

# ISO/IEC TR 23002-9:2024-07 (E)

## Information technology - MPEG video technologies - Part 9: Film grain synthesis technology for video applications

---

<b>Contents</b>		<b>Page</b>
Foreword .....		v
Introduction .....		vi
<b>1</b>	<b>Scope .....</b>	<b>1</b>
<b>2</b>	<b>Normative references .....</b>	<b>1</b>
<b>3</b>	<b>Terms and definitions .....</b>	<b>1</b>
<b>4</b>	<b>Abbreviated terms .....</b>	<b>2</b>
<b>5</b>	<b>Conventions .....</b>	<b>2</b>
5.1	General .....	2
5.2	Arithmetic operators .....	2
5.3	Bit-wise operators .....	3
5.4	Assignment operators .....	3
5.5	Relational, logical and other operators .....	3
5.6	Range notation .....	4
5.7	Mathematical functions .....	4
5.8	Order of operations .....	4
<b>6</b>	<b>Overview of film grain technologies .....</b>	<b>5</b>
6.1	General .....	5
6.2	Film grain technical characteristics .....	5
6.3	Film grain modelling .....	7
6.4	Film grain use cases and applications .....	8
6.5	Film grain workflow .....	8
<b>7</b>	<b>Film grain synthesis .....</b>	<b>10</b>
7.1	General .....	10
7.2	General description of film grain synthesis .....	10
7.2.1	General .....	10
7.2.2	Grain pattern template generation .....	11
7.2.3	Randomization .....	12
7.2.4	Local adaptation .....	15
7.2.5	Deblocking .....	17
7.2.6	Blending .....	17
7.3	Examples of film grain synthesis using the frequency filtering model .....	17
7.3.1	SMPTE RDD 5 .....	17
7.3.2	Variants based on SMPTE RDD 5 .....	19
7.4	Examples of film grain synthesis using the autoregressive model .....	20
7.4.1	FGC SEI message based autoregressive model .....	20
7.4.2	AFGS1 model .....	21
7.5	Example of film grain synthesis supporting both the frequency filtering and autoregressive models .....	24
7.5.1	General .....	24
7.5.2	Film grain template generation .....	24
7.5.3	Randomization .....	24
7.5.4	Local adaptation .....	24
7.5.5	Deblocking .....	25

7.5.6	Blending .....	25
8	Film grain analysis .....	25
8.1	General .....	25
8.2	Denoising and image analysis .....	26
8.2.1	Denoising .....	26
8.2.2	Edge and texture analysis .....	26
8.3	Determination of grain scaling function .....	27
8.3.1	General .....	27
8.3.2	An example of FGC SEI message scaling factor estimation .....	27
8.3.3	An example of AFGS1 scaling factor estimation .....	31
8.4	Determination of cut-off frequencies for frequency filtering model .....	31
8.4.1	General .....	31
8.4.2	An example of FGC SEI message cut-off frequency estimation .....	32
8.5	Determination of autoregressive model coefficients .....	33
9	Film grain metadata .....	33
9.1	General .....	33
9.2	Film grain characteristics SEI message .....	34
9.2.1	General .....	34
9.2.2	Interpretation of FGC SEI message syntax .....	34
9.3	AFGS1 metadata .....	36
9.3.1	General .....	36
9.3.2	Interpretation of AFGS1 metadata syntax .....	36
Annex A (informative) Example implementations of the derivation of x/y offset .....		39
Annex B (informative) Example implementations of film grain synthesis technologies .....		41
Bibliography .....		47