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Information technology – UPnP Device Architecture – Part 6-12: Heating, Ventilation and Air Conditioning Device Control Protocol – Fan Speed Service

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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CONTENTS

LIST OF TABLES

INFORMATION TECHNOLOGY – UPNP DEVICE ARCHITECTURE –

Part 6-12: Heating, Ventilation and Air Conditioning Device Control Protocol – Fan Speed Service

FOREWORD

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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
UPnP DimmableLight:1 Device	ISO/IEC 29341-7-2
UPnP Dimming:1 Service	ISO/IEC 29341-7-10
UPnP SwitchPower:1 Service	ISO/IEC 29341-7-11
UPnP InternetGatewayDevice:1 Device	ISO/IEC 29341-8-1
UPnP LANDevice:1 Device	ISO/IEC 29341-8-2
UPnP WANDevice:1 Device	ISO/IEC 29341-8-3
UPnP WANConnectionDevice:1 Device	ISO/IEC 29341-8-4
UPnP WLANAccessPointDevice:1 Device	ISO/IEC 29341-8-5
UPnP LANHostConfigManagement:1 Service	ISO/IEC 29341-8-10
UPnP Layer3Forwarding:1 Service	ISO/IEC 29341-8-11
UPnP LinkAuthentication:1 Service	ISO/IEC 29341-8-12
UPnP RadiusClient:1 Service	ISO/IEC 29341-8-13
UPnP WANCableLinkConfig:1 Service	ISO/IEC 29341-8-14
UPnP WANCommonInterfaceConfig:1 Service	ISO/IEC 29341-8-15
UPnP WANDSLLinkConfig:1 Service	ISO/IEC 29341-8-16
UPnP WANEthernetLinkConfig:1 Service	ISO/IEC 29341-8-17
UPnP WANIPConnection:1 Service	ISO/IEC 29341-8-18
UPnP WANPOTSLinkConfig:1 Service	ISO/IEC 29341-8-19
UPnP WANPPPConnection:1 Service	ISO/IEC 29341-8-20
UPnP WLANConfiguration:1 Service	ISO/IEC 29341-8-21
UPnP Printer:1 Device	ISO/IEC 29341-9-1
UPnP Scanner:1.0 Device	ISO/IEC 29341-9-2
UPnP ExternalActivity:1 Service	ISO/IEC 29341-9-10
UPnP Feeder:1.0 Service	ISO/IEC 29341-9-11
UPnP PrintBasic:1 Service	ISO/IEC 29341-9-12
UPnP Scan:1 Service	ISO/IEC 29341-9-13
UPnP QoS Architecture:1.0	ISO/IEC 29341-10-1
UPnP QosDevice:1 Service	ISO/IEC 29341-10-10
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. It defines a service type referred to herein as FanSpeed:1.

FanSpeed:1 provides programmatic control and status information for air fans used in Heating, Ventilation and Air-Conditioning (HVAC) applications. It allows a control point to command the speed of the fan by means of a continuous 0% to 100% control variable. Fans which are On/ Off or three speed (Off/ Low/ Medium/ High) respond by mapping the continuous control variable to specific vendor-dependent switching points. It provides optional functionality for dual direction reversible fans.

FanSpeed:1 enables the following functions:

- Control of the speed of an air-conditioning or ventilation fan.
- Reversible fans.

2. Service Modeling Definitions

2.1. Service Type

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

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

The shorthand FanSpeed:1 is used herein to refer to this service type.

2.2. State Variables

Defines the state variables for the target running speed of the fan and its actual speed. Additionally defines optional state variables for "forward" and "reverse" operation.

NOTE: (Explanation of the meaning of speed): Table 1 below describes Allowed Value ranges of 0 to 100 which signify a fan speed in the range of 0% to 100%. In all such cases, a value of 0% corresponds to a FULLY STOPPED physical condition, and a value of 100% corresponds to the FULL SPEED physical condition. For values between 0% and 100% the physical condition of the fan is mapped as closely as possible to the 0% to 100% control variable. In particular for fans with discrete speeds (e.g. Off/ Low/ Medium/ High) the mapping takes the form of a "staircase". The exact mapping is left to the vendor's discretion.

Table 1: State Variables

Variable Name	Req. or Opt.[1]	Data Type	Allowed Value[2]	Default Value[2]	Eng. Units
FanSpeedTarget	R	ui1	>= 0, <= 100, += 1	0	Percent
FanSpeedStatus	R	ui1	>= 0, <= 100, += 1	0	Percent
DirectionTarget	O	boolean	0 = "Forward", 1 = "Reverse"	0	n/a
DirectionStatus	O	boolean	0 = "Forward", 1 = "Reverse"	0	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 (all) required.

2.2.1. FanSpeedTarget

Determines the target speed for the fan. (See the above note "Explanation of the meaning of speed").

2.2.2. FanSpeedStatus

Represents the actual speed for the fan. (See the above note "Explanation of the meaning of speed").

2.2.3. DirectionTarget

Determines the target running direction for the fan. This is an optional state variable; in the case of fans that do not implement this state variable, they must behave as if DirectionTarget were equal to 0 i.e. "Forward".

2.2.4. DirectionStatus

Represents the actual running direction for the fan. This is an optional state variable; in the case of fans that do not implement this state variable, a control point must behave as if DirectionStatus were equal to 0 i.e. "Forward".

2.2.5. Relationships Between State Variables

Whenever the value of FanSpeedTarget changes, the actual physical fan speed should start to change toward the value of FanSpeedTarget according to the mapping illustrated in the examples below. Due to the physical inertia of the fan, this process will take a certain period of time that depends on the vendor's implementation. The value of the FanSpeedStatus state variable should correspond to the actual physical fan speed according to the mapping illustrated in the examples below.

FanSpeedTarget and FanSpeedStatus are integers with the range 0% to 100%. Depending on the actual type of fan employed (e.g. three speed fan, modulating fan etc.), the 0…100% range should map to the actual physical fan speed according to the following principles.

Two common examples are given below for guidance, but actual implementation is at the discretion of the vendor:

Table 2: Modulating Fan Example

Input of Setting of FanSpeedTarget	Resulting Actual Physical Speed	Resulting value of FanSpeedStatus
0%	Off ("hard" off)	0%
1…Minimum Speed (i.e. Stalling Speed)%	Off ("soft" off)	1%
Min. Stall Speed…100%	Linear mapping according to the value of FanSpeedTarget	Actual speed: (Min. Stall Speed … 100%)

Table 3: Three-Speed Fan Example

Input of Setting of FanSpeedTarget	Resulting Actual Physical Speed	Resulting value of FanSpeedStatus
0%	Off ("hard" off)	0%
1…25%	Off ("soft" off)	Same mapping as FanSpeedTarget
26…50%	Low	ditto
51…75%	Medium	ditto
76…100%	High	ditto

NOTE: To facilitate certification, UPnP vendors should include their own version of the mapping table illustrated above.

Whenever the value of DirectionTarget changes, the actual physical fan direction should start to change toward the value of DirectionTarget. Due to the physical inertia of the fan, this process will take a period of time that depends on the vendor's implementation. The corresponding value of the DirectionStatus state variable should in turn reflect the actual physical fan direction.

NOTES:

i) If the actual physical fan speed or direction deviates from what is expected in FanSpeedTarget or DirectionTarget, then the corresponding xxxStatus state variable should reflect the real physical fan status and NOT the xxxTarget values.

ii) Vendors that implement control point strategies should bear in mind that due to friction, inertia, hysteresis and numerical rounding it is quite possible that the xxxStatus variables will take an indeterminate time to reach the value of the corresponding xxxTarget variables. Indeed (especially in the case of the fan speed), it is quite likely that the xxxStatus variable might *never* achieve exactly the same value as the xxxTarget variable.

Relationships between standard state variable(s) defined herein and any non-standard state variable(s) is TBD.

2.3. Eventing and Moderation

Table 4: Event Moderation

Variable Name	Evented	Moderated Event	Max Event Rate[1]	Logical Combination	Min Delta per Event[2]
FanSpeedTarget	no				
FanSpeedStatus	yes	yes	30	OR	10 * (Step)
DirectionTarget	no				
DirectionStatus	yes	no			
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).

2.4. Actions

Table 5: Actions

Name	Req. or Opt. [1]
SetFanSpeed	R
GetFanSpeed	R
GetFanSpeedTarget	R
SetFanDirection	O
GetFanDirection	O
GetFanDirectionTarget	O
Non-standard actions implemented by an UPnP vendor go here.	X

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

2.4.1. SetFanSpeed

Sets the new value of FanSpeedTarget.

2.4.1.1. Arguments

Table 6: Arguments for SetFanSpeed

Argument	Direction	relatedStateVariable
NewFanSpeedTarget	IN	FanSpeedTarget

2.4.1.2. Dependency on State

None.

2.4.1.3. Effect on State

Sets the new value of FanSpeedTarget. The actual physical fan speed, (and thus the value of FanSpeedStatus), should map to FanSpeedTarget according to section 2.2.

2.4.1.4. Errors

ErrorCode	errorDescription	Description
402	Invalid Args	See UPnP Device Architecture section on Control.
501	Action Failed	See UPnP Device Architecture section on Control.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.4.2. GetFanSpeed

Returns the current value of FanSpeedStatus.

2.4.2.1. Arguments

Table 7: Arguments for GetFanSpeed

Argument	Direction	relatedStateVariable
CurrentFanSpeedStatus	OUT [R]	FanSpeedStatus

[R] = Return Value (RETVAL)

2.4.2.2. Dependency on State

Returns the current value of FanSpeedStatus.

2.4.2.3. Effect on State

None.

2.4.2.4. Errors

errorCode	errorDescription	Description
402	Invalid Args	See UPnP Device Architecture section on Control.
501	Action Failed	See UPnP Device Architecture section on Control.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.4.3. GetFanSpeedTarget

Returns the current value of FanSpeedTarget.

2.4.3.1. Arguments

Table 8: Arguments for GetFanSpeedTarget

Argument	Direction	relatedStateVariable
CurrentFanSpeedTarget	OUT [R]	FanSpeedTarget

[R] = Return Value (RETVAL)

2.4.3.2. Dependency on State

Returns the current value of FanSpeedTarget.

2.4.3.3. Effect on State

None.

2.4.3.4. Errors

errorCode	errorDescription	Description
402	Invalid Args	See UPnP Device Architecture section on Control.
501	Action Failed	See UPnP Device Architecture section on Control.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.4.4. SetFanDirection

Sets the new value of DirectionTarget.

2.4.4.1. Arguments

Table 9: Arguments for SetDirection

Argument	Direction	RelatedStateVariable
NewDirectionTarget	IN	DirectionTarget

2.4.4.2. Dependency on State

None.

2.4.4.3. Effect on State

Sets the new value of DirectionTarget. The actual physical fan direction, (and thus the value of DirectionStatus), should follow DirectionTarget.

2.4.4.4. Errors

errorCode	errorDescription	Description
402	Invalid Args	See UPnP Device Architecture section on Control.
501	Action Failed	See UPnP Device Architecture section on Control.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.4.5. GetFanDirection

Returns the current value of DirectionStatus.

2.4.5.1. Arguments

Table 10: Arguments for GetDirection

Argument	Direction	RelatedStateVariable
CurrentDirectionStatus	OUT [R]	DirectionStatus

[R] = Return Value (RETVAL)

2.4.5.2. Dependency on State

Returns the current value of DirectionStatus.

2.4.5.3. Effect on State

None.

2.4.5.4. Errors

errorCode	errorDescription	Description
402	Invalid Args	See UPnP Device Architecture section on Control.
501	Action Failed	See UPnP Device Architecture section on Control.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.4.6. GetFanDirectionTarget

Returns the current value of DirectionTarget.

2.4.6.1. Arguments

Table 11: Arguments for GetDirectionTarget

Argument	Direction	RelatedStateVariable
CurrentDirectionTarget	OUT [R]	DirectionTarget

[R] = Return Value (RETVAL)

2.4.6.2. Dependency on State

Returns the current value of DirectionTarget.

2.4.6.3. Effect on State

None.

2.4.6.4. Errors

errorCode	errorDescription	Description
402	Invalid Args	See UPnP Device Architecture section on Control.
501	Action Failed	See UPnP Device Architecture section on Control.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.4.7. Non-Standard Actions Implemented by an UPnP Vendor

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

2.4.8. Relationships Between Actions

The actions defined herein may be called in any order.

Relationships between standard action(s) defined herein and any non-standard action(s) is TBD.

2.4.9. Common Action 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.

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.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.5. Theory of Operation

Control Points will use SetFanSpeed to set the value of FanSpeedTarget; this in turn determines the running speed of the fan. Depending on the type of fan, it must adjust its actual physical speed to a value matching as closely as possible to the FanSpeedTarget – some examples of possible mappings are given in section 2.2. Due to the physical inertia of the fan, the physical fan speed and hence the value of FanSpeedStatus will take a period of time to "catch up" with FanSpeedTarget.

Control Points may interrogate the actual fan speed by calling GetFanSpeed. This function reads the value of FanSpeedStatus. In normal operation conditions, in the steady state, FanSpeedStatus will return +/- the same value as FanSpeedTarget. However, in the case of faults, or external overrides, the actual fan speed may differ from that requested by FanSpeedTarget. In such cases, FanSpeedStatus must return the actual physical speed in accordance with the mapping examples in section 2.2.

Similarly, Control Points will use SetFanDirection to set the value of DirectionTarget; this in turn determines the running direction of the fan. Depending on the type of fan, it must adjust its actual physical direction to the DirectionTarget. Due to the physical inertia of the fan, the physical fan speed and hence the value of DirectionStatus will take a period of time to "catch up" with DirectionTarget.

Control Points may interrogate the actual fan direction by calling GetFanDirection. This function reads the value of DirectionStatus. In normal operation conditions, in the steady state, DirectionStatus will return the same value as DirectionTarget. However, in the case of faults, or external overrides, the actual fan direction may differ from that requested by DirectionTarget. In such cases, DirectionStatus must return the actual physical fan direction.

NOTE: It is possible that a Control Point could issue a series of SetFanSpeed or SetFanDirection commands in rapid succession. The vendor is responsible for ensuring that in all cases, the fan responds safely, smoothly and without damage to itself. E.g. if a fan is running at (say) 100% speed "forward", and a control point switches the value of DirectionTarget to 1 "reverse", then it is the responsibility of the vendor to ensure that the fan transitions gradually from 100% "forward" to 0% "stopped" to 100% "reverse".

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>SetFanSpeed</name>
      <argumentList>
        <argument>
          <name>NewFanSpeedTarget</name>
          <direction>in</direction>
          <relatedStateVariable>FanSpeedTarget</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetFanSpeed</name>
      <argumentList>
        <argument>
          <name>CurrentFanSpeedStatus</name>
          <direction>out</direction>
          <retval />
          <relatedStateVariable>FanSpeedStatus</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetFanSpeedTarget</name>
      <argumentList>
        <argument>
          <name>CurrentFanSpeedTarget</name>
          <direction>out</direction>
          <retval />
          <relatedStateVariable>FanSpeedTarget</relatedStateVariable>
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      </argumentList>
    </action>
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    <action>
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          <relatedStateVariable>DirectionStatus</relatedStateVariable>
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      </argumentList>
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```
    </action>
    <action>
    <name>GetFanDirectionTarget</name>
      <argumentList>
        <argument>
          <name>CurrentDirectionTarget</name>
          <direction>out</direction>
          <retval />
          <relatedStateVariable>DirectionTarget</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    Declarations for other actions added by UPnP vendor (if any) go here
  </actionList>
  <serviceStateTable>
    <stateVariable sendEvents="no">
      <name>FanSpeedTarget</name>
      <dataType>ui1</dataType>
      <defaultValue>0</defaultValue>
      <allowedValueRange>
        <minimum>0</minimum>
        <maximum>100</maximum>
        <step>1</step>
      </allowedValueRange>
    </stateVariable>
    <stateVariable sendEvents="yes">
      <name>FanSpeedStatus</name>
      <dataType>ui1</dataType>
      <defaultValue>0</defaultValue>
      <allowedValueRange>
        <minimum>0</minimum>
        <maximum>100</maximum>
        <step>1</step>
      </allowedValueRange>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>DirectionTarget</name>
      <dataType>boolean</dataType>
      <defaultValue>0</defaultValue>
    </stateVariable>
    <stateVariable sendEvents="yes">
      <name>DirectionStatus</name>
      <dataType>boolean</dataType>
      <defaultValue>0</defaultValue>
    </stateVariable>
    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: ***FanSpeed1.xml***
- The UPnP Test Tool service template test file: ***FanSpeed1.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.

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch