# ISO/IEC 29341-6-16

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# INTERNATIONAL STANDARD

## Information technology – UPnP Device Architecture – Part 6-16: Heating, Ventilation and Air Conditioning Device Control Protocol – Temperature Setpoint Service

ISO/IEC 29341-6-16:2008(E)

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The list of all currently available parts of the ISO/IEC 29341 series, under the general title *Universal plug and play (UPnP) architecture*, can be found on the IEC web site.

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# ORIGINAL UPNP DOCUMENTS
(informative)

Reference may be made in this document to original UPnP documents. These references are retained in order to maintain consistency between the specifications as published by ISO/IEC and by UPnP Implementers Corporation. The following table indicates the original UPnP document titles and the corresponding part of ISO/IEC 29341:

| **UPnP Document Title** | **ISO/IEC 29341 Part** |
|---|---|
| UPnP Device Architecture 1.0 | ISO/IEC 29341-1 |
| UPnP Basic:1 Device | ISO/IEC 29341-2 |
| UPnP AV Architecture:1 | ISO/IEC 29341-3-1 |
| UPnP MediaRenderer:1 Device | ISO/IEC 29341-3-2 |
| UPnP MediaServer:1 Device | ISO/IEC 29341-3-3 |
| UPnP AVTransport:1 Service | ISO/IEC 29341-3-10 |
| UPnP ConnectionManager:1 Service | ISO/IEC 29341-3-11 |
| UPnP ContentDirectory:1 Service | ISO/IEC 29341-3-12 |
| UPnP RenderingControl:1 Service | ISO/IEC 29341-3-13 |
| UPnP MediaRenderer:2 Device | ISO/IEC 29341-4-2 |
| UPnP MediaServer:2 Device | ISO/IEC 29341-4-3 |
| UPnP AV Datastructure Template:1 | ISO/IEC 29341-4-4 |
| UPnP AVTransport:2 Service | ISO/IEC 29341-4-10 |
| UPnP ConnectionManager:2 Service | ISO/IEC 29341-4-11 |
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| UPnP QoS Architecture:2 | ISO/IEC 29341-11-1 |
| UPnP QOS v2 Schema Files | ISO/IEC 29341-11-2 |

| UPnP Document Title | ISO/IEC 29341 Part |
|---|---|
| UPnP QosDevice:2 Service | ISO/IEC 29341-11-10 |
| UPnP QosManager:2 Service | ISO/IEC 29341-11-11 |
| UPnP QosPolicyHolder:2 Service | ISO/IEC 29341-11-12 |
| UPnP RemoteUIClientDevice:1 Device | ISO/IEC 29341-12-1 |
| UPnP RemoteUIServerDevice:1 Device | ISO/IEC 29341-12-2 |
| UPnP RemoteUIClient:1 Service | ISO/IEC 29341-12-10 |
| UPnP RemoteUIServer:1 Service | ISO/IEC 29341-12-11 |
| UPnP DeviceSecurity:1 Service | ISO/IEC 29341-13-10 |
| UPnP SecurityConsole:1 Service | ISO/IEC 29341-13-11 |

# 1. Overview and Scope

This service definition is compliant with the UPnP Device Architecture version *1.0*.

This service-type enables the following functions:

- The means to set and get a temperature set point for use by a temperature controller.
- The highest and lowest valid temperature values for the set point are defined by the vendor.
- An interface is provided that allows notification when a controlled region has reached the temperature control band per this temperature controller's design.
- A vendor fined application type. This allows re-use of this service for multiple applications.

This service does not include:

- The closed-loop control interface that is part of a temperature controller.

# 2. Service Modeling Definitions

## 2.1. ServiceType

The following service type identifies a service that is compliant with this template:

**urn:schemas-upnp-org:service:TemperatureSetpoint:1**

## 2.2. State Variables

**Table 1 State Variables**

| Variable Name | Req. or Opt.[1] | Data Type | Allowed Value [2] | Default Value[2] | Eng. Units |
|---|---|---|---|---|---|
| Application | R | string | see table | (none) | n/a |
| CurrentSetpoint | R | i4 | see table | (none) | .01 degrees Celsius |
| SetpointAchieved | O | boolean | 1, 0 | 0 | none |
| Name | O | string | | Zero length string | N/a |
| *Non-standard state variables implemented by an UPnP vendor go here.* | *X* | *TBD* | *TBD* | *TBD* | *TBD* |

[1] R = Required, O = Optional, X = Non-standard.

[2] Values listed in this column are required. To specify standard optional values or to delegate assignment of values to the vendor, you must reference a specific instance of an appropriate table below.

**Table 2 AllowedValueList for Application**

| Value | Req. or Opt. [1] |
|---|---|
| *Vendor defined as "none"*<br><br>*R/W -This allows a control point to establish the application type* | *O* |
| *Vendor-defined – Read only*<br><br>*Vendor defined – one value only*<br><br>*Reserved names are:*<br><br>*Heating,*<br>*Cooling,*<br>*DualHeatingCooling,*<br>*Dryer,*<br>*WaterHeater,*<br>*Refrigerator,*<br>*Freezer* | *O* |

[1] R = Required, O = Optional, X = Non-standard.

**Table 3 AllowedValueRange for CurrentSetpoint**

| | Value | Req. or Opt. [1] |
|---|---|---|
| minimum | *Vendor-defined* | R |
| maximum | *Vendor-defined* | R |
| step | *Step=1 (i.e. 0.01 Celsius)* | R |

[1] R = Required, O = Optional, X = Non-standard.

### 2.2.1. Application

This variable states the intended application of this service.

### 2.2.2. CurrentSetpoint

This variable exposes the setpoint of a service that is controlling temperature to that setpoint.

### 2.2.3. SetpointAchieved

This variable changes from false to true when the temperature in the controlled region is within the control band. This variable changes to false when a new setpoint is set or when the temperature is no longer in the control band. The value of this variable is determined from information provided by a temperature controller- typically PID..

### 2.2.4. Name

This optional variable may be used to capture a friendly name or location for this sensor.

### 2.2.5. Relationships Between State Variables

SetpointAchieved changes from false to true when the temperature in the controlled region is within the control band determined by the CurrentSetpoint. This variable changes to false when a new CurrentSetpoint is set or when the temperature is no longer in the control band.

## 2.3. Eventing and Moderation

**Table 4 Eventing & Moderation**

| Variable Name | Evented | Moderated Event | Max Event Rate[1] | Logical Combination | Min Delta per Event[2] |
|---|---|---|---|---|---|
| Name | Yes | No | none | none | On-change |
| Application | Yes | No | none | none | n/a |
| CurrentSetpoint | Yes | Yes | none | none | On-change |
| SetpointAchieved | Yes | Yes | none | none | On-change |
| *Non-standard state variables implemented by an UPnP vendor go here.* | *TBD* | *TBD* | *TBD* | *TBD* | *TBD* |

[1] Determined by N, where Rate = (Event)/(N secs).
[2] (N) * (allowedValueRange Step).

### 2.3.1. Event Model

**Table 5 Event Model**

| Variable Name | UI requirements | Async Requirements | Func. Vs max rate tradeoffs | Est of Max rate | Reason not evented |
|---|---|---|---|---|---|
| Application | Needed for UI | | | | N/a |
| CurrentTemperature | Needed for UI | | | Very low | N/a |
| Name | Needed for UI | | | Very low | N/a |
| SetpointAchieved | Needed for UI | | | Very low | N/a |

## 2.4. Actions

**Table 6 Action list**

| Name | Req. or Opt. [1] |
|---|---|
| GetApplication | *R* |
| SetApplication | *O* |
| SetCurrentSetpoint | *R* |
| GetCurrentSetpoint | *R* |
| GetSetpointAchieved | *O* |
| GetName | O |
| SetName | O |
| *Non-standard actions implemented by an UPnP vendor go here.* | X |

[1] R = Required, O = Optional, X = Non-standard.

## 2.4.1. GetApplication

Provides the Application value to a control point or other devices

### *2.4.1.1. Arguments*

**Table 7 Arguments for GetApplication**

| Argument | Direction | relatedStateVariable |
|---|---|---|
| CurrentApplication | *Out* [R] | Application |

[R] Return Value

### *2.4.1.2. Dependency on State (if any)*

Depends on Application

### *2.4.1.3. Effect on State (if any)*

None

### *2.4.1.4. Errors*

| errorCode | errorDescription | Description |
|---|---|---|
| none | | |

## 2.4.2. SetApplication

If the allowed value for Application is not set to a fixed value this action allows a control point to establish the value for Application

**Table 8 Arguments for SetApplication**

| Argument | Direction | relatedStateVariable |
|---|---|---|
| NewApplication | *In* | Application |

### *2.4.2.1. Dependency on State (if any)*

None

### *2.4.2.2. Effect on State (if any)*

Changes the value of Application

### *2.4.2.3. Errors*

| errorCode | errorDescription | Description |
|---|---|---|
| 701 | Not settable | This implementation of this service does not permit writing of this variable. |

## 2.4.3. SetCurrentSetpoint

This action establishes a new setpoint for this service. This directs a temperature controller associated with this service to control to a new temperature

### *2.4.3.1. Arguments*

**Table 9 Arguments for SetCurrentSetpoint**

| Argument | Direction | relatedStateVariable |
|---|---|---|
| NewCurrentSetpoint | *In* | CurrentSetpoint |

### *2.4.3.2. Dependency on State (if any)*

If this service is for cooling and a heating setpoint service is also provided, the cooling value must be less than the heating setpoint. If this service is for heating and a cooling setpoint service is also provided, the heating value must be greater than the cooling setpoint

### *2.4.3.3. Effect on State*

Changes CurrentSetpoint to = NewCurrentSetpoint

### *2.4.3.4. Errors*

| errorCode | errorDescription | Description |
|---|---|---|
| 700 | Invalid Temperature | NewCurrentSetpoint is outside of the specified range |
| 701 | Rejected – value inconsistent with other setpoint values | If cooling, the value is less than the heating setpoint. If heating the value is more than the cooling setpoint |

## 2.4.4. GetCurrentSetpoint

The action retrieves the current setpoint value from this service.

### *2.4.4.1. Arguments*

**Table 10 Arguments for GetCurrentSetpoint**

| Argument | Direction | relatedStateVariable |
|---|---|---|
| CurrentSP | *Out*[R] | CurrentSetpoint |

[R] Return Value

### *2.4.4.2. Dependency on State (if any)*

Depends on CurrentSetpoint

### *2.4.4.3. Effect on State*

None

#### *2.4.4.4. Errors*

| errorCode | errorDescription | Description |
|---|---|---|
| none | | |

### 2.4.5. GetSetPointAchieved

Provides the SetpointAchieved Value to a control point or other devices

#### *2.4.5.1. Arguments*

**Table 11 Arguments for GetSetPointAcheived**

| Argument | Direction | relatedStateVariable |
|---|---|---|
| CurrentSPA | *Out*[R] | SetpointAchieved |

[R] Return Value

#### *2.4.5.2. Dependency on State (if any)*

Depends on whether controller has reached the setpoint and is inside the control proportional band.

#### *2.4.5.3. Effect on State*

None

#### *2.4.5.4. Errors*

| errorCode | errorDescription | Description |
|---|---|---|
| none | | |

### 2.4.6. GetName

Provides the Name value to a control point or other UPnP device

#### *2.4.6.1. Arguments*

**Table 12 Arguments for GetName**

| Argument | Direction | relatedStateVariable |
|---|---|---|
| CruuentName | *Out*[R] | Name |

[R] Return Value

#### *2.4.6.2. Dependency on State (if any)*

Depends on Name

#### *2.4.6.3. Effect on State*

None

#### *2.4.6.4. Errors*

| errorCode | errorDescription | Description |
|---|---|---|
| none | | |

### 2.4.7. SetName

Provides a new Name value for the Name variable.

#### *2.4.7.1. Arguments*

**Table 13 Arguments for SetName**

| Argument | Direction | relatedStateVariable |
|---|---|---|
| NewName | *In* | Name |

#### *2.4.7.2. Dependency on State (if any)*

None

#### *2.4.7.3. Effect on State*

Changes Name

#### *2.4.7.4. Errors*

| errorCode | errorDescription | Description |
|---|---|---|
| none | | |

### 2.4.8. Non-Standard Actions Implemented by a UPnP Vendor

To facilitate certification, non-standard actions implemented by UPnP vendors should be included in this service template. The UPnP Device Architecture lists naming requirements for non-standard actions (see the section on Description).

### 2.4.9. Relationships Between Actions

*None.*

### 2.4.10.Common Error Codes

The following table lists error codes common to actions for this service type. If an action results in multiple errors, the most specific error should be returned.

**Table 14: Common Error Codes**

| errorCode | errorDescription | Description |
|---|---|---|
| 401 | Invalid Action | See UPnP Device Architecture section on Control. |
| 402 | Invalid Args | See UPnP Device Architecture section on Control. |
| 404 | Invalid Var | See UPnP Device Architecture section on Control. |
| 501 | Action Failed | See UPnP Device Architecture section on Control. |
| 600-699 | TBD | Common action errors. Defined by UPnP Forum Technical Committee. |
| 701-799 | | Common action errors defined by the UPnP Forum working committees. |
| *800-899* | *TBD* | *(Specified by UPnP vendor.)* |

## 2.5. Theory of Operation

This service exposes the variables to control and observe a temperature controller that controls the heating or cooling of a region or a space. Examples of these mechanisms are an oven control, a water heater control, a room heater control, or a thermostat for a central heating or cooling system.

To achieve closed-loop control of the temperature, these mechanisms frequently sense the current temperature of the region and compare it with a temperature setpoint and then take the appropriate action to have the current temperature be equal (within a control band) to the setpoint.

To control and observe a temperature controller this service uses the following variables:

- Application
- CurrentTemperature
- SetpointAchieved

CurrentSetpoint allows a ControlPoint or other device to establish a new temperature setpoint.

Manufacturers shall establish the allowable range of temperatures using Maximum and Minimum allowed values. These values are observable via the XML description.

Application allows a manufacturer to designate the intended application for this service. The value is observable by a Get action. The following applications are defined:

- Heating – for use in a HVAC heating system. Both heating and cooling setpoints are used in some systems that both heat and cool.
- Cooling – for use in a HVAC cooling system. Both heating and cooling setpoints are used in some systems that both heat and cool.
- DualHeatingCooling – used in systems that use a single setpoint for both heating and cooling.
- Dryer – used for a clothes dryer.
- WaterHeater – used for a domestic water heater.
- Refrigerator – used for the main fresh food compartment of a refrigerator.
- Freezer – used for a standalone freezer or the frozen food compartment of a refrigerator.

A vendor also has the ability to define the allowed value of Application to be “none” if the vendor wishes to make it writable.

The optional variable, SetpointAchived, is provided for situations where an event is to be generated when the temperature controller first observes the current temperature has entered the control band. This variable is set to "False" when a new CurrentSetpoint is set or when the temperature is outside the control band.

# 3. XML Service Description

```
<?xml version="1.0"?>
<scpd xmlns="urn:schemas-upnp-org:service-1-0">
  <specVersion>
    <major>1</major>
    <minor>0</minor>
  </specVersion>
  <actionList>
    <action>
    <name>GetApplication</name>
      <argumentList>
        <argument>
          <name>CurrentApplicationname>
          <direction>out</direction>
          <retval />
          <relatedStateVariable>Application</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
The following action is optional
<action>
    <name>SetApplication</name>
      <argumentList>
        <argument>
          <name>NewApplicationname>
          <direction>in</direction>
          <relatedStateVariable>Application</relatedStateVariable>
        </argument>
      </argumentList>
    </action>


<action>
    <name>SetCurrentSetpoint</name>
      <argumentList>
        <argument>
          <name>NewCurrentSetpoint</name>
          <direction>in</direction>
          <relatedStateVariable>CurrentSetpoint</relatedStateVariable>
        </argument>
      </argumentList>
    </action>

<action>
    <name>GetCurrentSetpoint</name>
      <argumentList>
        <argument>
          <name>CurrentSP</name>
          <direction>out</direction>
          <retval />
          <relatedStateVariable>CurrentSetpoint</relatedStateVariable>
        </argument>
      </argumentList>
    </action>

<action>
    <name>GetSetpointAchieved</name>
      <argumentList>
        <argument>
          <name>CurrentSPA</name>
          <direction>out</direction>
          <retval />
```

```
            <relatedStateVariable>SetpointAchieved</relatedStateVariable>
          </argument>
        </argumentList>
      </action>
The following action is optional
<action>
      <name>GetName</name>
        <argumentList>
          <argument>
            <name>CurrentName</name>
            <direction>out</direction>
            <retval />
            <relatedStateVariable>Name</relatedStateVariable>
          </argument>
        </argumentList>
      </action>
The following action is optional
      <action>
      <name>SetName</name>
        <argumentList>
          <argument>
            <name>NewName</name>
            <direction>in</direction>
           <relatedStateVariable>Name</relatedStateVariable>
          </argument>
        </argumentList>
      </action>
      Declarations for other actions added by UPnP vendor (if any) go here
    </actionList>

    <serviceStateTable>
      <stateVariable sendEvents="yes">
        <name>Application</name>
        <dataType>string</dataType>
        <allowedValueList>
          <allowedValue> vendor defined </allowedValue>
          Other allowed values defined by UPnP Forum working committee (if
          any) go here
        </allowedValueList>
      </stateVariable>

      <stateVariable sendEvents="yes">
        <name>CurrentSetpoint</name>
        <dataType>i4</dataType>
        <allowedValueRange>
          <minimum>manufacturer defined</minimum>
          <maximum>manufacturer defined</maximum>
          <step>1</step>
         </allowedValueRange>
      </stateVariable>

      <stateVariable sendEvents="yes">
        <name>SetpointAchieved</name>
        <dataType>boolean</dataType>
        <defaultValue>0</defaultValue>
        <allowedValueList>
          <allowedValue>0</allowedValue>
          <allowedValue>1</allowedValue>
        </allowedValueList>
      </stateVariable>
The following state variable is optional
        <stateVariable sendEvents="yes">
        <name>Name</name>
        <dataType>string</dataType>
```

```
    </stateVariable>

    Declarations for other state variables defined by UPnP Forum working
    committee(if any) go here
    Declarations for other state variables added by UPnP vendor (if any)
    go here
  </serviceStateTable>
</scpd>
```

# 4. Test

Testing of the UPnP functions Addressing, Discovery, Description, Control (Syntax) and Eventing are performed by the UPnP Test Tool v1.1 based on the following documents:

- UPnP Device Architecture v1.0
- The Service Definitions in chapter 2 of this document
- The XML Service Description in chapter 3 of this document
- The UPnP Test Tool service template test file: ***TemperatureSetpoint1.xml***
- The UPnP Test Tool service template test file: ***TemperatureSetpoint1.SyntaxTests.xml***

The test suite does not include tests for Control Semantics, since it is felt that such tests would not provide a higher level of interoperability.

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