
 Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	\bar{P}_0^{ac}
APRM 2:	\bar{P}_0^{ac}
- STEP 4: APRM Level:[\bar{P}_0^{ac} , Core Flow Level:[\bar{P}_0^{ac} (OPRM Region)
 Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	\bar{P}_0^{ac}
APRM 2:	\bar{P}_0^{ac}
- STEP 5: APRM Level:[\bar{P}_0^{ac} , Core Flow Level:[\bar{P}_0^{ac}
 Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	\bar{P}_0^{ac}
APRM 2:	\bar{P}_0^{ac}
- STEP 6: APRM Level:[\bar{P}_0^{ac} , Core Flow Level:[\bar{P}_0^{ac}
 Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	\bar{P}_0^{ac}
APRM 2:	\bar{P}_0^{ac}
- STEP 7: APRM Level:[\bar{P}_0^{ac} , Core Flow Level:[\bar{P}_0^{ac} (OPRM Region)
 Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	\bar{P}_0^{ac}
APRM 2:	\bar{P}_0^{ac}
- Check that status of discrete outputs, module display and PC data output on Optical Signal Receive Simulator is as expected in Tables 10.3.1 through 10.3-3.

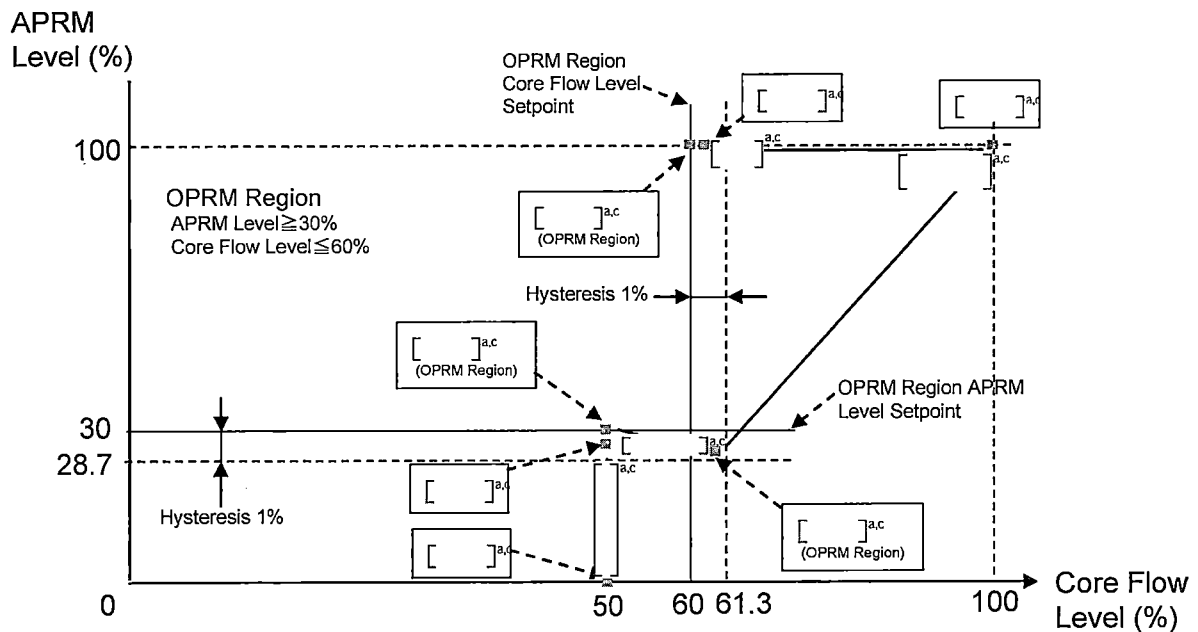


Figure 10.3-1 Overview of Test Patterns for OPRM Region Determination Function

Table 10.3-1 Expected Output for Discrete Output

Step	Test Pattern (Optical Signal Transmit Simulator)				Acceptance Criteria (Expected Output) (Discrete Output)		Remarks
	APRM data 1		APRM data 2		OPRM Automatic Bypass		
	APRM Level	Core Flow Level	APRM Level	Core Flow Level			
1					ON		
2					ON		
3					OFF		OPRM Region
4					OFF		OPRM Region
5					ON		
6					ON		
7					OFF		OPRM Region

Table 10.3-2- Expected Output for Displayed Items

Step	Test Pattern (Optical Signal Transmit Simulator)				Acceptance Criteria (Expected Output) (Displays on CELL module)				Remarks
	APRM data 1		APRM data 2		APRM Level (APRM)	Core Flow Level (FLOW)	OPRM Automatic Bypass (BYP)	OPRM Operation Region (OPRM REGION)	
	APRM Level	Core Flow Level	APRM Level	Core Flow Level					
1							ON	OFF	
2							ON	OFF	
3							OFF	ON	OPRM Region
4							OFF	ON	OPRM Region
5							ON	OFF	
6							ON	OFF	
7							OFF	ON	OPRM Region

Table 10.3-3 Expected Output for Optical Output Signal for ELCS

Step	Test Pattern (Optical Signal Transmit Simulator)				Acceptance Criteria (Expected Output) (Optical Signal Receive Simulator (PC data))			Remarks
	APRM Unit data 1		APRM Unit data 2		APRM Level [%]	FLOW Level [%]	OPRM Automatic Bypass	
	APRM Level	Core Flow Level	APRM Level	Core Flow Level				
1							ON	
2							ON	
3							OFF	OPRM Region
4							OFF	OPRM Region
5							ON	
6							ON	
7							OFF	OPRM Region

(2) Acceptance Criteria

- Check that status of discrete outputs, module display and PC data output on Optical Signal Receive Simulator is as expected in Tables 10.3-1 through 10.3-3.

10.4 Trip Determination Functions

To verify the trip determination functions, it is to be checked that trip determination is performed in the correct manner for the Growth Rate-Based Trip (GRA Trip), the Amplitude-Based Maximum Trip (ABA Trip), and the Period-Based Trip (PBDA Trip) algorithms in accordance with input variations.

10.4.1 Amplitude-Based Maximum Trip (ABA Trip) Determination

The purpose of this test item is to check that trip determination is performed in the correct manner for the Amplitude-Based Maximum Trip (ABA Trip) determination.

(1) Test Patterns and Procedures

1. Test Pattern 1

This test pattern is used to check the ABA algorithm operation for 44 cells. LPRM Levels simulating a waveform that consists of sine curve whose amplitude value is amplified with time and a constant value are used as the test pattern. This test pattern simulates LPRM Levels for 52 channels so that the ABA trip occurs separately in CELL 1 through CELL 44. This test pattern also simulates LPRM Levels for 52 channels so that the ABA trip occurs simultaneously in CELL 1 through CELL 44 after the ABA trip occurs in 44 cells. This test pattern is set up not to make the GRA trip (Setpoint: DR = 1.3) occur. Use this test pattern to check that an ABA trip occurs at each of 44 cells at the intervals of 5 seconds (i.e., 44 times in total), and then one ABA trip occurs at the end as an OR output of all of those 44 ABA trips.

- Set the OPRM unit to the "Normal Status." Click "All Stop" for LPRM 1 to 4.
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.

After "Single Output" of selected test patterns is finished, the Optical Signal Transmit Simulator transmits 0% LPRM levels for LPRM CH1 through CH52 automatically, and the number of active OPRM Cells becomes "0." Thus, the CELL module generates an OPRM Inoperative signal.
- Check that status of discrete outputs and ELCS[]^{sg}data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.

2. Test Pattern 2

In this test pattern, CELL 2 is selected as a representative to check the detailed operation of the ABA algorithm.

This test pattern has following features:

A pattern that after the thresholds S1 and S2 are exceeded in the ABA algorithm, LPRM Levels with low amplitude peak simulating that Normalized Oscillation Signal (St) does not reach to Smax=1.3 on purpose. By using this pattern, check that after the thresholds S1 and S2 are exceeded, the ABA trip does not occur in CELL 2.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)

LPRM 4:[(Single Output)
Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[(Single Output) data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.

3. Test Pattern 3

In this test pattern, CELL 3 is selected as a representative to check the detailed operation of the ABA algorithm. Parameters applied to this test pattern are "Standard Settings" except "Smax." Use this test pattern to check that the ABA trip occurs in CELL 3 as expected at setpoint of "Smax =1.2."

- Set the parameter "Smax" of the AGRD module to "1.2."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:[(Single Output)
LPRM 2:[(Single Output)
LPRM 3:[(Single Output)
LPRM 4:[(Single Output)

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[(Single Output) data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.

4. Test Pattern 4

In this test pattern, CELL 4 is selected as a representative to check the detailed operation of the ABA algorithm. Parameters applied to this test pattern are "Standard Settings" except "Smax." Use this test pattern to check that the ABA trip occurs in CELL 4 as expected at setpoint of "Smax =1.4."

- Set the parameter "Smax" of the AGRD module to "1.4."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:[(Single Output)
LPRM 2:[(Single Output)
LPRM 3:[(Single Output)
LPRM 4:[(Single Output)

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[(Single Output) data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.
- After testing with this test pattern, set the "Smax" to "1.3."

5. Test Pattern 5

In this test pattern, CELL 5 is selected as a representative to check the detailed operation of the ABA algorithm.

This test pattern has following features:

A pattern that after the thresholds S1 and S2 are exceeded in the ABA algorithm, LPRM Levels with low frequency (equivalent to 0.2 Hz for the Normalized Oscillation Signal (St)) are input on purpose. Its related parameter is TH (TH = 2.20 s). By using this pattern, check that after the thresholds S1 and S2 are exceeded, the ABA trip does not occur in CELL 5.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.

6. Test Pattern 6

In this test pattern, CELL 6 is selected as a representative to check the detailed operation of the ABA algorithm.

This test pattern has following features:

A pattern that after the thresholds S1 and S2 are exceeded in the ABA algorithm, LPRM Levels with high frequency (equivalent to 1.7 Hz for the Normalized Oscillation Signal (St)) are input on purpose. Its related parameter is Tl (Tl = 0.38 s). By using this pattern, check that after the thresholds S1 and S2 are exceeded, the ABA trip does not occur in CELL 6.

- Set the parameter "Smax" of the AGRD module to "1.2."
- Set the parameter "Tl" of the AGRD module to "0.38."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.
- After testing with this test pattern, set the "Smax" to "1.3."
- After testing with this test pattern, set the "Tl" to "0.31."

7. Test Pattern 7

In this test pattern, CELL 7 is selected as a representative to check the detailed operation of the ABA algorithm.

This test pattern simulates such LPRM Levels that after the thresholds S1 and S2 are exceeded in the ABA algorithm, LPRM Levels are slowly increased on purpose to exceed Smax after the elapse of the period of time $3 \times (tp2 - tp1)$ following the fix of tp1 in the Normalized Oscillation Signal (St). By using this pattern, check that after the thresholds S1 and S2 are exceeded, the ABA trip does not occur in CELL 7.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as

expected in Table 10.4.1.

8. Test Pattern 8

In this test pattern, CELL 8 is selected as a representative to check the detailed operation of the ABA algorithm. This test pattern simulates such LPRM Levels that after the threshold S1 is exceeded in the ABA algorithm, LPRM Levels are slowly or swiftly decreased on purpose and then increased so that the threshold S2 is not exceeded. By using this pattern, check that after the threshold S1 is exceeded, the threshold S2 is not exceeded and the ABA trip does not occur in CELL 8.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.

(2) Acceptance Criteria

- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.1.

Table 10.4.1 Test Pattern and Expected Output

Test Pattern No.	Items to be checked		Acceptance Criteria	Reference Figure and Table
	Type of signal/display	Signal name/displayed item		
Test Pattern 1	Discrete Outputs	ABA_TRIP	45 times of “ABA_TRIP” signal generation are observed.	Figure 10.4.1-1-A
		OPRM_TRIP	45 times of “OPRM_TRIP” signal generation are observed.	
		GRA_TRIP	“GRA_TRIP” signal is not generated.	
		PBDA_TRIP	“PBDA_TRIP” signal is not generated.	
	AGRD module display	AMP_JUDGE1 and ABA_TRIP	Time difference between AMP_JUDGE1 and ABA_TRIP generation for CELL1 is [] ^{a,c} sec.	Figure 10.4.1-2-B
		“TRIP” LED “ABA TRIP” LED	Check that “TRIP” and “ABA TRIP” LEDs turn on at first trip generation. Check that the LEDs turns off by pushing the “RESET” button when trip generation is off, and turns on again at next trip generation.	N/A
	Optical Signal Receive Simulator Viewer (ELCS[] ^{a,c} data)	ABA Trip for CELL1 through 44.	The ABA Trip signals are generated according to the sequence specified in Table 10.4.1-1.	Table 10.4.1-1.
Test Pattern 2	Discrete Outputs	ABA_TRIP	“ABA_TRIP” signal is <u>not</u> generated.	Figure 10.4.1-2
Test Pattern 3	Discrete Outputs	ABA_TRIP	“ABA_TRIP” signal is generated.	Figure 10.4.1-3
Test Pattern 4	Discrete Outputs	ABA_TRIP	“ABA_TRIP” signal is generated.	Figure 10.4.1-4
Test Pattern 5	Discrete Outputs	ABA_TRIP	“ABA_TRIP” signal is <u>not</u> generated.	Figure 10.4.1-5
Test Pattern 6	Discrete Outputs	ABA_TRIP	“ABA_TRIP” signal is <u>not</u> generated.	Figure 10.4.1-6
Test Pattern 7	Discrete Outputs	ABA_TRIP	“ABA_TRIP” signal is <u>not</u> generated.	Figure 10.4.1-7
Test Pattern 8	Discrete Outputs	ABA_TRIP	“ABA_TRIP” signal is <u>not</u> generated.	Figure 10.4.1-8

10.4.1 Test Pattern 1 (Time Sequence)

A.C

Figure 10.4.1-1-A Time Sequence for Test Pattern 1

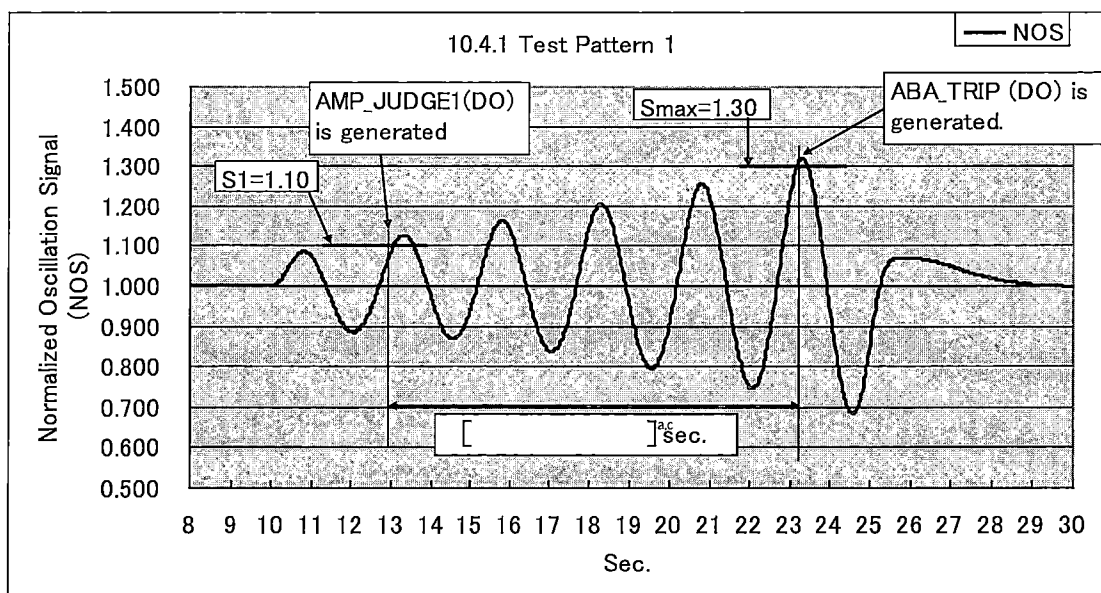


Figure 10.4.1-1-B Wave Form and Expected Output for Test Pattern 1

Table 10.4.1-1 Sequence of ABA Trip Generation

The ABA Trip signals are generated according to following sequence.

Cycle No	Seq. No.	CELL No	Cycle No	Seq. No.	CELL No	Cycle No	Seq. No.	CELL No
1	1	1	6	21	6	11	41	11
	2	12		22	17		42	15
	3	23		23	28		43	33
	4	39		24	38		44	36
2	5	2	7	25	7	12	45	All cells
	6	13		26	18			
	7	24		27	29			
	8	34		28	43			
3	9	3	8	29	8			
	10	21		30	19			
	11	25		31	30			
	12	41		32	44			
4	13	4	9	33	9			
	14	22		34	20			
	15	26		35	31			
	16	42		36	40			
5	17	5	10	37	10			
	18	16		38	14			
	19	27		39	32			
	20	37		40	35			

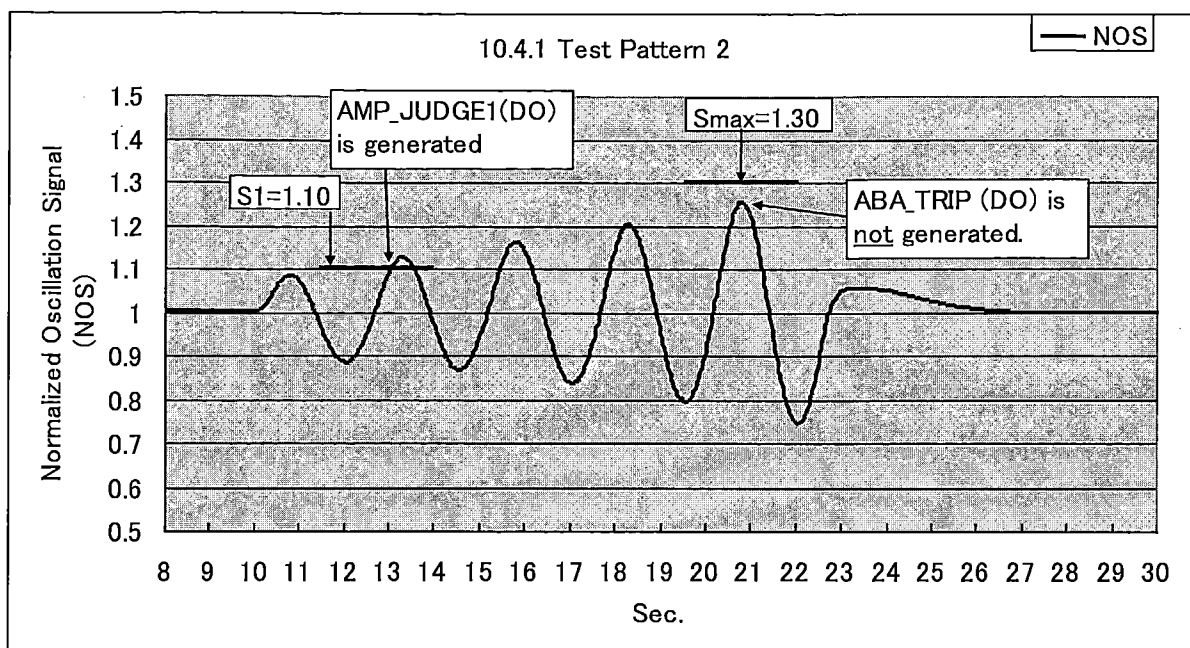


Figure 10.4.1-2 Wave Form and Expected Output for Test Pattern 2

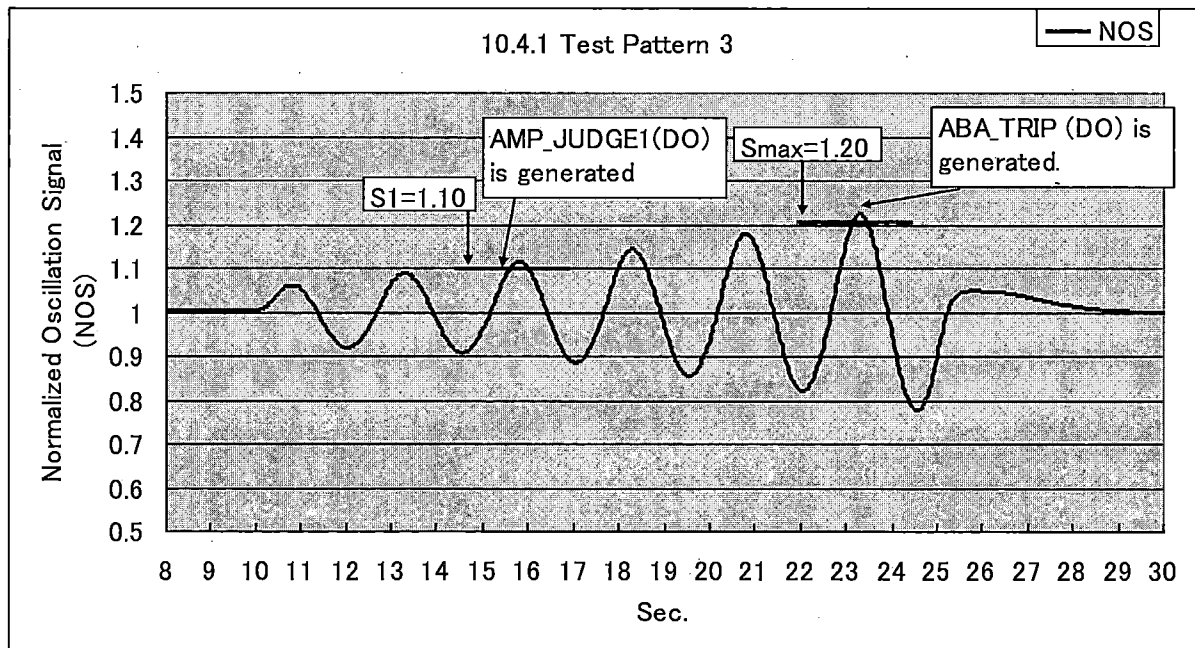


Figure 10.4.1-3 Wave Form and Expected Output for Test Pattern 3

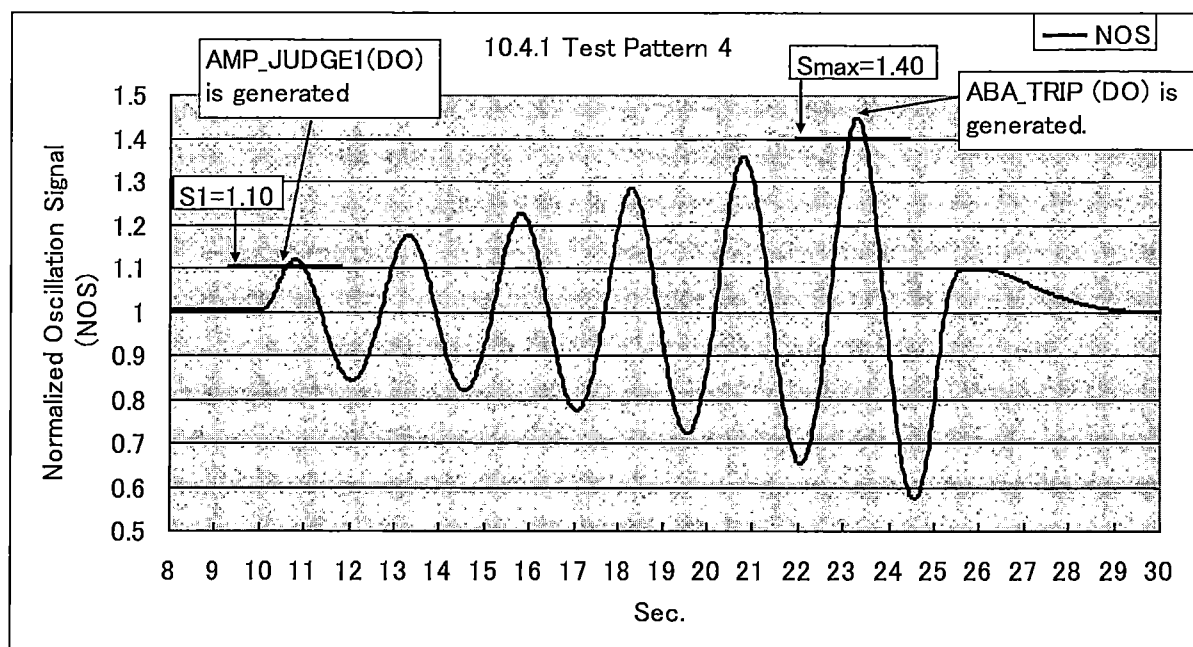


Figure 10.4.1-4 Wave Form and Expected Output for Test Pattern 4

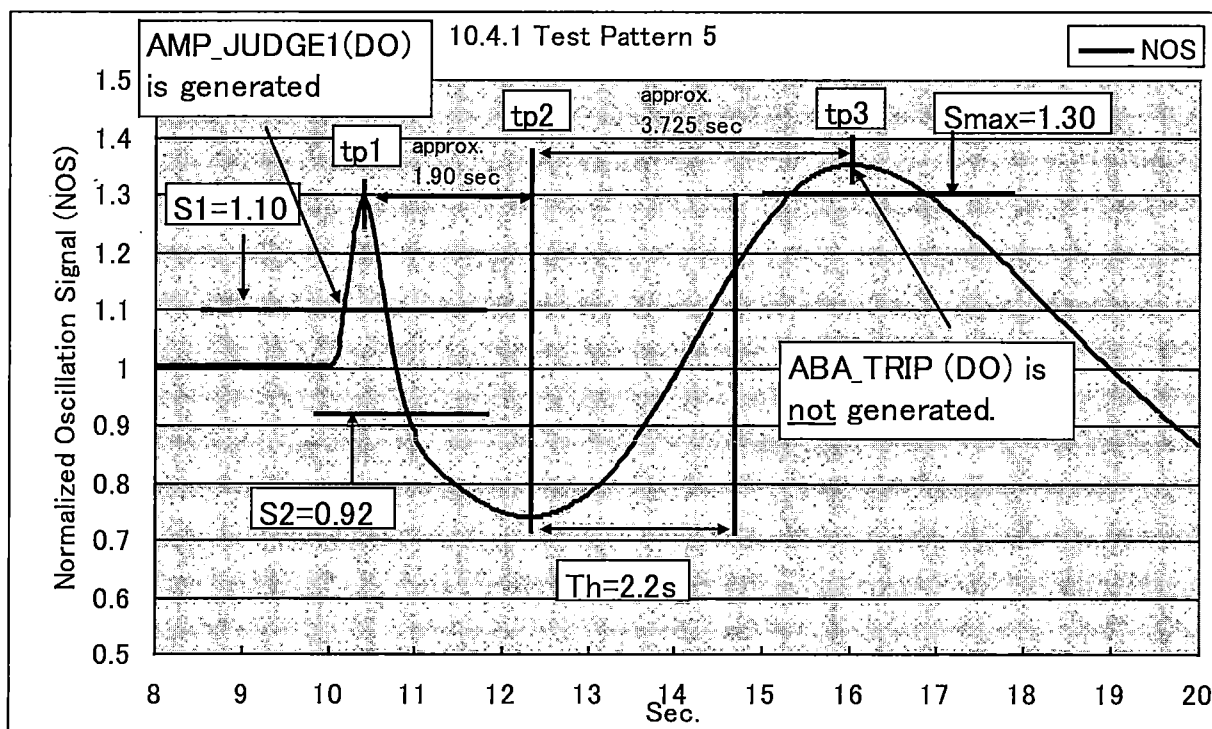


Figure 10.4.1-5 Wave Form and Expected Output for Test Pattern 5

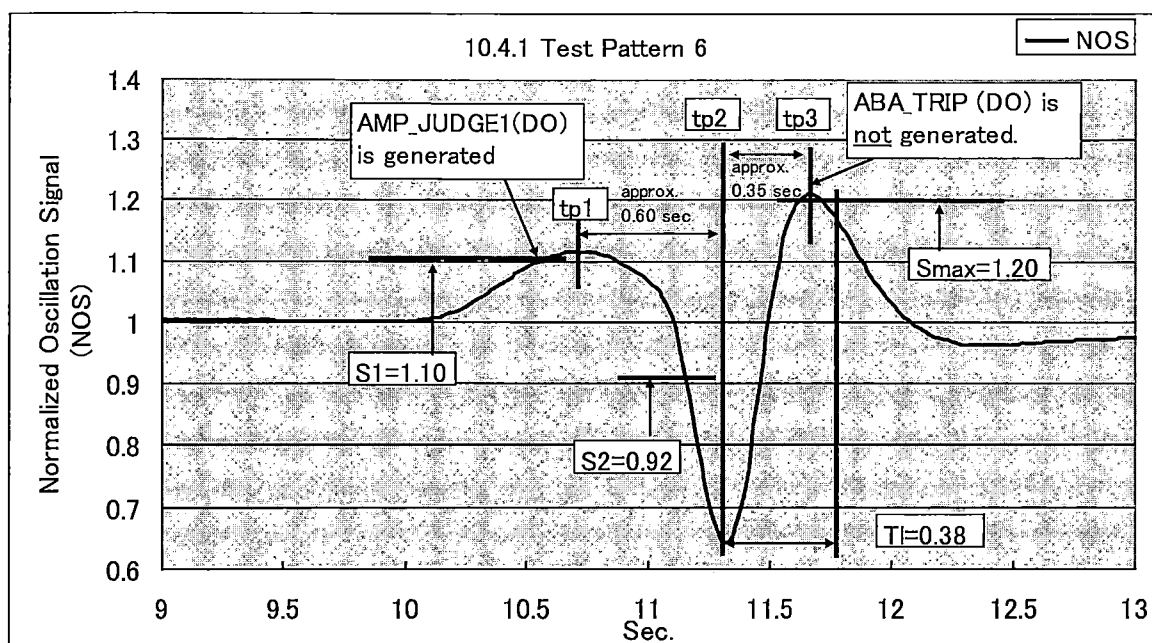


Figure 10.4.1-6 Wave Form and Expected Output for Test Pattern 6

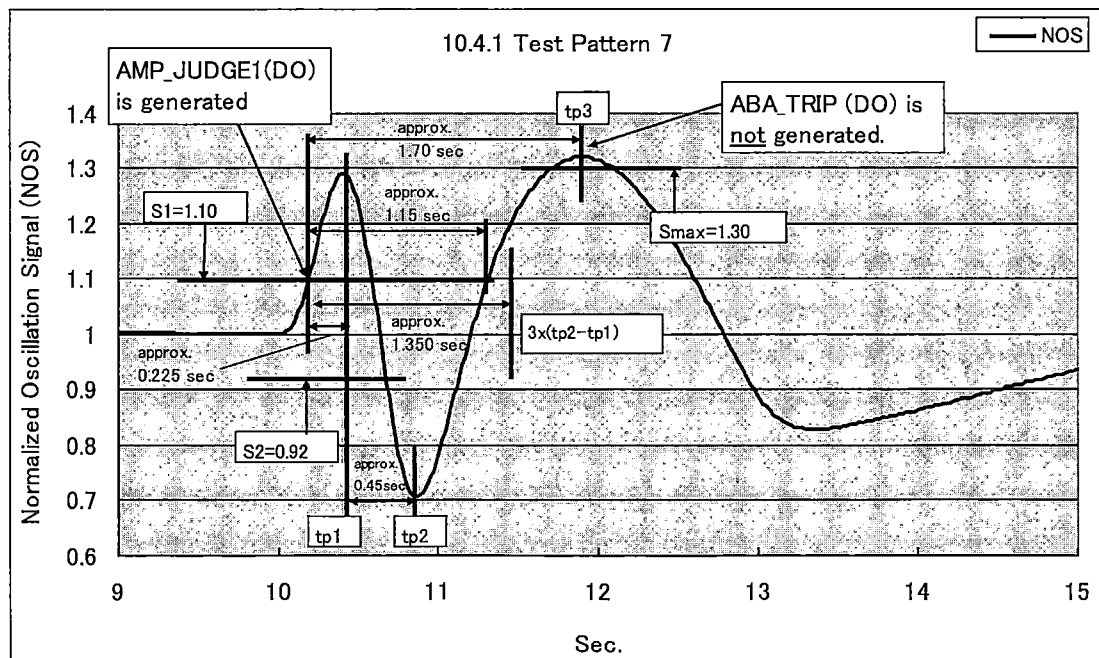


Figure 10.4.1-7 Wave Form and Expected Output for Test Pattern 7

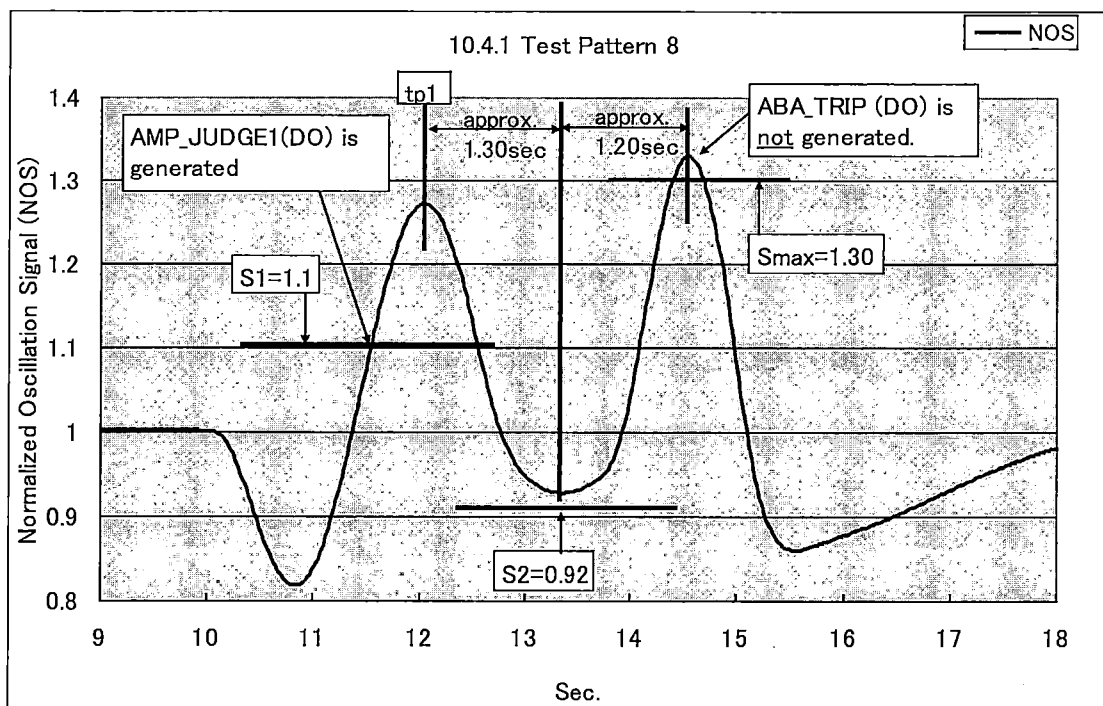


Figure 10.4.1-8 Wave Form and Expected Output for Test Pattern 8

10.4.2 Growth Rate-Based Trip (GRA Trip) Determination

The purpose of this test item is to check that trip determination is performed in the correct manner for the Growth Rate-Based Trip (GRA Trip) determination.

(1) Test Patterns and Procedures

1. Test Pattern 1

This test pattern is used to check the GRA algorithm operation for 44 cells. LPRM Levels simulating a waveform that consists of sine curve whose amplitude value is amplified with time and a constant value are used as the test pattern. This test pattern simulates LPRM Levels for 52 channels so that the GRA trip occurs separately in CELL 1 through CELL 44. This test pattern also simulates LPRM Levels for 52 channels so that the AGA trip occurs simultaneously in CELL 1 through CELL 44 after the GRA trip occurs in 44 cells. Use this test pattern to check that an GRA trip occurs at each of 44 cells at the intervals of 5 seconds (i.e., 44 times in total), and then one GRA trip occurs at the end as an OR output of all of those 44 GRA trips.

- Set the OPRM unit to the "Normal Status." Click "All Stop" for LPRM 1 to 4.
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.

After "Single Output" of selected test patterns is finished, the Optical Signal Transmit Simulator transmits 0% LPRM levels for LPRM CH1 through CH52 automatically, and the number of active OPRM Cells becomes "0." Thus, the CELL module generates an OPRM Inoperative signal.

- Check that status of discrete outputs and ELCS[]^{acc} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.

2. Test Pattern 2

In this test pattern, CELL 12 is selected as a representative to check the detailed operation of the GRA algorithm.

This test pattern has following features:

A pattern that after the thresholds S1 and S2 are exceeded in the GRA algorithm, LPRM Levels with low amplitude peak simulating that Normalized Oscillation Signal (St) does not reach to S3 (Growth Rate Amplitude Setpoint (S3) = (First Peak Value(P1)-1.0) × DR3 + 1.0) on purpose. By using this pattern, check that after the thresholds S1 and S2 are exceeded, the GRA trip does not occur in CELL 12.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{acc} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.

3. Test Pattern 3

In this test pattern, CELL 13 is selected as a representative to check the detailed operation of the GRA algorithm. Parameters applied to this test pattern are "Standard Settings" except "DR3." Use this test pattern to check that the GRA trip occurs in CELL 13 as expected at setpoint of "DR3 =1.2."

- Set the parameter "DR3" of the AGRD module to "1.2."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{ac} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.

4. Test Pattern 4

In this test pattern, CELL 14 is selected as a representative to check the detailed operation of the GRA algorithm. Parameters applied to this test pattern are "Standard Settings" except "DR3." Use this test pattern to check that the GRA trip occurs in CELL 14 as expected at setpoint of "DR3 =1.4."

- Set the parameter "DR3" of the AGRD module to "1.4."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{ac} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.
- After testing with this test pattern, set the "DR3" to "1.3."

5. Test Pattern 5

In this test pattern, CELL 15 is selected as a representative to check the detailed operation of the GRA algorithm.

This test pattern has following features:

A pattern that after the thresholds S1 and S2 are exceeded in the GRA algorithm, LPRM Levels with low frequency (equivalent to 0.2 Hz for the Normalized Oscillation Signal (St)) are input on purpose. Its related parameter is TH (TH = 2.20 s). By using this pattern, check that after the thresholds S1 and S2 are exceeded, the GRA trip does not occur in CELL 15.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{ac} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.

6. Test Pattern 6

In this test pattern, CELL 16 is selected as a representative to check the detailed operation of the GRA algorithm.

This test pattern has following features:

A pattern that after the thresholds S1 and S2 are exceeded in the GRA algorithm, LPRM Levels with high frequency (equivalent to 1.7 Hz for the Normalized Oscillation Signal (St)) are input on purpose. Its related parameter is T1 (T1 = 0.38 s). By using this pattern, check that after the thresholds S1 and S2 are exceeded, the GRA trip does not occur in CELL 16.

- Set the parameter "T1" of the AGRD module to "0.38."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{ac} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.
- After testing with this test pattern, set the "T1" to "0.31."

7. Test Pattern 7

In this test pattern, CELL 17 is selected as a representative to check the detailed operation of the GRA algorithm.

This test pattern simulates such LPRM Levels that after the thresholds S1 and S2 are exceeded in the GRA algorithm, LPRM Levels are slowly increased on purpose to exceed S3 after the elapse of the period of time $3 \times (tp2 - tp1)$ following the fix of tp1 in the Normalized Oscillation Signal (St). By using this pattern, check that after the thresholds S1 and S2 are exceeded, the GRA trip does not occur in CELL 17.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{ac} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.

8. Test Pattern 8

In this test pattern, CELL 18 is selected as a representative to check the detailed operation of the GRA algorithm.

This test pattern simulates such LPRM Levels that after the threshold S1 is exceeded in the GRA algorithm, LPRM Levels are slowly or swiftly decreased on purpose and then increased so that the threshold S2 is not exceeded. By using this pattern, check that after the threshold S1 is exceeded, the threshold S2 is not exceeded and the GRA trip does not occur in CELL 18.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1: (Single Output)
 LPRM 2: (Single Output)
 LPRM 3: (Single Output)
 LPRM 4: (Single Output)

Click “All Stop” for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{ac} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.

(2) Acceptance Criteria

- Check that status of discrete outputs and ELCS[]^{ac} data output on Optical Signal Receive Simulator is as expected in Table 10.4.2.

Table 10.4.2 Test Pattern and Expected Output

Test Pattern No.	Items to be checked		Acceptance Criteria	Reference Figure and Table
	Type of signal/display	Signal name/displayed item		
Test Pattern 1	Discrete Outputs	GRA_TRIP	45 times of “GRA_TRIP” signal generation are observed.	Figure 10.4.2-1-A
		OPRM_TRIP	45 times of “OPRM_TRIP” signal generation are observed.	
		ABA_TRIP	“ABA_TRIP” signal is not generated.	
		PBDA_TRIP	“PBDA_TRIP” signal is not generated.	
		AMP_JUDGE2 and GRA_TRIP	Time difference between AMP_JUDGE2 and GRA_TRIP generation for CELL1 is [] ^{ac} sec.	Figure 10.4.2-2-B
	AGRD module display	“TRIP” LED “GRA TRIP” LED	Check that “TRIP” and “GRA TRIP” LEDs turn on at first trip generation. Check that the LEDs turns off by pushing the “RESET” button when trip generation is off, and turns on again at next trip generation.	N/A
	Optical Signal Receive Simulator Viewer (ELCS[] ^{ac} data)	GRA Trip for CELL1 through 44.	The GRA Trip signals are generated according to the sequence specified in Table 10.4.2-1.	Table 10.4.2-1.
Test Pattern 2	Discrete Outputs	GRA_TRIP	“GRA_TRIP” signal is <u>not</u> generated.	Figure 10.4.2-2
Test Pattern 3	Discrete Outputs	GRA_TRIP	“GRA_TRIP” signal is generated.	Figure 10.4.2-3
Test Pattern 4	Discrete Outputs	GRA_TRIP	“GRA_TRIP” signal is generated.	Figure 10.4.2-4
Test Pattern 5	Discrete Outputs	GRA_TRIP	“GRA_TRIP” signal is <u>not</u> generated.	Figure 10.4.2-5
Test Pattern 6	Discrete Outputs	GRA_TRIP	“GRA_TRIP” signal is <u>not</u> generated.	Figure 10.4.2-6

Test Pattern No.	Items to be checked		Acceptance Criteria	Reference Figure and Table
	Type of signal/display	Signal name/displayed item		
Test Pattern 7	Discrete Outputs	GRA_TRIP	"GRA_TRIP" signal is <u>not</u> generated.	Figure 10.4.2-7
Test Pattern 8	Discrete Outputs	GRA_TRIP	"GRA_TRIP" signal is <u>not</u> generated.	Figure 10.4.2-8

10.4.2 Test Pattern 1 (Time Sequence)

a,c

Figure 10.4.2-1-A Time Sequence for Test Pattern 1

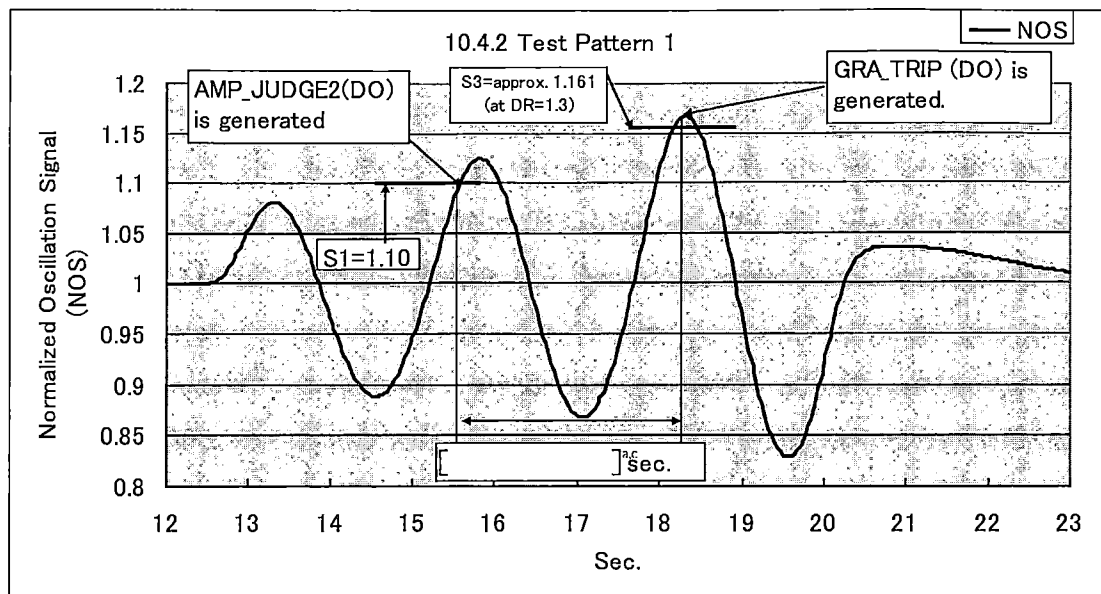


Figure 10.4.2-1-B Wave Form and Expected Output for Test Pattern 1

Table 10.4.2-1 Sequence of GRA Trip Generation

The GRA Trip signals are generated according to following sequence.

Cycle No	Seq. No.	CELL No	Cycle No	Seq. No.	CELL No	Cycle No	Seq. No.	CELL No
1	1	1	6	21	6	11	41	11
	2	12		22	17		42	15
	3	23		23	28		43	33
	4	39		24	38		44	36
2	5	2	7	25	7	12	45	All cells
	6	13		26	18			
	7	24		27	29			
	8	34		28	43			
3	9	3	8	29	8			
	10	21		30	19			
	11	25		31	30			
	12	41		32	44			
4	13	4	9	33	9			
	14	22		34	20			
	15	26		35	31			
	16	42		36	40			
5	17	5	10	37	10			
	18	16		38	14			
	19	27		39	32			
	20	37		40	35			

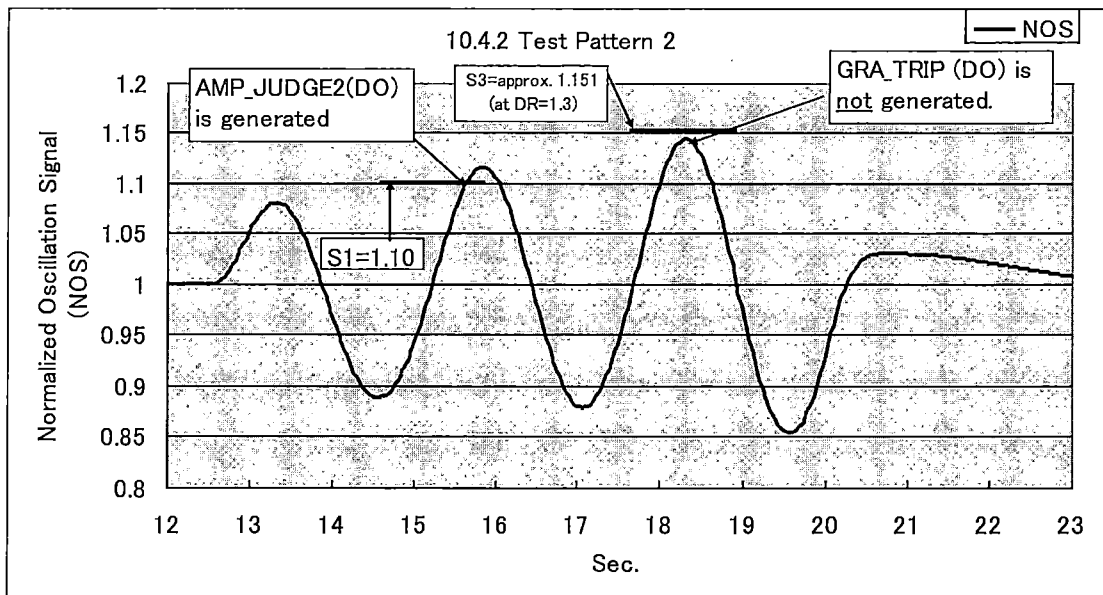


Figure 10.4.2-2 Wave Form and Expected Output for Test Pattern 2

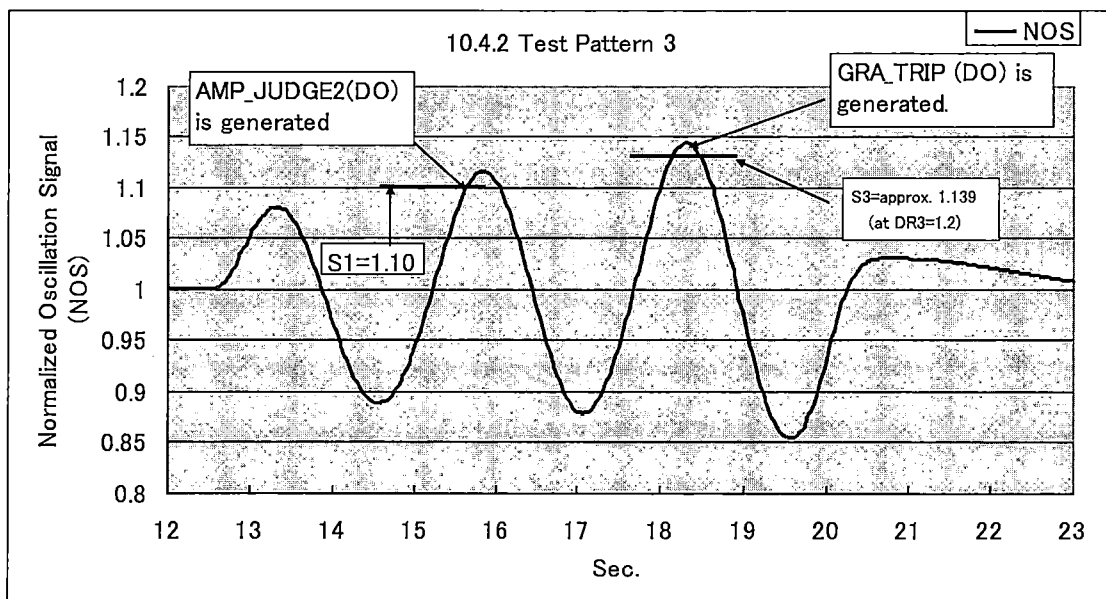


Figure 10.4.2-3 Wave Form and Expected Output for Test Pattern 3

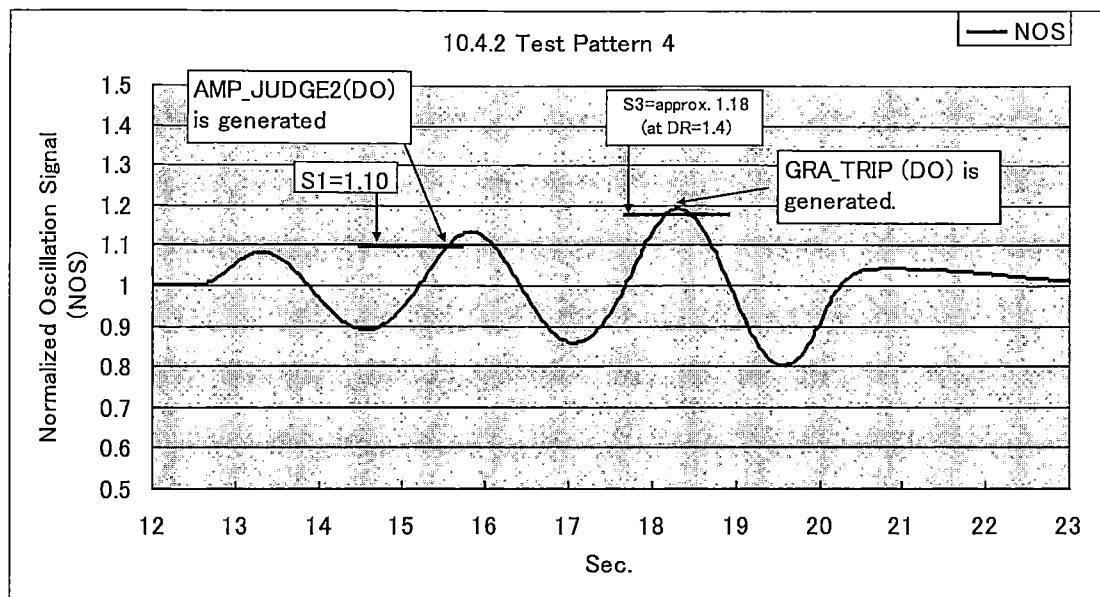


Figure 10.4.2-4 Wave Form and Expected Output for Test Pattern 4

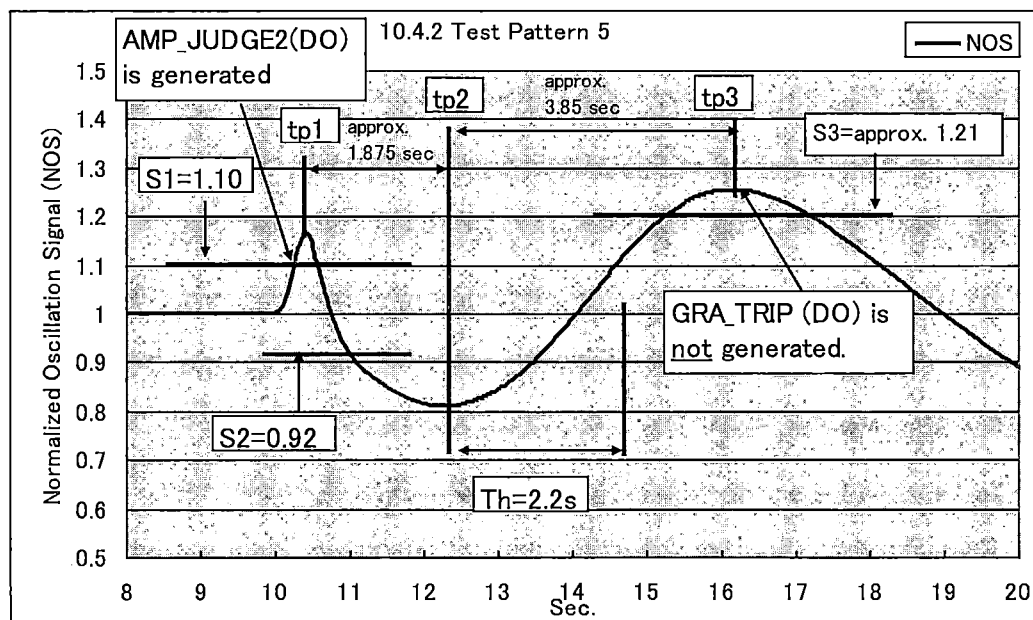


Figure 10.4.2-5 Wave Form and Expected Output for Test Pattern 5

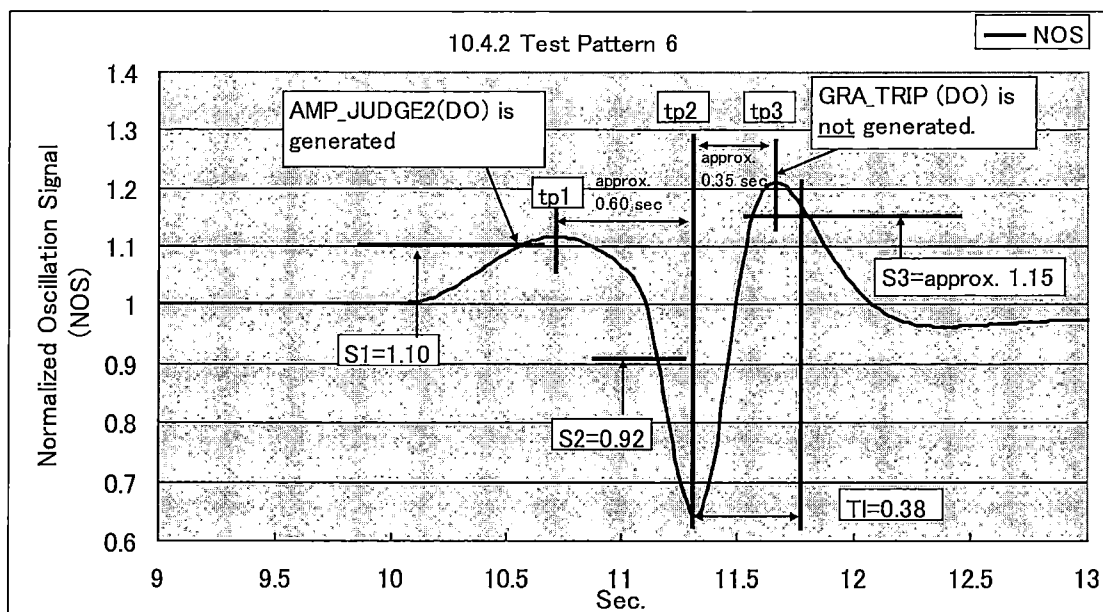


Figure 10.4.2-6 Wave Form and Expected Output for Test Pattern 6

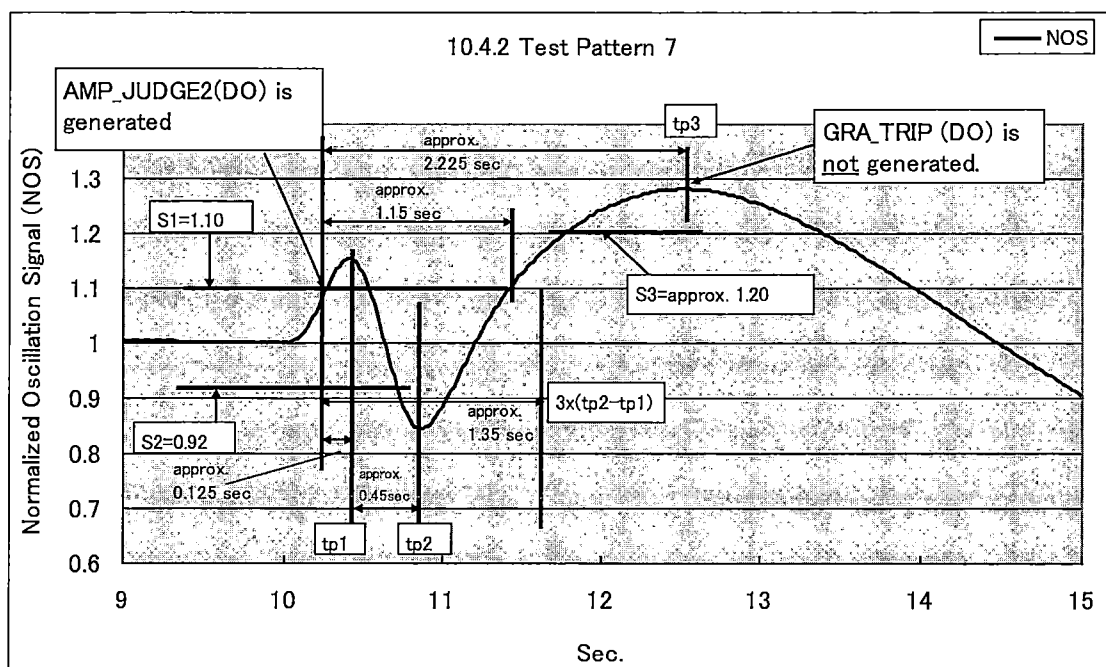


Figure 10.4.2-7 Wave Form and Expected Output for Test Pattern 7

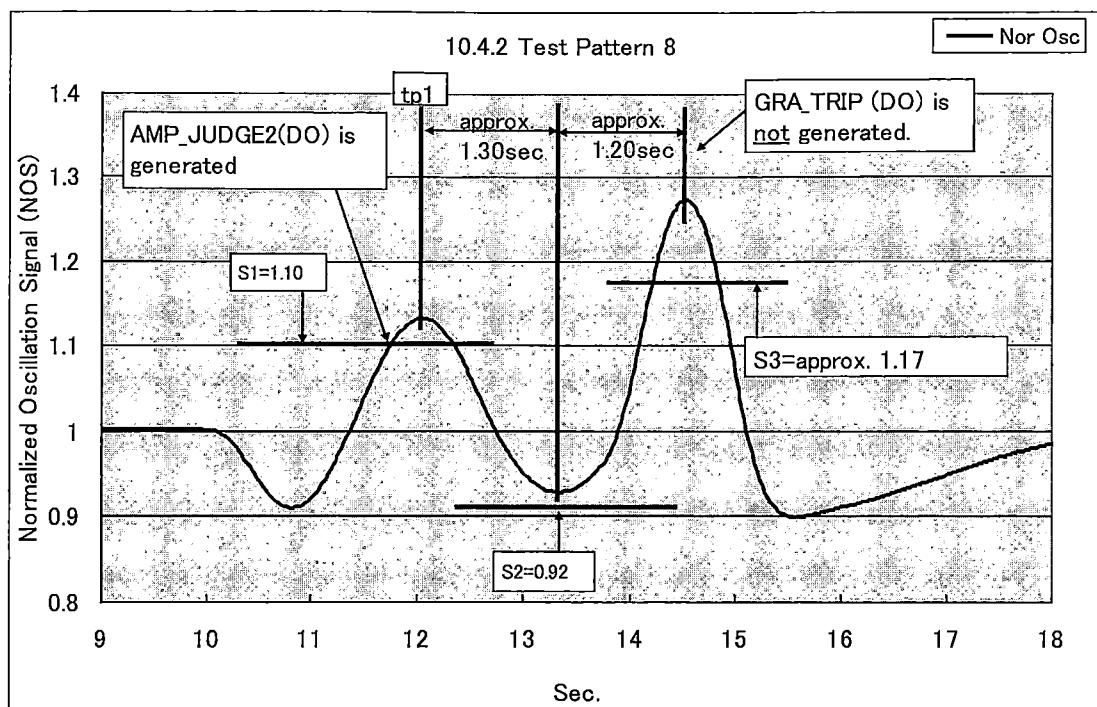


Figure 10.4.2-8 Wave Form and Expected Output for Test Pattern 8

10.4.3 Period-Based Trip (PBDA Trip) Determination

The purpose of this test item is to check that trip determination is performed in the correct manner for the Period-Based Trip (PBDA Trip) determination.

(1) Test Patterns and Procedures

1. Test Pattern 1

This test pattern is used to check the PBDA algorithm operation for 44 cells. LPRM Levels simulating a waveform that consists of sine curve and a constant value are used as the test pattern. This test pattern simulates LPRM Levels for 52 channels so that the PBDA trip occurs separately in CELL 1 through CELL 44. This test pattern also simulates LPRM Levels for 52 channels so that the PBDA trip occurs simultaneously in CELL 1 through CELL 44 after the GRA trip occurs in 44 cells. Use this test pattern to check that an PBDA trip occurs at each of 44 cells at the intervals of 5 seconds (i.e., 44 times in total), and then one PBDA trip occurs at the end as an OR output of all of those 44 PBDA trips at the initial setpoints of "Np = 10" and "Sp = 1.1."

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.

After "Single Output" of selected test patterns is finished, the Optical Signal Transmit Simulator transmits 0% LPRM levels for LPRM CH1 through CH52 automatically, and the number of active OPRM Cells becomes "0." Thus, the CELL module generates an OPRM Inoperative signal.

- Check that status of discrete outputs and ELCS[]^{acc} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

2. Test Pattern 2

In this test pattern, CELL 22 is selected as a representative to check the detailed operation of the PBDA algorithm. Parameters applied to this test pattern are "Standard Settings" except "Np." Use this test pattern to check that the PBDA trip occurs in CELL 22 as expected at setpoint of "Np = 8."

- Set the parameter "Np" of the PBD module to "8."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{acc} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

3. Test Pattern 3

In this test pattern, CELL 23 is selected as a representative to check the detailed operation of the PBDA algorithm. Parameters applied to this test pattern are "Standard Settings" except "Np." Use this test pattern to check that the

PBDA trip occurs in CELL 23 as expected at setpoint of "Np = 20."

- Set the parameter "Np" of the PBD module to "20."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

4. Test Pattern 4

In this test pattern, CELL 24 is selected as a representative to check the detailed operation of the PBDA algorithm. Parameters applied to this test pattern are "Standard Settings" except "Np." Use this test pattern to check that the PBDA trip occurs in CELL 24 as expected at setpoints of "Np = 20" and "Sp = 1.2."

- Set the parameter "Sp" of the PBD module (Digital Switches on the module) to "1.2."
- Check that the parameter "Np" of the PBD module is "20."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

5. Test Pattern 5

In this test pattern, CELL 25 is selected as a representative to check the detailed operation of the PBDA algorithm. Parameters applied to this test pattern are "Standard Settings" except "Np." Use this test pattern to check that the PBDA trip occurs in CELL 25 as expected at setpoints of "Np = 20" and "Sp = 1.05."

- Set the parameter "Sp" of the PBD module (Digital Switches on the module) to "1.05."
- Check that the parameter "Np" of the PBD module is "20."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

 Click "All Stop" for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.
- After testing with this test pattern, set the "Np" to "10."

- After testing with this test pattern, set the “Sp” to “1.1.”

6. Test Pattern 6

In this test pattern, CELL 26 is selected as a representative to check the detailed operation of the PBDA algorithm.

This test pattern has following features:

LPRM Levels with low frequency (equivalent to 0.28 Hz for the Normalized Oscillation Signal (St)) are input on purpose. Its related parameter is Tmax (Tmax = 3.50s). By using this pattern, check that the PBDA trip does not occur in CELL 26.

- Set the OPRM unit to the “Normal Status.” Click “All Stop” for LPRM 1 to 4.
- Run (“All Start”) the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click “All Stop” for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a6}data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

7. Test Pattern 7

In this test pattern, CELL 27 is selected as a representative to check the detailed operation of the PBDA algorithm.

This test pattern has following features:

LPRM Levels with high frequency (equivalent to 1.1 Hz for the Normalized Oscillation Signal (St)) are input on purpose. Its related parameter is Tmin (Tmin = 1.00s). By using this pattern, check that the PBDA trip does not occur in CELL 27.

- Run (“All Start”) the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)

Click “All Stop” for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]^{a6}data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

8. Test Pattern 8

In this test pattern, CELL 28 is selected as a representative to check the detailed operation of the PBDA algorithm.

This test pattern has following features:

A pattern that after the Confirmation Count (N) counts up in the PBDA algorithm, LPRM Levels with low frequency are input on purpose. Its related parameter is Te (Te = 0.15s). By using this pattern, check that the PBDA trip does not occur in CELL 28.

- Run (“All Start”) the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
---------	-----------------

LPRM 2:] (Single Output)
LPRM 3:	
LPRM 4:	

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

9. Test Pattern 9

In this test pattern, CELL 29 is selected as a representative to check the detailed operation of the PBDA algorithm.

This test pattern has following features:

A pattern that after the Confirmation Count (N) counts up in the PBDA algorithm, LPRM Levels with high frequency are input on purpose. Its related parameter is Te (Te = 0.15s). By using this pattern, check that the PBDA trip does not occur in CELL 29.

- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:] (Single Output)
LPRM 2:	
LPRM 3:	
LPRM 4:	

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

10. Test Pattern 10

In this test pattern, CELL 30 is selected as a representative to check the detailed operation of the PBDA algorithm. Oscillating LPRM Levels with random noise are input on purpose. Its related parameter is Peak and Valley Detection Width Setpoint (a). By using this pattern, check that Confirmation Count (N) counts up and reset to "0" at random in CELL 30, and a PBDA trip signal is not generated at the setpoint of "Peak and Valley Detection Width Setpoint (a) = 0.001."

- Set the parameter "Peak and Valley Detection Width Setpoint (a)" of the PBD module (Digital Switches on the module) to "0.001."
- Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:] (Single Output)
LPRM 2:	
LPRM 3:	
LPRM 4:	

Click "All Stop" for LPRM 1 to 4.

- Check that status of discrete outputs and ELCS[]^{a,c} data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

11. Test Pattern 11

The same pattern used for Test Pattern 10 is used for this test pattern. CELL 30 is selected as a representative to check the detailed operation of the PBDA algorithm. Oscillating LPRM Levels with random noise are input on purpose. Its related parameter is Peak and Valley Detection Width Setpoint (a). By using this pattern, check that the PBDA trip signal is generated in CELL 30 at the setpoint of "Peak and Valley Detection Width Setpoint (a) = 0.003."

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- Set the parameter “Peak and Valley Detection Width Setpoint (a)” of the PBD module (Digital Switches on the module) to “0.003.”
- Run (“All Start”) the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	[] ²⁶ (Single Output)
LPRM 2:	[] ²⁶ (Single Output)
LPRM 3:	[] ²⁶ (Single Output)
LPRM 4:	[] ²⁶ (Single Output)

Click “All Stop” for LPRM 1 to 4.
- Check that status of discrete outputs and ELCS[]²⁶ data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

(2) Acceptance Criteria

- Check that status of discrete outputs and ELCS[]²⁶ data output on Optical Signal Receive Simulator is as expected in Table 10.4.3.

Table 10.4.3 Test Pattern and Expected Output

Test Pattern No.	Items to be checked		Acceptance Criteria	Reference Figure and Table
	Type of signal/display	Signal name/displayed item		
Test Pattern 1	Discrete Outputs	PBDA_TRIP	45 times of "PBDA_TRIP" signal generation are observed.	Figure 10.4.3-1-A
		OPRM_TRIP	45 times of "OPRM_TRIP" signal generation are observed.	
		ABA_TRIP	"ABA_TRIP" signal is not generated.	
		GRA_TRIP	"GRA_TRIP" signal is not generated.	
		COUNT_ST and PBDA_TRIP	Time difference between COUNT_ST and PBDA_TRIP generation for CELL1 is [] ^{sec} .	Figure 10.4.3-1-B
	PBD module display	"TRIP" LED "PBDA TRIP" LED	Check that "TRIP" and "PBDA TRIP" LEDs turn on at first trip generation. Check that the LEDs turns off by pushing the "RESET" button when trip generation is off, and turns on again at next trip generation.	N/A
	Optical Signal Receive Simulator Viewer (ELCS[] ^{ac} data)	PBDA Trip for CELL1 through 44.	The PBDA Trip signals are generated according to the sequence specified in Table 10.4.3-1.	Table 10.4.3-1.
Test Pattern 2	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is generated.	Figure 10.4.3-2
Test Pattern 3	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is generated.	Figure 10.4.3-3
Test Pattern 4	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is generated.	Figure 10.4.3-4
Test Pattern 5	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is generated.	Figure 10.4.3-5
Test Pattern 6	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is <u>not</u> generated.	Figure 10.4.3-6
Test Pattern 7	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is <u>not</u> generated.	Figure 10.4.3-7
Test Pattern 8	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is <u>not</u> generated.	Figure 10.4.3-8
Test Pattern 9	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is <u>not</u> generated.	Figure 10.4.3-9
Test Pattern 10	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is <u>not</u> generated.	Figure 10.4.3-10
Test Pattern 11	Discrete Outputs	PBDA_TRIP	"PBDA_TRIP" signal is generated.	Figure 10.4.3-11

10.4.3 Test Pattern 1 (Time Sequence)

a.c

Figure 10.4.3-1-A Time Sequence for Test Pattern 1

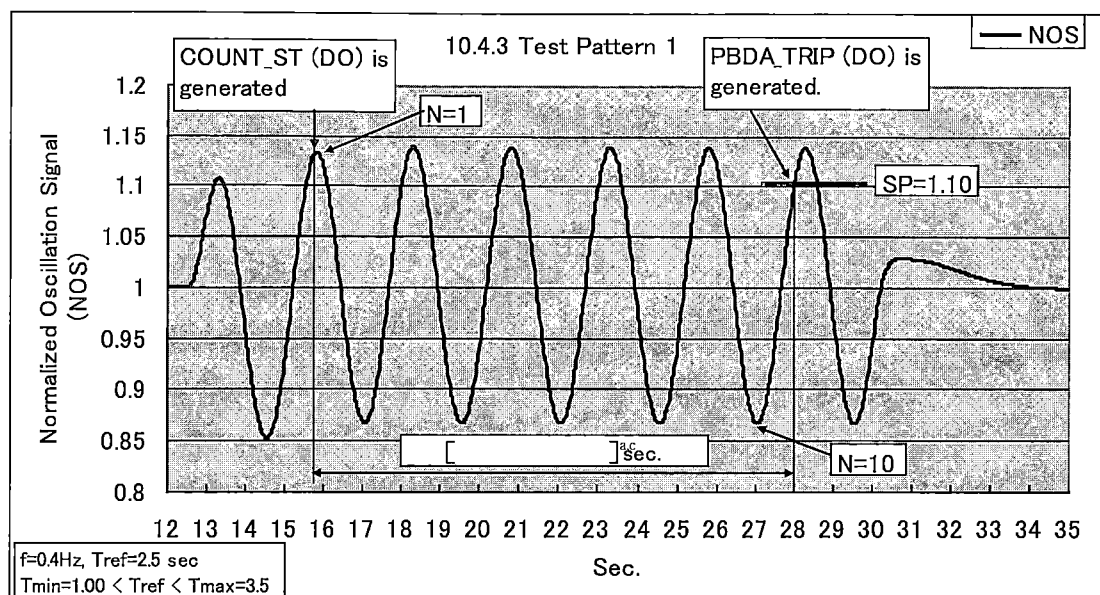


Figure 10.4.3-1-B Wave Form and Expected Output for Test Pattern 1

Table 10.4.3-1 Sequence of PBDA Trip Generation

The PBDA Trip signals are generated according to following sequence.

Cycle No	Seq. No.	CELL No	Cycle No	Seq. No.	CELL No	Cycle No	Seq. No.	CELL No
1	1	1	6	21	6	11	41	11
	2	12		22	17		42	15
	3	23		23	28		43	33
	4	39		24	38		44	36
2	5	2	7	25	7	12	45	All cells
	6	13		26	18			
	7	24		27	29			
	8	34		28	43			
3	9	3	8	29	8			
	10	21		30	19			
	11	25		31	30			
	12	41		32	44			
4	13	4	9	33	9			
	14	22		34	20			
	15	26		35	31			
	16	42		36	40			
5	17	5	10	37	10			
	18	16		38	14			
	19	27		39	32			
	20	37		40	35			

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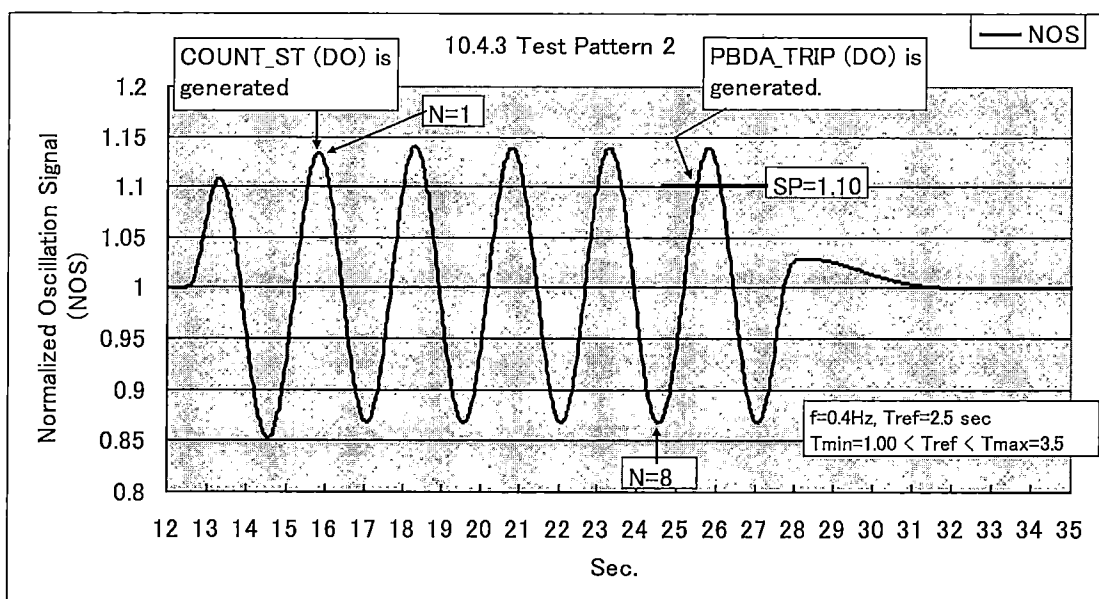


Figure 10.4.3-2 Wave Form and Expected Output for Test Pattern 2

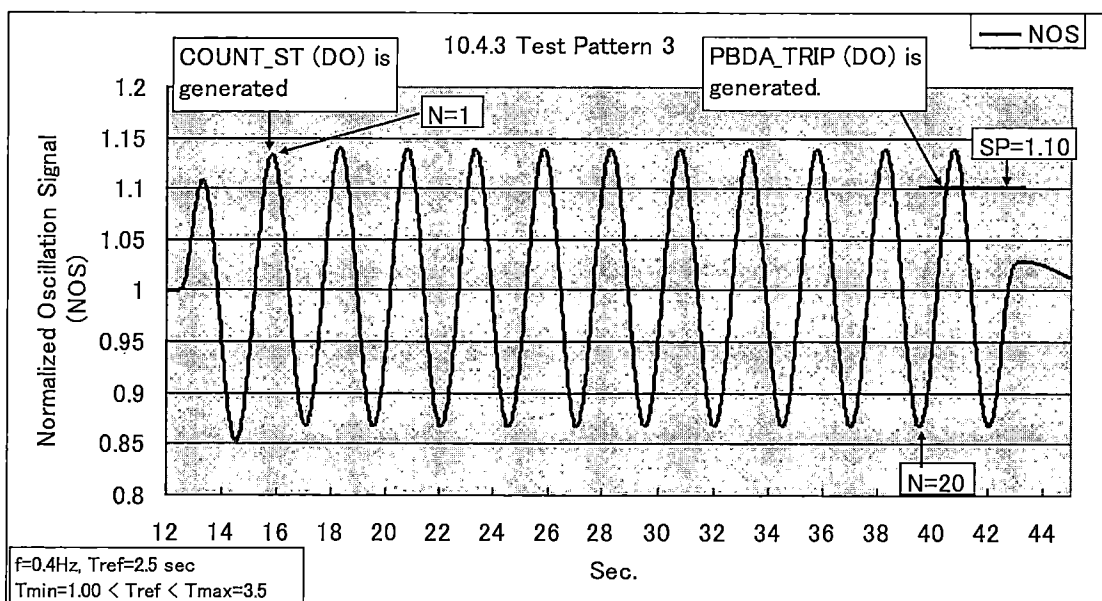


Figure 10.4.3-3 Wave Form and Expected Output for Test Pattern 3

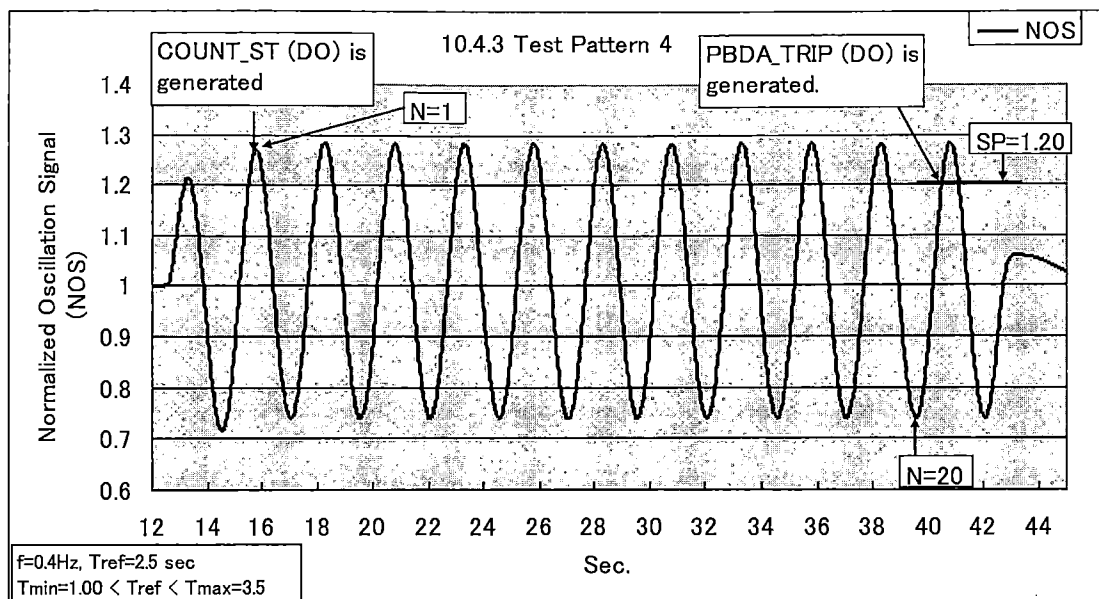


Figure 10.4.3-4 Wave Form and Expected Output for Test Pattern 4

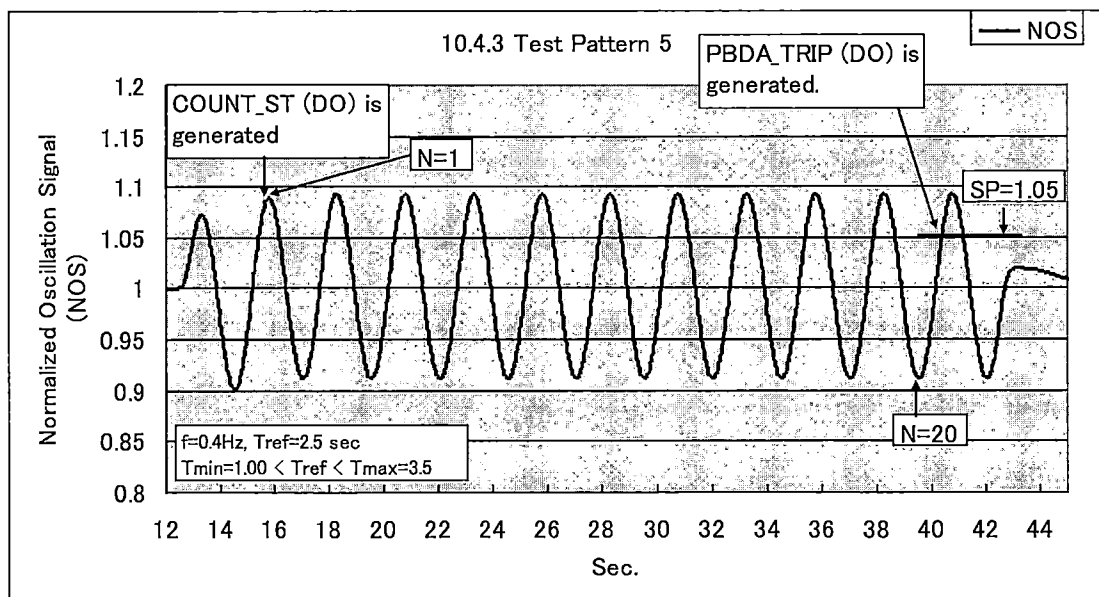


Figure 10.4.3-5 Wave Form and Expected Output for Test Pattern 5

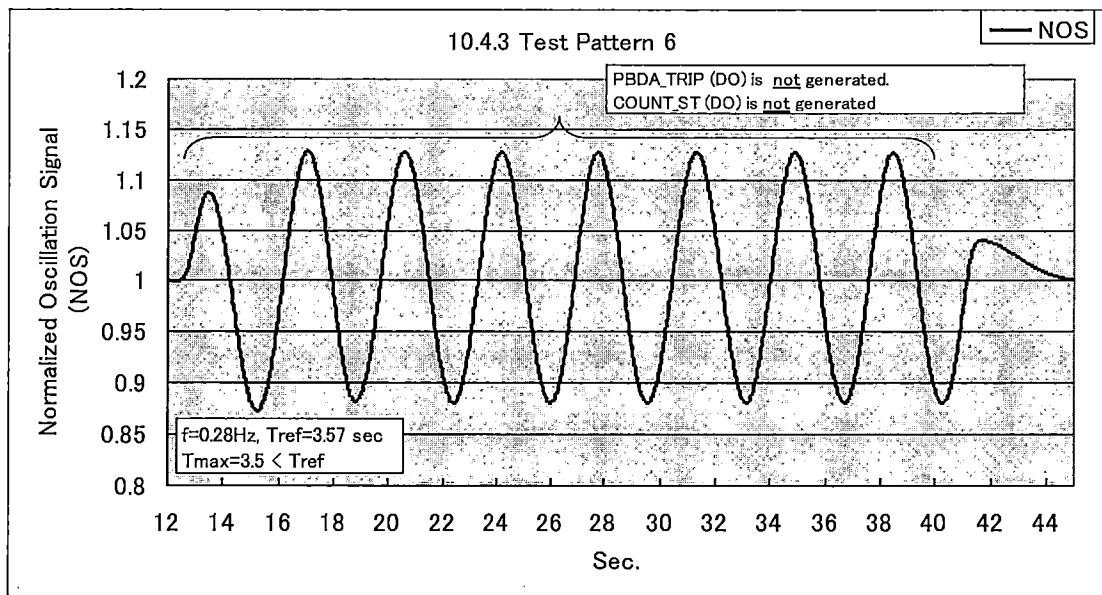


Figure 10.4.3-6 Wave Form and Expected Output for Test Pattern 6

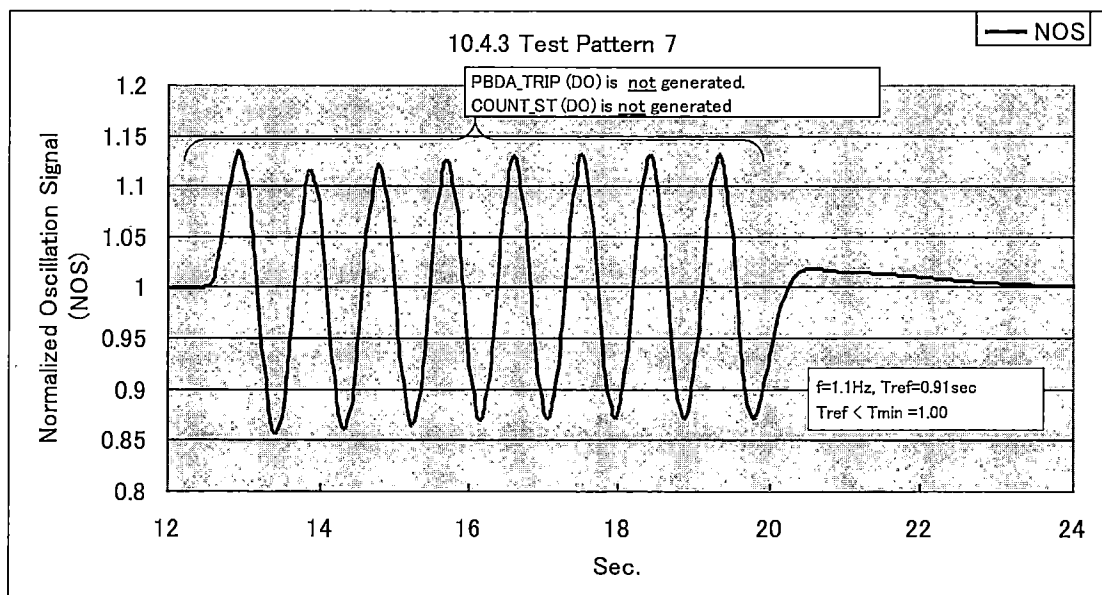


Figure 10.4.3-7 Wave Form and Expected Output for Test Pattern 7

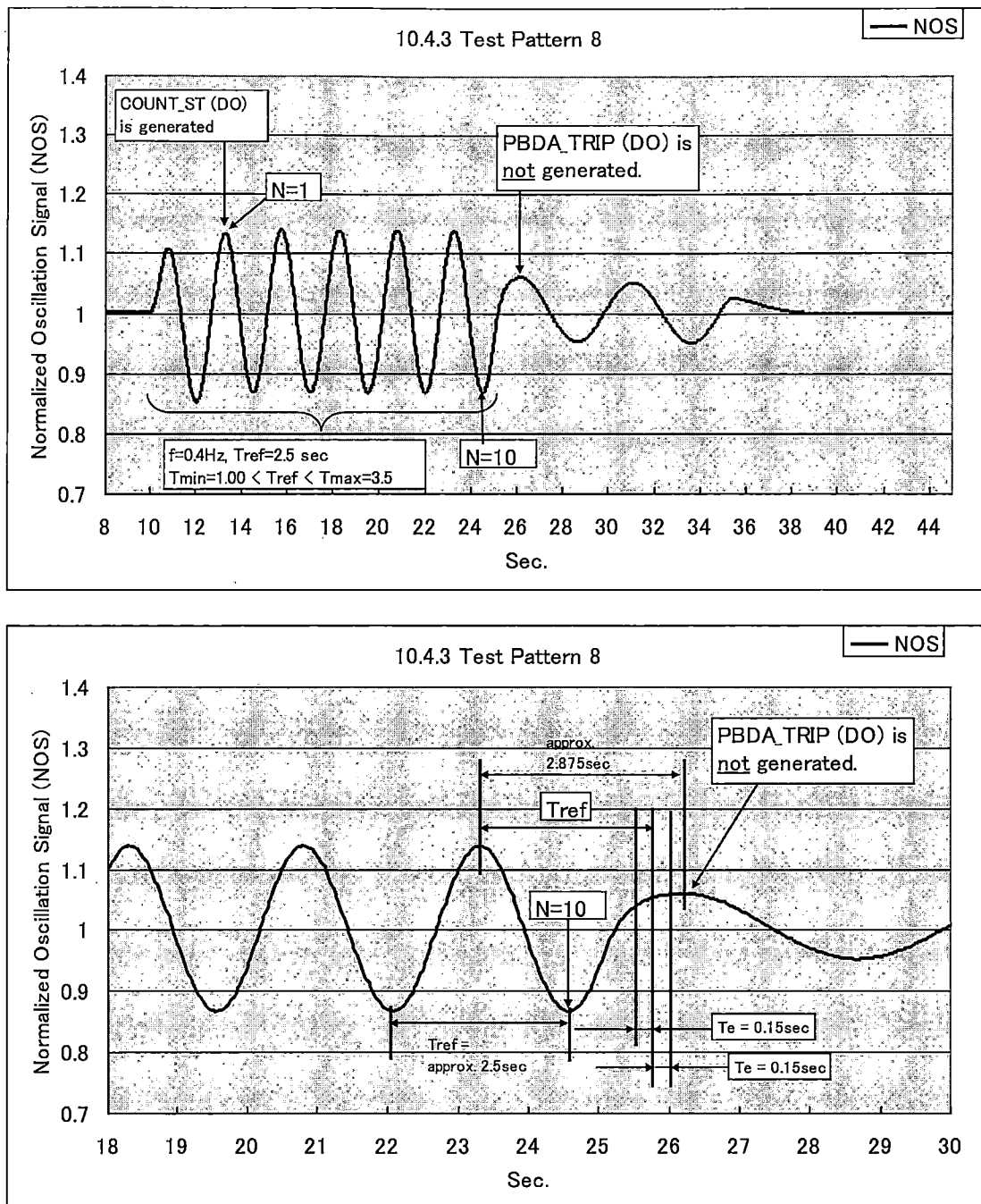


Figure 10.4.3-8 Wave Form and Expected Output for Test Pattern 8

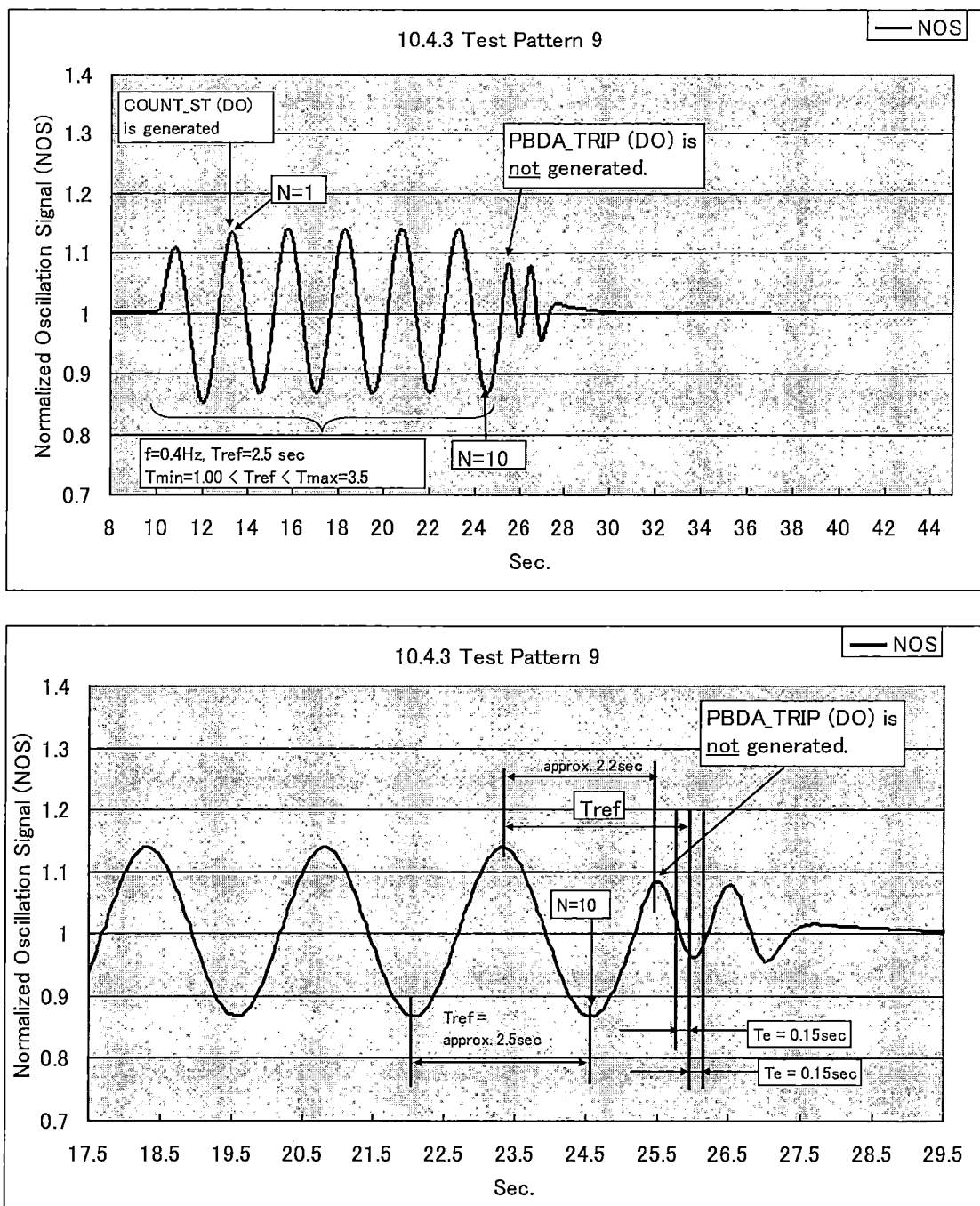


Figure 10.4.3-9 Wave Form and Expected Output for Test Pattern 9

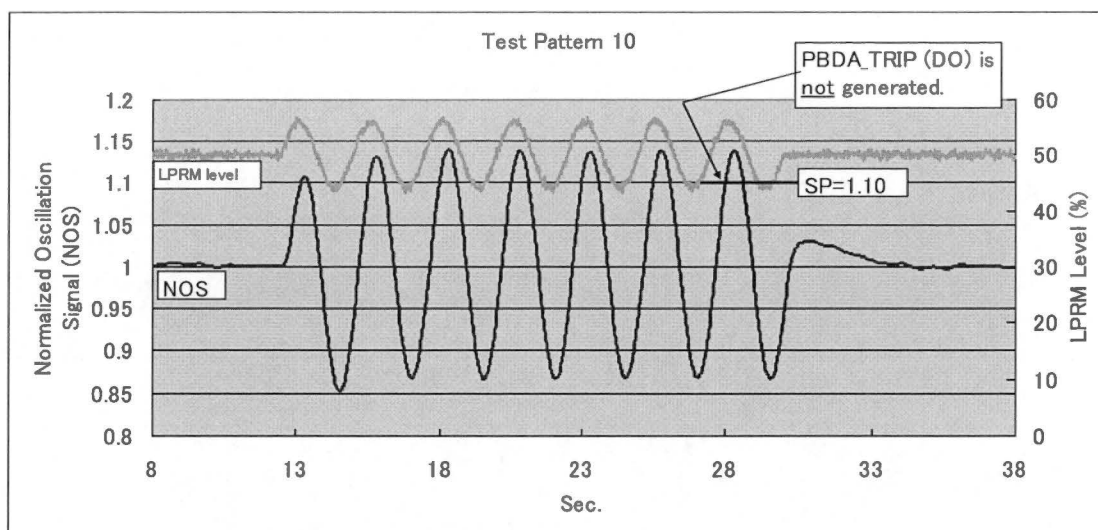


Figure 10.4.3-10 Wave Form and Expected Output for Test Pattern 10

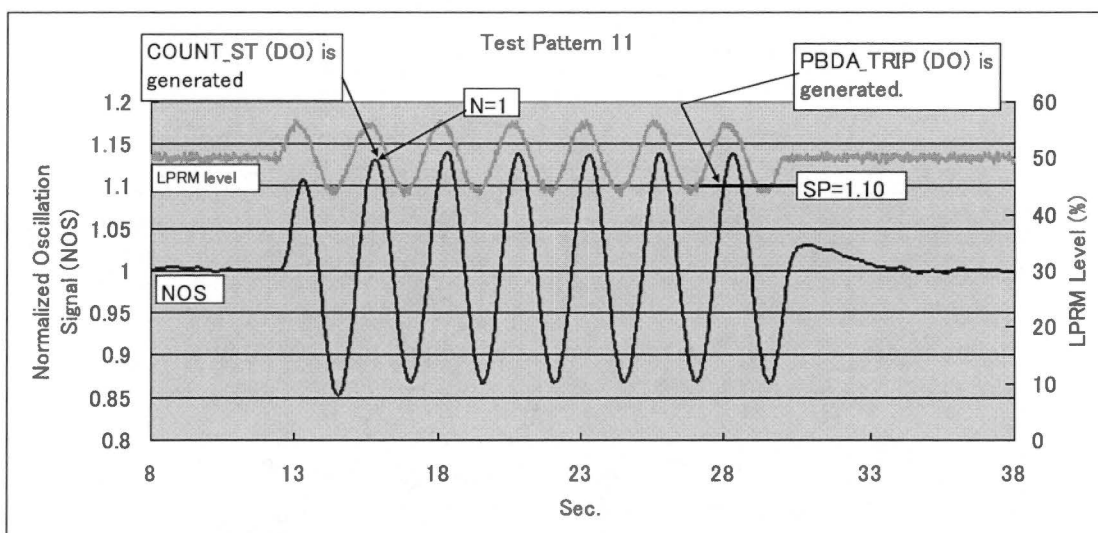


Figure 10.4.3-11 Wave Form and Expected Output for Test Pattern 11

10.4.4 Trip Algorithm Initialization

The purpose of this test item is to check that the trip algorithm initialization is performed in the correct manner in accordance with input conditions changes. LPRM Levels simulating a waveform that consists of sine curve and a constant value are used as the test pattern. This test pattern simulates LPRM Levels for CELL 9, CELL 12, CELL and 30 so that the ABA Trip occurs in CELL 9, the GRA Trip occurs in CELL 12, and the PBDA trip occurs in CELL 30 simultaneously for 4 cycles with time period of 30 seconds.

(1) Test Patterns and Procedures

1. Test Pattern 1 (Trip Algorithm Initialization by APRM Bypass Cancellation)

The purpose of this test pattern is to check that trip algorithms are initialized when the APRM Bypass signal input turns from ON to OFF state.

- **Step 1**
Set the OPRM unit to the "Normal Status." Click "All Stop" for LPRM 1 to 4.
Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)
- **Step 2**
Turn ON the APRM Bypass Signal (operation on Aux-Relay Plate) within 2 seconds after first trip generations from DIO module turn OFF.
- **Step 3**
After 53 +/-1 seconds* elapse, turn OFF the APRM Bypass Signal (operation on Aux-Relay Plate).
* This time interval is a target value for tester to control input signal operation. The required timing to turn OFF the APRM Bypass Signal is within 5 seconds before third trip generation.
- In each step, check that the discrete outputs change as expected specified in Table 10.4.4-1 and Figure 10.4.4-1. Click "All Stop" for LPRM 1 to 4.

Table 10.4.4-1 Test Pattern and Expected Output (Test Pattern 1)

Step	Test Pattern		Acceptance Criteria (Expected Output)				
			Discrete Outputs/ Optical Signal Receive Simulator Viewer (ELCS/) ^c				
	Optical Signal Transmit Simulator	Discrete Input APRM Bypass Signal	ABA Trip Signal	GRA Trip Signal	PBDA Trip Signal	OPRM Trip Signal	Remarks
1	Running the test pattern files						Trips occur normally
2	Running the test pattern files						Trips occur normally
3	Running the test pattern files						Trip algorithm initialization occurs.

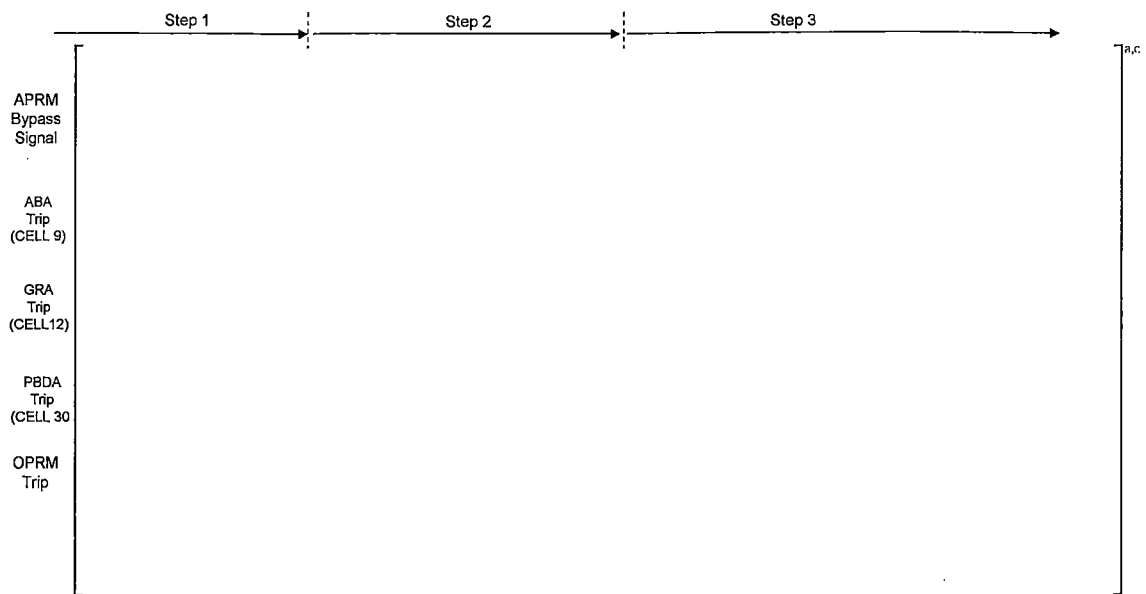


Figure 10.4.4-1 Test Pattern and Expected Output (Test Pattern 1)

2. Test Pattern 2 (Trip Algorithm Initialization by OPRM Inoperative Cancellation (AGRD module is STANDBY mode))

The purpose of this test pattern is to check that trip algorithms are initialized when the OPRM Inoperative signal to CELL module turns from ON to OFF state. The OPRM Inoperative signal to CELL module is simulated by changing the operation mode of AGRD module.

- Step 1
Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)
- Step 2
Turn the key switch of AGRD module to "STANDBY" position within 2 seconds after first trip generations from DIO module turn OFF.
- Step 3
After 53+/-1 seconds* elapse, turn the key switch of AGRD module to "OP" position.
* This time interval is a target value for tester to operate the key switch. The required timing to turn to "OP" position is within 5 seconds before third trip generation.
- In each step, check that the discrete outputs change as expected specified in Table 10.4.4-2 and Figure 10.4.4-2. Click "All Stop" for LPRM 1 to 4.

Table 10.4.4-2 Test Pattern and Expected Output (Test Pattern 2)

Step	Test Pattern		Acceptance Criteria (Expected Output)				
			Discrete Outputs/ Optical Signal Receive Simulator Viewer (ELCS[]) ^{a,c}				
	Optical Signal Transmit Simulator	AGRD module Key switch	ABA Trip Signal	GRA Trip Signal	PBDA Trip Signal	OPRM Trip Signal	Remarks
1	Running the test pattern files						Trips occur normally
2	Running the test pattern files						Trips occur normally
3	Running the test pattern files						Trip algorithm initialization occurs.

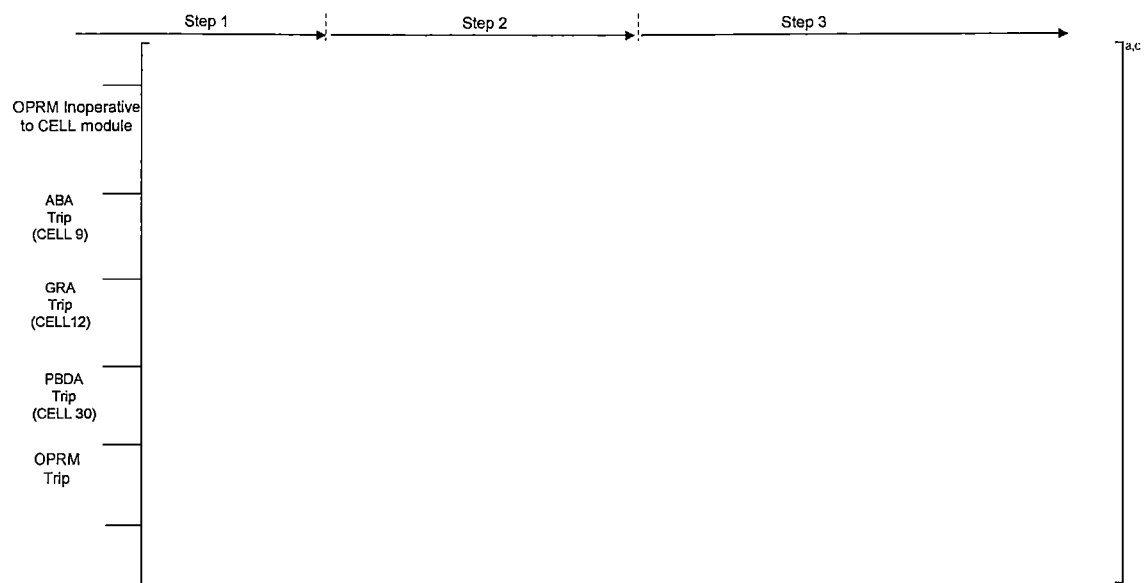


Figure 10.4.4-2 Test Pattern and Expected Output (Test Pattern 2)

3. Test Pattern 3 (Trip Algorithm Initialization by OPRM Inoperative Cancelation (PBD module is STANDBY mode))

The purpose of this test pattern is to check that trip algorithms are initialized when the OPRM Inoperative signal to CELL module turns from ON to OFF state. The OPRM Inoperative signal to CELL module is simulated by changing the operation mode of PBD module.

- Step 1
Run (“All Start”) the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)
- Step 2
Turn the key switch of PBD module to “STANDBY” position within 2 seconds after first trip generations from DIO module turn OFF.
- Step 3
After 53+/-1 seconds* elapse, turn the key switch of PBD module to “OP” position.
* This time interval is a target value for tester to operate the key switch. The required timing to turn to “OP” position is within 5 seconds before third trip generation
- In each step, check that the discrete outputs change as expected specified in Table 10.4.4-3 and Figure 10.4.4-3. Click “All Stop” for LPRM 1 to 4.

Table 10.4.4-3 Test Pattern and Expected Output (Test Pattern 3)

Step	Test Pattern		Acceptance Criteria (Expected Output)				
			Discrete Outputs/ Optical Signal Receive Simulator Viewer (ELCS/PICS)				
	Optical Signal Transmit Simulator	AGR module Key switch	ABA Trip Signal	GRA Trip Signal	PBDA Trip Signal	OPRM Trip Signal	Remarks
1	Running the test pattern files						^{a,c} Trips occur normally
2	Running the test pattern files						Trips occur normally
3	Running the test pattern files						Trip algorithm initialization occurs.

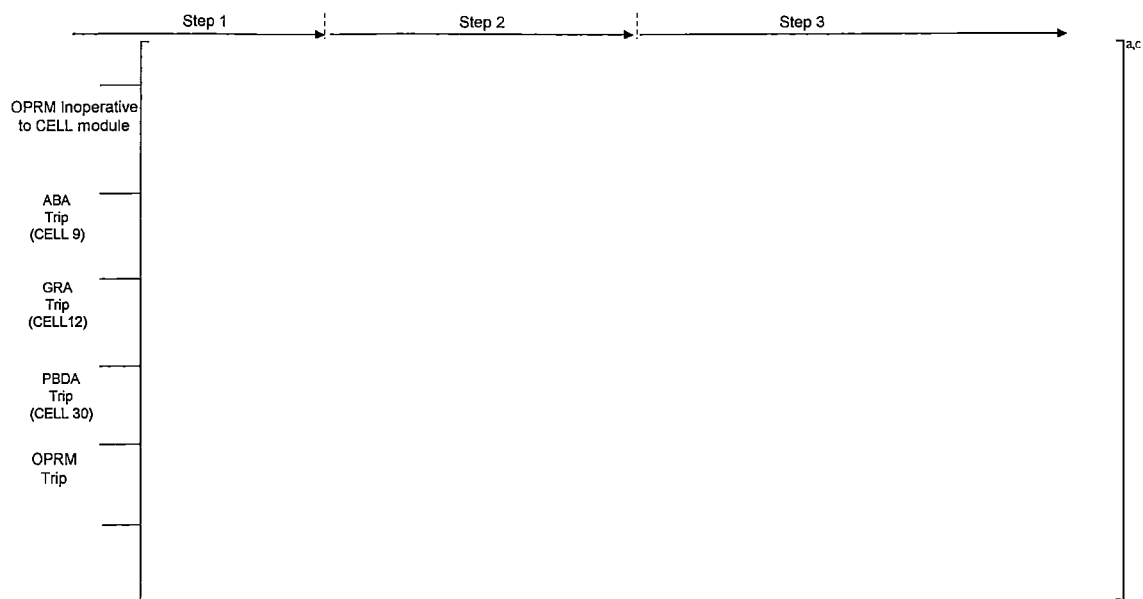


Figure 10.4.4-3 Test Pattern and Expected Output (Test Pattern 3)

4. Test Pattern 4 (Trip Algorithm Initialization by OPRM Automatic Bypass)

The purpose of this test pattern is to check that trip algorithms are initialized when the CELL module generates the OPRM Automatic Bypass signal.

- Step 1
Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	(Single Output)
LPRM 2:	(Single Output)
LPRM 3:	(Single Output)
LPRM 4:	(Single Output)
APRM 1]a,c
APRM 2	
- Step 2
Click "Stop" for APRM 1 channel on the Optical Signal Transmit Simulator within 2 seconds after first trip generations from DIO module turn OFF.
- Step 3
After 53+/-1 seconds elapse, click "Start" for APRM 1 channel on the Optical Signal Transmit Simulator.
- In each step, check that the discrete outputs change as expected specified in Table 10.4.4-4 and Figure 10.4.4-4. Click "All Stop" for LPRM 1 to 4.

Table 10.4.4-4 Test Pattern and Expected Output (Test Pattern 4)

Step	Test Pattern	Acceptance Criteria (Expected Output)				
		Discrete Outputs/ Optical Signal Receive Simulator Viewer (ELCS				
		ABA Trip Signal	GRA Trip Signal	PBDA Trip Signal	OPRM Trip Signal	Remarks
1	Run the following test pattern files. LPRM 1: LPRM 2: LPRM 3: LPRM 4: APRM 1: APRM 2:					Trips occur normally
2	Click "Stop" for APRM 1 channel (after the trip signals turn OFF)					OPRM Automatic Bypass
3	Click "Start" for APRM 1 channel (after seconds elapsed)					Trip algorithm initialization occurs.

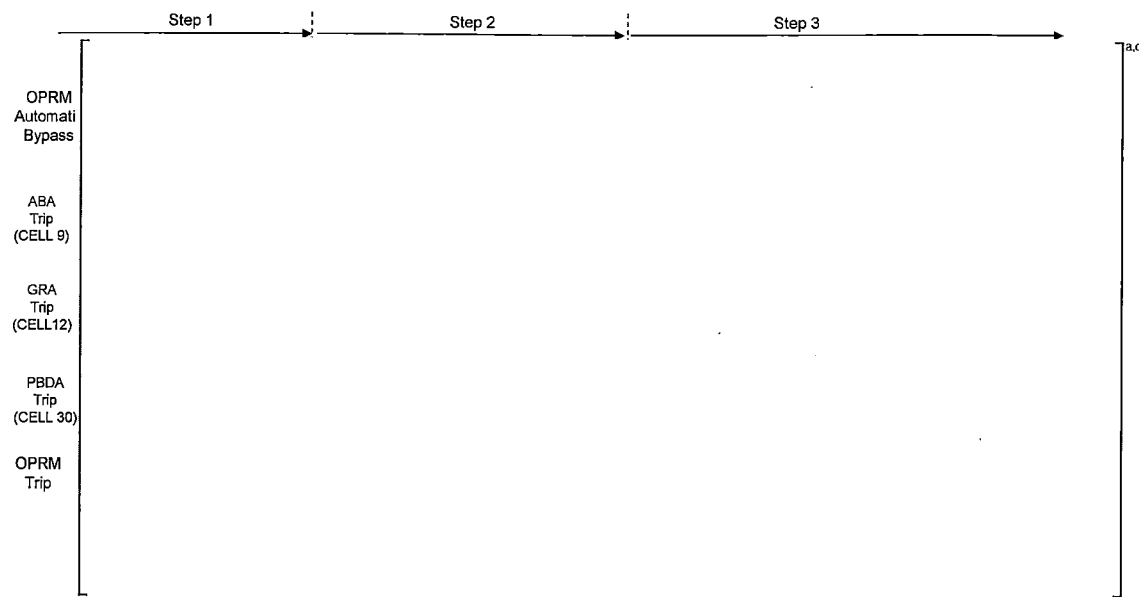


Figure 10.4.4-4 Test Pattern and Expected Output (Test Pattern 4)

5. Test Pattern 5 (Trip Algorithm Initialization by Number of Active LPRMs change)

The purpose of this test pattern is to check that trip algorithms are initialized when the number of active LPRMs in each Cell changes.

- Run (“All Start”) the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:
LPRM 2:
LPRM 3:
LPRM 4:

(Single Output)
(Single Output)
(Single Output)
(Single Output)
- Click “All Stop” for LPRM 1 to 4.
- Check that the discrete outputs change as expected specified in Table 10.4.4-5 and Figure 10.4.4-5.

Table 10.4.4-5 Test Pattern and Expected Output (Test Pattern 5)

Step	Test Pattern	Acceptance Criteria (Expected Output)				
		Discrete Outputs/ Optical Signal Receive Simulator Viewer (ELCS)				
		ABA Trip Signal	GRA Trip Signal	PBDA Trip Signal	OPRM Trip Signal	Remarks
-	Running the test pattern files (Simulating that a LPRM level in each CELL is decreased below 5%)	Second cycle trip is not observed.	Second cycle trip is not observed.	Second cycle trip is not observed.	Second cycle trip is not observed.	Trip algorithm initialization occurs at second cycle.

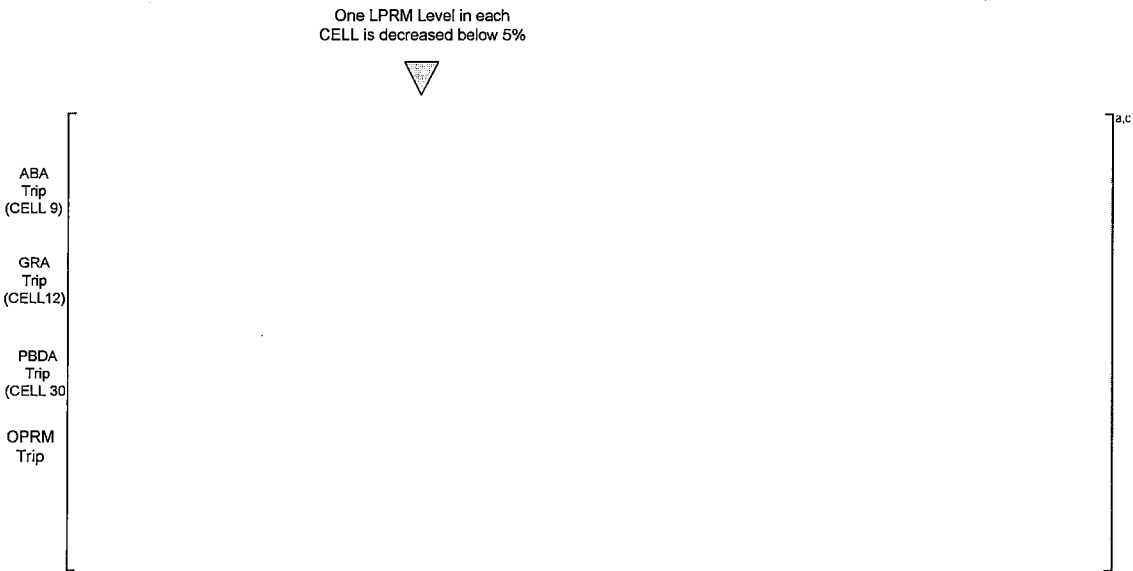


Figure 10.4.4-5 Test Pattern and Expected Output (Test Pattern 5)

6. Test Pattern 6 (Trip Algorithm Initialization by CELL Bypass)

The purpose of this test pattern is to check that trip algorithms are initialized when the CELL Bypass in each Cell occurs.

- Run (“All Start”) the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:
LPRM 2:
LPRM 3:
LPRM 4:

(Single Output)
(Single Output)
(Single Output)
(Single Output)

Click “All Stop” for LPRM 1 to 4.

Check that the discrete outputs change as expected specified in Table 10.4.4-6 and Figure 10.4.4-6.

Table 10.4.4-6 Test Pattern and Expected Output (Test Pattern 6)

Step	Test Pattern	Acceptance Criteria (Expected Output)				
		Discrete Outputs/ Optical Signal Receive Simulator Viewer (ELCS[]) ^{a,c}				
		ABA Trip Signal	GRA Trip Signal	PBDA Trip Signal	OPRM Trip Signal	Remarks
-	Running the test pattern files (Simulating that 3 LPRM level in each CELL is decreased below 5%)	Only one cycle trip is observed.	Only one cycle trip is observed.	Only one cycle trip is observed.	Only one cycle trip is observed.	CELL bypass occurs at second cycle.

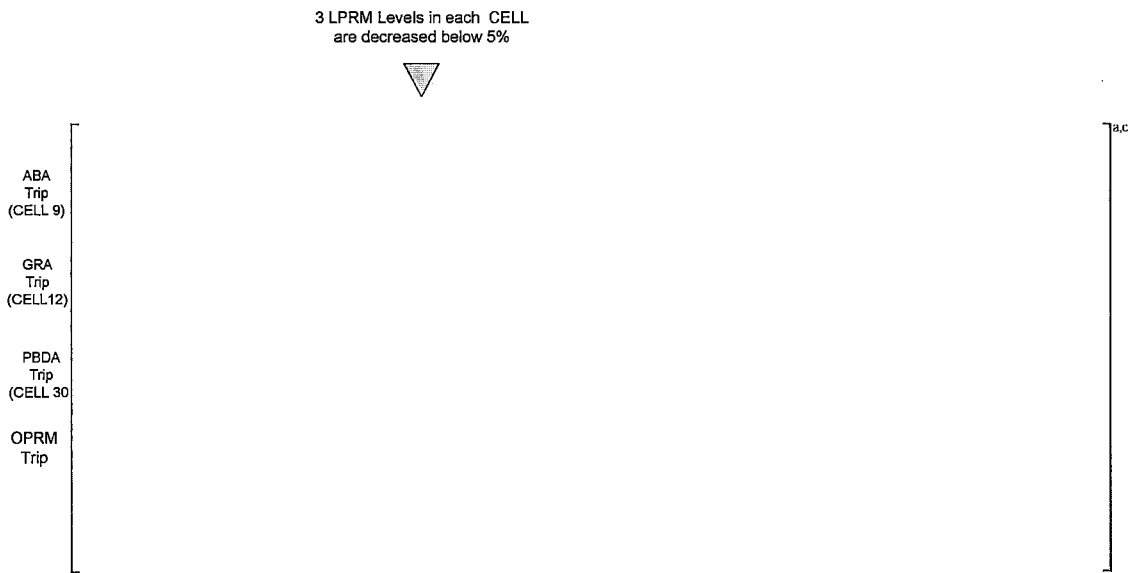


Figure 10.4.4-6 Test Pattern and Expected Output (Test Pattern 6)

(2) Acceptance Criteria

Acceptance criteria for each test pattern are shown in Tables 10.4.4.1 through Tables 10.4.4.6.

10.5 Failure Detection and Self Diagnosis Functions

Failure detection and self diagnosis functions of the OPRM unit under abnormal conditions are tested by simulating postulated failures of external system and internal modules equipment.

10.5.1 OPRM Inoperative

The purpose of this test item is to check that the OPRM unit generates an OPRM Inoperative signal under the following conditions.

- APRM Unit Data both system transmission error is detected
- APRM Inoperative occurs (CELL module)
- “STANDBY” (or “CAL”) mode is selected on CELL module
- “STANDBY” (or “CAL”) mode is selected on AGRD module
- “STANDBY” (or “CAL”) mode is selected on PBD module
- Number of Active OPRM Cell is lower than the setpoint (CELL module)

(1) Test Patterns and Procedures

- Step 1: APRM Unit Data both system transmission error is detected
Set the OPRM unit to the “Normal Status.”
Click “All Stop” for APRM1 and APRM2 data on the Optical Signal Transmit Simulator.
Set the OPRM unit to the “Normal Status.”
- Step 2: APRM Inoperative occurs (CELL module)
Set the OPRM unit to the “Normal Status.”
Run (All Start) the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:	a.c
APRM 2:	

Set the OPRM unit to the “Normal Status.”
- Step 3: “STANDBY” mode is selected on CELL module
Set the OPRM unit to the “Normal Status.”
Turn the key switch of CELL module to “STANDBY” position.
Set the OPRM unit to the “Normal Status.”
- Step 4: “CAL” mode is selected on CELL module
Set the OPRM unit to the “Normal Status.”
Turn the key switch of CELL module to “CAL” position.
Set the OPRM unit to the “Normal Status.”
- Step 5: “STANDBY” mode is selected on AGRD module
Set the OPRM unit to the “Normal Status.”
Turn the key switch of AGRD module to “STANDBY” position.
Set the OPRM unit to the “Normal Status.”
- Step 6: “CAL” mode is selected on AGRD module
Set the OPRM unit to the “Normal Status.”
Turn the key switch of AGRD module to “CAL” position.

Set the OPRM unit to the "Normal Status."

- Step 7 "STANDBY" mode is selected on PBD module
Set the OPRM unit to the "Normal Status."
Turn the key switch of PBD module to "STANDBY" position.
Set the OPRM unit to the "Normal Status."
- Step 8: "CAL" mode is selected on PBD module
Set the OPRM unit to the "Normal Status."
Turn the key switch of PBD module to "CAL" position.
Set the OPRM unit to the "Normal Status."
- Step 9: Number of Active OPRM Cell is lower than the setpoint (CELL module)
Set the OPRM unit to the "Normal Status."
Run the following test pattern files, which simulate status that 13 Cells are bypassed, on the Optical Signal Transmit Simulator.

LPRM 1:] a.c
LPRM 2:	
LPRM 3:	
LPRM 4:	

Set the OPRM unit to the "Normal Status."
- Step 10: Number of Active OPRM Cell is lower than the setpoint (Loss of 4 LPRM units input)
Set the OPRM unit to the "Normal Status."
Remove the optical cable to J61 (BSL 5 RCV module IN1) (LPRM unit 1 data).
Remove the optical cable to J62 (BSL 5 RCV module IN2) (LPRM unit 2 data).
Remove the optical cable to J63 (BSL 5 RCV module IN3) (LPRM unit 3 data).
Remove the optical cable to J64 (BSL 5 RCV module IN4) (LPRM unit 4 data).
Set the OPRM unit to the "Normal Status."
- In each step, check that the discrete outputs and module displays change as expected specified in Table 10.5.1.

(2) Acceptance Criteria

- In each step, before starting test, check that the OPRM unit can be set to "Normal Status."
- In each step, check that the discrete outputs and module displays change as expected specified in Table 10.5.1.
- In each step, check recovery from abnormal condition by checking that the OPRM unit can be set to "Normal Status."

Table 10.5.1 Test Pattern and Expected Output

Step	Test Pattern		Acceptance Criteria (Expected Output)				
			Displays on modules				Discrete Outputs and Optical Signal Receive Simulator Viewer (ELCS[] a.c
	Optical Signal Transmit Simulator	Module Operations	CELL module (INOP)	AGRD module (INOP)	PBD module (INOP)	Others	OPRM Inoperative Signal
1	"All Stop" for APRM1 and APRM2 data	N/A	ON	OFF	OFF	DAT/ST module FAIL/APRM 1: ON FAIL/APRM 2: ON	ON

Step	Test Pattern		Acceptance Criteria (Expected Output)				
			Displays on modules				Discrete Outputs and Optical Signal Receive Simulator Viewer (ELCS[] ^{a,c})
	Optical Signal Transmit Simulator	Module Operations	CELL module (INOP)	AGR module (INOP)	PBD module (INOP)	Others	OPRM Inoperative Signal
2	Run the following test pattern files. APRM 1: [] ^{a,c} APRM 2: [] ^{a,c}	N/A	ON	OFF	OFF	N/A	ON
3	N/A	Turn the key switch of CELL module to "STANDBY" position.	ON	OFF	OFF	N/A	ON
4	N/A	Turn the key switch of CELL module to "CAL" position.	ON	OFF	OFF	N/A	ON
5	N/A	Turn the key switch of AGRD module to "STANDBY" position.	OFF	ON	OFF	N/A	ON
6	N/A	Turn the key switch of AGRD module to "CAL" position.	OFF	ON	OFF	N/A	ON
7	N/A	Turn the key switch of PBD module to "STANDBY" position.	OFF	OFF	ON	N/A	ON
8	N/A	Turn the key switch of PBD module to "CAL" position.	OFF	OFF	ON	N/A	ON
9	Run the following test pattern files on the Optical Signal Transmit Simulator. LPRM 1: [] ^{a,c} LPRM 2: [] ^{a,c} LPRM 3: [] ^{a,c} LPRM 4: [] ^{a,c}	N/A	ON	OFF	OFF	CELL module: Numerical display "Amp%/Count" of CELL module. Select "CELL Count" to show the Number of Active OPRM Cells. Acceptance Criteria Number of Active OPRM Cells: 31	ON
10	Remove the optical cable to J61, J62, J63, J64 (BSL 5 RCV module IN1 to IN4)	N/A	ON	OFF	OFF	CELL module: Numerical display "Amp%/Count" of CELL module. Select "CELL Count" to show the Number of Active OPRM Cells. Acceptance Criteria Number of Active OPRM Cells: 0	ON

10.5.2 OPRM Minor failure

The purpose of this test item is to check that the OPRM unit generates an OPRM Minor Failure signal under the following conditions.

- LPRM unit data input error occurs.
- APRM unit data input error occurs.
- LVPS module power supply failure occurs.

(1) Test Patterns and Procedures

- Step 1: LPRM Unit 1 Data transmission failure is detected
Set the OPRM unit to the "Normal Status."
Remove the optical cable to J61 (BSL 5 RCV module IN1) (LPRM unit 1 data).
Set the OPRM unit to the "Normal Status."
- Step 2: LPRM Unit 2 Data transmission failure is detected
Set the OPRM unit to the "Normal Status."
Remove the optical cable to J62 (BSL 5 RCV module IN2) (LPRM unit 2 data).
Set the OPRM unit to the "Normal Status."
- Step 3: LPRM Unit 3 Data transmission failure is detected
Set the OPRM unit to the "Normal Status."
Remove the optical cable to J63 (BSL 5 RCV module IN3) (LPRM unit 3 data).
Set the OPRM unit to the "Normal Status."
- Step 4: LPRM Unit 4 Data transmission failure is detected
Set the OPRM unit to the "Normal Status."
Remove the optical cable to J64 (BSL 5 RCV module IN4) (LPRM unit 4 data).
Set the OPRM unit to the "Normal Status."
- Step 5: APRM Unit Data 1 transmission failure is detected
Set the OPRM unit to the "Normal Status."
Click "Stop" for APRM 1 data on the Optical Signal Transmit Simulator.
Set the OPRM unit to the "Normal Status."
- Step 6: APRM Unit Data 2 transmission failure is detected
Set the OPRM unit to the "Normal Status."
Click "Stop" for APRM 2 data on the Optical Signal Transmit Simulator.
Set the OPRM unit to the "Normal Status."
- Step 7: LVPS module 1 power supply failure occurs
Set the OPRM unit to the "Normal Status."
Turn off the power to LVPS module 1.
Set the OPRM unit to the "Normal Status."
- Step 8: LVPS module 2 power supply failure occurs
Set the OPRM unit to the "Normal Status."
Turn off the power to LVPS module 2.
Set the OPRM unit to the "Normal Status."
- In each step, check that the discrete outputs and module displays change as expected specified in Table 10.5.2.

(2) Acceptance Criteria

- In each step, before starting test, check that the OPRM unit can be set to "Normal Status."
- In each step, check that the discrete outputs and module displays change as expected specified in Table 10.5.2.
- In each step, check recovery from abnormal condition by checking that the OPRM unit can be set to "Normal Status."

Table 10.5.2 Test Pattern and Expected Output

Step	Test Pattern		Acceptance Criteria (Expected Output)					
			Displays on modules				Discrete Outputs and Optical Signal Receive Simulator Viewer (ELCS[] ^{p.c})	
			CELL module (FAIL)	DAT/ST module (FAIL)	DAT/ST module (LINE STATUS)	DAT/ST module (LVPS ALARM)	OPRM Minor Failure Signal	OPRM Inoperative ABA Trip GRA Trip PBDA Trip OPRM Trip
1	Remove the optical cable to J61 (BSL 5 RCV module IN1).	N/A	ON	ON	FAIL/APRM 1: OFF FAIL/APRM 2: OFF FAIL/LPRM 1: <input type="checkbox"/> ON FAIL/LPRM 2: OFF FAIL/LPRM 3: OFF FAIL/LPRM 4: OFF	LVPS 1: OFF LVPS 2: OFF	ON	OFF
2	Remove the optical cable to J62 (BSL 5 RCV module IN2).	N/A	ON	ON	FAIL/APRM 1: OFF FAIL/APRM 2: OFF FAIL/LPRM 1: OFF FAIL/LPRM 2: <input type="checkbox"/> ON FAIL/LPRM 3: OFF FAIL/LPRM 4: OFF	LVPS 1: OFF LVPS 2: OFF	ON	OFF
3	Remove the optical cable to J63 (BSL 5 RCV module IN3).	N/A	ON	ON	FAIL/APRM 1: OFF FAIL/APRM 2: OFF FAIL/LPRM 1: OFF FAIL/LPRM 2: OFF FAIL/LPRM 3: <input type="checkbox"/> ON FAIL/LPRM 4: OFF	LVPS 1: OFF LVPS 2: OFF	ON	OFF
4	Remove the optical cable to J64 (BSL 5 RCV module IN4).	N/A	ON	ON	FAIL/APRM 1: OFF FAIL/APRM 2: OFF FAIL/LPRM 1: OFF FAIL/LPRM 2: OFF FAIL/LPRM 3: OFF FAIL/LPRM 4: <input type="checkbox"/> ON	LVPS 1: OFF LVPS 2: OFF	ON	OFF
5	"Stop" the data for APRM1	N/A	ON	ON	FAIL/APRM 1: <input type="checkbox"/> ON FAIL/APRM 2: OFF FAIL/LPRM 1: OFF FAIL/LPRM 2: OFF FAIL/LPRM 3: OFF FAIL/LPRM 4: OFF	LVPS 1: OFF LVPS 2: OFF	ON	OFF
6	"Stop" the data for APRM2	N/A	ON	ON	FAIL/APRM 1: OFF FAIL/APRM 2: <input type="checkbox"/> ON FAIL/LPRM 1: OFF FAIL/LPRM 2: OFF FAIL/LPRM 3: OFF FAIL/LPRM 4: OFF	LVPS 1: OFF LVPS 2: OFF	ON	OFF
7	N/A	Turn off the power to LVPS module 1	OFF	ON	FAIL/APRM 1: OFF FAIL/APRM 2: OFF FAIL/LPRM 1: OFF FAIL/LPRM 2: OFF FAIL/LPRM 3: OFF FAIL/LPRM 4: OFF	LVPS 1: <input type="checkbox"/> ON LVPS 2: OFF	ON	OFF

Step	Test Pattern		Acceptance Criteria (Expected Output)					
			Displays on modules				Discrete Outputs and	
							Optical Signal Receive Simulator Viewer (ELCS) ¹ p.c	
	Optical Signal Transmit Simulator	Module Operations	CELL module (FAIL)	DAT/ST module (FAIL)	DAT/ST module (LINE STATUS)	DAT/ST module (LVPS ALARM)	OPRM Minor Failure Signal	OPRM Inoperative ABA Trip GRA Trip PBDA Trip OPRM Trip
8	N/A	Turn off the power to LVPS module 2	OFF	ON	FAIL/APRM 1: OFF FAIL/APRM 2: OFF FAIL/LPRM 1: OFF FAIL/LPRM 2: OFF FAIL/LPRM 3: OFF FAIL/LPRM 4: OFF	LVPS 1: OFF LVPS 2: <input checked="" type="checkbox"/>	ON	OFF

10.6 Other Functions

10.6.1 Test Functions

An internal test circuit of the OPRM unit allows checking the algorithm operation of LPRM Bypass, OPRM Cell Bypass, OPRM Automatic Bypass, and ABA, GRA, PBDA Trips at "CAL" mode of CELL module. These test functions are used by users of the OPRM unit for surveillance testing. The purpose of this test items is to check that the test functions operate as expected in accordance with the OPRM Unit User's Manual (Reference (7)).

(1) Test Patterns and Procedures

- Step 1: ABA Trip Test (Test number 1)
Set the OPRM unit to the "Normal Status."
Perform an ABA Trip test according to procedures described in Section 6.2.1 of the OPRM Unit User's Manual.
Set the OPRM unit to the "Normal Status."
- Step 2: GRA Trip Test (Test number 2)
Set the OPRM unit to the "Normal Status."
Perform a GRA Trip test according to procedures described in Section 6.2.1 of the OPRM Unit User's Manual.
Set the OPRM unit to the "Normal Status."
- Step 3: PBDA Trip Test (Test number 3)
Set the OPRM unit to the "Normal Status."
Perform a PBDA Trip test according to procedures described in Section 6.2.1 of the OPRM Unit User's Manual.
Set the OPRM unit to the "Normal Status."
- Step 4: LPRM Bypass test using Filtered Flux Calibration Input
Set the OPRM unit to the "Normal Status."
Select arbitrary 3 LPRM positions (i.e., UL, UR, LL, or LR), and set a Filtered Flux calibration input under 5% according to procedures described in Section 6.2.2 of the OPRM Unit User's Manual.
Set the OPRM unit to the "Normal Status."
- Step 5: OPRM Automatic Bypass Test using APRM/Flow Level Calibration Input
Set the OPRM unit to the "Normal Status."
According to procedures described in Section 6.2.3 of the OPRM Unit User's Manual set the APRM level and Core Flow level calibration inputs as follows.
 - (1) Set APRM level calibration input to 50.0 %.
Set Core Flow level calibration input to 50.0 %.
 - (2) Set APRM level calibration input to 28.7% (Setpoint 30% - hysteresis 1%FS).
 - (3) Set APRM level calibration input to 50.0 %.
 - (4) Set Core Flow level calibration input to 61.3 % (Setpoint 60% + hysteresis 1%FS)Set the OPRM unit to the "Normal Status."

(2) Acceptance Criteria

- In each step, check that the discrete outputs and module displays operates as expected specified in Table 10.6.1.

Table 10.6.1 Test Pattern and Expected Output

Step	Test Pattern		Acceptance Criteria (Expected Output)
	Operation using HMI of OPRM unit		
1	ABA Trip Test (Test number 1)		<ul style="list-style-type: none">Before this test, the OPRM unit can be set to “Normal Status.”ABA Trip and OPRM Trip are generated on discrete output and Optical Signal Receive Simulator Viewer (ELCS[]P:^cThe “ABA TRIP” and “TRIP” LEDs of AGRD module turn on.After this test, the OPRM unit can be set to “Normal Status.”
2	GRA Trip Test (Test number 2)		<ul style="list-style-type: none">Before this test, the OPRM unit can be set to “Normal Status.”GRA Trip and OPRM Trip are generated on discrete output and Optical Signal Receive Simulator Viewer (ELCS[]P:^cThe “GRA TRIP” and “TRIP” LEDs of AGRD module turn on.After this test, the OPRM unit can be set to “Normal Status.”
3	PBDA Trip Test (Test number 3)		<ul style="list-style-type: none">Before this test, the OPRM unit can be set to “Normal Status.”PBDA Trip and OPRM Trip are generated on discrete output and Optical Signal Receive Simulator Viewer (ELCS[]P:^cThe “PBDA TRIP” and “TRIP” LEDs of PBD module turn on.After this test, the OPRM unit can be set to “Normal Status.”
4	LPRM Bypass test using Filtered Flux Calibration Input		<ul style="list-style-type: none">Before this test, the OPRM unit can be set to “Normal Status.”Check that the selected LPRM position (i.e., UL, UR, LL, or LR) is bypassed.“BYP” (LPRM Bypass) LEDs corresponding to selected UL, LL, UR, or LR display of Filtered Flux on CELL module turn on.Numerical display “Amp/%/Count” of CELL module. Select “CELL Count” to show the Number of Active OPRM Cells. <p>Acceptance Criteria: Number of Active OPRM Cells: 43.</p> <ul style="list-style-type: none">After this test, the OPRM unit can be set to “Normal Status.”
5	OPRM Automatic Bypass Test using APRM/Flow Level Calibration Input	Normal Status	<ul style="list-style-type: none">Before this test, the OPRM unit can be set to “Normal Status.”
		(1) Set APRM level calibration input to 50.0 %. Set Core Flow level calibration input to 50.0 %.	<ul style="list-style-type: none">The “OPRM REGION” LED of CELL module turns ON.The “BYP” LED of CELL module turns OFF.OPRM_AT_BYP (OPRM Automatic Bypass) signal is <u>not</u> generated.
		(2) Set APRM level calibration input to 28.7% (Setpoint 30% - hysteresis 1%FS).	<ul style="list-style-type: none">The “OPRM REGION” LED of CELL module turns OFF.The “BYP” LED of CELL module turns ON.OPRM_AT_BYP (OPRM Automatic Bypass) signal is generated.
		(3) Set APRM level calibration input to 50.0 %.	<ul style="list-style-type: none">The “OPRM REGION” LED of CELL module turns ON.The “BYP” LED of CELL module turns OFF.OPRM_AT_BYP (OPRM Automatic Bypass) signal is <u>not</u> generated.
		(4) Set Core Flow level calibration input to 61.3 % (Setpoint 60% + hysteresis 1%FS)	<ul style="list-style-type: none">The “OPRM REGION” LED of CELL module turns OFF.The “BYP” LED of CELL module turns ON.OPRM_AT_BYP (OPRM Automatic Bypass) signal is generated.
		Normal Status	<ul style="list-style-type: none">After this test, the OPRM unit can be set to “Normal Status.”

10.6.2 Discrete Input Signal Toggling

The purpose of this test item is to check the response of the OPRM unit when APRM Bypass signal toggling.

(1) Test Patterns and Procedures

- Set the OPRM unit to the "Normal Status."
- Toggle the APRM Bypass signal input as follows.

ON/OFF Cycle: 1 second +/- 10% interval for 1 minute

(2) Acceptance Criteria

- Check that "BYP" LED on the CELL module turns on and off cyclically.
- The OPRM unit does not generate an OPRM Inoperative signal (OPRM_INOP) and OPRM Trip signal (SCRAM) of discrete outputs during APRM Bypass signal toggling.
- After this test, the OPRM unit can be set to "Normal Status."

10.6.3 Optical Transmission Integrity Test

The integrity of optical transmission signals under abnormal conditions postulated is evaluated in this test.

(1) Test Patterns and Procedures

1. Test Pattern 1 :LPRM Level Toggling

The purpose of this test pattern is to check response of the OPRM unit when the OPRM unit receives abnormal LPRM data that drives all the LPRM level inputs from 0 to 125% at 1 Hz interval for one minute simultaneously. The CELL module generates an OPRM Inoperative signal because number of active OPRM Cell changes due to changes of LPRM levels.

- Set the OPRM unit to the "Normal Status."

Click "All Stop" for LPRM 1 to 4.

Run ("All Start") the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:] a.c
LPRM 2:	
LPRM 3:	
LPRM 4:	

- Set the OPRM unit to the "Normal Status."
- Check that the status of OPRM unit is expected specified in Table 10.6.3.

2. Test Pattern 2: APRM Level and Core Flow Level Toggling

The purpose of this test pattern is to check response of the OPRM unit when the OPRM unit receives abnormal APRM data that drives all the APRM level and Core Flow level inputs from 0 to 125% at 1 Hz interval for one minute simultaneously.

- Step 1

Terminate the application software of Optical Signal Transmit Simulator.

Remove the initial file of "TrnRcvApp_Initial.xml" in the "¥NMS試験ツール¥TrnRcvApp¥ini."

Copy the "TrnRcvApp_Initial.xml" in the "¥NMS試験ツール¥TrnRcvApp ¥ini¥APRM toggling" and paste it in the "¥NMS試験ツール¥TrnRcvApp ¥ini."

Start up the application software of Optical Signal Transmit Simulator.

Run the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:] a.c
LPRM 2:	
LPRM 3:	
LPRM 4:	
APRM 1:	
APRM 2:	

Push the "RESET" buttons on CELL module, AGRD module, PBD module, and DAT/ST module, and check that the all "FAIL" and "INOP" LEDs on these modules turn OFF.

- Step 2

Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:] a.c
APRM 2:	

- Step 3

Run the following test pattern files on the Optical Signal Transmit Simulator.

APRM 1:] a.c
APRM 2:	

Push the “RESET” buttons on CELL module, AGRD module, PBD module, and DAT/ST module, and check that the all “FAIL” and “INOP” LEDs on these modules turn OFF.

- After this test is finished, terminate the application software of Optical Signal Transmit Simulator.
Remove the initial file of “TrnRcvApp_Initial.xml” in the “¥NMS試験ツール¥TrnRcvApp ¥ini.”
Copy the “TrnRcvApp_Initial.xml” in the “¥NMS試験ツール¥TrnRcvApp ¥ini¥Normal” and paste it in the “¥NMS試験ツール¥TrnRcvApp ¥ini.”
- Check that the status of OPRM unit is expected specified in Table 10.6.3.

3. Test Pattern 3 : Parity error simulation

- Step 1
Terminate the application software of Optical Signal Transmit Simulator.
Remove the initial file of “TrnRcvApp_Initial.xml” in the “¥NMS試験ツール¥TrnRcvApp ¥ini.”
Copy the “TrnRcvApp_Initial.xml” in the “¥NMS試験ツール¥TrnRcvApp ¥ini¥APRM toggling” and paste it in the “¥NMS試験ツール¥TrnRcvApp ¥ini.”
Start up the application software of Optical Signal Transmit Simulator.
Run the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:	} a,c
LPRM 2:	
LPRM 3:	
LPRM 4:	
APRM 1:	
APRM 2:	

Push the “RESET” buttons on CELL module, AGRD module, PBD module, and DAT/ST module, and check that the all “FAIL” and “INOP” LEDs on these modules turn OFF.

- Step 2
Run the following test pattern files on the Optical Signal Transmit Simulator.
- | | | |
|---------|-------|--|
| LPRM 1: | } a,c | (OPRM Inoperative signal is generated) |
| LPRM 2: | | |
| LPRM 3: | | |
| LPRM 4: | | |
| APRM 1: | | |
| APRM 2: | | |
| | | |
| | | |

- Step3
Run the following test pattern files on the Optical Signal Transmit Simulator.
- | | | |
|---------|-------|--------------------------------------|
| APRM 2: | } a,c | (OPRM Inoperative signal is cleared) |
| APRM 1: | | |
| LPRM 4: | } a,c | |
| LPRM 3: | | |
| LPRM 2: | | |
| LPRM 1: | | |
| | | |
| | | |

Push the “RESET” buttons on CELL module, AGRD module, PBD module, and DAT/ST module, and check that the all “FAIL” and “INOP” LEDs on these modules turn OFF.

- After this test is finished, terminate the application software of Optical Signal Transmit Simulator.
Remove the initial file of “TrnRcvApp_Initial.xml” in the “¥NMS試験ツール¥TrnRcvApp ¥ini.”
Copy the “TrnRcvApp_Initial.xml” in the “¥NMS試験ツール¥TrnRcvApp ¥ini¥Normal” and paste it in the “¥NMS試験ツール¥TrnRcvApp ¥ini.”

- Check that the status of OPRM unit is as expected specified in Table 10.6.3.

4. Test Pattern 4: Random Data Input Simulation

The purpose of this test pattern is to check response of the OPRM unit when the OPRM unit receives random data from the LPRM units and APRM unit for one minute simultaneously.

• Step 1

Set the OPRM unit to the "Normal Status."

Terminate the application software of Optical Signal Transmit Simulator.

Remove the initial file of "TrnRcvApp_Initial.xml" in the "¥NMS試験ツール¥TrnRcvApp¥ini."

Copy the "TrnRcvApp_Initial.xml" in the "¥NMS試験ツール¥TrnRcvApp ¥ini¥APRM toggling" and paste it in the "¥NMS試験ツール¥TrnRcvApp ¥ini."

Start up the application software of Optical Signal Transmit Simulator.

Run the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:] a.c
LPRM 2:	
LPRM 3:	
LPRM 4:	
APRM 1:	
APRM 2:	

Push the "RESET" buttons on CELL module, AGRD module, PBD module, and DAT/ST module, and check that the all "FAIL" and "INOP" LEDs on these modules turn OFF.

• Step 2

Run the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:] a.c
LPRM 2:	
LPRM 3:	
LPRM 4:	
APRM 1:	
APRM 2:	

During this test pattern files running, the OPRM unit operates as follows

CELL module:

"BYP" and "OPRM REGION" LEDs flash due to random change of APRM level and Core Flow level signal.

"BYP" LEDs of "Filtered Flux" flash due to random change of LPRM levels and LPRM Inoperative status.

Normalized Oscillation Signal, APRM level, and Core Flow level change randomly.

"INOP" (OPRM Inoperative) LEDs turns on because number of active OPRM Cell reduces under the Minimum Number of Active OPRM Cell Setpoint.

AGRD module, PBD module, and DAT/ST module:

These modules operate without OPRM Inoperative signal and OPRM Minor Failure signal generation.

• Step 3

Run the following test pattern files on the Optical Signal Transmit Simulator.

LPRM 1:] a.c
LPRM 2:	
LPRM 3:	
LPRM 4:	
APRM 1:	
APRM 2:	

Push the "RESET" buttons on CELL module, AGRD module, PBD module, and DAT/ST module, and check that the all "FAIL" and "INOP" LEDs on these modules turn OFF.

- After this test is finished, terminate the application software of Optical Signal Transmit Simulator.

Remove the initial file of “TrnRcvApp_Initial.xml” in the “~~¥~~NMS試験ツールTrnRcvApp ¥ini.”

Copy the “TrnRcvApp_Initial.xml” in the “~~¥~~NMS試験ツール¥TrnRcvApp ¥ini¥Normal” and paste it in the “~~¥~~NMS試験ツール¥TrnRcvApp ¥ini.”

- Check that the status of OPRM unit is expected specified in Table 10.6.3.
5. Test Pattern 5 (Response of the OPRM unit when optical signals are input into the output port of the TRN module))
- Step 1
Set the OPRM unit to the “Normal Status.”
Remove the optical cable to J72 (BSL 6 RCV module IN2), and connect it to J73 (BSL 6 RCV module IN3).
Wait approx. 10 seconds.
 - Step 2
Remove the optical cable to J73 (BSL 6 RCV module IN3), and connect it to J74 (BSL 6 RCV module IN4).
Wait approx. 10 seconds.
 - Step 3
Remove the optical cable to J74 (BSL 6 RCV module IN4), and connect it to J82 (BSL 7 TRN module OUT 2).
Wait approx. 10 seconds.
 - Step 4
Remove the optical cable to J82 (BSL 7 TRN module OUT 2), and connect it to J83 (BSL 7 TRN module OUT 3).
Wait approx. 10 seconds.
 - Step 5
Remove the optical cable to J83 (BSL 7 TRN module OUT 3), and connect it to J84 (BSL 7 TRN module OUT 4).
Wait approx. 10 seconds.
 - Step 6
Remove the optical cable to J84 (BSL 7 TRN module OUT 4), and connect it to J92 (BSL 8 TRN module OUT 2).
Wait approx. 10 seconds.
 - Step 7
Remove the optical cable to J92 (BSL 8 TRN module OUT 2), and connect it to J93 (BSL 8 TRN module OUT 3).
Wait approx. 10 seconds.
 - Step 8
Remove the optical cable to J93 (BSL 8 TRN module OUT 3), and connect it to J94 (BSL 8 TRN module OUT 4).
Wait approx. 10 seconds.
 - Step 9
Set the OPRM unit to the “Normal Status.”
 - In each step, check that the status of OPRM unit is expected specified in Table 10.6.3.

(2) Acceptance Criteria

- In each test pattern, check that the status of OPRM unit is expected specified in Table 10.6.3.

Table 10.6.3 Test Pattern and Expected Output

Test Pattern No.	Step	Items to be checked	Acceptance Criteria
Test Pattern 1	N/A	OPRM unit	Before this test, the OPRM unit can be set to "Normal Status."
		CELL module	"INOP" LED of CELL module cyclically turns ON.
		Discrete Output	<ul style="list-style-type: none"> "OPRM_INOP" (OPRM Inoperative) signal is cyclically generated. "SCRAM" (OPRM Trip) signal is <u>not</u> generated.
		Optical Signal Receive Simulator (PC data)	LPRM Level signals change from 0 to 125% cyclically.
		OPRM unit	After this test, the OPRM unit can be set to "Normal Status."
Test Pattern 2	1	OPRM unit	Check that the all "FAIL" and "INOP" LEDs on the OPRM unit turn OFF.
	2	Discrete Output	<ul style="list-style-type: none"> "OPRM_INOP" (OPRM Inoperative) signal is <u>not</u> generated. "SCRAM" (OPRM Trip) signal is <u>not</u> generated.
		Optical Signal Receive Simulator (PC data)	<ul style="list-style-type: none"> APRM Level signals change from 0 to 125% cyclically. Core Flow Level signals change from 0 to 125% cyclically.
	3	OPRM unit	Check that the all "FAIL" and "INOP" LEDs on the OPRM unit turn OFF by pushing "RESET" buttons on the OPRM unit.
Test Pattern 3	1	OPRM unit	Check that the all "FAIL" and "INOP" LEDs on the OPRM unit turn OFF.
	2	CELL module	"FAIL" LED of CELL module turns ON.
		DAT/ST module	"FAIL" LED of DAT/ST module turns ON.
			<ul style="list-style-type: none"> "FAIL" LED of "LPRM1" in "LINE STATUS" on DAT/ST module. (LPRM Unit 1 Data transmission failure) turns ON. "FAIL" LED of "LPRM2" in "LINE STATUS" on DAT/ST module. (LPRM Unit 2 Data transmission failure) turns ON. "FAIL" LED of "LPRM3" in "LINE STATUS" on DAT/ST module. (LPRM Unit 3 Data transmission failure) turns ON. "FAIL" LED of "LPRM4" in "LINE STATUS" on DAT/ST module. (LPRM Unit 4 Data transmission failure) turns ON. "FAIL" LED of "APRM1" in "LINE STATUS" on DAT/ST module. (APRM Unit 1 Data transmission failure) turns ON. "FAIL" LED of "APRM2" in "LINE STATUS" on DAT/ST module. (APRM Unit 2 Data transmission failure) turns ON.
		Discrete Output	<ul style="list-style-type: none"> "OPRM_INOP" (OPRM Inoperative) signal is generated after the LPRM unit 3 data error is simulated. "OPRM_FAIL" (OPRM Minor Failure) signal is generated. "SCRAM" (OPRM Trip) signal is <u>not</u> generated.
	3	DAT/ST module	<p>"FAIL" LED of DAT/ST module turns ON.</p> <ul style="list-style-type: none"> "FAIL" LED of "APRM2" in "LINE STATUS" on DAT/ST module. (APRM Unit 2 Data transmission failure) turns OFF. "FAIL" LED of "APRM1" in "LINE STATUS" on DAT/ST module. (APRM Unit 1 Data transmission failure) turns OFF. "FAIL" LED of "LPRM4" in "LINE STATUS" on DAT/ST module. (LPRM Unit 4 Data transmission failure) turns OFF. "FAIL" LED of "LPRM3" in "LINE STATUS" on DAT/ST module. (LPRM Unit 3 Data transmission failure) turns OFF. "FAIL" LED of "LPRM2" in "LINE STATUS" on DAT/ST module. (LPRM Unit 2 Data transmission failure) turns OFF.

Test Pattern No.	Step	Items to be checked	Acceptance Criteria
			<ul style="list-style-type: none"> “FAIL” LED of “LPRM1” in “LINE STATUS” on DAT/ST module. (LPRM Unit 1 Data transmission failure) turns OFF.
		Discrete Output	<ul style="list-style-type: none"> “OPRM_INOP” (OPRM Inoperative) signal is cleared after the LPRM unit 3 data error is cleared. “OPRM_FAIL” (OPRM Minor Failure) signal is cleared after the LPRM unit 1 data error is cleared. “SCRAM” (OPRM Trip) signal is <u>not</u> generated.
		OPRM unit	Check that the all “FAIL” and “INOP” LEDs on the OPRM unit turn OFF by pushing “RESET” buttons on the OPRM unit.
Test Pattern 4	1	OPRM unit	Check that the all “FAIL” and “INOP” LEDs on the OPRM unit turn OFF.
	2	Discrete Output	“OPRM_INOP” (OPRM Inoperative) signal is generated.
	3	OPRM unit	Check that the all “FAIL” and “INOP” LEDs on the OPRM unit turn OFF by pushing “RESET” buttons on the OPRM unit.
Test Pattern 5	1	OPRM unit	The OPRM unit can be set to “Normal Status.”
	1 to 8	DAT/ST module	“FAIL” LED and “FAIL” LED of “APRM2” in “LINE STATUS” on DAT/ST module. (APRM Unit 2 Data transmission failure) turns ON.
		CELL module	<ul style="list-style-type: none"> “FAIL” LED of CELL module turns ON. “INOP” LEDs on the CELL module does not turn ON.
		AGRD module, PBD module	“FAIL” and “INOP” LEDs on the AGRD module and PBD module do not turn ON.
		Discrete Output	<ul style="list-style-type: none"> “OPRM_INOP” (OPRM Inoperative) signal is <u>not</u> generated. “OPRM_FAIL” (OPRM Minor Failure) signal is generated. “SCRAM” (OPRM Trip) signal is <u>not</u> generated.
	9	OPRM unit	After this test, the OPRM unit can be set to “Normal Status.”

10.6.4 Random HMI Operation

The purpose of this test item is to check response of the OPRM unit when user operates the HMI (buttons) on the modules unintentionally at Operation (OP) mode of the OPRM unit.

(1) Test Patterns and Procedures

- Set the OPRM unit to the "Normal Status."
- Push the buttons on the CELL module, AGRD module, PBD module, and DAT/ST module at random with both hands for one minute.

(2) Acceptance Criteria

- Check that "FAIL" LEDs on CELL module, AGRD module, PBD module, and DAT/ST module do not turn on.
- Check that "INOP" LEDs on CELL module, AGRD module, and PBD module do not turn on.
- Check that "TRIP" LEDs on AGRD module, and PBD module do not turn on.

10.6.5 Initialization

The purpose of this test item is to check the initialization function of the OPRM unit. Data recording of the Optical Signal Receive Simulator for ELCS[] and PC is not required.

(1) Test Patterns and Procedures

- Step 1
Set the OPRM unit to the "Normal Status".
- Step 2
Shut off the both of the redundant AC power sources to the test specimens.
Check discrete outputs (SCRAM, ABA_TRIP, GRA_TRIP, PBDA_TRIP, OPRM_INOP and OPRM_FAIL).
- Step 3
Reapply the both of the redundant power sources at the same time.

(2) Acceptance Criteria

- Check that status of discrete outputs is as expected in Table 10.6.5

Table 10.6.5 Expected Output for Initialization

STEP	Acceptance Criteria (Expected Output)					
	Discrete Outputs					
	SCRAM	ABA_TRIP	GRA_TRIP	PBDA_TRIP	OPRM_INOP	OPRM_FAIL
1	Not Generated					
2	Generated					
3	Generated (Generation of discrete outputs continues for more than []ms after the 5 VDC of the LVPS module (LVPS1) turns on)					

Attachment A List of Test Pattern Files

List of LPRM Data Files

Section No. of SVTP	Test Pattern No.	File Name	Remarks
Common	Common		All LPRM Levels are 50%.
			All LPRM Levels are 50%.
			All LPRM Levels are 50%.
			All LPRM Levels are 50%.
10.2.1	1		
	2		
	4		
	5		
10.2.2	-		
10.4.1	1		
	2		
	3		
	4		
	5		

Section No. of SVTP	Test Pattern No.	File Name	Remarks
	6		
	7		
	8		
10.4.2	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
10.4.3	1		
	2		

Section No. of SVTP	Test Pattern No.	File Name	Remarks
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10,11		
	10.4.4		1,2,3,4
	5		
	6		
10.5.1	-		

Attachment B Run Time of Test Pattern

Anticipated run time of each test pattern file used with “Single Output” mode is provided in the following table as a test supporting information.

Section No. of SVTP	Test Pattern No.	Run Time (sec.)
10.2.1	Test Pattern 1	
	Test Pattern 2	
	Test Pattern 4	
	Test Pattern 5	
10.4.1	Test Pattern 1	
	Test Pattern 2	
	Test Pattern 3	
	Test Pattern 4	
	Test Pattern 5	
	Test Pattern 6	
	Test Pattern 7	
	Test Pattern 8	
10.4.2	Test Pattern 1	
	Test Pattern 2	
	Test Pattern 3	
	Test Pattern 4	
	Test Pattern 5	
	Test Pattern 6	
	Test Pattern 7	
	Test Pattern 8	
10.4.3	Test Pattern 1	
	Test Pattern 2	
	Test Pattern 3	
	Test Pattern 4	
	Test Pattern 5	
	Test Pattern 6	
	Test Pattern 7	
	Test Pattern 8	
	Test Pattern 9	
	Test Pattern 10,11	
10.4.4	Test Pattern 1,2,3,4	
	Test Pattern 5	
	Test Pattern 6	