

# aircraft

Tight Rope v0.6

21st November 2015

## 1 ID Files

### 1.1 MissionIds

**section** *MissionIds* **parents** *scj\_prelude*, *MissionId*

*MainMissionID* : *MissionID*  
*TakeOffMissionID* : *MissionID*  
*CruiseMissionID* : *MissionID*  
*LandMissionID* : *MissionID*

---

*distinct*(*nullMissionId*, *MainMissionID*, *TakeOffMissionID*,  
*CruiseMissionID*, *LandMissionID*)

## 1.2 SchedulablesIds

**section** *SchedulableIds* **parents** *scj\_prelude*, *SchedulableId*

*MainMissionSequencerID* : *SchedulableID*  
*ACModeChangerID* : *SchedulableID*  
*EnvironmentMonitorID* : *SchedulableID*  
*ControlHandlerID* : *SchedulableID*  
*FlightSensorsMonitorID* : *SchedulableID*  
*CommunicationsHandlerID* : *SchedulableID*  
*AperiodicSimulatorID* : *SchedulableID*  
*LandingGearHandlerTakeOffID* : *SchedulableID*  
*TakeOffMonitorID* : *SchedulableID*  
*TakeOffFailureHandlerID* : *SchedulableID*  
*BeginLandingHandlerID* : *SchedulableID*  
*NavigationMonitorID* : *SchedulableID*  
*GroundDistanceMonitorID* : *SchedulableID*  
*LandingGearHandlerLandID* : *SchedulableID*  
*InstrumentLandingSystemMonitorID* : *SchedulableID*  
*SafeLandingHandlerID* : *SchedulableID*

---

*distinct*(*nullSequencerId*, *nullSchedulableId*, *MainMissionSequencerID*,  
*ACModeChangerID*, *EnvironmentMonitorID*,  
*ControlHandlerID*, *FlightSensorsMonitorID*,  
*CommunicationsHandlerID*, *AperiodicSimulatorID*,  
*LandingGearHandlerTakeOffID*, *TakeOffMonitorID*,  
*TakeOffFailureHandlerID*, *BeginLandingHandlerID*,  
*NavigationMonitorID*, *GroundDistanceMonitorID*,  
*LandingGearHandlerLandID*, *InstrumentLandingSystemMonitorID*,  
*SafeLandingHandlerID*)

### 1.3 ThreadIDs

**section** *ThreadIDs* **parents** *scj\_prelude, GlobalTypes*

*ACModeChangerThreadID : ThreadID*  
*EnvironmentMonitorThreadID : ThreadID*  
*ControlHandlerThreadID : ThreadID*  
*FlightSensorsMonitorThreadID : ThreadID*  
*CommunicationsHandlerThreadID : ThreadID*  
*AperiodicSimulatorThreadID : ThreadID*  
*LandingGearHandlerTakeOffThreadID : ThreadID*  
*TakeOffMonitorThreadID : ThreadID*  
*TakeOffFailureHandlerThreadID : ThreadID*  
*BeginLandingHandlerThreadID : ThreadID*  
*NavigationMonitorThreadID : ThreadID*  
*GroundDistanceMonitorThreadID : ThreadID*  
*LandingGearHandlerLandThreadID : ThreadID*  
*InstrumentLandingSystemMonitorThreadID : ThreadID*  
*SafeLandingHandlerThreadID : ThreadID*

---

*distinct(SafeletThreadId, nullThreadId,*  
*ACModeChangerThreadID, EnvironmentMonitorThreadID,*  
*ControlHandlerThreadID, FlightSensorsMonitorThreadID,*  
*CommunicationsHandlerThreadID, AperiodicSimulatorThreadID,*  
*LandingGearHandlerTakeOffThreadID, TakeOffMonitorThreadID,*  
*TakeOffFailureHandlerThreadID, BeginLandingHandlerThreadID,*  
*NavigationMonitorThreadID, GroundDistanceMonitorThreadID,*  
*LandingGearHandlerLandThreadID, InstrumentLandingSystemMonitorThreadID,*  
*SafeLandingHandlerThreadID)*

## 1.4 ObjectIds

section *ObjectIds* parents *scj\_prelude*, *GlobalTypes*

*ACSafeletObjectID* : *ObjectID*  
*MainMissionObjectID* : *ObjectID*  
*ACModeChangerObjectID* : *ObjectID*  
*EnvironmentMonitorObjectID* : *ObjectID*  
*ControlHandlerObjectID* : *ObjectID*  
*FlightSensorsMonitorObjectID* : *ObjectID*  
*CommunicationsHandlerObjectID* : *ObjectID*  
*AperiodicSimulatorObjectID* : *ObjectID*  
*TakeOffMissionObjectID* : *ObjectID*  
*LandingGearHandlerTakeOffObjectID* : *ObjectID*  
*TakeOffMonitorObjectID* : *ObjectID*  
*TakeOffFailureHandlerObjectID* : *ObjectID*  
*CruiseMissionObjectID* : *ObjectID*  
*BeginLandingHandlerObjectID* : *ObjectID*  
*NavigationMonitorObjectID* : *ObjectID*  
*LandMissionObjectID* : *ObjectID*  
*GroundDistanceMonitorObjectID* : *ObjectID*  
*LandingGearHandlerLandObjectID* : *ObjectID*  
*InstrumentLandingSystemMonitorObjectID* : *ObjectID*  
*SafeLandingHandlerObjectID* : *ObjectID*

*distinct*(*ACSafeletObjectID*, *MainMissionObjectID*,  
*ACModeChangerObjectID*, *EnvironmentMonitorObjectID*,  
*ControlHandlerObjectID*, *FlightSensorsMonitorObjectID*,  
*CommunicationsHandlerObjectID*, *AperiodicSimulatorObjectID*,  
*TakeOffMissionObjectID*, *LandingGearHandlerTakeOffObjectID*,  
*TakeOffMonitorObjectID*, *TakeOffFailureHandlerObjectID*,  
*CruiseMissionObjectID*, *BeginLandingHandlerObjectID*,  
*NavigationMonitorObjectID*, *LandMissionObjectID*,  
*GroundDistanceMonitorObjectID*, *LandingGearHandlerLandObjectID*,  
*InstrumentLandingSystemMonitorObjectID*, *SafeLandingHandlerObjectID*)

## 2 Network

**section** *NetworkChannels* **parents** *scj\_prelude, MissionId, MissionIds, SchedulableId, SchedulableIds, MissionChan, SchedulableChan, TopLevelMissionSequencerFWChan, FrameworkChan, SafeletChan*

**channelset** *TerminateSync* ==  
    { *schedulables\_terminated, schedulables\_stopped, get\_activeSchedulables* }

**channelset** *ControlTierSync* ==  
    { *start\_toplevel\_sequencer, done\_toplevel\_sequencer, done\_safeletFW* }

**channelset** *TierSync* ==  
    { *start\_mission ., done\_mission ., done\_safeletFW, done\_toplevel\_sequencer* }

**channelset** *MissionSync* ==  
    { *done\_safeletFW, done\_toplevel\_sequencer, register, signalTerminationCall, signalTerminationRet, activate\_schedulables, done\_schedulable, cleanupSchedulableCall, cleanupSchedulableRet* }

**channelset** *SchedulablesSync* ==  
    { *activate\_schedulables, done\_safeletFW, done\_toplevel\_sequencer* }

**channelset** *ClusterSync* ==  
    { *done\_toplevel\_sequencer, done\_safeletFW* }

**channelset** *AppSync* ==  
    { *SafeltAppSync, MissionSequencerAppSync, MissionAppSync, MTAAppSync, OSEHSync, APEHSync, getSequencer, end\_mission\_app, end\_managedThread\_app, setCeilingPriority, requestTerminationCall, requestTerminationRet, terminationPendingCall, terminationPendingRet, handleAsyncEventCall, handleAsyncEventRet* }

**channelset** *ObjectSync* ==  
    { }

**channelset** *ThreadSync* ==  
    { }

**channelset** *LockingSync* ==  
    { *lockAcquired, startSyncMeth, endSyncMeth, waitCall, waitRet, notify* }

**channelset** *Tier0Sync* ==  
    { *done\_toplevel\_sequencer, done\_safeletFW, start\_mission ., done\_mission ., initializeRet ., requestTermination . ., start\_mission ., done\_mission ., initializeRet ., requestTermination . ., start\_mission ., done\_mission ., initializeRet ., requestTermination . .* }

**section** *Program* **parents** *scj\_prelude, MissionId, MissionIds,*  
*SchedulableId, SchedulableIds, MissionChan, SchedulableMethChan, MissionFW,*  
*SafeletFW, TopLevelMissionSequencerFW, NetworkChannels, ManagedThreadFW,*  
*SchedulableMissionSequencerFW, PeriodicEventHandlerFW, OneShotEventHandlerFW,*  
*AperiodicEventHandlerFW, ACSafeletApp, MainMissionSequencerApp,*  
*ObjectFW, ThreadFW, MainMissionApp, ACModeChangerApp, ControlHandlerApp, CommunicationsHandlerApp*

**process** *ControlTier*  $\hat{=}$   

$$\left( \begin{array}{l} \text{SafeletFW} \\ \llbracket \text{ControlTierSync} \rrbracket \\ \text{TopLevelMissionSequencerFW}(\text{MainMissionSequencer}) \end{array} \right)$$

**process** *Tier0*  $\hat{=}$   

$$\left( \begin{array}{l} \text{MissionFW}(\text{MainMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left( \begin{array}{l} \text{SchedulableMissionSequencerFW}(\text{ACModeChanger}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left( \begin{array}{l} \text{AperiodicEventHandlerFW}(\text{ControlHandler}) \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{AperiodicEventHandlerFW}(\text{CommunicationsHandler}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left( \begin{array}{l} \text{PeriodicEventHandlerFW}(\text{EnvironmentMonitor}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{FlightSensorsMonitor}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{AperiodicSimulator}) \end{array} \right) \end{array} \right) \end{array} \right)$$

**process** *Tier1*  $\hat{=}$   

$$\left( \begin{array}{l} \text{MissionFW}(\text{TakeOffMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left( \begin{array}{l} \left( \begin{array}{l} \text{AperiodicEventHandlerFW}(\text{LandingGearHandlerTakeOff}) \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{AperiodicEventHandlerFW}(\text{TakeOffFailureHandler}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{TakeOffMonitor}) \end{array} \right) \\ \llbracket \text{ClusterSync} \rrbracket \\ \left( \begin{array}{l} \text{MissionFW}(\text{CruiseMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left( \begin{array}{l} \text{AperiodicEventHandlerFW}(\text{BeginLandingHandler}) \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{PeriodicEventHandlerFW}(\text{NavigationMonitor}) \\ \llbracket \text{ClusterSync} \rrbracket \\ \left( \begin{array}{l} \text{MissionFW}(\text{LandMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left( \begin{array}{l} \left( \begin{array}{l} \text{AperiodicEventHandlerFW}(\text{LandingGearHandlerLand}) \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{AperiodicEventHandlerFW}(\text{SafeLandingHandler}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left( \begin{array}{l} \text{PeriodicEventHandlerFW}(\text{GroundDistanceMonitor}) \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{PeriodicEventHandlerFW}(\text{InstrumentLandingSystemMonitor}) \end{array} \right) \end{array} \right) \end{array} \right) \end{array} \right)$$

**process** *Framework*  $\hat{=}$   

$$\left( \begin{array}{l} \text{ControlTier} \\ \llbracket \text{TierSync} \rrbracket \\ \left( \begin{array}{l} \text{Tier0} \\ \llbracket \text{Tier0Sync} \rrbracket \end{array} \right) \\ \text{Tier1} \end{array} \right)$$

**process** *Application*  $\hat{=}$

```
(
  ACSafeletApp
  |||
  MainMissionSequencerApp
  |||
  MainMissionApp
  |||
  ACModeChangerApp(5, MainMissionID)
  |||
  ControlHandlerApp(5, (NULL, nullSchedulableId),)
  |||
  CommunicationsHandlerApp(5, (NULL, nullSchedulableId),)
  |||
  EnvironmentMonitorApp(5, (10, 0, NULL, nullSchedulableId), , MainMissionID)
  |||
  FlightSensorsMonitorApp(5, (10, 0, NULL, nullSchedulableId), , MainMissionID)
  |||
  AperiodicSimulatorApp(5, (10, 0, NULL, nullSchedulableId), controlHandler, 5, (10, 0, NULL, nullSchedulableId), commsL)
  |||
  TakeOffMissionApp
  |||
  LandingGearHandlerTakeOffApp(5, (NULL, nullSchedulableId), , TakeOffMissionID)
  |||
  TakeOffFailureHandlerApp(5, (NULL, nullSchedulableId), , TakeOffMissionID, )
  |||
  TakeOffMonitorApp(PriorityScheduler.instance().getMaxPriority(), (0, 0, NULL, newRelativeTime(500, 0)), TakeOffMi)
  |||
  CruiseMissionApp
  |||
  BeginLandingHandlerApp(5, (NULL, nullSchedulableId), , CruiseMissionID)
  |||
  NavigationMonitorApp(PriorityScheduler.instance().getMaxPriority(), (0, 0, NULL, newRelativeTime(10, 0)), , CruiseM)
  |||
  LandMissionApp
  |||
  LandingGearHandlerLandApp(5, (NULL, nullSchedulableId), , LandMissionID)
  |||
  SafeLandingHandlerApp(5, (NULL, nullSchedulableId), , LandMissionID, )
  |||
  GroundDistanceMonitorApp(5, (0, 0, NULL, newRelativeTime(10, 0)), LandMissionID)
  |||
  InstrumentLandingSystemMonitorApp(5, (0, 0, NULL, newRelativeTime(10, 0)), , LandMissionID)
)
```

*Locking*  $\triangleq$

(  
 ThreadFW(*ACModeChangerThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*EnvironmentMonitorThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*ControlHandlerThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*FlightSensorsMonitorThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*CommunicationsHandlerThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*AperiodicSimulatorThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*LandingGearHandlerTakeOffThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*TakeOffMonitorThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*TakeOffFailureHandlerThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*BeginLandingHandlerThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*NavigationMonitorThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*GroundDistanceMonitorThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*LandingGearHandlerLandThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*InstrumentLandingSystemMonitorThreadID*, *MinPriority*)  
 [[*ThreadSync*]]  
 ThreadFW(*SafeLandingHandlerThreadID*, *MinPriority*)  
 )

|||

(  
 ObjectFW(*ACSafeletObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*MainMissionObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*ACModeChangerObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*EnvironmentMonitorObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*ControlHandlerObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*FlightSensorsMonitorObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*CommunicationsHandlerObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*AperiodicSimulatorObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*TakeOffMissionObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*LandingGearHandlerTakeOffObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*TakeOffMonitorObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*TakeOffFailureHandlerObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*CruiseMissionObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*BeginLandingHandlerObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*NavigationMonitorObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*LandMissionObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*GroundDistanceMonitorObjectID*)  
 [[*ObjectSync*]]  
 ObjectFW(*LandingGearHandlerLandObjectID*)  
 )



**process**  $Program \hat{=} Framework \llbracket AppSync \rrbracket Application \llbracket LockingSync \rrbracket Locking$

### 3 Safelet

**section** *ACSafeletApp* **parents** *scj\_prelude, SchedulableId, SchedulableIds, SafeletChan*

**process** *ACSafeletApp*  $\hat{=}$  **begin**

*InitializeApplication*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{initializeApplicationCall} \longrightarrow \\ \textit{initializeApplicationRet} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

*GetSequencer*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{getSequencerCall} \longrightarrow \\ \textit{getSequencerRet} ! \textit{MainMissionSequencer} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

*Methods*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{GetSequencer} \\ \square \\ \textit{InitializeApplication} \end{array} \right); \textit{Methods}$

•  $(\textit{Methods}) \triangle (\textit{end\_safelet\_app} \longrightarrow \mathbf{Skip})$

**end**

## 4 Top Level Mission Sequencer

**section** *MainMissionSequencerApp* **parents** *TopLevelMissionSequencerChan*,  
*MissionId*, *MissionIds*, *SchedulableId*, *MainMissionSequencerClass*

**process** *MainMissionSequencerApp*  $\hat{=}$  **begin**

<i>State</i> <i>this</i> : <b>ref</b> <i>MainMissionSequencerClass</i>
---------------------------------------------------------------------------

**state** *State*

<i>Init</i> <i>State</i> '
<i>this</i> ' = <b>new</b> <i>MainMissionSequencerClass</i> ()

*GetNextMission*  $\hat{=}$  **var** *ret* : *MissionID* •  
 $\left( \begin{array}{l} \textit{getNextMissionCall} . \textit{MainMissionSequencer} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getNextMission}(); \\ \textit{getNextMissionRet} . \textit{MainMissionSequencer} ! \textit{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

*Methods*  $\hat{=}$   
 $(\textit{GetNextMission}) ; \textit{Methods}$

•  $(\textit{Init} ; \textit{Methods}) \triangle (\textit{end\_sequencer\_app} . \textit{MainMissionSequencer} \longrightarrow \mathbf{Skip})$

**end**

**class** *MainMissionSequencerClass*  $\hat{=}$  **begin**

<b>state</b> <i>State</i> <i>returnedMission</i> : $\mathbb{B}$
--------------------------------------------------------------------

**state** *State*

<b>initial</b> <i>Init</i> <i>State</i> '
----------------------------------------------

**protected** *getNextMission*  $\hat{=}$  **var** *ret* : *MissionID* •

$$\left( \begin{array}{l} \text{if } (\neg \text{returnedMission} = \mathbf{True}) \longrightarrow \\ \quad \left( \begin{array}{l} \text{this}.\text{returnedMission} := \text{true}; \\ \text{ret} := \text{MainMission} \end{array} \right) \\ \parallel \neg (\neg \text{returnedMission} = \mathbf{True}) \longrightarrow \\ \quad (\text{ret} := \text{nullMissionId}) \\ \text{fi} \end{array} \right)$$

• **Skip**

**end**

**section** *MainMissionSequencerMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**channel** *getNextMissionCall* : *SchedulableID*

**channel** *getNextMissionRet* : *SchedulableID*  $\times$  *MissionID*

## 5 Missions

### 5.1 MainMission

**section** *MainMissionApp* **parents** *scj\_prelude*, *MissionId*, *MissionIds*,  
*SchedulableId*, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *MainMissionClass*  
, *MainMissionMethChan*

**process** *MainMissionApp*  $\hat{=}$  **begin**

---

*State*  
*this* : **ref** *MainMissionClass*

---

**state** *State*

---

*Init*  
*State'*  


---

*this'* = **new** *MainMissionClass*()

---

*InitializePhase*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{initializeCall} . \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{ACModeChanger} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{EnvironmentMonitor} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{ControlHandler} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{FlightSensorsMonitor} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{CommunicationsHandler} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{AperiodicSimulator} ! \textit{MainMission} \longrightarrow \\ \textit{initializeRet} . \textit{MainMission} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*CleanupPhase*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{cleanupMissionCall} . \textit{MainMission} \longrightarrow \\ \textit{cleanupMissionRet} . \textit{MainMission} ! \textbf{True} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*getAirSpeedMeth*  $\hat{=}$  **var** *ret* : double •  
 $\left( \begin{array}{l} \textit{getAirSpeedCall} . \textit{MainMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getAirSpeed}(); \\ \textit{getAirSpeedRet} . \textit{MainMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*getAltitudeMeth*  $\hat{=}$  **var** *ret* : double •  
 $\left( \begin{array}{l} \textit{getAltitudeCall} . \textit{MainMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getAltitude}(); \\ \textit{getAltitudeRet} . \textit{MainMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*getCabinPressureMeth*  $\hat{=}$  **var** *ret* : double •  
 $\left( \begin{array}{l} \textit{getCabinPressureCall} . \textit{MainMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getCabinPressure}(); \\ \textit{getCabinPressureRet} . \textit{MainMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

$$\text{getEmergencyOxygenMeth} \hat{=} \mathbf{var} \text{ ret} : \text{double} \bullet \left( \begin{array}{l} \text{getEmergencyOxygenCall} . \text{MainMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getEmergencyOxygen}(); \\ \text{getEmergencyOxygenRet} . \text{MainMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{getFuelRemainingMeth} \hat{=} \mathbf{var} \text{ ret} : \text{double} \bullet \left( \begin{array}{l} \text{getFuelRemainingCall} . \text{MainMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getFuelRemaining}(); \\ \text{getFuelRemainingRet} . \text{MainMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{getHeadingMeth} \hat{=} \mathbf{var} \text{ ret} : \text{double} \bullet \left( \begin{array}{l} \text{getHeadingCall} . \text{MainMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getHeading}(); \\ \text{getHeadingRet} . \text{MainMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setAirSpeedMeth} \hat{=} \left( \begin{array}{l} \text{setAirSpeedCall} . \text{MainMission} ? \text{airSpeed} \longrightarrow \\ \text{this} . \text{setAirSpeed}(\text{airSpeed}); \\ \text{setAirSpeedRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setAltitudeMeth} \hat{=} \left( \begin{array}{l} \text{setAltitudeCall} . \text{MainMission} ? \text{altitude} \longrightarrow \\ \text{this} . \text{setAltitude}(\text{altitude}); \\ \text{setAltitudeRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setCabinPressureMeth} \hat{=} \left( \begin{array}{l} \text{setCabinPressureCall} . \text{MainMission} ? \text{cabinPressure} \longrightarrow \\ \text{this} . \text{setCabinPressure}(\text{cabinPressure}); \\ \text{setCabinPressureRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setEmergencyOxygenMeth} \hat{=} \left( \begin{array}{l} \text{setEmergencyOxygenCall} . \text{MainMission} ? \text{emergencyOxygen} \longrightarrow \\ \text{this} . \text{setEmergencyOxygen}(\text{emergencyOxygen}); \\ \text{setEmergencyOxygenRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setFuelRemainingMeth} \hat{=} \left( \begin{array}{l} \text{setFuelRemainingCall} . \text{MainMission} ? \text{fuelRemaining} \longrightarrow \\ \text{this} . \text{setFuelRemaining}(\text{fuelRemaining}); \\ \text{setFuelRemainingRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setHeadingMeth} \hat{=} \left( \begin{array}{l} \text{setHeadingCall} . \text{MainMission} ? \text{heading} \longrightarrow \\ \text{this} . \text{setHeading}(\text{heading}); \\ \text{setHeadingRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$Methods \triangleq \left( \begin{array}{l} InitializePhase \\ \square \\ CleanupPhase \\ \square \\ getAirSpeedMeth \\ \square \\ getAltitudeMeth \\ \square \\ getCabinPressureMeth \\ \square \\ getEmergencyOxygenMeth \\ \square \\ getFuelRemainingMeth \\ \square \\ getHeadingMeth \\ \square \\ setAirSpeedMeth \\ \square \\ setAltitudeMeth \\ \square \\ setCabinPressureMeth \\ \square \\ setEmergencyOxygenMeth \\ \square \\ setFuelRemainingMeth \\ \square \\ setHeadingMeth \end{array} \right) ; Methods$$

- $(Init ; Methods) \triangle (end\_mission\_app . MainMission \longrightarrow \mathbf{Skip})$

**end**



**class** *MainMissionClass*  $\hat{=}$  **begin**

**state** *State*

---

*ALTITUDE\_READING\_ON\_GROUND* : *double*  
*cabinPressure* : *double*  
*emergencyOxygen* : *double*  
*fuelRemaining* : *double*  
*altitude* : *double*  
*airSpeed* : *double*  
*heading* : *double*

---

**state** *State*

**initial** *Init*

---

*State*'

---

*ALTITUDE\_READING\_ON\_GROUND*' = 0.0

---

**public** *getAirSpeed*  $\hat{=}$  **var** *ret* : *double* •  
(*ret* := *airSpeed*)

**public** *getAltitude*  $\hat{=}$  **var** *ret* : *double* •  
(*ret* := *altitude*)

**public** *getCabinPressure*  $\hat{=}$  **var** *ret* : *double* •  
(*ret* := *cabinPressure*)

**public** *getEmergencyOxygen*  $\hat{=}$  **var** *ret* : *double* •  
(*ret* := *emergencyOxygen*)

**public** *getFuelRemaining*  $\hat{=}$  **var** *ret* : *double* •  
(*ret* := *fuelRemaining*)

**public** *getHeading*  $\hat{=}$  **var** *ret* : *double* •  
(*ret* := *heading*)

**public** *setAirSpeed*  $\hat{=}$   
(*this* . *this* . *airSpeed* := *airSpeed*)

**public** *setAltitude*  $\hat{=}$   
(*this* . *this* . *altitude* := *altitude*)

**public** *setCabinPressure*  $\hat{=}$   
(*this* . *this* . *cabinPressure* := *cabinPressure*)

**public** *setEmergencyOxygen*  $\hat{=}$   
(*this* . *this* . *emergencyOxygen* := *emergencyOxygen*)

```
public setFuelRemaining  $\hat{=}$   
(this.this.fuelRemaining := fuelRemaining)
```

```
public setHeading  $\hat{=}$   
(this.this.heading := heading)
```

- **Skip**

```
end
```

**section** *MainMissionMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**channel** *getAirSpeedCall* : *MissionID*  
**channel** *getAirSpeedRet* : *MissionID*  $\times$  *double*

**channel** *getAltitudeCall* : *MissionID*  
**channel** *getAltitudeRet* : *MissionID*  $\times$  *double*

**channel** *getCabinPressureCall* : *MissionID*  
**channel** *getCabinPressureRet* : *MissionID*  $\times$  *double*

**channel** *getEmergencyOxygenCall* : *MissionID*  
**channel** *getEmergencyOxygenRet* : *MissionID*  $\times$  *double*

**channel** *getFuelRemainingCall* : *MissionID*  
**channel** *getFuelRemainingRet* : *MissionID*  $\times$  *double*

**channel** *getHeadingCall* : *MissionID*  
**channel** *getHeadingRet* : *MissionID*  $\times$  *double*

**channel** *setAirSpeedCall* : *MissionID*  $\times$  *double*  
**channel** *setAirSpeedRet* : *MissionID*

**channel** *setAltitudeCall* : *MissionID*  $\times$  *double*  
**channel** *setAltitudeRet* : *MissionID*

**channel** *setCabinPressureCall* : *MissionID*  $\times$  *double*  
**channel** *setCabinPressureRet* : *MissionID*

**channel** *setEmergencyOxygenCall* : *MissionID*  $\times$  *double*  
**channel** *setEmergencyOxygenRet* : *MissionID*

**channel** *setFuelRemainingCall* : *MissionID*  $\times$  *double*  
**channel** *setFuelRemainingRet* : *MissionID*

**channel** *setHeadingCall* : *MissionID*  $\times$  *double*  
**channel** *setHeadingRet* : *MissionID*

## 5.2 Schedulables of MainMission

**section** *ACModeChangerApp* **parents** *TopLevelMissionSequencerChan*,  
*MissionId*, *MissionIds*, *SchedulableId*, *ACModeChangerClass*

**process** *ACModeChangerApp*  $\hat{=}$   
*PriorityParameters* ;  
*ProbablyMission* • **begin**

*GetNextMission*  $\hat{=}$  **var** *ret* : *MissionID* •  
 $\left( \begin{array}{l} \text{getNextMissionCall} . \text{ACModeChanger} \longrightarrow \\ \text{ret} := \text{this} . \text{getNextMission}(); \\ \text{getNextMissionRet} . \text{ACModeChanger} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$

*changeToMeth*  $\hat{=}$   
 $\left( \begin{array}{l} \text{changeToCall} . \text{ACModeChanger} ? \text{newMode} \longrightarrow \\ (\text{this} . \text{currentMode} := \text{newMode}); \\ \text{changeToRet} . \text{ACModeChanger} \longrightarrow \\ \text{Skip} \end{array} \right)$

*advanceModeSyncMeth*  $\hat{=}$   
 $\left( \begin{array}{l} \text{advanceModeCall} . \text{ACModeChanger} ? \text{thread} \longrightarrow \\ \left( \begin{array}{l} \text{startSyncMeth} . \text{ACModeChangerObject} . \text{thread} \longrightarrow \\ \text{lockAcquired} . \text{ACModeChangerObject} . \text{thread} \longrightarrow \\ \text{Skip}; \\ \text{if } (\text{modesLeft} = 3) \longrightarrow \\ \quad \left( \begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{changeTo}(\text{launchMode}) \end{array} \right) \\ \square \neg (\text{modesLeft} = 3) \longrightarrow \\ \quad \text{if } (\text{modesLeft} = 2) \longrightarrow \\ \quad \quad \left( \begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{changeTo}(\text{cruiseMode}) \end{array} \right) \\ \square \neg (\text{modesLeft} = 2) \longrightarrow \\ \quad \text{if } (\text{modesLeft} = 1) \longrightarrow \\ \quad \quad \left( \begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{changeTo}(\text{landMode}) \end{array} \right) \\ \square \neg (\text{modesLeft} = 1) \longrightarrow \\ \quad \quad (\text{changeTo}(\text{null})) \\ \text{fi} \\ \text{fi} \\ \text{fi} \end{array} \right); \\ \text{endSyncMeth} . \text{ACModeChangerObject} . \text{thread} \longrightarrow \\ \text{advanceModeRet} . \text{ACModeChanger} . \text{thread} \longrightarrow \\ \text{Skip} \end{array} \right)$

*Methods*  $\hat{=}$   
 $\left( \begin{array}{l} \text{GetNextMission} \\ \square \\ \text{changeToMeth} \\ \square \\ \text{advanceModeSyncMeth} \end{array} \right); \text{Methods}$

•  $(Methods) \triangle (end\_sequencer\_app . A CModeChanger \longrightarrow \mathbf{Skip})$

**end**

```
class ACModeChangerClass  $\hat{=}$  begin
```

```
  state State
```

```
    modesLeft :  $\mathbb{Z}$   
    ref currentModeClass : ModeClass  
    ref launchModeClass : ModeClass  
    ref cruiseModeClass : ModeClass  
    ref landModeClass : ModeClass
```

```
state State
```

```
  initial Init
```

```
    State'  
    modesLeft' = 3  
    ref currentModeClass' = new ModeClass()  
    ref launchModeClass' = new ModeClass()  
    ref cruiseModeClass' = new ModeClass()  
    ref landModeClass' = new ModeClass()
```

```
protected getNextMission  $\hat{=}$  var ret : MissionID •
```

```

  (
    if (modesLeft = 3)  $\longrightarrow$ 
      (
        modesLeft := modesLeft - 1;
        ret := TakeOffMission
      )
    []  $\neg$  (modesLeft = 3)  $\longrightarrow$ 
      if (modesLeft = 2)  $\longrightarrow$ 
        (
          modesLeft := modesLeft - 1;
          ret := CruiseMission
        )
      []  $\neg$  (modesLeft = 2)  $\longrightarrow$ 
        if (modesLeft = 1)  $\longrightarrow$ 
          (
            modesLeft := modesLeft - 1;
            ret := LandMission
          )
        []  $\neg$  (modesLeft = 1)  $\longrightarrow$ 
          (ret := nullMissionId)
    fi
    fi
    fi
  )
```

```
• Skip
```

```
end
```

**section** *ACModeChangerMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**channel** *changeToCall* : *SchedulableID* ×  
**channel** *changeToRet* : *SchedulableID*

**channel** *advanceModeCall* : *SchedulableID* × *ThreadID*  
**channel** *advanceModeRet* : *SchedulableID* × *ThreadID*

**section** *ControlHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

**process** *ControlHandlerApp*  $\hat{=}$   
*PriorityParameters* :,  
*AperiodicParameters* :,  
*MainMission* :• **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{ControlHandler} \longrightarrow \\ (\mathbf{Skip}) ; \\ \text{handleAsyncEventRet} . \text{ControlHandler} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_\_app* . *ControlHandler*  $\longrightarrow$  **Skip**)

**end**



**class** *ControlHandlerClass*  $\hat{=}$  **begin**

- **Skip**

**end**

**section** *ControlHandlerMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**section** *CommunicationsHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

**process** *CommunicationsHandlerApp*  $\hat{=}$   
*PriorityParameters* :,  
*AperiodicParameters* :,  
*MainMission* :• **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{CommunicationsHandler} \longrightarrow \\ (\mathbf{Skip}) ; \\ \text{handleAsyncEventRet} . \text{CommunicationsHandler} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_app* . *CommunicationsHandler*  $\longrightarrow$  **Skip**)

**end**

**class** *CommunicationsHandlerClass*  $\hat{=}$  **begin**

- **Skip**

**end**

**section** *CommunicationsHandlerMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**section** *EnvironmentMonitorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*MainMissionMethChan*

**process** *EnvironmentMonitorApp*  $\hat{=}$   
*PriorityParameters* :,  
*PeriodicParameters* :,  
*MainMission* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{EnvironmentMonitor} \longrightarrow \\ \left( \begin{array}{l} \mathbf{Skip}; \\ \text{setCabinPressureCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setCabinPressureRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setEmergencyOxygenCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setEmergencyOxygenRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setFuelRemainingCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setFuelRemainingRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right) ; \\ \text{handleAsyncEventRet} . \text{EnvironmentMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_periodic\_app* . *EnvironmentMonitor*  $\longrightarrow$  **Skip**)

**end**

**class** *EnvironmentMonitorClass*  $\hat{=}$  **begin**

- **Skip**

**end**

**section** *FlightSensorsMonitorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*MainMissionMethChan*

**process** *FlightSensorsMonitorApp*  $\hat{=}$   
*PriorityParameters* :,  
*PeriodicParameters* :,  
*MainMission* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{FlightSensorsMonitor} \longrightarrow \\ \left( \begin{array}{l} \mathbf{Skip}; \\ \text{setAirSpeedCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setAirSpeedRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setAltitudeCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setAltitudeRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setHeadingCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setHeadingRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right) ; \\ \text{handleAsyncEventRet} . \text{FlightSensorsMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_periodic\_app* . *FlightSensorsMonitor*  $\longrightarrow$  **Skip**)

**end**



**class** *FlightSensorsMonitorClass*  $\hat{=}$  **begin**

- **Skip**

**end**

**section** *AperiodicSimulatorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

**process** *AperiodicSimulatorApp*  $\hat{=}$   
*PriorityParameters* :,  
*PeriodicParameters* :,  
*controlHandler* :,  
*PriorityParameters* :,  
*PeriodicParameters* :,  
*commsHandler* :,  
*PriorityParameters* :,  
*PeriodicParameters* :,  
*beginLandingHandler* :• **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{AperiodicSimulator} \longrightarrow \\ \left( \begin{array}{l} \mathbf{Skip}; \\ \text{releaseCall} . \text{event} \longrightarrow \\ \text{releaseRet} . \text{event} ? \text{release} \longrightarrow \end{array} \right) ; \\ \mathbf{Skip} \\ \text{handleAsyncEventRet} . \text{AperiodicSimulator} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_periodic\_app* . *AperiodicSimulator*  $\longrightarrow$  **Skip**)

**end**

```
class AperiodicSimulatorClass  $\hat{=}$  begin
```

- **Skip**

```
end
```

### 5.3 TakeOffMission

**section** *TakeOffMissionApp* **parents** *scj\_prelude*, *MissionId*, *MissionIds*,  
*SchedulableId*, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *TakeOffMissionClass*  
*, TakeOffMissionMethChan*

**process** *TakeOffMissionApp*  $\hat{=}$  **begin**

---

*State*  
*this* : **ref** *TakeOffMissionClass*

---

**state** *State*

---

*Init*  
*State'*  


---

*this'* = **new** *TakeOffMissionClass*()

---

*InitializePhase*  $\hat{=}$   
 $\left( \begin{array}{l} \text{initializeCall} . \text{TakeOffMission} \longrightarrow \\ \text{register} ! \text{LandingGearHandlerTakeOff} ! \text{TakeOffMission} \longrightarrow \\ \text{register} ! \text{TakeOffMonitor} ! \text{TakeOffMission} \longrightarrow \\ \text{register} ! \text{TakeOffFailureHandler} ! \text{TakeOffMission} \longrightarrow \\ \text{initializeRet} . \text{TakeOffMission} \longrightarrow \\ \text{Skip} \end{array} \right)$

*CleanupPhase*  $\hat{=}$   
 $\left( \begin{array}{l} \text{cleanupMissionCall} . \text{TakeOffMission} \longrightarrow \\ \text{cleanupMissionRet} . \text{TakeOffMission} ! \text{True} \longrightarrow \\ \text{Skip} \end{array} \right)$

*abortMeth*  $\hat{=}$   
 $\left( \begin{array}{l} \text{abortCall} . \text{TakeOffMission} \longrightarrow \\ \text{this} . \text{abort}(); \\ \text{abortRet} . \text{TakeOffMission} \longrightarrow \\ \text{Skip} \end{array} \right)$

*getControllingMissionMeth*  $\hat{=}$  **var** *ret* : *MissionID* •  
 $\left( \begin{array}{l} \text{getControllingMissionCall} . \text{TakeOffMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getControllingMission}(); \\ \text{getControllingMissionRet} . \text{TakeOffMission} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$

*setControllingMissionMeth*  $\hat{=}$   
 $\left( \begin{array}{l} \text{setControllingMissionCall} . \text{TakeOffMission} ? \text{controllingMission} \longrightarrow \\ \text{this} . \text{setControllingMission}(\text{controllingMission}); \\ \text{setControllingMissionRet} . \text{TakeOffMission} \longrightarrow \\ \text{Skip} \end{array} \right)$

*cleanUpMeth*  $\hat{=}$  **var** *ret* :  $\mathbb{B}$  •  
 $\left( \begin{array}{l} \text{cleanUpCall} . \text{TakeOffMission} \longrightarrow \\ \text{ret} := \text{this} . \text{cleanUp}(); \\ \text{cleanUpRet} . \text{TakeOffMission} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$

$$\text{stowLandingGearMeth} \hat{=} \left( \begin{array}{l} \text{stowLandingGearCall} . \text{TakeOffMission} \longrightarrow \\ \text{this} . \text{stowLandingGear}(); \\ \text{stowLandingGearRet} . \text{TakeOffMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{isLandingGearDeployedMeth} \hat{=} \mathbf{var} \text{ret} : \mathbb{B} \bullet \left( \begin{array}{l} \text{isLandingGearDeployedCall} . \text{TakeOffMission} \longrightarrow \\ \text{ret} := \text{this} . \text{isLandingGearDeployed}(); \\ \text{isLandingGearDeployedRet} . \text{TakeOffMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{deployLandingGearSyncMeth} \hat{=} \left( \begin{array}{l} \text{deployLandingGearCall} . \text{TakeOffMission} ? \text{thread} \longrightarrow \\ \left( \begin{array}{l} \text{startSyncMeth} . \text{TakeOffMissionObject} . \text{thread} \longrightarrow \\ \text{lockAcquired} . \text{TakeOffMissionObject} . \text{thread} \longrightarrow \\ (\text{this} . \text{landingGearDeployed} := \text{true}); \\ \text{endSyncMeth} . \text{TakeOffMissionObject} . \text{thread} \longrightarrow \\ \text{deployLandingGearRet} . \text{TakeOffMission} . \text{thread} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \end{array} \right)$$

$$\text{Methods} \hat{=} \left( \begin{array}{l} \text{InitializePhase} \\ \square \\ \text{CleanupPhase} \\ \square \\ \text{abortMeth} \\ \square \\ \text{getControllingMissionMeth} \\ \square \\ \text{setControllingMissionMeth} \\ \square \\ \text{cleanUpMeth} \\ \square \\ \text{stowLandingGearMeth} \\ \square \\ \text{isLandingGearDeployedMeth} \\ \square \\ \text{deployLandingGearSyncMeth} \end{array} \right) ; \text{Methods}$$

$$\bullet (\text{Init} ; \text{Methods}) \triangle (\text{end\_mission\_app} . \text{TakeOffMission} \longrightarrow \mathbf{Skip})$$

**end**

**class** *TakeOffMissionClass*  $\hat{=}$  **begin**

**state** *State*

---

*SAFE\_AIRSPEED\_THRESHOLD* : *double*  
*TAKEOFF\_ALTITUDE* : *double*  
*abort* :  $\mathbb{B}$   
*landingGearDeployed* :  $\mathbb{B}$

---

**state** *State*

**initial** *Init*

---

*State'*  
  
*SAFE\_AIRSPEED\_THRESHOLD'* = 10.0  
*TAKEOFF\_ALTITUDE'* = 10.0  
*abort'* = *false*

---

**public** *abort*  $\hat{=}$   
(*this* . *abort* := *true*)

**public** *getControllingMission*  $\hat{=}$  **var** *ret* : *MissionID* •  
(*ret* := *controllingMission*)

**public** *setControllingMission*  $\hat{=}$   
(*this* . *this* . *controllingMission* := *controllingMission*)

**public** *cleanUp*  $\hat{=}$  **var** *ret* :  $\mathbb{B}$  •  
(**Skip**;  
*ret* := ( $\neg$  *abort* = **True**))

**public** *stowLandingGear*  $\hat{=}$   
(*this* . *landingGearDeployed* := *false*)

**public** *isLandingGearDeployed*  $\hat{=}$  **var** *ret* :  $\mathbb{B}$  •  
(*ret* := *landingGearDeployed* = **True**)

• **Skip**

**end**

**section** *TakeOffMissionMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**channel** *abortCall* : *MissionID*  
**channel** *abortRet* : *MissionID*

**channel** *getControllingMissionCall* : *MissionID*  
**channel** *getControllingMissionRet* : *MissionID*  $\times$  *MissionID*

**channel** *setControllingMissionCall* : *MissionID*  $\times$  *MissionID*  
**channel** *setControllingMissionRet* : *MissionID*

**channel** *cleanUpCall* : *MissionID*  
**channel** *cleanUpRet* : *MissionID*  $\times$   $\mathbb{B}$

**channel** *stowLandingGearCall* : *MissionID*  
**channel** *stowLandingGearRet* : *MissionID*

**channel** *isLandingGearDeployedCall* : *MissionID*  
**channel** *isLandingGearDeployedRet* : *MissionID*  $\times$   $\mathbb{B}$

**channel** *deployLandingGearCall* : *MissionID*  $\times$  *ThreadID*  
**channel** *deployLandingGearRet* : *MissionID*  $\times$  *ThreadID*

## 5.4 Schedulables of TakeOffMission

**section** *LandingGearHandlerTakeOffApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*TakeOffMissionMethChan*, *ObjectIds*, *ThreadIds*

**process** *LandingGearHandlerTakeOffApp*  $\hat{=}$   
*PriorityParameters* :,  
*AperiodicParameters* :,  
*TakeOffMission* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ \left( \begin{array}{l} \text{Skip}; \\ \text{isLandingGearDeployedCall} . \text{mission} \longrightarrow \\ \text{isLandingGearDeployedRet} . \text{mission} ? \text{isLandingGearDeployed} \longrightarrow \\ \\ \text{var landingGearIsDeployed} : \mathbb{B} \bullet \text{landingGearIsDeployed} := \text{isLandingGearDeployed} \\ \text{if } \text{landingGearIsDeployed} = \text{True} \longrightarrow \\ \left( \begin{array}{l} \text{stowLandingGearCall} . \text{mission} \longrightarrow \\ \text{stowLandingGearRet} . \text{mission} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \square \neg \text{landingGearIsDeployed} = \text{True} \longrightarrow \\ \left( \begin{array}{l} \text{deployLandingGearCall} . \text{mission} . \text{LandingGearHandlerTakeOffThread} \longrightarrow \\ \text{deployLandingGearRet} . \text{mission} . \text{LandingGearHandlerTakeOffThread} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \text{fi} \end{array} \right) \text{handleAsyncEventRet} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ \text{Skip} \end{array} \right) ;$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_\_app* . *LandingGearHandlerTakeOff*  $\longrightarrow$  **Skip**)

**end**



**class** *LandingGearHandlerTakeOffClass*  $\hat{=}$  **begin**

- **Skip**

**end**

**section** *LandingGearHandlerTakeOffMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**section** *TakeOffFailureHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*TakeOffMissionMethChan*

**process** *TakeOffFailureHandlerApp*  $\hat{=}$   
*PriorityParameters* :,  
*AperiodicParameters* :,  
*TakeOffMission* :,  
: *ProbablyMission*,  
:• **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{TakeOffFailureHandler} \longrightarrow \\ \left( \begin{array}{l} \text{getControllingMissionCall} . \text{takeoffMission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{takeoffMission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \end{array} \right) \\ \\ \mathbf{var} \text{ currentSpeed} : \text{double} \bullet \text{currentSpeed} := \text{getAirSpeed} \\ \mathbf{if} (\text{currentSpeed} < \text{threshold}) \longrightarrow \\ \quad \left( \begin{array}{l} \mathbf{Skip}; \\ \text{abortCall} . \text{takeoffMission} \longrightarrow \\ \text{abortRet} . \text{takeoffMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{requestTerminationCall} . \text{takeoffMission} \longrightarrow \\ \text{requestTerminationRet} . \text{takeoffMission} ? \text{requestTermination} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \\ \quad \square \neg (\text{currentSpeed} < \text{threshold}) \longrightarrow \\ \quad \quad (\mathbf{Skip}) \\ \mathbf{fi} \mathbf{Skip} \end{array} \right) ;$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_app* . *TakeOffFailureHandler*  $\longrightarrow$  **Skip**)

**end**

**class** *TakeOffFailureHandlerClass*  $\hat{=}$  **begin**

<b>state</b> <i>State</i> <i>threshold</i> : <i>double</i>
---------------------------------------------------------------

**state** *State*

<b>initial</b> <i>Init</i> <i>State</i> '
----------------------------------------------

- **Skip**

**end**

**section** *TakeOffFailureHandlerMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**section** *TakeOffMonitorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*TakeOffMissionMethChan*

**process** *TakeOffMonitorApp*  $\hat{=}$   
*PriorityParameters* :,  
*PeriodicParameters* :,  
: *ProbablyMission*,  
: ,  
*landingGearHandler* :• **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{TakeOffMonitor} \longrightarrow \\ \left( \begin{array}{l} \text{Skip}; \\ \text{getControllingMissionCall} . \text{takeoffMission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{takeoffMission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \text{var altitude : double} \bullet \text{altitude} := \text{getAltitude} \\ \text{if } (\text{altitude} > \text{takeOffAltitude}) \longrightarrow \\ \left( \begin{array}{l} \text{Skip}; \\ \text{releaseCall} . \text{landingGearHandler} \longrightarrow \\ \text{releaseRet} . \text{landingGearHandler} ? \text{release} \longrightarrow \\ \text{requestTerminationCall} . \text{takeoffMission} \longrightarrow \\ \text{requestTerminationRet} . \text{takeoffMission} ? \text{requestTermination} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \square \neg (\text{altitude} > \text{takeOffAltitude}) \longrightarrow \text{Skip} \\ \text{fi}; \\ \text{Skip} \end{array} \right) ; \\ \text{handleAsyncEventRet} . \text{TakeOffMonitor} \longrightarrow \\ \text{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_periodic\_app* . *TakeOffMonitor*  $\longrightarrow$  **Skip**)

**end**

**class** *TakeOffMonitorClass*  $\hat{=}$  **begin**

**state** *State*

*takeOffAltitude* : *double*

**state** *State*

**initial** *Init*

*State'*

• **Skip**

**end**

## 5.5 CruiseMission

**section** *CruiseMissionApp* **parents** *scj\_prelude*, *MissionId*, *MissionIds*,  
*SchedulableId*, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *CruiseMissionClass*  
*CruiseMissionMethChan*

**process** *CruiseMissionApp*  $\hat{=}$  **begin**

<i>State</i> <i>this</i> : <b>ref</b> <i>CruiseMissionClass</i>
--------------------------------------------------------------------

**state** *State*

<i>Init</i> <i>State'</i>
<i>this'</i> = <b>new</b> <i>CruiseMissionClass</i> ()

*InitializePhase*  $\hat{=}$   

$$\left( \begin{array}{l} \textit{initializeCall} . \textit{CruiseMission} \longrightarrow \\ \textit{register!BeginLandingHandler!CruiseMission} \longrightarrow \\ \textit{register!NavigationMonitor!CruiseMission} \longrightarrow \\ \textit{initializeRet} . \textit{CruiseMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*CleanupPhase*  $\hat{=}$   

$$\left( \begin{array}{l} \textit{cleanupMissionCall} . \textit{CruiseMission} \longrightarrow \\ \textit{cleanupMissionRet} . \textit{CruiseMission!True} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*getControllingMissionMeth*  $\hat{=}$  **var** *ret* : *MissionID* •  

$$\left( \begin{array}{l} \textit{getControllingMissionCall} . \textit{CruiseMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getControllingMission}(); \\ \textit{getControllingMissionRet} . \textit{CruiseMission!ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$  
$$\left( \begin{array}{l} \textit{InitializePhase} \\ \square \\ \textit{CleanupPhase} \\ \square \\ \textit{getControllingMissionMeth} \end{array} \right); \textit{Methods}$$

• (*Init* ; *Methods*)  $\triangle$  (*end\_mission\_app* . *CruiseMission*  $\longrightarrow$  **Skip**)

**end**



**class** *CruiseMissionClass*  $\hat{=}$  **begin**

**public** *getControllingMission*  $\hat{=}$  **var** *ret* : *MissionID* •  
(*ret* := *controllingMission*)

• **Skip**

**end**

**section** *CruiseMissionMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**channel** *getControllingMissionCall* : *MissionID*

**channel** *getControllingMissionRet* : *MissionID*  $\times$  *MissionID*

## 5.6 Schedulables of CruiseMission

**section** *BeginLandingHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

**process** *BeginLandingHandlerApp*  $\hat{=}$   
*PriorityParameters* :,  
*AperiodicParameters* :,  
*CruiseMission* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{BeginLandingHandler} \longrightarrow \\ \left( \begin{array}{l} \mathbf{Skip}; \\ \text{requestTerminationCall} . \text{controllingMission} \longrightarrow \\ \text{requestTerminationRet} . \text{controllingMission} ? \text{requestTermination} \longrightarrow \end{array} \right) ; \\ \mathbf{Skip} \end{array} \right) ;$$
  

$$\left( \begin{array}{l} \text{handleAsyncEventRet} . \text{BeginLandingHandler} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_\_app* . *BeginLandingHandler*  $\longrightarrow$  **Skip**)

**end**

**class** *BeginLandingHandlerClass*  $\hat{=}$  **begin**

- **Skip**

**end**

**section** *BeginLandingHandlerMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**section** *NavigationMonitorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*CruiseMissionMethChan*

**process** *NavigationMonitorApp*  $\hat{=}$   
*PriorityParameters* :,  
*PeriodicParameters* :,  
*CruiseMission* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{NavigationMonitor} \longrightarrow \\ \left( \begin{array}{l} \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \end{array} \right) \\ \\ \text{var heading : double} \bullet \text{heading} := \text{getHeading} \\ \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \text{var airSpeed : double} \bullet \text{airSpeed} := \text{getAirSpeed} \\ \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \text{var altitude : double} \bullet \text{altitude} := \text{getAltitude} \\ \text{Skip} \end{array} \right) ; \\ \text{handleAsyncEventRet} . \text{NavigationMonitor} \longrightarrow \\ \text{Skip}$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_periodic\_app* . *NavigationMonitor*  $\longrightarrow$  **Skip**)

**end**

**class** *NavigationMonitorClass*  $\hat{=}$  **begin**

- **Skip**

**end**

## 5.7 LandMission

**section** *LandMissionApp* **parents** *scj\_prelude*, *MissionId*, *MissionIds*,  
*SchedulableId*, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *LandMissionClass*  
*, LandMissionMethChan*

**process** *LandMissionApp*  $\hat{=}$  **begin**

---

*State*  
*this* : **ref** *LandMissionClass*

---

**state** *State*

---

*Init*  
*State'*  
*this'* = **new** *LandMissionClass*()

---

*InitializePhase*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{initializeCall} . \textit{LandMission} \longrightarrow \\ \textit{register} ! \textit{GroundDistanceMonitor} ! \textit{LandMission} \longrightarrow \\ \textit{register} ! \textit{LandingGearHandlerLand} ! \textit{LandMission} \longrightarrow \\ \textit{register} ! \textit{InstrumentLandingSystemMonitor} ! \textit{LandMission} \longrightarrow \\ \textit{register} ! \textit{SafeLandingHandler} ! \textit{LandMission} \longrightarrow \\ \textit{initializeRet} . \textit{LandMission} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*CleanupPhase*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{cleanupMissionCall} . \textit{LandMission} \longrightarrow \\ \textit{cleanupMissionRet} . \textit{LandMission} ! \textbf{True} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*stowLandingGearMeth*  $\hat{=}$   
 $\left( \begin{array}{l} \textit{stowLandingGearCall} . \textit{LandMission} \longrightarrow \\ \textit{this} . \textit{stowLandingGear}(); \\ \textit{stowLandingGearRet} . \textit{LandMission} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*isLandingGearDeployedMeth*  $\hat{=}$  **var** *ret* :  $\mathbb{B}$  •  
 $\left( \begin{array}{l} \textit{isLandingGearDeployedCall} . \textit{LandMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{isLandingGearDeployed}(); \\ \textit{isLandingGearDeployedRet} . \textit{LandMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$

*getControllingMissionMeth*  $\hat{=}$  **var** *ret* : *MissionID* •  
 $\left( \begin{array}{l} \textit{getControllingMissionCall} . \textit{LandMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getControllingMission}(); \\ \textit{getControllingMissionRet} . \textit{LandMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$



$$\text{abortMeth} \hat{=} \left( \begin{array}{l} \text{abortCall} . \text{LandMission} \longrightarrow \\ \text{this} . \text{abort}(); \\ \text{abortRet} . \text{LandMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{cleanUpMeth} \hat{=} \mathbf{var} \text{ ret} : \mathbb{B} \bullet \left( \begin{array}{l} \text{cleanUpCall} . \text{LandMission} \longrightarrow \\ \text{ret} := \text{this} . \text{cleanUp}(); \\ \text{cleanUpRet} . \text{LandMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{deployLandingGearSyncMeth} \hat{=} \left( \begin{array}{l} \text{deployLandingGearCall} . \text{LandMission} ? \text{thread} \longrightarrow \\ \left( \begin{array}{l} \text{startSyncMeth} . \text{LandMissionObject} . \text{thread} \longrightarrow \\ \text{lockAcquired} . \text{LandMissionObject} . \text{thread} \longrightarrow \\ (\text{this} . \text{landingGearDeployed} := \text{true}); \\ \text{endSyncMeth} . \text{LandMissionObject} . \text{thread} \longrightarrow \\ \text{deployLandingGearRet} . \text{LandMission} . \text{thread} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \end{array} \right)$$

$$\text{Methods} \hat{=} \left( \begin{array}{l} \text{InitializePhase} \\ \square \\ \text{CleanupPhase} \\ \square \\ \text{stowLandingGearMeth} \\ \square \\ \text{isLandingGearDeployedMeth} \\ \square \\ \text{getControllingMissionMeth} \\ \square \\ \text{abortMeth} \\ \square \\ \text{cleanUpMeth} \\ \square \\ \text{deployLandingGearSyncMeth} \end{array} \right); \text{Methods}$$

$$\bullet (\text{Init} ; \text{Methods}) \triangle (\text{end\_mission\_app} . \text{LandMission} \longrightarrow \mathbf{Skip})$$

**end**

**class** *LandMissionClass*  $\hat{=}$  **begin**

**state** *State*

*SAFE\_LANDING\_ALTITUDE* : *double*

*abort* :  $\mathbb{B}$

*landingGearDeployed* :  $\mathbb{B}$

**state** *State*

**initial** *Init*

*State'*

*SAFE\_LANDING\_ALTITUDE'* = 10.0

*abort'* = *false*

**public** *stowLandingGear*  $\hat{=}$

(*this* . *landingGearDeployed* := *false*)

**public** *isLandingGearDeployed*  $\hat{=}$  **var** *ret* :  $\mathbb{B}$  •

(*ret* := *landingGearDeployed* = **True**)

**public** *getControllingMission*  $\hat{=}$  **var** *ret* : *MissionID* •

(*ret* := *controllingMission*)

**public** *abort*  $\hat{=}$

(*this* . *abort* := *true*)

**public** *cleanUp*  $\hat{=}$  **var** *ret* :  $\mathbb{B}$  •

(**Skip**;  
*ret* := ( $\neg$  *abort* = **True**))

• **Skip**

**end**

**section** *LandMissionMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**channel** *stowLandingGearCall* : *MissionID*  
**channel** *stowLandingGearRet* : *MissionID*

**channel** *isLandingGearDeployedCall* : *MissionID*  
**channel** *isLandingGearDeployedRet* : *MissionID*  $\times$   $\mathbb{B}$

**channel** *getControllingMissionCall* : *MissionID*  
**channel** *getControllingMissionRet* : *MissionID*  $\times$  *MissionID*

**channel** *abortCall* : *MissionID*  
**channel** *abortRet* : *MissionID*

**channel** *cleanUpCall* : *MissionID*  
**channel** *cleanUpRet* : *MissionID*  $\times$   $\mathbb{B}$

**channel** *deployLandingGearCall* : *MissionID*  $\times$  *ThreadID*  
**channel** *deployLandingGearRet* : *MissionID*  $\times$  *ThreadID*

## 5.8 Schedulables of LandMission

**section** *LandingGearHandlerLandApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*LandMissionMethChan*, *ObjectIds*, *ThreadIds*

**process** *LandingGearHandlerLandApp*  $\hat{=}$   
*PriorityParameters* :,  
*AperiodicParameters* :,  
*LandMission* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{LandingGearHandlerLand} \longrightarrow \\ \left( \begin{array}{l} \text{Skip}; \\ \text{isLandingGearDeployedCall} . \text{mission} \longrightarrow \\ \text{isLandingGearDeployedRet} . \text{mission} ? \text{isLandingGearDeployed} \longrightarrow \\ \\ \text{var landingGearIsDeployed} : \mathbb{B} \bullet \text{landingGearIsDeployed} := \text{isLandingGearDeployed} \\ \text{if landingGearIsDeployed} = \text{True} \longrightarrow \\ \left( \begin{array}{l} \text{stowLandingGearCall} . \text{mission} \longrightarrow \\ \text{stowLandingGearRet} . \text{mission} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \square \neg \text{landingGearIsDeployed} = \text{True} \longrightarrow \\ \left( \begin{array}{l} \text{deployLandingGearCall} . \text{mission} . \text{LandingGearHandlerLandThread} \longrightarrow \\ \text{deployLandingGearRet} . \text{mission} . \text{LandingGearHandlerLandThread} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \text{fi} \end{array} \right) \text{handleAsyncEventRet} . \text{LandingGearHandlerLand} \longrightarrow \\ \text{Skip} \end{array} \right) ;$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_\_app* . *LandingGearHandlerLand*  $\longrightarrow$  **Skip**)

**end**

**class** *LandingGearHandlerLandClass*  $\hat{=}$  **begin**

- **Skip**

**end**

**section** *LandingGearHandlerLandMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**section** *SafeLandingHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*LandMissionMethChan*

**process** *SafeLandingHandlerApp*  $\hat{=}$   
*PriorityParameters* :,  
*AperiodicParameters* :,  
*LandMission* :,  
: *ProbablyMission*,  
:• **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{SafeLandingHandler} \longrightarrow \\ \left( \begin{array}{l} \text{getControllingMissionCall} . \text{landMission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{landMission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \end{array} \right) \\ \\ \text{var } \text{altitude} : \text{double} \bullet \text{altitude} := \text{getAltitude} \\ \text{if } (\text{altitude} < \text{threshold}) \longrightarrow \\ \quad (\text{Skip}) \\ \quad \square \neg (\text{altitude} < \text{threshold}) \longrightarrow \\ \quad \quad (\text{Skip}) \\ \text{fi} \\ \text{handleAsyncEventRet} . \text{SafeLandingHandler} \longrightarrow \\ \text{Skip} \end{array} \right) ;$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_\_app* . *SafeLandingHandler*  $\longrightarrow$  **Skip**)

**end**

**class** *SafeLandingHandlerClass*  $\hat{=}$  **begin**

<b>state</b> <i>State</i> <i>threshold</i> : <i>double</i>
---------------------------------------------------------------

**state** *State*

<b>initial</b> <i>Init</i> <i>State</i> '
----------------------------------------------

- **Skip**

**end**



**section** *SafeLandingHandlerMethChan* **parents** *scj\_prelude, GlobalTypes, MissionId, SchedulableId*

**section** *GroundDistanceMonitorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,  
*LandMissionMethChan*

**process** *GroundDistanceMonitorApp*  $\hat{=}$   
*PriorityParameters* :,  
*PeriodicParameters* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   

$$\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{GroundDistanceMonitor} \longrightarrow \\ \left( \begin{array}{l} \mathbf{Skip}; \\ \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \mathbf{var} \text{ distance} : \text{double} \bullet \text{distance} := \text{getAltitude} \\ \mathbf{if} (\text{distance} = \text{readingOnGround}) \longrightarrow \\ \left( \begin{array}{l} \mathbf{Skip}; \\ \text{requestTerminationCall} . \text{mission} \longrightarrow \\ \text{requestTerminationRet} . \text{mission} ? \text{requestTermination} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \\ \Box \neg (\text{distance} = \text{readingOnGround}) \longrightarrow \mathbf{Skip} \\ \mathbf{fi}; \\ \mathbf{Skip} \end{array} \right) ; \\ \text{handleAsyncEventRet} . \text{GroundDistanceMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_periodic\_app* . *GroundDistanceMonitor*  $\longrightarrow$  **Skip**)

**end**

**class** *GroundDistanceMonitorClass*  $\hat{=}$  **begin**

**state** *State*

*readingOnGround* : *double*

**state** *State*

**initial** *Init*

*State'*

• **Skip**

**end**

**section** *InstrumentLandingSystemMonitorApp* **parents** *PeriodicEventHandlerChan, SchedulableId, SchedulableIds*

**process** *InstrumentLandingSystemMonitorApp*  $\hat{=}$   
*PriorityParameters* :,  
*PeriodicParameters* :,  
*LandMission* :,  
: *ProbablyMission* • **begin**

*handlerAsyncEvent*  $\hat{=}$   
 $\left( \begin{array}{l} \text{handleAsyncEventCall} . \text{InstrumentLandingSystemMonitor} \longrightarrow \\ (\mathbf{Skip}) ; \\ \text{handleAsyncEventRet} . \text{InstrumentLandingSystemMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

*Methods*  $\hat{=}$   
(*handlerAsyncEvent*) ; *Methods*

• (*Methods*)  $\triangle$  (*end\_periodic\_app* . *InstrumentLandingSystemMonitor*  $\longrightarrow$  **Skip**)

**end**

**class** *InstrumentLandingSystemMonitorClass*  $\hat{=}$  **begin**

- **Skip**

**end**