```
CONTEXT
   System_Ctx
CONSTANTS
   TIME
   sigma
   plantV0
AXIOMS
   axm1   :   TIME = RRealPlus
   axm2   :   sigma ∈ RRealPlus ∧ sigma ↦Rzero ∈gt
   axm3   :   plantV0∈ RReal
END
```

```
MACHINE
   System_M
SEES
   System_Ctx
   Theorems
VARIABLES
   t
   plantV
INVARIANTS
   inv1   :   t ∈ TIME
   inv2   :   plantV ∈ Closed2Closed(Rzero, t) ⇸ RReal
EVENTS
   INITIALISATION   ≙
   STATUS
     ordinary
   BEGIN
     act1   :   t≔Rzero
     act2   :   plantV ≔{Rzero↦plantV0}
   END

   Progress   ≙
   STATUS
     ordinary
   BEGIN
     act1   :   t :∣ t' ∈ TIME ∧ (t ↦ t' ∈ lt ∧ minus(t'↦t) ↦ sigma ∈ geq)
   END

   Plant   ≙
   STATUS
     ordinary
   ANY
     e
     plant1
   WHERE
     grd1   :   e ∈ DE(RReal)
     grd2   :   Solvable(Closed2Closed(Rzero, t)\dom(plantV),e)
                plant1 ∈ Closed2Closed(Rzero, t)\dom(plantV) → RReal ∧
                AppendSolutionBAP(e,
     grd3   :   Closed2Closed(Rzero, t)\dom(plantV),
                Closed2Closed(Rzero, t)\dom(plantV), plant1)
   THEN
     act1   :   plantV≔plantV⩤plant1
   END

END
```

```
CONTEXT
    EventTriggered_Ctx
EXTENDS
    System_Ctx
SETS
    EXEC
    PROP
CONSTANTS
    prop_safe
    prop_evt_trig
    ctrl
    plant
    prg
    f_evol
    f_evol_plantV
    prop_evade_values
AXIOMS
    axm1   :   prop_safe ∈ PROP⟶((RReal  × RReal) ⟶ BOOL)
    axm2   :   prop_evt_trig ∈ PROP⟶((RReal×RReal)×RReal ⟶ BOOL)
    axm3   :   partition(EXEC,  {ctrl},{plant},{prg})
    axm4   :   f_evol ∈ RReal ⟶ RReal
    axm5   :   f_evol_plantV ∈ (RReal ⟶ (TIME × RReal ⟶ RReal))
    axm6   :   ∀ ctrlV · ctrlV ∈ RReal ⇒ (f_evol_plantV(ctrlV) =
                     (λ t ↦ plantV · t ∈ TIME ∧ plantV ∈ RReal | f_evol(ctrlV)))
    axm7   :   prop_evade_values∈PROP⟶ℙ1(RReal)
END
```

```
MACHINE
   EventTriggered_M
REFINES
   System_M
SEES
   EventTriggered_Ctx
VARIABLES
   t
   plantV
   ctrlV
   exec
INVARIANTS
   inv1   :   ctrlV ∈ RReal
   inv2   :   exec ∈ EXEC
   inv3   :   exec≠plant ⇒ dom(plantV)=Closed2Closed(Rzero, t)
   inv4   :   exec=plant ⇒ t∉ dom(plantV)
EVENTS
   INITIALISATION   ≙
     extended
   STATUS
     ordinary
   BEGIN
     act1   :   t≔Rzero
     act2   :   plantV ≔{Rzero↦plantV0}
     act3   :   ctrlV :∈ RReal
     act4   :   exec ≔ ctrl
   END

   Progress   ≙
   STATUS
     ordinary
   REFINES
     Progress
   ANY
     t1
   WHERE
     grd1   :   exec=prg
     grd2   :   t1 ∈ TIME ∧ (t ↦ t1 ∈ lt ∧ minus(t1↦t) ↦ sigma ∈ geq)
                ∀x· x∈ PROP ⇒
     grd3   :     (ctrlV∉ prop_evade_values(x)⇒
                       (prop_evt_trig(x))(plantV(t)↦minus(t1↦t)↦ctrlV) = TRUE)
   THEN
     act1   :   t≔t1
     act2   :   exec ≔ plant
   END

   Plant   ≙
   STATUS
     ordinary
   REFINES
     Plant
   ANY
     plant1
   WHERE
     grd1   :   exec=plant
     grd2   :   plant1 ∈ Closed2Closed(Rzero, t)\dom(plantV) ⟶ RReal
     grd3   :   ode(f_evol_plantV(ctrlV),plant1(t),t) ∈ DE(RReal)
                Solvable(Closed2Closed(Rzero, t)\dom(plantV),
     grd4   :                ode(f_evol_plantV(ctrlV),plant1(t),t))
                AppendSolutionBAP(ode(f_evol_plantV(ctrlV),plant1(t),t),
     grd5   :   Closed2Closed(Rzero, t)\dom(plantV),
                Closed2Closed(Rzero, t)\dom(plantV), plant1)
   WITH
     e   :   e = ode(f_evol_plantV(ctrlV),plant1(t),t)
```

```
  THEN
    act1   :   plantV≔plantV⊲plant1
    act2   :   exec≔ctrl
  END

  Ctrl   ≙
  STATUS
    ordinary
  ANY
    value
  WHERE
    grd1   :   exec = ctrl
    grd2   :   value∈RReal
               ∀x· x∈ PROP ⇒
    grd3   :     (value∉ prop_evade_values(x)
               ⇒(prop_safe(x))(plantV(t)↦value) = TRUE)
  THEN
    act1   :   ctrlV ≔value
    act2   :   exec ≔ prg
  END

END
```

```
CONTEXT
   TimeTriggered_Ctx
EXTENDS
   EventTriggered_Ctx
CONSTANTS
   epsilon
   prop_safeEpsilon
AXIOMS
   axm1   :   epsilon ∈ TIME ∧ sigma↦epsilon ∈leq
   axm2   :   prop_safeEpsilon ∈ PROP⟶((RReal × RReal) ⟶ BOOL)
   axm3   :   Rzero↦epsilon ∈lt
END
```

```
MACHINE
   TimeTriggered_M
REFINES
   EventTriggered_M
SEES
   TimeTriggered_Ctx
   Theorems
VARIABLES
   t
   plantV
   ctrlV
   exec
EVENTS
   INITIALISATION  ≙
     extended
   STATUS
     ordinary
   BEGIN
     act1   :   t≔Rzero
     act2   :   plantV ≔{Rzero↦plantV0}
     act3   :   ctrlV :∈ RReal
     act4   :   exec ≔ ctrl
   END

   Progress  ≙
     extended
   STATUS
     ordinary
   REFINES
     Progress
   ANY
     t1
   WHERE
     grd1   :   exec=prg
     grd2   :   t1 ∈ TIME ∧ (t ↦ t1 ∈ lt ∧ minus(t1↦t) ↦ sigma ∈ geq)
                ∀x· x∈ PROP ⇒
     grd3   :     (ctrlV∉ prop_evade_values(x)⇒
                       (prop_evt_trig(x))(plantV(t)↦minus(t1↦t)↦ctrlV) = TRUE)
     grd4   :   t1 ∈ TIME ∧ (t ↦ t1 ∈ lt) ∧ minus(t1↦t) ↦ sigma ∈ geq ∧ minus(t1↦t) ↦ epsilon ∈ leq
   THEN
     act1   :   t≔t1
     act2   :   exec ≔ plant
   END

   Plant  ≙
     extended
   STATUS
     ordinary
   REFINES
     Plant
   ANY
     plant1
   WHERE
     grd1   :   exec=plant
     grd2   :   plant1 ∈ Closed2Closed(Rzero, t)\dom(plantV) ⟶ RReal
     grd3   :   ode(f_evol_plantV(ctrlV),plant1(t),t) ∈ DE(RReal)
                Solvable(Closed2Closed(Rzero, t)\dom(plantV),
     grd4   :                ode(f_evol_plantV(ctrlV),plant1(t),t))
                AppendSolutionBAP(ode(f_evol_plantV(ctrlV),plant1(t),t),
     grd5   :   Closed2Closed(Rzero, t)\dom(plantV),
                Closed2Closed(Rzero, t)\dom(plantV), plant1)
   THEN
     act1   :   plantV≔plantV⊲plant1
     act2   :   exec≔ctrl
```

```
END

Ctrl  ≙
  extended
STATUS
  ordinary
REFINES
  Ctrl
ANY
  value
WHERE
  grd1  :  exec = ctrl
  grd2  :  value∈RReal
           ∀x· x∈ PROP ⇒
  grd3  :    (value∉ prop_evade_values(x)
           ⇒(prop_safe(x))(plantV(t)↦value) = TRUE)
           ∀x· x∈ PROP ⇒
  grd4  :        (value∉ prop_evade_values(x)
           ⇒(prop_safeEpsilon(x))(plantV(t)↦value) = TRUE)
THEN
  act1  :  ctrlV ≔value
  act2  :  exec ≔ prg
END

END
```

```
CONTEXT
   Theorems
AXIOMS
   axm1   :  ∀a,b,c,d·a↦b∈ leq ∧ c↦d ∈leq ⇒ plus(a↦c) ↦plus(b↦d) ∈ leq
   axm2   :  ∀a,b,c,d·Rzero↦a ∈ leq ∧ Rzero↦b ∈ leq ∧ Rzero↦c ∈ leq ∧ Rzero↦d ∈ leq ∧ a↦b∈ leq ∧ c↦d ∈leq ⇒ times
             (a↦c) ↦times(b↦d) ∈ leq
   axm3   :  ∀a,b,c· a↦b ∈ leq ∧ b↦c ∈ leq⇒ a ↦c ∈ leq
             ∀a,b· a∈ RReal ∧ b ∈ RReal
   axm4   :  ⇒
             minus(times(a↦a) ↦times(b↦b))=times(plus(a↦b)↦minus(a↦b))
   axm5   :  ∀a· a∈ RReal ⇒ uminus(a)=minus(Rzero↦a)
             ∀a· a∈ RReal ⇒
             a=plus(
                    times(divide(Rone ↦ Rtwo) ↦a)
   axm6   :     ↦
                    times(divide(Rone ↦ Rtwo) ↦a)
                  )
             ∀a,b· a∈ RReal ∧ b∈ RReal ∧ times(a↦b)∈ RRealStar
   axm7   :  ⇒
             inverse(times(a↦b))=times(inverse(a)↦inverse(b))
END
```

```
CONTEXT
   Desolve
EXTENDS
   TimeTriggered_Ctx
CONSTANTS
   B_desolve
   prop
AXIOMS
   axm1   :   B_desolve ∈  ℕ × RReal × (TIME ⇸ RReal ) ×TIME × (TIME × RReal) ⟶ (RReal ⇸ RReal)
   axm2   :   prop∈ RReal ⟶BOOL
   axm3   :   prop(plantV0)=TRUE
END
```

```
MACHINE
   TimeTriggered_desolve_M
REFINES
   TimeTriggered_M
SEES
   Desolve
   Theorems
VARIABLES
   t
   plantV
   ctrlV
   exec
INVARIANTS
   inv1   :   ∀x· x∈ dom(plantV)⇒prop(plantV(x))=TRUE
EVENTS
   INITIALISATION   ≙
     extended
   STATUS
     ordinary
   BEGIN
     act1   :   t≔Rzero
     act2   :   plantV ≔{Rzero↦plantV0}
     act3   :   ctrlV :∈ RReal
     act4   :   exec ≔ ctrl
   END

   Progress   ≙
     extended
   STATUS
     ordinary
   REFINES
     Progress
   ANY
     t1
   WHERE
     grd1   :   exec=prg
     grd2   :   t1 ∈ TIME ∧ (t ↦ t1 ∈ lt ∧ minus(t1↦t) ↦ sigma ∈ geq)
                ∀x· x∈ PROP ⇒
     grd3   :     (ctrlV∉ prop_evade_values(x)⇒
                        (prop_evt_trig(x))(plantV(t)↦minus(t1↦t)↦ctrlV) = TRUE)
     grd4   :   t1 ∈ TIME ∧ (t ↦ t1 ∈ lt) ∧ minus(t1↦t) ↦ sigma ∈ geq ∧ minus(t1↦t) ↦ epsilon ∈ leq
   THEN
     act1   :   t≔t1
     act2   :   exec ≔ plant
   END

   Plant   ≙
   STATUS
     ordinary
   REFINES
     Plant
   ANY
     plant1
     lastTime
   WHERE
     grd1   :   exec=plant
     grd2   :   lastTime∈ TIME ∧ dom(plantV)=Closed2Closed(Rzero,lastTime)
     grd3   :   plant1 =B_desolve(1 ↦ ctrlV ↦ plantV ↦ t ↦ (lastTime↦plantV(lastTime)))
     grd4   :   plant1 ∈ Closed2Closed(Rzero, t)\dom(plantV) ⟶ RReal
     grd5   :   ode(f_evol_plantV(ctrlV),plant1(t),t) ∈ DE(RReal)
     grd6   :   Solvable(Closed2Closed(Rzero, t)\dom(plantV),
                         ode(f_evol_plantV(ctrlV),plant1(t),t))
     grd7   :   AppendSolutionBAP(ode(f_evol_plantV(ctrlV),plant1(t),t),
                Closed2Closed(Rzero, t)\dom(plantV),
```

```
                Closed2Closed(Rzero, t)\dom(plantV), plant1)
    grd8   :    ∀xx· xx∈ dom(plant1)⇒ prop(plant1(xx))=TRUE
  THEN
    act1   :    plantV≔plantV⩤plant1
    act2   :    exec≔ctrl
  END

  Ctrl   ≙
    extended
  STATUS
    ordinary
  REFINES
    Ctrl
  ANY
    value
  WHERE
    grd1   :    exec = ctrl
    grd2   :    value∈RReal
                ∀x· x∈ PROP ⇒
    grd3   :      (value∉ prop_evade_values(x)
                ⇒(prop_safe(x))(plantV(t)↦value) = TRUE)
                ∀x· x∈ PROP ⇒
    grd4   :           (value∉ prop_evade_values(x)
                ⇒(prop_safeEpsilon(x))(plantV(t)↦value) = TRUE)
  THEN
    act1   :    ctrlV ≔value
    act2   :    exec ≔ prg
  END

END
```