Generating Test Data From Requirements/Specifications: Final Report

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EXECUTIVE SUMMARY

This report presents results for the Rockwell Collins Inc. sponsored project on generating test data from requirements/specifications, which started May 19, 1997. The purpose of this project is to improve our ability to test software that needs to be highly reliable by developing formal techniques for generating test cases from formal specificational descriptions of the software. Formal specifications represent a significant opportunity for testing because they precisely describe what functions the software is supposed to provide in a form that can be easily manipulated by automated means.

This report presents a general **model** for developing test inputs from state-based specifications, a **derivation process** for obtaining the test cases, a fully worked out **example** for a small system, and **test cases** from specifications of an industrial system. The test data generation model includes **techniques** for generating tests at several levels of abstraction for specifications, including the complete transition sequence level, the transition-pair level, and the detailed transition level. These techniques provide **coverage criteria** that are based on the specifications, and are made up of **several parts**, including test **prefixes** that contain inputs necessary to put the software into the appropriate state for the test values. The test generation process includes **several steps** for transforming specifications to tests.

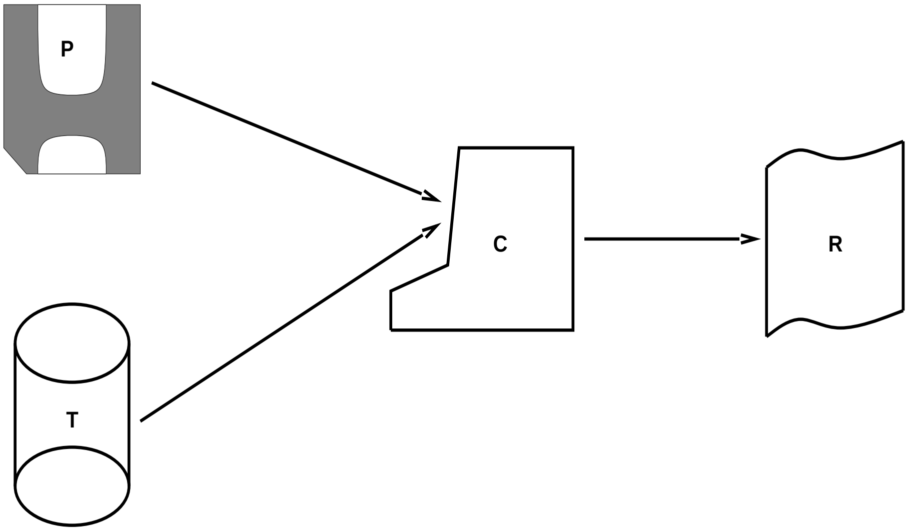


Figure 1: Specifications and Programs in Testing

1 INTRODUCTION

Formal specifications represent a significant opportunity for testing because they precisely describe what functions the software is supposed to provide in a form that can be easily manipulated by automated means. This research assumes that both code-based and specification-based testing are valuable, and they are complementary. It is also noted that specification-based test data generation has several advantages over code-based generation. Output checking is one of the major costs of testing, and although it is an undecidable problem, requirements/specifications can be used to partially solve it. The process of generating tests from the specifications will often help test engineers discover problems with the specifications themselves; if this step is done early, then the problems can be eliminated early, saving time and resources. Additionally, generating tests early in the development process allows testing activities to be shifted to an earlier part of the development process, allowing for more effective planning and utilization of resources.

Software functional specifications have been incorporated into testing in several ways. They have been used as a basis for test case generation, to check the output of software on test inputs, and as a basis for formalizing *test specifications* (as opposed to functional specifications). This research is primarily concerned with the first use, that of generating test cases from specifications. The immediate goal is to develop *mechanical* procedures to derive test cases from formal specifications; long term goals include automated tool support to transform formal functional specifications into effective test cases.

An abstract view of part of the test process is summarized by the diagram in Figure 1. A program P (represented by a diskette), along with a set of test cases T, is submitted to a computer C, which runs T on P to produce some results. A primary concern for testers is how to produce T; the tests should be effective at finding faults in the program, adequate at providing some information about the quality of the program, and preferably satisfy some requirements or criterion for testing that is repeatable, automatable, and measurable.

A common source for tests is the program code. In *code-based test generation*, a testing criterion is imposed on the software to produce test requirements. For example, if the criterion of branch

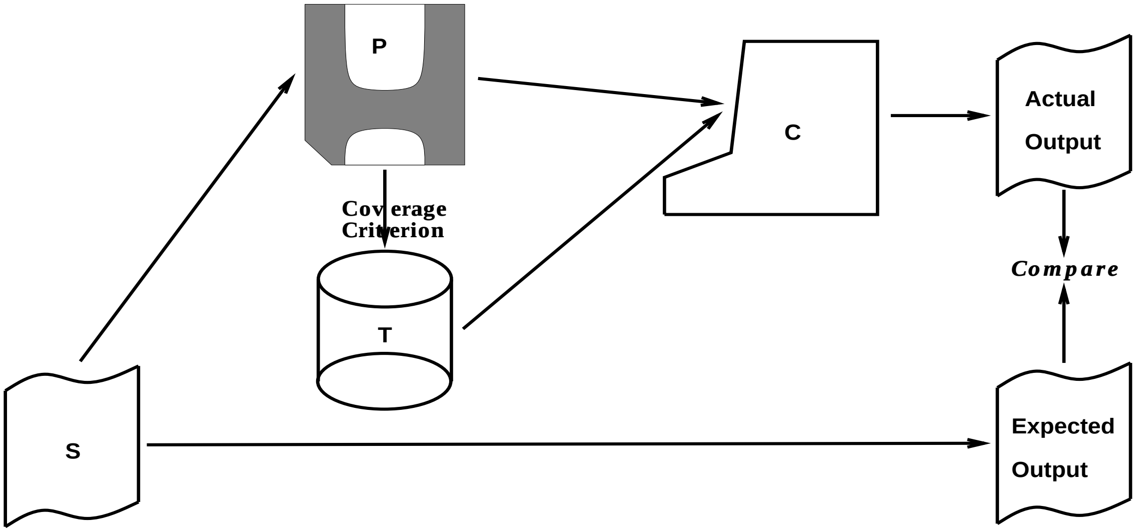


Figure 2: Code-based Test Generation

testing is used, the tests are required to cover each branch in the program. An abstract view of part of a typical test process that might be used for code-based test generation is summarized by the diagram in Figure 2. The specification S (which can be formal or informal) is used as a basis for writing the program P, which is used to generate the tests T, according to some coverage criterion such as branch or data flow. Execution of T on P creates the *actual output*, which must be compared with the *expected output*. The expected output is produced with some knowledge of the specifications. Thus, code-based generation uses the specifications to generate the code and check the output of the tests.

This is in contrast to *specification-based testing*, an abstract view of which is shown in Figure 3. Here the specifications are used to produce test cases, as well as to produce the program. In this scenario, the specifications are more likely to be formalized, so the arc from S to P is labeled "refine", to indicate a refinement process, which is often used to create code from formal specifications. One significance of producing tests from specifications is that the tests can be created earlier in the development process, and be ready for execution **before** the program is finished. Additionally, when the tests are generated, the test engineer will often find inconsistencies and ambiguities in the specifications, allowing the specifications to be improved before the program is written (hence the feedback arc from T back to S). The arcs from S to T and from S to $ExpectedOutput$ are labeled with a "?", because these are currently areas of active research. This project is looking at ways to generate tests from specifications; others, such as Li et al. have been developing techniques for creating expected output from specifications [LS96, HKL$^+$95, LYZ94].

Both specification-based and code-based test generation have strengths, and both are used in practice. Both methods have been criticized (sometimes unfairly), and both have supported (sometimes too strongly). The Principal Investigator on this project has carried out research involving both approaches, and this report attempts to present the strengths and weaknesses of both approaches in a scientific, unbiased manner. While some of these are accidental differences of the current state of the research and available technology (using the philosophical distinction popularized by Brooks [Bro87]), some are also essential. This research takes the position that specification-based test data generation is complementary to code-based test data generation, and

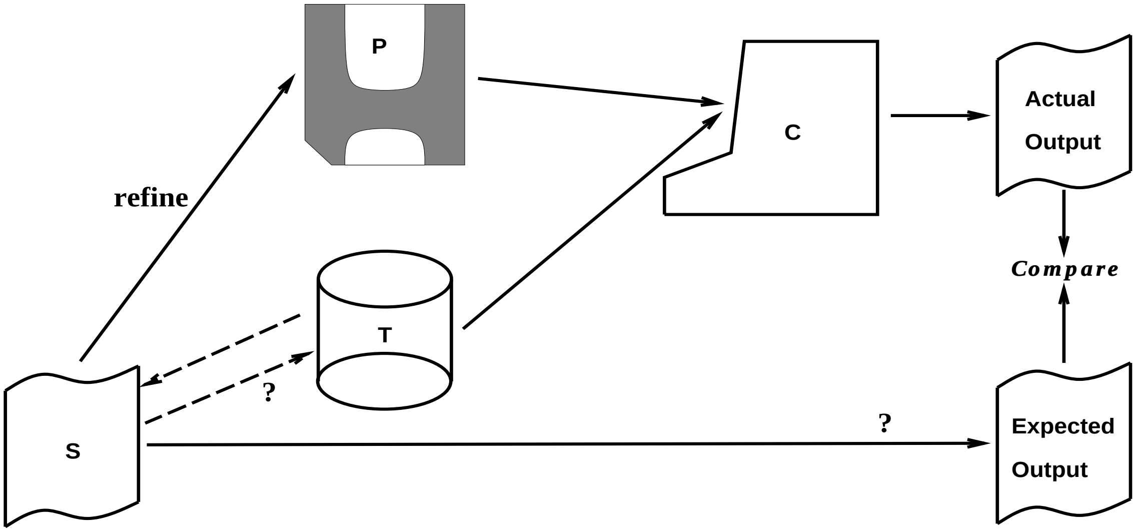


Figure 3: Specification-based Test Generation

that both are necessary. Indeed most wise practical testers do this.

Because specification-based testing only considers an external view of the software, it can be said to test the products, but not the design decisions, and it may not test all of the program. By deriving tests from the specifications, it is often possible to find problems in the specifications. While this effect has not been formalized or quantified, experience has provided strong anecdotal evidence. An example is a project, called Mistix, that has been used in several classes and research projects [AO94, OI95]. It is a simplified file system program used to illustrate trees, lists, type parameterization, and inheritance. Informal specifications had been supplied to several classes before it was used as an assignment in a graduate testing class. The students applied a modification of the category-partition method [OB88, BHO89] to the specifications to produce test cases. During the exercise, they identified many inconsistencies and ambiguities in the specifications, and found several points of incompleteness. These problems helped find faults in existing implementations that had previously gone undiscovered.

Specification-based testing is also currently immature, which means there is a scarcity of formalizable criteria and automated tool support. It is this problem that this research is attempting to address. Specification-based testing has the potential to benefit from formal specifications, by using the formal specifications as input to a formalizable, automatable test generation process. Another advantage of specification-based testing is that it can support the automation of testing result analysis, by using specifications to produce expected output of test cases.

A major disadvantage of code-based generation is that it tests what was **built**, not what was **intended**. Also, code-based generation tests may not cover the entire input domain. On the other hand, code-based generation technology is very mature, and there are many formalized criteria for testing, and many tools available.

There are several things that are not known about generating tests from code and from specifications. If specification-based testing is used, it is not known how well those tests might cover the program code; likewise, we do not know how well code-based tests might cover the input domain.

The two approaches are sometimes used in combination. The most common way is to generate tests based on the specifications, and then use *code-based coverage analysis* to measure the quality of the tests. For example, the tests might be measured by how many branches in the software are covered (as in Section 5.4 of this report). No results have been published concerning how effective this combination is. It is known, however, that it is difficult to construct system and subsystem level tests that cover detailed code-level requirements (such as branches). This is why code-based test generation is often thought of as useful for *unit testing*, when individual functions or modules are tested, and specification-based test generation is often thought of as useful for *system testing*, when entire working systems are tested. These are rally orthogonal issues, however. Specification-based testing techniques can be and are used at the unit level. The key difference is in the questions that the two approaches attempt to answer. Specification-based testing addresses the question of "why am I testing?", whereas code-based testing addresses the question of "how much software is being covered during testing?".

As said, this report addresses the problem of a lack of formalizable, measurable criteria for generating test cases from specifications. Specifically, a model for generating tests from requirements/specifications is presented. This report first reviews the small but growing body of work on using formal specifications as a basis for producing test cases, then presents a model for generating tests from requirements/specifications. Then a derivation process is presented, and a small example of testing a cruise control software system is given.

2 APPROACHES TO SPECIFICATION-BASED TESTING

The current research literature reports on specific tools for specific formal specification languages [BGM91, BCFG86, GMH81, Jal92, OSW86, TVK90, WGS94], manual methods for deriving tests from specifications [AA92, AO94, Ber91, DF93, Hay86], case studies on using specifications to check the output of the software on specifications [DF91, Kem85, Lay92, SC93a], and formalizations of test specifications [SC96, SC93b, BHO89, Cho86]. The term *specification-based testing* is used in the narrow sense of using specifications as a basis for deciding what tests to run on software. Some of these techniques are reviewed, dividing them into approaches that use model-based, algebraic, and state-based specifications.

2.1 Model-based Approaches

Model-based specification languages, such as Z and VDM, attempt to derive formal specifications of the software based on models of real-world objects. Spence and Meudec [SM] and Dick and Faivre [DF93] suggested using specifications to produce predicates, and then using predicate satisfaction techniques to generate test data. Given a set of predicates that reflect preconditions, invariants, and postconditions, test cases are generated to satisfy individual clauses. Their work was for VDM specifications, and primarily focused on state-based specifications, using finite state automata representations. Dick and Faivre discussed straightforward translation of the specifications into disjunctive normal form predicates, and presented solutions to the problem of predicate satisfaction by using prolog theorem proving techniques.

Stocks and Carrington [SC93b, SC93a] and Amla, Ammann, and Offutt [AA92, AO94] proposed using a form of *domain partitioning* to generate test cases. Given description of input domain, the idea is to use specifications to partition the input domain into subsets. The Amla, Ammann, and Offutt approach is based on a modification to the category-partition method for test generation [BHO89, OSW86]. Hierons [Hie97] presents algorithms that rewrite Z specifications into a form that can be used to partition the input domain. From this, states of a finite state automaton are derived, which is then used to control the test process.

Hayes [Hay86] has suggested a dynamic scheme that uses *run-time verification* of the program. The idea is to add code to the program to check predicates from the specifications, such as type invariants, preconditions, and input-output pairs.

2.2 Algebraic Approaches

Algebraic specification languages describe software by making formal statements, called *axioms*, about relationships among operations and the functions that operate on them. Gannon, McMullin and Hamlet [GMH81] used a *script derivation* approach. They treated the axioms as a language description and generated strings on that language to serve as test cases. Doong and Frankl [DF91] used a similar approach to test object-oriented software.

Bernot [Ber91] proposed a similar scheme, with more formalization of the process and the test cases. Bougé et al. [BCFG86] suggested a logic programming approach to generating test cases from algebraic specifications. Tsai, Volovik, and Keefe [TVK90] used a similar approach, but started with relational algebra queries.

2.3 State-based Approaches

State-based specifications describe software in terms of state transitions. Typical state-based specifications define *preconditions* on transitions, which are values that specific variables must have for the transition to be enabled, and *triggering events*, which are changes in variable values that cause the transition to be taken. For example, SCR [Hen80, AG93] calls these WHEN conditions and triggering events. The values the triggering events have before the transition are sometimes called *before-values*, and the values after the transition are sometimes called *after-values*. The state immediately preceding the transition is called the *pre-state*, and the *post-state* is the state after the transition.

Blackburn [BB96] used state-based functional specifications of the software, expressed in the language `T-Vec`, to derive disjunctive normal form constraints, similarly to Dick and Faivre's method. These constraints are then solved to generate test cases, using special-purpose heuristic algorithms. There is a strong similarity to Blackburn's algorithms and the algorithms used by Offutt's test data generator [DGK$^+$88, DO91]; the key difference being that Blackburn's is specification-based, whereas Offutt's constraints are code-based.

Weyuker, Goradia, and Singh [WGS94] present a method to generate test data from boolean logic specifications of software. They applied their techniques to the FAA's Traffic Collision and Avoidance System (TCAS), and used a few mutation-style faults to measure the quality of the test cases.

2.4 Summary

Most of the current specification-based testing techniques use manual methods that cannot be easily generalized or automated. Goals of this research include generalizing the currently known techniques, defining measurable criteria, and developing automated tools.

3 SPECIFICATION-BASED TESTING MODEL

Section 2 discusses the notion of *predicate satisfaction*. Predicate satisfaction uses preconditions, invariants, and postconditions to create predicates, and then generates test cases to satisfy individual clauses within the predicates. This is closely related to previous code-based automatic test generation research [DO91]. The model presented here extends the promising ideas of predicate satisfaction in several ways.

Instead of just covering the pre and postconditions, it is important to use the tests to relate the preconditions to the postconditions. Tests should also be created to find faults, as well as to cover the input domain. This report presents examples using Software Cost Reduction specifications (SCR) [Hen80, AG93] and CoRE [FBWK92].

In this model, tests are generated as multi-part, multi-step, multi-level artifacts. The multi-part aspect means that a test case is composed of several components. Input values are the values for the test case; these are the values needed to directly satisfy the test requirements. The other components supply supporting values, including expected outputs, inputs necessary to get to the appropriate pre-state, and inputs necessary to observe the effect of the test case. The multi-step aspect means that tests are generated in several steps from the functional specifications by a refinement process. The functional specifications are refined into test specifications, which are then refined into test scripts. The multi-level aspect means that tests are generated to test the software at several levels of abstraction.

The multiple parts of the test case are based on research in test case specifications [BHO89, SC93b]. The category-partition method includes a test specification language called TSL [BHO89], which was designed for command-line interface software. A *test case* in TSL is a command or software function and values for its parameters and relevant environment variables. A *test specification* in TSL consists of the operations necessary to create the environmental conditions (called the SETUP portion), the test case itself, whatever command is necessary to observe the affect of the operation (VERIFY in TSL), and any exit command (CLEANUP in TSL). Test specifications written in TSL can be used to automatically generate executable *test scripts* that are ready for input to the software.

In this state-based approach, the test case operation of TSL is replaced by `Test case values`, which are derived directly from a triggering event and the preconditions for the transition. The setup operation is called a `Prefix`, and includes all inputs necessary to reach the pre-state and to give the triggering event variable its before-value. Any inputs that are necessary to show the results are `Verify` operations, and `Exit` commands depend on the system being tested. `Expected outputs` are created from the after-values of the triggering events and any postconditions that are associated with the transition.

The model currently defines test cases at four levels: (1) the transition coverage level, (2) the full predicate coverage level, (3) the transition-pair coverage level, and (4) the complete sequence level. These are defined in the next four subsections. To apply these, a state-based requirement/specification is viewed as a directed graph, called the *specification graph*. Each node represents a state (or mode) in the requirement/specification, and edges represent possible transitions.

It is possible to apply all levels, or to choose a level based on a cost/benefit tradeoff. The first two are related; the transition coverage level requires many fewer test cases than the full predicate coverage level, but if the full predicate coverage level is used, the tests will also satisfy the transition coverage level (full predicate coverage *subsumes* transition coverage). Thus only one of these two should be used. The latter two levels are meant to be independent; transition-pair coverage is intended to check the interfaces among states, and complete sequence testing is intended to check the software by executing the software through complete execution paths. As it happens, transition-pair coverage subsumes transition coverage, but they are designed to test the software in very different ways.

3.1 Transition Coverage Level

This level is analogous to the branch coverage criterion in structural testing. The requirement is that each transition in the specification graph is taken at least once. This is another way of requiring that each precondition in the specification is satisfied at least once.

Transition coverage: Each transition in the specification graph is taken at least once.

3.2 Full Predicate Coverage Level

One question during testing is whether the predicates in the specifications are formulated correctly. Small inaccuracies in the specification predicates can lead to major problems in the software. The full predicate coverage level takes the philosophy that to test the software, we should at least provide inputs to test each clause in each predicate. This level requires that each clause in each predicate on each transition is tested independently, thus attempting to address the question of whether each clause is necessary and is formulated correctly. Following the definitions in DO178B [SC-92], the Boolean operators are AND, OR, and NOT, and clause and predicate are defined as follows (DO178B uses the terms "condition" and "decision"):

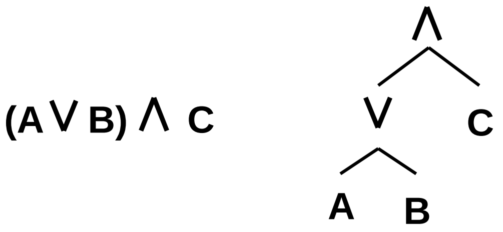
- A *clause* is a Boolean expression that contains no Boolean operators. For example, relational expressions and Boolean variables are clauses.
- A *predicate* is a Boolean expression that is composed of clauses and zero or more Boolean operators. A predicate without a Boolean operator is also a clause. If a clause appears more than once in a predicate, each occurrence is a distinct clause.

The concept of full predicate coverage is based on the structural testing criterion of modified condition/decision coverage (MC/DC) [CM94], which requires that every decision and every condition within the decision has taken every outcome at least once, and every condition has been shown to independently affect its decision. The full predicate coverage level is defined as follows:

Full predicate coverage: Each clause in turn takes the values of `True` and `False` while all other clauses in the predicate have values such that the value of the predicate will always be the same as clause being tested.

This definition ensures that each clause is tested without being influenced by the other clauses. Note that if full predicate coverage is achieved, transition coverage will also be achieved. To satisfy the requirement that the *test clause* controls the value of the predicate, other clauses must be either `True` or `False`. If the predicate is $(X \wedge Y)$, and the test clause is X, then Y must be `True`. Likewise, if the predicate is $(X \vee Y)$, Y must be `False`.

The simplest way to satisfy full predicate is to use an expression parse tree. An expression parse tree is a binary tree that has binary and unary operators for internal nodes, and variables or constants at leaf nodes. The relevant binary operators are **and** ($\wedge$), **or** ($\vee$), and the relational operators $\{>, <, \leq, \geq, =, \neq\}$; the relevant unary operator is **not**. For example, the expression parse tree for $(A \vee B) \wedge C$ is:



Given a parse tree, full predicate coverage is satisfied by walking the tree. First, a test clause is chosen. Then the parse tree is walked from the test clause up to the root, then from the root down to each clause. If its parent is ∨, its sibling must have the value of `False`, if its parent is ∧, its sibling must have the value of `True`. If a node is the inverse operator **not**, the parent node is given the inverse value of the child node. This is repeated for each node between the test clause and the root.

Once the root is reached, values can be propagated back down using a simple tree walk. If a ∧ node has the value of `True`, then both children must have the value `True`; if a ∧ node has the value of `False`, then either child must have the value `False` (which one is arbitrary). If a ∨ node has the value of `False`, then both children must have the value `False`; if a ∨ node has the value of `True`, then either child must have the value `True` (which one is arbitrary). If a node is the inverse operator **not**, the parent node is given the inverse value of the child node.

Figure 4 illustrates the process for the expression above, showing both B and C as test clauses. In the top sequence, B is the test clause (shown with a dashed box). In tree 2, its sibling, A, is assigned the value `False`, and in tree 3, C is assigned the value `True`. In the bottom sequence, C is the test clause. In tree 2, C's sibling is a ∨ node, and is assigned the value `True`. In tree 3, A is assigned the value `True`. Note that in tree 3, either A or B could be given the `True` value; the choice is arbitrary.

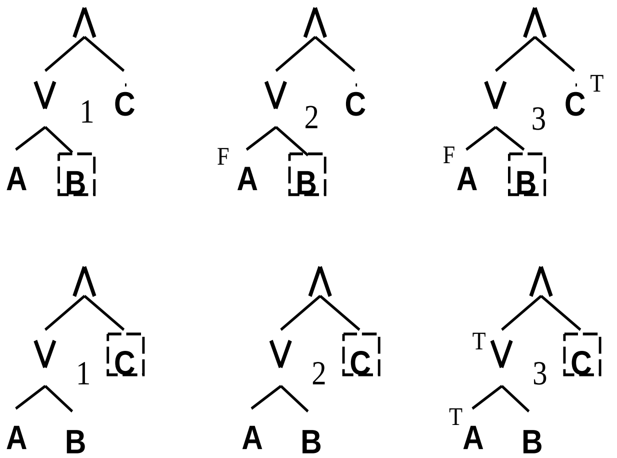


Figure 4: Constructing Test Case Requirements From an Expression Parse Tree

Although this may seem complicated, it is easy to automate and relatively straightforward to apply by hand. It has also been our experience that most specification predicates tend to be fairly small and simple in form.

These test cases sample from both **valid** and **invalid** transitions, with only one transition being valid at a time. In addition, the test engineer may choose semantically meaningful combinations of conditions. Testing with invalid inputs can help find faults in the implementation as well as the formulation of the specifications. Of course, this brings up a philosophical question about responsibility. Many developers believe that if a software component has well-stated preconditions, it is the responsibility of the user to ensure that the preconditions are met. This can be taken to imply that the component does not need to be tested with inputs that violate the preconditions (as in the design-by-contract approach [MM92]). Without taking a side on this issue, the technique described here provides a mechanism for developing invalid inputs; they can be used or discarded as the tester sees fit.

As a concrete example, consider the formula whose parse tree was given above, $(A \vee B) \wedge C$. The following partial truth table provides the values for the test clauses:

	$(A$	$\vee$	$B)$	$\wedge$	C
1	T				
2	F				
3			T		
4			F		
5					T
6					F

To ensure the requirement that the test clause must control the final result, the partial truth table must be filled out as follows (for the last two entries, either A or B could have been `True`, both were assigned the value `True`):

	$(A$	$\vee$	$B)$	$\wedge$	C
1	**T**		F		T
2	**F**		F		F
3	F		**T**		T
4	F		**F**		F
5	T		T		**T**
6	T		T		**F**

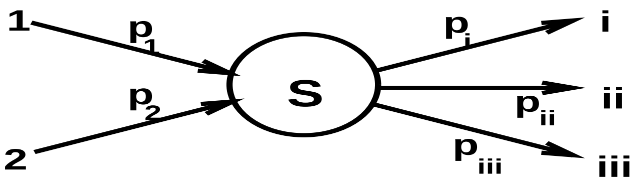
Some specification languages, such as SCR and CoRE, treat triggering event variables differently from other variables in transition predicates. When this is the case, the clause that corresponds to the triggering event should be given a different value, but should **remain** the triggering event. If it is no longer a triggering event, it is equivalent to not executing a test case. Moreover, a triggering event actually specifies two values, a before-value and an after-value. To fully test predicates with triggering events, both before- and after-values should be tested. This is done by assuming two versions of the triggering event, A and A', where A represents the before-value of A and A' represents its after-value.

3.3 Transition-Pair Coverage Level

The previous testing levels test transitions independently, but do not test sequences of state transitions. This level requires that pairs of transitions be taken.

Transition-pair coverage level: For each state S, form test requirements such that for each incoming transition and each outgoing transition, both transitions must be taken sequentially.

Consider the following state:



To test the state `S` at the transition-pair level, six tests are required: (1) from 1 to i, (2) 2 to i, (3) 1 to ii, (4) 2 to ii, (5) 1 to iii, and (6) 2 to iii. These tests require inputs that satisfy the predicates: P_1:P_i, P_1:P_{ii}, P_1:P_{iii}, P_2:P_i, P_2:P_{ii}, and P_2:P_{iii}.

3.4 Complete Sequence Level

It seems very unlikely that any successful test method could be based on purely mechanical methods; at some point the experience and knowledge of the test engineer must be used. Particularly at the system level, effective testing probably requires detailed domain knowledge. A *complete sequence* is a sequence of state transitions that form a complete practical use of the system. This use of the term is similar to that of "use cases". In most realistic applications, the number of possible sequences is too large to choose all complete sequences. In many cases, the number of complete sequences is infinite.

Complete sequence level: The test engineer must define meaningful sequences of transitions on the specification graph by choosing sequences of states that should be entered.

Which sequences to choose is something that can only be determined by the test engineer with the use of domain knowledge and experience. This is the least automatable level of testing.

3.5 Summary

To generate tests according to this methodology, tests must be generated at the following four levels:

1. Transition Coverage Level
   - Definition: Each transition in the specification graph is taken at least once.
   - Requirements: Predicates on the edges must evaluate to `True`.
   - Specifications:
     - Prefix: Inputs to get to the pre-state immediately preceding the edge.
     - Test case values: Assignments to variables to satisfy the preconditions and a new value for the triggering event variable.
     - Verify: Input to the software to show the post-state; depends on the software.

    - Exit: Input to the software to stop execution; depends on the software.
    - Expected outputs: Post-state from the requirements.
  - Script: A sequence of inputs to the software; the format depends on the software.

2. Full Predicate Coverage Level
   - Definition: Each clause in turn takes the values of `True` and `False` while all other clauses in the predicate have values such that the value of the predicate will always be the same as clause being tested.
   - Requirements: Certain rows from the truth tables of the predicates must be chosen.
   - Specifications:
     - Prefix: Inputs to get to the pre-state immediately preceding the edge.
     - Test case values: Assignments to variables to satisfy the preconditions and a new value for the triggering event variable.
     - Verify: Inputs to the software to show the post-state; depends on the software.
     - Exit: Input to the software to stop execution; depends on the software.
     - Expected outputs: Post-state from the requirements.
   - Script: A sequence of inputs to the software; the format depends on the software.
3. Transition-Pair Coverage Level
   - Definition: For each state S, form test requirements such that for each incoming transition and each outgoing transition, both transitions must be taken in sequence.
   - Requirements: Predicates on two edges of the specification graph must evaluate to `True`.
   - Specifications:
     - Prefix: Inputs to get to the pre-state immediately preceding the edge.
     - Test case values: Assignments to variables to satisfy the preconditions and a new value for the triggering event variable.
     - Verify: Inputs to the software to show the post-state; depends on the software.
     - Exit: Input to the software to stop execution; depends on the software.
     - Expected outputs: Post-state from the requirements.
   - Script: A sequence of inputs to the software; the format depends on the software.
4. Complete Sequence Level
   - Definition: The test engineer must define **meaningful** sequences of transitions on the specification graph by choosing sequences of states that should be entered.
   - Requirements: Lists of states.
   - Specifications:
     - Setup: Should be empty
     - Test case value: Value assignments necessary to take every transition on the sequence path.
     - Verify: Inputs to the software to show the post-state; depends on the software.
     - Exit: Input to the software to stop execution; depends on the software.
     - Expected outputs: Sequence of states.
   - Script: A sequence of inputs to the software; the format depends on the software.

4 DERIVATION PROCESS

This section presents a process that can be used to derive test cases. The process steps for all four levels of testing are presented together, as there is a fair amount of overlap. If not all four levels are used, some of these steps should be skipped. The steps are presented as being purely manual; in the future schemes for automating as many of the steps as possible will be developed.

The general process is shown in Figure 5; this merely reflects the multi-step aspect of our test generation process that was presented in Section 3.

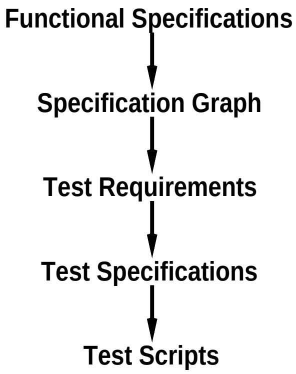


Figure 5: General Process for Generating Test Cases

1. **Develop transition conditions.** The first step is to develop **transition conditions**, which are predicates that define under what conditions each transition will be taken. With some specification languages (e.g., SCR and CoRE), the transition conditions are encoded directly into the specifications. With other languages, the conditions may have to be derived.

2. **Develop specification graph.** The specification graph was described in Section 3. It can be directly derived from the specification table, and edges annotated with the conditions derived in step 1.

   This is the point at which the process separates for the four testing levels.

3. **Develop transition coverage test requirements.**

   (a) **Derive transition predicates.** The conditions from step 1 are listed one at a time to form test requirements.

4. **Develop full predicate test requirements.**

   (a) **Construct truth tables for all predicates in the specification graph.** The predicate coverage tests can be based on an expression tree or directly on the predicates. If all the logical connectors are the same (all ANDs or all ORs), it is a simple matter to modify the values for the clauses in the predicates directly. If ANDs and ORs are mixed freely, however, it is less error-prone to construct the expression tree. Most specification languages differentiate between trigger events and preconditions; in this case, the trigger events must be marked specially so that the test engineer remembers to put that input after the precondition inputs.

5. **Develop transition-pair test requirements.**

   (a) **Identify all pairs of transitions.** Transition-pair tests are ordered pairs of condition values, each representing an input to the state and an output from the state. These are formed by enumerating all the input transitions (M), all the output transitions (N), then creating $M * N$ pairs of transitions.

   (b) **Construct predicate pairs.** These pairs of transitions are then replaced by the predicates from the specification graph.

6. **Develop complete sequence test requirements.**

   (a) **Identify complete lists of states.** The complete sequence tests are created by the tester. This is done by choosing sequences of states from the specification graph to enter.

   (b) **Construct sequence of predicates.** The sequences of states are transformed into sequences of conditions that will cause those states to be entered.

   At this point, test requirements for the four levels will be in a uniform format, as truth assignments for predicates.

7. **Construct test specifications.** For each unique test requirement, generate prefix values, test case values, verify conditions, exit conditions, and expected outputs. Note that there may be a fair amount of overlap among the test requirements, thus the "unique" restriction. Generating the actual values may involve solving some algebraic equations. For example, if a condition is $A > B$, values for A and B must be chosen to give the predicate the appropriate value. It is also at this point that some "invalid" tests might be discovered. For example, it may be impossible or meaningless to pair all incoming and outgoing transitions for each state. In this case, certain test specifications will be discarded.

8. **Construct test scripts.** Each test specification is used to construct one test script. The actual scripts must reflect the input syntax of the program, so knowledge of the input syntax of the program is required for this step. (Note that this is the only step that requires any knowledge of the implementation, all preceding steps depend solely on the functional specifications.)

4.1 Automation Notes

It is possible to automate almost all of this derivation process. If a machine-readable form of the specification table is available, the transition conditions can be read directly from the table. The specification graph can then be automatically created from the states and transition conditions. Test requirements take the form of partial truth tables defined on transition predicates, state transition predicates, and pairs of state transition predicates. Given a formal functional specification, most if not all of these test requirements can be generated automatically. The prefix of a test case includes inputs necessary to put the system into a particular pre-state. Given the specification graph, many of these prefixes can be generated automatically. One open question is whether this problem is generally solvable (unlike the related reachability problem in general software, which is generally unsolvable), and how to solve or partially solve the problem. It is also possible to automatically refine test specifications into test scripts. Finally, algorithms for automatically generating test scripts can be developed, although the input syntax of the program will be needed. The final step, generating complete sequence tests, cannot be fully automated. But an appropriate interface could present the specification graph, and allow the tester to choose sequences of states by pointing and clicking on the screen. Each time a state is chosen, the transition from the previous state could be automatically translated into values and saved as part of the test case. This would allow the tester's job to become the purely intellectual exercise of choosing sequences of states to be entered.

5 CRUISE CONTROL EXAMPLE

This section presents an example of applying the test data generation model to a specification for an automobile cruise control system. Cruise control is a common example in the literature [Atl94, Jin96]. Table 1 shows the specifications for the system (note that it does not model the throttle). It has four states: OFF (the initial state), INACTIVE, CRUISE, and OVERRIDE. The system's environmental conditions indicate whether the automobile's ignition is on (*Ignited*), the engine is running (*Running*), the automobile is going too fast to be controlled (*Toofast*), the brake pedal is being pressed (*Brake*), and whether the cruise control level is set to *Activate*, *Deactivate*, or *Resume*.

Previous Mode	Ignited	Running	Toofast	Brake	Activate	Deactivate	Resume	New Mode
Off	@T	-	-	-	-	-	-	Inactive
Inactive	@F	-	-	-	-	-	-	Off
	t	t	-	f	@T	-	-	Cruise
Cruise	@F	-	-	-	-	-	-	Off
	t	@F	-	-	-	-	-	Inactive
	t	-	@T	-	-	-	-	
	t	t	f	@T	-	-	-	Override
	t	t	f	-	-	@T	-	
Override	@F	-	-	-	-	-	-	Off
	t	@F	-	-	-	-	-	Inactive
	t	t	-	f	@T	-	-	Cruise
	t	t	-	f	-	-	@T	

Table 1: SCR Specifications for the Cruise Control System

Each row in the table specifies a conditioned event that activates a transition from the mode on the left to the mode on the right. A table entry of @T or @F under a column header C represents a triggering event @T(C) or @F(C). This means that the value of C must change for the transition to be taken. A table entry of `t` or `f` represents a WHEN condition. WHEN[C] means the transition can only be taken if C is true, and WHEN[¬C] means it can only be taken if C is false. If the value of an environmental condition C does not affect a conditioned event, the table entry is marked with a hyphen "-" (don't care conditions).

Table 2 shows the transitions of the specification in predicate form, numbered P_1 through P_{12}. Figure 6 shows the specification graph, with the edges labeled with the condition numbers.

5.1 Full Predicate Coverage Level

There are nine transitions in the cruise control specifications, and twelve disjunctive predicates (Table 1 shows each disjunctive predicate on a separate line). For convenience, the technique is applied by considering each predicate specification separately. As stated in Section 3.2, both the before- and after-values of the triggering event should be tested. For SCR, this is handled by treating @ as an operator and expanding it algebraically. The relevant expansions are:

- $@T(X) \equiv X \wedge X'$
- $@T(X \wedge Y) \equiv \neg(X \wedge Y) \wedge (X' \wedge Y') \equiv (\neg X \vee \neg Y) \wedge X' \wedge Y'$
- $@T(X \vee Y) \equiv \neg(X \vee Y) \wedge (X' \wedge Y') \equiv \neg X \wedge \neg Y \wedge X' \wedge Y'$

Table 3 repeats Table 2, but with the trigger events expanded appropriately.

The test case requirements for the full predicate coverage level are below with the environmental variables shown as I (Ignited) R (Running), T (Toofast), B (Brake), A (Activate), D (Deactivate),

P_1	OFF	$@T\, Ignited$	INACTIVE
P_2	INACTIVE	$@F\, Ignited$	OFF
P_3	INACTIVE	$@T\, Activate \wedge Ignited \wedge Running \wedge \neg Brake$	CRUISE
P_4	CRUISE	$@F\, Ignited$	OFF
P_5	CRUISE	$@F\, Running \wedge Ignited$	INACTIVE
P_6	CRUISE	$@T\, Toofast \wedge Ignited$	INACTIVE
P_7	CRUISE	$@T\, Brake \wedge Ignited \wedge Running \wedge \neg Toofast$	OVERRIDE
P_8	CRUISE	$@T\, Deactivate \wedge Ignited \wedge Running \wedge \neg Toofast$	OVERRIDE
P_9	OVERRIDE	$@F\, Ignited$	OFF
P_{10}	OVERRIDE	$@F\, Running \wedge Ignited$	INACTIVE
P_{11}	OVERRIDE	$@T\, Activate \wedge Ignited \wedge Running \wedge \neg Brake$	CRUISE
P_{12}	OVERRIDE	$@T\, Resume \wedge Ignited \wedge Running \wedge \neg Brake$	CRUISE

Table 2: Cruise Control Specification Predicates

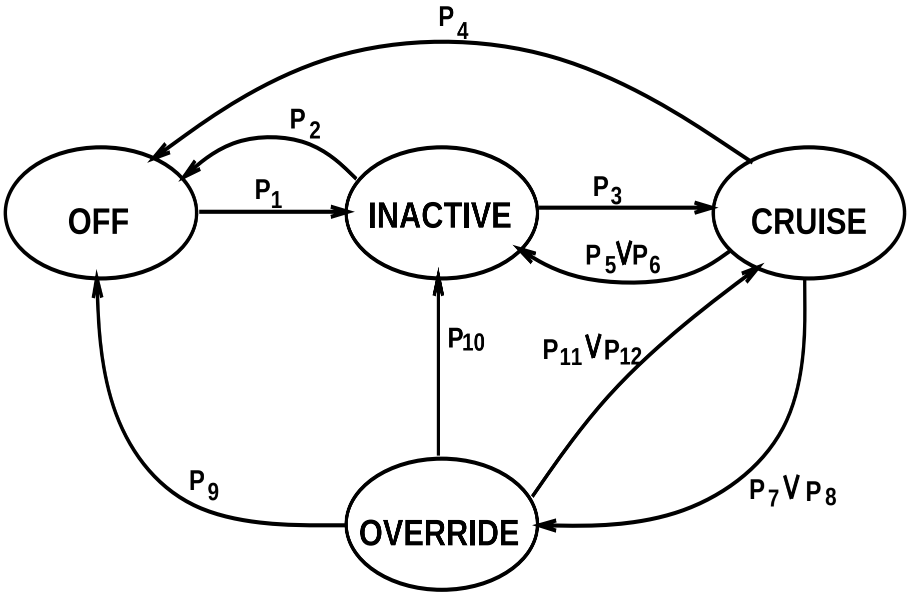


Figure 6: Specification Graph for Cruise Control

P_1	OFF	$\neg \mathit{Ignited} \wedge \mathit{Ignited}'$	INACTIVE
P_2	INACTIVE	$\mathit{Ignited} \wedge \neg \mathit{Ignited}'$	OFF
P_3	INACTIVE	$\neg \mathit{Activate} \wedge \mathit{Ignited} \wedge \mathit{Running} \wedge \neg \mathit{Brake} \wedge \mathit{Activate}'$	CRUISE
P_4	CRUISE	$\mathit{Ignited} \wedge \neg \mathit{Ignited}'$	OFF
P_5	CRUISE	$\mathit{Running} \wedge \mathit{Ignited} \wedge \neg \mathit{Running}'$	INACTIVE
P_6	CRUISE	$\neg Toofast \wedge \mathit{Ignited} \wedge Toofast'$	INACTIVE
P_7	CRUISE	$\neg \mathit{Brake} \wedge \mathit{Ignited} \wedge \mathit{Running} \wedge \neg Toofast \wedge \mathit{Brake}'$	OVERRIDE
P_8	CRUISE	$\neg \mathit{Deactivate} \wedge \mathit{Ignited} \wedge \mathit{Running} \wedge \neg Toofast \wedge \mathit{Deactivate}'$	OVERRIDE
P_9	OVERRIDE	$\mathit{Ignited} \wedge \neg \mathit{Ignited}'$	OFF
P_{10}	OVERRIDE	$\mathit{Running} \wedge \mathit{Ignited} \wedge \neg \mathit{Running}'$	INACTIVE
P_{11}	OVERRIDE	$\neg \mathit{Activate} \wedge \mathit{Ignited} \wedge \mathit{Running} \wedge \neg \mathit{Brake} \wedge \mathit{Activate}'$	CRUISE
P_{12}	OVERRIDE	$\neg \mathit{Resume} \wedge \mathit{Ignited} \wedge \mathit{Running} \wedge \neg \mathit{Brake} \wedge \mathit{Resume}'$	CRUISE

Table 3: Expanded Cruise Control Specification Predicates

and S (Resume). The variable values are taken from the predicates, and are shown as T, F, t, f, and -. A T or F means the clause is triggering, and the table contains a before-and after-value. The values for the test case are the new value for the triggering clause (T or F), and the t and f values from the WHEN conditions. The expected output for the test specification is derived from the triggering event, the post-state, and any terms or variables that are defined as a result of the transition.

The first two transitions have only one clause, so the only test cases are based on the triggering event. The third transition, P_3, has four clauses:

$@T \mathit{Activate} \wedge \mathit{Ignited} \wedge \mathit{Running} \wedge \neg \mathit{Brake}$

and its expanded version is:

$\neg \mathit{Activate} \wedge \mathit{Ignited} \wedge \mathit{Running} \wedge \neg \mathit{Brake} \wedge \mathit{Activate}'$

Its test case requirements are:

Pre State	*Activate*	*Ignited*	*Running*	*Brake*	*Activate′*	Post State
INACTIVE	F	t	t	f	T	CRUISE
INACTIVE	T	t	t	f	T	INACTIVE
INACTIVE	F	f	t	f	T	OFF
INACTIVE	F	t	f	f	T	INACTIVE
INACTIVE	F	t	t	t	T	INACTIVE
INACTIVE	F	t	t	f	F	INACTIVE

The first row is the predicate as it appears in the specification; every clause is `True`. The subsequent rows make each clause false in turn. Because there are no $\vee$ operators, the full predicate coverage criterion is satisfied by holding all other clauses `True`.

Below are the requirements for all the predicates in the cruise control program. There are 54 test cases for the 12 predicates.

	Pre	Variable	Triggering	Post
	State	Values	Event	State
		I R T B A D S		
P1	OFF	F - - - - - -	$Ignited' =$ True	INACTIVE
	OFF	T - - - - - -	$Ignited' =$ True	OFF
	OFF	F - - - - - -	$Ignited' =$ False	OFF
P2	INACTIVE	T - - - - - -	$Ignited' =$ False	OFF
	INACTIVE	F - - - - - -	$Ignited' =$ False	INACTIVE
	INACTIVE	T - - - - - -	$Ignited' =$ True	INACTIVE
P3	INACTIVE	t t - f F - -	$Activate' =$ True	CRUISE
	INACTIVE	f t - f F - -	$Activate' =$ True	INACTIVE
	INACTIVE	t f - f F - -	$Activate' =$ True	OFF
	INACTIVE	t t - t F - -	$Activate' =$ True	INACTIVE
	INACTIVE	t t - f T - -	$Activate' =$ True	INACTIVE
	INACTIVE	t t - f F - -	$Activate' =$ False	INACTIVE
P4	CRUISE	T - - - - - -	$Ignited' =$ False	OFF
	CRUISE	F - - - - - -	$Ignited' =$ False	CRUISE
	CRUISE	T - - - - - -	$Ignited' =$ True	CRUISE
P5	CRUISE	t T - - - - -	$Running' =$ False	INACTIVE
	CRUISE	f T - - - - -	$Running' =$ False	CRUISE
	CRUISE	t F - - - - -	$Running' =$ False	CRUISE
	CRUISE	t T - - - - -	$Running' =$ True	CRUISE
P6	CRUISE	t - F - - - -	$Toofast' =$ True	INACTIVE
	CRUISE	f - F - - - -	$Toofast' =$ True	CRUISE
	CRUISE	t - T - - - -	$Toofast' =$ True	CRUISE
	CRUISE	t - F - - - -	$Toofast' =$ False	CRUISE
P7	CRUISE	t t f F - - -	$Brake' =$ True	OVERRIDE
	CRUISE	f t f F - - -	$Brake' =$ True	CRUISE
	CRUISE	t f f F - - -	$Brake' =$ True	CRUISE
	CRUISE	t t t F - - -	$Brake' =$ True	CRUISE
	CRUISE	t t f T - - -	$Brake' =$ True	CRUISE
	CRUISE	t t f F - - -	$Brake' =$ False	CRUISE
P8	CRUISE	t t f - - F -	$Deactivate' =$ True	OVERRIDE
	CRUISE	f t f - - F -	$Deactivate' =$ True	CRUISE
	CRUISE	t f f - - F -	$Deactivate' =$ True	CRUISE
	CRUISE	t t t - - F -	$Deactivate' =$ True	CRUISE
	CRUISE	t t f - - T -	$Deactivate' =$ True	CRUISE
	CRUISE	t t f - - F -	$Deactivate' =$ False	CRUISE
P9	OVERRIDE	T - - - - - -	$Ignited' =$ False	OFF
	OVERRIDE	F - - - - - -	$Ignited' =$ False	OVERRIDE
	OVERRIDE	T - - - - - -	$Ignited' =$ True	OVERRIDE

P10	OVERRIDE	t	T	-	-	-	-	-	$Running'$ = False	INACTIVE
	OVERRIDE	f	T	-	-	-	-	-	$Running'$ = False	OVERRIDE
	OVERRIDE	t	F	-	-	-	-	-	$Running'$ = False	OVERRIDE
	OVERRIDE	t	T	-	-	-	-	-	$Running'$ = True	OVERRIDE
P11	OVERRIDE	t	t	-	f	F	-	-	$Activate'$ = True	CRUISE
	OVERRIDE	f	t	-	f	F	-	-	$Activate'$ = True	OVERRIDE
	OVERRIDE	t	f	-	f	F	-	-	$Activate'$ = True	OVERRIDE
	OVERRIDE	t	t	-	t	F	-	-	$Activate'$ = True	OVERRIDE
	OVERRIDE	t	t	-	f	T	-	-	$Activate'$ = True	OVERRIDE
	OVERRIDE	t	t	-	f	F	-	-	$Activate'$ = False	OVERRIDE
P12	OVERRIDE	t	t	-	f	-	-	F	$Resume'$ = True	CRUISE
	OVERRIDE	f	t	-	f	-	-	F	$Resume'$ = True	OVERRIDE
	OVERRIDE	t	f	-	f	-	-	F	$Resume'$ = True	OVERRIDE
	OVERRIDE	t	t	-	t	-	-	F	$Resume'$ = True	OVERRIDE
	OVERRIDE	t	t	-	f	-	-	T	$Resume'$ = True	OVERRIDE
	OVERRIDE	t	t	-	f	-	-	F	$Resume'$ = False	OVERRIDE

5.1.1 Test specifications

The actual test specifications and test scripts are mechanically derived from the above test requirements, and are too numerous to list. The predicate P3 is chosen as an illustrative example. P3 has six full predicate level tests. For the first test case for P3, the test case must reach the INACTIVE state; this forms the `Prefix`. The `Test case values` set the before-value for the triggering event, and the WHEN condition variables of *Inactive*, *Running*, and *Brake*, and then sets *Activate* to be `True` as the triggering event. The `Verify` and `Exit` parts of the specifications are not shown, as they depend on the software. The software can safely be assumed to automatically print the (post) current state, and to not require an exit.

1. Test specification P3-1:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
Test case value:	*Activate*	= `False`	– Trigger before-value
	Running	= `True`	– Condition variable
	Brake	= `False`	– Condition variable
	Activate	= `True`	– Triggering event
Expected outputs:	CRUISE		

2. Test specification P3-2:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
Test case value:	*Activate*	= `False`	– Trigger before-value
	Ignited	= `False`	– Condition variable
	Running	= `True`	– Condition variable
	Brake	= `False`	– Condition variable
	Activate	= `True`	– Triggering event
Expected outputs:	INACTIVE		

3. Test specification P3-3:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
Test case value:	*Activate*	= `False`	– Trigger before-value
	Running	= `False`	– Condition variable
	Brake	= `False`	– Condition variable
	Activate	= `True`	– Triggering event
Expected outputs:	OFF		

4. Test specification P3-4:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
Test case value:	*Activate*	= `False`	– Trigger before-value
	Running	= `True`	– Condition variable
	Brake	= `True`	– Condition variable
	Activate	= `True`	– Triggering event
Expected outputs:	INACTIVE		

5. Test specification P3-5:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
Test case value:	*Activate*	= `True`	– Trigger before-value
	Running	= `True`	– Condition variable
	Brake	= `False`	– Condition variable
	Activate	= `True`	– Triggering event
Expected outputs:	INACTIVE		

6. Test specification P3-6:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
Test case value:	*Activate*	= `False`	– Trigger before-value
	Running	= `True`	– Condition variable
	Brake	= `False`	– Condition variable
	Activate	= `False`	– Triggering event
Expected outputs:	INACTIVE		

There are several interesting points to note about these test specifications. First, it should be clear that there is some redundancy; some of the condition variables will not need to be explicitly set, as they will already have the appropriate values. While this is true, the analysis necessary to decide what values do and do not need to be set probably outweighs the small savings that could result from eliminating a few variable assignments. It is probable, however, that this could be done automatically. Jin [Jin96] provided algorithms for deriving invariants on modes; these could be used to directly eliminate unneeded variable assignments. Her method used a static analysis. A dynamic analysis that uses the information in the test specification could be used to potentially eliminate more variable assignments. Another interesting point is the derivation of the prefix part of the test specification. Reaching the pre-state is essentially a reachability problem. Given a control flow graph of a program, it is an undecidable problem to find a test case that reaches a particular statement. Although no theoretical analysis has been done as yet, it seems likely that the deterministic nature of state-based systems means that this problem is solvable for specification graphs derived from state-based systems.

Test scripts are simple rewrites of test specifications with modifications made for the input requirements of the program being tested. The test script for the first test specification above is:

```
Ignited = True
Activate = False
Running = True
Brake = False
Activate = True
```

5.2 Transition-Pair Coverage Level

At the transition-pair level, each state is considered separately. Each input transition into the state is matched with each transition out of the state, and the combination is used to create test requirements, which are ordered pairs of predicates. The ordered pairs are turned into ordered pairs of inputs to form test specifications.

Following are the test requirements for the four states. The pairs for the OFF state are:

1. P2:P1
2. P4:P1
3. P9:P1

The pairs for the INACTIVE state are:

1. P1:P2
2. P1:P3
3. P10:P2
4. P10:P3
5. (P5 OR P6):P2
6. (P5 OR P6):P3

The pairs for the CRUISE state are:

1. P3:P4
2. P3:(P5 OR P6)
3. P3:(P7 OR P8)
4. (P11 OR P12):P4
5. (P11 OR P12):(P5 OR P6)
6. (P11 OR P12):(P7 OR P8)

The pairs for the OVERRIDE state are:

1. (P7 OR P8):P9
2. (P7 OR P8):P10
3. (P7 OR P8):(P11 OR P12)

These ordered pairs are transformed into predicates from Table 2. The "**OR**" entries result from the transitions that have two conditions; either condition could be satisfied to take that transition. Rather than list before- and after-values for the triggering events in this table, only the after-values are shown; the before-values are assumed to be the inverse.

		I	R	T	B	A	D	S	
OFF:	1. INACTIVE	F	-	-	-	-	-	-	OFF
	OFF	T	-	-	-	-	-	-	INACTIVE
	2. CRUISE	F	-	-	-	-	-	-	OFF
	OFF	T	-	-	-	-	-	-	INACTIVE
	3. OVERRIDE	F	-	-	-	-	-	-	OFF
	OFF	T	-	-	-	-	-	-	INACTIVE
INACTIVE:	1. OFF	T	-	-	-	-	-	-	INACTIVE
	INACTIVE	F	-	-	-	-	-	-	OFF
	2. OFF	T	-	-	-	-	-	-	INACTIVE
	INACTIVE	t	t	-	f	T	-	-	CRUISE
	3. OVERRIDE	t	F	-	-	-	-	-	INACTIVE
	INACTIVE	F	-	-	-	-	-	-	OFF
	4. OVERRIDE	t	F	-	-	-	-	-	INACTIVE
	INACTIVE	t	t	-	f	T	-	-	CRUISE
	5. CRUISE	t	F	-	-	-	-	-	INACTIVE
	OR								
	CRUISE	t	-	T	-	-	-	-	INACTIVE
	INACTIVE	F	-	-	-	-	-	-	OFF
	6. CRUISE	t	F	-	-	-	-	-	INACTIVE
	OR								
	CRUISE	t	-	T	-	-	-	-	INACTIVE
	INACTIVE	t	t	-	f	T	-	-	CRUISE
CRUISE:	1. INACTIVE	t	t	-	f	T	-	-	CRUISE
	CRUISE	F	-	-	-	-	-	-	OFF
	2. INACTIVE	t	t	-	f	T	-	-	CRUISE
	CRUISE	t	F	-	-	-	-	-	INACTIVE
	OR								
	CRUISE	t	-	T	-	-	-	-	INACTIVE
	3. INACTIVE	t	t	-	f	T	-	-	CRUISE
	CRUISE	t	t	f	T	-	-	-	OVERRIDE
	OR								
	CRUISE	t	t	f	-	-	T	-	OVERRIDE
	4. OVERRIDE	t	t	-	f	T	-	-	CRUISE
	OR								
	OVERRIDE	t	t	-	f	-	-	T	CRUISE
	CRUISE	F	-	-	-	-	-	-	OFF
	5. OVERRIDE	t	t	-	f	T	-	-	CRUISE
	OR								
	OVERRIDE	t	t	-	f	-	-	T	CRUISE
	CRUISE	t	F	-	-	-	-	-	INACTIVE
	OR								
	CRUISE	t	-	T	-	-	-	-	INACTIVE
	6. OVERRIDE	t	t	-	f	T	-	-	CRUISE

		OR		
		OVERRIDE	t t - f - - T	CRUISE
		CRUISE	t t f T - - -	OVERRIDE
		OR		
		CRUISE	t t f - - T -	OVERRIDE
OVERRIDE:	1.	CRUISE	t t f T - - -	OVERRIDE
		OR		
		CRUISE	t t f - - T -	OVERRIDE
		OVERRIDE	F - - - - - -	OFF
	2.	CRUISE	t t f T - - -	OVERRIDE
		OR		
		CRUISE	t t f - - T -	OVERRIDE
		OVERRIDE	t F - - - - -	INACTIVE
	3.	CRUISE	t t f T - - -	OVERRIDE
		OR		
		CRUISE	t t f - - T -	OVERRIDE
		OVERRIDE	t t - f T - -	CRUISE
		OR		
		OVERRIDE	t t - f - - T	CRUISE

5.2.1 Test specifications

The actual test specifications and test scripts are mechanically derived from the above test requirements, and are too numerous to list. The requirements for the OFF state are chosen as an illustrative example. OFF has four transition-pair coverage level tests. For the first test case for OFF, the test case must reach the INACTIVE state; this forms the `Prefix`. Then the test case must pass through transitions $P1$ and $P2$.

1. Test specification OFF-1:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
Test case values:	*Ignited*	= `False`	– P2 Triggering event
	Ignited	= `True`	– P1 Triggering event
Expected outputs:	INACTIVE		

2. Test specification OFF-2:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
	Ignited	= `True`	– P3 Condition variable
	Running	= `True`	– P3 Condition variable
	Brake	= `False`	– P3 Condition variable
	Activate	= `True`	– Reach CRUISE state
Test case values:	*Ignited*	= `False`	– P4 Triggering event
	Ignited	= `True`	– P1 Triggering event
Expected outputs:	INACTIVE		

3. Test specification OFF-3:

Prefix:	*Ignited*	= `True`	– Reach INACTIVE state
	Ignited	= `True`	– P3 Condition variable
	Running	= `True`	– P3 Condition variable
	Brake	= `False`	– P3 Condition variable
	Activate	= `True`	– Reach CRUISE state
	Ignited	= `True`	– P7 Condition variable
	Running	= `True`	– P7 Condition variable
	Toofast	= `False`	– P7 Condition variable
	Brake	= `True`	– Reach OVERRIDE state
Test case values:	*Ignited*	= `False`	– P9 Triggering event
	Ignited	= `True`	– P1 Triggering event
Expected outputs:	INACTIVE		

5.3 Complete Sequence Level

At the complete sequence level, test engineers must use their experience and judgment to develop sequences of states that should be tested. To do this well requires experience with testing, experience with programming, and knowledge of the domain. These tests are omitted in this example.

5.4 Results

To evaluate this technique, a model of the cruise control problem was implemented in about 400 lines of C. The program accepts pairs of variable:values, where a value can be ’t’, ’f’, ’T’, or ’F’. Upper case inputs signify a triggering event. For convenience, the program was implemented so that the pre-state could be either set with a test case `Prefix`, or by an explicit input state value.

As a way to measure the quality of these tests, block and decision coverage was computed using the full predicate test cases. The coverage was measured using Atac [HL92]. The program, `cruise`, has five functions, 184 total blocks, and 174 decisions. The 54 test cases covered 163 of the blocks (89%) and 155 of the decisions (89%). Of the 20 uncovered decisions, five were infeasible, and eleven were related to input parameters that were not used during testing. That is, these eleven decisions were not related to the functional specifications given in Table 1. The remaining decisions were left uncovered because the variables *Activate*, *Deactivate*, and *Resume* are only used as triggering events, not condition variables. Although there have been very few published studies on the ability of specification-based tests to satisfy code-based coverage criteria, these results seem very promising.

6 INDUSTRIAL EXAMPLE TEST CASES

One of the goals of this project was to generate and provide examples of actual test cases that are derived from industrial software specifications. A specification was provided by Rockwell Collins, Inc. of a Flight Guidance System (FGS), written in CoRE [FBWK92]. No implementation has been provided, so the test case have not been applied.

The report supplied [MH97] describes the application CoRE method to the mode control logic of a Flight Guidance System. This example is considered to be a typical avionics problem, and complex enough to be realistic, but small enough to be used to evaluate software engineering techniques (such as the test data generation technique presented here).

Our test cases are derived primarily from the transition tables in Appendix A of the report. These tables are listed on page 11 of the report, under List of Tables. The tables are:

1. Overspeed Mode Transition Table
2. Autopilot Mode Transition Table
3. Aotopilot ENGAGED Submode Transition Table
4. Autopilot DISENGAGED Submode Transition Table
5. Flight Director Mode Transition Table
6. Flight Director ON Transition Table
7. Active Lateral Mode Transition Table
8. Active Lateral ROLL Submode Transition Table
9. Active Lateral Navigation Submode Transition Table
10. Active Lateral Approach Submode Transition Table
11. Active Vertical Mode Transition Table
12. Flight Level Change Submode Transition Table
13. Altitude Select Mode Transition Table
14. Altitude Select ENABLED Submode Transition Table
15. Altitude Select ACTIVE Submode Transition Table
16. Vertical Approach Mode Transition Table
17. Vertical Approach ENABLED Submode Transition Table

The rest of this section provides each table and the associated tests. For many of the tables, variables were defined for several of the longer terms. This was done to save writing effort during construction of the test requirements. The definitions are given first, then the list of conditions. The conditions use the same syntax as in the cruise control example of Section 5; T or F represents a triggering event decision, @ represents a triggering event Boolean, `t` or `f` represents a WHEN condition, and a hyphen "-" represents a don't care condition.

After the conditions, test requirements for full predicate coverage level test cases are given, then their associated test specifications. The transition pair coverage level test requirements are also supplied. Complete sequence level tests are not included, as that requires domain knowledge that we do not have.

Four issues came up while these test were being constructed. Two relate to handling of triggering events, another to test case prefixes, and a third that is specific to CoRE.

1. When these tests were started, the approach being used was to **not** modify trigger conditions during conjunctive level test generation. The experience of generating these tests convinced us that was wrong; and trigger conditions should be modified. This change was implemented in the cruise control case study of Section 5, and resulted in a higher level of branch coverage being achieved, but this change is not reflected in the following tests.

2. The triggering events were not adequately handled. Specifically, a triggering event includes an explicit value (the after-value), and an implicit before-value. To adequately test a triggering event, the before-values needed to be set. Again, this change was reflected in the cruise control case study, but not in the following tests.

3. During the generation of the FGS tests, the importance of prefixes to test cases were recognized. This was added to the technique, and the cruise control example, but is not reflected in the FGS tests.

4. CoRE allows nested submodes, which were not considered when this technique was being developed. The primary effect of this is on the transition-pair level tests. It is not clear whether it is reasonable to construct tests for transition-pairs when one mode is within a submode, and another is not. This is an issue that is left for future research, and as a result, the tests for transition tables 4, 9, 10, 15, 16, and 17 have no transition-pair requirements.

6.1 Overspeed Mode Test Cases

Id	From	Events	To
1	SPEED_OK	@T(mon_Indicated_Airspeed > (term_Vmo + 10 kts) AND NOT term_Above_Transition_Altitude)	TOO_FAST
2	SPEED_OK	@T(mon_Indicated_Mach_Number > (term_Mmo + 0.03) AND term_Above_Transition_Altitude)	TOO_FAST
3	TOO_FAST	@T(mon_Indicated_Airspeed ≤ term_Vmo AND NOT term_Above_Transition_Altitude)	SPEED_OK
4	TOO_FAST	@T(mon_Indicated_Mach_Number ≤ term_Mmo AND term_Above_Transition_Altitude)	SPEED_OK

Table 6.1: Overspeed Mode Transition Table
(Table A.1, pg. 58 in the FGS report)

Definitions:

- X1 = (mon_Indicated_Airspeed > term_Vmo + 10kts)
- X2 = (mon_Indicated_Mach_Number > term_Mmo + 0.03)
- X3 = (mon_Indicated_Airspeed <= term_Vmo)
- X4 = (mon_Indicated_Mach_Number <= term_Mmo)
- X5 = term_Above_Transition_Altitude

- X1' −− After-value of trigger event X1
- X2' −− After-value of trigger event X2
- X3' −− After-value of trigger event X3
- X4' −− After-value of trigger event X4
- X5' −− After-value of trigger event X5

6.1.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X3	X4	X5	X1'	X2'	X3'	X4'	X5'	Post State
P1	SPEED_OK	F	-	-	-	T	T	-	-	-	F	TOO_FAST
	SPEED_OK	T	-	-	-	T	T	-	-	-	F	SPEED_OK
	SPEED_OK	F	-	-	-	F	T	-	-	-	F	SPEED_OK
	SPEED_OK	F	-	-	-	T	F	-	-	-	F	SPEED_OK
	SPEED_OK	F	-	-	-	T	T	-	-	-	T	SPEED_OK
P2	SPEED_OK	-	F	-	-	F	-	T	-	-	T	TOO_FAST
	SPEED_OK	-	T	-	-	T	-	T	-	-	T	SPEED_OK
	SPEED_OK	-	F	-	-	F	-	F	-	-	T	SPEED_OK
	SPEED_OK	-	F	-	-	F	-	T	-	-	F	SPEED_OK
P3	TOO_FAST	-	-	F	-	T	-	-	T	-	F	SPEED_OK
	TOO_FAST	-	-	T	-	T	-	-	T	-	F	TOO_FAST
	TOO_FAST	-	-	F	-	F	-	-	T	-	F	TOO_FAST
	TOO_FAST	-	-	F	-	T	-	-	F	-	F	TOO_FAST
	TOO_FAST	-	-	F	-	T	-	-	T	-	T	TOO_FAST
P4	TOO_FAST	-	-	-	F	F	-	-	-	T	T	SPEED_OK
	TOO_FAST	-	-	-	T	T	-	-	-	T	T	TOO_FAST
	TOO_FAST	-	-	-	F	F	-	-	-	F	T	TOO_FAST
	TOO_FAST	-	-	-	F	F	-	-	-	T	F	TOO_FAST

Test specifications:

```
1) Test specification P1-1:

   Prefix:           X3 = True
                     X5 = False         - Reach SPEED_OK
                     X4 = True
                     X5 = True          - Reach SPEED_OK
   Test case value:  X1 = False         - Trigger before-value
                     X5 = True          - Trigger before-value
                     X1 = True          - Trigger event
                     X5 = False         - Trigger event
   Expected Output:  TOO_FAST

2) Test specification P1-2:

   Prefix:           X3 = True
```

```
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X1 = True           - Trigger before-value
                     X5 = True           - Trigger before-value
                     X1 = True           - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  SPEED_OK

3) Test specification P1-3:

   Prefix:           X3 = True
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X1 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X1 = True           - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  SPEED_OK

4) Test specification P1-4:

   Prefix:           X3 = True
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X1 = False          - Trigger before-value
                     X5 = True           - Trigger before-value
                     X1 = False          - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  SPEED_OK

5) Test specification P1-5:

   Prefix:           X3 = True
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X1 = False          - Trigger before-value
                     X5 = True           - Trigger before-value
                     X1 = False          - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  SPEED_OK

6) Test specification P2-1:

   Prefix:           X3 = True
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X2 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X2 = True           - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  TOO_FAST

7) Test specification P2-2:

   Prefix:           X3 = True
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X2 = True           - Trigger before-value
                     X5 = True           - Trigger before-value
                     X2 = True           - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  SPEED_OK

8) Test specification P2-3:

   Prefix:           X3 = True
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X2 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X2 = False          - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  SPEED_OK

9) Test specification P2-4:

   Prefix:           X3 = True
                     X5 = False          - Reach SPEED_OK
                     X4 = True
                     X5 = True           - Reach SPEED_OK
   Test case value:  X2 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X2 = True           - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  SPEED_OK

10) Test specification P3-1:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X3 = False          - Trigger before-value
                     X5 = True           - Trigger before-value
                     X3 = True           - Trigger event
```

```
                   X5 = False          - Trigger event
   Expected Output:  SPEED_OK

11) Test specification P3-2:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X3 = True           - Trigger before-value
                     X5 = True           - Trigger before-value
                     X3 = True           - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  TOO_FAST

12) Test specification P3-3:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X3 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X3 = True           - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  TOO_FAST

13) Test specification P3-4:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X3 = False          - Trigger before-value
                     X5 = True           - Trigger before-value
                     X3 = False          - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  TOO_FAST

14) Test specification P3-5:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X3 = False          - Trigger before-value
                     X5 = True           - Trigger before-value
                     X3 = True           - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  TOO_FAST
```

```
15) Test specification P4-1:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X4 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X4 = True           - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  SPEED_OK

16) Test specification P4-2:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X4 = True           - Trigger before-value
                     X5 = True           - Trigger before-value
                     X4 = True           - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  TOO_FAST

17) Test specification P4-3:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X4 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X4 = False          - Trigger event
                     X5 = True           - Trigger event
   Expected Output:  TOO_FAST

18) Test specification P4-4:

   Prefix:           X1 = True
                     X5 = False          - Reach TOO_FAST
                     X2 = True
                     X5 = True           - Reach TOO_FAST
   Test case value:  X4 = False          - Trigger before-value
                     X5 = False          - Trigger before-value
                     X4 = True           - Trigger event
                     X5 = False          - Trigger event
   Expected Output:  TOO_FAST
```

6.1.2 Transition Pair Coverage Level Requirements:

The pairs for the SPEED_OK Mode are:

(P3 or P4) : (P1 or P2)

The pairs for the TOO_FAST Mode are:

(P1 or P2) : (P3 or P4)

		X1	X2	X3	X4	X5	
SPEED_OK:	TOO_FAST	-	-	T	-	F	SPEED_OK
	OR						
	TOO_FAST	-	-	-	T	T	SPEED_OK
	SPEED_OK	T	-	-	-	F	TOO_FAST
	OR						
	SPEED_OK	-	T	-	-	T	TOO_FAST
TOO_FAST	SPEED_OK	T	-	-	-	F	TOO_FAST
	OR						
	SPEED_OK	-	T	-	-	T	TOO_FAST
	TOO_FAST	-	-	T	-	F	SPEED_OK
	OR						
	TOO_FAST	-	-	-	T	T	SPEED_OK

Test specifications

```
 1) Test specification SPEED_OK:
    Prefix:            X1 = True
                       X5 = False           - Reach TOO_FAST
                       X2 = True
                       X5 = True            - Reach TOO_FAST
    Test case value:   X3 = True
                       X5 = False           - P3 trigger event
                       X4 = True
                       X5 = True            - P4 trigger event
                       X1 = True
                       X5 = False           - P1 trigger event
                       X2 = True
                       X5 = True            - P2 trigger event
    Expected Output:   TOO_FAST

 2) Test specification TOO_FAST:
    Prefix:            X3 = True
                       X5 = False           - Reach SPEED_OK
                       X4 = True
                       X5 = True            - Reach SPEED_OK
    Test case value:   X1 = True
                       X5 = False           - P1 trigger event
                       X2 = True
                       X5 = True            - P2 trigger event
                       X3 = True
                       X5 = False           - P3 trigger event
```

```
                  X4 = True
                  X5 = True             - P4 trigger event
Expected Output:  SPEED_OK
```

6.2 Autopilot Mode Test Cases

Id	From	Events	To
5	DISENGAGED	@AP_Engage_Switch_Pressed WHEN mon_AP_Disconnect_Bar = UP	ENGAGED
6	ENGAGED	@AP_Disengage_Pressed	DISENGAGED
7	ENGAGED	@T(mon_AP_Disconnect_Bar = DOWN)	DISENGAGED
8	ENGAGED	@T(mond_Active_Lateral = GA OR mode_Active_Vertical = GA)	DISENGAGED/ Warning

Table 6.2: Autopilot Mode Transition Table (Table A.2, pg. 63 in the FGS report)

Definitions:

- X1 = @(AP_Engage_Switch_Pressed)
- X2 = MON_AP_Disconnect_Bar = UP
- X3 = @(AP_Disengage_Pressed)
- X4 = (mon_AP_Disconnect_Bar = DOWN)
- X5 = (mode_Active_Lateral = GA)
- X6 = (mode_Active_Vertical = GA)
- X1' –– After-value of trigger event X1
- X3' –– After-value of trigger event X3
- X4' –– After-value of trigger event X4
- X5' –– After-value of trigger event X5
- X6' –– After-value of trigger event X6

6.2.1 Full predicate coverage level test case requirements:

```
       Pre      X1  X2  X3  X4  X5  X6  X1'  X3'  X4'  X5' X6'   Post
      State                                                    State

P5 DISENGAGED  NOT@ t   -   -   -   -   @     -    -    -   - ENGAGED
   DISENGAGED   @   t   -   -   -   -   @     -    -    -   - DISENGAGED
   DISENGAGED  NOT@ f   -   -   -   -   @     -    -    -   - DISENGAGED
   DISENGAGED  NOT@ t   -   -   -   -  NOT@   -    -    -   - DISENGAGED
P6 ENGAGED      -   -  NOT@ -   -   -   -     @    -    -   - DISENGAGED
   ENGAGED      -   -   @   -   -   -   -     @    -    -   - ENGAGED
```

	ENGAGED	-	-	NOT@	-	-	-	-	NOT@	-	-	-	ENGAGED
P7	ENGAGED	-	-	-	F	-	-	-	-	T	-	-	DISENGAGED
	ENGAGED	-	-	-	T	-	-	-	-	T	-	-	ENGAGED
	ENGAGED	-	-	-	F	-	-	-	-	F	-	-	ENGAGED
P8	ENGAGED	-	-	-	-	F	F	-	-	-	T	T	DISENGAGED/Warning
	ENGAGED	-	-	-	-	T	F	-	-	-	T	T	ENGAGED
	ENGAGED	-	-	-	-	F	T	-	-	-	T	T	ENGAGED
	ENGAGED	-	-	-	-	F	F	-	-	-	F	T	ENGAGED
	ENGAGED	-	-	-	-	F	F	-	-	-	T	F	ENGAGED

Test specifications:

1) Test specification P5-1:

Prefix:	X3	- Reach DISENGAGED
	X4 = True	- Reach DISENGAGED
	X5 = True	- Reach DISENGAGED
	X6 = True	
Test case value:	NOT X1	- Trigger before-value
	X2 = True	- Condition variable
	X1	- Trigger event
Expected Output:	ENGAGED	

2) Test specification P5-2:

Prefix:	X3	- Reach DISENGAGED
	X4 = True	- Reach DISENGAGED
	X5 = True	- Reach DISENGAGED
	X6 = True	
Test case value:	X1	- Trigger before-value
	X2 = True	- Condition variable
	X1	- Trigger event
Expected Output:	DISENGAGED	

3) Test specification P5-3:

Prefix:	X3	- Reach DISENGAGED
	X4 = True	- Reach DISENGAGED
	X5 = True	- Reach DISENGAGED
	X6 = True	
Test case value:	NOT X1	- Trigger before-value
	X2 = False	- Condition variable
	X1	- Trigger event
Expected Output:	DISENGAGED	

4) Test specification P5-4:

Prefix:	X3	- Reach DISENGAGED
	X4 = True	- Reach DISENGAGED
	X5 = True	- Reach DISENGAGED
	X6 = True	

```
   Test case value:  NOT X1              - Trigger before-value
                     X2 = True           - Condition variable
                     NOT X1              - Trigger event
   Expected Output:  DISENGAGED

5) Test specification P6-1:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  NOT X3              - Trigger before-value
                     X3                  - Trigger event
   Expected Output:  DISENGAGED

6) Test specification P6-2:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X3                  - Trigger before-value
                     X3                  - Trigger event
   Expected Output:  ENGAGED

7) Test specification P6-3:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  NOT X3              - Trigger before-value
                     NOT X3              - Trigger event
   Expected Output:  ENGAGED

8) Test specification P7-1:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X4 = False          - Trigger before-value
                     X4 = True           - Trigger event
   Expected Output:  DISENGAGED

9) Test specification P7-2:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X4 = True           - Trigger before-value
                     X4 = True           - Trigger event
   Expected Output:  ENGAGED

10) Test specification P7-3:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X4 = False          - Trigger before-value
                     X4 = False          - Trigger event
   Expected Output:  ENGAGED

11) Test specification P8-1:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X5 = False          - Trigger before-value
                     X6 = False          - Trigger before-value
                     X5 = True           - Trigger event
                     X6 = True           - Trigger event
   Expected Output:  DISENGAGED/Warning

12) Test specification P8-2:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X5 = True           - Trigger before-value
                     X6 = False          - Trigger before-value
                     X5 = True           - Trigger event
                     X6 = True           - Trigger event
   Expected Output:  ENGAGED

13) Test specification P8-3:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X5 = False          - Trigger before-value
                     X6 = True           - Trigger before-value
                     X5 = True           - Trigger event
                     X6 = True           - Trigger event
   Expected Output:  ENGAGED

14) Test specification P8-4:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X5 = False          - Trigger before-value
                     X6 = False          - Trigger before-value
                     X5 = False          - Trigger event
                     X6 = True           - Trigger event
   Expected Output:  ENGAGED

15) Test specification P8-5:

   Prefix:           X1                  - Reach ENGAGED
                     X2 = True           - Condition variable
   Test case value:  X5 = False          - Trigger before-value
                     X6 = False          - Trigger before-value
                     X5 = True           - Trigger event
                     X6 = False          - Trigger event
   Expected Output:  ENGAGED
```

6.2.2 Transition Pair Coverage Level Requirements:

The pairs for the DISENGAGED Mode are:

```
(P6 or P7 or P8) : P5
```

The pairs for the ENGAGED Mode are:

```
P5 : (P6 or P7 or P8)
```

		X1	X2	X3	X4	X5	X6	
DISENGAGED	ENGAGED	-	-	@	-	-	-	DISENGAGED
	OR							
	ENGAGED	-	-	-	T	-	-	DISENGAGED
	OR							
	ENGAGED	-	-	-	-	T	T	DISENGAGED/Warning
	DISENGAGED	-	t	-	-	-	-	ENGAGED
ENGAGED	DISENGAGED	-	t	-	-	-	-	ENGAGED
	ENGAGED	-	-	@	-	-	-	DISENGAGED
	OR							
	ENGAGED	-	-	-	T	-	-	DISENGAGED
	OR							
	ENGAGED	-	-	-	-	T	T	DISENGAGED/Warning

Test specifications

```
1) Test specification DISENGAGED:
   Prefix:            X1                   - Reach ENGAGED
                      X2 = True            - Condition Variable
   Test case value:   X3                   - P6 trigger event
                      X4 = True            - P7 trigger event
                      X5 = True            - P8 trigger event
                      X6 = True
                      X1                   - P5 trigger event
                      X2 = True            - Condition Variable
   Expected Output:   ENGAGED

2) Test specification ENGAGED:
   Prefix:            X3                   - Reach DISENGAGED
                      X4 = True            - Reach DISENGAGED
                      X5 = True
                      X6 = True            - Reach DISENGAGED
   Test case value:   X1                   - P5 trigger event
                      X2 = True            - Condition Variable
                      NOT X3               - P6 trigger event
                      X4 = True            - P7 trigger event
```

```
                  X5 = True             - P8 trigger event
                  X6 = True
Expected Output:  DISENGAGED
```

6.3 Aotopilot ENGAGED Submode Test Cases

Id	From	Events	To
9	Normal	@T(term_SYNC)	Sync
10	Sync	@F(term_SYNC)	Normal

Table 6.3: Aotopilot ENGAGED Submode Transition Table (Table A.3, pg. 63 in the FGS report)

6.3.1 Full predicate coverage level test case requirements:

	Pre State	term_SYNC	term_SYNC'	Post State
P9	Normal	F	T	Sync
	Normal	T	T	Normal
	Normal	F	F	Normal
P10	Sync	T	F	Normal
	Sync	F	F	Sync
	Sync	T	T	Sync

Test specifications:

```
 1) Test specification P9-1:

    Prefix:           term_SYNC = False   - Reach Normal
    Test case value:  term_SYNC = False   - Trigger before-value
                      term_SYNC = True    - Trigger event
    Expected Output:  Sync

 2) Test specification P9-2:

    Prefix:           term_SYNC = False   - Reach Normal
    Test case value:  term_SYNC = True    - Trigger before-value
                      term_SYNC = True    - Trigger event
    Expected Output:  Normal

 3) Test specification P9-3:

    Prefix:           term_SYNC = False   - Reach Normal
    Test case value:  term_SYNC = False   - Trigger before-value
                      term_SYNC = False   - Trigger event
    Expected Output:  Normal

 4) Test specification P10-1:

    Prefix:           term_SYNC = True    - Reach Sync
```

```
   Test case value:  term_SYNC = True    - Trigger before-value
                     term_SYNC = False   - Trigger event
   Expected Output:  Normal

5) Test specification P10-2:

   Prefix:           term_SYNC = True    - Reach Sync
   Test case value:  term_SYNC = False   - Trigger before-value
                     term_SYNC = False   - Trigger event
   Expected Output:  Sync

6) Test specification P10-3:

   Prefix:           term_SYNC = True    - Reach Sync
   Test case value:  term_SYNC = True    - Trigger before-value
                     term_SYNC = True    - Trigger event
   Expected Output:  Sync
```

6.3.2 Transition Pair Coverage Level Requirements:

The pairs for the Normal Mode are:

```
P10 : P9
```

The pairs for the Sync Mode are:

```
P9 : P10
```

		term_SYNC'	
Normal	Sync	F	Normal
	Normal	T	Sync
Sync	Normal	T	Sync
	Sync	F	Normal

Test specifications

```
1) Test specification Normal:
   Prefix:           term_Sync = True     - Reach Sync
   Test case value:  term_Sync = False    - P10 trigger event
                     term_Sync = True     - P9 trigger event
   Expected Output:  Sync

2) Test specification Sync:
   Prefix:           term_Sync = False    - Reach Normal
   Test case value:  term_Sync = True     - P9 trigger event
                     term_Sync = False    - P10 trigger event
   Expected Output:  Normal
```

6.4 Autopilot DISENGAGED Submode Test Cases

Id	From	Events	To
11	Warning	@T(Duration(INMODE(Warning)) $>$ 10 sec)	Normal

Table 6.4: Autopilot DISENGAGED Submode Transition Table (Table A.4, pg. 63 in the FGS report)

Definitions:

- X1 = Duration(INMODE(Warning)) $>$ 10 sec
- X' $--$ After-value of trigger event X1
- Pre-P10 = (mode_Active_Lateral = GA or mode_Active_Vertical = GA)

6.4.1 Full predicate coverage level test case requirements:

	Pre State	X1	X1'	Post State
P10	Warning	F	T	Normal
	Warning	T	T	Warning
	Warning	F	F	Warning

Test specifications:

```
 1) Test specification P11-1:

    Prefix:            Pre-P10 = True       - Reach Warning
    Test case value:   X1 = False           - Trigger before-value
                       X1 = True            - Trigger event
    Expected Output:   Normal

 2) Test specification P11-2:

    Prefix:            Pre-P10 = True       - Reach Warning
    Test case value:   X1 = True            - Trigger before-value
                       X1 = True            - Trigger event
    Expected Output:   Warning

 3) Test specification P11-3:

    Prefix:            Pre-P10 = True       - Reach Warning
    Test case value:   X1 = True            - Trigger before-value
                       X1 = True            - Trigger event
    Expected Output:   Warning
```

6.4.2 Transition Pair Coverage Level Requirements:

NONE.

6.5 Flight Director Mode Test Cases

Id	From	Events	To
12	OFF	@Flight_Mode_Requested	ON
13	OFF	@T(term_Overspeed)	OFF
14	OFF	@T(term_AP_Engaged)	OFF
15	OFF	@FD_Pressed	OFF/
16	ON	@FD_Pressed WHEN (NOT term_Overspeed AND NOT term_AP_Engaged)	OFF

Table 6.5: Flight Director Mode Transition Table (Table A.5, pg. 69 in the FGS report)

Definitions:

- X1 = @Flight_Mode_Requested
- X2 = term_Overspeed
- X3 = term_Ap_Engaged
- X4 = @FD_Pressed
- X1' −− After-value of trigger event X1
- X2' −− After-value of trigger event X2
- X3' −− After-value of trigger event X3
- X4' −− After-value of trigger event X4

6.5.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X3	X4	X1'	X2'	X3'	X4'	Post State
P12	OFF	NOT@	-	-	-	@	-	-	-	ON
	OFF	@	-	-	-	@	-	-	-	OFF
	OFF	NOT@	-	-	-	NOT@	-	-	-	OFF
P13	OFF	-	F	-	-	-	T	-	-	ON
	OFF	-	T	-	-	-	T	-	-	OFF
	OFF	-	F	-	-	-	F	-	-	OFF
P14	OFF	-	-	F	-	-	-	F	-	ON
	OFF	-	-	T	-	-	-	T	-	OFF
	OFF	-	-	F	-	-	-	F	-	OFF
P15	OFF	-	-	-	NOT@	-	-	-	@	ON
	OFF	-	-	-	@	-	-	-	@	OFF
	OFF	-	-	-	NOT@	-	-	-	NOT@	OFF
P16	ON	-	-	-	NOT@	-	f	f	@	OFF
	ON	-	-	-	@	-	f	f	@	ON
	ON	-	-	-	NOT@	-	t	f	@	ON
	ON	-	-	-	NOT@	-	f	t	@	ON
	ON	-	-	-	NOT@	-	t	f	NOT@	ON

Test specifications:

```
 1) Test specification P12-1:

    Prefix:            X4                    - Reach OFF
                       X2 = False            - Condition variable
                       X3 = False            - Condition variable
    Test case value:   NOT X1                - Trigger before-value
                       X1                    - Trigger event
    Expected Output:   ON

 2) Test specification P12-2:

    Prefix:            X4                    - Reach OFF
                       X2 = False            - Condition variable
                       X3 = False            - Condition variable
    Test case value:   X1                    - Trigger before-value
                       X1                    - Trigger event
    Expected Output:   OFF

 3) Test specification P12-3:

    Prefix:            X4                    - Reach OFF
                       X2 = False            - Condition variable
                       X3 = False            - Condition variable
    Test case value:   NOT X1                - Trigger before-value
                       NOT X1                - Trigger event
    Expected Output:   OFF

 4) Test specification P13-1:

    Prefix:            X4                    - Reach OFF
                       X2 = False            - Condition variable
                       X3 = False            - Condition variable
    Test case value:   X2 = False            - Trigger before-value
                       X2 = True             - Trigger event
    Expected Output:   ON

 5) Test specification P13-2:

    Prefix:            X4                    - Reach OFF
                       X2 = False            - Condition variable
                       X3 = False            - Condition variable
    Test case value:   X2 = True             - Trigger before-value
                       X2 = True             - Trigger event
    Expected Output:   OFF

 6) Test specification P13-3:

    Prefix:            X4                    - Reach OFF
                       X2 = False            - Condition variable
                       X3 = False            - Condition variable
```

```
   Test case value:  X2 = False           - Trigger before-value
                     X2 = False           - Trigger event
   Expected Output:  OFF

7) Test specification P14-1:

   Prefix:           X4                   - Reach OFF
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X3 = False           - Trigger before-value
                     X3 = True            - Trigger event
   Expected Output:  ON

8) Test specification P14-2:

   Prefix:           X4                   - Reach OFF
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X3 = True            - Trigger before-value
                     X3 = True            - Trigger event
   Expected Output:  OFF

9) Test specification P14-3:

   Prefix:           X4                   - Reach OFF
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X3 = False           - Trigger before-value
                     X3 = False           - Trigger event
   Expected Output:  OFF

10) Test specification P15-1:

   Prefix:           X4                   - Reach OFF
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  NOT X4               - Trigger before-value
                     X4                   - Trigger event
   Expected Output:  ON

11) Test specification P15-2:

   Prefix:           X4                   - Reach OFF
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X4                   - Trigger before-value
                     X4                   - Trigger event
   Expected Output:  OFF

12) Test specification P15-3:
   Prefix:            X4                    - Reach OFF
                      X2 = False            - Condition variable
                      X3 = False            - Condition variable
   Test case value:   NOT X4                - Trigger before-value
                      NOT X4                - Trigger event
   Expected Output:   OFF
```

13) Test specification P16-1:

```
   Prefix:            X1                    - Reach ON
                      X2 = True             - Reach ON
                      X3 = True             - Reach ON
   Test case value:   NOT X4                - Trigger before-value
                      X2 = False            - Condition variable
                      X3 = False            - Condition variable
                      X4                    - Trigger event
   Expected Output:   OFF
```

14) Test specification P16-2:

```
   Prefix:            X1                    - Reach ON
                      X2 = True             - Reach ON
                      X3 = True             - Reach ON
   Test case value:   X4                    - Trigger before-value
                      X2 = False            - Condition variable
                      X3 = False            - Condition variable
                      X4                    - Trigger event
   Expected Output:   ON
```

15) Test specification P16-3:

```
   Prefix:            X1                    - Reach ON
                      X2 = True             - Reach ON
                      X3 = True             - Reach ON
   Test case value:   NOT X4                - Trigger before-value
                      X2 = True             - Condition variable
                      X3 = False            - Condition variable
                      X4                    - Trigger event
   Expected Output:   ON
```

16) Test specification P16-4:

```
   Prefix:            X1                    - Reach ON
                      X2 = True             - Reach ON
                      X3 = True             - Reach ON
   Test case value:   NOT X4                - Trigger before-value
                      X2 = False            - Condition variable
                      X3 = True             - Condition variable
                      X4                    - Trigger event
   Expected Output:   ON
```

17) Test specification P16-5:

Prefix:	X1	- Reach ON
	X2 = True	- Reach ON
	X3 = True	- Reach ON
Test case value:	NOT X4	- Trigger before-value
	X2 = False	- Condition variable
	X3 = False	- Condition variable
	NOT X4	- Trigger event
Expected Output:	ON	

6.5.2 Transition Pair Coverage Level Requirements:

The pairs for the OFF Mode are:

P16 : (P12 or P13 or P14 or P15)

The pairs for the ON Mode are:

(P12 or P13 or P14 or P15) : P16

		X1	X2	X3	X4	
OFF	ON	-	f	f	@	OFF
	OFF	@	-	-	-	ON
	OR					
	OFF	-	T	-	-	ON
	OR					
	OFF	-	-	T	-	ON
	OR					
	OFF	-	-	-	@	ON
ON	OFF	@	-	-	-	ON
	OR					
	OFF	-	T	-	-	ON
	OR					
	OFF	-	-	T	-	ON
	OR					
	OFF	-	-	-	@	ON
	ON	-	f	f	@	OFF

Test specifications

1) Test specification OFF:

Prefix:	X1	- Reach ON
	X2 = True	- Reach ON
	X3 = True	- Reach ON
	X4	- Reach ON
Test case value:	X4	- P16 trigger event

```
                  X2 = False          - Condition variable
                  X3 = False          - Condition variable
                  X1                  - P12 trigger event
                  X2 = True           - P13 trigger event
                  X3 = True           - P14 trigger event
                  X4                  - P15 trigger event
Expected Output:  ON

2) Test specification ON:
   Prefix:           X4                  - Reach OFF
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
   Test case value:  X1                  - P12 trigger event
                     X2 = True           - P13 trigger event
                     X3 = True           - P14 trigger event
                     X4                  - P15 trigger event
                     X4                  - P16 trigger event
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
   Expected Output:  OFF
```

6.6 Flight Director ON Submode Test Cases

Id	From	Events	To
17	No_Cues	@FD_Pressed WHEN (term_AP_Engaged OR term_Overspeed)	Cues
18	No_Cues	@T(term_Overspeed)	Cues
19	Cues	@FD_Pressed WHEN (term_AP_Engaged OR term_Overspeed)	No_Cues

Table 6.6: Flight Director ON Submode Transition Table (Table A.6, pg. 69 in the FGS report)

Definitions:

- X1 = @FD_Predded
- X2 = term_AP_Engaged
- X3 = term_Overspeed
- X1’ −− After-value of trigger event X1
- X3’ −− After-value of trigger event X3

6.6.1 Full predicate coverage level test case requirements:

```
       Pre      X1    X2   X3    X1'    X3'    Post
      State                                    State

P17   No_Cues  NOT@   t    -     @      -       Cues
      No_Cues   @     t    -     @      -     No_Cues
      No_Cues  NOT@   f    -     @      -     No_Cues
```

	No_Cues	NOT@	t	-	NOT@	-	No_Cues
	No_Cues	NOT@	-	t	@	-	Cues
	No_Cues	@	-	t	@	-	No_Cues
	No_Cues	NOT@	-	f	@	-	No_Cues
	No_Cues	NOT@	-	t	NOT@	-	No_Cues
P18	No_Cues	-	-	F	-	T	Cues
	No_Cues	-	-	T	-	T	No_Cues
	No_Cues	-	-	F	-	F	No_Cues
P19	Cues	NOT@	t	-	@	-	No_Cues
	Cues	@	t	-	@	-	Cues
	Cues	NOT@	f	-	@	-	Cues
	Cues	NOT@	t	-	NOT@	-	Cues
	Cues	NOT@	-	t	@	-	No_Cues
	Cues	@	-	t	@	-	Cues
	Cues	NOT@	-	f	@	-	Cues
	Cues	NOT@	-	t	NOT@	-	Cues

Test specifications:

```
1) Test specification P17-1:

   Prefix:            X1                    - Reach No_Cues
                      X2 = True             - Condition variable
                      X3 = True             - Condition variable
   Test case value:   NOT X1                - Trigger before-value
                      X2 = True             - Condition variable
                      X1                    - Trigger event
   Expected Output:   Cues

2) Test specification P17-2:

   Prefix:            X1                    - Reach No_Cues
                      X2 = True             - Condition variable
                      X3 = True             - Condition variable
   Test case value:   X1                    - Trigger before-value
                      X2 = True             - Condition variable
                      X1                    - Trigger event
   Expected Output:   No_Cues

3) Test specification P17-3:

   Prefix:            X1                    - Reach No_Cues
                      X2 = True             - Condition variable
                      X3 = True             - Condition variable
   Test case value:   NOT X1                - Trigger before-value
                      X2 = Fasle            - Condition variable
                      X1                    - Trigger event
   Expected Output:   No_Cues

4) Test specification P17-4:

   Prefix:            X1                    - Reach No_Cues
```

```
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
   Test case value:  NOT X1               - Trigger before-value
                     X2 = True            - Condition variable
                     NOT X1               - Trigger event
   Expected Output:  No_Cues

5) Test specification P17-5:

   Prefix:           X1                   - Reach No_Cues
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
   Test case value:  NOT X1               - Trigger before-value
                     X3 = True            - Condition variable
                     X1                   - Trigger event
   Expected Output:  Cues

6) Test specification P17-6:

   Prefix:           X1                   - Reach No_Cues
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
   Test case value:  X1                   - Trigger before-value
                     X3 = True            - Condition variable
                     X1                   - Trigger event
   Expected Output:  No_Cues

7) Test specification P17-7:

   Prefix:           X1                   - Reach No_Cues
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
   Test case value:  NOT X1               - Trigger before-value
                     X3 = False           - Condition variable
                     X1                   - Trigger event
   Expected Output:  No_Cues

8) Test specification P17-8:

   Prefix:           X1                   - Reach No_Cues
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
   Test case value:  NOT X1               - Trigger before-value
                     X3 = True            - Condition variable
                     NOT X1               - Trigger event
   Expected Output:  No_Cues

9) Test specification P18-1:

   Prefix:           X1                   - Reach No_Cues
                     X2 = True            - Condition variable
```

```
Test case value:  X3 = False            - Trigger before-value
                  X3 = True             - Trigger event
Expected Output:  Cues
```

10) Test specification P18-2:

```
Prefix:           X1                    - Reach No_Cues
                  X2 = True             - Condition variable
Test case value:  X3 = True             - Trigger before-value
                  X3 = True             - Trigger event
Expected Output:  No_Cues
```

11) Test specification P18-3:

```
Prefix:           X1                    - Reach No_Cues
                  X2 = True             - Condition variable
Test case value:  X3 = True             - Trigger before-value
                  X3 = False            - Trigger event
Expected Output:  No_Cues
```

12) Test specification P19-1:

```
Prefix:           X2 = True             - Condition variable
                  X3 = True             - Condition variable
                  X1                    - Reach Cues
                  X3 = True             - Reach Cues
Test case value:  NOT X1                - Trigger before-value
                  X2 = True             - Condition variable
                  X1                    - Trigger event
Expected Output:  No_Cues
```

13) Test specification P19-2:

```
Prefix:           X2 = True             - Condition variable
                  X3 = True             - Condition variable
                  X1                    - Reach Cues
                  X3 = True             - Reach Cues
Test case value:  X1                    - Trigger before-value
                  X2 = True             - Condition variable
                  X1                    - Trigger event
Expected Output:  Cues
```

14) Test specification P19-3:

```
Prefix:           X2 = True             - Condition variable
                  X3 = True             - Condition variable
                  X1                    - Reach Cues
                  X3 = True             - Reach Cues
Test case value:  NOT X1                - Trigger before-value
                  X2 = False            - Condition variable
                  X1                    - Trigger event
```

```
   Expected Output:  Cues
```

15) Test specification P19-4:

```
   Prefix:           X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X1                   - Reach Cues
                     X3 = True            - Reach Cues
   Test case value:  NOT X1               - Trigger before-value
                     X2 = True            - Condition variable
                     NOT X1               - Trigger event
   Expected Output:  Cues
```

16) Test specification P19-5:

```
   Prefix:           X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X1                   - Reach Cues
                     X3 = True            - Reach Cues
   Test case value:  NOT X1               - Trigger before-value
                     X3 = True            - Condition variable
                     X1                   - Trigger event
   Expected Output:  No_Cues
```

17) Test specification P19-6:

```
   Prefix:           X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X1                   - Reach Cues
                     X3 = True            - Reach Cues
   Test case value:  X1                   - Trigger before-value
                     X3 = True            - Condition variable
                     X1                   - Trigger event
   Expected Output:  Cues
```

18) Test specification P19-7:

```
   Prefix:           X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X1                   - Reach Cues
                     X3 = True            - Reach Cues
   Test case value:  NOT X1               - Trigger before-value
                     X3 = False           - Condition variable
                     X1                   - Trigger event
   Expected Output:  Cues
```

19) Test specification P19-8:

```
   Prefix:           X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X1                   - Reach Cues
```

```
                    X3 = True            - Reach Cues
Test case value:    NOT X1               - Trigger before-value
                    X3 = True            - Condition variable
                    NOT X1               - Trigger event
Expected Output:    Cues
```

6.6.2 Transition Pair Coverage Level Requirements:

The pairs for the No_Cues Mode are:

```
P19 : (P17 or P18)
```

The pairs for the Cues Mode are:

```
(P17 or P18) : P19
```

		X1	X2	X3	
No_Cues	Cues	@	t	-	No_Cues
	Cues	@	-	t	No_Cues
	No_Cues	@	t	-	Cues
	No_Cues	@	-	t	Cues
	OR				
	No_Cues	-	-	T	Cues
Cues	No_Cues	@	t	-	Cues
	No_Cues	@	-	t	Cues
	OR				
	No_Cues	-	-	T	Cues
	Cues	@	t	-	No_Cues
	Cues	@	-	t	No_Cues

Test specifications

```
1) Test specification No_Cues:
   Prefix:           X2 = True            - Condition Variable
                     X3 = True            - Condition Variable
                     X1                   - Reach Cues
                     X3                   - Reach Cues
   Test case value:  X1                   - P19 trigger event
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X1                   - P17 trigger event
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X3 = True            - P18 trigger event
   Expected Output:  Cues

2) Test specification Cues:
   Prefix:           X2 = True            - Condition Variable
                     X3 = True            - Condition Variable
                     X1                   - Reach No_Cues
   Test case value:  X1                   - P17 trigger event
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
                     X3 = True            - P18 trigger event
                     X1                   - P19 trigger event
                     X2 = True            - Condition variable
                     X3 = True            - Condition variable
   Expected Output:  Cues
```

6.7 Active Lateral Mode Test Cases

Id	From	Events	To
20	HDG	@HDG_Switch_Pressed	ROLL
21	NAV	@NAV_Switch_Pressed	ROLL
22	NAV	@Nav_Source_Change	ROLL
23	APPR	@APPR_Switch_Pressed	ROLL
24	APPR	@Nav_Source_Change	ROLL
25	GA	@T(term_AP_Engaged)	ROLL
26	GA	@T(term_SYNC)	ROLL
27	GA	@F(mode_Active_Vertical = GA)	ROLL
28	$\overline{\text{HDG}}$	@HDG_Switch_Pressed	HDG
29	$\overline{\text{NAV}}$	@NAV_Switch_Pressed	NAV
30	$\overline{\text{APPR}}$	@APPR_Switch_Pressed	APPR
31	$\overline{\text{GA}}$	@GA_Switch_Pressed	GA

Table 6.7: Active Lateral Mode Transition Table (Table A.7, pg. 75 in the FGS report)

Definitions:

- X1 = @HDG_Switch_Pressed
- X2 = @NAV_Switch_Pressed
- X3 = @Nav_Source_Change
- X4 = @APPR_Switch_Pressed
- X5 = term_AP_Engaged
- X6 = term_SYNC
- X7 = (mode_Active_Vertical = GA)
- X8 = GA_Switch_Pressed
- X1’ −− After-value of trigger event X1

- X2' −− After-value of trigger event X2
- X3' −− After-value of trigger event X3
- X4' −− After-value of trigger event X4
- X5' −− After-value of trigger event X5
- X6' −− After-value of trigger event X6
- X7' −− After-value of trigger event X7
- X8' −− After-value of trigger event X8

6.7.1 Full predicate coverage level test case requirements:

	Pre	X1	X2	X3	X4	X5	X6	X7	X8	X1'	X2'	X3'	X4'	X5'	X6'	X7'	X8'	Post
	State																	State
P20	HDG	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	ROLL
	HDG	@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	HDG
	HDG	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	HDG
P21	NAV	-	NOT@	-	-	-	-	-	-	@	-	-	-	-	-	-	-	ROLL
	NAV	-	@	-	-	-	-	-	-	@	-	-	-	-	-	-	-	NAV
	NAV	-	NOT@	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	NAV
P22	NAV	-	-	NOT@	-	-	-	-	-	@	-	-	-	-	-	-	-	ROLL
	NAV	-	-	@	-	-	-	-	-	@	-	-	-	-	-	-	-	NAV
	NAV	-	-	NOT@	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	NAV
P23	APPR	-	-	-	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	ROLL
	APPR	-	-	-	@	-	-	-	-	-	-	-	@	-	-	-	-	APPR
	APPR	-	-	-	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	APPR
P24	APPR	-	-	NOT@	-	-	-	-	-	@	-	-	-	-	-	-	-	ROLL
	APPR	-	-	@	-	-	-	-	-	@	-	-	-	-	-	-	-	APPR
	APPR	-	-	NOT@	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	APPR
P25	GA	-	-	-	-	F	-	-	-	-	-	-	-	T	-	-	-	ROLL
	GA	-	-	-	-	T	-	-	-	-	-	-	-	T	-	-	-	GA
	GA	-	-	-	-	F	-	-	-	-	-	-	-	F	-	-	-	GA
P26	GA	-	-	-	-	-	F	-	-	-	-	-	-	-	T	-	-	ROLL
	GA	-	-	-	-	-	T	-	-	-	-	-	-	-	T	-	-	GA
	GA	-	-	-	-	-	F	-	-	-	-	-	-	-	F	-	-	GA
P27	GA	-	-	-	-	-	-	T	-	-	-	-	-	-	-	F	-	ROLL
	GA	-	-	-	-	-	-	F	-	-	-	-	-	-	-	F	-	GA
	GA	-	-	-	-	-	-	T	-	-	-	-	-	-	-	T	-	GA
P28	NAV	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	HDG
	NAV	@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	NAV
	NAV	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	NAV
	APPR	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	HDG
	APPR	@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	APPR
	APPR	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	APPR
	GA	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	HDG
	GA	@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	GA
	GA	NOT	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	GA

P29	HDG	-	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	NAV
	HDG	-	@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	HDG
	HDG	-	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	HDG
	APPR	-	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	NAV
	APPR	-	@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	APPR
	APPR	-	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	APPR
	GA	-	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	NAV
	GA	-	@	-	-	-	-	-	-	-	@	-	-	-	-	-	-	GA
	GA	-	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	GA
P30	HDG	-	-	-	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	APPR
	HDG	-	-	-	@	-	-	-	-	-	-	-	@	-	-	-	-	HDG
	HDG	-	-	-	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	HDG
	NAV	-	-	-	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	APPR
	NAV	-	-	-	@	-	-	-	-	-	-	-	@	-	-	-	-	NAV
	NAV	-	-	-	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	NAV
	GA	-	-	-	NOT@	-	-	-	-	-	-	-	@	-	-	-	-	APPR
	GA	-	-	-	@	-	-	-	-	-	-	-	@	-	-	-	-	GA
	GA	-	-	-	NOT@	-	-	-	-	-	-	-	NOT@	-	-	-	-	GA
P31	HDG	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	@	GA
	HDG	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	@	HDG
	HDG	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	NOT@	HDG
	NAV	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	@	GA
	NAV	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	@	NAV
	NAV	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	NOT@	NAV
	APPR	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	@	GA
	APPR	-	-	-	-	-	-	-	@	-	-	-	-	-	-	-	@	APPR
	APPR	-	-	-	-	-	-	-	NOT@	-	-	-	-	-	-	-	NOT@	APPR

Test specifications:

```
  1) Test specification P20-1:

     Prefix:           X1                  - Reach HDG
     Test case value:  NOT X1              - Trigger event before value
                       X1                  - Trigger event
     Expected Output:  ROLL

  2) Test specification P20-2:

     Prefix:           X1                  - Reach HDG
     Test case value:  X1                  - Trigger event before value
                       X1                  - Trigger event
     Expected Output:  HDG

  3) Test specification P20-3:

     Prefix:           X1                  - Reach HDG
     Test case value:  NOT X1              - Trigger event before value
                       NOT X1              - Trigger event
     Expected Output:  HDG

  4) Test specification P21-1:
   Prefix:           X2                    - Reach NAV
   Test case value:  NOT X2                - Trigger event before value
                     X2                    - Trigger event
   Expected Output:  ROLL

5) Test specification P21-2:

   Prefix:           X2                    - Reach NAV
   Test case value:  X2                    - Trigger event before value
                     X2                    - Trigger event
   Expected Output:  NAV

6) Test specification P21-3:

   Prefix:           X2                    - Reach NAV
   Test case value:  NOT X2                - Trigger event before value
                     NOT X2                - Trigger event
   Expected Output:  NAV

7) Test specification P22-1:

   Prefix:           X2                    - Reach NAV
   Test case value:  NOT X3                - Trigger event before value
                     X3                    - Trigger event
   Expected Output:  ROLL

8) Test specification P22-2:

   Prefix:           X2                    - Reach NAV
   Test case value:  X3                    - Trigger event before value
                     X3                    - Trigger event
   Expected Output:  NAV

9) Test specification P22-3:

   Prefix:           X2                    - Reach NAV
   Test case value:  NOT X3                - Trigger event before value
                     NOT X3                - Trigger event
   Expected Output:  NAV

10) Test specification P23-1:

   Prefix:           X4                    - Reach APPR
   Test case value:  NOT X4                - Trigger event before value
                     X4                    - Trigger event
   Expected Output:  ROLL

11) Test specification P23-2:

   Prefix:           X4                    - Reach APPR
   Test case value:  X4                    - Trigger event before value
```

```
                  X4                    - Trigger event
   Expected Output:  APPR

12) Test specification P23-3:

   Prefix:           X4                    - Reach APPR
   Test case value:  NOT X4                - Trigger event before value
                     NOT X4                - Trigger event
   Expected Output:  APPR

13) Test specification P24-1:

   Prefix:           X4                    - Reach APPR
   Test case value:  NOT X3                - Trigger event before value
                     X3                    - Trigger event
   Expected Output:  ROLL

14) Test specification P24-2:

   Prefix:           X4                    - Reach APPR
   Test case value:  X3                    - Trigger event before value
                     X3                    - Trigger event
   Expected Output:  APPR

15) Test specification P24-3:

   Prefix:           X4                    - Reach APPR
   Test case value:  NOT X3                - Trigger event before value
                     NOT X3                - Trigger event
   Expected Output:  APPR

16) Test specification P25-1:

   Prefix:           X8                    - Reach GA
   Test case value:  X5 = False            - Trigger event before-value
                     X5 = True             - Trigger event
   Expected Output:  ROLL

17) Test specification P25-2:

   Prefix:           X8                    - Reach GA
   Test case value:  X5 = True             - Trigger event before-value
                     X5 = True             - Trigger event
   Expected Output:  GA

18) Test specification P25-3:

   Prefix:           X8                    - Reach GA
   Test case value:  X5 = False            - Trigger event before-value
                     X5 = False            - Trigger event
   Expected Output:  GA
```

19) Test specification P26-1:

```
Prefix:            X8                    - Reach GA
Test case value:   X6 = False            - Trigger event before-value
                   X6 = True             - Trigger event
Expected Output:   ROLL
```

20) Test specification P26-2:

```
Prefix:            X8                    - Reach GA
Test case value:   X6 = True             - Trigger event before-value
                   X6 = True             - Trigger event
Expected Output:   GA
```

21) Test specification P26-3:

```
Prefix:            X8                    - Reach GA
Test case value:   X6 = False            - Trigger event before-value
                   X6 = False            - Trigger event
Expected Output:   GA
```

22) Test specification P27-1:

```
Prefix:            X8                    - Reach GA
Test case value:   X7 = True             - Trigger event before-value
                   X7 = False            - Trigger event
Expected Output:   ROLL
```

23) Test specification P27-2:

```
Prefix:            X8                    - Reach GA
Test case value:   X7 = False            - Trigger event before-value
                   X7 = False            - Trigger event
Expected Output:   GA
```

24) Test specification P27-3:

```
Prefix:            X8                    - Reach GA
Test case value:   X7 = True             - Trigger event before-value
                   X7 = True             - Trigger event
Expected Output:   GA
```

25) Test specification P28-1:

```
Prefix:            X2                    - Reach NAV
Test case value:   NOT X1                - Trigger event before-value
                   X1                    - Trigger event
Expected Output:   HDG
```

26) Test specification P28-2:

```
   Prefix:           X2                    - Reach NAV
   Test case value:  X1                    - Trigger event before-value
                     X1                    - Trigger event
   Expected Output:  NAV
```

27) Test specification P28-3:

```
   Prefix:           X2                    - Reach NAV
   Test case value:  NOT X1                - Trigger event before-value
                     NOT X1                - Trigger event
   Expected Output:  NAV
```

28) Test specification P28-4:

```
   Prefix:           X4                    - Reach APPR
   Test case value:  NOT X1                - Trigger event before-value
                     X1                    - Trigger event
   Expected Output:  HDG
```

29) Test specification P28-5:

```
   Prefix:           X4                    - Reach APPR
   Test case value:  X1                    - Trigger event before-value
                     X1                    - Trigger event
   Expected Output:  APPR
```

30) Test specification P28-6:

```
   Prefix:           X4                    - Reach APPR
   Test case value:  NOT X1                - Trigger event before-value
                     NOT X1                - Trigger event
   Expected Output:  APPR
```

31) Test specification P28-7:

```
   Prefix:           X8                    - Reach GA
   Test case value:  NOT X1                - Trigger event before-value
                     X1                    - Trigger event
   Expected Output:  HDG
```

32) Test specification P28-8:

```
   Prefix:           X8                    - Reach GA
   Test case value:  X1                    - Trigger event before-value
                     X1                    - Trigger event
   Expected Output:  GA
```

33) Test specification P28-9:

```
   Prefix:           X8                    - Reach GA
   Test case value:  NOT X1                - Trigger event before-value
```

```
                     NOT X1                  - Trigger event
   Expected Output:  GA
```

34) Test specification P29-1:

```
   Prefix:           X1                      - Reach HDG
   Test case value:  NOT X2                  - Trigger event before-value
                     X2                      - Trigger event
   Expected Output:  NAV
```

35) Test specification P29-2:

```
   Prefix:           X1                      - Reach HDG
   Test case value:  X2                      - Trigger event before-value
                     X2                      - Trigger event
   Expected Output:  HDG
```

36) Test specification P29-3:

```
   Prefix:           X1                      - Reach HDG
   Test case value:  NOT X2                  - Trigger event before-value
                     NOT X2                  - Trigger event
   Expected Output:  HDG
```

37) Test specification P29-4:

```
   Prefix:           X4                      - Reach APPR
   Test case value:  NOT X2                  - Trigger event before-value
                     X2                      - Trigger event
   Expected Output:  NAV
```

38) Test specification P29-5:

```
   Prefix:           X4                      - Reach APPR
   Test case value:  X2                      - Trigger event before-value
                     X2                      - Trigger event
   Expected Output:  APPR
```

39) Test specification P29-6:

```
   Prefix:           X4                      - Reach APPR
   Test case value:  NOT X2                  - Trigger event before-value
                     NOT X2                  - Trigger event
   Expected Output:  APPR
```

40) Test specification P29-7:

```
   Prefix:           X8                      - Reach GA
   Test case value:  NOT X2                  - Trigger event before-value
                     X2                      - Trigger event
   Expected Output:  NAV
```

```
41) Test specification P29-8:

   Prefix:           X8                  - Reach GA
   Test case value:  X2                  - Trigger event before-value
                     X2                  - Trigger event
   Expected Output:  GA

42) Test specification P29-9:

   Prefix:           X8                  - Reach GA
   Test case value:  NOT X2              - Trigger event before-value
                     NOT X2              - Trigger event
   Expected Output:  GA

43) Test specification P30-1:

   Prefix:           X1                  - Reach HDG
   Test case value:  NOT X4              - Trigger event before-value
                     X4                  - Trigger event
   Expected Output:  APPR

44) Test specification P30-2:

   Prefix:           X1                  - Reach HDG
   Test case value:  X4                  - Trigger event before-value
                     X4                  - Trigger event
   Expected Output:  HDG

45) Test specification P30-3:

   Prefix:           X1                  - Reach HDG
   Test case value:  NOT X4              - Trigger event before-value
                     NOT X4              - Trigger event
   Expected Output:  HDG

46) Test specification P30-4:

   Prefix:           X2                  - Reach NAV
   Test case value:  NOT X4              - Trigger event before-value
                     X4                  - Trigger event
   Expected Output:  APPR

47) Test specification P30-5:

   Prefix:           X2                  - Reach NAV
   Test case value:  X4                  - Trigger event before-value
                     X4                  - Trigger event
   Expected Output:  NAV

48) Test specification P30-6:
   Prefix:            X2                    - Reach NAV
   Test case value:   NOT X4                - Trigger event before-value
                      NOT X4                - Trigger event
   Expected Output:   NAV
```

49) Test specification P30-7:

```
   Prefix:            X8                    - Reach GA
   Test case value:   NOT X4                - Trigger event before-value
                      X4                    - Trigger event
   Expected Output:   APPR
```

50) Test specification P30-8:

```
   Prefix:            X8                    - Reach GA
   Test case value:   X4                    - Trigger event before-value
                      X4                    - Trigger event
   Expected Output:   GA
```

51) Test specification P30-9:

```
   Prefix:            X8                    - Reach GA
   Test case value:   NOT X4                - Trigger event before-value
                      NOT X4                - Trigger event
   Expected Output:   GA
```

52) Test specification P31-1:

```
   Prefix:            X1                    - Reach HDG
   Test case value:   NOT X8                - Trigger event before-value
                      X8                    - Trigger event
   Expected Output:   GA
```

53) Test specification P31-2:

```
   Prefix:            X1                    - Reach HDG
   Test case value:   X8                    - Trigger event before-value
                      X8                    - Trigger event
   Expected Output:   HDG
```

54) Test specification P31-3:

```
   Prefix:            X1                    - Reach HDG
   Test case value:   NOT X8                - Trigger event before-value
                      NOT X8                - Trigger event
   Expected Output:   HDG
```

55) Test specification P31-4:

```
   Prefix:            X2                    - Reach NAV
   Test case value:   NOT X8                - Trigger event before-value
```

```
                     X8                  - Trigger event
   Expected Output:  GA

56) Test specification P31-5:

   Prefix:           X2                  - Reach NAV
   Test case value:  X8                  - Trigger event before-value
                     X8                  - Trigger event
   Expected Output:  NAV

57) Test specification P31-6:

   Prefix:           X2                  - Reach NAV
   Test case value:  NOT X8              - Trigger event before-value
                     NOT X8              - Trigger event
   Expected Output:  NAV

58) Test specification P31-7:

   Prefix:           X4                  - Reach APPR
   Test case value:  NOT X8              - Trigger event before-value
                     X8                  - Trigger event
   Expected Output:  GA

59) Test specification P31-8:

   Prefix:           X4                  - Reach APPR
   Test case value:  X8                  - Trigger event before-value
                     X8                  - Trigger event
   Expected Output:  APPR

60) Test specification P31-9:

   Prefix:           X4                  - Reach APPR
   Test case value:  NOT X8              - Trigger event before-value
                     NOT X8              - Trigger event
   Expected Output:  APPR
```

6.7.2 Transition Pair Coverage Level Requirements:

The pairs for the HDG Mode are:

```
    P28 : (P20 or P29 or P30 or P31)
```

The pairs for the NAV Mode are:

```
    P29 : (P21 or P22 or P28 or P30 or P31)
```

The pairs for the APPR Mode are:

```
    P30 : (P23 or P24 or P28 or P29 or P31)
```

The pairs for the GA Mode are:

```
    P31 : (P25 or P26 or P27 or P28 or P29 or P30)


             X1   X2   X3   X4   X5   X6   X7   X8
HDG   NAV    @    -    -    -    -    -    -    -   HDG
      OR
      APPR   @    -    -    -    -    -    -    -   HDG
      OR
      GA     @    -    -    -    -    -    -    -   HDG

      HDG    @    -    -    -    -    -    -    -   ROLL
      OR
      HDG    -    @    -    -    -    -    -    -   NAV
      OR
      HDG    -    -    -    @    -    -    -    -   APPR
      OR
      HDG    -    -    -    -    -    -    -    @   GA

NAV   HDG    -    @    -    -    -    -    -    -   NAV
      OR
      APPR   -    @    -    -    -    -    -    -   NAV
      OR
      GA     -    @    -    -    -    -    -    -   NAV

      NAV    -    @    -    -    -    -    -    -   ROLL
      OR
      NAV    -    -    @    -    -    -    -    -   ROLL
      OR
      NAV    @    -    -    -    -    -    -    -   HDG
      OR
      NAV    -    -    -    @    -    -    -    -   APPR
      OR
      NAV    -    -    -    -    -    -    -    @   GA

APPR  HDG    -    -    -    @    -    -    -    -   APPR
      OR
      NAV    -    -    -    @    -    -    -    -   APPR
      OR
      GA     -    -    -    @    -    -    -    -   APPR

      APPR   -    -    -    @    -    -    -    -   ROLL
      OR
      APPR   -    -    @    -    -    -    -    -   ROLL
      OR
      APPR   @    -    -    -    -    -    -    -   HDG
      OR
      APPR   -    @    -    -    -    -    -    -   NAV
      OR
      APPR   -    -    -    -    -    -    -    @   GA
```

GA	HDG	-	-	-	-	-	-	-	@	GA
	OR									
	NAV	-	-	-	-	-	-	-	@	GA
	OR									
	APPR	-	-	-	-	-	-	-	@	GA
	GA	-	-	-	-	T	-	-	-	ROLL
	OR									
	GA	-	-	-	-	-	T	-	-	ROLL
	OR									
	GA	-	-	-	-	-	-	F	-	ROLL
	OR									
	GA	@	-	-	-	-	-	-	-	HDG
	OR									
	GA	-	@	-	-	-	-	-	-	NAV
	OR									
	GA	-	-	-	@	-	-	-	-	APPR

Test Specifications:

```
1) Test specification HDG-1:

   Prefix:           X2                    - Reach NAV
                     X4                    - Reach APPR
                     X8                    - Reach GA
   Test case value:  X1                    - Trigger event P28
                     X1                    - Trigger event P20
   Expected Output:  ROLL

2) Test specification HDG-2:

   Prefix:           X2                    - Reach NAV
                     X4                    - Reach APPR
                     X8                    - Reach GA
   Test case value:  X1                    - Trigger event P28
                     X2                    - Trigger event P29
   Expected Output:  NAV

3) Test specification HDG-3:

   Prefix:           X2                    - Reach NAV
                     X4                    - Reach APPR
                     X8                    - Reach GA
   Test case value:  X1                    - Trigger event P28
                     X4                    - Trigger event P30
   Expected Output:  APPR

4) Test specification HDG-4:

   Prefix:           X2                    - Reach NAV
                     X4                    - Reach APPR
```

```
                  X8                    - Reach GA
Test case value:  X1                    - Trigger event P28
                  X8                    - Trigger event P31
Expected Output:  GA
```

5) Test specification NAV-1:

```
Prefix:           X1                    - Reach HDG
                  X4                    - Reach APPR
                  X8                    - Reach GA
Test case value:  X2                    - Trigger event P29
                  X2                    - Trigger event P21
Expected Output:  ROLL
```

6) Test specification NAV-2:

```
Prefix:           X1                    - Reach HDG
                  X4                    - Reach APPR
                  X8                    - Reach GA
Test case value:  X2                    - Trigger event P29
                  X3                    - Trigger event P22
Expected Output:  ROLL
```

7) Test specification NAV-3:

```
Prefix:           X1                    - Reach HDG
                  X4                    - Reach APPR
                  X8                    - Reach GA
Test case value:  X2                    - Trigger event P29
                  X1                    - Trigger event P28
Expected Output:  HDG
```

8) Test specification NAV-4:

```
Prefix:           X1                    - Reach HDG
                  X4                    - Reach APPR
                  X8                    - Reach GA
Test case value:  X2                    - Trigger event P29
                  X4                    - Trigger event P30
Expected Output:  APPR
```

9) Test specification NAV-5:

```
Prefix:           X1                    - Reach HDG
                  X4                    - Reach APPR
                  X8                    - Reach GA
Test case value:  X2                    - Trigger event P29
                  X8                    - Trigger event P31
Expected Output:  GA
```

10) Test specification APPR-1:

```
   Prefix:           X1                     - Reach HDG
                     X2                     - Reach NAV
                     X8                     - Reach GA
   Test case value:  X4                     - Trigger event P30
                     X4                     - Trigger event P23
   Expected Output:  ROLL
```

11) Test specification APPR-2:

```
   Prefix:           X1                     - Reach HDG
                     X2                     - Reach NAV
                     X8                     - Reach GA
   Test case value:  X4                     - Trigger event P30
                     X3                     - Trigger event P24
   Expected Output:  ROLL
```

12) Test specification APPR-3:

```
   Prefix:           X1                     - Reach HDG
                     X2                     - Reach NAV
                     X8                     - Reach GA
   Test case value:  X4                     - Trigger event P30
                     X1                     - Trigger event P28
   Expected Output:  HDG
```

13) Test specification APPR-4:

```
   Prefix:           X1                     - Reach HDG
                     X2                     - Reach NAV
                     X8                     - Reach GA
   Test case value:  X4                     - Trigger event P30
                     X2                     - Trigger event P29
   Expected Output:  NAV
```

14) Test specification APPR-5:

```
   Prefix:           X1                     - Reach HDG
                     X2                     - Reach NAV
                     X8                     - Reach GA
   Test case value:  X4                     - Trigger event P30
                     X8                     - Trigger event P31
   Expected Output:  GA
```

15) Test specification GA-1:

```
   Prefix:           X1                     - Reach HDG
                     X2                     - Reach NAV
                     X4                     - Reach APPR
   Test case value:  X8                     - Trigger event P31
                     X5 = True              - Trigger event P25
   Expected Output:  ROLL
```

16) Test specification GA-2:

```
Prefix:           X1                  - Reach HDG
                  X2                  - Reach NAV
                  X4                  - Reach APPR
Test case value:  X8                  - Trigger event P31
                  X6 = True           - Trigger event P26
Expected Output:  ROLL
```

17) Test specification GA-3:

```
Prefix:           X1                  - Reach HDG
                  X2                  - Reach NAV
                  X4                  - Reach APPR
Test case value:  X8                  - Trigger event P31
                  X7 = False          - Trigger event P27
Expected Output:  ROLL
```

18) Test specification GA-4:

```
Prefix:           X1                  - Reach HDG
                  X2                  - Reach NAV
                  X4                  - Reach APPR
Test case value:  X8                  - Trigger event P31
                  X1                  - Trigger event P28
Expected Output:  HDG
```

19) Test specification GA-5:

```
Prefix:           X1                  - Reach HDG
                  X2                  - Reach NAV
                  X4                  - Reach APPR
Test case value:  X8                  - Trigger event P31
                  X2                  - Trigger event P29
Expected Output:  NAV
```

20) Test specification GA-6:

```
Prefix:           X1                  - Reach HDG
                  X2                  - Reach NAV
                  X4                  - Reach APPR
Test case value:  X8                  - Trigger event P31
                  X4                  - Trigger event P30
Expected Output:  APPR
```

6.8 Active Lateral ROLL Submode Test Cases

Id	From	Events	To
32	Entry to ROLL mode	@T(mode_Active_Lateral = ROLL) WHEN (term_Roll_LE_Threshold OR mon_On_Ground)	Hdg_Hold
33	ROLL_Hold	@T(term_SYNC AND term_Roll_LE_Threshold)	Hdg_Hold
34	ROLL_Hold	@T(term_AP_Engaged) WHEN (term_Roll_LE_Threshold)	Hdg_Hold
35	ROLL_Hold	@T(mon_On_Ground)	Hdg_Hold
36	Entry to ROLL mode	@T(mode_Active_Lateral = ROLL) WHEN (NOT mon_On_Ground AND NOT term_Roll_LE_Threshold)	ROLL_Hold
37	Hdg_Hold	@T(term_SYNC AND NOT term_Roll_LE_Threshold AND NOT mon_On_Ground)	ROLL_Hold
38	Hdg_Hold	@T(term_AP_Engaged) WHEN (NOT mon_On_Ground AND NOT term_Roll_LE_Threshold)	ROLL_Hold

Table 6.8: Active Lateral ROLL Submode Transition Table (Table A.8, pg. 75 in the FGS report)

Definitions:

- X1 = (mode_Active_Lateral = ROLL)
- X2 = term_Roll_LE_Threshold
- X3 = mon_On_Ground
- X4 = term_SYNC
- X5 = term_AP_Engaged
- X1' –– After-value of trigger event X1
- X2' –– After-value of trigger event X2
- X3' –– After-value of trigger event X3
- X4' –– After-value of trigger event X4
- X5' –– After-value of trigger event X5

6.8.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X3	X4	X5	X1'	X2'	X3'	X4'	X5'	Post State
P32	Entry to ROLL	F	-	-	-	-	T	t	-	-	-	Hdg_Hold
	Entry to ROLL	T	-	-	-	-	T	t	-	-	-	Entry to ROLL
	Entry to ROLL	F	-	-	-	-	T	f	-	-	-	Entry to ROLL
	Entry to ROLL	F	-	-	-	-	F	t	-	-	-	Entry to ROLL
	Entry to ROLL	F	-	-	-	-	T	-	t	-	-	Hdg_Hold
	Entry to ROLL	T	-	-	-	-	T	-	t	-	-	Entry to ROLL

	Entry to ROLL	F	-	-	-	-	T	-	f	-	-	Entry to ROLL
	Entry to ROLL	F	-	-	-	-	F	-	t	-	-	Entry to ROLL
P33	ROLL_Hold	-	F	-	F	-	-	T	-	T	-	Hdg_Hold
	ROLL_Hold	-	T	-	T	-	-	T	-	T	-	ROLL_Hold
	ROLL_Hold	-	F	-	F	-	-	F	-	T	-	ROLL_Hold
	ROLL_Hold	-	F	-	F	-	-	F	-	F	-	ROLL_Hold
P34	ROLL_Hold	-	t	-	-	F	-	-	-	-	T	Hdg_Hold
	ROLL_Hold	-	f	-	-	F	-	-	-	-	T	ROLL_Hold
	ROLL_Hold	-	t	-	-	T	-	-	-	-	T	ROLL_Hold
	ROLL_Hold	-	t	-	-	F	-	-	-	-	F	ROLL_Hold
P35	ROLL_Hold	-	-	F	-	-	-	-	T	-	-	Hdg_Hold
	ROLL_Hold	-	-	T	-	-	-	-	T	-	-	ROLL_Hold
	ROLL_Hold	-	-	F	-	-	-	-	F	-	-	ROLL_Hold
P36	Entry to ROLL	F	-	-	-	-	T	f	f	-	-	ROLL_Hold
	Entry to ROLL	T	-	-	-	-	T	f	f	-	-	Entry to ROLL
	Entry to ROLL	F	-	-	-	-	T	t	f	-	-	Entry to ROLL
	Entry to ROLL	F	-	-	-	-	T	f	t	-	-	Entry to ROLL
	Entry to ROLL	F	-	-	-	-	F	f	f	-	-	Entry to ROLL
P37	Hdg_Hold	-	T	T	F	-	F	F	T	-	-	ROLL_Hold
	Hdg_Hold	-	F	T	F	-	F	F	T	-	-	Hdg_Hold
	Hdg_Hold	-	T	F	F	-	F	F	T	-	-	Hdg_Hold
	Hdg_Hold	-	T	T	T	-	F	F	T	-	-	Hdg_Hold
	Hdg_Hold	-	T	T	F	-	T	F	T	-	-	Hdg_Hold
	Hdg_Hold	-	T	T	F	-	F	T	T	-	-	Hdg_Hold
	Hdg_Hold	-	T	T	F	-	F	F	F	-	-	Hdg_Hold
P38	Hdg_Hold	-	-	-	-	F	-	f	f	-	T	ROLL_Hold
	Hdg_Hold	-	-	-	-	F	-	t	f	-	T	Hdg_Hold
	Hdg_Hold	-	-	-	-	F	-	t	t	-	T	Hdg_Hold
	Hdg_Hold	-	-	-	-	T	-	f	f	-	T	Hdg_Hold

Test specifications:

```
 1) Test specification P32-1:

    Prefix:            Entry to Roll
    Test case value:   X1 = False          - Trigger before-value
                       X2 = True           - Condition variable
                       X1 = True           - Trigger event
    Expected Output:   Hdg_Hold

 2) Test specification P32-2:

    Prefix:            Entry to Roll
    Test case value:   X1 = True           - Trigger before-value
                       X2 = True           - Condition variable
                       X1 = True           - Trigger event
    Expected Output:   Entry to ROLL

 3) Test specification P32-3:

    Prefix:            Entry to Roll
```

```
   Test case value:  X1 = False          - Trigger before-value
                     X2 = False          - Condition variable
                     X1 = True           - Trigger event
   Expected Output:  Entry to ROLL

4) Test specification P32-4:

   Prefix:           Entry to Roll
   Test case value:  X1 = False          - Trigger before-value
                     X2 = True           - Condition variable
                     X1 = False          - Trigger event
   Expected Output:  Entry to ROLL

5) Test specification P32-5:

   Prefix:           Entry to Roll
   Test case value:  X1 = False          - Trigger before-value
                     X3 = True           - Condition variable
                     X1 = True           - Trigger event
   Expected Output:  Hdg_Hold

6) Test specification P32-6:

   Prefix:           Entry to Roll
   Test case value:  X1 = True           - Trigger before-value
                     X3 = True           - Condition variable
                     X1 = True           - Trigger event
   Expected Output:  Entry to ROLL

7) Test specification P32-7:

   Prefix:           Entry to Roll
   Test case value:  X1 = False          - Trigger before-value
                     X3 = False          - Condition variable
                     X1 = True           - Trigger event
   Expected Output:  Entry to ROLL

8) Test specification P32-8:

   Prefix:           Entry to Roll
   Test case value:  X1 = False          - Trigger before-value
                     X3 = True           - Condition variable
                     X1 = False          - Trigger event
   Expected Output:  Entry to ROLL

9) Test specification P33-1:

   Prefix:           X4 = True           - Reach ROLL_Hold
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X5 = True           - Reach ROLL_Hold
   Test case value:  X2 = False          - Trigger before-value
                     X4 = False          - Trigger before-value
                     X2 = True           - Trigger event
                     X4 = True           - Trigger event
   Expected Output:  Hdg_Hold
```

10) Test specification P33-2:

```
   Prefix:           X4 = True           - Reach ROLL_Hold
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X5 = True           - Reach ROLL_Hold
   Test case value:  X2 = True           - Trigger before-value
                     X4 = True           - Trigger before-value
                     X2 = True           - Trigger event
                     X4 = True           - Trigger event
   Expected Output:  ROLL_Hold
```

11) Test specification P33-3:

```
   Prefix:           X4 = True           - Reach ROLL_Hold
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X5 = True           - Reach ROLL_Hold
   Test case value:  X2 = False          - Trigger before-value
                     X4 = False          - Trigger before-value
                     X2 = False          - Trigger event
                     X4 = True           - Trigger event
   Expected Output:  ROLL_Hold
```

12) Test specification P33-4:

```
   Prefix:           X4 = True           - Reach ROLL_Hold
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X5 = True           - Reach ROLL_Hold
   Test case value:  X2 = True           - Trigger before-value
                     X4 = True           - Trigger before-value
                     X2 = True           - Trigger event
                     X4 = False          - Trigger event
   Expected Output:  ROLL_Hold
```

13) Test specification P34-1:

```
   Prefix:           X4 = True           - Reach ROLL_Hold
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
   Test case value:  X5 = False          - Trigger before-value
                     X2 = True           - Condition variable
                     X5 = True           - Trigger event
   Expected Output:  Hdg_Hold
```

14) Test specification P34-2:

```
   Prefix:           X4 = True            - Reach ROLL_Hold
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X5 = True            - Trigger before-value
                     X2 = True            - Condition variable
                     X5 = True            - Trigger event
   Expected Output:  ROLL_Hold
```

15) Test specification P34-3:

```
   Prefix:           X4 = True            - Reach ROLL_Hold
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X5 = False           - Trigger before-value
                     X2 = False           - Condition variable
                     X5 = True            - Trigger event
   Expected Output:  ROLL_Hold
```

16) Test specification P34-4:

```
   Prefix:           X4 = True            - Reach ROLL_Hold
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X5 = False           - Trigger before-value
                     X2 = True            - Condition variable
                     X5 = False           - Trigger event
   Expected Output:  ROLL_Hold
```

17) Test specification P35-1:

```
   Prefix:           X4 = True            - Reach ROLL_Hold
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X3 = False           - Trigger before-value
                     X3 = True            - Trigger event
   Expected Output:  Hdg_Hold
```

18) Test specification P35-2:

```
   Prefix:           X4 = True            - Reach ROLL_Hold
                     X2 = False           - Condition variable
                     X3 = False           - Condition variable
   Test case value:  X3 = True            - Trigger before-value
                     X3 = True            - Trigger event
   Expected Output:  ROLL_Hold
```

19) Test specification P35-3:

```
   Prefix:           X4 = True            - Reach ROLL_Hold
```

```
                  X2 = False          - Condition variable
                  X3 = False          - Condition variable
   Test case value:  X3 = False          - Trigger before-value
                  X3 = False          - Trigger event
   Expected Output:  ROLL_Hold

20) Test specification P36-1:

   Prefix:           Entry to Roll
   Test case value:  X1 = False          - Trigger before-value
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X1 = True           - Trigger event
   Expected Output:  ROLL_Hold

21) Test specification P36-2:

   Prefix:           Entry to Roll
   Test case value:  X1 = True           - Trigger before-value
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X1 = True           - Trigger event
   Expected Output:  Entry to ROLL

22) Test specification P36-3:

   Prefix:           Entry to Roll
   Test case value:  X1 = False          - Trigger before-value
                     X2 = True           - Condition variable
                     X3 = False          - Condition variable
                     X1 = False          - Trigger event
   Expected Output:  Entry to ROLL

23) Test specification P36-4:

   Prefix:           Entry to Roll
   Test case value:  X1 = False          - Trigger before-value
                     X2 = False          - Condition variable
                     X3 = True           - Condition variable
                     X1 = False          - Trigger event
   Expected Output:  Entry to ROLL

24) Test specification P37-1:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X2 = True           - Trigger before-value
                     X3 = True           - Trigger before-value
                     X4 = False          - Trigger before-value
                     X2 = False          - Trigger event
                  X3 = False          - Trigger event
                  X4 = True           - Trigger event
   Expected Output:  ROLL_Hold

25) Test specification P37-2:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X2 = False          - Trigger before-value
                     X3 = True           - Trigger before-value
                     X4 = False          - Trigger before-value
                     X2 = False          - Trigger event
                     X3 = False          - Trigger event
                     X4 = True           - Trigger event
   Expected Output:  Hdg_Hold

26) Test specification P37-3:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X2 = True           - Trigger before-value
                     X3 = False          - Trigger before-value
                     X4 = False          - Trigger before-value
                     X2 = False          - Trigger event
                     X3 = False          - Trigger event
                     X4 = True           - Trigger event
   Expected Output:  Hdg_Hold

27) Test specification P37-4:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X2 = True           - Trigger before-value
                     X3 = True           - Trigger before-value
                     X4 = True           - Trigger before-value
                     X2 = False          - Trigger event
                     X3 = False          - Trigger event
                     X4 = True           - Trigger event
   Expected Output:  Hdg_Hold

28) Test specification P37-5:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X2 = True           - Trigger before-value
                     X3 = True           - Trigger before-value
                     X4 = False          - Trigger before-value
                  X2 = True           - Trigger event
                  X3 = False          - Trigger event
                  X4 = True           - Trigger event
   Expected Output:  Hdg_Hold
```

29) Test specification P37-6:

```
   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X2 = True           - Trigger before-value
                     X3 = True           - Trigger before-value
                     X4 = False          - Trigger before-value
                     X2 = False          - Trigger event
                     X3 = True           - Trigger event
                     X4 = True           - Trigger event
   Expected Output:  Hdg_Hold
```

30) Test specification P37-7:

```
   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X2 = True           - Trigger before-value
                     X3 = True           - Trigger before-value
                     X4 = False          - Trigger before-value
                     X2 = False          - Trigger event
                     X3 = False          - Trigger event
                     X4 = False          - Trigger event
   Expected Output:  Hdg_Hold
```

31) Test specification P38-1:

```
   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X5 = False          - Trigger before-value
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X5 = True           - Trigger event
   Expected Output:  ROLL_Hold
```

32) Test specification P38-2:

```
   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X5 = True           - Trigger before-value
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X5 = True           - Trigger event
   Expected Output:  Hdg_Hold

33) Test specification P38-3:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X5 = False          - Trigger before-value
                     X2 = True           - Condition variable
                     X3 = False          - Condition variable
                     X5 = True           - Trigger event
   Expected Output:  Hdg_Hold

34) Test specification P38-4:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X5 = False          - Trigger before-value
                     X2 = False          - Condition variable
                     X3 = True           - Condition variable
                     X5 = True           - Trigger event
   Expected Output:  Hdg_Hold

35) Test specification P38-5:

   Prefix:           X1 = True           - Reach Hdg_Hold
                     X5 = True
                     X3 = True
   Test case value:  X5 = False          - Trigger before-value
                     X2 = False          - Condition variable
                     X3 = False          - Condition variable
                     X5 = False          - Trigger event
   Expected Output:  Hdg_Hold
```

6.8.2 Transition Pair Coverage Level Requirements:

The pairs for the ROLL_Hold Mode are:

```
   (P37 or P38) : (P33 or P34 or P35)
    P36 : (P33 or P34 or P35)
```

The pairs for the Hdg_Hold Mode are:
(P33 or P34 or P35) : (P37 or P38) P32 :(P37 or P38)

		X1	X2	X3	X4	X5	
ROLL_Hold	1.Hdg_Hold	-	F	F	T	-	ROLL_Hold
	OR						
	Hdg_Hold	-	f	f	-	T	ROLL_Hold

```
            ROLL_Hold       -      T      -      T      -     Hdg_Hold
               OR
            ROLL_Hold       -      t      -      -      T     Hdg_Hold
               OR
            ROLL_Hold       -      -      T      -      -     Hdg_Hold

          2.Entry to ROLL   -      f      f      T      -     ROLL_Hold
            ROLL_Hold       -      T      -      T      -     Hdg_Hold
               OR
            ROLL_Hold       -      t      -      -      T     Hdg_Hold
               OR
            ROLL_Hold       -      -      T      -      -     Hdg_Hold

Hdg_Hold 1.ROLL_Hold        -      T      -      T      -     Hdg_Hold
               OR
            ROLL_Hold       -      t      -      -      T     Hdg_Hold
               OR
            ROLL_Hold       -      -      T      -      -     Hdg_Hold

            Hdg_Hold        -      F      F      T      -     ROLL_Hold
               OR
            Hdg_Hold        -      f      f      -      T     ROLL_Hold

          2.Entry to ROLL   T      t      t      -      -     Hdg_Hold

            Hdg_Hold        -      F      F      T      -     ROLL_Hold
               OR
            Hdg_Hold        -      f      f      -      T     ROLL_Hold
```

Test specifications

```
1) Test specification ROLL_Hold-1:
   Prefix:           X2 = True
                     X4 = True             - Reach Hdg_Hold
                     X5 = True
                     X2 = True             - Reach Hdg_Hold
                     X3 = True             - Reach Hdg_Hold
   Test case value:  X4 = True             - P37 trigger event
                     X2 = False
                     X3 = False
                     X5 = True             - P38 trigger event
                     X2 = False
                     X3 = False
                     X4 = True             - P33 trigger event
                     X5 = True             - P34 trigger event
                     X2 = True             - Condition variable
                     X3 = True             - P35 trigger event
   Expected Output:  Hdg_Hold

2) Test specification ROLL_Hold-2:
   Prefix:                                   - Reach Entry to ROLL
   Test case value:  X4 = True               - P33 trigger event
                     X5 = True               - P34 trigger event
                     X2 = True               - Condition variable
                     X3 = True               - P35 trigger event
   Expected Output:  Hdg_Hold

3) Test specification Hdg_Hold-1
   Prefix:           X4 = True               - Reach ROLL_Hold
                     X2 = False
                     X3 = False
                     X5 = True               - Reach ROLL_Hold
                     X2 = False
                     X3 = False
   Test case value:  X4 = True               - P33 trigger event
                     X5 = True               - P34 trigger event
                     X2 = True               - Condition variable
                     X3 = True               - P35 trigger event
                     X4 = True               - P37 trigger event
                     X2 = False
                     X3 = False
                     X5 = True               - P38 trigger event
                     X2 = False
                     X3 = False
   Expected Output:  ROLL_Hold

4) Test specification Hdg_Hold-2:
   Prefix:                                   - Reach Entry to ROLL
   Test case value:  X4 = True               - P37 trigger event
                     X2 = False
                     X3 = False
                     X5 = True               - P38 trigger event
                     X2 = False
                     X3 = False
   Expected Output:  ROLL_Hold
```

6.9 Active Lateral Navigation Submode Test Cases

Id	From	Events	To
39	Armed	@T(mode_Lateral_NAV_Track_Cond_Met AND Duration(INMODE) > const_min_armed_period)	Track

Table 6.9: Active Lateral Navigation Submode Transition Table (Table A.9, pg. 75 in the FGS report)

Definitions:

- X1 = (term_lateral_NAV_Track_Cond_Met)
- X2 = (Duration(INMODE) > const_min_armed_period)
- X1' −− After-value of trigger event X1

- X2' −− After-value of trigger event X2
- Pre-P39 = @(NAV_Switch_Pressed)

6.9.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X1'	X2'	Post State
P39	Armed	F	F	T	T	Track
	Armed	T	T	T	T	Armed
	Armed	T	T	F	T	Armed
	Armed	T	T	T	F	Armed

Test specifications:

```
1) Test specification P39-1:

   Prefix:            Pre-P39              - Reach Armed
   Test case value:   X1 = False           - Trigger before-value
                      X2 = False           - Trigger before-value
                      X1 = True            - Trigger event
                      X2 = True            - Trigger event
   Expected Output:   Track

2) Test specification P39-2:

   Prefix:            Pre-P39              - Reach Armed
   Test case value:   X1 = True            - Trigger before-value
                      X2 = True            - Trigger before-value
                      X1 = True            - Trigger event
                      X2 = True            - Trigger event
   Expected Output:   Armed

3) Test specification P39-3:

   Prefix:            Pre-P39              - Reach Armed
   Test case value:   X1 = False           - Trigger before-value
                      X2 = False           - Trigger before-value
                      X1 = False           - Trigger event
                      X2 = True            - Trigger event
   Expected Output:   Armed

4) Test specification P39-4:

   Prefix:            Pre-P39              - Reach Armed
   Test case value:   X1 = False           - Trigger before-value
                      X2 = False           - Trigger before-value
                      X1 = True            - Trigger event
                      X2 = False           - Trigger event
   Expected Output:   Armed
```

6.9.2 Transition Pair Coverage Level Requirements:

NONE.

6.10 Active Lateral Approach Submode Test Cases

Id	From	Events	To
40	Armed	@T(mode_Lateral_APPR_Track_Cond_Met AND Duration(INMODE) > const_min_armed_period)	Track

Table 6.10: Active Lateral Approach Submode Transition Table (Table A.10, pg. 75 in the FGS report)

Definitions:

- X1 = (term_lateral_APPR_Track_Cond_Met)
- X2 = (Duration(INMODE) > const_min_armed_period)
- X1' −− After-value of trigger event X1
- X2' −− After-value of trigger event X2
- Pre-P40 = @(APPR_Switech_Pressed)

6.10.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X1'	X2'	Post State
P40	Armed	F	F	T	T	Track
	Armed	T	T	T	T	Armed
	Armed	T	T	F	T	Armed
	Armed	T	T	T	F	Armed

Test specifications:

```
1) Test specification P40-1:

   Prefix:           Pre-P40            - Reach Armed
   Test case value:  X1 = False         - Trigger before-value
                     X2 = False         - Trigger before-value
                     X1 = True          - Trigger event
                     X2 = True          - Trigger event
   Expected Output:  Track

2) Test specification P40-2:

   Prefix:           Pre-P40            - Reach Armed
   Test case value:  X1 = True          - Trigger before-value
                     X2 = True          - Trigger before-value
                     X1 = True          - Trigger event
                     X2 = True          - Trigger event
   Expected Output:  Armed

3) Test specification P40-3:

   Prefix:           Pre-P40                - Reach Armed
   Test case value:  X1 = False             - Trigger before-value
                     X2 = False             - Trigger before-value
                     X1 = False             - Trigger event
                     X2 = True              - Trigger event
   Expected Output:  Armed

4) Test specification P40-4:

   Prefix:           Pre-P40                - Reach Armed
   Test case value:  X1 = False             - Trigger before-value
                     X2 = False             - Trigger before-value
                     X1 = True              - Trigger event
                     X2 = False             - Trigger event
   Expected Output:  Armed
```

6.10.2 Transition Pair Coverage Level Requirements:

NONE.

6.11 Active Vertical Mode Test Cases

Id	From	Events	To
41	GA	@T(term_SYNC)	PITCH
42	$\overline{\text{VS OR}}$ $\overline{\text{APPR OR}}$ $\overline{\text{ALTSEL OR}}$ $\overline{\text{PITCH}}$	@VS_Pitch_Wheel_Changed	PITCH
43	$\overline{\text{ALTSEL}}$	@T(mode_Altitude_Select = ACTIVE)	ALTSEL
44	ALTSEL	@CHANGED(Preselected_Altitude) WHEN mode_Altitude_Select = ACTIVE/Capture	PITCH
45	ALTSEL	@CHANGED(Preselected_Altitude) WHEN mode_Altitude_Select = ACTIVE/Track	ALTHOLD
46	$\overline{\text{APPR OR}}$ $\overline{\text{ALTHOLD}}$	@ALT_Switch_Pressed	ALTHOLD
47	ALTHOLD	@ALT_Switch_Pressed	PITCH
48	$\overline{\text{APPRORVS}}$	@VS_Switch_Pressed	VS
49	VS	@VS_Switch_Pressed	PITCH
50	$\overline{\text{APPRORFLC}}$	@FLC_Switch_Pressed	FLC
51	FLC	@FLC_Switch_Pressed	PITCH
52	$\overline{\text{ALTSEL OR}}$ $\overline{\text{ALTHOLD OR}}$ $\overline{\text{APPRORFLC}}$	CONTINUOUSLY WHEN term_Overspeed	FLC
53	$\overline{\text{APPR}}$	@T(mode_Vertical_Approach = TRACK)	APPR
54	APPR	@T(mode_Vertical_Approach = TRACK) AND NOT @GA_Pressed	PITCH
55	$\overline{\text{GA}}$	@GA_Pressed	GA
56	GA	@T(term_AP_Engaged)	PITCH
57	GA	@F(mode_Active_Lateral = GA)	PITCH

Table 6.11: Active Vertical Mode Transition Table
(Table A.11, pg. 81 in the FGS report)

Definitions:

- X1 = term_SYNC
- X2 = @(VS_Pitch_Wheel_Changed)
- X3 = (mode_Altitude_Select = ACTIVE)
- X4 = @CHANGED(preselected_Altitude)
- X5 = (mode_Altitude_Select = ACTIVE/Capture)
- X6 = (mode_Altitude_Select = ACTIVE/Track)
- X7 = term_Overspeed
- X8 = (mode_Vertical_Approach = Track)

- X9 = term_AP_Engaged
- X10 = (mode_Active_Lateral = GA)
- X11 = @ALT_Switch_Pressed
- X12 = @VS_Switch_Pressed
- X13 = @FLC_Switch_Pressed
- X14 = @GA_Pressed

Full predicate coverage level test case requirements:

	Pre State	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14		Post State
P41	GA	F	-	-	-	-	-	-	-	-	-	-	-	-	-	X1' = T	PITCH
	GA	T	-	-	-	-	-	-	-	-	-	-	-	-	-	X1' = T	GA
	GA	T	-	-	-	-	-	-	-	-	-	-	-	-	-	X1' = T	GA
P42	GA	-	NOT@	-	-	-	-	-	-	-	-	-	-	-	-	X2'	PITCH
	GA	-	@	-	-	-	-	-	-	-	-	-	-	-	-	X2'	GA
	GA	-	NOT@	-	-	-	-	-	-	-	-	-	-	-	-	NOT X2'	GA
	ALTHOLD	-	NOT@	-	-	-	-	-	-	-	-	-	-	-	-	X2'	PITCH
	ALTHOLD	-	@	-	-	-	-	-	-	-	-	-	-	-	-	X2'	ALTHOLD
	ALTHOLD	-	NOT@	-	-	-	-	-	-	-	-	-	-	-	-	NOT X2'	ALTHOLD
	FLC	-	NOT@	-	-	-	-	-	-	-	-	-	-	-	-	X2'	PITCH
	FLC	-	@	-	-	-	-	-	-	-	-	-	-	-	-	X2'	FLC
	FLC	-	NOT@	-	-	-	-	-	-	-	-	-	-	-	-	NOT X2'	FLC
P43	GA	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = T	ALTSEL
	GA	-	-	T	-	-	-	-	-	-	-	-	-	-	-	X3' = T	GA
	GA	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = F	GA
	VS	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = T	ALTSEL
	VS	-	-	T	-	-	-	-	-	-	-	-	-	-	-	X3' = T	VS
	VS	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = F	VS
	APPR	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = T	ALTSEL
	APPR	-	-	T	-	-	-	-	-	-	-	-	-	-	-	X3' = T	APPR
	APPR	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = F	APPR
	PITCH	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = T	ALTSEL
	PITCH	-	-	T	-	-	-	-	-	-	-	-	-	-	-	X3' = T	PITCH
	PITCH	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = F	PITCH
	ALTHOLD	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = T	ALTSEL
	ALTHOLD	-	-	T	-	-	-	-	-	-	-	-	-	-	-	X3' = T	ALTHOLD
	ALTHOLD	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = F	ALTHOLD
	FLC	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = T	ALTSEL
	FLC	-	-	T	-	-	-	-	-	-	-	-	-	-	-	X3' = T	FLC
	FLC	-	-	F	-	-	-	-	-	-	-	-	-	-	-	X3' = F	FLC
P44	ALTSEL	-	-	-	NOT@	t	-	-	-	-	-	-	-	-	-	X4'	PITCH
	ALTSEL	-	-	-	@	t	-	-	-	-	-	-	-	-	-	X4'	ALTSEL
	ALTSEL	-	-	-	NOT@	f	-	-	-	-	-	-	-	-	-	X4'	ALTSEL

```
    ALTSEL-  -  -NOT@ t  -  -  -  -  -   -   -   -   -    NOT X4'      ALTSEL

P45 ALTSEL-  -  -NOT@ t  -  -  -  -  -   -   -   -   -    X4'          ALTHOLD
    ALTSEL-  -  -  @  t  -  -  -  -  -   -   -   -   -    X4'          ALTSEL
    ALTSEL-  -  -NOT@ f  -  -  -  -  -   -   -   -   -    X4'          ALTSEL
    ALTSEL-  -  -NOT@ t  -  -  -  -  -   -   -   -   -    NOT X4'      ALTSEL

P46 GA    -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    X11'         ALTHOLD
    GA    -  -  -  -  -  -  -  -  -   -  @   -   -   -    X11'         GA
    GA    -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    NOT X11'     GA
    VS    -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    X11'         ALTHOLD
    VS    -  -  -  -  -  -  -  -  -   -  @   -   -   -    X11'         VS
    VS    -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    NOT X11'     VS
    ALTSEL-  -  -  -  -  -  -  -  -   - NOT@ -   -   -    X11'         ALTHOLD
    ALTSEL-  -  -  -  -  -  -  -  -   -  @   -   -   -    X11'         ALTSEL
    ALTSEL-  -  -  -  -  -  -  -  -   - NOT@ -   -   -    NOT X11'     ALTSEL
    PITCH -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    X11'         ALTHOLD
    PITCH -  -  -  -  -  -  -  -  -   -  @   -   -   -    X11'         PITCH
    PITCH -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    NOT X11'     PITCH
    FLC   -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    X11'         ALTHOLD
    FLC   -  -  -  -  -  -  -  -  -   -  @   -   -   -    X11'         FLC
    FLC   -  -  -  -  -  -  -  -  -   - NOT@ -   -   -    NOT X11'     FLC

P47ALTHOLD-  -  -  -  -  -  -  -  -   - NOT@ -   -   -    X11'         PITCH
   ALTHOLD-  -  -  -  -  -  -  -  -   -  @   -   -   -    X11'         ALTHOLD
   ALTHOLD-  -  -  -  -  -  -  -  -   - NOT@ -   -   -    NOT X11'     ALTHOLD

P48 GA    -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    X12'         VS
    GA    -  -  -  -  -  -  -  -  -   -  -    @  -   -    X12'         GA
    GA    -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    NOT X12'     GA
    ALTSEL-  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    X12'         VS
    ALTSEL-  -  -  -  -  -  -  -  -   -  -    @  -   -    X12'         ALTSEL
    ALTSEL-  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    NOT X12'     ALTSEL
    PITCH -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    X12'         PITCH
    PITCH -  -  -  -  -  -  -  -  -   -  -    @  -   -    X12'         ALTSEL
    PITCH -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    NOT X12'     ALTSEL
   ALTHOLD-  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    X12'         PITCH
   ALTHOLD-  -  -  -  -  -  -  -  -   -  -    @  -   -    X12'         ALTHOLD
   ALTHOLD-  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    NOT X12'     ALTHOLD
    FLC   -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    X12'         VS
    FLC   -  -  -  -  -  -  -  -  -   -  -    @  -   -    X12'         FLC
    FLC   -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    NOT X12'     FLC

P49 VS    -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    X12'         PITCH
    VS    -  -  -  -  -  -  -  -  -   -  -    @  -   -    X12'         VS
    VS    -  -  -  -  -  -  -  -  -   -  -  NOT@ -   -    NOT X12'     VS

P50 GA    -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    X13'         FLC
    GA    -  -  -  -  -  -  -  -  -   -  -    -  @   -    X13'         GA
    GA    -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    NOT X13'     GA
    VS    -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    X13'         FLC
    VS    -  -  -  -  -  -  -  -  -   -  -    -  @   -    X13'         VS
    VS    -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    NOT X13'     VS
    ALTSEL-  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    X13'         FLC
    ALTSEL-  -  -  -  -  -  -  -  -   -  -    -  @   -    X13'         ALTSEL
    ALTSEL-  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    NOT X13'     ALTSEL
    PITCH -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    X13'         FLC
    PITCH -  -  -  -  -  -  -  -  -   -  -    -  @   -    X13'         PITCH
    PITCH -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    NOT X13'     PITCH
  ALTHOLD -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    X13'         FLC
  ALTHOLD -  -  -  -  -  -  -  -  -   -  -    -  @   -    X13'         ALTHOLD
  ALTHOLD -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    NOT X13'     ALTHOLD

P51 FLC   -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    X13'         PITCH
    FLC   -  -  -  -  -  -  -  -  -   -  -    -  @   -    X13'         FLC
    FLC   -  -  -  -  -  -  -  -  -   -  -   -  NOT@ -    NOT X13'     FLC

P52ALTSEL -  -  -  -  -  -  t  -  -  -   -   -   -   -                 ALTSEL
   ALTSEL -  -  -NOT@ t  -  t  -  -  -   -   -   -   -    X4'          FLC
   ALTSEL -  -  -NOT@ t  -  f  -  -  -   -   -   -   -    X4'          PITCH
   ALTSEL -  -  -  @  t  -  t  -  -  -   -   -   -   -    X4'          ALTSEL
   ALTSEL -  -  -NOT@ f  -  t  -  -  -   -   -   -   -    X4'          ALTSEL
   ALTSEL -  -  -NOT@ t  -  t  -  -  -   -   -   -   -    NOT X4'      ALTSEL
   ALTSEL -  -  -  -  -  -  t  -  -  -   -  NOT@ -   -    X12'         FLC
   ALTSEL -  -  -  -  -  -  f  -  -  -   -  NOT@ -   -    X12'         VS
   ALTSEL -  -  -  -  -  -  t  -  -  -   -   @   -   -    X12'         ALTSEL
   ALTSEL -  -  -  -  -  -  t  -  -  -   -  NOT@ -   -    NOT X12'     ALTSEL
   ALTSEL -  -  -  -  -  -  t  -  -  -   -   -   -  NOT@  X14'         FLC
   ALTSEL -  -  -  -  -  -  f  -  -  -   -   -   -  NOT@  X14'         GA
   ALTSEL -  -  -  -  -  -  t  -  -  -   -   -   -   @    X14'         ALTSEL
   ALTSEL -  -  -  -  -  -  t  -  -  -   -   -   -  NOT@  NOT X14'     ALTSEL

  ALTHOLD -  -  -  -  -  -  t  -  -  -   -   -   -   -                 ALTHOLD
  ALTHOLD -NOT@ -  -  -  -  t  -  -  -   -   -   -   -    X2'          FLC
  ALTHOLD -NOT@ -  -  -  -  f  -  -  -   -   -   -   -    X2'          PITCH
  ALTHOLD -  @  -  -  -  -  t  -  -  -   -   -   -   -    X2'          ALTHOLD
  ALTHOLD -NOT@ -  -  -  -  t  -  -  -   -   -   -   -    NOT X2'      ALTHOLD
  ALTHOLD -  -  -  -  -  -  t  -  -  -  NOT@ -   -   -    X11'         FLC
  ALTHOLD -  -  -  -  -  -  f  -  -  -  NOT@ -   -   -    X11'         PITCH
  ALTHOLD -  -  -  -  -  -  t  -  -  -   @   -   -   -    X11'         ALTHOLD
  ALTHOLD -  -  -  -  -  -  t  -  -  -  NOT@ -   -   -    NOT X11'     ALTHOLD
  ALTHOLD -  -  -  -  -  -  t  -  -  -   -  NOT@ -   -    X12'         FLC
  ALTHOLD -  -  -  -  -  -  f  -  -  -   -  NOT@ -   -    X12'         VS
  ALTHOLD -  -  -  -  -  -  t  -  -  -   -   @   -   -    X12'         ALTHOLD
  ALTHOLD -  -  -  -  -  -  t  -  -  -   -  NOT@ -   -    NOT X12'     ALTHOLD
  ALTHOLD -  -  -  -  -  -  t  -  -  -   -   -   -  NOT@  X14'         FLC
  ALTHOLD -  -  -  -  -  -  f  -  -  -   -   -   -  NOT@  X14'         GA
  ALTHOLD -  -  -  -  -  -  t  -  -  -   -   -   -   @    X14'         ALTHOLD
  ALTHOLD -  -  -  -  -  -  f  -  -  -   -   -   -  NOT@  NOT X14'     ALTHOLD

     APPR -  -  -  -  -  -  t  -  -  -   -   -   -   -                 APPR
     APPR -  -  -  -  -  -  t  F  -  -   -   -   -   @    X8' = True   FLC
```

```
                                                          NOT X14'
     APPR -  -  -  -  -  -  f  F  -  -   -   -   -   @    X8' = True   PITCH
                                                          NOT X14'
     APPR -  -  -  -  -  -  t  T  -  -   -   -   -   @    X8' = True   APPR
                                                          NOT X14'
     APPR -  -  -  -  -  -  t  F  -  -   -   -   -  NOT@  X8' = True   APPR
                                                          NOT X14'
     APPR -  -  -  -  -  -  t  F  -  -   -   -   -   @    X8' = False  APPR
                                                          NOT X14'
     APPR -  -  -  -  -  -  t  F  -  -   -   -   -   @    X8' = True   APPR
                                                          X14'
     APPR -  -  -  -  -  -  t  -  -  -   -   -   -  NOT@  X14'         FLC
     APPR -  -  -  -  -  -  f  -  -  -   -   -   -  NOT@  X14'         GA
     APPR -  -  -  -  -  -  t  -  -  -   -   -   -   @    X14'         APPR
     APPR -  -  -  -  -  -  t  -  -  -   -   -   -  NOT@  NOT X14'     APPR

      FLC -  -  -  -  -  -  t  -  -  -   -   -   -   -                 FLC
      FLC -NOT@ -  -  -  -  t  -  -  -   -   -   -   -    X2'          FLC
      FLC -NOT@ -  -  -  -  f  -  -  -   -   -   -   -    X2'          PITCH
      FLC -  @  -  -  -  -  t  -  -  -   -   -   -   -    X2'          FLC
      FLC -NOT@ -  -  -  -  t  -  -  -   -   -   -   -    NOT X2'      FLC
      FLC -  -  -  -  -  -  t  -  -  -   -  NOT@ -   -    X12'         FLC
      FLC -  -  -  -  -  -  f  -  -  -   -  NOT@ -   -    X12'         VS
      FLC -  -  -  -  -  -  t  -  -  -   -   @   -   -    X12'         FLC
      FLC -  -  -  -  -  -  t  -  -  -   -  NOT@ -   -    NOT X12'     FLC
      FLC -  -  -  -  -  -  t  -  -  -   -   -  NOT@ -    X13'         FLC
      FLC -  -  -  -  -  -  f  -  -  -   -   -  NOT@ -    X13'         PITCH
      FLC -  -  -  -  -  -  t  -  -  -   -   -   @   -    X13'         FLC
      FLC -  -  -  -  -  -  t  -  -  -   -   -  NOT@ -    NOT X13'     FLC
      FLC -  -  -  -  -  -  t  -  -  -   -   -   -  NOT@  X14'         FLC
      FLC -  -  -  -  -  -  f  -  -  -   -   -   -  NOT@  X14'         GA
      FLC -  -  -  -  -  -  t  -  -  -   -   -   -   @    X14'         FLC
      FLC -  -  -  -  -  -  t  -  -  -   -   -   -  NOT@  NOT X14'     FLC

P53 GA    -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = T      APPR
    GA    -  -  -  -  -  -  -  T  -  -   -   -   -   -    X8' = T      GA
    GA    -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = F      GA
    VS    -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = T      APPR
    VS    -  -  -  -  -  -  -  T  -  -   -   -   -   -    X8' = T      VS
    VS    -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = F      VS
    ALTSEL-  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = T      APPR
    ALTSEL-  -  -  -  -  -  -  T  -  -   -   -   -   -    X8' = T      ALTSEL
    ALTSEL-  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = F      ALTSEL
    PITCH -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = T      APPR
    PITCH -  -  -  -  -  -  -  T  -  -   -   -   -   -    X8' = T      PITCH
    PITCH -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = F      PITCH
  ALTHOLD -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = T      APPR
  ALTHOLD -  -  -  -  -  -  -  T  -  -   -   -   -   -    X8' = T      ALTHOLD
  ALTHOLD -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = F      ALTHOLD
     FLC  -  -  -  -  -  -  -  F  -  -   -   -   -   -    X8' = T      APPR
     FLC  -  -  -  -  -  -  -  T  -  -   -   -   -   -    X8' = T      FLC
```

	FLC	-	-	-	-	-	-	-	F	-	-	-	-	-	-	X8' = F	FLC
P54	APPR	-	-	-	-	-	-	-	F	-	-	-	-	-	@	X8'= T NOT X14'	PITCH
	APPR	-	-	-	-	-	-	-	F	-	-	-	-	-	NOT@	X8'= T NOT X14'	APPR
	APPR	-	-	-	-	-	-	-	T	-	-	-	-	-	@	X8'= T NOT X14'	APPR
	APPR	-	-	-	-	-	-	-	F	-	-	-	-	-	@	X8'= F NOT X14'	APPR
	APPR	-	-	-	-	-	-	-	F	-	-	-	-	-	@	X8'= T X14'	APPR
P55	VS	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	X14'	GA
	VS	-	-	-	-	-	-	-	-	-	-	-	-	-	@	X14'	VS
	VS	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	NOT X14'	VS
	APPR	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	X14'	GA
	APPR	-	-	-	-	-	-	-	-	-	-	-	-	-	@	X14'	APPR
	APPR	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	NOT X14'	APPR
	ALTSEL	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	X14'	GA
	ALTSEL	-	-	-	-	-	-	-	-	-	-	-	-	-	@	X14'	ALTSEL
	ALTSEL	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	NOT X14'	ALTSEL
	PITCH	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	X14'	GA
	PITCH	-	-	-	-	-	-	-	-	-	-	-	-	-	@	X14'	PITCH
	PITCH	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	NOT X14'	PITCH
	ALTHOLD	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	X14'	GA
	ALTHOLD	-	-	-	-	-	-	-	-	-	-	-	-	-	@	X14'	ALTHOLD
	ALTHOLD	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	NOT X14'	ALTHOLD
	FLC	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	X14'	GA
	FLC	-	-	-	-	-	-	-	-	-	-	-	-	-	@	X14'	FLC
	FLC	-	-	-	-	-	-	-	-	-	-	-	-	-	NOT@	NOT X14'	FLC
P56	GA	-	-	-	-	-	-	-	-	F	-	-	-	-	-	X9' = T	PITCH
	GA	-	-	-	-	-	-	-	-	T	-	-	-	-	-	X9' = T	GA
	GA	-	-	-	-	-	-	-	-	F	-	-	-	-	-	X9' = F	GA
P57	GA	-	-	-	-	-	-	-	-	-	T	-	-	-	-	X10' = F	PITCH
	GA	-	-	-	-	-	-	-	-	-	F	-	-	-	-	X10' = F	GA
	GA	-	-	-	-	-	-	-	-	-	T	-	-	-	-	X10' = T	GA

Test specifications:

1) Test specification P41-1:

Prefix:	X14	- Reach GA
Test case value:	X1 = False	- Trigger event before-value
	X1 = True	- Trigger event
Expected Output:	PITCH	

2) Test specification P41-2:

Prefix:	X14	- Reach GA

```
  Test case value:   X1 = True           - Trigger event before-value
                     X1 = True           - Trigger event
  Expected Output:   GA

3) Test specification P41-3:

  Prefix:            X14                 - Reach GA
  Test case value:   X1 = False          - Trigger event before-value
                     X1 = False          - Trigger event
  Expected Output:   GA

4) Test specification P42-1:

  Prefix:            X14                 - Reach GA
  Test case value:   NOT X2              - Trigger event before-value
                     X2                  - Trigger event
  Expected Output:   PITCH

5) Test specification P42-2:

  Prefix:            X14                 - Reach GA
  Test case value:   X2                  - Trigger event before-value
                     X2                  - Trigger event
  Expected Output:   GA

6) Test specification P42-3:

  Prefix:            X14                 - Reach GA
  Test case value:   NOT X2              - Trigger event before-value
                     NOT X2              - Trigger event
  Expected Output:   GA

7) Test specification P42-4:

  Prefix:            X4 = True           - Reach ALTHOLD
                     X5 = True           - Condition variable
                     X11                 - Reach ALTHOLD
  Test case value:   NOT X2              - Trigger event before-value
                     X2                  - Trigger event
  Expected Output:   PITCH

8) Test specification P42-5:

  Prefix:            X4 = True           - Reach ALTHOLD
                     X5 = True           - Condition variable
                     X11                 - Reach ALTHOLD
  Test case value:   X2                  - Trigger event before-value
                     X2                  - Trigger event
  Expected Output:   ALTHOLD

9) Test specification P42-6:
  Prefix:             X14                  - Reach ALTHOLD
  Test case value:    NOT X2               - Trigger event before-value
                      NOT X2               - Trigger event
  Expected Output:    ALTHOLD
```

10) Test specification P42-7:

```
  Prefix:             X13                  - Reach FLC
  Test case value:    NOT X2               - Trigger event before-value
                      X2                   - Trigger event
  Expected Output:    PITCH
```

11) Test specification P42-8:

```
  Prefix:             X13                  - Reach FLC
  Test case value:    X2                   - Trigger event before-value
                      X2                   - Trigger event
  Expected Output:    FLC
```

12) Test specification P42-9:

```
  Prefix:             X13                  - Reach FLC
  Test case value:    NOT X2               - Trigger event before-value
                      NOT X2               - Trigger event
  Expected Output:    FLC
```

13) Test specification P43-1:

```
  Prefix:             X14                  - Reach GA
  Test case value:    X3 = False           - Trigger event before-value
                      X3 = True            - Trigger event
  Expected Output:    ALTSEL
```

14) Test specification P43-2:

```
  Prefix:             X14                  - Reach GA
  Test case value:    X3 = True            - Trigger event before-value
                      X3 = True            - Trigger event
  Expected Output:    GA
```

15) Test specification P43-3:

```
  Prefix:             X14                  - Reach GA
  Test case value:    X3 = False           - Trigger event before-value
                      X3 = False           - Trigger event
  Expected Output:    GA
```

16) Test specification P43-4:

```
  Prefix:             X12                  - Reach VS
  Test case value:    X3 = False           - Trigger event before-value
```

```
                    X3 = True           - Trigger event
  Expected Output:  ALTSEL

17) Test specification P43-5:

  Prefix:           X12                 - Reach VS
  Test case value:  X3 = True           - Trigger event before-value
                    X3 = True           - Trigger event
  Expected Output:  VS

18) Test specification P43-6:

  Prefix:           X12                 - Reach VS
  Test case value:  X3 = False          - Trigger event before-value
                    X3 = False          - Trigger event
  Expected Output:  VS

19) Test specification P43-7:

  Prefix:           X8 = True           - Reach APPR
  Test case value:  X3 = False          - Trigger event before-value
                    X3 = True           - Trigger event
  Expected Output:  ALTSEL

20) Test specification P43-8:

  Prefix:           X8 = True           - Reach APPR
  Test case value:  X3 = True           - Trigger event before-value
                    X3 = True           - Trigger event
  Expected Output:  APPR

21) Test specification P43-9:

  Prefix:           X8 = True           - Reach APPR
  Test case value:  X3 = False          - Trigger event before-value
                    X3 = False          - Trigger event
  Expected Output:  APPR

22) Test specification P43-10:

  Prefix:           X2                  - Reach PITCH
  Test case value:  X3 = False          - Trigger event before-value
                    X3 = True           - Trigger event
  Expected Output:  ALTSEL

23) Test specification P43-11:

  Prefix:           X2                  - Reach PITCH
  Test case value:  X3 = True           - Trigger event before-value
                    X3 = True           - Trigger event
  Expected Output:  PITCH
```

24) Test specification P43-12:

```
  Prefix:             X2                    - Reach PITCH
  Test case value:    X3 = False            - Trigger event before-value
                      X3 = False            - Trigger event
  Expected Output:    PITCH
```

25) Test specification P43-13:

```
  Prefix:             X4                    - Reach ALTHOLD
                      X5 = True             - Condition variable
                      X11                   - Reach ALTHOLD
  Test case value:    X3 = False            - Trigger event before-value
                      X3 = True             - Trigger event
  Expected Output:    ALTSEL
```

26) Test specification P43-14:

```
  Prefix:             X4                    - Reach ALTHOLD
                      X5 = True             - Condition variable
                      X11                   - Reach ALTHOLD
  Test case value:    X3 = True             - Trigger event before-value
                      X3 = True             - Trigger event
  Expected Output:    ALTHOLD
```

27) Test specification P43-15:

```
  Prefix:             X4                    - Reach ALTHOLD
                      X5 = True             - Condition variable
                      X11                   - Reach ALTHOLD
  Test case value:    X3 = False            - Trigger event before-value
                      X3 = False            - Trigger event
  Expected Output:    ALTHOLD
```

28) Test specification P43-16:

```
  Prefix:             X13                   - Reach FLC
  Test case value:    X3 = False            - Trigger event before-value
                      X3 = True             - Trigger event
  Expected Output:    ALTHOLD
```

29) Test specification P43-17:

```
  Prefix:             X13                   - Reach FLC
  Test case value:    X3 = True             - Trigger event before-value
                      X3 = True             - Trigger event
  Expected Output:    ALTHOLD
```

30) Test specification P43-18:

```
  Prefix:             X13                   - Reach FLC
  Test case value:   X3 = False          - Trigger event before-value
                     X3 = False          - Trigger event
  Expected Output:   ALTHOLD

31) Test specification P44-1:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event before-value
                     X5 = True           - Condition variable
                     X4                  - Trigger event
  Expected Output:   PITCH

32) Test specification P44-2:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X4                  - Trigger event before-value
                     X5 = True           - Condition variable
                     X4                  - Trigger event
  Expected Output:   ALTSEL

33) Test specification P44-3:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event before-value
                     X5 = False          - Condition variable
                     X4                  - Trigger event
  Expected Output:   ALTSEL

34) Test specification P44-4:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event before-value
                     X5 = True           - Condition variable
                     NOT X4              - Trigger event
  Expected Output:   ALTSEL

35) Test specification P45-1:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event before-value
                     X6 = True           - Condition variable
                     X4                  - Trigger event
  Expected Output:   PITCH

36) Test specification P45-2:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X4                  - Trigger event before-value
                     X6 = True           - Condition variable
                     X4                  - Trigger event
  Expected Output:   ALTSEL
```

37) Test specification P45-3:

```
  Prefix:              X3 = True           - Reach ALTSEL
  Test case value:     NOT X4              - Trigger event before-value
                       X5 = False          - Condition variable
                       X4                  - Trigger event
  Expected Output:     ALTSEL
```

38) Test specification P45-4:

```
  Prefix:              X3 = True           - Reach ALTSEL
  Test case value:     NOT X4              - Trigger event before-value
                       X5 = True           - Condition variable
                       NOT X4              - Trigger event
  Expected Output:     ALTSEL
```

39) Test specification P46-1:

```
  Prefix:              X14                 - Reach GA
  Test case value:     NOT X11             - Trigger event before-value
                       X11                 - Trigger event
  Expected Output:     ALTHOLD
```

40) Test specification P46-2:

```
  Prefix:              X14                 - Reach GA
  Test case value:     X11                 - Trigger event before-value
                       X11                 - Trigger event
  Expected Output:     GA
```

41) Test specification P46-3:

```
  Prefix:              X14                 - Reach GA
  Test case value:     NOT X11             - Trigger event before-value
                       NOT X11             - Trigger event
  Expected Output:     GA
```

42) Test specification P46-4:

```
  Prefix:              X12                 - Reach VS
  Test case value:     NOT X11             - Trigger event before-value
                       X11                 - Trigger event
  Expected Output:     ALTHOLD
```

43) Test specification P46-5:

```
  Prefix:              X12                 - Reach VS
  Test case value:     X11                 - Trigger event before-value
                       X11                 - Trigger event
  Expected Output:     VS
```

```
44) Test specification P46-6:

  Prefix:            X12                 - Reach VS
  Test case value:   NOT X11             - Trigger event before-value
                     NOT X11             - Trigger event
  Expected Output:   VS

45) Test specification P46-7:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X11             - Trigger event before-value
                     X11                 - Trigger event
  Expected Output:   ALTHOLD

46) Test specification P46-8:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X11                 - Trigger event before-value
                     X11                 - Trigger event
  Expected Output:   ALTSEL

47) Test specification P46-9:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X11             - Trigger event before-value
                     NOT X11             - Trigger event
  Expected Output:   ALTSEL

48) Test specification P46-10:

  Prefix:            X2                  - Reach PITCH
  Test case value:   NOT X11             - Trigger event before-value
                     X11                 - Trigger event
  Expected Output:   ALTHOLD

49) Test specification P46-11:

  Prefix:            X2                  - Reach PITCH
  Test case value:   X11                 - Trigger event before-value
                     X11                 - Trigger event
  Expected Output:   PITCH

50) Test specification P46-12:

  Prefix:            X2                  - Reach PITCH
  Test case value:   NOT X11             - Trigger event before-value
                     NOT X11             - Trigger event
  Expected Output:   PITCH

51) Test specification P46-13:
  Prefix:            X13                - Reach FLC
  Test case value:   NOT X11            - Trigger event before-value
                     X11                - Trigger event
  Expected Output:   ALTHOLD
```

52) Test specification P46-14:

```
  Prefix:            X13                - Reach FLC
  Test case value:   X11                - Trigger event before-value
                     X11                - Trigger event
  Expected Output:   FLC
```

53) Test specification P46-15:

```
  Prefix:            X13                - Reach FLC
  Test case value:   NOT X11            - Trigger event before-value
                     NOT X11            - Trigger event
  Expected Output:   FLC
```

54) Test specification P47-1:

```
  Prefix:            X4 = True          - Reach ALTHOLD
                     X5 = True          - Condition variable
                     X11                - Reach ALTHOLD
  Test case value:   NOT X11            - Trigger event before-value
                     X11                - Trigger event
  Expected Output:   PITCH
```

55) Test specification P47-2:

```
  Prefix:            X4 = True          - Reach ALTHOLD
                     X5 = True          - Condition variable
                     X11                - Reach ALTHOLD
  Test case value:   X11                - Trigger event before-value
                     X11                - Trigger event
  Expected Output:   ALTHOLD
```

56) Test specification P47-3:

```
  Prefix:            X4 = True          - Reach ALTHOLD
                     X5 = True          - Condition variable
                     X11                - Reach ALTHOLD
  Test case value:   NOT X11            - Trigger event before-value
                     NOT X11            - Trigger event
  Expected Output:   ALTHOLD
```

57) Test specification P48-1:

```
  Prefix:            X14                - Reach GA
  Test case value:   NOT X12            - Trigger event before-value
                     X12                - Trigger event
  Expected Output:   VS

58) Test specification P48-2:

  Prefix:            X14                 - Reach GA
  Test case value:   X12                 - Trigger event before-value
                     X12                 - Trigger event
  Expected Output:   GA

59) Test specification P48-3:

  Prefix:            X14                 - Reach GA
  Test case value:   NOT X12             - Trigger event before-value
                     NOT X12             - Trigger event
  Expected Output:   GA

60) Test specification P48-4:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X12             - Trigger event before-value
                     X12                 - Trigger event
  Expected Output:   VS

61) Test specification P48-5:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X12                 - Trigger event before-value
                     X12                 - Trigger event
  Expected Output:   ALTSEL

62) Test specification P48-6:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X12             - Trigger event before-value
                     NOT X12             - Trigger event
  Expected Output:   ALTSEL

63) Test specification P48-7:

  Prefix:            X2                  - Reach PITCH
  Test case value:   NOT X12             - Trigger event before-value
                     X12                 - Trigger event
  Expected Output:   VS

64) Test specification P48-8:

  Prefix:            X2                  - Reach PITCH
  Test case value:   X12                 - Trigger event before-value
                     X12                 - Trigger event
  Expected Output:   PITCH
```

65) Test specification P48-9:

```
  Prefix:            X2                 - Reach PITCH
  Test case value:   NOT X12            - Trigger event before-value
                     NOT X12            - Trigger event
  Expected Output:   PITCH
```

66) Test specification P48-10:

```
  Prefix:            X4                 - Reach ALTHOLD
                     X6 = True          - Condition variable
                     X11                - Reach ALTHOLD
  Test case value:   X12                - Trigger event before-value
                     NOT X12            - Trigger event
  Expected Output:   VS
```

67) Test specification P48-11:

```
  Prefix:            X4                 - Reach ALTHOLD
                     X6 = True          - Condition variable
                     X11                - Reach ALTHOLD
  Test case value:   X12                - Trigger event before-value
                     X12                - Trigger event
  Expected Output:   ALTHOLD
```

68) Test specification P48-12:

```
  Prefix:            X4                 - Reach ALTHOLD
                     X6 = True          - Condition variable
                     X11                - Reach ALTHOLD
  Test case value:   NOT X12            - Trigger event before-value
                     NOT X12            - Trigger event
  Expected Output:   ALTHOLD
```

69) Test specification P48-13:

```
  Prefix:            X13                - Reach FLC
  Test case value:   NOT X12            - Trigger event before-value
                     X12                - Trigger event
  Expected Output:   VS
```

70) Test specification P48-14:

```
  Prefix:            X13                - Reach FLC
  Test case value:   X12                - Trigger event before-value
                     X12                - Trigger event
  Expected Output:   FLC
```

71) Test specification P48-15:

```
  Prefix:            X13                - Reach FLC
  Test case value:   NOT X12            - Trigger event before-value
                     NOT X12            - Trigger event
  Expected Output:   ALTHOLD

72) Test specification P49-1:

  Prefix:            X12                - Reach VS
  Test case value:   NOT X12            - Trigger event before-value
                     X12                - Trigger event
  Expected Output:   PITCH

73) Test specification P49-2:

  Prefix:            X12                - Reach VS
  Test case value:   X12                - Trigger event before-value
                     X12                - Trigger event
  Expected Output:   VS

74) Test specification P49-3:

  Prefix:            X12                - Reach VS
  Test case value:   NOT X12            - Trigger event before-value
                     NOT X12            - Trigger event
  Expected Output:   VS

75) Test specification P50-1:

  Prefix:            X14                - Reach GA
  Test case value:   NOT X13            - Trigger event before-value
                     X13                - Trigger event
  Expected Output:   FLC

76) Test specification P50-2:

  Prefix:            X14                - Reach GA
  Test case value:   X13                - Trigger event before-value
                     X13                - Trigger event
  Expected Output:   GA

77) Test specification P50-3:

  Prefix:            X14                - Reach GA
  Test case value:   NOT X13            - Trigger event before-value
                     NOT X13            - Trigger event
  Expected Output:   GA

78) Test specification P50-4:

  Prefix:            X12                - Reach VS
  Test case value:   NOT X13            - Trigger event before-value
                     X13                - Trigger event
  Expected Output:   FLC

79) Test specification P50-5:

  Prefix:            X12                 - Reach VS
  Test case value:   X13                 - Trigger event before-value
                     X13                 - Trigger event
  Expected Output:   VS

80) Test specification P50-6:

  Prefix:            X12                 - Reach VS
  Test case value:   NOT X13             - Trigger event before-value
                     NOT X13             - Trigger event
  Expected Output:   VS

81) Test specification P50-7:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X13             - Trigger event before-value
                     X13                 - Trigger event
  Expected Output:   FLC

82) Test specification P50-8:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X13                 - Trigger event before-value
                     X13                 - Trigger event
  Expected Output:   ALTSEL

83) Test specification P50-9:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X13             - Trigger event before-value
                     NOT X13             - Trigger event
  Expected Output:   ALTSEL

84) Test specification P50-10:

  Prefix:            X2                  - Reach PITCH
  Test case value:   NOT X13             - Trigger event before-value
                     X13                 - Trigger event
  Expected Output:   FLC

85) Test specification P50-11:

  Prefix:            X2                  - Reach PITCH
  Test case value:   X13                 - Trigger event before-value
                     X13                 - Trigger event
  Expected Output:   PITCH
```

86) Test specification P50-12:

```
  Prefix:             X2                  - Reach PITCH
  Test case value:    NOT X13             - Trigger event before-value
                      NOT X13             - Trigger event
  Expected Output:    PITCH
```

87) Test specification P50-13:

```
  Prefix:             X4                  - Reach ALTHOLD
                      X6 = True           - Condition variable
                      X11                 - Reach ALTHOLD
  Test case value:    NOT X13             - Trigger event before-value
                      X13                 - Trigger event
  Expected Output:    FLC
```

88) Test specification P50-14:

```
  Prefix:             X4                  - Reach ALTHOLD
                      X6 = True           - Condition variable
                      X11                 - Reach ALTHOLD
  Test case value:    X13                 - Trigger event before-value
                      X13                 - Trigger event
  Expected Output:    ALTHOLD
```

89) Test specification P50-15:

```
  Prefix:             X4                  - Reach ALTHOLD
                      X6 = True           - Condition variable
                      X11                 - Reach ALTHOLD
  Test case value:    NOT X13             - Trigger event before-value
                      NOT X13             - Trigger event
  Expected Output:    ALTHOLD
```

90) Test specification P51-1:

```
  Prefix:             X13                 - Reach FLC
  Test case value:    NOT X13             - Trigger event before-value
                      X13                 - Trigger event
  Expected Output:    PITCH
```

91) Test specification P51-2:

```
  Prefix:             X13                 - Reach FLC
  Test case value:    X13                 - Trigger event before-value
                      X13                 - Trigger event
  Expected Output:    FLC
```

92) Test specification P51-3:

```
  Prefix:             X13                 - Reach FLC
  Test case value:   NOT X13             - Trigger event before-value
                     NOT X13             - Trigger event
  Expected Output:   FLC
```

93) Test specification P52-1:

```
  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X7 = True           - Condition variable
  Expected Output:   FLC
```

94) Test specification P52-2:

```
  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event befor-value
                     X5 = True           - Conditon variable
                     X7 = True           - Conditon variable
                     X4                  - Trigger event
  Expected Output:   FLC
```

95) Test specification P52-3:

```
  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event befor-value
                     X5 = True           - Conditon variable
                     X7 = False          - Conditon variable
                     X4                  - Trigger event
  Expected Output:   PITCH
```

96) Test specification P52-4:

```
  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X4                  - Trigger event befor-value
                     X5 = True           - Conditon variable
                     X7 = True           - Conditon variable
                     X4                  - Trigger event
  Expected Output:   ALTSEL
```

97) Test specification P52-5:

```
  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event befor-value
                     X5 = False          - Conditon variable
                     X7 = True           - Conditon variable
                     X4                  - Trigger event
  Expected Output:   ALTSEL
```

98) Test specification P52-6:

```
  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X4              - Trigger event befor-value
                     X5 = True           - Conditon variable
                     X7 = True          - Conditon variable
                     NOT X4             - Trigger event
  Expected Output:   ALTSEL

99) Test specification P52-7:

  Prefix:            X3 = True          - Reach ALTSEL
  Test case value:   NOT X12            - Trigger event befor-value
                     X7 = True          - Conditon variable
                     X12                - Trigger event
  Expected Output:   FLC

100) Test specification P52-8:

  Prefix:            X3 = True          - Reach ALTSEL
  Test case value:   NOT X12            - Trigger event befor-value
                     X7 = False         - Conditon variable
                     X12                - Trigger event
  Expected Output:   VS

101) Test specification P52-9:

  Prefix:            X3 = True          - Reach ALTSEL
  Test case value:   X12                - Trigger event befor-value
                     X7 = True          - Conditon variable
                     X12                - Trigger event
  Expected Output:   ALTSEL

102) Test specification P52-10:

  Prefix:            X3 = True          - Reach ALTSEL
  Test case value:   NOT X12            - Trigger event befor-value
                     X7 = True          - Conditon variable
                     NOT X12            - Trigger event
  Expected Output:   ALTSEL

103) Test specification P52-11:

  Prefix:            X3 = True          - Reach ALTSEL
  Test case value:   NOT X14            - Trigger event befor-value
                     X7 = True          - Conditon variable
                     X14                - Trigger event
  Expected Output:   FLC

104) Test specification P52-12:

  Prefix:            X3 = True          - Reach ALTSEL
  Test case value:   NOT X14            - Trigger event befor-value
                     X7 = False         - Conditon variable
                     X14                - Trigger event
  Expected Output:   GA
```

```
105) Test specification P52-13:

  Prefix:             X3 = True           - Reach ALTSEL
  Test case value:    X14                 - Trigger event befor-value
                      X7 = False          - Conditon variable
                      X14                 - Trigger event
  Expected Output:    ALTSEL

106) Test specification P52-14:

  Prefix:             X3 = True           - Reach ALTSEL
  Test case value:    NOT X14             - Trigger event befor-value
                      X7 = False          - Conditon variable
                      NOT X14             - Trigger event
  Expected Output:    ALTSEL

107) Test specification P52-15:

  Prefix:             X11                 - Reach ALTHOLD
                      X4                  - Reach ALTHOLD
                      X6 = True           - Condition variable
  Test case value:    X7 = True           - Condition variable
  Expected Output:    ALTHOLD

108) Test specification P52-16:

  Prefix:             X11                 - Reach ALTHOLD
                      X4                  - Reach ALTHOLD
                      X6 = True           - Condition variable
  Test case value:    NOT X2              - Trigger event before-value
                      X7 = True           - Conditon variable
                      X2                  - Trigger event
  Expected Output:    FLC

109) Test specification P52-17:

  Prefix:             X11                 - Reach ALTHOLD
                      X4                  - Reach ALTHOLD
                      X6 = True           - Condition variable
  Test case value:    NOT X2              - Trigger event before-value
                      X7 = False          - Conditon variable
                      X2                  - Trigger event
  Expected Output:    PITCH

110) Test specification P52-18:

  Prefix:             X11                 - Reach ALTHOLD
                      X4                  - Reach ALTHOLD
                      X6 = True           - Condition variable
  Test case value:    X2                  - Trigger event before-value
                      X7 = True           - Conditon variable
```

```
                   X2                  - Trigger event
 Expected Output:  ALTHOLD
```

111) Test specification P52-19:

```
 Prefix:           X11                 - Reach ALTHOLD
                   X4                  - Reach ALTHOLD
                   X6 = True           - Condition variable
 Test case value:  NOT X2              - Trigger event before-value
                   X7 = True           - Conditon variable
                   NOT X2              - Trigger event
 Expected Output:  ALTHOLD
```

112) Test specification P52-20:

```
 Prefix:           X11                 - Reach ALTHOLD
                   X4                  - Reach ALTHOLD
                   X6 = True           - Condition variable
 Test case value:  NOT X11             - Trigger event before-value
                   X7 = True           - Conditon variable
                   X11                 - Trigger event
 Expected Output:  FLC
```

113) Test specification P52-21:

```
 Prefix:           X11                 - Reach ALTHOLD
                   X4                  - Reach ALTHOLD
                   X6 = True           - Condition variable
 Test case value:  NOT X11             - Trigger event before-value
                   X7 = False          - Conditon variable
                   X11                 - Trigger event
 Expected Output:  PITCH
```

114) Test specification P52-22:

```
 Prefix:           X11                 - Reach ALTHOLD
                   X4                  - Reach ALTHOLD
                   X6 = True           - Condition variable
 Test case value:  X11                 - Trigger event before-value
                   X7 = True           - Conditon variable
                   X11                 - Trigger event
 Expected Output:  ALTHOLD
```

115) Test specification P52-23:

```
 Prefix:           X11                 - Reach ALTHOLD
                   X4                  - Reach ALTHOLD
                   X6 = True           - Condition variable
 Test case value:  NOT X11             - Trigger event before-value
                   X7 = True           - Conditon variable
                   NOT X11             - Trigger event
```

```
  Expected Output:   ALTHOLD

116) Test specification P52-24:

  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   NOT X12             - Trigger event before-value
                     X7 = True           - Conditon variable
                     X12                 - Trigger event
  Expected Output:   FLC

117) Test specification P52-25:

  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   NOT X12             - Trigger event before-value
                     X7 = False          - Conditon variable
                     X12                 - Trigger event
  Expected Output:   VS

118) Test specification P52-26:

  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   X12                 - Trigger event before-value
                     X7 = True           - Conditon variable
                     X12                 - Trigger event
  Expected Output:   ALTHOLD

119) Test specification P52-27:

  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   NOT X12             - Trigger event before-value
                     X7 = True           - Conditon variable
                     NOT X12             - Trigger event
  Expected Output:   ALTHOLD

120) Test specification P52-28:

  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   X14                 - Trigger event before-value
                     X7 = True           - Conditon variable
                     NOT X14             - Trigger event
  Expected Output:   FLC
```

121) Test specification P52-29:

```
  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   NOT X14             - Trigger event before-value
                     X7 = False          - Conditon variable
                     X14                 - Trigger event
  Expected Output:   GA
```

122) Test specification P52-30:

```
  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   X14                 - Trigger event before-value
                     X7 = True           - Conditon variable
                     X14                 - Trigger event
  Expected Output:   ALTHOLD
```

123) Test specification P52-31:

```
  Prefix:            X11                 - Reach ALTHOLD
                     X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
  Test case value:   NOT X14             - Trigger event before-value
                     X7 = True           - Conditon variable
                     NOT X14             - Trigger event
  Expected Output:   ALTHOLD
```

124) Test specification P52-32:

```
  Prefix:            X8 = True           - Reach APPR
  Test case value:   X7 = True           - Conditon variable
  Expected Output:   APPR
```

125) Test specification P52-33:

```
  Prefix:            X8 = True           - Reach APPR
  Test case value:   X8 = False          - Trigger event before-value
                     X14                 - Trigger event before-value
                     X7 = True           - Conditon variable
                     X8 = True           - Trigger event
                     NOT X14             - Trigger event
  Expected Output:   FLC
```

126) Test specification P52-34:

```
  Prefix:            X8 = True           - Reach APPR
  Test case value:   X8 = False          - Trigger event before-value
                     X14                 - Trigger event before-value
                     X7 = False         - Conditon variable
                     X8 = True          - Trigger event
                     NOT X14            - Trigger event
  Expected Output:   PITCH

127) Test specification P52-35:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X8 = True          - Trigger event before-value
                     X14                - Trigger event before-value
                     X7 = True          - Conditon variable
                     X8 = True          - Trigger event
                     NOT X14            - Trigger event
  Expected Output:   APPR

128) Test specification P52-36:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X8 = False         - Trigger event before-value
                     NOT X14            - Trigger event before-value
                     X7 = True          - Conditon variable
                     X8 = True          - Trigger event
                     NOT X14            - Trigger event
  Expected Output:   APPR

129) Test specification P52-37:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X8 = False         - Trigger event before-value
                     X14                - Trigger event before-value
                     X7 = True          - Conditon variable
                     X8 = False         - Trigger event
                     NOT X14            - Trigger event
  Expected Output:   APPR

130) Test specification P52-38:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X8 = False         - Trigger event before-value
                     X14                - Trigger event before-value
                     X7 = True          - Conditon variable
                     X8 = True          - Trigger event
                     X14                - Trigger event
  Expected Output:   APPR

131) Test specification P52-39:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   NOT X14            - Trigger event before-value
                     X7 = True          - Conditon variable
                     X14                - Trigger event
  Expected Output:   FLC

132) Test specification P52-40:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   NOT X14            - Trigger event before-value
                     X7 = False         - Conditon variable
                     X14                - Trigger event
  Expected Output:   APPR

133) Test specification P52-41:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X14                - Trigger event before-value
                     X7 = True          - Conditon variable
                     X14                - Trigger event
  Expected Output:   APPR

134) Test specification P52-42:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   NOT X14            - Trigger event before-value
                     X7 = True          - Conditon variable
                     NOT X14            - Trigger event
  Expected Output:   APPR

135) Test specification P52-43:

  Prefix:            X13                - Reach FLC
  Test case value:   X7 = True          - Conditon variable
  Expected Output:   FLC

136) Test specification P52-44:

  Prefix:            X13                - Reach FLC
  Test case value:   NOT X2             - Trigger event before-value
                     X7 = True          - Conditon variable
                     X2                 - Trigger event
  Expected Output:   FLC

137) Test specification P52-45:

  Prefix:            X13                - Reach FLC
  Test case value:   NOT X2             - Trigger event before-value
                     X7 = False         - Conditon variable
                     X2                 - Trigger event
  Expected Output:   PITCH

138) Test specification P52-46:

  Prefix:            X13                - Reach FLC
  Test case value:   X2                   - Trigger event before-value
                     X7 = True            - Conditon variable
                     X2                   - Trigger event
  Expected Output:   FLC

139) Test specification P52-47:

  Prefix:            X13                  - Reach FLC
  Test case value:   NOT X2               - Trigger event before-value
                     X7 = True            - Conditon variable
                     X2                   - Trigger event
  Expected Output:   FLC

140) Test specification P52-48:

  Prefix:            X13                  - Reach FLC
  Test case value:   NOT X12              - Trigger event before-value
                     X7 = True            - Conditon variable
                     X12                  - Trigger event
  Expected Output:   FLC

141) Test specification P52-49:

  Prefix:            X13                  - Reach FLC
  Test case value:   NOT X12              - Trigger event before-value
                     X7 = False           - Conditon variable
                     X12                  - Trigger event
  Expected Output:   VS

142) Test specification P52-50:

  Prefix:            X13                  - Reach FLC
  Test case value:   X12                  - Trigger event before-value
                     X7 = True            - Conditon variable
                     X12                  - Trigger event
  Expected Output:   FLC

143) Test specification P52-51:

  Prefix:            X13                  - Reach FLC
  Test case value:   NOT X12              - Trigger event before-value
                     X7 = True            - Conditon variable
                     NOT X12              - Trigger event
  Expected Output:   FLC

144) Test specification P52-52:

  Prefix:            X13                  - Reach FLC
  Test case value:   NOT X14              - Trigger event before-value
                     X7 = True            - Conditon variable
                     X14                  - Trigger event
  Expected Output:   FLC

145) Test specification P52-53:

  Prefix:            X13                 - Reach FLC
  Test case value:   NOT X14             - Trigger event before-value
                     X7 = False          - Conditon variable
                     X14                 - Trigger event
  Expected Output:   GA

146) Test specification P52-54:

  Prefix:            X13                 - Reach FLC
  Test case value:   X14                 - Trigger event before-value
                     X7 = True           - Conditon variable
                     X14                 - Trigger event
  Expected Output:   FLC

147) Test specification P52-55:

  Prefix:            X13                 - Reach FLC
  Test case value:   NOT X14             - Trigger event before-value
                     X7 = True           - Conditon variable
                     NOT X14             - Trigger event
  Expected Output:   FLC

148) Test specification P52-56:

  Prefix:            X13                 - Reach FLC
  Test case value:   NOT X13             - Trigger event before-value
                     X7 = True           - Conditon variable
                     X13                 - Trigger event
  Expected Output:   FLC

149) Test specification P52-57:

  Prefix:            X13                 - Reach FLC
  Test case value:   NOT X13             - Trigger event before-value
                     X7 = False          - Conditon variable
                     X13                 - Trigger event
  Expected Output:   PITCH

150) Test specification P52-58:

  Prefix:            X13                 - Reach FLC
  Test case value:   X13                 - Trigger event before-value
                     X7 = False          - Conditon variable
                     X13                 - Trigger event
  Expected Output:   FLC

151) Test specification P52-59:
  Prefix:             X13                 - Reach FLC
  Test case value:    NOT X13             - Trigger event before-value
                      X7 = False          - Conditon variable
                      NOT X13             - Trigger event
  Expected Output:    FLC

152) Test specification P53-1:

  Prefix:             X14                 - Reach GA
  Test case value:    X8 = False          - Trigger event before-value
                      X8 = True           - Trigger event
  Expected Output:    APPR

153) Test specification P53-2:

  Prefix:             X14                 - Reach GA
  Test case value:    X8 = True           - Trigger event before-value
                      X8 = True           - Trigger event
  Expected Output:    GA

154) Test specification P53-3:

  Prefix:             X14                 - Reach GA
  Test case value:    X8 = False          - Trigger event before-value
                      X8 = False          - Trigger event
  Expected Output:    GA

155) Test specification P53-4:

  Prefix:             X12                 - Reach VS
  Test case value:    X8 = False          - Trigger event before-value
                      X8 = True           - Trigger event
  Expected Output:    APPR

156) Test specification P53-5:

  Prefix:             X12                 - Reach VS
  Test case value:    X8 = True           - Trigger event before-value
                      X8 = True           - Trigger event
  Expected Output:    VS

157) Test specification P53-6:

  Prefix:             X12                 - Reach VS
  Test case value:    X8 = False          - Trigger event before-value
                      X8 = False          - Trigger event
  Expected Output:    VS

158) Test specification P53-7:

  Prefix:             X3 = True           - Reach ALTSEL
  Test case value:   X8 = False          - Trigger event before-value
                     X8 = True           - Trigger event
  Expected Output:   APPR

159) Test specification P53-8:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X8 = True           - Trigger event before-value
                     X8 = True           - Trigger event
  Expected Output:   ALTSEL

160) Test specification P53-9:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X8 = False          - Trigger event before-value
                     X8 = False          - Trigger event
  Expected Output:   ALTSEL

161) Test specification P53-10:

  Prefix:            X2                  - Reach PITCH
  Test case value:   X8 = False          - Trigger event before-value
                     X8 = True           - Trigger event
  Expected Output:   APPR

162) Test specification P53-11:

  Prefix:            X2                  - Reach PITCH
  Test case value:   X8 = True           - Trigger event before-value
                     X8 = True           - Trigger event
  Expected Output:   PITCH

163) Test specification P53-12:

  Prefix:            X2                  - Reach PITCH
  Test case value:   X8 = False          - Trigger event before-value
                     X8 = False          - Trigger event
  Expected Output:   PITCH

164) Test specification P53-13:

  Prefix:            X4                  - Reach ALTHOLD
                     X6 = True           - Condition variable
                     X11                 - Reach ALTHOLD
  Test case value:   X8 = False          - Trigger event before-value
                     X8 = True           - Trigger event
  Expected Output:   APPR

165) Test specification P53-14:

  Prefix:            X4                  - Reach ALTHOLD
```

```
                   X6 = True           - Condition variable
                   X11                 - Reach ALTHOLD
  Test case value: X8 = True           - Trigger event before-value
                   X8 = True           - Trigger event
  Expected Output: ALTHOLD

166) Test specification P53-15:

  Prefix:          X4                  - Reach ALTHOLD
                   X6 = True           - Condition variable
                   X11                 - Reach ALTHOLD
  Test case value: X8 = False          - Trigger event before-value
                   X8 = False          - Trigger event
  Expected Output: ALTHOLD

167) Test specification P53-16:

  Prefix:          X13                 - Reach FLC
  Test case value: X8 = False          - Trigger event before-value
                   X8 = True           - Trigger event
  Expected Output: APPR

168) Test specification P53-17:

  Prefix:          X13                 - Reach FLC
  Test case value: X8 = True           - Trigger event before-value
                   X8 = True           - Trigger event
  Expected Output: FLC

169) Test specification P53-18:

  Prefix:          X13                 - Reach FLC
  Test case value: X8 = False          - Trigger event before-value
                   X8 = False          - Trigger event
  Expected Output: FLC

170) Test specification P54-1:

  Prefix:          X8 = True           - Reach APPR
  Test case value: X9 = False          - Trigger event before-value
                   X14                 - Trigger event before-value
                   X9 = True           - Trigger event
                   NOT X14             - Trigger event
  Expected Output: PITCH

171) Test specification P54-2:

  Prefix:          X8 = True           - Reach APPR
  Test case value: X9 = True           - Trigger event before-value
                   X14                 - Trigger event before-value
                   X9 = True           - Trigger event
```

```
                     NOT X14            - Trigger event
  Expected Output:   APPR

172) Test specification P54-3:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X9 = False         - Trigger event before-value
                     NOT X14            - Trigger event before-value
                     X9 = True          - Trigger event
                     NOT X14            - Trigger event
  Expected Output:   APPR

173) Test specification P54-4:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X9 = False         - Trigger event before-value
                     X14                - Trigger event before-value
                     X9 = False         - Trigger event
                     NOT X14            - Trigger event
  Expected Output:   APPR

174) Test specification P54-5:

  Prefix:            X8 = True          - Reach APPR
  Test case value:   X9 = False         - Trigger event before-value
                     X14                - Trigger event before-value
                     X9 = True          - Trigger event
                     X14                - Trigger event
  Expected Output:   APPR

175) Test specification P55-1:

  Prefix:            X12                - Reach VS
  Test case value:   NOT X14            - Trigger event before-value
                     X14                - Trigger event
  Expected Output:   GA

176) Test specification P55-2:

  Prefix:            X12                - Reach VS
  Test case value:   X14                - Trigger event before-value
                     X14                - Trigger event
  Expected Output:   VS

177) Test specification P55-3:

  Prefix:            X12                - Reach VS
  Test case value:   NOT X14            - Trigger event before-value
                     NOT X14            - Trigger event
  Expected Output:   VS
```

```
178) Test specification P55-4:

  Prefix:            X8                  - Reach APPR
  Test case value:   NOT X14             - Trigger event before-value
                     X14                 - Trigger event
  Expected Output:   GA

179) Test specification P55-5:

  Prefix:            X8                  - Reach APPR
  Test case value:   X14                 - Trigger event before-value
                     X14                 - Trigger event
  Expected Output:   APPR

180) Test specification P55-6:

  Prefix:            X8                  - Reach APPR
  Test case value:   NOT X14             - Trigger event before-value
                     NOT X14             - Trigger event
  Expected Output:   APPR

181) Test specification P55-7:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X14             - Trigger event before-value
                     X14                 - Trigger event
  Expected Output:   GA

182) Test specification P55-8:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   X14                 - Trigger event before-value
                     X14                 - Trigger event
  Expected Output:   ALTSEL

183) Test specification P55-9:

  Prefix:            X3 = True           - Reach ALTSEL
  Test case value:   NOT X14             - Trigger event before-value
                     NOT X14             - Trigger event
  Expected Output:   ALTSEL

184) Test specification P55-10:

  Prefix:            X2                  - Reach PITCH
  Test case value:   NOT X14             - Trigger event before-value
                     X14                 - Trigger event
  Expected Output:   GA

185) Test specification P55-11:
  Prefix:             X2                    - Reach PITCH
  Test case value:    X14                   - Trigger event before-value
                      X14                   - Trigger event
  Expected Output:    PITCH
```

186) Test specification P55-12:

```
  Prefix:             X2                    - Reach PITCH
  Test case value:    NOT X14               - Trigger event before-value
                      NOT X14               - Trigger event
  Expected Output:    PITCH
```

187) Test specification P55-13:

```
  Prefix:             X4                    - Reach ALTHOLD
                      X6 = True             - Condition variable
                      X11                   - Reach ALTHOLD
  Test case value:    NOT X14               - Trigger event before-value
                      X14                   - Trigger event
  Expected Output:    GA
```

188) Test specification P55-14:

```
  Prefix:             X4                    - Reach ALTHOLD
                      X6 = True             - Condition variable
                      X11                   - Reach ALTHOLD
  Test case value:    X14                   - Trigger event before-value
                      X14                   - Trigger event
  Expected Output:    ALTHOLD
```

189) Test specification P55-15:

```
  Prefix:             X4                    - Reach ALTHOLD
                      X6 = True             - Condition variable
                      X11                   - Reach ALTHOLD
  Test case value:    NOT X14               - Trigger event before-value
                      NOT X14               - Trigger event
  Expected Output:    ALTHOLD
```

190) Test specification P55-16:

```
  Prefix:             X13                   - Reach FLC
  Test case value:    NOT X14               - Trigger event before-value
                      X14                   - Trigger event
  Expected Output:    GA
```

191) Test specification P55-17:

```
  Prefix:             X13                   - Reach FLC
  Test case value:    X14                   - Trigger event before-value
                      X14                   - Trigger event
  Expected Output:   FLC

192) Test specification P55-18

  Prefix:            X13                 - Reach FLC
  Test case value:   NOT X14             - Trigger event before-value
                     NOT X14             - Trigger event
  Expected Output:   FLC

193) Test specification P56-1

  Prefix:            X14                 - Reach GA
  Test case value:   X9 = False          - Trigger event before-value
                     X9 = True           - Trigger event
  Expected Output:   PITCH

194) Test specification P56-2

  Prefix:            X14                 - Reach GA
  Test case value:   X9 = True           - Trigger event before-value
                     X9 = True           - Trigger event
  Expected Output:   GA

195) Test specification P56-3

  Prefix:            X14                 - Reach GA
  Test case value:   X9 = False          - Trigger event before-value
                     X9 = False          - Trigger event
  Expected Output:   GA

196) Test specification P57-1

  Prefix:            X14                 - Reach GA
  Test case value:   X10 = True          - Trigger event before-value
                     X10 = False         - Trigger event
  Expected Output:   PITCH

197) Test specification P57-2

  Prefix:            X14                 - Reach GA
  Test case value:   X10 = False         - Trigger event before-value
                     X10 = False         - Trigger event
  Expected Output:   GA

198) Test specification P56-3

  Prefix:            X14                 - Reach GA
  Test case value:   X10 = True          - Trigger event before-value
                     X10 = True          - Trigger event
  Expected Output:   GA
```

Transition Pair Coverage Level Requirements:
The pairs for the PITCH Mode are:

```
(P41 or P42 or P44 or P47 or P49 or P51 or P54 or P56 or P57) :
   (P43 or P46 or P48 or P50 or P52 or P53 or P55)
```

The pairs for the ALTSEL Mode are:

```
P43 : (P44 or P45 or P46 or P48 or P50 or P53 or P55)
```

The pairs for the ALTHOLD Mode are:

```
(P45 or P46) : (P42 or P43 or P47 or P48 or P50 or P53 or P55)
```

The pairs for VS Mode are:

```
P48 : (P43 or P46 or P49 or P50 or P52 or P53 or P55)
```

The pairs for FLC Mode are:

```
(P50 or P52) : (P42 or P43 or P46 or P48 or P51 or P53 or P55)
```

The pairs for APPR Mode are:

```
P53 : (P43 or P55 or P54)
```

The pairs for GA Mode are:

```
P55 : (P41 or P42 or P43 or P46 or P48 or P50 or P52 or P53)
```

		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	
PITCH	GA	T	-	-	-	-	-	-	-	-	-	-	-	-	-	PITCH
	OR															
	GA	-	@	-	-	-	-	-	-	-	-	-	-	-	-	PITCH
	OR															
	ALTHOLD	-	@	-	-	-	-	-	-	-	-	-	-	-	-	PITCH
	OR															
	FLC	-	@	-	-	-	-	-	-	-	-	-	-	-	-	PITCH
	OR															
	ALTSEL	-	-	-	@	t	-	-	-	-	-	-	-	-	-	PITCH
	OR															
	ALTHOLD	-	-	-	-	-	-	-	-	-	-	@	-	-	-	PITCH
	OR															
	VS	-	-	-	-	-	-	-	-	-	-	-	@	-	-	PITCH
	OR															
	FLC	-	-	-	-	-	-	-	-	-	-	-	-	@	-	PITCH
	OR															
	APPR	-	-	-	-	-	-	-	T	-	-	-	-	-	NOT@	PITCH
	OR															
	GA	-	-	-	-	-	-	-	-	T	-	-	-	-	-	PITCH
	OR															

```
        GA      -  -  -  -  -  -  -  -  -   F   -   -   -   -   PITCH

      PITCH     -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
      PITCH     -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD
        OR
      PITCH     -  -  -  -  -  -  -  -  -   -   -   @   -   -   VS
        OR
      PITCH     -  -  -  -  -  -  -  -  -   -   -   -   @   -   FLC
        OR
      PITCH     -  -  -  -  -  -  -  T  -   -   -   -   -   -   APPR
        OR
      PITCH     -  -  -  -  -  -  -  -  -   -   -   -   -   @   GA


ALTSEL  GA      -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
        VS      -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
        APPR    -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
     ALTHOLD    -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
        PITCH   -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
        FLC     -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL

      ALTSEL    -  -  -  @  t  -  t  -  -   -   -   -   -   -   FLC
        OR
      ALTSEL    -  -  -  @  t  -  f  -  -   -   -   -   -   -   PITCH
        OR
      ALTSEL    -  -  -  @  -  t  -  -  -   -   -   -   -   -   ALTHOLD
        OR
      ALTSEL    -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD
        OR
      ALTSEL    -  -  -  -  -  -  t  -  -   -   -   @   -   -   FLC
        OR
      ALTSEL    -  -  -  -  -  -  f  -  -   -   -   @   -   -   VS
        OR
      ALTSEL    -  -  -  -  -  -  -  -  -   -   -   -   @   -   FLC
        OR
      ALTSEL    -  -  -  -  -  -  -  T  -   -   -   -   -   -   APPR
        OR
      ALTSEL    -  -  -  -  -  -  t  -  -   -   -   -   -   @   FLC
        OR
      ALTSEL    -  -  -  -  -  -  f  -  -   -   -   -   -   @   GA


ALTHOLD ALTSEL  -  -  -  @  -  t  -  -  -   -   -   -   -   -   ALTHOLD
        OR
        GA      -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD
        OR
        VS      -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD
        OR
        PITCH   -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD
        OR
        ALTSEL  -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD
        OR
        FLC     -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD

        ALTHOLD -  @  -  -  -  -  t  -  -   -   -   -   -   -   FLC
        OR
        ALTHOLD -  @  -  -  -  -  f  -  -   -   -   -   -   -   PITCH
        OR
        ALTHOLD -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
        ALTHOLD -  -  -  -  -  -  t  -  -   -   -   @   -   -   FLC
        OR
        ALTHOLD -  -  -  -  -  -  f  -  -   -   -   @   -   -   PITCH
        OR
        ALTHOLD -  -  -  -  -  -  -  -  -   -   -   -   @   -   FLC
        OR
        ALTHOLD -  -  -  -  -  -  -  T  -   -   -   -   -   -   APPR
        OR
        ALTHOLD -  -  -  -  -  -  t  -  -   -   @   -   -   -   FLC
        OR
        ALTHOLD -  -  -  -  -  -  f  -  -   -   @   -   -   -   PITCH
        OR
        ALTHOLD -  -  -  -  -  -  t  -  -   -   -   -   -   @   FLC
        OR
        ALTHOLD -  -  -  -  -  -  f  -  -   -   -   -   -   @   GA

VS      GA      -  -  -  -  -  -  -  -  -   -   -   @   -   -   VS
        OR
        ALTSEL  -  -  -  -  -  -  -  -  -   -   -   @   -   -   VS
        OR
        ALTHOLD -  -  -  -  -  -  -  -  -   -   -   @   -   -   VS
        OR
        PITCH   -  -  -  -  -  -  -  -  -   -   -   @   -   -   VS
        OR
        FLC     -  -  -  -  -  -  -  -  -   -   -   @   -   -   VS

        VS      -  -  T  -  -  -  -  -  -   -   -   -   -   -   ALTSEL
        OR
        VS      -  -  -  -  -  -  -  -  -   -   @   -   -   -   ALTHOLD
        OR
        VS      -  -  -  -  -  -  -  -  -   -   -   @   -   -   PITCH
        OR
        VS      -  -  -  -  -  -  -  -  -   -   -   -   @   -   FLC
        OR
        VS      -  -  -  -  -  -  -  T  -   -   -   -   -   -   APPR
        OR
```

	VS	-	-	-	-	-	-	-	-	-	-	-	-	-	@	GA
FLC	GA	-	-	-	-	-	-	-	-	-	-	-	-	@	-	FLC
	OR															
	VS	-	-	-	-	-	-	-	-	-	-	-	-	@	-	FLC
	OR															
	ALTSEL	-	-	-	-	-	-	-	-	-	-	-	-	@	-	FLC
	OR															
	ALTSEL	-	-	-	@	-	-	t	-	-	-	-	-	-	-	FLC
	OR															
	ALTSEL	-	-	-	-	-	-	t	-	-	-	-	@	-	-	FLC
	OR															
	ALTSEL	-	-	-	-	-	-	t	-	-	-	-	-	-	@	FLC
	OR															
	ALTHOLD	-	-	-	-	-	-	-	-	-	-	-	-	@	-	FLC
	OR															
	ALTHOLD	-	@	-	-	-	-	t	-	-	-	-	-	-	-	FLC
	OR															
	ALTHOLD	-	-	-	-	-	-	t	-	-	-	@	-	-	-	FLC
	OR															
	ALTHOLD	-	-	-	-	-	-	t	-	-	-	-	@	-	-	FLC
	OR															
	ALTHOLD	-	-	-	-	-	-	t	-	-	-	-	-	-	@	FLC
	OR															
	PITCH	-	-	-	-	-	-	-	-	-	-	-	-	@	-	FLC
	OR															
	APPR	-	-	-	-	-	-	t	T	-	-	-	-	-	NOT@	FLC
	OR															
	APPR	-	-	-	-	-	-	t	-	-	-	-	-	-	@	FLC
	FLC	-	@	-	-	-	-	f	-	-	-	-	-	-	-	PITCH
	OR															
	FLC	-	-	T	-	-	-	-	-	-	-	-	-	-	-	ALTSEL
	OR															
	FLC	-	-	-	-	-	-	-	-	-	-	@	-	-	-	ALTHOLD
	OR															
	FLC	-	-	-	-	-	-	f	-	-	-	-	@	-	-	VS
	OR															
	FLC	-	-	-	-	-	-	f	-	-	-	-	-	@	-	PITCH
	OR															
	FLC	-	-	-	-	-	-	-	T	-	-	-	-	-	-	APPR
	OR															
	FLC	-	-	-	-	-	-	f	-	-	-	-	-	-	@	GA
APPR	GA	-	-	-	-	-	-	-	T	-	-	-	-	-	-	APPR
	OR															
	VS	-	-	-	-	-	-	-	T	-	-	-	-	-	-	APPR
	OR															
	ALTSEL	-	-	-	-	-	-	-	T	-	-	-	-	-	-	APPR
	OR															
	ALTHOLD	-	-	-	-	-	-	-	T	-	-	-	-	-	-	APPR

```
        OR
        PITCH   - - - - - - - T - - - - - -    APPR
        OR
        FLC     - - - - - - - T - - - - - -    APPR

        APRR    - - T - - - - - - - - - - -    ALTSEL
        OR
        APRR    - - - - - - t T - - - - - NOT@ FLC
        OR
        APRR    - - - - - - f T - - - - - NOT@ PITCH
        OR
        APRR    - - - - - - t - - - - - -  @   FLC
        OR
        APRR    - - - - - - f - - - - - -  @   GA

GA      VS      - - - - - - - - - - - - -  @   GA
        OR
        ALTSEL  - - - - - - - - - - - - -  @   GA
        OR
        ALTHOLD - - - - - - - - - - - - -  @   GA
        OR
        PITCH   - - - - - - - - - - - - -  @   GA
        OR
        APPR    - - - - - - - - - - - - -  @   GA
        OR
        FLC     - - - - - - - - - - - - -  @   GA

        GA      T - - - - - - - - - - - - -    PITCH
        OR
        GA      - @ - - - - - - - - - - - -    PITCH
        OR
        GA      - - T - - - - - - - - - - -    ALTSEL
        OR
        GA      - - - - - - - - - - @ - - -    ALTHOLD
        OR
        GA      - - - - - - - - - - - @ - -    VS
        OR
        GA      - - - - - - - - - - - - @ -    FLC
        OR
        GA      - - - - - - - T - - - - - -    APPR
        OR
        GA      - - - - - - - - T - - - - -    PITCH
        OR
        GA      - - - - - - - - - F - - - -    PITCH
```

Test Specifications:

```
 1) Test specification PITCH-GA-1

    Prefix:           X14                  - Reach GA
    Test case value:  X1                   - P41 trigger event
```

```
                  X3 = True              - P43 trigger event
   Expected Output:  ALTSEL

2) Test specification PITCH-GA-2

   Prefix:           X14                 - Reach GA
   Test case value:  X1                  - P41 trigger event
                     X11                 - P46 trigger event
   Expected Output:  ALTHOLD

3) Test specification PITCH-GA-3

   Prefix:           X14                 - Reach GA
   Test case value:  X1                  - P41 trigger event
                     X12                 - P48 trigger event
   Expected Output:  VS

4) Test specification PITCH-GA-4

   Prefix:           X14                 - Reach GA
   Test case value:  X1                  - P41 trigger event
                     X13                 - P50 trigger event
   Expected Output:  FLC

5) Test specification PITCH-GA-5

   Prefix:           X14                 - Reach GA
   Test case value:  X1                  - P41 trigger event
                     X8 = True           - P53 trigger event
   Expected Output:  APPR

6) Test specification PITCH-GA-6

   Prefix:           X14                 - Reach GA
   Test case value:  X1                  - P41 trigger event
                     X14                 - P55 trigger event
   Expected Output:  GA

7) Test specification PITCH-GA-7

   Prefix:           X14                 - Reach GA
   Test case value:  X2                  - P42 trigger event
                     X3 = True           - P43 trigger event
   Expected Output:  ALTSEL

8) Test specification PITCH-GA-8

   Prefix:           X14                 - Reach GA
   Test case value:  X2                  - P42 trigger event
                     X11                 - P46 trigger event
   Expected Output:  ALTHOLD
```

```
9) Test specification PITCH-GA-9

   Prefix:            X14                     - Reach GA
   Test case value:   X2                      - P42 trigger event
                      X12                     - P48 trigger event
   Expected Output:   VS

10) Test specification PITCH-GA-10

   Prefix:            X14                     - Reach GA
   Test case value:   X2                      - P42 trigger event
                      X12                     - P50 trigger event
   Expected Output:   FLC

11) Test specification PITCH-GA-11

   Prefix:            X14                     - Reach GA
   Test case value:   X2                      - P42 trigger event
                      X8 = True               - P53 trigger event
   Expected Output:   APPR

12) Test specification PITCH-GA-12

   Prefix:            X14                     - Reach GA
   Test case value:   X2                      - P42 trigger event
                      X14                     - P55 trigger event
   Expected Output:   GA

13) Test specification PITCH-GA-13

   Prefix:            X14                     - Reach GA
   Test case value:   X9 = True               - P56 trigger event
                      X3 = True               - P43 trigger event
   Expected Output:   ALTSEL

14) Test specification PITCH-GA-14

   Prefix:            X14                     - Reach GA
   Test case value:   X9 = True               - P56 trigger event
                      X11                     - P46 trigger event
   Expected Output:   ALTHOLD

15) Test specification PITCH-GA-15

   Prefix:            X14                     - Reach GA
   Test case value:   X9 = True               - P56 trigger event
                      X12                     - P48 trigger event
   Expected Output:   VS

16) Test specification PITCH-GA-16
```

```
Prefix:            X14                    - Reach GA
Test case value:   X9 = True              - P56 trigger event
                   X13                    - P50 trigger event
Expected Output:   FLC
```

17) Test specification PITCH-GA-17

```
Prefix:            X14                    - Reach GA
Test case value:   X9 = True              - P56 trigger event
                   X8 = True              - P53 trigger event
Expected Output:   FLC
```

18) Test specification PITCH-GA-18

```
Prefix:            X14                    - Reach GA
Test case value:   X9 = True              - P56 trigger event
                   X14                    - P55 trigger event
Expected Output:   GA
```

19) Test specification PITCH-GA-19

```
Prefix:            X14                    - Reach GA
Test case value:   X10 = False            - P57 trigger event
                   X3 = True              - P43 trigger event
Expected Output:   ALTSEL
```

20) Test specification PITCH-GA-20

```
Prefix:            X14                    - Reach GA
Test case value:   X10 = False            - P57 trigger event
                   X11                    - P46 trigger event
Expected Output:   ALTHOLD
```

21) Test specification PITCH-GA-21

```
Prefix:            X14                    - Reach GA
Test case value:   X10 = False            - P57 trigger event
                   X12                    - P48 trigger event
Expected Output:   VS
```

22) Test specification PITCH-GA-22

```
Prefix:            X14                    - Reach GA
Test case value:   X10 = False            - P57 trigger event
                   X13                    - P50 trigger event
Expected Output:   FLC
```

23) Test specification PITCH-GA-23

```
Prefix:            X14                    - Reach GA
Test case value:   X10 = False            - P57 trigger event
```

```
                  X14                      - P55 trigger event
   Expected Output:  GA

24) Test specification PITCH-GA-24

   Prefix:           X14                      - Reach GA
   Test case value:  X10 = False              - P57 trigger event
                     X8 = True                - P53 trigger event
   Expected Output:  APPR

25) Test specification PITCH-ALTHOLD-1

   Prefix:           X11                      - Reach ALTHOLD
   Test case value:  X2                       - P42 trigger event
                     X3 = True                - P43 trigger event
   Expected Output:  ALTSEL

26) Test specification PITCH-ALTHOLD-2

   Prefix:           X11                      - Reach ALTHOLD
   Test case value:  X2                       - P42 trigger event
                     X11                      - P46 trigger event
   Expected Output:  ALTHOLD

27) Test specification PITCH-ALTHOLD-3

   Prefix:           X11                      - Reach ALTHOLD
   Test case value:  X2                       - P42 trigger event
                     X12                      - P48 trigger event
   Expected Output:  VS

28) Test specification PITCH-ALTHOLD-4

   Prefix:           X11                      - Reach ALTHOLD
   Test case value:  X2                       - P42 trigger event
                     X13                      - P50 trigger event
   Expected Output:  FLC

29) Test specification PITCH-ALTHOLD-5

   Prefix:           X11                      - Reach ALTHOLD
   Test case value:  X2                       - P42 trigger event
                     X8 = True                - P53 trigger event
   Expected Output:  APPR

30) Test specification PITCH-ALTHOLD-6

   Prefix:           X11                      - Reach ALTHOLD
   Test case value:  X2                       - P42 trigger event
                     X14                      - P55 trigger event
   Expected Output:  GA
```

31) Test specification PITCH-ALTHOLD-7

```
Prefix:           X11                    - Reach ALTHOLD
Test case value:  X11                    - P47 trigger event
                  X3 = True              - P43 trigger event
Expected Output:  ALTSEL
```

32) Test specification PITCH-ALTHOLD-8

```
Prefix:           X11                    - Reach ALTHOLD
Test case value:  X11                    - P47 trigger event
                  X11                    - P46 trigger event
Expected Output:  ALTHOLD
```

33) Test specification PITCH-ALTHOLD-9

```
Prefix:           X11                    - Reach ALTHOLD
Test case value:  X11                    - P47 trigger event
                  X12                    - P48 trigger event
Expected Output:  VS
```

34) Test specification PITCH-ALTHOLD-10

```
Prefix:           X11                    - Reach ALTHOLD
Test case value:  X11                    - P47 trigger event
                  X13                    - P50 trigger event
Expected Output:  FLC
```

35) Test specification PITCH-ALTHOLD-11

```
Prefix:           X11                    - Reach ALTHOLD
Test case value:  X11                    - P47 trigger event
                  X8 = True              - P53 trigger event
Expected Output:  APPR
```

36) Test specification PITCH-ALTHOLD-12

```
Prefix:           X11                    - Reach ALTHOLD
Test case value:  X2                     - P42 trigger event
                  X14                    - P55 trigger event
Expected Output:  GA
```

37) Test specification PITCH-FLC-1

```
Prefix:           X13                    - Reach FLC
Test case value:  X2                     - P42 trigger event
                  X3 = True              - P43 trigger event
Expected Output:  ALTSEL
```

38) Test specification PITCH-FLC-2

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X2                     - P42 trigger event
                      X11                    - P46 trigger event
   Expected Output:   ALTHOLD
```

39) Test specification PITCH-FLC-3

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X2                     - P42 trigger event
                      X12                    - P48 trigger event
   Expected Output:   VS
```

40) Test specification PITCH-FLC-4

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X2                     - P42 trigger event
                      X13                    - P50 trigger event
   Expected Output:   FLC
```

41) Test specification PITCH-FLC-5

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X2                     - P42 trigger event
                      X8 = True              - P53 trigger event
   Expected Output:   APPR
```

42) Test specification PITCH-FLC-6

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X2                     - P42 trigger event
                      X14                    - P55 trigger event
   Expected Output:   GA
```

43) Test specification PITCH-FLC-7

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X13                    - P51 trigger event
                      X3 = True              - P43 trigger event
   Expected Output:   ALTSEL
```

44) Test specification PITCH-FLC-8

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X13                    - P51 trigger event
                      X11                    - P46 trigger event
   Expected Output:   ALTHOLD
```

45) Test specification PITCH-FLC-9

```
   Prefix:            X13                    - Reach FLC
   Test case value:   X13                    - P51 trigger event
```

```
                  X12                     - P48 trigger event
Expected Output:  VS
```

46) Test specification PITCH-FLC-10

```
Prefix:           X13                     - Reach FLC
Test case value:  X13                     - P51 trigger event
                  X13                     - P50 trigger event
Expected Output:  FLC
```

47) Test specification PITCH-FLC-11

```
Prefix:           X13                     - Reach FLC
Test case value:  X13                     - P51 trigger event
                  X8 = True               - P53 trigger event
Expected Output:  APPR
```

48) Test specification PITCH-FLC-12

```
Prefix:           X13                     - Reach FLC
Test case value:  X13                     - P51 trigger event
                  X14                     - P55 trigger event
Expected Output:  GA
```

49) Test specification PITCH-ALTSEL-1

```
Prefix:           X3 = True               - Reach ALTSEL
Test case value:  X4                      - P44 trigger event
                  X5 = True               - Condition variable
                  X3 = True               - P43 trigger event
Expected Output:  ALTSEL
```

50) Test specification PITCH-ALTSEL-2

```
Prefix:           X3 = True               - Reach ALTSEL
Test case value:  X4                      - P44 trigger event
                  X5 = True               - Condition variable
                  X11                     - P46 trigger event
Expected Output:  ALTHOLD
```

51) Test specification PITCH-ALTSEL-3

```
Prefix:           X3 = True               - Reach ALTSEL
Test case value:  X4                      - P44 trigger event
                  X5 = True               - Condition variable
                  X12                     - P48 trigger event
Expected Output:  VS
```

52) Test specification PITCH-ALTSEL-4

```
Prefix:           X3 = True               - Reach ALTSEL
```

```
   Test case value:  X4                      - P44 trigger event
                     X5 = True               - Condition variable
                     X13                     - P50 trigger event
   Expected Output:  FLC
```

53) Test specification PITCH-ALTSEL-5

```
   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X4                      - P44 trigger event
                     X5 = True               - Condition variable
                     X8                      - P53 trigger event
   Expected Output:  APPR
```

54) Test specification PITCH-ALTSEL-6

```
   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X4                      - P44 trigger event
                     X5 = True               - Condition variable
                     X14                     - P53 trigger event
   Expected Output:  GA
```

55) Test specification PITCH-APPR-1

```
   Prefix:           X3 = True               - Reach APPR
   Test case value:  X8 = True
                     NOT X14                 - P54 trigger event
                     X3 = True               - P43 trigger event
   Expected Output:  ALTSEL
```

56) Test specification PITCH-APPR-2

```
   Prefix:           X3 = True               - Reach APPR
   Test case value:  X8 = True
                     NOT X14                 - P54 trigger event
                     X11                     - P46 trigger event
   Expected Output:  ALTHOLD
```

57) Test specification PITCH-APPR-3

```
   Prefix:           X3 = True               - Reach APPR
   Test case value:  X8 = True
                     NOT X14                 - P54 trigger event
                     X12                     - P48 trigger event
   Expected Output:  VS
```

58) Test specification PITCH-APPR-4

```
   Prefix:           X3 = True               - Reach APPR
   Test case value:  X8 = True
                     NOT X14                 - P54 trigger event
                     X13                     - P50 trigger event
   Expected Output:  FLC

59) Test specification PITCH-APPR-5

   Prefix:           X3 = True             - Reach APPR
   Test case value:  X8 = True
                     NOT X14               - P54 trigger event
                     X8 = True             - P53 trigger event
   Expected Output:  APPR

60) Test specification PITCH-APPR-6

   Prefix:           X3 = True             - Reach APPR
   Test case value:  X8 = True
                     NOT X14               - P54 trigger event
                     X14                   - P55 trigger event
   Expected Output:  GA

61) Test specification PITCH-VS-1

   Prefix:           X12                   - Reach VS
   Test case value:  X12                   - P54 trigger event
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL

62) Test specification PITCH-VS-2

   Prefix:           X12                   - Reach VS
   Test case value:  X12                   - P54 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD

63) Test specification PITCH-VS-3

   Prefix:           X12                   - Reach VS
   Test case value:  X12                   - P54 trigger event
                     X12                   - P48 trigger event
   Expected Output:  VS

64) Test specification PITCH-VS-4

   Prefix:           X12                   - Reach VS
   Test case value:  X12                   - P54 trigger event
                     X13                   - P50 trigger event
   Expected Output:  FLC

65) Test specification PITCH-VS-5

   Prefix:           X12                   - Reach VS
   Test case value:  X12                   - P54 trigger event
                     X8 = True             - P53 trigger event
   Expected Output:  APPR

66) Test specification PITCH-VS-6

   Prefix:           X12                   - Reach VS
   Test case value:  X12                   - P54 trigger event
                     X14                   - P55 trigger event
   Expected Output:  GA

67) Test specification ALTSEL-GA-1

   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P52 trigger event
                     X5 = True             - Condition variable
                     X7 = True             - Condition variable
   Expected Output:  FLC

68) Test specification ALTSEL-GA-2

   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P44 trigger event
                     X5 = True             - Condition variable
                     X7 = False            - Condition variable
   Expected Output:  PITCH

69) Test specification ALTSEL-GA-3

   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P45 trigger event
                     X6 = True             - Condition variable
   Expected Output:  ALTHOLD

70) Test specification ALTSEL-GA-4

   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD

71) Test specification ALTSEL-GA-5

   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X12                   - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC

72) Test specification ALTSEL-GA-6
```

```
   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X12                   - P48 trigger event
                     X7 = False            - Condition variable
   Expected Output:  VS
```

73) Test specification ALTSEL-GA-7

```
   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X13                   - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC
```

74) Test specification ALTSEL-GA-8

```
   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X8 = True             - P53 trigger event
   Expected Output:  APPR
```

75) Test specification ALTSEL-GA-9

```
   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X14                   - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC
```

76) Test specification ALTSEL-GA-10

```
   Prefix:           X14                   - Reach GA
   Test case value:  X3 = True             - P43 trigger event
                     X14                   - P55 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

77) Test specification ALTSEL-VS-1

```
   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P52 trigger event
                     X5 = True             - Condition variable
                     X7 = True             - Condition variable
   Expected Output:  FLC
```

78) Test specification ALTSEL-VS-2

```
   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P44 trigger event
```

```
                  X5 = True             - Condition variable
                  X7 = False            - Condition variable
   Expected Output:  PITCH

79) Test specification ALTSEL-VS-3

   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P45 trigger event
                     X6 = True             - Condition variable
   Expected Output:  ALTHOLD

80) Test specification ALTSEL-VS-4

   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD

81) Test specification ALTSEL-VS-5

   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X12                   - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC

82) Test specification ALTSEL-VS-6

   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X12                   - P48 trigger event
                     X7 = False            - Condition variable
   Expected Output:  VS

83) Test specification ALTSEL-VS-7

   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X13                   - P50 trigger event
   Expected Output:  FLC

84) Test specification ALTSEL-VS-8

   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X8 = APPR             - P53 trigger event
   Expected Output:  APPR

85) Test specification ALTSEL-VS-9
```

```
   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X8 = APPR             - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC
```

86) Test specification ALTSEL-VS-10

```
   Prefix:           X12                   - Reach VS
   Test case value:  X3 = True             - P43 trigger event
                     X8 = APPR             - P52 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

87) Test specification ALTSEL-APPR-1

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P52 trigger event
                     X5 = True             - Condition variable
                     X7 = True             - Condition variable
   Expected Output:  FLC
```

88) Test specification ALTSEL-APPR-2

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P44 trigger event
                     X5 = True             - Condition variable
                     X7 = False            - Condition variable
   Expected Output:  PITCH
```

89) Test specification ALTSEL-APPR-3

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P45 trigger event
                     X6 = True             - Condition variable
   Expected Output:  ALTHOLD
```

90) Test specification ALTSEL-APPR-4

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X3 = True             - P43 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD
```

91) Test specification ALTSEL-APPR-5

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X3 = True             - P43 trigger event
```

```
                  X12                   - P52 trigger event
                  X7 = True             - Condition variable
Expected Output:  FLC
```

92) Test specification ALTSEL-APPR-6

```
Prefix:           X8 = True             - Reach APPR
Test case value:  X3 = True             - P43 trigger event
                  X12                   - P48 trigger event
                  X7 = False            - Condition variable
Expected Output:  VS
```

93) Test specification ALTSEL-APPR-7

```
Prefix:           X8 = True             - Reach APPR
Test case value:  X3 = True             - P43 trigger event
                  X13                   - P50 trigger event
Expected Output:  FLC
```

94) Test specification ALTSEL-APPR-8

```
Prefix:           X8 = True             - Reach APPR
Test case value:  X3 = True             - P43 trigger event
                  X8 = APPR             - P53 trigger event
Expected Output:  APPR
```

95) Test specification ALTSEL-APPR-9

```
Prefix:           X8 = True             - Reach APPR
Test case value:  X3 = True             - P43 trigger event
                  X14                   - P52 trigger event
                  X7 = True             - Condition variable
Expected Output:  FLC
```

96) Test specification ALTSEL-APPR-10

```
Prefix:           X8 = True             - Reach APPR
Test case value:  X3 = True             - P43 trigger event
                  X14                   - P55 trigger event
                  X7 = False            - Condition variable
Expected Output:  GA
```

97) Test specification ALTSEL-ALTHOLD-1

```
Prefix:           X11                   - Reach ALTHOLD
Test case value:  X3 = True             - P43 trigger event
                  X4                    - P52 trigger event
                  X5 = True             - Condition variable
                  X7 = True             - Condition variable
Expected Output:  FLC
```

```
98) Test specification ALTSEL-ALTHOLD-2

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X3 = True              - P43 trigger event
                     X4                     - P44 trigger event
                     X5 = True              - Condition variable
                     X7 = False             - Condition variable
   Expected Output:  PITCH

99) Test specification ALTSEL-ALTHOLD-3

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X3 = True              - P43 trigger event
                     X4                     - P45 trigger event
                     X6 = True              - Condition variable
   Expected Output:  ALTHOLD

100) Test specification ALTSEL-ALTHOLD-4

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X3 = True              - P43 trigger event
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD

101) Test specification ALTSEL-ALTHOLD-5

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X3 = True              - P43 trigger event
                     X12                    - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC

102) Test specification ALTSEL-ALTHOLD-6

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X3 = True              - P43 trigger event
                     X12                    - P48 trigger event
                     X7 = False             - Condition variable
   Expected Output:  VS

103) Test specification ALTSEL-ALTHOLD-7

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X3 = True              - P43 trigger event
                     X13                    - P50 trigger event
   Expected Output:  FLC

104) Test specification ALTSEL-ALTHOLD-8

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X3 = True              - P43 trigger event
```

```
                     X8 = APPR             - P53 trigger event
   Expected Output:  APPR

105) Test specification ALTSEL-ALTHOLD-9

   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X3 = True             - P43 trigger event
                     X14                   - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC

106) Test specification ALTSEL-ALTHOLD-10

   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X3 = True             - P43 trigger event
                     X14                   - P55 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA

107) Test specification ALTSEL-PITCH-1

   Prefix:           X2                    - Reach PITCH
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P52 trigger event
                     X5 = True             - Condition variable
                     X7 = True             - Condition variable
   Expected Output:  FLC

108) Test specification ALTSEL-PITCH-2

   Prefix:           X2                    - Reach PITCH
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P44 trigger event
                     X5 = True             - Condition variable
                     X7 = False            - Condition variable
   Expected Output:  PITCH

109) Test specification ALTSEL-PITCH-3

   Prefix:           X2                    - Reach PITCH
   Test case value:  X3 = True             - P43 trigger event
                     X4                    - P45 trigger event
                     X6 = True             - Condition variable
   Expected Output:  ALTHOLD

110) Test specification ALTSEL-PITCH-4

   Prefix:           X2                    - Reach PITCH
   Test case value:  X3 = True             - P43 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD
```

```
111) Test specification ALTSEL-PITCH-5

   Prefix:           X2                      - Reach PITCH
   Test case value:  X3 = True               - P43 trigger event
                     X12                     - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

112) Test specification ALTSEL-PITCH-6

   Prefix:           X2                      - Reach PITCH
   Test case value:  X3 = True               - P43 trigger event
                     X12                     - P48 trigger event
                     X7 = False              - Condition variable
   Expected Output:  VS

113) Test specification ALTSEL-PITCH-7

   Prefix:           X2                      - Reach PITCH
   Test case value:  X3 = True               - P43 trigger event
                     X13                     - P50 trigger event
   Expected Output:  FLC

114) Test specification ALTSEL-PITCH-8

   Prefix:           X2                      - Reach PITCH
   Test case value:  X3 = True               - P43 trigger event
                     X8 = APPR               - P53 trigger event
   Expected Output:  APPR

115) Test specification ALTSEL-PITCH-9

   Prefix:           X2                      - Reach PITCH
   Test case value:  X3 = True               - P43 trigger event
                     X14                     - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

116) Test specification ALTSEL-PITCH-10

   Prefix:           X2                      - Reach PITCH
   Test case value:  X3 = True               - P43 trigger event
                     X14                     - P55 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA

117) Test specification ALTSEL-FLC-1

   Prefix:           X13                     - Reach FLC
   Test case value:  X3 = True               - P43 trigger event
                     X4                      - P52 trigger event
```

```
                   X5 = True              - Condition variable
                   X7 = True              - Condition variable
Expected Output:   FLC
```

118) Test specification ALTSEL-FLC-2

```
Prefix:            X13                    - Reach FLC
Test case value:   X3 = True              - P43 trigger event
                   X4                     - P44 trigger event
                   X5 = True              - Condition variable
                   X7 = False             - Condition variable
Expected Output:   PITCH
```

119) Test specification ALTSEL-FLC-3

```
Prefix:            X13                    - Reach FLC
Test case value:   X3 = True              - P43 trigger event
                   X4                     - P45 trigger event
                   X6 = True              - Condition variable
Expected Output:   ALTHOLD
```

120) Test specification ALTSEL-FLC-4

```
Prefix:            X13                    - Reach FLC
Test case value:   X3 = True              - P43 trigger event
                   X11                    - P46 trigger event
Expected Output:   ALTHOLD
```

121) Test specification ALTSEL-FLC-5

```
Prefix:            X13                    - Reach FLC
Test case value:   X3 = True              - P43 trigger event
                   X12                    - P52 trigger event
                   X7 = True              - Condition variable
Expected Output:   FLC
```

122) Test specification ALTSEL-FLC-6

```
Prefix:            X13                    - Reach FLC
Test case value:   X3 = True              - P43 trigger event
                   X12                    - P48 trigger event
                   X7 = False             - Condition variable
Expected Output:   VS
```

123) Test specification ALTSEL-FLC-7

```
Prefix:            X13                    - Reach FLC
Test case value:   X3 = True              - P43 trigger event
                   X13                    - P50 trigger event
Expected Output:   FLC
```

124) Test specification ALTSEL-FLC-8

```
Prefix:           X13                  - Reach FLC
Test case value:  X3 = True            - P43 trigger event
                  X8 = APPR            - P53 trigger event
Expected Output:  APPR
```

125) Test specification ALTSEL-FLC-9

```
Prefix:           X13                  - Reach FLC
Test case value:  X3 = True            - P43 trigger event
                  X14                  - P52 trigger event
                  X7 = True            - Condition variable
Expected Output:  FLC
```

126) Test specification ALTSEL-FLC-10

```
Prefix:           X13                  - Reach FLC
Test case value:  X3 = True            - P43 trigger event
                  X14                  - P55 trigger event
                  X7 = False           - Condition variable
Expected Output:  GA
```

127) Test specification ALTHOLD-ALTSEL-1

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X2                   - P52 trigger event
                  X7 = True            - Condition variable
Expected Output:  FLC
```

128) Test specification ALTHOLD-ALTSEL-2

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X2                   - P42 trigger event
                  X7 = False           - Condition variable
Expected Output:  PITCH
```

129) Test specification ALTHOLD-ALTSEL-3

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X3 = True            - P43 trigger event
Expected Output:  ALTSEL
```

130) Test specification ALTHOLD-ALTSEL-4

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X12                  - P52 trigger event
                  X7 = True            - Condition variable
Expected Output:  FLC
```

131) Test specification ALTHOLD-ALTSEL-5

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X12                  - P50 trigger event
                  X7 = False           - Condition variable
Expected Output:  PITCH
```

132) Test specification ALTHOLD-ALTSEL-6

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X13                  - P52 trigger event
Expected Output:  FLC
```

133) Test specification ALTHOLD-ALTSEL-7

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X8 = True            - P53 trigger event
Expected Output:  APPR
```

134) Test specification ALTHOLD-ALTSEL-8

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X11                  - P46 trigger event
                  X7 = True            - Condition variable
Expected Output:  FLC
```

135) Test specification ALTHOLD-ALTSEL-9

```
Prefix:           X3 = True            - Reach ALTSEL
Test case value:  X4                   - P45 trigger event
                  X6 = True            - Condition variable
                  X11                  - P47 trigger event
                  X7 = False           - Condition variable
Expected Output:  PITCH
```

136) Test specification ALTHOLD-ALTSEL-10

```
   Prefix:            X3 = True              - Reach ALTSEL
   Test case value:   X4                     - P45 trigger event
                      X6 = True              - Condition variable
                      X14                    - P55 trigger event
                      X7 = True              - Condition variable
   Expected Output:   FLC
```

137) Test specification ALTHOLD-ALTSEL-11

```
   Prefix:            X3 = True              - Reach ALTSEL
   Test case value:   X4                     - P45 trigger event
                      X6 = True              - Condition variable
                      X14                    - P55 trigger event
                      X7 = False             - Condition variable
   Expected Output:   GA
```

138) Test specification ALTHOLD-GA-1

```
   Prefix:            X14                    - Reach GA
   Test case value:   X11                    - P46 trigger event
                      X2                     - P52 trigger event
                      X7 = True              - Condition variable
   Expected Output:   FLC
```

139) Test specification ALTHOLD-GA-2

```
   Prefix:            X14                    - Reach GA
   Test case value:   X11                    - P46 trigger event
                      X2                     - P42 trigger event
                      X7 = False             - Condition variable
   Expected Output:   PITCH
```

140) Test specification ALTHOLD-GA-3

```
   Prefix:            X14                    - Reach GA
   Test case value:   X11                    - P46 trigger event
                      X3 = True              - P43 trigger event
   Expected Output:   ALTSEL
```

141) Test specification ALTHOLD-GA-4

```
   Prefix:            X14                    - Reach GA
   Test case value:   X11                    - P46 trigger event
                      X12                    - P52 trigger event
                      X7 = True              - Condition variable
   Expected Output:   FLC
```

142) Test specification ALTHOLD-GA-5

```
   Prefix:            X14                    - Reach GA
   Test case value:   X11                    - P46 trigger event
```

```
                 X12                     - P50 trigger event
                 X7 = False              - Condition variable
Expected Output: PITCH

143) Test specification ALTHOLD-GA-6

   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X13                     - P52 trigger event
   Expected Output:  FLC

144) Test specification ALTHOLD-GA-7

   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X8 = True               - P53 trigger event
   Expected Output:  APPR

145) Test specification ALTHOLD-GA-8

   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X11                     - P46 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

146) Test specification ALTHOLD-GA-9

   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X11                     - P47 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH

147) Test specification ALTHOLD-GA-10

   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X14                     - P55 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

148) Test specification ALTHOLD-GA-11

   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X14                     - P55 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA

149) Test specification ALTHOLD-VS-1
```

```
   Prefix:           X12                  - Reach VS
   Test case value:  X11                  - P46 trigger event
                     X2                   - P52 trigger event
                     X7 = True            - Condition variable
   Expected Output:  FLC
```

150) Test specification ALTHOLD-VS-2

```
   Prefix:           X14                  - Reach GA
   Test case value:  X11                  - P46 trigger event
                     X2                   - P42 trigger event
                     X7 = False           - Condition variable
   Expected Output:  PITCH
```

151) Test specification ALTHOLD-VS-3

```
   Prefix:           X14                  - Reach GA
   Test case value:  X11                  - P46 trigger event
                     X3 = True            - P43 trigger event
   Expected Output:  ALTSEL
```

152) Test specification ALTHOLD-VS-4

```
   Prefix:           X14                  - Reach GA
   Test case value:  X11                  - P46 trigger event
                     X12                  - P52 trigger event
                     X7 = True            - Condition variable
   Expected Output:  FLC
```

153) Test specification ALTHOLD-VS-5

```
   Prefix:           X14                  - Reach GA
   Test case value:  X11                  - P46 trigger event
                     X12                  - P50 trigger event
                     X7 = False           - Condition variable
   Expected Output:  PITCH
```

154) Test specification ALTHOLD-VS-6

```
   Prefix:           X14                  - Reach GA
   Test case value:  X11                  - P46 trigger event
                     X13                  - P52 trigger event
   Expected Output:  FLC
```

155) Test specification ALTHOLD-VS-7

```
   Prefix:           X14                  - Reach GA
   Test case value:  X11                  - P46 trigger event
                     X8 = True            - P53 trigger event
   Expected Output:  APPR
```

156) Test specification ALTHOLD-VS-8

```
   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X11                     - P46 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC
```

157) Test specification ALTHOLD-VS-9

```
   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X11                     - P47 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH
```

158) Test specification ALTHOLD-VS-10

```
   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X14                     - P55 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC
```

159) Test specification ALTHOLD-VS-11

```
   Prefix:           X14                     - Reach GA
   Test case value:  X11                     - P46 trigger event
                     X14                     - P55 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA
```

160) Test specification ALTHOLD-PITCH-1

```
   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X2 = True               - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC
```

161) Test specification ALTHOLD-PITCH-2

```
   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X2                      - P42 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH
```

162) Test specification ALTHOLD-PITCH-3

```
   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X3 = True               - P43 trigger event
   Expected Output:  ALTSEL

163) Test specification ALTHOLD-PITCH-4

   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X12                     - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

164) Test specification ALTHOLD-PITCH-5

   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X12                     - P50 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH

165) Test specification ALTHOLD-PITCH-6

   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X13                     - P52 trigger event
   Expected Output:  FLC

166) Test specification ALTHOLD-PITCH-7

   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X8 = True               - P53 trigger event
   Expected Output:  APPR

167) Test specification ALTHOLD-PITCH-8

   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X11                     - P46 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

168) Test specification ALTHOLD-PITCH-9

   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X11                     - P47 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH

169) Test specification ALTHOLD-PITCH-10
```

```
   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X14                     - P55 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

170) Test specification ALTHOLD-PITCH-11

   Prefix:           X2                      - Reach PITCH
   Test case value:  X11                     - P46 trigger event
                     X14                     - P55 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA

171) Test specification ALTHOLD-ALTSEL-1

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X11                     - P46 trigger event
                     X2                      - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

172) Test specification ALTHOLD-ALTSEL-2

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X11                     - P46 trigger event
                     X2                      - P42 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH

173) Test specification ALTHOLD-ALTSEL-3

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X11                     - P46 trigger event
                     X3 = True               - P43 trigger event
   Expected Output:  ALTSEL

174) Test specification ALTHOLD-ALTSEL-4

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X11                     - P46 trigger event
                     X12                     - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC

175) Test specification ALTHOLD-ALTSEL-5

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X11                     - P46 trigger event
                     X12                     - P50 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH

176) Test specification ALTHOLD-ALTSEL-6

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X11                  - P46 trigger event
                     X13                  - P52 trigger event
   Expected Output:  FLC

177) Test specification ALTHOLD-ALTSEL-7

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X11                  - P46 trigger event
                     X8 = True            - P53 trigger event
   Expected Output:  APPR

178) Test specification ALTHOLD-ALTSEL-8

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X11                  - P46 trigger event
                     X11                  - P46 trigger event
                     X7 = True            - Condition variable
   Expected Output:  FLC

179) Test specification ALTHOLD-ALTSEL-9

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X11                  - P46 trigger event
                     X11                  - P47 trigger event
                     X7 = False           - Condition variable
   Expected Output:  PITCH

180) Test specification ALTHOLD-ALTSEL-10

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X11                  - P46 trigger event
                     X14                  - P55 trigger event
                     X7 = True            - Condition variable
   Expected Output:  FLC

181) Test specification ALTHOLD-ALTSEL-11

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X11                  - P46 trigger event
                     X14                  - P55 trigger event
                     X7 = False           - Condition variable
   Expected Output:  GA

182) Test specification ALTHOLD-FLC-1

   Prefix:           X13                  - Reach FLC
   Test case value:  X11                    - P46 trigger event
                     X2                     - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC
```

183) Test specification ALTHOLD-FLC-2

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X11                    - P46 trigger event
                     X2                     - P42 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH
```

184) Test specification ALTHOLD-FLC-3

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X11                    - P46 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL
```

185) Test specification ALTHOLD-FLC-4

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X11                    - P46 trigger event
                     X12                    - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC
```

186) Test specification ALTHOLD-FLC-5

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X11                    - P46 trigger event
                     X12                    - P50 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH
```

187) Test specification ALTHOLD-FLC-6

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X11                    - P46 trigger event
                     X13                    - P52 trigger event
   Expected Output:  FLC
```

188) Test specification ALTHOLD-FLC-7

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X11                    - P46 trigger event
                     X8 = True              - P53 trigger event
   Expected Output:  APPR
```

189) Test specification ALTHOLD-FLC-8

```
   Prefix:           X13                      - Reach FLC
   Test case value:  X11                      - P46 trigger event
                     X11                      - P46 trigger event
                     X7 = True                - Condition variable
   Expected Output:  FLC
```

190) Test specification ALTHOLD-FLC-9

```
   Prefix:           X13                      - Reach FLC
   Test case value:  X11                      - P46 trigger event
                     X11                      - P47 trigger event
                     X7 = False               - Condition variable
   Expected Output:  PITCH
```

191) Test specification ALTHOLD-FLC-10

```
   Prefix:           X13                      - Reach FLC
   Test case value:  X11                      - P46 trigger event
                     X14                      - P55 trigger event
                     X7 = True                - Condition variable
   Expected Output:  FLC
```

192) Test specification ALTHOLD-FLC-11

```
   Prefix:           X13                      - Reach FLC
   Test case value:  X11                      - P46 trigger event
                     X14                      - P55 trigger event
                     X7 = False               - Condition variable
   Expected Output:  GA
```

193) Test specification VS-GA-1

```
   Prefix:           X14                      - Reach GA
   Test case value:  X12                      - P48 trigger event
                     X3 = True                - P43 trigger event
   Expected Output:  ALTSEL
```

194) Test specification VS-GA-2

```
   Prefix:           X14                      - Reach GA
   Test case value:  X12                      - P48 trigger event
                     X11                      - P46 trigger event
   Expected Output:  ALTHOLD
```

195) Test specification VS-GA-3

```
   Prefix:           X14                      - Reach GA
   Test case value:  X12                      - P48 trigger event
                     X12                      - P49 trigger event
   Expected Output:  PITCH
```

196) Test specification VS-GA-4

```
Prefix:            X14                  - Reach GA
Test case value:   X12                  - P48 trigger event
                   X13                  - P50 trigger event
Expected Output:   FLC
```

197) Test specification VS-GA-5

```
Prefix:            X14                  - Reach GA
Test case value:   X12                  - P48 trigger event
                   X8 = True            - P53 trigger event
Expected Output:   APPR
```

198) Test specification VS-GA-6

```
Prefix:            X14                  - Reach GA
Test case value:   X12                  - P48 trigger event
                   X14                  - P55 trigger event
Expected Output:   GA
```

199) Test specification VS-ALTSEL-1

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X12                  - P48 trigger event
                   X3 = True            - P43 trigger event
Expected Output:   ALTSEL
```

200) Test specification VS-ALTSEL-2

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X12                  - P48 trigger event
                   X11                  - P46 trigger event
Expected Output:   ALTHOLD
```

201) Test specification VS-ALTSEL-3

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X12                  - P48 trigger event
                   X12                  - P49 trigger event
Expected Output:   PITCH
```

202) Test specification VS-ALTSEL-4

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X12                  - P48 trigger event
                   X13                  - P50 trigger event
Expected Output:   FLC
```

203) Test specification VS-ALTSEL-5

```
Prefix:            X3 = True             - Reach ALTSEL
Test case value:   X12                   - P48 trigger event
                   X8 = True             - P53 trigger event
Expected Output:   APPR
```

204) Test specification VS-ALTSEL-6

```
Prefix:            X3 = True             - Reach ALTSEL
Test case value:   X12                   - P48 trigger event
                   X14                   - P55 trigger event
Expected Output:   GA
```

205) Test specification VS-ALTHOLD-1

```
Prefix:            X11                   - Reach ALTHOLD
Test case value:   X12                   - P48 trigger event
                   X3 = True             - P43 trigger event
Expected Output:   ALTSEL
```

206) Test specification VS-ALTHOLD-2

```
Prefix:            X11                   - Reach ALTHOLD
Test case value:   X12                   - P48 trigger event
                   X11                   - P46 trigger event
Expected Output:   ALTHOLD
```

207) Test specification VS-ALTHOLD-3

```
Prefix:            X11                   - Reach ALTHOLD
Test case value:   X12                   - P48 trigger event
                   X12                   - P49 trigger event
Expected Output:   PITCH
```

208) Test specification VS-ALTHOLD-4

```
Prefix:            X11                   - Reach ALTHOLD
Test case value:   X12                   - P48 trigger event
                   X13                   - P50 trigger event
Expected Output:   FLC
```

209) Test specification VS-ALTHOLD-5

```
Prefix:            X11                   - Reach ALTHOLD
Test case value:   X12                   - P48 trigger event
                   X8 = True             - P53 trigger event
Expected Output:   APPR
```

210) Test specification VS-ALTHOLD-6

```
Prefix:            X11                   - Reach ALTHOLD
Test case value:   X12                   - P48 trigger event
```

```
                 X14                    - P55 trigger event
   Expected Output:  GA

211) Test specification VS-PITCH-1

   Prefix:           X2                     - Reach PITCH
   Test case value:  X12                    - P48 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL

212) Test specification VS-PITCH-2

   Prefix:           X2                     - Reach PITCH
   Test case value:  X12                    - P48 trigger event
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD

213) Test specification VS-PITCH-3

   Prefix:           X2                     - Reach PITCH
   Test case value:  X12                    - P48 trigger event
                     X12                    - P49 trigger event
   Expected Output:  PITCH

214) Test specification VS-PITCH-4

   Prefix:           X2                     - Reach PITCH
   Test case value:  X12                    - P48 trigger event
                     X13                    - P50 trigger event
   Expected Output:  FLC

215) Test specification VS-PITCH-5

   Prefix:           X2                     - Reach PITCH
   Test case value:  X12                    - P48 trigger event
                     X8 = True              - P53 trigger event
   Expected Output:  APPR

216) Test specification VS-PITCH-6

   Prefix:           X2                     - Reach PITCH
   Test case value:  X12                    - P48 trigger event
                     X14                    - P55 trigger event
   Expected Output:  GA

217) Test specification VS-FLC-1

   Prefix:           X13                    - Reach FLC
   Test case value:  X12                    - P48 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL
```

218) Test specification VS-FLC-2

```
   Prefix:            X13                      - Reach FLC
   Test case value:   X12                      - P48 trigger event
                      X11                      - P46 trigger event
   Expected Output:   ALTHOLD
```

219) Test specification VS-FLC-3

```
   Prefix:            X13                      - Reach FLC
   Test case value:   X12                      - P48 trigger event
                      X12                      - P49 trigger event
   Expected Output:   PITCH
```

220) Test specification VS-FLC-4

```
   Prefix:            X13                      - Reach FLC
   Test case value:   X12                      - P48 trigger event
                      X13                      - P50 trigger event
   Expected Output:   FLC
```

221) Test specification VS-FLC-5

```
   Prefix:            X13                      - Reach FLC
   Test case value:   X12                      - P48 trigger event
                      X8 = True                - P53 trigger event
   Expected Output:   APPR
```

222) Test specification VS-FLC-6

```
   Prefix:            X13                      - Reach FLC
   Test case value:   X12                      - P48 trigger event
                      X14                      - P55 trigger event
   Expected Output:   GA
```

223) Test specification FLC-GA-1

```
   Prefix:            X14                      - Reach GA
   Test case value:   X13                      - P50 trigger event
                      X2                       - P42 trigger event
                      X7 = False               - Condition variable
   Expected Output:   GA
```

224) Test specification FLC-GA-2

```
   Prefix:            X14                      - Reach GA
   Test case value:   X13                      - P50 trigger event
                      X3 = True                - P43 trigger event
   Expected Output:   ALTSEL
```

225) Test specification FLC-GA-3

```
   Prefix:           X14                    - Reach GA
   Test case value:  X13                    - P50 trigger event
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD
```

226) Test specification FLC-GA-4

```
   Prefix:           X14                    - Reach GA
   Test case value:  X13                    - P50 trigger event
                     X12                    - P48 trigger event
                     X7 = False             - Condition variable
   Expected Output:  VS
```

227) Test specification FLC-GA-5

```
   Prefix:           X14                    - Reach GA
   Test case value:  X13                    - P50 trigger event
                     X13                    - P49 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH
```

228) Test specification FLC-GA-6

```
   Prefix:           X14                    - Reach GA
   Test case value:  X13                    - P50 trigger event
                     X8 = True              - P53 trigger event
   Expected Output:  APPR
```

229) Test specification FLC-GA-7

```
   Prefix:           X14                    - Reach GA
   Test case value:  X13                    - P50 trigger event
                     X14                    - P55 trigger event
                     X7 = False             - Condition variable
   Expected Output:  GA
```

230) Test specification FLC-VS-1

```
   Prefix:           X12                    - Reach VS
   Test case value:  X13                    - P50 trigger event
                     X2                     - P42 trigger event
                     X7 = False             - Condition variable
   Expected Output:  GA
```

231) Test specification FLC-VS-2

```
   Prefix:           X12                    - Reach VS
   Test case value:  X13                    - P50 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL
```

```
232) Test specification FLC-VS-3

   Prefix:           X12                    - Reach VS
   Test case value:  X13                    - P50 trigger event
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD

233) Test specification FLC-VS-4

   Prefix:           X12                    - Reach VS
   Test case value:  X13                    - P50 trigger event
                     X12                    - P48 trigger event
                     X7 = False             - Condition variable
   Expected Output:  VS

234) Test specification FLC-VS-5

   Prefix:           X12                    - Reach VS
   Test case value:  X13                    - P50 trigger event
                     X13                    - P49 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH

235) Test specification FLC-VS-6

   Prefix:           X12                    - Reach VS
   Test case value:  X13                    - P50 trigger event
                     X8 = True              - P53 trigger event
   Expected Output:  APPR

236) Test specification FLC-VS-7

   Prefix:           X12                    - Reach VS
   Test case value:  X13                    - P50 trigger event
                     X14                    - P55 trigger event
                     X7 = False             - Condition variable
   Expected Output:  GA

237) Test specification FLC-ALTSEL-1

   Prefix:           X3 = True              - Reach ALTSEL
   Test case value:  X13                    - P50 trigger event
                     X2                     - P42 trigger event
                     X7 = False             - Condition variable
   Expected Output:  GA

238) Test specification FLC-ALTSEL-2

   Prefix:           X3 = True              - Reach ALTSEL
   Test case value:  X13                    - P50 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL
```

239) Test specification FLC-ALTSEL-3

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X13                   - P50 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD
```

240) Test specification FLC-ALTSEL-4

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X13                   - P50 trigger event
                     X12                   - P48 trigger event
                     X7 = False            - Condition variable
   Expected Output:  VS
```

241) Test specification FLC-ALTSEL-5

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X13                   - P50 trigger event
                     X13                   - P49 trigger event
                     X7 = False            - Condition variable
   Expected Output:  PITCH
```

242) Test specification FLC-ALTSEL-6

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X13                   - P50 trigger event
                     X8 = True             - P53 trigger event
   Expected Output:  APPR
```

243) Test specification FLC-ALTSEL-7

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X13                   - P50 trigger event
                     X14                   - P55 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

244) Test specification FLC-ALTSEL-8

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X4                    - P52 trigger event
                     X7 = True             - Condition variable
                     X2                    - P42 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

245) Test specification FLC-ALTSEL-9

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X4                    - P52 trigger event
                     X7 = True             - Condition variable
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL
```

246) Test specification FLC-ALTSEL-10

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X4                    - P52 trigger event
                     X7 = True             - Condition variable
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD
```

247) Test specification FLC-ALTSEL-11

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X4                    - P52 trigger event
                     X7 = True             - Condition variable
                     X12                   - P48 trigger event
                     X7 = False            - Condition variable
   Expected Output:  VS
```

248) Test specification FLC-ALTSEL-12

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X4                    - P52 trigger event
                     X7 = True             - Condition variable
                     X13                   - P49 trigger event
                     X7 = False            - Condition variable
   Expected Output:  PITCH
```

249) Test specification FLC-ALTSEL-13

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X4                    - P52 trigger event
                     X7 = True             - Condition variable
                     X8 = True             - P53 trigger event
   Expected Output:  APPR
```

250) Test specification FLC-ALTSEL-14

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X4                    - P52 trigger event
                     X7 = True             - Condition variable
                     X14                   - P55 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

251) Test specification FLC-ALTSEL-15

```
   Prefix:            X3 = True             - Reach ALTSEL
   Test case value:   X11                   - P52 trigger event
                      X7 = True             - Condition variable
                      X2                    - P42 trigger event
                      X7 = False            - Condition variable
   Expected Output:   GA
```

252) Test specification FLC-ALTSEL-16

```
   Prefix:            X3 = True             - Reach ALTSEL
   Test case value:   X11                   - P52 trigger event
                      X7 = True             - Condition variable
                      X3 = True             - P43 trigger event
   Expected Output:   ALTSEL
```

253) Test specification FLC-ALTSEL-17

```
   Prefix:            X3 = True             - Reach ALTSEL
   Test case value:   X11                   - P52 trigger event
                      X7 = True             - Condition variable
                      X11                   - P46 trigger event
   Expected Output:   ALTHOLD
```

254) Test specification FLC-ALTSEL-18

```
   Prefix:            X3 = True             - Reach ALTSEL
   Test case value:   X11                   - P52 trigger event
                      X7 = True             - Condition variable
                      X12                   - P48 trigger event
                      X7 = False            - Condition variable
   Expected Output:   VS
```

255) Test specification FLC-ALTSEL-19

```
   Prefix:            X3 = True             - Reach ALTSEL
   Test case value:   X11                   - P52 trigger event
                      X7 = True             - Condition variable
                      X13                   - P49 trigger event
                      X7 = False            - Condition variable
   Expected Output:   PITCH
```

256) Test specification FLC-ALTSEL-20

```
   Prefix:            X3 = True             - Reach ALTSEL
   Test case value:   X11                   - P52 trigger event
                      X7 = True             - Condition variable
                      X8 = True             - P53 trigger event
   Expected Output:   APPR
```

257) Test specification FLC-ALTSEL-21

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X11                  - P52 trigger event
                   X7 = True            - Condition variable
                   X14                  - P55 trigger event
                   X7 = False           - Condition variable
Expected Output:   GA
```

258) Test specification FLC-ALTSEL-22

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X14                  - P52 trigger event
                   X7 = True            - Condition variable
                   X2                   - P42 trigger event
                   X7 = False           - Condition variable
Expected Output:   GA
```

259) Test specification FLC-ALTSEL-23

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X14                  - P52 trigger event
                   X7 = True            - Condition variable
                   X3 = True            - P43 trigger event
Expected Output:   ALTSEL
```

260) Test specification FLC-ALTSEL-24

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X14                  - P52 trigger event
                   X7 = True            - Condition variable
                   X11                  - P46 trigger event
Expected Output:   ALTHOLD
```

261) Test specification FLC-ALTSEL-25

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X14                  - P52 trigger event
                   X7 = True            - Condition variable
                   X12                  - P48 trigger event
                   X7 = False           - Condition variable
Expected Output:   VS
```

262) Test specification FLC-ALTSEL-26

```
Prefix:            X3 = True            - Reach ALTSEL
Test case value:   X14                  - P52 trigger event
                   X7 = True            - Condition variable
                   X13                  - P49 trigger event
                   X7 = False           - Condition variable
Expected Output:   PITCH
```

263) Test specification FLC-ALTSEL-27

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X14                   - P52 trigger event
                     X7 = True             - Condition variable
                     X8 = True             - P53 trigger event
   Expected Output:  APPR
```

264) Test specification FLC-ALTSEL-28

```
   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X14                   - P52 trigger event
                     X7 = True             - Condition variable
                     X14                   - P55 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

265) Test specification FLC-ALTHOLD-1

```
   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X13                   - P50 trigger event
                     X2                    - P42 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

266) Test specification FLC-ALTHOLD-2

```
   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X13                   - P50 trigger event
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL
```

267) Test specification FLC-ALTHOLD-3

```
   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X13                   - P50 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD
```

268) Test specification FLC-ALTHOLD-4

```
   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X13                   - P50 trigger event
                     X12                   - P48 trigger event
                     X7 = False            - Condition variable
   Expected Output:  VS
```

269) Test specification FLC-ALTHOLD-5

```
   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X13                   - P50 trigger event
                     X13                   - P49 trigger event
                     X7 = False            - Condition variable
   Expected Output:  PITCH
```

270) Test specification FLC-ALTHOLD-6

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X13                     - P50 trigger event
                     X8 = True               - P53 trigger event
   Expected Output:  APPR
```

271) Test specification FLC-ALTHOLD-7

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X13                     - P52 trigger event
                     X14                     - P55 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA
```

272) Test specification FLC-ALTHOLD-8

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X2                      - P52 trigger event
                     X7 = True               - Condition variable
                     X2                      - P42 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA
```

273) Test specification FLC-ALTHOLD-9

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X2                      - P52 trigger event
                     X7 = True               - Condition variable
                     X3 = True               - P43 trigger event
   Expected Output:  ALTSEL
```

274) Test specification FLC-ALTHOLD-10

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X2                      - P52 trigger event
                     X7 = True               - Condition variable
                     X11                     - P46 trigger event
   Expected Output:  ALTHOLD
```

275) Test specification FLC-ALTHOLD-11

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X2                      - P52 trigger event
                     X7 = True               - Condition variable
                     X12                     - P48 trigger event
                     X7 = False              - Condition variable
   Expected Output:  VS
```

276) Test specification FLC-ALTHOLD-12

```
Prefix:           X11                  - Reach ALTHOLD
Test case value:  X2                   - P52 trigger event
                  X7 = True            - Condition variable
                  X13                  - P49 trigger event
                  X7 = False           - Condition variable
Expected Output:  PITCH
```

277) Test specification FLC-ALTHOLD-13

```
Prefix:           X11                  - Reach ALTHOLD
Test case value:  X2                   - P52 trigger event
                  X7 = True            - Condition variable
                  X8 = True            - P53 trigger event
Expected Output:  APPR
```

278) Test specification FLC-ALTHOLD-14

```
Prefix:           X11                  - Reach ALTHOLD
Test case value:  X2                   - P52 trigger event
                  X7 = True            - Condition variable
                  X14                  - P55 trigger event
                  X7 = False           - Condition variable
Expected Output:  GA
```

279) Test specification FLC-ALTHOLD-15

```
Prefix:           X11                  - Reach ALTHOLD
Test case value:  X11                  - P52 trigger event
                  X7 = True            - Condition variable
                  X2                   - P42 trigger event
                  X7 = False           - Condition variable
Expected Output:  GA
```

280) Test specification FLC-ALTHOLD-16

```
Prefix:           X11                  - Reach ALTHOLD
Test case value:  X11                  - P52 trigger event
                  X7 = True            - Condition variable
                  X3 = True            - P43 trigger event
Expected Output:  ALTSEL
```

281) Test specification FLC-ALTHOLD-17

```
Prefix:           X11                  - Reach ALTHOLD
Test case value:  X11                  - P52 trigger event
                  X7 = True            - Condition variable
                  X11                  - P46 trigger event
Expected Output:  ALTHOLD
```

```
282) Test specification FLC-ALTHOLD-18

   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X11                     - P52 trigger event
                     X7 = True               - Condition variable
                     X12                     - P48 trigger event
                     X7 = False              - Condition variable
   Expected Output:  VS

283) Test specification FLC-ALTHOLD-19

   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X11                     - P52 trigger event
                     X7 = True               - Condition variable
                     X13                     - P49 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH

284) Test specification FLC-ALTHOLD-20

   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X11                     - P52 trigger event
                     X7 = True               - Condition variable
                     X8 = True               - P53 trigger event
   Expected Output:  APPR

285) Test specification FLC-ALTHOLD-21

   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X11                     - P52 trigger event
                     X7 = True               - Condition variable
                     X14                     - P55 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA

286) Test specification FLC-ALTHOLD-22

   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X12                     - P52 trigger event
                     X7 = True               - Condition variable
                     X2                      - P42 trigger event
                     X7 = False              - Condition variable
   Expected Output:  GA

287) Test specification FLC-ALTHOLD-23

   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X12                     - P52 trigger event
                     X7 = True               - Condition variable
                     X3 = True               - P43 trigger event
   Expected Output:  ALTSEL
```

288) Test specification FLC-ALTHOLD-24

```
   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X12                    - P52 trigger event
                     X7 = True              - Condition variable
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD
```

289) Test specification FLC-ALTHOLD-25

```
   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X12                    - P52 trigger event
                     X7 = True              - Condition variable
                     X12                    - P48 trigger event
                     X7 = False             - Condition variable
   Expected Output:  VS
```

290) Test specification FLC-ALTHOLD-26

```
   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X12                    - P52 trigger event
                     X7 = True              - Condition variable
                     X13                    - P49 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH
```

291) Test specification FLC-ALTHOLD-27

```
   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X12                    - P52 trigger event
                     X7 = True              - Condition variable
                     X8 = True              - P53 trigger event
   Expected Output:  APPR
```

292) Test specification FLC-ALTHOLD-28

```
   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X12                    - P52 trigger event
                     X7 = True              - Condition variable
                     X14                    - P55 trigger event
                     X7 = False             - Condition variable
   Expected Output:  GA
```

293) Test specification FLC-ALTHOLD-29

```
   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X2                     - P42 trigger event
                     X7 = False             - Condition variable
   Expected Output:  GA
```

```
294) Test specification FLC-ALTHOLD-30

   Prefix:            X11                      - Reach ALTHOLD
   Test case value:   X14                      - P52 trigger event
                      X7 = True                - Condition variable
                      X3 = True                - P43 trigger event
   Expected Output:   ALTSEL

295) Test specification FLC-ALTHOLD-31

   Prefix:            X11                      - Reach ALTHOLD
   Test case value:   X14                      - P52 trigger event
                      X7 = True                - Condition variable
                      X11                      - P46 trigger event
   Expected Output:   ALTHOLD

296) Test specification FLC-ALTHOLD-32

   Prefix:            X11                      - Reach ALTHOLD
   Test case value:   X14                      - P52 trigger event
                      X7 = True                - Condition variable
                      X12                      - P48 trigger event
                      X7 = False               - Condition variable
   Expected Output:   VS

297) Test specification FLC-ALTHOLD-33

   Prefix:            X11                      - Reach ALTHOLD
   Test case value:   X14                      - P52 trigger event
                      X7 = True                - Condition variable
                      X13                      - P49 trigger event
                      X7 = False               - Condition variable
   Expected Output:   PITCH

298) Test specification FLC-ALTHOLD-34

   Prefix:            X11                      - Reach ALTHOLD
   Test case value:   X14                      - P52 trigger event
                      X7 = True                - Condition variable
                      X8 = True                - P53 trigger event
   Expected Output:   APPR

299) Test specification FLC-ALTHOLD-35

   Prefix:            X11                      - Reach ALTHOLD
   Test case value:   X14                      - P52 trigger event
                      X7 = True                - Condition variable
                      X14                      - P55 trigger event
                      X7 = False               - Condition variable
   Expected Output:   GA
```

```
300) Test specification FLC-PITCH-1

   Prefix:            X2                     - Reach PITCH
   Test case value:   X13                    - P50 trigger event
                      X2 = True              - P42 trigger event
                      X7 = False             - Condition variable
   Expected Output:   GA

301) Test specification FLC-PITCH-2

   Prefix:            X2                     - Reach PITCH
   Test case value:   X13                    - P50 trigger event
                      X3 = True              - P43 trigger event
   Expected Output:   ALTSEL

302) Test specification FLC-PITCH-3

   Prefix:            X2                     - Reach PITCH
   Test case value:   X13                    - P50 trigger event
                      X11                    - P46 trigger event
   Expected Output:   ALTHOLD

303) Test specification FLC-PITCH-4

   Prefix:            X2                     - Reach PITCH
   Test case value:   X13                    - P50 trigger event
                      X12                    - P48 trigger event
                      X7 = False             - Condition variable
   Expected Output:   VS

304) Test specification FLC-PITCH-5

   Prefix:            X2                     - Reach PITCH
   Test case value:   X13                    - P50 trigger event
                      X13                    - P49 trigger event
                      X7 = False             - Condition variable
   Expected Output:   PITCH

305) Test specification FLC-PITCH-6

   Prefix:            X2                     - Reach PITCH
   Test case value:   X13                    - P52 trigger event
                      X8 = True              - P53 trigger event
   Expected Output:   APPR

306) Test specification FLC-PITCH-7

   Prefix:            X2                     - Reach PITCH
   Test case value:   X13                    - P52 trigger event
                      X14                    - P55 trigger event
                      X7 = False             - Condition variable
   Expected Output:  GA
```

307) Test specification FLC-APPR-1

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X8 = True             - P52 trigger event
                     NOT X14               - P52 trigger event
                     X7 = True             - Condition variable
                     X2                    - P42 trigger event
                     X7 = False            - Condition variable
   Expected Output:  GA
```

308) Test specification FLC-APPR-2

```
   Prefix:           X2                    - Reach PITCH
   Test case value:  X8 = True             - P52 trigger event
                     NOT X14               - P52 trigger event
                     X7 = True             - Condition variable
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL
```

309) Test specification FLC-APPR-3

```
   Prefix:           X2                    - Reach PITCH
   Test case value:  X8 = True             - P52 trigger event
                     NOT X14               - P52 trigger event
                     X7 = True             - Condition variable
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD
```

310) Test specification FLC-APPR-4

```
   Prefix:           X2                    - Reach PITCH
   Test case value:  X8 = True             - P52 trigger event
                     NOT X14               - P52 trigger event
                     X7 = True             - Condition variable
                     X12                   - P48 trigger event
                     X7 = False            - Condition variable
   Expected Output:  VS
```

311) Test specification FLC-APPR-5

```
   Prefix:           X2                    - Reach PITCH
   Test case value:  X8 = True             - P52 trigger event
                     NOT X14               - P52 trigger event
                     X7 = True             - Condition variable
                     X13                   - P49 trigger event
                     X7 = False            - Condition variable
   Expected Output:  PITCH
```

312) Test specification FLC-APPR-6

```
   Prefix:           X2                     - Reach PITCH
   Test case value:  X8 = True              - P52 trigger event
                     NOT X14                - P52 trigger event
                     X7 = True              - Condition variable
                     X8 = True              - P53 trigger event
   Expected Output:  APPR

313) Test specification FLC-APPR-7

   Prefix:           X2                     - Reach PITCH
   Test case value:  X8 = True              - P52 trigger event
                     NOT X14                - P52 trigger event
                     X7 = True              - Condition variable
                     X14                    - P55 trigger event
                     X7 = False             - Condition variable

314) Test specification FLC-APPR-8

   Prefix:           X8 = True              - Reach APPR
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X2                     - P42 trigger event
                     X7 = False             - Condition variable
   Expected Output:  GA

315) Test specification FLC-APPR-9

   Prefix:           X2                     - Reach PITCH
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL

316) Test specification FLC-APPR-10

   Prefix:           X2                     - Reach PITCH
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD

317) Test specification FLC-APPR-11

   Prefix:           X2                     - Reach PITCH
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X12                    - P48 trigger event
                     X7 = False             - Condition variable
   Expected Output:  VS

318) Test specification FLC-APPR-12
```

```
   Prefix:           X2                     - Reach PITCH
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X13                    - P49 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH
```

319) Test specification FLC-APPR-13

```
   Prefix:           X2                     - Reach PITCH
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X8 = True              - P53 trigger event
   Expected Output:  APPR
```

320) Test specification FLC-APPR-14

```
   Prefix:           X2                     - Reach PITCH
   Test case value:  X14                    - P52 trigger event
                     X7 = True              - Condition variable
                     X14                    - P55 trigger event
                     X7 = False             - Condition variable
   Expected Output:  APPR
```

321) Test specification APPR-GA-1

```
   Prefix:           X14                    - Reach GA
   Test case value:  X8 = True              - P53 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL
```

322) Test specification APPR-GA-2

```
   Prefix:           X14                    - Reach GA
   Test case value:  X8 = True              - P53 trigger event
                     X8 = True              - P52 trigger event
                     NOT X14                - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC
```

323) Test specification APPR-GA-3

```
   Prefix:           X14 = True             - Reach GA
   Test case value:  X8 = True              - P53 trigger event
                     X8 = True              - P52 trigger event
                     NOT X14                - P52 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH
```

324) Test specification APPR-GA-4

```
   Prefix:            X14 = True              - Reach GA
   Test case value:  X8 = True              - P53 trigger event
                     X14                    - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC

325) Test specification APPR-GA-5

   Prefix:           X14                    - Reach GA
   Test case value:  X8 = True              - P53 trigger event
                     X14                    - P55 trigger event
                     X7 = True              - Condition variable
   Expected Output:  GA

326) Test specification APPR-VS-1

   Prefix:           X12                    - Reach VS
   Test case value:  X8 = True              - P53 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL

327) Test specification APPR-VS-2

   Prefix:           X12                    - Reach VS
   Test case value:  X8 = True              - P53 trigger event
                     X8 = True              - P52 trigger event
                     NOT X14                - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC

328) Test specification APPR-VS-3

   Prefix:           X12                    - Reach VS
   Test case value:  X8 = True              - P53 trigger event
                     X8 = True              - P52 trigger event
                     NOT X14                - P52 trigger event
                     X7 = False             - Condition variable
   Expected Output:  PITCH

329) Test specification APPR-VS-4

   Prefix:           X12                    - Reach VS
   Test case value:  X8 = True              - P53 trigger event
                     X14                    - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC

330) Test specification APPR-VS-5

   Prefix:           X12                    - Reach VS
   Test case value:  X8 = True              - P53 trigger event
```

```
                     X14                   - P55 trigger event
                     X7 = True             - Condition variable
   Expected Output:  GA

331) Test specification APPR-ALTSEL-1

   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X8 = True             - P53 trigger event
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL

332) Test specification APPR-ALTSEL-2

   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X8 = True             - P53 trigger event
                     X8 = True             - P52 trigger event
                     NOT X14               - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC

333) Test specification APPR-ALTSEL-3

   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X8 = True             - P53 trigger event
                     X8 = True             - P52 trigger event
                     NOT X14               - P52 trigger event
                     X7 = False            - Condition variable
   Expected Output:  PITCH

334) Test specification APPR-ALTSEL-4

   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X8 = True             - P53 trigger event
                     X14                   - P52 trigger event
                     X7 = True             - Condition variable
   Expected Output:  FLC

335) Test specification APPR-ALTSEL-5

   Prefix:           X3 = True             - Reach ALTSEL
   Test case value:  X8 = True             - P53 trigger event
                     X14                   - P55 trigger event
                     X7 = True             - Condition variable
   Expected Output:  GA

336) Test specification APPR-ALTHOLD-1

   Prefix:           X11                   - Reach ALTHOLD
   Test case value:  X8 = True             - P53 trigger event
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL
```

337) Test specification APPR-ALTHOLD-2

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X8 = True               - P53 trigger event
                     X8 = True               - P52 trigger event
                     NOT X14                 - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC
```

338) Test specification APPR-ALTHOLD-3

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X8 = True               - P53 trigger event
                     X8 = True               - P52 trigger event
                     NOT X14                 - P52 trigger event
                     X7 = False              - Condition variable
   Expected Output:  PITCH
```

339) Test specification APPR-ALTHOLD-4

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X8 = True               - P53 trigger event
                     X14                     - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC
```

340) Test specification APPR-ALTHOLD-5

```
   Prefix:           X11                     - Reach ALTHOLD
   Test case value:  X8 = True               - P53 trigger event
                     X14                     - P55 trigger event
                     X7 = True               - Condition variable
   Expected Output:  GA
```

341) Test specification APPR-PITCH-1

```
   Prefix:           X2                      - Reach PITCH
   Test case value:  X8 = True               - P53 trigger event
                     X3 = True               - P43 trigger event
   Expected Output:  ALTSEL
```

342) Test specification APPR-PITCH-2

```
   Prefix:           X2                      - Reach PITCH
   Test case value:  X8 = True               - P53 trigger event
                     X8 = True               - P52 trigger event
                     NOT X14                 - P52 trigger event
                     X7 = True               - Condition variable
   Expected Output:  FLC
```

343) Test specification APPR-PITCH-3

```
Prefix:            X2                     - Reach PITCH
Test case value:   X8 = True              - P53 trigger event
                   X8 = True              - P52 trigger event
                   NOT X14                - P52 trigger event
                   X7 = False             - Condition variable
Expected Output:   PITCH
```

344) Test specification APPR-PITCH-4

```
Prefix:            X2                     - Reach PITCH
Test case value:   X8 = True              - P53 trigger event
                   X14                    - P52 trigger event
                   X7 = True              - Condition variable
Expected Output:   FLC
```

345) Test specification APPR-PITCH-5

```
Prefix:            X2                     - Reach PITCH
Test case value:   X8 = True              - P53 trigger event
                   X14                    - P55 trigger event
                   X7 = True              - Condition variable
Expected Output:   GA
```

346) Test specification APPR-FLC-1

```
Prefix:            X13                    - Reach FLC
Test case value:   X8 = True              - P53 trigger event
                   X3 = True              - P43 trigger event
Expected Output:   ALTSEL
```

347) Test specification APPR-FLC-2

```
Prefix:            X13                    - Reach FLC
Test case value:   X8 = True              - P53 trigger event
                   X8 = True              - P52 trigger event
                   NOT X14                - P52 trigger event
                   X7 = True              - Condition variable
Expected Output:   FLC
```

348) Test specification APPR-FLC-3

```
Prefix:            X13                    - Reach FLC
Test case value:   X8 = True              - P53 trigger event
                   X8 = True              - P52 trigger event
                   NOT X14                - P52 trigger event
                   X7 = False             - Condition variable
Expected Output:   PITCH
```

349) Test specification APPR-FLC-4

```
Prefix:            X13                    - Reach FLC
```

```
   Test case value:  X8 = True              - P53 trigger event
                     X14                    - P52 trigger event
                     X7 = True              - Condition variable
   Expected Output:  FLC
```

350) Test specification APPR-FLC-5

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X8 = True              - P53 trigger event
                     X14                    - P55 trigger event
                     X7 = True              - Condition variable
   Expected Output:  GA
```

351) Test specification GA-VS-1

```
   Prefix:           X12                    - Reach VS
   Test case value:  X14                    - P55 trigger event
                     X1 = True              - P41 trigger event
   Expected Output:  PITCH
```

352) Test specification GA-VS-2

```
   Prefix:           X12                    - Reach VS
   Test case value:  X14                    - P55 trigger event
                     X2                     - P42 trigger event
   Expected Output:  PITCH
```

353) Test specification GA-VS-3

```
   Prefix:           X12                    - Reach VS
   Test case value:  X14                    - P55 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL
```

354) Test specification GA-VS-4

```
   Prefix:           X12                    - Reach VS
   Test case value:  X14                    - P55 trigger event
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD
```

355) Test specification GA-VS-5

```
   Prefix:           X12                    - Reach VS
   Test case value:  X14                    - P55 trigger event
                     X12                    - P48 trigger event
   Expected Output:  VS
```

356) Test specification GA-VS-6

```
   Prefix:           X12                    - Reach VS
   Test case value:  X14                     - P55 trigger event
                     X13                     - P50 trigger event
   Expected Output:  FLC

357) Test specification GA-VS-7

   Prefix:           X12                     - Reach VS
   Test case value:  X14                     - P55 trigger event
                     X8 = True               - P53 trigger event
   Expected Output:  APPR

358) Test specification GA-VS-8

   Prefix:           X12                     - Reach VS
   Test case value:  X14                     - P55 trigger event
                     X9 = True               - P56 trigger event
   Expected Output:  PITCH

359) Test specification GA-VS-9

   Prefix:           X12                     - Reach VS
   Test case value:  X14                     - P55 trigger event
                     X10 = False              - P57 trigger event
   Expected Output:  PITCH

360) Test specification GA-ALTSEL-1

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X14                     - P55 trigger event
                     X1 = True               - P41 trigger event
   Expected Output:  PITCH

361) Test specification GA-ALTSEL-2

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X14                     - P55 trigger event
                     X2                      - P42 trigger event
   Expected Output:  PITCH

362) Test specification GA-ALTSEL-3

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X14                     - P55 trigger event
                     X3 = True               - P43 trigger event
   Expected Output:  ALTSEL

363) Test specification GA-ALTSEL-4

   Prefix:           X3 = True               - Reach ALTSEL
   Test case value:  X14                     - P55 trigger event
                     X11                     - P46 trigger event
   Expected Output:  ALTHOLD

364) Test specification GA-ALTSEL-5

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X14                  - P55 trigger event
                     X12                  - P48 trigger event
   Expected Output:  VS

365) Test specification GA-ALTSEL-6

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X14                  - P55 trigger event
                     X13                  - P50 trigger event
   Expected Output:  FLC

366) Test specification GA-ALTSEL-7

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X14                  - P55 trigger event
                     X8 = True            - P53 trigger event
   Expected Output:  APPR

367) Test specification GA-ALTSEL-8

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X14                  - P55 trigger event
                     X9 = True            - P56 trigger event
   Expected Output:  PITCH

368) Test specification GA-ALTSEL-9

   Prefix:           X3 = True            - Reach ALTSEL
   Test case value:  X14                  - P55 trigger event
                     X10 = False          - P57 trigger event
   Expected Output:  PITCH

369) Test specification GA-ALTHOLD-1

   Prefix:           X11                  - Reach ALTHOLD
   Test case value:  X14                  - P55 trigger event
                     X1 = True            - P41 trigger event
   Expected Output:  PITCH

370) Test specification GA-ALTHOLD-2

   Prefix:           X11                  - Reach ALTHOLD
   Test case value:  X14                  - P55 trigger event
                     X2                   - P42 trigger event
   Expected Output:  PITCH
```

```
371) Test specification GA-ALTHOLD-3

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P55 trigger event
                     X3 = True              - P43 trigger event
   Expected Output:  ALTSEL

372) Test specification GA-ALTHOLD-4

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P55 trigger event
                     X11                    - P46 trigger event
   Expected Output:  ALTHOLD

373) Test specification GA-ALTHOLD-5

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P55 trigger event
                     X12                    - P48 trigger event
   Expected Output:  VS

374) Test specification GA-ALTHOLD-6

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P55 trigger event
                     X13                    - P50 trigger event
   Expected Output:  FLC

375) Test specification GA-ALTHOLD-7

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P55 trigger event
                     X8 = True              - P53 trigger event
   Expected Output:  APPR

376) Test specification GA-ALTHOLD-8

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P55 trigger event
                     X9 = True              - P56 trigger event
   Expected Output:  PITCH

377) Test specification GA-ALTHOLD-9

   Prefix:           X11                    - Reach ALTHOLD
   Test case value:  X14                    - P55 trigger event
                     X10 = False            - P57 trigger event
   Expected Output:  PITCH

378) Test specification GA-PITCH-1
```

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
                  X1 = True              - P41 trigger event
Expected Output:  PITCH
```

379) Test specification GA-PITCH-2

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
                  X2                     - P42 trigger event
Expected Output:  PITCH
```

380) Test specification GA-PITCH-3

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
                  X3 = True              - P43 trigger event
Expected Output:  ALTSEL
```

381) Test specification GA-PITCH-4

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
                  X11                    - P46 trigger event
Expected Output:  ALTHOLD
```

382) Test specification GA-PITCH-5

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
                  X12                    - P48 trigger event
Expected Output:  VS
```

383) Test specification GA-PITCH-6

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
                  X13                    - P50 trigger event
Expected Output:  FLC
```

384) Test specification GA-PITCH-7

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
                  X8 = True              - P53 trigger event
Expected Output:  APPR
```

385) Test specification GA-PITCH-8

```
Prefix:           X2                     - Reach PITCH
Test case value:  X14                    - P55 trigger event
```

```
                  X9 = True             - P56 trigger event
   Expected Output:  PITCH

386) Test specification GA-PITCH-9

   Prefix:           X2                    - Reach PITCH
   Test case value:  X14                   - P55 trigger event
                     X10 = False           - P57 trigger event
   Expected Output:  PITCH

387) Test specification GA-APPR-1

   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X1 = True             - P41 trigger event
   Expected Output:  PITCH

388) Test specification GA-APPR-2

   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X2                    - P42 trigger event
   Expected Output:  PITCH

389) Test specification GA-APPR-3

   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL

390) Test specification GA-APPR-4

   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD

391) Test specification GA-APPR-5

   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X12                   - P48 trigger event
   Expected Output:  VS

392) Test specification GA-APPR-6

   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X13                   - P50 trigger event
   Expected Output:  FLC
```

393) Test specification GA-APPR-7

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X8 = True             - P53 trigger event
   Expected Output:  APPR
```

394) Test specification GA-APPR-8

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X9 = True             - P56 trigger event
   Expected Output:  PITCH
```

395) Test specification GA-APPR-9

```
   Prefix:           X8 = True             - Reach APPR
   Test case value:  X14                   - P55 trigger event
                     X10 = False           - P57 trigger event
   Expected Output:  PITCH
```

396) Test specification GA-FLC-1

```
   Prefix:           X13                   - Reach FLC
   Test case value:  X14                   - P55 trigger event
                     X1 = True             - P41 trigger event
   Expected Output:  PITCH
```

397) Test specification GA-FLC-2

```
   Prefix:           X13                   - Reach FLC
   Test case value:  X14                   - P55 trigger event
                     X2                    - P42 trigger event
   Expected Output:  PITCH
```

398) Test specification GA-FLC-3

```
   Prefix:           X13                   - Reach FLC
   Test case value:  X14                   - P55 trigger event
                     X3 = True             - P43 trigger event
   Expected Output:  ALTSEL
```

399) Test specification GA-FLC-4

```
   Prefix:           X13                   - Reach FLC
   Test case value:  X14                   - P55 trigger event
                     X11                   - P46 trigger event
   Expected Output:  ALTHOLD
```

400) Test specification GA-FLC-5

```
   Prefix:           X13                    - Reach FLC
   Test case value:  X14                    - P55 trigger event
                     X12                    - P48 trigger event
   Expected Output:  VS

401) Test specification GA-FLC-6

   Prefix:           X13                    - Reach FLC
   Test case value:  X14                    - P55 trigger event
                     X13                    - P50 trigger event
   Expected Output:  FLC

402) Test specification GA-FLC-7

   Prefix:           X13                    - Reach FLC
   Test case value:  X14                    - P55 trigger event
                     X8 = True              - P53 trigger event
   Expected Output:  APPR

403) Test specification GA-FLC-8

   Prefix:           X13                    - Reach FLC
   Test case value:  X14                    - P55 trigger event
                     X9 = True              - P56 trigger event
   Expected Output:  PITCH

404) Test specification GA-FLC-9

   Prefix:           X13                    - Reach FLC
   Test case value:  X14                    - P55 trigger event
                     X10 = False            - P57 trigger event
   Expected Output:  PITCH
```

6.12 Flight Level Change Submode Test Cases

Id	From	Events	To
58	-	@T(Mode_Active_Vertical = FLC) AND NOT @T(term_Overspeed)	Track
59	Overspeed	@F(term_Overspeed)	Track
60	-	@T(Mode_Active_Vertical = FLC) AND @T(term_Overspeed)	Overspeed
61	Track	@T(term_Overspeed)	Overspeed

Table 6.12: Flight Level Change Submode Transition Table (Table A.12, pg. 81 in the FGS report)

Definitions:

- X1 = (mode_Active_Vertical + FLC)
- X2 = @term_Overspeed
- X1' −− After-value of trigger event X1

- X2' −− After-value of trigger event X2
- Pre-P58 = @(FLC_Switched_Pressed)
- Pre-P60 = @(FLC_Switched_Pressed)

6.12.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X1'	X2'	Post State
P58	Entry to FLC	F	T	T	F	Track
	Entry to FLC	T	T	T	F	Entry to FLC
	Entry to FLC	F	F	T	F	Entry to FLC
	Entry to FLC	F	F	F	F	Entry to FLC
	Entry to FLC	F	F	T	T	Entry to FLC
P59	Overspeed	-	T	-	F	Track
	Overspeed	-	F	-	F	Overspeed
	Overspeed	-	F	-	T	Overspeed
P60	Entry to FLC	F	F	T	T	Overspeed
	Entry to FLC	T	F	T	T	Entry to FLC
	Entry to FLC	F	T	T	T	Entry to FLC
	Entry to FLC	F	F	F	T	Entry to FLC
	Entry to FLC	F	F	T	F	Entry to FLC
P61	Track	-	F	-	T	Overspeed
	Track	-	T	-	T	Track
	Track	-	F	-	F	Track

Test specifications:

```
 1) Test specification P58-1:

    Prefix:            Pre-P58              - Reach Entry to FLC
    Test case value:   X1 = False           - Trigger before-value
                       X2 = True            - Trigger before-value
                       X1 = True            - Trigger event
                       X2 = False           - Trigger event
    Expected Output:   Track

 2) Test specification P58-2:

    Prefix:            Pre-P58              - Reach Entry to FLC
    Test case value:   X1 = True            - Trigger before-value
                       X2 = True            - Trigger before-value
                       X1 = True            - Trigger event
                       X2 = False           - Trigger event
    Expected Output:   Entry to FLC

 3) Test specification P58-3:

    Prefix:            Pre-P58              - Reach Entry to FLC
```

```
   Test case value:  X1 = False           - Trigger before-value
                     X2 = False           - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = False           - Trigger event
   Expected Output:  Entry to FLC

4) Test specification P58-4:

   Prefix:           Pre-P58              - Reach Entry to FLC
   Test case value:  X1 = False           - Trigger before-value
                     X2 = True            - Trigger before-value
                     X1 = False           - Trigger event
                     X2 = False           - Trigger event
   Expected Output:  Entry to FLC

5) Test specification P58-5:

   Prefix:           Pre-P58              - Reach Entry to FLC
   Test case value:  X1 = False           - Trigger before-value
                     X2 = True            - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = True            - Trigger event
   Expected Output:  Entry to FLC

6) Test specification P59-1:

   Prefix:           X1 = True            - Reach Overspeed
                     X2 = True
   Test case value:  X2 = True            - Trigger before-value
                     X2 = False           - Trigger event
   Expected Output:  Track

7) Test specification P59-2:

   Prefix:           X1 = True            - Reach Overspeed
                     X2 = True
   Test case value:  X2 = False           - Trigger before-value
                     X2 = False           - Trigger event
   Expected Output:  Overspeed

8) Test specification P59-3:

   Prefix:           X1 = True            - Reach Overspeed
                     X2 = True
   Test case value:  X2 = True            - Trigger before-value
                     X2 = True            - Trigger event
   Expected Output:  Overspeed

9) Test specification P60-1:

   Prefix:           Pre-P60              - Reach Entry to FLC
   Test case value:  X1 = False           - Trigger before-value
                     X2 = False           - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = True            - Trigger event
   Expected Output:  Overspeed

10) Test specification P60-2:

   Prefix:           Pre-P60              - Reach Entry to FLC
   Test case value:  X1 = True            - Trigger before-value
                     X2 = False           - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = True            - Trigger event
   Expected Output:  Entry to FLC

11) Test specification P60-3:

   Prefix:           Pre-P60              - Reach Entry to FLC
   Test case value:  X1 = False           - Trigger before-value
                     X2 = True            - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = True            - Trigger event
   Expected Output:  Entry to FLC

12) Test specification P60-4:

   Prefix:           Pre-P60              - Reach Entry to FLC
   Test case value:  X1 = False           - Trigger before-value
                     X2 = False           - Trigger before-value
                     X1 = False           - Trigger event
                     X2 = True            - Trigger event
   Expected Output:  Entry to FLC

13) Test specification P60-5:

   Prefix:           Pre-P60              - Reach Entry to FLC
   Test case value:  X1 = False           - Trigger before-value
                     X2 = False           - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = False           - Trigger event
   Expected Output:  Entry to FLC

14) Test specification P61-1:

   Prefix:           X1 = True            - Reach Track
                     X2 = False
   Test case value:  X2 = False           - Trigger before-value
                     X2 = True            - Trigger event
   Expected Output:  Overspeed

15) Test specification P61-2:
```

```
Prefix:            X1 = True            - Reach Track
                   X2 = False
Test case value:   X2 = True            - Trigger before-value
                   X2 = True            - Trigger event
Expected Output:   Track
```

16) Test specification P61-3:

```
Prefix:            X1 = True            - Reach Track
                   X2 = False
Test case value:   X2 = False           - Trigger before-value
                   X2 = False           - Trigger event
Expected Output:   Track
```

6.12.2 Transition Pair Coverage Level Requirements:

The pairs for the Track Mode are:

(P58 or P59) : P61

The pairs for the Overspeed Mode are:

(P60 or P61) : P59

		X1	X2	
Track	Overspeed	-	F	Track
	OR			
	Entry to FLC	T	F	Track
	Track	-	T	Overspeed
Overspeed	Track	-	T	Overspeed
	OR			
	Entry to FLC	T	T	Overspeed
	Overspeed	-	F	Track

Test specifications

1) Test specification Track:

```
Prefix:            X1 = True             - Reach Overspeed
                   X2 = True
Test case value:   X2 = False            - P59 trigger event
                   X1 = True             - P58 trigger event
                   X2 = False
                   X2 = True             - P61 trigger event
```

```
   Expected Output:  Overspeed

2) Test specification Overspeed:

   Prefix:           X1 = True             - Reach Track
                     X2 = False
   Test case value:  X1 = True             - P60 trigger event
                     X2 = True
                     X2 = True             - P61 trigger event
                     X2 = False            - P59 trigger event
   Expected Output:  Track
```

6.13 Altitude Select Mode Test Cases

Id	From	Events	To
62	CLEARED	@F(Mode_Active_Vertical ∈ {APPR, GA, ALTHOLD})	ENABLED
63	ENABLED	@T(Mode_Active_Vertical ∈ {APPR, GA, ALTHOLD})	CLEARED

Table 6.13: Altitude Select Mode Transition Table (Table A.13, pg. 84 in the FGS report)

Definitions:

- X1 = mode_Active_Vertical ∈ APPR, GA, ALTHOLD
- X1’ −− After-value of trigger event X1

6.13.1 Full predicate coverage level test case requirements:

	Pre State	X1	X1’	Post State
P62	CLEARED	T	F	ENABLED
	CLEARED	F	F	CLEARED
	CLEARED	T	T	CLEARED
P63	ENABLED	F	T	CLEARED
	ENABLED	T	T	ENABLED
	ENABLED	F	F	ENABLED

Test specifications:

```
1) Test specification P62-1:

   Prefix:           X1 = True           - Reach CLEARED
   Test case value:  X1 = True           - Trigger before-value
                     X1 = False          - Trigger event
   Expected Output:  ENABLED

2) Test specification P62-2:

   Prefix:           X1 = True           - Reach CLEARED
   Test case value:  X1 = False          - Trigger before-value
                     X1 = False          - Trigger event
   Expected Output:  CLEARED

3) Test specification P62-3:

   Prefix:           X1 = True           - Reach CLEARED
   Test case value:  X1 = True           - Trigger before-value
                     X1 = True           - Trigger event
   Expected Output:  CLEARED

4) Test specification P63-1:

   Prefix:           X1 = False          - Reach ENABLED
   Test case value:  X1 = False          - Trigger before-value
                     X1 = True           - Trigger event
   Expected Output:  CLEARED

5) Test specification P63-2:

   Prefix:           X1 = False          - Reach ENABLED
   Test case value:  X1 = True           - Trigger before-value
                     X1 = True           - Trigger event
   Expected Output:  ENABLED

6) Test specification P63-3:

   Prefix:           X1 = False          - Reach ENABLED
   Test case value:  X1 = False          - Trigger before-value
                     X1 = False          - Trigger event
   Expected Output:  ENABLED
```

6.13.2 Transition Pair Coverage Level Requirements:

The pairs for the CLEARED Mode are:

```
P63 : P62
```

The pairs for the ENABLED Mode are:

```
P62 : P63
```

		X1	
CLEARED	ENABLED	T	CLEARED
	CLEARED	F	ENABLED
ENABLED	CLEARED	F	ENABLED
	ENABLED	T	CLEARED

Test specifications

```
 1) Test specification CLEARED:

    Prefix:            X1 = False            - Reach ENABLED
    Test case value:   X1 = True             - P63 trigger event
                       X1 = False            - P62 trigger event
    Expected Output:   ENABLED

 2) Test specification ENABLED:

    Prefix:            X1 = True             - Reach CLEARED
    Test case value:   X1 = False            - P62 trigger event
                       X1 = True             - P63 trigger event
    Expected Output:   CLEARED
```

6.14 Altitude Select ENABLED Submode Test Cases

Id	From	Events	To
64	ARMED	@T(term_ALTSEL_Cond = Capture AND Duration(INMODE) > const_min_armed_period)	ACTIVE
65	ACTIVE	@T(Mode_Active_Vertical ∈ {APPR, GA, ALTHOLD})	ARMED

Table 6.14: Altitude Select ENABLED Submode Transition Table (Table A.14, pg. 84 in the FGS report)

Definitions:

- X1 = (term_ALTSEL_Cond = Capture)
- X2 = (Duration(INMODE) > const_min_armed_period)
- X3 = (mode_Active_Vertical ∈ APPR, GA, ALTSEL, ALTHOLD)
- X1' −− After-value of trigger event X1
- X2' −− After-value of trigger event X2
- X3' −− After-value of trigger event X3

6.14.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X3	X1'	X2'	X3'	Post State
P64	ARMED	F	F	-	T	T	-	ACTIVE
	ARMED	T	T	-	T	T	-	ARMED
	ARMED	T	T	-	F	T	-	ARMED
	ARMED	T	T	-	T	F	-	ARMED
P65	ACTIVE	-	-	F	-	-	T	ARMED
	ACTIVE	-	-	T	-	-	T	ACTIVE
	ACTIVE	-	-	F	-	-	F	ACTIVE

Test specifications:

1) Test specification P64-1:

```
Prefix:           X3 = True            - Reach ARMED
Test case value:  X1 = False           - Trigger before-value
                  X2 = False           - Trigger before-value
                  X1 = True            - Trigger event
                  X2 = True            - Trigger event
Expected Output:  ACTIVE
```

2) Test specification P64-2:

```
Prefix:           X3 = True            - Reach ARMED
Test case value:  X1 = True            - Trigger before-value
                  X2 = True            - Trigger before-value
                  X1 = True            - Trigger event
                  X2 = True            - Trigger event
Expected Output:  ARMED
```

3) Test specification P64-3:

```
Prefix:           X3 = True            - Reach ARMED
Test case value:  X1 = True            - Trigger before-value
                  X2 = True            - Trigger before-value
                  X1 = False           - Trigger event
                  X2 = True            - Trigger event
Expected Output:  ARMED
```

4) Test specification P64-4:

```
Prefix:           X3 = True            - Reach ARMED
Test case value:  X1 = True            - Trigger before-value
                  X2 = True            - Trigger before-value
                  X1 = True            - Trigger event
                  X2 = False           - Trigger event
Expected Output:  ARMED
```

5) Test specification P65-1:

```
Prefix:           X1 = True            - Reach ACTIVE
                  X2 = True
Test case value:  X3 = False           - Trigger before-value
                  X3 = True            - Trigger event
Expected Output:  ARMED
```

6) Test specification P65-2:

```
Prefix:           X1 = True            - Reach ACTIVE
                  X2 = True
Test case value:  X3 = True            - Trigger before-value
                  X3 = True            - Trigger event
Expected Output:  ACTIVE
```

```
7) Test specification P65-3:

   Prefix:           X1 = True           - Reach ACTIVE
                     X2 = True
   Test case value:  X3 = False          - Trigger before-value
                     X3 = False          - Trigger event
   Expected Output:  ACTIVE
```

6.14.2 Transition Pair Coverage Level Requirements:

The pairs for the ACTIVE Mode are:

```
P64 : P65
```

The pairs for the ARMED Mode are:

```
P65 : P64
```

		X1	X2	X3	
ACTIVE	ARMED	T	T	-	ACTIVE
	ACTIVE	-	-	T	ARMED
ARMED	ACTIVE	-	-	T	ARMED
	ARMED	T	T	-	ACTIVE

Test specifications

```
1) Test specification ACTIVE:

   Prefix:           X3 = True             - Reach ARMED
   Test case value:  X1 = True             - P64 trigger event
                     X2 = True
                     X3 = True             - P65 trigger event
   Expected Output:  ACTIVE

2) Test specification ARMED:

   Prefix:           X1 = True             - Reach ACTIVE
                     X2 = True
   Test case value:  X3 = True             - P65 trigger event
                     X1 = True             - P64 trigger event
                     X2 = True
   Expected Output:  ARMED
```

6.15 Altitude Select ACTIVE Submode Test Cases

Id	From	Events	To
66	Capture	@T(term_ALTSEL_Cond = Track AND Duration(INMODE) > const_min_armed_period)	Track

Table 6.15: Altitude Select ACTIVE Submode Transition Table (Table A.15, pg. 84 in the FGS report)

Definitions:

- X1 = (term_ALTSEL_Cond = Track)
- X2 = (Duration(INMODE) > const_min_armed_period
- X1' −− After-value of trigger event X1
- X2' −− After-value of trigger event X2
- Pre-P66-1 = (term_ALTSEL_Cond = Capture)
- Pre-P66-2 = (Duration(INMODE) > const_min_armed_period)

6.15.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X1'	X2'	Post State
P66	Capture	F	F	T	T	Track
	Capture	T	T	T	T	Capture
	Capture	T	T	F	T	Capture
	Capture	T	T	T	F	Capture

Test specifications:

```
1) Test specification P66-1:

   Prefix:           Pre-P66-1 = True     - Reach Entry to Capture
                     Pre-P66-2 = True
   Test case value:  X1 = False           - Trigger before-value
                     X2 = False           - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = True            - Trigger event
   Expected Output:  Track

2) Test specification P66-2:

   Prefix:           Pre-P66-1 = True     - Reach Entry to Capture
                     Pre-P66-2 = True
   Test case value:  X1 = True            - Trigger before-value
                     X2 = True            - Trigger before-value
                     X1 = True            - Trigger event
                     X2 = True            - Trigger event
   Expected Output:  Capture

3) Test specification P66-3:

   Prefix:           Pre-P66-1 = True     - Reach Entry to Capture
```

```
                   Pre-P66-2 = True
Test case value:   X1 = True           - Trigger before-value
                   X2 = True           - Trigger before-value
                   X1 = False          - Trigger event
                   X2 = True           - Trigger event
Expected Output:   Capture
```

```
4) Test specification P66-4:

   Prefix:            Pre-P66-1 = True     - Reach Entry to Capture
                      Pre-P66-2 = True
   Test case value:   X1 = True            - Trigger before-value
                      X2 = True            - Trigger before-value
                      X1 = True            - Trigger event
                      X2 = False           - Trigger event
   Expected Output:   Capture
```

6.15.2 Transition Pair Coverage Level Requirements:

NONE.

6.16 Vertical Approach Mode Test Cases

Id	From	Events	To
67	CLEARED	@T(mode_Active_Lateral = APPR/Track)	ENABLED
68	ENABLED	@F(mode_Active_Lateral = APPR/Track)	CLEARED

Table 6.16: Vertical Approach Mode Transition Table (Table A.16, pg. 87 in the FGS report)

Definitions:

- X1 = (mode_Active_Lateral = APPR/Track)
- X1' −− After-value of trigger event X1

6.16.1 Full predicate coverage level test case requirements:

	Pre State	X1	X1'	Post State
P67	CLEARED	F	T	ENABLED
	CLEARED	T	T	CLEARED
	CLEARED	F	F	CLEARED
P68	ENABLED	T	F	CLEARED
	ENABLED	F	F	ENABLED
	ENABLED	T	T	ENABLED

Test specifications:

```
1) Test specification P67-1:

   Prefix:           X1 = False          - Reach CLEARED
   Test case value:  X1 = False          - Trigger before-value
                     X1 = True           - Trigger event
   Expected Output:  ENABLED

2) Test specification P67-2:

   Prefix:           X1 = False          - Reach CLEARED
   Test case value:  X1 = True           - Trigger before-value
                     X1 = True           - Trigger event
   Expected Output:  ENABLED

3) Test specification P67-3:

   Prefix:           X1 = False          - Reach CLEARED
   Test case value:  X1 = False          - Trigger before-value
                     X1 = False          - Trigger event
   Expected Output:  ENABLED

4) Test specification P67-4:

   Prefix:           X1 = False          - Reach ENABLED
   Test case value:  X1 = True           - Trigger before-value
                     X1 = False          - Trigger event
   Expected Output:  CLEARED

5) Test specification P68-1:

   Prefix:           X1 = True           - Reach ENABLED
   Test case value:  X1 = True           - Trigger before-value
                     X1 = False          - Trigger event
   Expected Output:  CLEARED

6) Test specification P68-2:

   Prefix:           X1 = True           - Reach ENABLED
   Test case value:  X1 = False          - Trigger before-value
                     X1 = False          - Trigger event
   Expected Output:  ENABLED

7) Test specification P68-3:

   Prefix:           X1 = True           - Reach ENABLED
   Test case value:  X1 = True           - Trigger before-value
                     X1 = True           - Trigger event
   Expected Output:  ENABLED
```

6.16.2 Transition Pair Coverage Level Requirements:

The pairs for the ENABLED Mode are:

```
P67 : P68
```

The pairs for the CLEARED Mode are:

```
P68 : P67
```

		X1	
ENABLED	CLEARED	T	ENABLED
	ENABLED	F	CLEARED
CLEARED	ENABLED	F	CLEARED
	CLEARED	T	ENABLED

Test specifications

```
 1) Test specification ENABLED:

    Prefix:           X1 = False          - Reach CLEARED
    Test case value:  X1 = True           - P67 trigger event
                      X1 = False          - P68 trigger event
    Expected Output:  CLEARED

 2) Test specification CLEARED:

    Prefix:           X1 = True           - Reach ENABLED
    Test case value:  X1 = False          - P68 trigger event
                      X1 = True           - P67 trigger event
    Expected Output:  ENABLED
```

6.17 Vertical Approach ENABLED Submode Test Cases

Id	From	Events	To
69	ARMED	@T(term_Vertical_Appr_Track_Cond_Met AND Duration(INMODE) > const_min_armed_period)	Track

Table 6.17: Vertical Approach ENABLED Submode Transition Table (Table A.17, pg. 87 in the FGS report)

Definitions:

- X1 = (term_Vertical_APPR_Track_Cond_Met)
- X2 = (Duration(INMODE) > const_min_armed_period)
- X1' −− After-value of trigger event X1
- X2' −− After-value of trigger event X2
- Pre-P69 = (Mode_Active_Lateral = APPR/Track)

6.17.1 Full predicate coverage level test case requirements:

	Pre State	X1	X2	X1'	X2'	Post State
P69	ARMED	F	F	T	T	Track
	ARMED	T	T	T	T	ARMED
	ARMED	T	T	F	T	ARMED
	ARMED	T	T	T	F	ARMED

Test specifications:

```
 1) Test specification P69-1:

    Prefix:            Pre-P69 = True       - Reach ENABLED
    Test case value:  X1 = False            - Trigger before-value
                      X2 = False            - Trigger before-value
                      X1 = True             - Trigger event
                      X2 = True             - Trigger event
    Expected Output:  Track

 2) Test specification P69-2:

    Prefix:            Pre-P69 = True       - Reach ENABLED
    Test case value:  X1 = True             - Trigger before-value
                      X2 = True             - Trigger before-value
                      X1 = True             - Trigger event
                      X2 = True             - Trigger event
    Expected Output:  ARMED

 3) Test specification P69-3:

    Prefix:            Pre-P69 = True       - Reach ENABLED
    Test case value:  X1 = True             - Trigger before-value
                      X2 = True             - Trigger before-value
                      X1 = False            - Trigger event
                      X2 = True             - Trigger event
    Expected Output:  ARMED

 4) Test specification P69-4:

    Prefix:            Pre-P69 = True       - Reach ENABLED
    Test case value:  X1 = True             - Trigger before-value
                      X2 = True             - Trigger before-value
                      X1 = True             - Trigger event
                      X2 = False            - Trigger event
    Expected Output:  ARMED
```

6.17.2 Transition Pair Coverage Level Requirements:

NONE.

7 CONCLUSIONS

This report introduces a new technique for generating test data from formal software specifications. Formal specifications represent a significant opportunity for testing because they precisely describe the functionality of the software in a form that can be easily manipulated by automated means. This research addresses the problem of developing formalizable, measurable criteria for generating test cases from specifications. A model for generating tests from requirements/specifications and a derivation process for generating the test cases were presented. Results from applying the model and process to a small example were presented. This case study was evaluated using Atac to measure decision coverage, and the technique was found to achieve a high level of coverage. This result indicates that this technique can benefit software developers who construct formal specifications during development.

As an additional validation, tests were generated for specifications of an industrial software system, the Flight Guidance System. Construction of these tests resulted in several modifications to this technique, and found at least one problem with the specification.

One interesting result from the decision coverage is that only the functional specifications related to the cruise control state machine itself were covered. While this was certainly the focus of the study, several decisions having to do with the input were left out. For testing of real systems, the input specifications must be considered as well, either by adapting the method presented here, or by using another testing method.

The immediate goal of this research was to develop a model and formal criterion for generating tests from state-based specifications. Short term goals are to develop *mechanical* procedures to derive test cases from formal specifications, and apply the method to industrial software specifications supplied by the sponsor, Rockwell Collins, Inc. One observation from the case study and the industrial example is that it requires a lot of very detailed hand analysis to apply the technique. Both to save costs, and improve accuracy, a long term goal is to develop automated tool support to transform formal functional specifications into effective test cases. An eventual goal is to build an automatic test data generation tool for this technique.

8 ACKNOWLEDGMENTS

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A APPENDIX: CRUISE CONTROL IMPLEMENTATION

This program was written to model the cruise control specifications of Section 5. The test cases listed in that section were tested on this program.

```
/*/////////////////////////////////////////////////////////*/
/*  Programmer : Lei Sun and Jeff Offutt                   */
/*  Module     : Cruise Control implementation.            */
/*  Purpose    : To model the state diagram for the        */
/*             : cruise control program.                   */
/*  Usage      : cruise [-s] [file]                        */
/*             : "-s" will allow the current state to be   */
/*             : entered each time through the loop.       */
/*             : [file] is the input data file.  If it’s   */
/*             : not present, stdinput is used.            */
/*             : Accepts sequences of VARIABLE VALUE pairs.*/
/*             : X t -- sets condition variable X TRUE.    */
/*             : X f -- sets condition variable X FALSE.   */
/*             : X T -- X=TRUE is a trigger event.         */
/*             : X F -- X=FALSE is a trigger event.        */
/*  Date       : 8/97                                      */
/*  Compile    : On SITE, g++ -o cruise cruise.C           */
/*/////////////////////////////////////////////////////////*/

#include <stdio.h>

#define FALSE 0
#define TRUE 1

/* enum StateType {OFF, INACTIVE, CRUISE, OVERRIDE, QUIT};*/

int CurState;
int Ignited, Running, Toofast, Brake, Activate, Deactivate, Resume;

/* Results from GetNextInput() .. exit from the program,
 * set a condition variable,
 * or a triggering event.
 */
#define EXIT -1
#define CONDITION 0
#define TRIGIGNITED 1
#define TRIGRUNNING 2
#define TRIGTOOFAST 3
#define TRIGBRAKE 4
#define TRIGACTIVATE 5
#define TRIGDEACTIVATE 6
#define TRIGRESUME 7

/* State */
#define OFF 1
#define INACTIVE 2
```

```
#define CRUISE 3
#define OVERRIDE 4
#define QUIT 5

/* Defaults: */
int FileIn = FALSE,        /* input is standard input */
    CurStPersists = TRUE;  /* current state stays persistent */
FILE *FP, *fopen ();

/*//////////////////////////////////////////////////*/
/*  Programmer : Jeff Offutt                        */
/*  Function   : ParseArgs                          */
/*  Purpose    : To parse the arguments to set      */
/*             : global parameters.                 */
/*  Date       : 6/97                               */
/*//////////////////////////////////////////////////*/
void ParseArgs (argc, argv)
int argc;
char *argv[];
{
   int argi;

   for (argi = 1; argi <= argc-1; argi++)
   {
      if (argv[argi][0] == ’-’)
      {
         if (argv[argi][1] == ’s’)
            CurStPersists = FALSE;
      }
      else
      {
         FileIn = TRUE;
         FP = fopen (argv[argi], "r");
         if (!FP)
         {  /* File was not opened. */
            fprintf (stderr, "File %s is not available for reading.\n", argv[argi]);
            fprintf (stderr, "Running in interactive mode.\n");
            FileIn = FALSE;
         }
      }
   }
}


/*//////////////////////////////////////////////////*/
/*  Programmer : Jeff Offutt                        */
/*  Function   : PrintState                         */
/*  Purpose    : Print a string representing the    */
/*             : state.                             */
/*  Date       : 6/97                               */
/*//////////////////////////////////////////////////*/
```

```
void PrintState (S)
int S;
{
   switch (S)
   {
   case OFF:
      printf ("OFF");
      break;
   case INACTIVE:
      printf ("INACTIVE");
      break;
   case CRUISE:
      printf ("CRUISE");
      break;
   case OVERRIDE:
      printf ("OVERRIDE");
      break;
   case QUIT:
      printf ("QUIT");
      break;
   }
}


/*//////////////////////////////////////////////////////*/
/*  Programmer : Jeff Offutt                           */
/*  Function   : GetState                              */
/*  Purpose    : Input a current state from user.      */
/*             : Default is OFF.                       */
/*  Date       : 6/97                                  */
/*//////////////////////////////////////////////////////*/
int GetState ()
{
   char state_str [80];

   if (FileIn == FALSE)
   {  /* Interactive mode */
      printf ("enter OFF, INACTIVE, CRUISE, or OVERRIDE: ");
      scanf ("%s", state_str);
   }
   else
      fscanf (FP, "%s", state_str);

   switch (state_str [0])
   {
   case 'O': case 'o':
      if (state_str[1] == 'F' || state_str[1] == 'f')
         return (OFF);
      else /* 'V' or 'v' */
         return (OVERRIDE);
      break;
   case 'I': case 'i':
      return (INACTIVE);
      break;
   case 'C': case 'c':
      return (CRUISE);
      break;
   default:
      return (OFF);
      break;
   }
}


/*//////////////////////////////////////////////////*/
/*  Programmer : Jeff Offutt                        */
/*  Function   : GetNextInput                       */
/*  Purpose    : Read next variable value pair.     */
/*  Date       : 8/97                               */
/*//////////////////////////////////////////////////*/
int GetNextInput ()
{
   char variable [20];
   char c_value;
   int  value;
   int  ret_val = CONDITION;

   if (FileIn == FALSE)
   {  /* Interactive mode */
      printf ("Input 'variable value' pair.\n");

      scanf ("%s", variable);
      scanf ("%c", &c_value);
      while (c_value == ' ') /* Skip spaces. */
         scanf ("%c", &c_value);
   }
   else
   {
      fscanf (FP, "%s", variable);
      fscanf (FP, "%c", &c_value);
      while (c_value == ' ') /* Skip spaces. */
         fscanf (FP, "%c", &c_value);
   }

   if (strcmp (variable, "Exit") == 0)
   {
      ret_val = EXIT;
      return (ret_val);
   }

   if ((c_value == 't') || (c_value == 'T'))
      value = TRUE;
   else
      value = FALSE;

   if (strcmp (variable, "Ignited") == 0)
   {
      Ignited = value;
      if ((c_value == ’T’) || (c_value == ’F’))
         ret_val = TRIGIGNITED;
   }
   else if (strcmp (variable, "Running") == 0)
   {
      Running = value;
      if ((c_value == ’T’) || (c_value == ’F’))
         ret_val = TRIGRUNNING;
   }
   else if (strcmp (variable, "Toofast") == 0)
   {
      Toofast = value;
      if ((c_value == ’T’) || (c_value == ’F’))
        ret_val = TRIGTOOFAST;
   }
   else if (strcmp (variable, "Brake") == 0)
   {
      Brake = value;
      if ((c_value == ’T’) || (c_value == ’F’))
         ret_val = TRIGBRAKE;
   }
   else if (strcmp (variable, "Activate") == 0)
   {
      Activate = value;
      if ((c_value == ’T’) || (c_value == ’F’))
         ret_val = TRIGACTIVATE;
   }
   else if (strcmp (variable, "Deactivate") == 0)
   {
      Deactivate = value;
      if ((c_value == ’T’) || (c_value == ’F’))
         ret_val = TRIGDEACTIVATE;
   }
   else if (strcmp (variable, "Resume") == 0)
   {
      Resume = value;
      if ((c_value == ’T’) || (c_value == ’F’))
         ret_val = TRIGRESUME;
   }
   else
      fprintf (stderr, "Could not read the input, must be a variable name.\n");

   return (ret_val);
}
```

```
/*/////////////////////////////////////////////////////////*/
/*  main program function                                  */
/*/////////////////////////////////////////////////////////*/
main (argc, argv)
int argc;
char *argv[];
{
   int result = CONDITION;
   int trig_event;

   CurState = OFF;

   ParseArgs (argc, argv);

   while (TRUE)
   {  /* Run until EXIT is entered */

      /* Check the current state */
      if (CurStPersists == TRUE)
      {
         printf ("Current state := ");
         PrintState (CurState);
         printf ("\n");
      }
      else
      {
         if (FileIn == FALSE)
            printf ("Enter current state, ");
         CurState = GetState ();
      }

      result = GetNextInput ();
      while (result == CONDITION)   /* Set condition variables until Exit */
         result = GetNextInput ();  /* or a trigger event. */

      if (result == EXIT)
         return 0;

      /* TRIGGER event was entered. */
      /* This case statement encodes the transition table. */
      trig_event = result;
      switch (CurState)
      {
      case OFF:
         switch (trig_event)
         {
         case TRIGIGNITED:
            if (Ignited == TRUE)
            {
               CurState = INACTIVE;
               printf ("State change: OFF --> INACTIVE\n");
      }
      break;
   }
   if (CurState == OFF)
      printf ("No state change: OFF\n");
   break;

/*----------------------------------------------------------------*/
case INACTIVE:
   switch (trig_event)
   {
   case TRIGIGNITED:
      if (Ignited == FALSE)
      {
         CurState = OFF;
         printf ( "State change: INACTIVE --> OFF\n");
      }
      break;
   case TRIGACTIVATE:
      if (Activate == TRUE && Running == TRUE && Ignited == TRUE && Brake == FALSE)
      {
         CurState = CRUISE;
         printf ("State change: INACTIVE --> CRUISE\n");
      }
      break;
   }
   if (CurState == INACTIVE)
      printf ("No state change: INACTIVE\n");
   break;

/*----------------------------------------------------------------*/
case CRUISE:
   switch (trig_event)
   {
   case TRIGIGNITED: /* C4 */
      if (Ignited == FALSE)
      {
         CurState = OFF;
         printf ( "State change: CRUISE --> OFF\n");
      }
      break;
   case TRIGRUNNING: /* C5 */
      if (Running == FALSE && Ignited == TRUE )
      {
         CurState = INACTIVE;
         printf ("State change: CRUISE -->  INACTIVE\n");
      }
      break;
   case TRIGTOOFAST: /* C6 */
      if (Toofast == TRUE && Ignited == TRUE )
      {
         CurState = INACTIVE;
         printf ("State change: CRUISE -->  INACTIVE\n");
      }
      break;
   case TRIGBRAKE: /* C7 */
      if ((Brake == TRUE && Ignited == TRUE &&
           Running == TRUE && Toofast == FALSE))
      {
         CurState =  OVERRIDE;
         printf ("State change: CRUISE --> OVERRIDE\n");
      }
      break;
   case TRIGDEACTIVATE:
      if ((Deactivate == TRUE && Ignited == TRUE &&
           Running == TRUE && Toofast == FALSE))
      {
         CurState =  OVERRIDE;
         printf ("State change: CRUISE --> OVERRIDE\n");
      }
      break;
   }
   if (CurState == CRUISE)
      printf ("No state change: CRUISE\n");
   break;

/*----------------------------------------------------------------*/
case OVERRIDE:
   switch (trig_event)
   {
   case TRIGIGNITED:
      if (Ignited == FALSE)
      {
         CurState = OFF;
         printf ( "State change: OVERRIDE --> OFF\n");
      }
      break;
   case TRIGRUNNING:
      if (Running == FALSE && Ignited == TRUE)
      {
         CurState = INACTIVE;
         printf ("State change: OVERRIDE --> INACTIVE\n");
      }
      break;
   case TRIGACTIVATE:
      if (Activate == TRUE && Ignited == TRUE &&
          Running == TRUE && Brake == FALSE)
      {
         CurState = CRUISE;
         printf ("State change: OVERRIDE --> CRUISE\n");
      }
      break;
```

```
         case TRIGRESUME:
            if (Resume == TRUE && Ignited == TRUE &&
                Running == TRUE && Brake == FALSE)
            {
               CurState = CRUISE;
               printf ("State change: OVERRIDE --> CRUISE\n");
            }
            break;
         }
         if (CurState == OVERRIDE)
            printf ("No state change: OVERRIDE\n");
         break;

      } /* End switch (CurState)*/
   }  /* End while */
} /* End main */
```

Contents