RP 165-1994
Revision of RP 165-1993

SMPTE RECOMMENDED PRACTICE

Error Detection Checkwords and Status Flags for Use in Bit-Serial Digital Interfaces for Television

1 Scope

1.1 This practice, also known as the error detection and handling (EDH) system, describes the generation of error detection checkwords and related status flags to be used optionally in conjunction with the serial digital interface for system M (525/59.94) and systems B, G, H, and I (625/50) digital television equipment operating with either 13.5-MHz or 18-MHz sampled 4:2:2 component digital signals or 4fsc composite digital signals. Although it is preferred that this error-checking method be used in all serial transmitters and receivers, it is recognized that some equipment must minimize complexity. Additionally, there is nothing in this practice which should preclude its use in a parallel digital interface for 4:2:2 component digital signals.

1.2 Two checkwords are defined: one based on a field of active picture samples and the other on a full field of samples. This two-word approach provides continuing error detection for the active picture when the digital signal has passed through processing equipment that has changed data outside the active picture area without recalculating the full-field checkword.

1.3 Three sets of flags are provided to feed forward information regarding detected errors to help facilitate identification of faulty equipment and the type of fault. One set of flags is associated with each of the two field related checkwords. A third set of flags is used to provide similar information based on evaluating all of the ancillary data checksums within a field. Implementation of these flags is not a requirement of this practice.

1.4 The checkwords and flags are combined in an error detection data packet which is included as ancillary data in the serial digital signal. At the receiver, a recalculation of checkwords may be compared to the error detection data packet information to determine if a transmission error occurred.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this practice. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this practice are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below.

SMPTE RP 168-1993, Definition of Vertical Interval Switching Point for Synchronous Video Switching

3 Location of checkwords, flags, identification number, and included samples

3.1 Location of checkwords, flags, and identification number

Digital data packets containing the calculated checkwords, error information flags, and identification number are located in the ancillary data area of the vertical interval in a manner to complement the recommended practice of source switching. Locations are shown graphically in figure 1 and specified in table 1 for 525/59.94 systems and table 2 for 625/50 systems. For composite signals, the error detection data packet is located in the ancillary data area of the first horizontal pulse occurring in the line prior to the recommended vertical interval switching point of each field. For component signals, the error

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detection data packet is located just prior to SAV (start of video) in the same lines. To enable proper operation of equipment implementing this practice, signal switching must take place in the vertical interval and conform to SMPTE RP 168.

3.2 Samples included in checkword calculations

Starting and ending samples for active picture and full-field checkword calculations are shown in table 3. For the active picture checkword, only the samples in the active picture area of each line are included in the calculation. As used in this practice, the active picture includes only those lines which, in composite systems, are full lines (that is, half-lines are not included). Full-field checkwords include all the samples in all lines except the line containing the error detection data packet and the two following lines. The line following the error detection data packet is normally used for vertical interval switching and the next line is excluded to ensure that word framing and TRS propagation are restored after a switch.

		Vertical Blanking Interval	
		(Line n with last full-field sample)	eef
ccc		(Line n+1 with error detection data packet)	
		(Line n+2 used for switching)	
		(Line n+3 not included in full-field sample)	
fff		(Line n+4 first full-field sample)	
	aaa	(Line with first active picture sample)	
H-interval		Active Picture Area (see 3.2 for definition)	
samples not contained in active picture checkword			
		(Line with last active picture sample)	eea

NOTES
1 See tables 1 and 2 for exact sample locations in both fields.
2 ccc = location of checkwords and status flags.
3 fff = first sample included in the full-field checkword.
4 aaa = first sample included in the active picture checkword.
5 eea = last sample included in the active picture checkword.
6 eef = last sample included in the full-field checkword.

Figure 1 – Location of checkwords and included samples

Table 1 – Location of 525/59.94 system checkwords

Error checking data locations: Line 9, fields I and III; line 272, fields II and IV			
Data item	Composite	13.5-MHz component	18-MHz component
Ancillary data header, word 1 – component		1689 (000_h)	2261 (000_h)
Ancillary data header, word 2 – component		1690 ($3FF_h$)	2262 ($3FF_h$)
Ancillary data header, word 3 – component		1691 ($3FF_h$)	2263 ($3FF_h$)
Ancillary data flag – composite	795 ($3FC_h$)		
Data ID	796 ($1F4_h$)	1692 ($1F4_h$)	2264 ($1F4_h$)
Block number	797 (200_h)	1693 (200_h)	2265 (200_h)
Data count	798 (110_h)	1694 (110_h)	2266 (110_h)
Active picture data word 0	799	1695	2267
Active picture data word 1	800	1696	2268
Active picture data word 2	801	1697	2269
Full-field data word 0	802	1698	2270
Full-field data word 1	803	1699	2271
Full-field data word 2	804	1700	2272
Ancillary data error flags	805	1701	2273
Active picture error flags	806	1702	2274
Full-field error flags	807	1703	2275
Reserved words (7 total)	808–814 (200_h)	1704–1710 (200_h)	2276–2282 (200_h)
Checksum for this ancillary data block	815	1711	2283

Table 2 – Location of 625/50 system checkwords

Error checking data locations: Line 5, fields I and III and V and VII; line 318, fields II and IV and VI and VIII			
Data item	Composite	13.5-MHz component	18-MHz component
Ancillary data header, word 1 – component		Y 850 (000_h)	Y 1138 (000h)
Ancillary data header, word 2 – component		C_r 425 ($3FF_h$)	C_r 569 ($3FF_h$)
Ancillary data header, word 3 – component		Y 851 ($3FF_h$)	Y 1139 ($3FF_h$)
Ancillary data flag – composite	972 ($3FC_h$)		
Data ID	973 ($1F4_h$)	C_b 426 ($1F4_h$)	C_b 570 (1F4h)
Block number	974 (200_h)	Y 852 (200_h)	Y 1140 (200_h)
Data count	975 (110_h)	C_r 426 (110_h)	C_r 570 (110_h)
Active picture data word 0	976	Y 853	Y 1141
Active picture data word 1	977	C_b 427	Cb 571
Active picture data word 2	978	Y 854	Y 1142
Full-field data word 0	979	C_r 427	Cr 571
Full-field data word 1	980	Y 855	Y 1143
Full-field data word 2	981	C_b 428	Cb 572
Ancillary data error flags	982	Y 856	Y 1144
Active picture error flags	983	C_r 428	C_r 572
Full-field error flags	984	Y 857	Y 1145
Reserved words (7 total)	985–991 (200_h)	C_b 429–Cr 430 (200_h)	C_b 573–Cr 574 (200_h)
Checksum for this ancillary data block	992	Y 861	Y 1149

NOTES

1 Values in the tables are word numbers for the appropriate standard.
2 Values in parentheses are sample values.

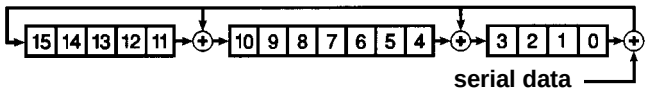
NOTE - For the purpose of performing the CRC calculations in PAL composite systems, sample 967 is defined as the TRS sample with value $3FF_h$. This is consistent with IEC 1179, but must be clearly defined for CRC calculations in case a nonstandard horizontal interval is encountered.

4 Definition of data words

4.1 Checkword values

Each checkword value consists of 16 bits of data calculated using the CRC-CCITT polynomial generation method. The equation and a conceptual logic diagram are shown below:

$$\text{Checkword (16-bit)} = X^{16} + X^{12} + X^5 + 1$$



All data words with values between $3FC_h$ and $3FE_h$ inclusive shall be recoded to $3FF_h$ at the input to the CRC-CCITT polynomial generator. This recoding is necessary only at the polynomial generator, for the purposes of ensuring compatibility between 8-bit and 10-bit equipment, and between different implementations of serial digital interface TRS and ancillary data flag coding.

4.2 Ancillary data housekeeping, checkwords, and flags

Definitions of each ancillary data word specified by this practice are shown in table 4. Zeros are used in the two least significant bits of all words in the data packet to provide compatibility with 8-bit equipment. Bit b7 (V) in picture/field data word 3 is a 1 if a valid CRC has been calculated. This allows implementations which calculate only one or the other of the checkwords. A P in b8 provides even parity for b7 through b0; that is, the total number of 1s in b8 through b0 is an even number. The most significant bit, b9, is the logical inverse of b8. A checksum is the last word in the error detection data packet as required by the ancillary data formatting for the serial digital interface.

The checksum word is used to determine the validity of the included words. The checksum word shall consist of 9 bits and is the sum of the 9 least significant bits (b8 through b0) of all words including data ID through reserved words. The sum should be preset to all zeros at the start of each calculation and ignore the carry.

4.3 Error flags

4.3.1 Definition of individual error status flags

All error flags indicate only the status of the previous field; that is, each flag is set or cleared on a field-by-field basis. A logical 1 is the set state and a logical 0 is the unset state. The flags are defined as follows:

edh – error detected here: Signifies that a serial transmission data error was detected. In the case of ancillary data, this means that one or more ANC data blocks did not match its checksum.

eda – error detected already: Signifies that a serial transmission data error has been detected somewhere upstream. If device B receives a signal from device A and device A has set the edh flag, when device B retransmits the data to device C, the eda flag will be set and the edh flag will be unset if there is no further error in the data.

idh – internal error detected here: Signifies that a hardware error unrelated to serial transmission has been detected within a device. This is provided specifically for devices which have internal data error checking facilities, as an error reporting mechanism.

ida – internal error detected already: Signifies that an idh flag was received and there was a hardware device failure somewhere upstream.

ues – unknown error status: Signifies that a serial signal was received from equipment not supporting this error-detection practice.

4.3.2 Degrees of implementation

Individual error status flags, or all error status flags, may not be supported by all equipment. To maintain compatibility with full implementations of this practice, in all such cases where one or more error status flags are not supported, the unsupported flag or flags shall be reset (set to 0).

Table 3 – Checkword included samples

Data item	Composite	13.5 MHz component	18 MHz component
525/59.94 systems			
First full-field sample, lines 12 and 275	795	1444	1924
First active picture sample, lines 21 and 284	0	0	0
Last active picture sample, lines 262 and 525	767	1439	1919
Last full-field sample, lines 8 and 271	767	1439	1919
625/50 systems			
First full-field sample, lines 8 and 321	972	C_b 361	Cb 481
First active picture sample, lines 24 and 336	0	C_b 0	C_b 0
Last active picture sample, lines 310 and 622	947	Y 719	Y 959
Last full-field sample, lines 4 and 317	947	Y 719	Y 959

Table 4 – Definition of ancillary data words

Data item	b9 msb	b8	b7	b6	b5	b4	b3	b2	b1	b0 lsb
Ancillary data header, word 1 – component	0	0	0	0	0	0	0	0	0	0
Ancillary data header, word 2 – component	1	1	1	1	1	1	1	1	1	1
Ancillary data header, word 3 – component	1	1	1	1	1	1	1	1	1	1
Ancillary data flag – composite	1	1	1	1	1	1	1	1	0	0
Data ID	0	1	1	1	1	1	0	1	0	0
Block number	1	0	0	0	0	0	0	0	0	0
Data count	0	1	0	0	0	1	0	0	0	0
Active picture data word 0 crc<5:0>	$\overline{P}$	P	c_5	c_4	c_3	c_2	c_1	c_0	0	0
Active picture data word 1 crc<11:6>	$\overline{P}$	P	c_{11}	c_{10}	c_9	c_8	c_7	c_6	0	0
Active picture data word 2 crc<15:12>	$\overline{P}$	P	V	0	c_{15}	c_{14}	c_{13}	c_{12}	0	0
Full-field data word 0 crc<5:0>	$\overline{P}$	P	c_5	c_4	c_3	c_2	c_1	c_0	0	0
Full-field data word 1 crc<11:6>	$\overline{P}$	P	c_{11}	c_{10}	c_9	c_8	c_7	c_6	0	0
Full-field data word 2 crc<15:12>	$\overline{P}$	P	V	0	c_{15}	c_{14}	c_{13}	c_{12}	0	0
Ancillary data error flags	$\overline{P}$	P	0	ues	ida	idh	eda	edh	0	0
Active picture error flags	$\overline{P}$	P	0	ues	ida	idh	eda	edh	0	0
Full-field error flags	$\overline{P}$	P	0	ues	ida	idh	eda	edh	0	0
Reserved words (7 total)	$\overline{1}$	0	0	0	0	0	0	0	0	0
Checksum	$\overline{S8}$	S8	S7	S6	S5	S4	S3	S2	S1	S0

NOTE – P and V are defined in 4.2.

Annex A (informative)
Bibliography

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ITU-R BT.656, Interfaces for Digital Component Video Signals in 525-Line and 625-Line Television Systems