DVB-ASI DISTRIBUTION AND SELECTION IN DVB-T/H REDUNDANCY SYSTEMS

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Key words: Telecommunications networks and systems, DVB-T/H Digital Video Broadcasting - Terrestrial/Handheld, Redundancy system, DVB - Digital Video Broadcasting, ASI - Asynchronous Serial Interface, DVB-ASI distributor, DVB-ASI selector

Abstract: DVB-ASI signal is used as a standard interconnection interface in digital broadcasting equipment. In article main focus is on DVB-T/H transmitter and redundancy systems, where specific demands regarding quality, size, price and flexibility are present. On more important transmission sites usually different types of redundancy systems are used for higher reliability. The most known types of redundancy systems are dual drive (DD), N+1 and N+M.

When redundancy system is used the need for additional DVB-ASI signals and control over signal is demanded. For this purpose DVB-ASI distributor and DVB-ASI selector units have been developed. Basic DVB-ASI distributor module has one DVB-ASI input and four DVB-ASI outputs. For achieving distribution to more outputs chaining of modules is used. Basic DVB-ASI selector module allows selection from four inputs to one main output and one spare (monitoring) output. With combination of selector modules more complex selections are possible. Decision for four outputs for DVB-ASI distributor and four inputs for DVB-ASI selector is a tradeoff that was made on basis of known demands in dual drive and usual size of N+1 system. In this way costs are reduced and with modular approach extension of system is still possible.

Delitev in izbiranje DVB-ASI signala v redundantnih DVB-T/H oddajnih sistemih

Kjučne besede: telekomunikacijski omrežja in sistemi, digitalna video radiodifuzija (DVB) DVB-ASI signal, digitalna prizemeljska televizija (DVB-T), mobilna prizemeljska televizija (DVB-H), redundantni sistemi, DVB-ASI delilnik, DVB-ASI selektor

Izvleček: V digitalni radiodifuzije je DVB-ASI signal standardiziran in najbolj razširjen način distribucije do oddajnih točk oziroma oddajnikov DVB-T/H signala. V članku je poudarek na DVB-T/H oddajnikih in redundantnih oddajniških sistemih, kjer so specifične zahteve za kvaliteto, velikost, ceno in prilagodljivost oddajniškega sistema. Na večjih in pomembnejših oddajnih točkah se pogosto uporabljajo redundantni sistemi oddajanja, ki zagotavljajo višjo zanesljivost oddajniškega sistema. Najbolj razširjeni sistemi so oddajniki z dvema gonilnikoma (tako imenovani Dual Drive), N+1 sistem (sistem kjer je na N oddajnikov na voljo en rezervni oddajnik) in N+M sistem (na N oddajnikov je M rezervnih oddajnikov). Kljub temu, da N+M sistem zagotavlja visoko stopnjo zanesljivosti se v praksi najpogosteje uporabljata sistem oddajnika z dvema gonilnikoma in N+1 sistem.

Ne glede na uporabljen sistem je osnovna naloga zagotoviti nemoteno oddajanje signala v primeru napake na oddajnem sistemu. Na oddajni točki je običajno na voljo en izvor DVB-ASI signala na posamezen oddajnik. Signal je potrebno zaradi podvajanja sklopov razdeliti na več enakih signalov in imeti možnost izbiranja vhodnega signala. Na tržišču sicer obstaja nekaj produktov, ki pa so običajno namenjeni za uporabo v večjih distribucijskih mrežah in so zato neekonomični za uporabo v zgoraj omenjenih redundantnih sistemih. Zaradi večje prilagodljivosti pri izvedbi različnih tipov in različnih velikosti redundantnih sistemih smo rešitev zasnovali modularno. Osnovni modul DVB-ASI delilnika deli DVB-ASI signal na štiri izhodne DVB-ASI signale. V primeru, da potrebujemo več izhodnih signalov zaporedno povežemo posamezne module. Pri DVB-ASI selektorju osnovni modul omogoča izbiro DVB-ASI signala med štirimi DVB-ASI vhodi. S pomočjo kombiniranja več osnovnih modulov DVB-ASI selektorja je možna razširitev izbire števila vhodnih signalov.

Pri sami izvedbi rešitve je veliko pozornosti potrebno posveti pravilni zasnovi in izbiri komponent, saj imamo opravka z visokofrekvenčnimi signali. Popačenje, ki nastanejo pri prehodu visokofrekvenčnega pravokotnega signala skozi koaksialni kabel zmanjšamo s pomočjo kabelskega izravnalnika. V nadaljevanju zmanjšamo še odstopanje (trepetanje) urinega takta. Pri DVB-ASI selektorji je za razliko od DVB-ASI delilnika pred časovnim sklopom dana še možnost izbira vhodnega signala. Amplitudno in časovno izboljšan signal je potem razdeljen in amplitudno ojačen na več izhodnih DVB-ASI signalov.

1 Introduction

For distribution of digital television and mobile television content from television studio to transmitter different distribution approaches (optic cables, wireless, satellite, coaxial cable and other) are used. Input signal is transformed (if needed) to standard input for DVB-T/H (Digital Video Broadcasting - Terrestrial/Handheld) transmitter regardless which distribution path is used. As standard input for transmitter DVB-ASI (Digital Video Broadcasting - Asynchronous Serial Interface) signal is used. Formal document describing professional interfaces for Digital Video Broadcasting is ETSI TR 101 891 (European Telecommunications Standards Institute) /1/. Physical characteristic of the DVB-ASI are similar to digital video signal SDI (Serial Digital Interface) defined by organization SMPTE (Society of Motion Picture and Television Engineers) under designation 259M. DVB-ASI defines interface and way of transmission of digital data. Signal is transmitted serial over 75Ω coaxial cable with nominal amplitude of 800mVpp at source. DVB-ASI is using 8B10 encoding and 270 Mbps bit rate /2/. Equipment used for transmission of SDI signal is not always compatible with DVB-ASI signal and using such equipment in transmission chain can cause problems. One of possible causes could be wrong clock detection, polarity of signal (DVB-ASI is polarity sensitive and SDI is not) and others.

Depending on size and importance of transmitting site different redundancy systems are used for achieving higher reliability of transmitting system. In most cases one of the following solutions is used for redundancy systems: dual drive (DD), N+1 and N+M. In case of dual drive system dividing DVB-ASI signal for two PA (Power Amplifier) drivers is needed. Basic concept of dual drive redundancy system is shown in picture 1.1.

In case of N+1 system dividing and selection unit is needed. For this purpose we need N dividing modules, one for each transmitter. One DVB-ASI output signal is used for transmitter and other one as input for selection unit. With selection unit appropriate DVB-ASI signal is selected for reserve transmitter. Basic concept of N+1 redundancy system is shown in picture 1.2. In case of failure of one transmitter, ASI selector will receive information from control unit about which input to select.

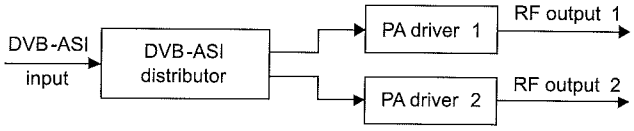

Fig. 1.1: Example of dividing DVB-ASI signal for dual drive system.

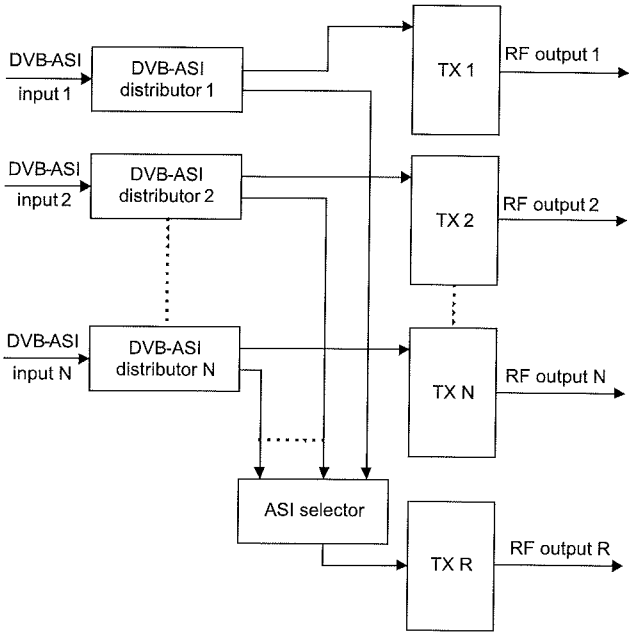

Fig. 1.2: Example of dividing and selection of DVB-ASI signal for N+1 system.

N+M redundancy system is extension of N+1 system. On each dividing module more outputs are used and M selection units are needed. Although N+M system ensures higher reliability it is rarely used because of higher price and complex architecture. If on transmitting site additional reserve DVB-ASI signal is present and one of described redundancy system is used, then demands for dividing and selecting units are doubled for every system.

2 Proposed solution

On basis of presented demands for redundancy systems DVB-ASI distribution (DVB-ASI divider) and DVB-ASI selector units have been developed. To have same basic construction block for all redundancy systems optimum solution is DVB-ASI distributor with four outputs per module and DVB-ASI selector with four inputs per module. Besides main output DVB-ASI selector has one spare monitoring output. To extend distribution to more outputs, chaining of modules is used. To extend number of inputs for DVB-ASI selector combining selector modules is also possible.

2.1 DVB-ASI distributor

Basic function of DVB-ASI distributor is dividing input signal on more equivalent outputs. Simply passive dividing of signal is not appropriate solution because in equipment that is following passive dividing system wrong detection could happen. For this reason active dividing is used. Example of active dividing system is shown on picture 2.1, where separated blocks with their functions are presented.

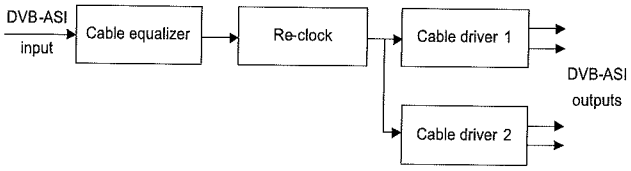

Fig. 2.1: DVB-ASI distributor module.

When high frequency digital signal is traveling through long coaxial cable signal will loose amplitude and shape because higher frequencies are more attenuated as lower ones /3/. On picture 2.2 /3/ example of dependence between frequency and attenuation for 100m coaxial cable is shown. Attenuation depends on frequency and cable length. Because of this property input signal is first recovered against cable length. For this purpose cable equalizer with inverse cable characteristic for compensating cable influence on signal is used.

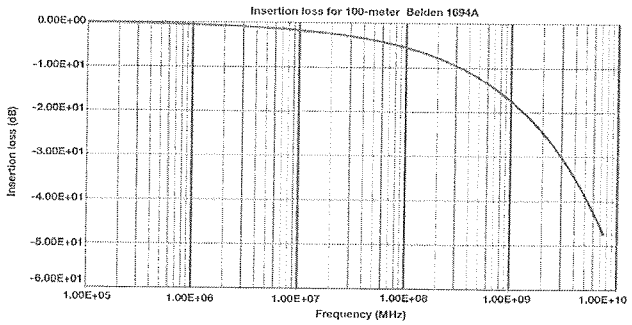

Fig. 2.2: Attenuation of signal against frequency for 100m long coaxial cable.

Long cables and different equipment in transmission chain have also influence on embedded clock of DVB-ASI sig-

nal. Such influence is manifested as jitter in signal. With reclocking embedded clock is recovered again. Depending on usage of ASI distributor reclocking function can be disabled. Such improved signal is then divided to four output signals.

At the end of circuit cable driver is amplifying signal to nominal amplitude of 800 mVpp. On picture 2.3 DVB-ASI signal is shown after passing long coaxial cable. If same signal is then used as input for DVB-ASI distributor the signal on output will be recovered to signal shown in picture 2.4. For such measurements special oscilloscopes with infinitive persistence and color display are used. One of such measuring instrument is Agilent Infiniium MSO8104A that was used for measuring DVB-ASI signal before and after usage of developed DVB-ASI distributor and DVB-ASI selector module /7/.

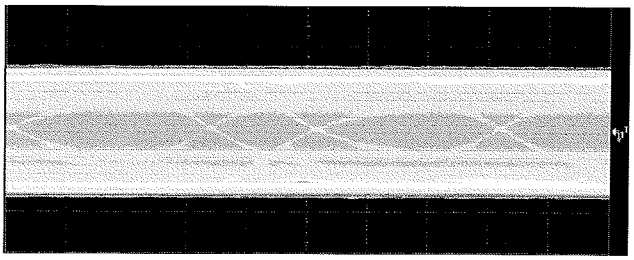

Fig. 2.3: Example of DVB-ASI signal after traveling through long coaxial cable.

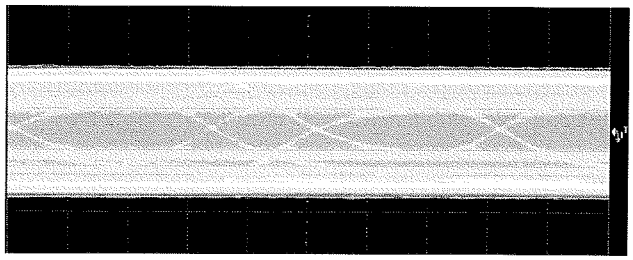

Fig. 2.4: Example of DVB-ASI signal on picture 2.3 after using DVB-ASI distributor.

2.2 DVB-ASI selector

For DVB-ASI selector module similar components as for DVB-ASI distributor are used. On picture 2.5 basic block of DVB-ASI selector module are shown. Input DVB-ASI signals are first reconstructed against coaxial cable deformation with cable equalizer. Selection block is main part of DVB-ASI selector. In this part selection of input signal is done. After selecting signal and reclocking cable driver is amplifying signal to nominal amplitude 800 mVpp.

3 Measurements and basic technical data

In table 3.1 demands for professional equipment that is using DVB-ASI according to European standard EN 50083-9 are presented /4/.

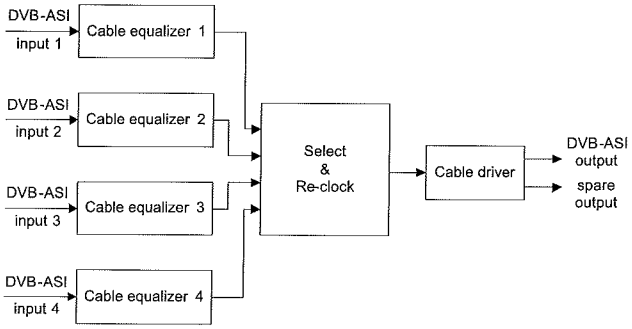

Fig. 2.5: DVB-ASI selector module.

Table 3.1: Demands for DVB-ASI equipment.

Transmitter output characteristics	Units	
Output voltage (p -p)	mV	800 ± 10%
Deterministic Jitter (DJ) (p -p)	%	10
Random Jitter (RJ) (p-p)	%	8
Return loss	dB	under consideration
Max. rise/fall time (20 -80%)	ns	1,2

Receiver input characteristics	Units	
Min. sensitivity (D21.5 idle pattern)	mV	200
Max. input voltage (p -p)	mV	880
S_{11} (range: 0,1 to 1,0 x bit rate)	dB	-17
Min. discrete connector return loss (0,3 MHz – 1 GHz)	dB	-15

Because DVB-ASI physical characteristic are similar to SDI signal descriptions and measurements proposed from EBU (European Broadcasting Union) document Tech 3283 (Measurements in digital component television studios) can be used /5/. On picture 3.1 basic DVB-ASI signal characteristic and measurement definitions are shown.

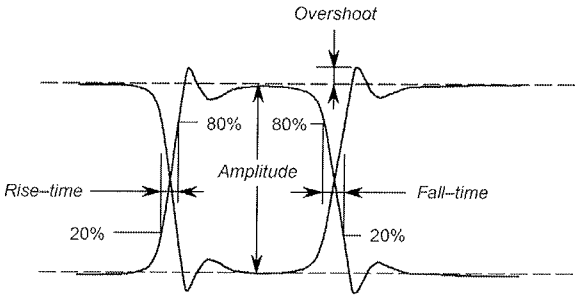

Fig. 3.1: Basic measurements for DVB-ASI signal.

Besides basic measurements for DVB-ASI signal important information is jitter. Jitter is short term variation of digital signal from their ideal position in Time /6, 8/. There are several ways how measuring of jitter is done. On basis of type of measure we know periodic jitter, cycle - cycle jitter, TIE - time interval error. Another way to visually represent jitter is eye diagram. Quick estimation of signal characteristics is possible from eye diagram. On picture 3.2 /reference 6 Figure 4.2.1b, 4.2.3b, 4.2.4c and 4.2.5a/ typical eye diagrams with their distributions for different types of jitter are shown. In the upper left part of picture

random jitter is shown. In the upper right periodic jitter is shown. In the lower left part of picture data depended jitter and lower right duty-cycle depended jitter is shown.

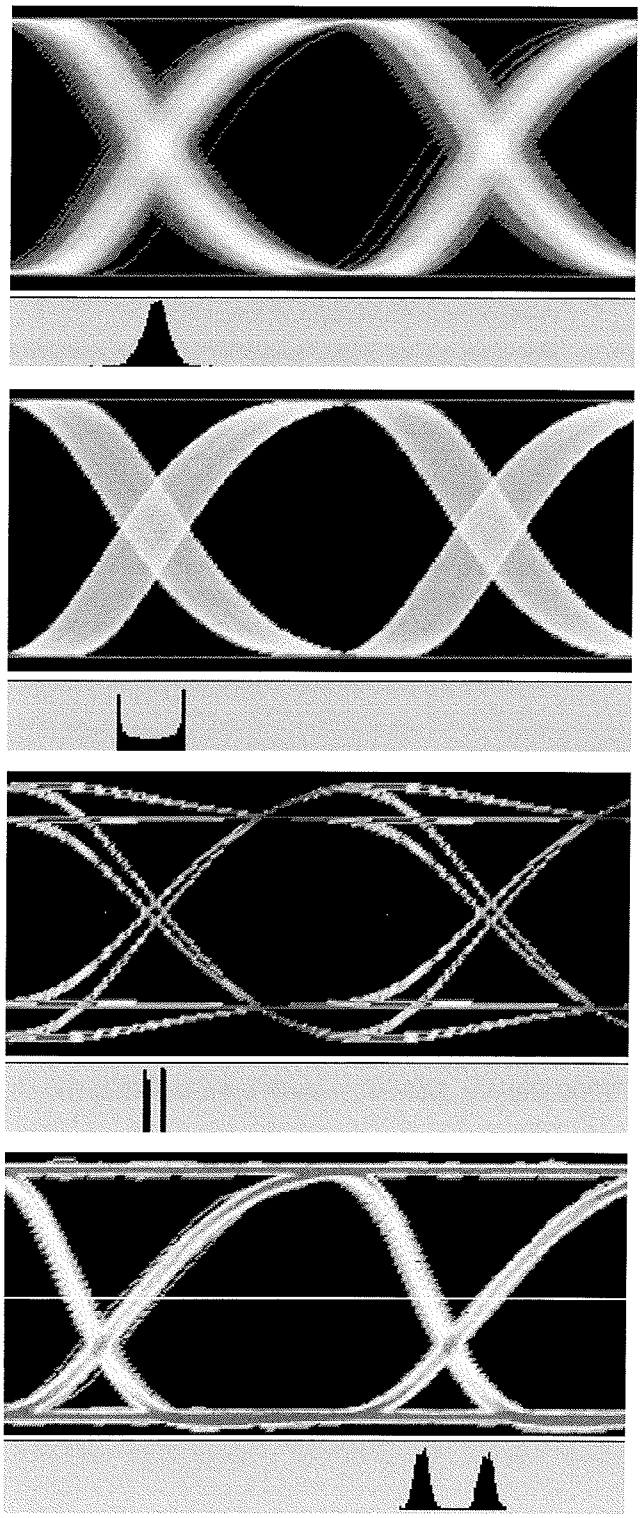

Fig. 3.2: Typical eye diagrams for different types of jitter.

On picture 3.3 and 3.4 results of measurements are shown. For measuring instrument Agilent Infiniium MSO8104A was used /7/. Both pictures are presenting typical values measured on DVB-ASI distributor and DVB-ASI selector modules. On picture 3.3 amplitude characteristic are shown with their current, mean, minimum and maximum values. Measured values for peak to peak amplitude (Vp-p), overshot and averaged amplitude (DC offset) are visible.

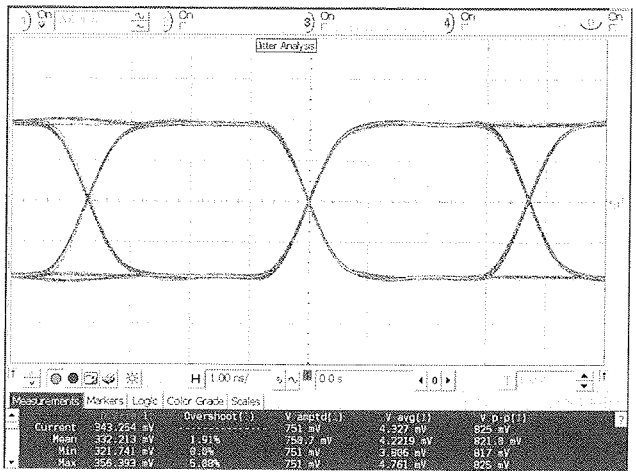

Fig. 3.3: Example of measure results.

On picture 3.4 time and eye diagram characteristic are shown with their current, mean, minimum and maximum values. Measured values for jitter, eye width, eye height, fall time and rise time are visible.

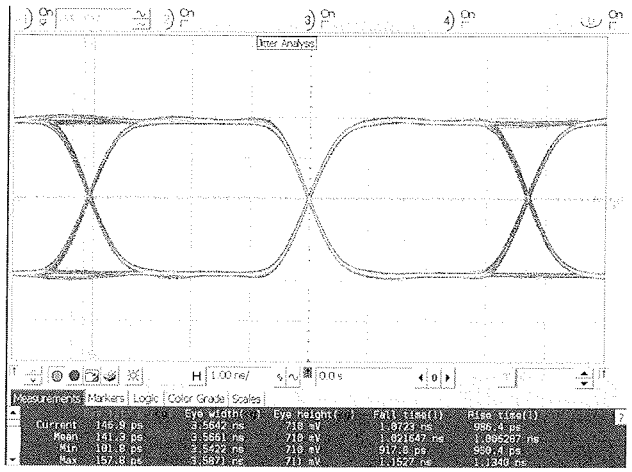

Fig. 3.4: Example of measure results.

In table 3.2 basic technical data for DVB-ASI distributor are shown.

4 Conclusions

In the article a concept for distribution and selection of DVB-ASI signal in DVB-T/H transmitting redundancy systems was shown. Solution with costs effective DVB-ASI distributor and DVB-ASI selector was presented. DVB-ASI distributor module has one DVB-ASI input and four DVB-ASI outputs per module. DVB-ASI selector module has four DVB-ASI inputs, one main and one monitoring DVB-ASI output per module. Because of modular concept different

Table 3.2: Technical data for DVB-ASI distributor.

Data	Value
Number of inputs	1 for each module
Signal type	DVB-ASI 270 Mb/s
Connector	BNC (IEC169-8)
Impedance	75 ohms
Return loss	18 dB to 540 MHz
Number of outputs	4 for each module (up to 3 modules in one rack)
Output amplitude	800 mV ± 10%
DC offset	0,0 V ± 0,5V
Overshoot	<10% of amplitude
Rise time	<1,2 ns
Jitter	< 0,2 UI peak-to-peak
External dimensions	19" rack, 1U, 180 mm depth
Mains AC voltage	85-264 V AC, 47-60Hz
Power consumption	<10 VA

In table 3.3 basic technical data for DVB-ASI selector are shown.

Table 3.3: Technical data for DVB-ASI selector.

Data	Value
Number of inputs	4 for each module
Signal type	DVB-ASI 270 Mb/s
Connector	BNC (IEC169-8)
Impedance	75 ohms
Return loss	18 dB to 540 MHz
Number of outputs	2 for each module (up to 2 modules in one rack)
Output amplitude	800 mV ± 10%
DC offset	0,0 V ± 0,5V
Overshoot	<10% of amplitude
Rise time	<1,2 ns
Jitter	< 0,2 UI peak-to-peak
Communication	RS232/RS422/RS485
Communication protocol	ASCII
External dimensions	19" rack, 1U, 180 mm depth
Mains AC voltage	85-264 V AC, 47-60Hz
Power consumption	<10 VA

types and sizes of redundancy systems are possible. Additional flexibility in planning or changing structure of redundancy systems is achieved. Usage of developed products is possible in any other system where distribution or selection of DVB-ASI signal is needed. Measuring results confirmed accordance to different standards for professional equipment and DVB-ASI signal.

5 References

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/3/ Use equalization to drive digital video through long cables, Mark Sauerwald, National Semiconductor Corp, June 2006, http://www.planetanalog.com/article/printableArticle.jhtml?articleID=188702457

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