

Move up to the next level!

The future of digital broadcasting is in your hands!

Solutions for the final round exercises

Introduction

- I DVB-T2 field trials are already underway in some countries. Regular DVB-T2 operation is starting up in the UK, Finland and Italy. And it will soon be launched in Sweden as well.
- I Transmission and reception equipment is already available. But development of T&M equipment is incomplete or is just getting started.



Exercises

- I Define the requirements for DVB-T2 T&M equipment. This equipment should serve to "harass" and test DVB-T2 receivers with the required receive scenarios, to measure the quality of transmitters and to measure the real reception situation at a specific location in the field.
- I The following tasks are related to questions that T&M developers and product managers must ask when defining T&M equipment for the DVB-T2 environment.
- I Based on these questions, create an appealing presentation that will convince your customer to give you the budget needed to develop the various products. Your presentation should impart the complexity of DVB-T2 and similar standards.



Exercise 1 (11 points)

- I Describe which customer groups need what T&M equipment for DVB-T2. This can also be in the form of a diagram.



Exercise 1 (11 Points in total)

- I Playout center: MPEG analyzer, image-quality analyzer, T2-MI analyzer (2 points)
- I Distribution network: T2-MI analyzer, MPEG analyzer (2 points)
- I Transmitter site: MPEG analyzer, T2-MI analyzer, measuring receiver (2 points)
- I Network: measuring receiver for coverage measurement (1 point)
- I Manufacturers of receivers, as well as test houses: MPEG generator, measuring transmitter (2 points)
- I Manufacturers of transmitters: MPEG generator, measuring receiver (2 points)

This can also be shown in a clear diagram.



Exercise 2 (9 points in total)

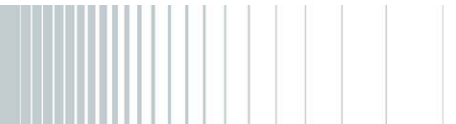
- I Define the test requirements for a DVB-T2 receiver in consumer devices. → 6 points
- I Describe the test setup. → 3 points



Exercise 2 (9 Points in total)

Exercise 2.1: Test requirements for a DVB-T2 receiver (6 points, at least six items):

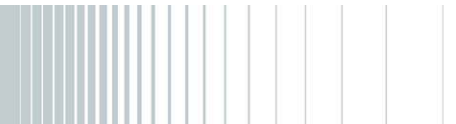
- I Test of the minimum receiver input level in the AWGN channel
- I Test of the minimum signal-to-noise ratio at specified level (60 dBuV)
- I Test with a number of multipath reception conditions in SISO and MISO modes
- I Test with adjacent channel assignment in the lower and upper adjacent channel
- I Mobile reception test with multipath reception
- I Test with single and multi-PLP signals



Exercise 2 (9 Points in total)

Exercise 2.2: Test setup (3 points):

- I MPEG-2 transport stream source with and without T2-MI signal structure with single-PLP signal and multi-PLP signals (TS, GCS, GFPS, GSE)
- I Measuring transmitter with noise generator, I/Q modulator with pre-distortion, fading simulator, interference sources
- I The DVB-T2 receiver is connected to the RF output of the measuring transmitter (antenna input)
- I A TV screen is connected to the DVB-T2 receiver



Exercise 3 (3 points in total)

- I What special advantages does MISO have in DVB-T2 compared with DVB-T networks? Explain your answer. → 2 points
- I How does the MISO principle used in DVB-T2 differ from the standard MISO principle? → 1 point



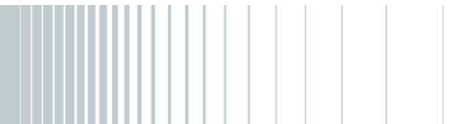
Exercise 3 (3 points in total)

Exercise 3.1 (2 points):

- I Distributed MISO in single-frequency networks makes it possible to avoid or at least minimize the destructive properties caused by overlapping signals from multiple transmitter sites. Reason: The signals from MISO modes 1 and 2 do not correlate and therefore do not lead to fading notches.
- I With co-located MISO, the different propagation conditions of horizontal and vertical polarization planes during portable or mobile reception can be positively utilized.

Exercise 3.2 (1 point):

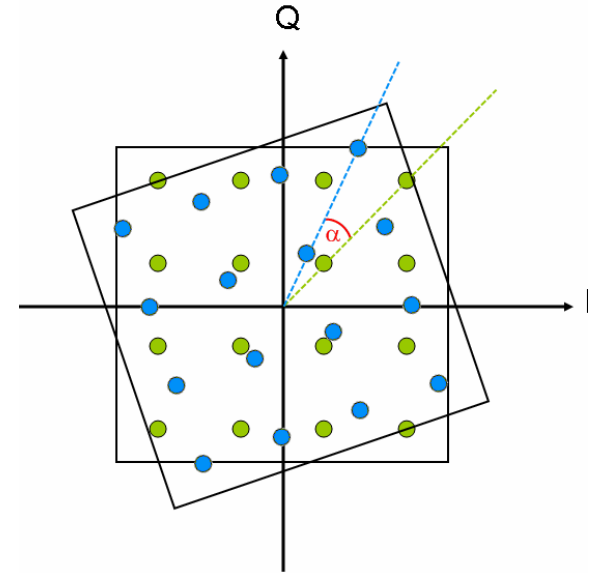
- I DVB-T2 uses space-frequency diversity and not the Alamouti space-time diversity method.



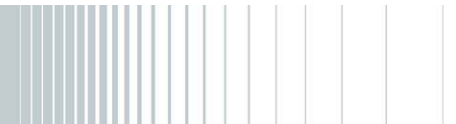
Exercise 4 (11 points in total)

DVB-T2 lets you use rotated and Q-delayed constellation diagrams.

- I Derive the optimal tilt angle α for 4QAM, 16QAM, 64QAM and 256QAM. → 9 points



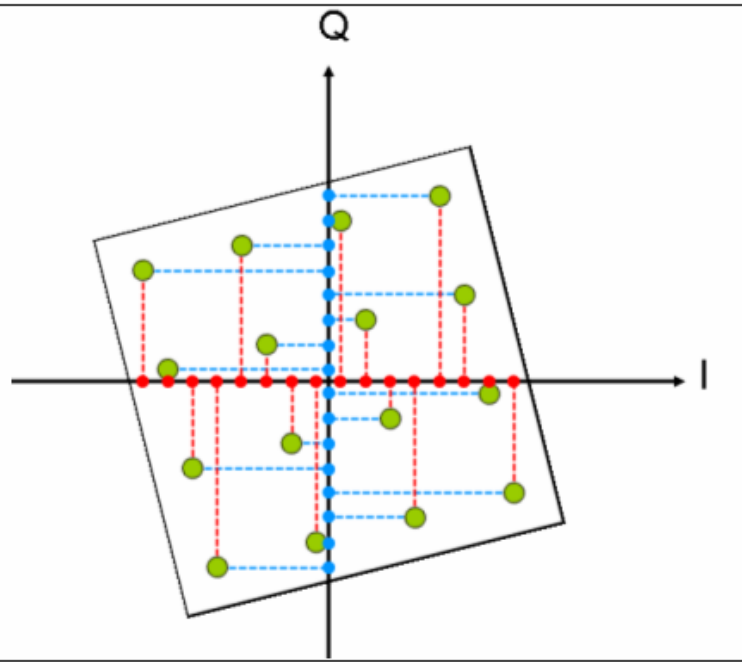
- I Why do the angles deviate from the tilt angles defined in the standard? → 1 point
- I Explain the advantages of this new process. → 1 point



Exercise 4 (11 points in total)

Exercise 4.1 (9 points)

1. The optimal tilt angle is reached when the projections of all constellation points on the I and Q axes are equidistant to each other, for then they can be most easily distinguished from each other. (1 point)



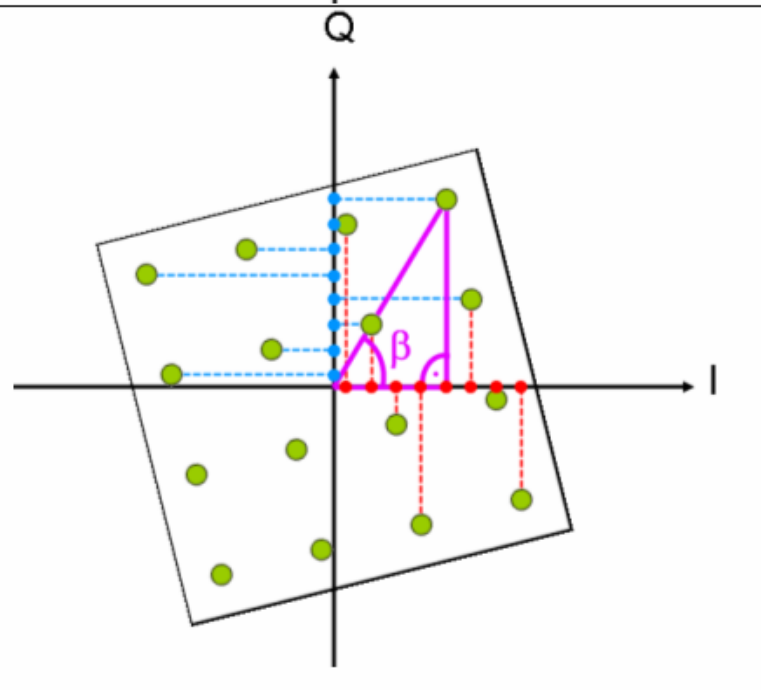
Exercise 4 (11 points in total)

Exercise 4.1 (9 points)

2. To calculate the angle of rotation, the right-angle triangle defined by the constellation point at the upper right is used.

As a function of the QAM order (m), the side adjacent to β is comprised of $\frac{1}{2} + \frac{m}{2} - \sqrt{m}$ equidistant intervals (red markings).

The side opposite to β is calculated analogously and has $\frac{m-1}{2}$ intervals (blue markings).



Exercise 4 (11 points in total)

Exercise 4.1 (9 points)

3.	The angle β is derived from the inverse tangent (<u>arctan</u>), and the desired tilt angle α is then found by subtracting 45° . (Exercise 4.1.2-4.1.3, correct derivation of formula: 7 points)	$\alpha = \beta - 45^\circ = a \tan \left(\frac{\frac{m-1}{2}}{\frac{1}{2} + \frac{m}{2} - \sqrt{m}} \right) - 45^\circ$				
4.	Results (1 point for table)	m	4	16	64	256
		α	26.6	14.0	7.1	3.6



Exercise 4 (11 points in total)

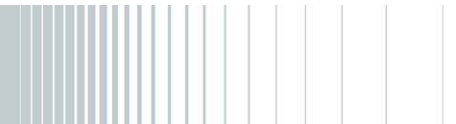
Exercise 4.2 (1 point):

- I The angle values of the standard
- I were optimized in a simulated iterative process for a nonideal transmission channel (fading, etc.).

m	4	16	64	256
α	29.0	16.8	8.6	3.6

Exercise 4.3 (1 point):

- I Since the information of a symbol (I/Q) is now redundantly transmitted in different cells (i.e. later carriers), robustness against frequency-selective interference increases.



Exercise 5 (4 points)

- I Describe what test parameters are used for checking and acceptance testing of DVB-T2 transmitters.



Exercise 5 (4 points in total)

- I RF level
- I Bit error ratios before LDPC, before BCH and after BCH
- I Modulation error ratios of all single carriers
- I Amplitude frequency response and group delay
- I Shoulder distance
- I Out-of-band components



Exercise 6 (2 points)

- I What special circumstances are to be expected during DVB-T2 network planning (MISO, guard)?



Exercise 6 (2 points in total)

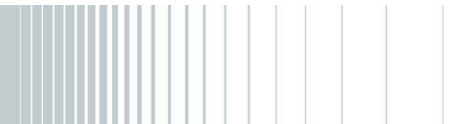
- I If distributed MISO is used in single-frequency networks, two coverages must be calculated: one for MISO mode 1 and one for MISO mode 2. Due to the lengthy guard intervals that can be selected, considerably larger transmitter intervals are possible.



Exercise 7 (3 points in total)

A customer (network operator) wants to set up a DVB-T2 network that should include services for portable indoor and high-data-rate roof antenna reception in one channel in a large SFN.

- I What transmission parameters would you select? → 1 point
- I What transmission parameters would you select to simultaneously use mobile and indoor capability in one channel? → 1 point
- I What is the conflict between large SFNs with high data rates and mobile reception? → 1 point



Exercise 7 (3 points in total)

Exercise 7.1 (1 point):

- I Choose a mode with as many carriers as possible (8K, 16K, 32K), and select the guard interval, equivalent to at least a length of 60 km to 70 km, that is suitable for the SFN.

Exercise 7.2 (1 point):

- I Choose a mode with fewer carriers (1K, 2K, 4K), since this increases the carrier spacing, thereby reducing the influence of the Doppler effect.

Exercise 7.3 (1 point):

- I Large SFNs require long guard intervals, which are only possible in modes with many carriers. This means that the carrier spacing is reduced, which increases the influence of the Doppler effect.



Exercise 8 (5 points)

- I Define the coverage measurement requirements (test parameters) placed on a DVB-T2 test receiver.



Exercise 8 (5 points in total)

A DVB-T2 measuring receiver must be able to measure the following test Parameters (5 points, at least five items):

- I Level
- I Bit error ratios before LDPC, before BCH and after BCH
- I Modulation error ratios of all carriers
- I Channel impulse response, if necessary separated according to MISO mode
- I Signaling information from P2 symbols



Exercise 9 (3 points)

- I Find out what DVB-T2 receivers and receiver chips are already available on the market or have been announced.



Exercise 9 (3 points in total)

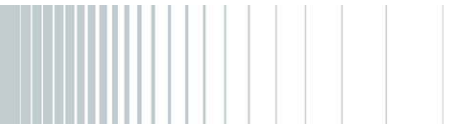
Receivers (2 points, at least two items):

- I Pace
- I Humax
- I Sony Bravia (has been announced)

Receiver chips (1 point):

- I Sony

Note: Others may also be correct now.

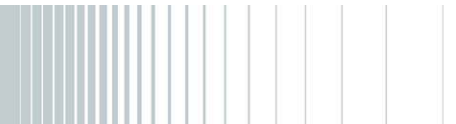


Exercise 10 (4 points in total)

Compare DVB-C2 with DVB-C and DVB-T2.

- I What do you notice in particular? → 2 points

- I What is new or different compared with the other two standards?
→ 2 points



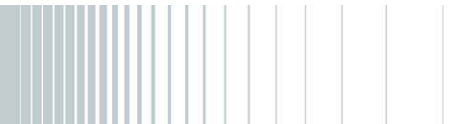
Exercise 10 (4 points in total)

Exercise 10.1 (2 points):

- I Now OFDM will also be used. Channel bundling up to 450 MHz is possible. DVB-C2 is based on DVB-T2.

Exercise 10.2 (2 points):

- I New compared with DVB-C: channel bundling instead of actual channels; data slices are used instead of channels
- I OFDM same as with DVB-T2, and no single-carrier modulation anymore as with DVB-C
- I FEC same as with DVB-T2, i.e. other new FECs compared with DVB-C
- I Multicarrier method, 1024QAM and 4096QAM



Exercise 11 (7 points in total)

Around the world, there are still many countries that only have analog TV operation.

I Which countries? → 1 point

Many of these countries are looking into currently existing digital terrestrial TV standards.

I Which standards? → 1 point

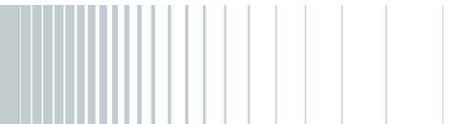
I Compare these standards by clearly stating their weaknesses and advantages. → 2 points

Analog TV standards vary worldwide.

I What are the main differences? → 1 point

I Which difference still affects digital TV today and where does it originate? → 1 point

I How does this affect T&M technology? → 1 point



Exercise 11 (7 points in total)

Exercise 11.1 (1 point, at least three countries):

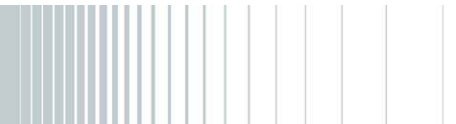
- I Many countries in Africa and in South America, as well as Turkey, Israel, Lebanon, Philippines, ...

Exercise 11.2 (1 point, at least four standards):

- I DVB-T, ISDB-T, ATSC, DTMB, DVB-T2

Exercise 11.3 (2 points, at least four items):

- I DVB-T: OFDM-based
- I ISDB-T: OFDM-based
- I ATSC: 8VSB single carrier – therefore problems with multipath reception, no configurability, fixed error protection, fixed modulation, fixed data rate
- I DTMB: OFDM-based, hardly any precise information available
- I DVB-T2: revolutionarily new, state-of-the-art error protection, multi-PLP, up to 255 input signals, OFDM-based



Exercise 11 (7 points in total)

Exercise 11.4 (1 point, if image frequency + color standard are mentioned):

- I Frame and field frequency and correlating number of lines
- I PAL, SECAM, NTSC color transmission methods
- I Sound transmission standard, channel-raster and channel tables

Exercise 11.5 (1 point):

- I In digital TV, the frame and field frequency in particular is still the same in the individual regions, i.e. 50/60 fields and 25/30 frames. Originally this frequency came from the connection between the synchronous motors of the Nipkow disk and the power frequency.

Exercise 11.6 (1 point):

- I Suitable baseband source material in 50/60 Hz must be made available for the receiver.



Exercise 12 (6 points in total)

Ever since "Avatar" came out, everyone is talking about 3D. For this reason, a network operator wants to use DVB-T2 to broadcast 3D HD TV.

- I Does this inevitably lead to a higher data rate? In this context, explain the possible 3D image formats that can be used today for TV transmissions. → 1 point

- I What coding methods are used (today / in the future)? → 1 point



- I What are the various technologies used to simulate 3D in the cinema and in TV? Briefly explain the principles and list the main advantages and disadvantages of these technologies. → 4 points



Exercise 12 (6 points in total)

Exercise 12.1 (1 point):

- I No, not necessarily – because the resolution can be horizontally or vertically divided into L/R images
- I 3D image formats

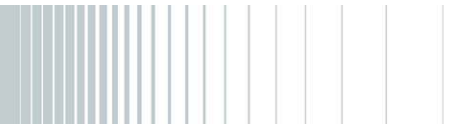
<p>Top-bottom Vertical division of full picture resolution.</p>	<p style="text-align: center;">1920</p>  <p style="text-align: right;">1080 1080</p>
<p>Side-by-side Horizontal division of full picture resolution.</p>	<p style="text-align: center;">960 960</p>  <p style="text-align: right;">1080</p>



Exercise 12 (6 points in total)

Exercise 12.2 (1 point):

- I Top-bottom and side-by-side formats use conventional H.264 coding. If 3D TV continues to be successful, new coding methods specially designed for 3D could be used in the future. Such methods would allow bandwidth-saving transmission of 3D content in full resolution – for example, the MPEG-4 AVC Multiview Video Coding (MVC) extension.



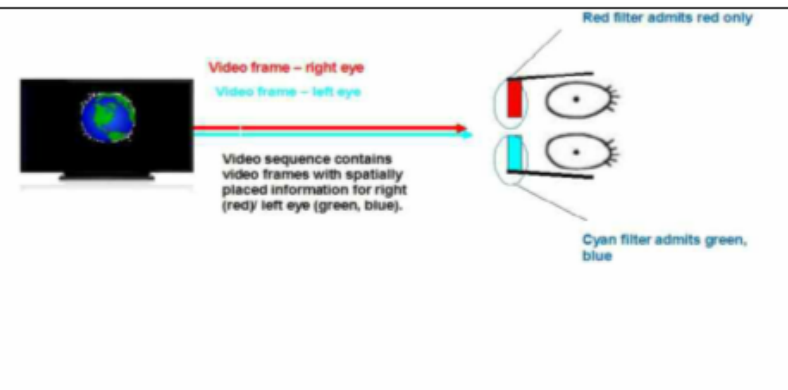
Exercise 12 (6 points in total)

Exercise 12.3 (4 point):

- 1 Left image for left eye, right image for right eye, medium for blanking the left images for the left and right eye.

Color anaglyph systems

The stereoscopic information is blended side-by-side into the active image, where the image information of the first perspective is processed through a red filter and that of the second perspective through a cyan filter. At the viewer end, the fused image information is separated by color filter glasses.



Exercise 12 (6 points in total)

Advantages: Economical, since this system can be implemented in 2D television sets

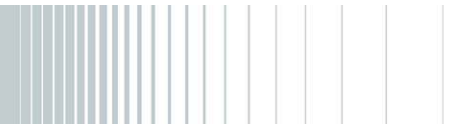
Disadvantages: No color fidelity

Passive systems with polarizing filter

The image information for the left eye and the right eye is polarized in different ways. Polarizing filter glasses are used to filter the information for each eye. Passive systems receive less support in the industry than active systems.

Advantages: Optimum image quality

Disadvantages: Expensive to manufacture and develop



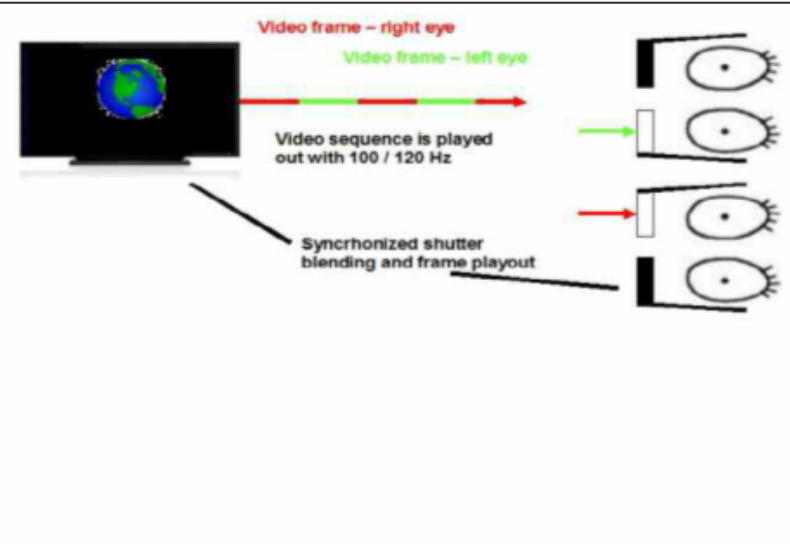
Exercise 12 (6 points in total)

Active systems with shutter glasses

The screen alternately plays out image information from the for the left eye and the right eye at a certain frequency, fore example 120 Hz. Infrared light is used to synchronize the shutter glass to the frame rate. Shutter glasses ensure that only one eye at a time receives the image information.

Advantages: Inexpensive to manufacture and develop

Disadvantages: Double images (ghosting), health problems



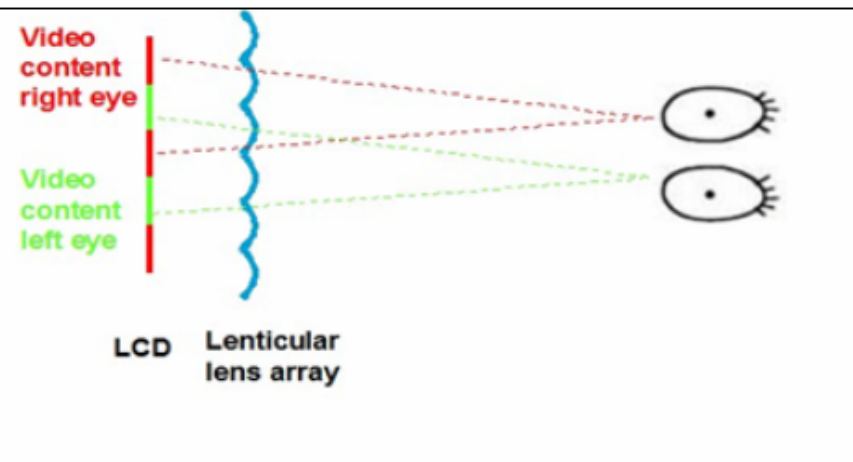
Exercise 12 (6 points in total)

Autostereoscopic systems

The difference from the systems described above is that special viewing glasses are not needed. The 3D effect is achieved by special lens systems affixed directly over the panel.

Advantages: No glasses necessary

Disadvantages: Currently very expensive, and 3D effect is only from one single position



(3 points for explaining the different technologies including their advantages and disadvantages; the participants can, of course, also simply list the technologies with an explanation; the quality of the presentation is evaluated in the soft skills section)