ISO/IEC 29341-6-16

Edition 1.0 2008-11

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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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE G

ICS 35.200

ISBN 2-8318-1008-2

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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.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

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
UPnP ContentDirectory:2 Service	ISO/IEC 29341-4-12
UPnP RenderingControl:2 Service	ISO/IEC 29341-4-13
UPnP ScheduledRecording:1	ISO/IEC 29341-4-14
UPnP DigitalSecurityCamera:1 Device	ISO/IEC 29341-5-1
UPnP DigitalSecurityCameraMotionImage:1 Service	ISO/IEC 29341-5-10
UPnP DigitalSecurityCameraSettings:1 Service	ISO/IEC 29341-5-11
UPnP DigitalSecurityCameraStillImage:1 Service	ISO/IEC 29341-5-12
UPnP HVAC_System:1 Device	ISO/IEC 29341-6-1
UPnP HVAC_ZoneThermostat:1 Device	ISO/IEC 29341-6-2
UPnP ControlValve:1 Service	ISO/IEC 29341-6-10
UPnP HVAC_FanOperatingMode:1 Service	ISO/IEC 29341-6-11
UPnP FanSpeed:1 Service	ISO/IEC 29341-6-12
UPnP HouseStatus:1 Service	ISO/IEC 29341-6-13
UPnP HVAC_SetpointSchedule:1 Service	ISO/IEC 29341-6-14
UPnP TemperatureSensor:1 Service	ISO/IEC 29341-6-15
UPnP TemperatureSetpoint:1 Service	ISO/IEC 29341-6-16
UPnP HVAC_UserOperatingMode:1 Service	ISO/IEC 29341-6-17
UPnP BinaryLight:1 Device	ISO/IEC 29341-7-1
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UPnP QosManager:1 Service	ISO/IEC 29341-10-11
UPnP QosPolicyHolder:1 Service	ISO/IEC 29341-10-12
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" *R/W -This allows a control point to establish the application type*	*O*
Vendor-defined – Read only *Vendor defined – one value only* *Reserved names are:* *Heating,* *Cooling,* *DualHeatingCooling,* *Dryer,* *WaterHeater,* *Refrigerator,* *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 />
```