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FSTP-CONF-F780.1

Conformance testing specification for ITU-T F.780.1

Technical Paper ITU-T FSTP-CONF-F780.1

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Summary

This Technical Paper specifies testing for conformance to ITU-T F.780.1, *Framework for telemedicine systems using ultra-high definition imaging*.

Keywords

Conformance testing, telemedicine systems, ultra-high definition imaging.

Note

This is an informative ITU-T publication. Mandatory provisions, such as those found in ITU-T Recommendations, are outside the scope of this publication. This publication should only be referenced bibliographically in ITU-T Recommendations.

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Conformance testing specification for ITU-T F.780.1

1 Scope

This Technical Paper specifies testing for conformance to [ITU-T F.780.1].

2 References

[ITU-T F.780.1] Recommendation ITU-T F.780.1 (2022), *Framework for telemedicine systems using ultra-high definition imaging*.

[ITU-T H.265] Recommendation ITU-T H.265 (2021), *High efficiency video coding*.

[ITU-R BT.709] Recommendation ITU-R BT.709 (2015), *Parameter values for the HDTV standards for production and international programme exchange*.

[ITU-R BT.1120] Recommendation ITU-R BT.1120-9 (2017), *Digital interfaces for studio signals with 1 920 × 1 080 image formats*.

[ITU-R BT.2020] Recommendation ITU-R BT.2020 (2015), *Parameter values for ultra-high definition television systems for production and international programme exchange*.

[ITU-R BT.2100] Recommendation ITU-R BT.2100 (2018), *Image parameter values for high dynamic range television for use in production and international programme exchange*.

[ARIB STD-B58] ARIB STD-B58 (2014), *Interface for UHDTV production systems*.

[IETF RFC 3550] IETF RFC 3550 (2003), *RTP: A transport protocol for real-time applications*.

[IETF RFC 4175] IETF-RFC 4175 (2005), *RTP payload format for uncompressed video*.

[SMPTE RDD 34] RDD 34:2015, *SMPTE registered disclosure doc – LLVC – Low latency video codec for network transfer*.

[SMPTE RDD 35] RDD 35:2016, *SMPTE registered disclosure doc – TICO lightweight codec used in IP networked or in SDI infrastructures*.

[SMPTE 292] ST 292-0:2011, *SMPTE overview document – SMPTE bit-serial interfaces at 1.5 Gb/s – Roadmap for the 292 document suite*.

[SMPTE 424] SMPTE ST 424:2012, *SMPTE standard –3 Gb/s signal/data serial interface*.

[SMPTE 425-1] SMPTE ST 425-1:2017, *SMPTE standard – Source image format and ancillary data mapping for the 3 Gb/s serial interface*.

[SMPTE 2022-5] SMPTE ST 2022-5:2013, [1] *SMPTE standard – Forward error correction for transport of high bit rate media over IP networks (HBRMT)*.

[SMPTE 2022-6] SMPTE ST 2022-6:2012, *SMPTE standard – Transport of high bit rate media signals over IP networks (HBRMT)*.

[SMPTE 2082-10] SMPTE ST 2082-10:2018, *SMPTE standard – 2160-line and 1080-line source image and ancillary data mapping for 12G-SDI*.

[1] Superseded.

[SMPTE 2110-20] SMPTE ST 2110-20:2017, *SMPTE standard – Professional media over managed IP networks: Uncompressed active video*.

3 Definitions

3.1 Terms defined elsewhere

This Technical Paper uses the following terms defined elsewhere:

3.1.1 dual green Bayer [ITU-T F.780.1]: A colour filter array for arranging RGB colour filters on a square grid of image sensors. Its particular arrangement of colour filters is found in most single-chip digital image sensors used in digital cameras to create a colour image. The filter pattern is 50% green, 25% red and 25% blue, hence it is also called RGBG, GRGB, RGGB.

3.1.2 ultra-high definition [ITU-T F.780.1]: A video format of digital display and camera in which the horizontal screen resolution is on the order of over 4 000 pixels.

3.1.3 ultra-high definition imaging [ITU-T F.780.1]: Video imaging using system parameters of UHDTV as defined by [ITU-R BT.2020].

3.1.4 4K UHD [ITU-T F.780.1]: A video format in which the horizontal screen resolution is 3 840 and the vertical screen resolution is 2 160 pixels (2160p).

3.1.5 8K UHD [ITU-T F.780.1]: A video format in which the horizontal screen resolution is 7 680 and the vertical screen resolution is 4 320 pixels (4320p).

3.1.6 microsurgery [ITU-T F.780.1]: Surgery requiring an operating microscope.

3.2 Terms defined here

None.

4 Abbreviations and acronyms

This Technical Report uses the following abbreviations and acronyms:

CCU Camera Control Unit

CMOS Complementary Metal Oxide Semiconductor

DG Dual Green

FEC Forward Error Correction

HD High Definition

HDMI High-Definition Multimedia Interface

IP Internet Protocol

IPS In-Plane Switching

LLVC Low-Latency Video Codec

Req. Requirement

SDI Serial Digital Interface

TICO Tiny Codec

TN Twisted Nematic

UHD Ultra-High Definition

VA Vertical Alignment

5 Conventions

None.

6 System requirements on systems in local usage

This clause describes testing requirements for an ultra-high definition (UHD) endoscopic system employed in closed local use, such as in an operating room. It is assumed that there is no external network connected to the system.

A UHD endoscope system in this setting consists of the following components:

– UHD endoscope lens;

– UHD endoscope camera head including a UHD image sensor;

– camera control unit (CCU);

– video signal converter;

– UHD display.

6.1 Physical requirements

6.1.1 Camera size (clause 7.1.1.1 of [ITU-T F.780.1])

For hand-held operation, the camera size is tested according to the following requirement.

RR-01: A UHD endoscope system is recommended to have a camera head with the following characteristics:

– a diameter less than 120 mm;

– a weight less than 500 g.

6.1.2 Image sensor size (clause 7.1.1.2 of [ITU-T F.780.1])

The image sensor size should be tested according to the following requirement.

RR-02: A UHD endoscope system is tested to determine whether it supports a complementary metal oxide semiconductor (CMOS) sensor with the following characteristics:

– a size less than or equal to "super-35 mm" (e.g., 24.6 × 13.9 mm, about 1.7 inch);

– a pixel pitch less than 3.2 μm.

6.1.3 Video interfaces (clause 7.1.1.3 of [ITU-T F.780.1])

6.1.3.1 Output from camera (clause 7.1.1.3.1 of [ITU-T F.780.1])

RR-03: A UHD endoscope system is tested to determine whether it supports at least one of the following video interfaces for the source signal from the camera unit.

For full 8K signals:

– high-definition multimedia interface (HDMI) 2.1 × 1 channel;

– 3G-SDI (as specified in [SMPTE 424] and [SMPTE 425-1]) × 16 channels;

– 12G-SDI (as specified in [SMPTE 2082-10]) × 4 channels;

– U-SDI [ARIB STD-B58] × 1 channel.

For 8K dual green (DG):

– 3G-SDI (as specified in [SMPTE 424] and [SMPTE 425-1]) × 8 channels;

– high definition-serial digital interface (HD-SDI) × 16 channels;

6.1.3.2 Input to display (clause 7.1.1.3.2 of [ITU-T F.780.1])

RR-04: A UHD endoscope system is tested to determine whether it supports at least one of the following video interfaces for the input signal to the video display.

For full 8K signal:

– 3G-SDI (as specified in [SMPTE 424] and [SMPTE 425-1]) × 16 channels;

– 12G-SDI (as specified in [SMPTE 2082-10]) × 4 channels;

– U-SDI [ARIB STD-B58] × 1 channel;

– HDMI 2.0 × 4 channels;

– HDMI 2.1 × 1 channel.

For 8K DG:

– HD-SDI (i.e., 1.5G-SDI as specified in [ITU-T BT.1120] [SMPTE 292]) ×16 channels;

– 3G-SDI (as specified in [SMPTE 424] and [SMPTE 425-1]) × 8 channels.

6.1.3.3 Video display panel type (clause 7.1.1.4 of [ITU-T F.780.1])

RR-05: A UHD endoscope system is tested to determine whether it supports at least one of the following display panel types.

– For LC: in-plane switching (IPS), twisted nematic (TN), vertical alignment (VA).

NOTE – Other display formats, such as the UHD projector and UHD-organic light emission display, are for further study.

6.1.4 Signal requirements (clause 7.1.1.2 of [ITU-T F.780.1])

6.1.4.1 Resolution of capture format (clause 7.1.2.1 of [ITU-T F.780.1])

RR-06: A UHD endoscope system is tested to determine whether it supports the following resolution:

– 7 680 × 4 320 pixels

NOTE – Other resolutions, such as square resolutions, are for further study.

6.1.4.2 Colour filter (clause 7.1.2.2 of [ITU-T F.780.1])

RR-07: A UHD endoscope system is tested to determine whether it supports:

– Bayer pattern colour filter array (i.e., green1, green2, red, blue).

6.1.5 Frame frequency and scan mode

6.1.5.1 Frame frequency (clause 7.1.2.3.1 of [ITU-T F.780.1])

RR-08: A UHD endoscope system is tested to determine whether it supports at least one of the following frame frequencies (in hertz):

– 120, 120/1.001, 100, 60, 60/1.001 and 50.

NOTE – The frame frequencies 30, 30/1.001, 25, 24, and 24/1.001 as specified in [ITU-R BT.2020] are not suitable for medical purposes.

6.1.5.2 Scan mode (clause 7.1.2.3.2 of [ITU-T F.780.1])

RR-09: A UHD endoscope system is tested to determine whether it supports progressive scan mode, as specified in [ITU-R BT.2020].

6.1.6 Display format

6.1.6.1 Resolution (clause 7.1.2.4.1 of [ITU-T F.780.1])

RR-10: A UHD endoscope system is tested to determine whether it supports the following resolutions:

– 7 680 × 4 320 pixels;

– 3 840 × 2 180 pixels;

– 1 920 × 1 080 pixels.

6.1.6.2 Colour signal (clause 7.1.2.4.2 of [ITU-T F.780.1])

RR-11: A UHD endoscope system is tested to determine whether it supports both of the following:

– RGB (4:4:4);

– YCbCr (4:2:2).

6.1.6.3 Colour space (clause 7.1.2.4.3 of [ITU-T F.780.1])

RR-12: A UHD endoscope system is tested to determine whether it supports one of the following:

– [ITU-R BT.2020];

– [ITU-R BT.2100].

NOTE 1 – For some legacy systems, [ITU-R BT.709] is a valid option.

NOTE 2 – It is preferable for the display used for real-time image displays of medical procedures to have low delay so as to have as little effect as possible on transmission while maintaining high-contrast resolution and performing quality image calibration.

7 System requirements on systems in wide-area network usage

Advanced endoscopic images are not for surgeons in operating rooms but for medical staff outside (including outside the hospital) to share for conferences, education, telemedicine, etc.

This clause describes the testing requirements for a UHD endoscopic system employed with an external Internet protocol (IP) network (remotely) connected to the system. A UHD endoscopic system in this setting consists of the following 10 components:

1) UHD endoscope lens;

2) UHD endoscope camera head including UHD image sensor;

3) CCU;

4) video encoder;

5) media converter (encoder);

6) IP network;

7) media converter (decoder);

8) video decoder;

9) video signal converter;

10) UHD display.

7.1 Video codec (clause 7.2.1 of [ITU-T F.780.1])

RR-13: A UHD endoscope system with an IP connection is tested to determine whether it supports either "uncompressed" or "compressed" video formats.

For compressed video:

– [ITU-T H.265];

– SMPTE RDD 35 (tiny codec (TICO));

– SMPTE RDD 34 (low-latency video codec (LLVC)).

7.1.1 Video over IP interface (clause 7.2.2 of [ITU-T F.780.1])

RR-14: A UHD endoscope system is tested to determine whether it supports the transport of SDI signals over IP, according to either of the following:

– [SMPTE 2022-6] or [SMPTE 2110-20] for uncompressed video;

– [IETF RFC 3550] for compressed video.

7.1.2 Physical layer network interface (clause 7.2.3 of [ITU-T F.780.1])

RR-15: A UHD endoscope system is tested to determine whether it specifies the network interface of the physical layer such that the system can be physically connected to a network.

7.1.3 End-to-end latency (clause 7.2.4 of [ITU-T F.780.1])

RR-16: A UHD endoscope system is tested to determine whether it keeps the total delay of video transmission for real-time medical procedures, such as operations, at no more than 85 ms, or no more than 5.1 frames with 60/1.001 or 10.2 frames with 120/1.001.

NOTE – For remote interactive service, it is preferable for a UHD endoscope system to be able to maintain the total delay of video transmission for real-time medical procedures, such as operations, at no more than 150 ms between the camera input and display output [b-Bate].

7.1.4 Encapsulation (clause 7.2.5 of [ITU-T F.780.1])

RR-17: A UHD endoscope system is tested to determine whether it supports the encapsulation of its signal data according to at least one of the following'

– [IETF RFC 3550];

– [IETF RFC 4175]

for uncompressed data.

7.1.5 Forward error correction (clause 7.2.6 of [ITU-T F.780.1])

RR-18: A UHD endoscope system is tested to determine whether it supports forward error correction (FEC), e.g., according to the following:

– [SMPTE ST 2022-5]

Appendix I

Check list for conformance

I.1 System requirements on systems in local usage

Table I.1 provides a summary of system requirements on systems in local usage, indicating the clause in [ITU-T F.780.1], the topic and, when applicable the testing element and detail, requirement (Req.) No. and the tested requirement.

Table I.1 – System requirements on systems in local usage

Clause in [ITU-T F.780.1]	Topic	Element	Detail	Req. No.	Tested requirements
7.1.1	Physical requirements				
7.1.1.1		Camera size		RR-01	For hand-held operation, the camera size should be tested according to the following requirement: A UHD endoscope system is recommended to have a camera head with the following characteristics: – a diameter less than 120 mm; – a weight less than 500 g.
7.1.1.2		Image sensor size		RR-02	A UHD endoscope system is recommended to support a CMOS sensor with the following characteristics: – a size less than or equal to "super-35 mm" (e.g., 24.6 × 13.9 mm, about 1.7 inch); – a pixel pitch less than 3.2 μm.
7.1.1.3		Video interfaces			

Table I.1 – System requirements on systems in local usage

Clause in [ITU-T F.780.1]	Topic	Element	Detail	Req. No.	Tested requirements
7.1.1.3.1			Output from camera	RR-03	A UHD endoscope system is recommended to support at least one of the following video interfaces for the source signal from the camera unit: For full 8K: – 3G-SDI× 16 channels; – 12G-SDI × 4 channels; – U-SDI × 1 channel. For 8K DG: – HD-SDI × 16 channels; – 3G-SDI × 8 channels;
7.1.1.3.2			Input to display	RR-04	A UHD endoscope system is recommended to support at least one of the following video interfaces for the input signal to the video display: For full 8K signal; – 3G-SDI × 16 channels – 12G-SDI × 4 channels – U-SDI × 1 channel – HDMI 2.0 × 4 channels. – HDMI 2.1 × 1 channel. For 8K DG: – HD-SDI ×16 channels – 3G-SDI × 8 channels
7.1.1.4 7.1.2		Video display panel type			
				RR-05	A UHD endoscope system is recommended to support at least one of the following display panel types: – For LC: IPS, TN, VA.

Table I.1 – System requirements on systems in local usage

Clause in [ITU-T F.780.1]	Topic	Element	Detail	Req. No.	Tested requirements
7.1.2.1	Signal requirements	Resolution of capture format		RR-06	A UHD endoscope system is recommended to support the following resolution: – 7 680 × 4 320 pixels
7.1.2.2		Colour filter		RR-07	A UHD endoscope system is recommended to support: – Bayer pattern colour filter array (i.e., green1, green2, red, blue).
		Frame frequency and scan mode			
7.1.2.3.1			Frame frequency	RR-08	A UHD endoscope system is recommended to support at least one of the following frame frequencies (in hertz): – 120, 120/1.001, 100, 60, 60/1.001, and 50.
7.1.2.3.2			Scan mode	RR-09	A UHD endoscope system is recommended to support progressive scan mode, as specified in [ITU-R BT.2020].
		Display format			
7.1.2.4.1			Resolution	RR-10	A UHD endoscope system is recommended to support the following resolutions: – 7 680 × 4 320 pixels; – 3 840 × 2 180 pixels; – 1 920 × 1 080 pixels.
7.1.2.4.2			Colour signal	RR-11	A UHD endoscope system is recommended to support both the following: – RGB (4:4:4); – YCbCr (4:2:2).
7.1.2.4.3			Colour space	RR-12	A UHD endoscope system is recommended to support one of the following: – [ITU-R BT.2020]; – [ITU-R BT.2100].

I.2 System requirements on systems in wide-area network usage

Table I.2 provides a summary of system requirements on systems in wide-area network usage, indicating the clause in [ITU-T F.780.1], the topic, Req. No. and the tested requirement.

Table I.2 – System requirements on systems in wide-area network usage

Clause in [ITU-T F.780.1]	Topic	Req. No.	Tested requirements
7.2.1	Video codec	RR-13	A UHD endoscope system with an IP connection is recommended to support either "uncompressed" or "compressed" video formats. For compressed video, it is recommended that at least one of the following coding formats be used: – [ITU-T H.265]; – SMPTE RDD 35 (TICO); – SMPTE RDD 34 (LLVC).
7.2.2	Video over IP interface	RR-14	A UHD endoscope system is recommended to support the transport of SDI signals over IP, according to either of the following: – [SMPTE 2022-6] or [SMPTE 2110-20] for uncompressed video; – [IETF RFC 3550] for compressed video.
7.2.3	Physical layer network interface	RR-15	A UHD endoscope system should specify the network interface of the physical layer such that the system can be physically connected to a network.
7.2.4	End-to-end latency	RR-16	A UHD endoscope system is recommended to keep the total delay of video transmission for real-time medical procedures, such as operations, at no more than 85 ms, or no more than 5.1 frames with 60/1.001 or 10.2 frames with 120/1.001.
7.2.5	Encapsulation	RR-17	A UHD endoscope system is recommended to support the encapsulation of its signal data according to at least [IETF RFC 3550] or [IETF RFC 4175] for uncompressed data.
7.2.6	Forward error correction	RR-18	A UHD endoscope system is recommended to support FEC, e.g., according to the following: – [SMPTE ST 2022-5].

Bibliography

[b-Bate] Bate, L., Cook, C. (2001), The feasibility of force control over the Internet, In: *Proc. 2001 Australian Conference on Robotics and Automation*, Sydney, 2001-11-14/15, pp. 146-151. Sydney: Australian Robotics and Automation Association.