

6 Receiver

6.1 The receiver shall present an input impedance of 75 ohms, with a return loss of 15 dB minimum over a frequency range of 5 MHz to $f_{req} = (\text{bit rate}) \times 2$.

6.2 Preferred data connectors shall have mechanical characteristics conforming to standard BNC type, with a characteristic impedance of 75 ohms.

PROPOSED SMPTE RECOMMENDED PRACTICE

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

1 Scope

1.1 This practice 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 (625/59.94) and systems B, G, H, and I (625/50) digital television equipment operating with either 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.

NOTE - Line numbers in tables 2 and 3 for 625/50 systems are tentative, and subject to change pending decisions on vertical interval switching for serial 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. 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.

1.4 The checkwords and flags are combined in an error 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 data packet information to determine if a transmission error occurred.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this practice. At the time of publication, the editions indicated were 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 standards indicated below.

ANSI/SMPTE 125M-1992, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

SMPTE 244M, Television — System M/NTSC Composite Video Signals — Bit-Parallel Digital Interface

SMPTE 259M, Television — 10-Bit 4:2:2 Component and 4fsc NTSC Composite Digital Signals — Serial Digital Interface

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

IEC 608(Sec)200, Helical-Scan Digital Composite Video Cassette Recording Using 19mm Magnetic Tape (Format D-2) (NTSC, PAL), Section Five, Video Interface

EBU Tech 3267-E, Parallel Interface for 625-Line Digital Video Signals

3 Location of checkwords, flags, and included samples

3.1 Location of checkwords and flags

Digital data packets containing the calculated checkwords and error information flags 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 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 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.

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

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

| Data item | Composite | Component |
|--|-----------------------------|-------------------------------|
| Error checking data locations | | |
| Line 9, fields I & III, Line 272, fields II & IV | | 1689 (00h) |
| Ancillary data header, word 1 – component | | 1690 (3FFh) |
| Ancillary data header, word 2 – component | | 1691 (3FFh) |
| Ancillary data header, word 3 – component | | |
| Auxiliary data flag – composite | 795 (3FC _h) | |
| Data ID | 796 (1F4 _h) | 1692 (1F4 _h) |
| Block number | 797 (200 _h) | 1693 (200 _h) |
| Data count | 798 (110 _h) | 1694 (110 _h) |
| Active picture data word 0 | 799 | 1695 |
| Active picture data word 1 | 800 | 1696 |
| Active picture data word 2 | 801 | 1697 |
| Full-field data word 0 | 802 | 1698 |
| Full-field data word 1 | 803 | 1699 |
| Full-field data word 2 | 804 | 1700 |
| Ancillary data error flags | 805 | 1701 |
| Active picture error flags | 806 | 1702 |
| Full-field error flags | 807 | 1703 |
| Reserved words (7 total) | 808–814 (200 _h) | 1704–1710 (200 _h) |
| Checksum for this ancillary data block | 815 | 1711 |

Table 2 – Location of 625/50 system checkwords

| Data item | Composite | Component |
|--|-----------------------------|---|
| Error checking data locations | | |
| Line (5), fields I & III, Line (318), fields II & IV | | Y 850 (00h) |
| Ancillary data header, word 1 – component | | C _r 425 (3FFh) |
| Ancillary data header, word 2 – component | | Y 851 (3FFh) |
| Ancillary data header, word 3 – component | | |
| Auxiliary data flag – composite | 972 (3FC _h) | C _b 426 (1F4 _h) |
| Data ID | 973 (1F4 _h) | Y 852 (200 _h) |
| Block number | 974 (200 _h) | C _r 426 (110 _h) |
| Data count | 975 (110 _h) | Y 853 |
| Active picture data word 0 | 976 | C _b 427 |
| Active picture data word 1 | 977 | Y 854 |
| Active picture data word 2 | 978 | C _r 427 |
| Full-field data word 0 | 979 | Y 855 |
| Full-field data word 1 | 980 | C _b 428 |
| Full-field data word 2 | 981 | Y 856 |
| Ancillary data error flags | 982 | C _r 428 |
| Active picture error flags | 983 | Y 857 |
| Full-field error flags | 984 | C _b 429–C _r 430 (200 _h) |
| Reserved words (7 total) | 985–991 (200 _h) | Y 861 |
| Checksum for this ancillary data block | 992 | |

NOTES

- 1 Values in the tables are word numbers for the appropriate standard.
- 2 Values in parentheses are sample values.
- 3 625/50 line numbers (in brackets) are tentative.

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 data packet and the two following lines. The line following the error 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.

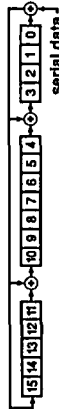
NOTE - For the purpose of performing the CRC calculations in PAL composite systems, sample 967 is defined as the TRS sample with value 3FFh. This is consistent with IEC 608(Sec)200, but must be clearly defined for CRC calculations, in case a nonstandard horizontal interval is encountered.

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:

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



4.2 Ancillary data housekeeping, checkwords, and flags

Definitions of each ancillary data word specified by this practice are shown in table 4. To provide compatibility with 8-bit equipment, 0s are used in the two least significant bits of all words in the data packet. 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 data packet as required by the ancillary data formatting for the serial digital interface.

The checkword word is used to determine the validity of the included words. The checkword 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. Preset to all zeros at the start of each calculation and ignore the carry.

4.3 Error 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 edg 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 mechanism.

Table 3 - Checkword Included samples

| Data item | Composite | Component |
|---|-----------|-----------|
| 525/59.94 systems | | |
| First full-field sample, lines 12 and 275 | 795 | 1444 |
| First active picture sample, lines 21 and 284 | 0 | 0 |
| Last active picture sample, lines 262 and 525 | 767 | 1439 |
| Last full-field sample, lines 8 and 271 | 767 | 1439 |
| 625/50 systems | | |
| First full-field sample, lines [8] and [321] | 972 | Cb 361 |
| First active picture sample, lines 24 and 336 | 0 | Cb 0 |
| Last active picture sample, lines 310 and 622 | 947 | Y 719 |
| Last full-field sample, lines [4] and [317] | 947 | Y 719 |

NOTE - Full-field 625/50 line numbers (in brackets) are tentative.

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 |
| Auxiliary 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> | P | P | C5 | C4 | C3 | C2 | C1 | C0 | 0 | 0 |
| Active picture data word 1 crc<11:6> | P | P | C11 | C10 | C9 | C8 | C7 | C6 | 0 | 0 |
| Active picture data word 2 crc<15:12> | P | P | V | 0 | C15 | C14 | C13 | C12 | 0 | 0 |
| Full-field data word 0 crc<5:0> | P | P | C5 | C4 | C3 | C2 | C1 | C0 | 0 | 0 |
| Full-field data word 1 crc<11:6> | P | P | C11 | C10 | C9 | C8 | C7 | C6 | 0 | 0 |
| Full-field data word 2 crc<15:12> | P | P | V | 0 | C15 | C14 | C13 | C12 | 0 | 0 |
| Auxiliary data error flags | P | P | 0 | ues | ida | ida | idh | eda | edh | 0 |
| Active picture error flags | P | P | 0 | ues | ida | ida | idh | eda | edh | 0 |
| Full-field error flags | P | P | 0 | ues | ida | ida | idh | eda | edh | 0 |
| Reserved words (7 total) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Checksum | S8 | S8 | S7 | S6 | S6 | S4 | S3 | S2 | S1 | S0 |

NOTE - P and V are defined in 4.2.

PROPOSED SMPTE RECOMMENDED PRACTICE Definition of Vertical Interval Switching Point for Synchronous Video Switching

Introduction

The intent of this practice is to ensure that switching of nominally synchronous signals occurs during the active video period of the specified line, which minimizes the possibility of sync disturbance. In serial systems, this allows a period for the serial receiver to re-establish clock lock and for the switching disturbance to be fully clocked through the descrambling shift register prior to the next timing reference signal (when word lock should be re-established). In many routing systems, the switching trigger is derived from a common timing reference signal. This practice defines a switching area close to the center of the active line to ensure switching within the active line period for the greatest possible timing spread of video inputs to the routing system.

The line designated for switching is chosen to be after vertical sync (to minimize the possibility of disturbances to vertical sync), but early in the vertical blanking area. This ensures that signals transmitted during the vertical blanking interval (time code, audio data, etc.) remain with the video field with which they are associated.

1 Scope

1.1 This practice defines an area of the vertical blanking interval to be used for switching of synchronous video signals. (The practice defines a switching area for both 525/60 and 625/50 signals. Values quoted for 625/50 systems should be regarded as tentative pending review by appropriate organizations. All such values are enclosed in brackets.)

1.2 The switching area is defined for 525/60 and 625/50 systems operating with composite or component, analog or digital signals. Digital

signals may be in either the bit-parallel or bit-serial digital interface form.

1.3 The switching area is defined so as to be compatible with the error detection checkword system used in bit-serial interfaces (see SMPTE RP 165).

1.4 This practice is intended for guidance in new system design. It should be recognized that existing equipment may not switch within the defined area.

2 Definition of terms

2.1 **switching point:** The point in time when a selected video source is changed.

2.2 **switching area:** The period of time during the vertical interval when the switching point is permitted to occur.

2.3 **horizontal reference point:** The 50% amplitude point of the leading edge of horizontal sync.

2.4 **start of active video:** The first sample following the horizontal digital blanking, generally sample '0' (zero) in SMPTE standards.

2.5 **clock interval:** The time period for one clock cycle at the bit-parallel clock frequency.

3 Switching area specifications

The switching area is shown in table 1 and figure 1 for 525/60 systems and figure 2 for 625/50 systems.

Table 1 - Switching area specifications

| Television standard | Line number | | µs after horizontal reference point | Clock intervals after start of active video |
|--|-------------|-----------|-------------------------------------|---|
| | Field 1.3 | Field 2.4 | | |
| 525/60 analog SMPTE 170M | 10 | 273 | 25 - 35 | N/A |
| 525/60 composite digital SMPTE 244M/SMPTE 259M | 10 | 273 | | 232 - 376 (@ 14.3 MHz) |
| 525/60 component digital SMPTE 125M/SMPTE 259M | 10 | 273 | | 565 - 835 (@ 27 MHz) |
| 625/50 analog | [6] | [319] | [25 - 35] | N/A |
| 625/50 composite digital | [6] | [319] | | [267 - 445] (@ 17.7 MHz) |
| 625/50 component digital EBU Tech 3267-E | [6] | [319] | | [565 - 835] (@ 27 MHz) |

¹ Clock frequency is shown in parentheses.

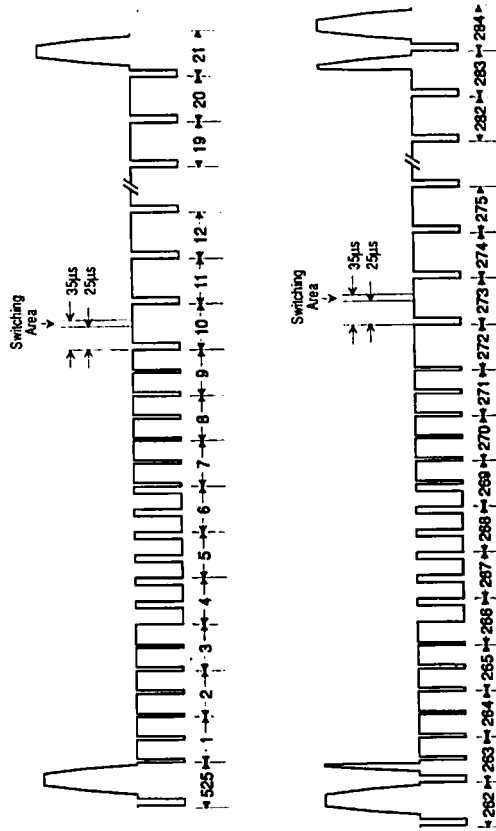


Figure 1 - 525-line system vertical interval switching area

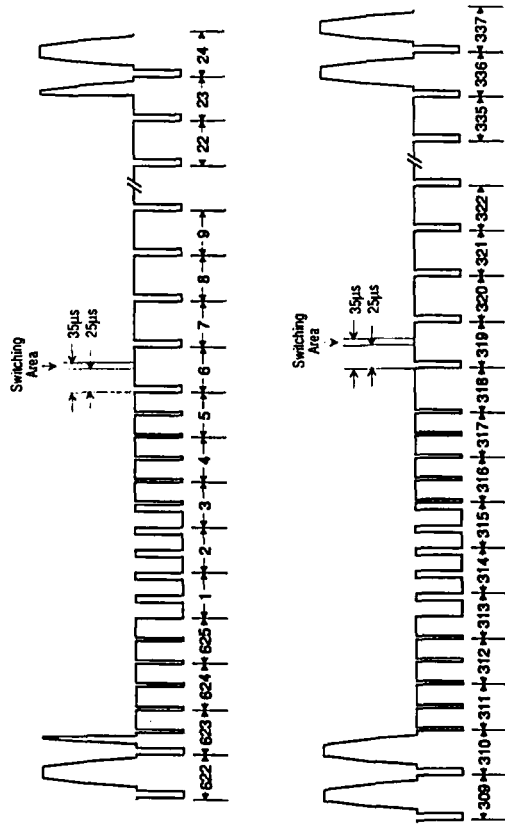


Figure 2 – 625-line system vertical interval switching area

Annex A (informative)
Bibliography

- ANSI/SMPTE 125M-1992, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface
- SMPTE 259M, Television — 10-Bit 4:2:2 Component and 4:1:1 NTSC Composite Digital Signals — Serial Digital Interface
- SMPTE 170M, Television — Composite Analog Video Signal — NTSC for Studio Applications
- SMPTE 244M, Television — System MINTSC Composite Video Signals — Bit-Parallel Digital Interface
- SMPTE RP 165, Error Detection Checkwords and Status Flags for Use in Bit-Serial Digital Interfaces for Television
- EBU Tech 3267-E, Parallel Interface for 625-Line Digital Video Signals