SW-4875 OFDM Demodulator Quad Controller
Set-up and control software for the CW-4875 and CW-4876 OFDM Demodulator Quad

Instruction Manual

The SW-4875 OFDM Demodulator Quad Controller has been designed for controlling the CW-4875 FTA version and the CW-4876 version equipped with Common Interface. The software permits setting up the demodulators and also offers numerous possibilities for inspecting the transmission parameters. The connection between the device and the controller computer is established by the CW-Net.

CW-Net is a 100 Mbit/s Ethernet network, which due the use of a special instruction set is referred to as CW-Net. The computer and the device communicate under Internet Protocol, in UDP/IP packets. The device and the computer can be connected directly through crossover cable, or indirectly via switch or other sophisticated switching unit through straight cables.

Technical literature about establishing and using the CW-Net:

CW_Net_.pdf	Basic knowledge of the structure and operation of the CW-Net.
CW_Net2.pdf	General description and block diagram of the CW-Net.
Using_CW_Net.pdf	First steps in putting into operation the CW-Net, configuring and testing the computer.
SW-4800	CW-Net Principal: software for setting IP addresses of the devices and checking up the function of CW-Net.
SW-4890	Computer Performance Tester: software for checking up the computer's set-up and performance.

Prior to starting the work with the device study the general instructions for putting into operation the devices in the Using_CW_Net.pdf description, and then read the instruction manuals delivered along with the device. The instruction manuals are available at the CableWorld web site, too.

Steps of installing the software and establishing connection with the device, in the simplest case:

- Install the software on the computer by running SW_4875_setup.exe.
- Set the computer to the 10.123.13.201 fix IP address.
- Connect the device to the computer with a crossover cable (100Base-T).
- Switch on the device.
- Note: All devices are shipped set to the 10.123.13.101 IP address.
- Run the software by clicking the icon on the desktop.
- Set the IP address in the left bottom corner of the QFDM Demodulator Quad screen to 10.123.13.101 and click the Query button.
- If everything is right, the software immediately displays the name and type number of the device.
- The existence of the communication between the computer and the device is indicated on the device by the "LINK" green LED on the front panel; in case of data traffic the "ACT" yellow LED blinks.

In case of error consult the Using_CW_Net.pdf description. For changing the IP address of the devices and establishing and checking up the CW-Net use the CW-Net Principal software. Until the connection between the computer and the device functions right, the work cannot be started. The structure and the partial operation of the software can be studied even without the device but no operation effects will be produced.

1.   Theoretical basics of the OFDM transmission

When using Orthogonal Frequency Division Multiplexing, abbreviated OFDM modulation, the digital information will be transmitted with multiple thousands of carriers. The number of carriers is 1704 in 2k mode and 6816 in 8k mode. When using 8 MHz bandwidth, the distance of the carriers is 4.46 kHz in 2 k mode and 1.12 kHz in 8k mode. The majority of the carriers transmit payload data, a smaller part of them serve as pilot carriers and some of the carriers are used for signalling the parameters of the transmission (Transmission Parameter Signalling – TPS). At 8k mode the number of payload carriers is 6048, that of the pilot carriers is 701, and the number of TPS data carriers is 68.

The data transmission on the carriers carrying payload data occurs with QPSK, 16QAM or 64QAM modulation, that is, each carrier will be transmitted with the amplitude and phase belonging to the data to be delivered by it. These states of amplitude and phase hold for 224 µs in 2k mode and for 896 µs in 8k mode, in 8 MHz systems. These states are referred to as symbol, and the time belonging to them as useful symbol time. In the 6 and 7 MHz systems the number of carriers is the same, the symbol time is proportionally larger and the carriers are closer to each other. For the easier discrimination the symbols are separated from each other with guard intervals. The guard interval can be the 1/32, 1/16, 1/8 or 1/4 of the useful symbol time. The actual symbol time is the sum of the guard interval and the useful symbol time. The gist of the OFDM modulation is shown in Figure 1.
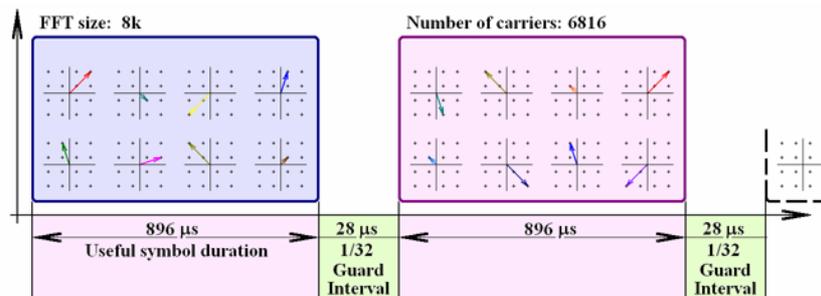

Figure 1
The carriers transmitted in the OFDM symbols and the guard intervals in 8k mode

For generating the OFDM signal a fast computer is used. The computer has to send to the output digital-analogue converter that kind of data, which result in the output signal according to the above model. This is the Inverse Fast Fourier Transformation. At the receiving side the opposite operation, the Fast Fourier Transformation is applied. The 2k and 8k specify the number of fundamental points of the FFT applied to discrete signals.

Demodulation of the OFDM signal is made in the opposite sequence. In the first step the VHF-UHF band input signal is transposed to the 36 1/6 MHz IF frequency, and then it is sampled. The oscilloscope picture of the OFDM signal transposed to the IF frequency is shown in the left side of Figure 2. The bottom red curve is an enlarged part of the upper signal.

The sampling A/D converter delivers the $y_1, y_2, y_3, \ldots$ sample data, which describe the signal in the time domain. The data describing the behaviour in the frequency domain are obtained by subjecting them to Fast Fourier transformation. Here, in the frequency domain the frequencies of the carriers can be regarded as known, the needed data are the $u_1\text{-}\phi_1, u_2\text{-}\phi_2, u_3\text{-}\phi_3 \ldots$ series of data pairs, which describe the amplitude and phase states of the particular carriers. These data pairs retrieve us the bit combinations having been assigned to the particular carriers. In the demodulator, the number of obtained bits per carrier is 2 with QPSK modulation, 4 with 16QAM and 6 with 64 QAM.
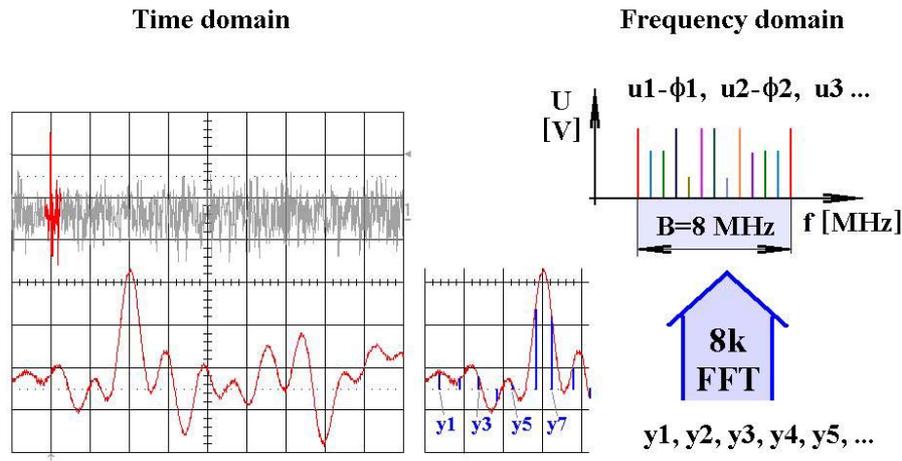
Figure 2
Sampling the OFDM signal and converting it into the frequency domain in the course of the demodulation procedure.

In course of the data separation after the Fast Fourier transformation, the data of the carriers carrying payload data can already be handled separately from the data of the pilot- and TPS carriers. When demodulating the OFDM signal, no data can be obtained until this point is reached. In order to reach this state, for implementing the Fast Fourier transformation, the demodulator must be informed of the signal frequency (e.g. 474 MHz), the signal bandwidth (e.g. 8 MHz), the size of the FFT to be applied (e.g. 8k), the value of the guard interval (e.g. 1/32) and the spectrum position (normal/inverse). In the demodulators all ways of solving this by auto mode are based on some trick, e.g. try method.

When continuing the demodulation from this point, the TPS data can already be read out, and the obtained data of the hierarchical mode, constellation and FEC can already used for automatic mode setting. The data of the pilot carriers will be used for improving the demodulation, removing the influence of the reflections etc. The block diagram of the OFDM demodulator is shown in Figure 3.
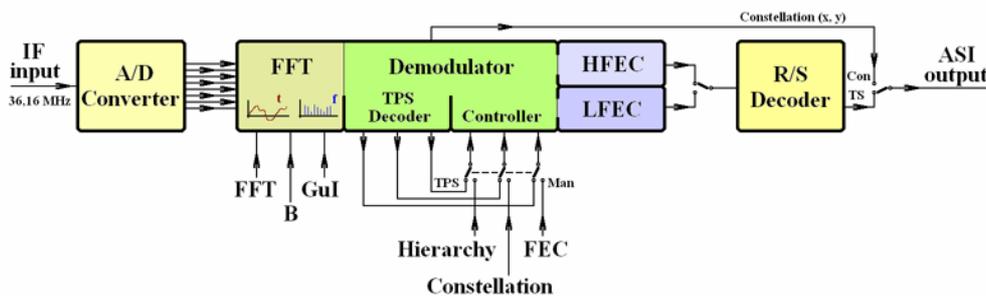

Figure 3
Block diagram of the OFDM demodulator used in the CW-4875 and CW-4876 devices.

The amplitude and phase data in the data stream delivered by the Fast Fourier transformation express the position of the carriers in polar coordinate system (u,ϕ). These data are then recalculated to x, y coordinates and the end points of the vectors represented by these x, y coordinates constitute the constellation diagram. In Figure 4, the constellation diagram for 16 QAM modulation demonstrates the states of all carriers. This constellation diagram shows - corresponding to the 16QAM modulation - 16 positions of the carriers, which forward the data. Figure 4. includes also the points representing the positions of the less known TPS carriers and the carriers used as pilots.
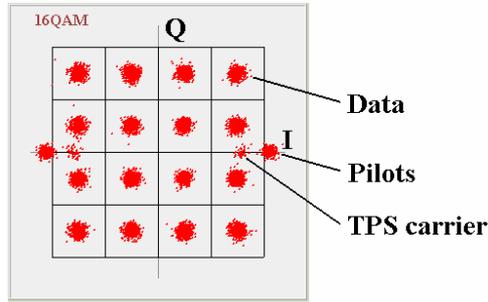
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Figure 4
Constellation diagram of the OFDM signal with 16QAM modulation of the 6048 payload carriers.
The diagram was taken with the use of the SW-4875 software.

With OFDM modulation, the carriers, which transmit the payload data are modulated according to QPSK, 16QAM or 64QAM. With QPSK modulation the transmission is the less sensitive to disturbances, but the amount of the transmitted data is the less, too. With 64QAM the amount of data, which can be transmitted is triple, but the sensitivity against disturbances is considerably larger.

The OFDM modulation permits by changing the constellation transmitting at the same time two transport streams instead of one. Of course, in this case the sum of both streams' data rates has to be the same as the earlier data rate was. The version, where two transport streams are transmitted is referred to as hierarchical modulation. Figure 5 demonstrates establishing hierarchical modulation. If the positions of the constellation points are not changed, but two transport streams are transmitted, the transmission is called α=1 level hierarchical transmission. If one of the transport streams is transmitted at higher signal level, than the other, the transmission is called α=2 or α=4 level hierarchical transmission according to the energy ratio.
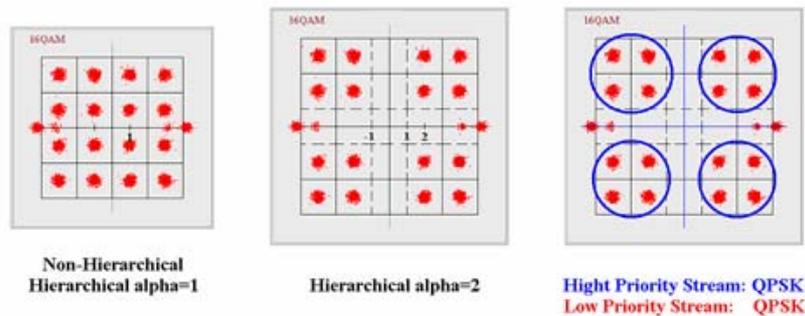

Figure 5
Establishing hierarchical modulation starting from 16QAM modulation.

With α=2 and α=4 hierarchical modulation, as a result of the surplus energy, the transmission of one of the streams will be more robust, that is less sensitive to disturbances, thus it can be send through larger distances. In Figure 5 the large blue circles illustrate the reinforced QPSK modulation and the QPSK modulation within with unchanged capacity marked with red.

At hierarchical modulation, the reinforced transmission is called high-priority path, and the weaker one low-priority path. In case of 16 QAM modulation, using hierarchical mode results in two QPSK transmission paths, that is, the 4 bits transmitted by each carrier will be transmitted through two paths of two bits each. In case of 64QAM, from the 6 bits transmitted by each carrier 2 bits will be transmitted through the high-priority path with QPSK modulation and the remaining 4 bits with 16 QAM modulation through the low-priority path.

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The OFDM modulation is used for terrestrial program broadcasting, where the adverse transmission conditions require also the use of the Viterbi error correction encoding beyond the Reed-Solomon error correction encoding. The kind of the Viterbi error correction encoding will be given by the extent of the Forward Error Correction (FEC). The FEC values used with OFDM modulation: 1/2, 2/3, 3/4, 5/6, 7/8. These fractional numbers (e.g. 3/4) give the payload data, if the whole amount of data is 1/1, and the difference is the amount of the error correction codes. The hierarchical transmission permits transmitting with different FEC values in the two transmission paths; for distinguish between the two FEC values the HFEC and the LFEC naming is used.

The measuring technology for the QAM and OFDM modulation applies mainly the parameters calculated from the constellation diagram. Most of the transmission parameters (S/N, jitter, carrier blow-out etc.) are calculated from the dispersion of the points representing the end points of the voltage vectors in the constellation diagram. Figure 6 shows the effect of white noise superposing to the OFDM signal.
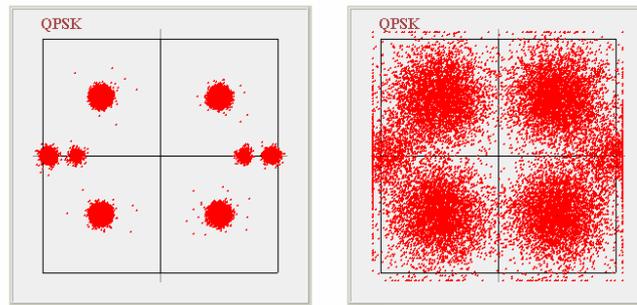

Figure 6
Effect of white noise superposing to the OFDM signal on the constellation diagram in case of QPSK modulation.

The most important and most precisely measurable parameter for qualifying the QAM and OFDM transmission is the Bit Error Rate (BER), which is the ratio of the erratic bits arisen in the course of the transmission to the total of transmitted bits. For quantifying the BER value the counters of the error correction circuitries are used. The OFDM demodulator at first tries to remove the errors arisen in the transmission path with the Viterbi error correction circuit, thus the first index number will be delivered by this circuit. The Viterbi BER measuring circuit shows the extent the processed input signal was found erratic to. This BER value is often called also BER value before Viterbi.

The output signal of the Viterbi error correction circuit is further processed by the Reed-Solomon error correction circuit, which corrects the remained smaller errors. In this circuit too, a counter indicates the number of the performed corrections. In case of good transmission the output signal of this stage must not contain a single error, therefore the Reed-Solomon BER value gives the BER between both error correctors, that is, before the Reed-Solomon error correction circuit.

At measuring both kinds of BER value, the crucial point is the duration of the measurement process. The data rate of the OFDM transmission is between 5 and 31.6 Mbit/s, depending on the mode, thus passing of just 100 Mbits of data needs several seconds. Consequently, examining the data of an amount of a single 100 Mbit and displaying the corresponding value of 1×10 E-8 magnitude needs a measuring time of 3 … 20 seconds. Measuring even better BER values needs the severalfold of this duration. The measuring time is especially long in case of low speed OFDM modes and at calculating average from multiple measurings.

2.   Setting the reception parameters of the OFDM demodulator

On clicking the SW-4875 icon on the desktop, first the user interfaces of the four demodulators appear. Click the Query button to ascertain the working connection between the device and the computer. The connection can be considered working if the name and type number of the device are displayed correctly. On the query also the state of the Output Selector is displayed.

The OFDM Demodulator and its managing software have been designed for use in large complex systems too, therefore without the operator's instruction the device and the computer does not communicate with each other, except for the communication conveyed by the Windows Network Manager.

Reading out the settings

The OFDM Demodulator has been designed for professional applications, where the device operates in 24 hours continuous run, and reading out the settings or making regular inspection should not cause any perceivable disturbance in the output signal of the device. The computer connected to the device and the software always start with Read only mode and so they do not change the settings of the device. The operator can freely check up the settings and transmission parameters of the four demodulators at the same time. Reading out the data can be requested in two modes. In Single mode the operator initiates reading out the data with clicking the Read from Device button. When selecting perpetual read-out by clicking the "Repetition time 1 sec" button, the software reads out and displays on the screen the actual data in every second. The software always offers the Single mode first.

Note: The demand for fast operation and the usability in large systems required the very fast answer of the device on the data read out instruction. Measuring several parameters needs long time, therefore at reading out the data the device always delivers the data gathered after the previous read out instruction, and starts gathering new data just after this. Therefore to get fresh data query them twice. In Continuous mode this cannot be perceived.

Storing the settings

The SW-4875 software provides four separate memories of 10 cells each with M0 … M9 numbering for storing the preset data of the four OFDM demodulators. The M0 cell is occupied, because at reading out the data will always be written in this cell. For the demodulation of the signal of OFDM transmitters the demodulator needs to get a set of data, which must not include any error. The user's task is to gather in the M1 … M9 cells the data of the DVB-T transmitters to be received most frequently, and to get out them from here when programming. The data set of the M0 cell is stored in the device, whereas the data of the M1 … M9 cells are stored in the computer. Users operating more than one device can use this database for any of their devices. The connection of the memory cells is shown in Figure 7.
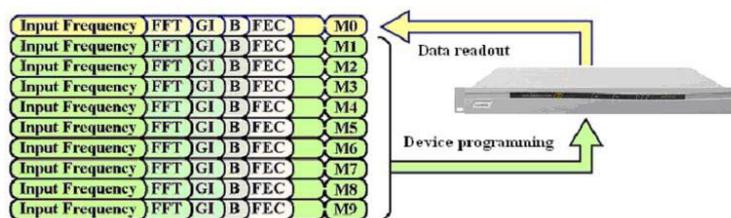
Figure 7
The connection of the data storage cells belonging to one OFDM demodulator module

Note: The data storage cells can be selected by clicking the Frequency roll-down list. All of the stored data are associated with the input signal frequency. To a particular frequency value multiple settings can be associated if this frequency will be enrolled more than once. To any of the settings an identifier text can be attached, too.

Setting the Input Frequency

The IF frequency of the OFDM demodulator is 36 1/6 MHz. The input signal has to be transposed to this frequency as accurate as possible, because the frequency pull-in range is not more than ±90 kHz. The OFDM signals are very sensitive to phase noise therefore tuning of the oscillator in the front end has to be made with the highest possible reference frequency. The oscillator of the front end can be tuned in 1/6 MHz, 62.5 kHz and 50 kHz steps (raster). The best quality is achieved when using the 1/6 MHz raster, therefore use this raster unless some other factor requires to change it.

For setting a receiving frequency, let the list roll down and click the cell, which you want to use for storing the data. The memory cells always store some data empty cell does not exist. Then set the frequency with stepping: the upper fast buttons change the frequency in 10 MHz steps, whereas the fine buttons below in steps preset by the user with the R (Raster) button. The adjustment range of the fine adjuster is 10 MHz, with -2 and +2 raster overlap at the ends. On over passing the extreme value, the fine adjuster changes to 10 MHz steps. After having set the desired value, the device stores the value along with the raster value automatically.

Setting the raster frequency

If only possible, use the 1/6 MHz (166 kHz) raster; this raster permits setting any standard value. The raster is changed with clicking the R (Raster) button.

Changing the raster may become necessary if for some reason the input signal will be transposed not to the 36 1/6 MHz IF frequency, in order to be precise not in the mid of the ±90 kHz pull-in range. The frequency error is displayed in the Measuring Platform. The possibility of changing the raster has been included eminently for being used by designers and professional users.

Setting the channel bandwidth

The Channel Bandwidth roll-down list offers 6, 7 and 8 MHz bandwidth. In the course of developing and manufacturing, due to lack of measuring instrument only the 8 MHz mode was tested. Remember, that with incorrectly set bandwidth data the demodulator cannot start up!

Setting the FFT size

The FFT Size roll-down list offers 2k, 8k and Auto mode. In the theoretical description it was discussed that auto mode can only be established by using some kind of try method, therefore in Auto mode the recovery time of the demodulator is longer. If the FFT size of the transmitter is known, set this value; use Auto mode when searching only. With incorrectly set FFT size data the demodulator cannot start up!

Setting the Guard Interval

The Guard Interval roll-down list offers 1/32, 1/16, 1/8, 1/4 and Auto mode. In the theoretical description it was discussed that auto mode can only be established by using some kind of try method, therefore in Auto mode the recovery time of the demodulator is longer. If the Guard Interval used by the DVB-T transmitter is known, set this value; use Auto mode when searching only. With incorrectly set Guard Interval data the demodulator cannot start up!

Setting the spectrum position

The roll-down list offers Normal and Inverse position. In the course of transposition the spectrum makes a turn, but this was taken into account at writing the software. Thus setting the Normal position is suitable in most cases, Inverse mode is needed in uncommon systems only. With incorrectly set spectrum position the demodulator cannot start up!

Using the TPS

After having finished setting the above parameters, support can be used for setting the further ones. In the OFDM signal in 2k mode 17 carriers, in 8k mode 68 carriers are assigned for signalling the parameters of the transmission (Transmitter Parameter Signalling – TPS).

If the "Use TPS" checkbox is checked, the demodulator reads out the data of the TPS carriers, and sets the QAM constellation, the parameters of the hierarchical mode and the FEC (Viterbi error correction) mode according to the read out data.

Precondition for the right operation is that in the DVB-T transmitter the TPS data are set according to the actual mode. Using the TPS does not considerably increase the recovery time of the demodulator.

Modulation

The QAM constellation of the payload carrier is set in the Modulation roll-down list. The offered values are: QPSK, 16QAM and 64QAM. Auto mode can be accessed by using the TPS.

In case of setting wrong modulation data, the first stages of the demodulator will report in the upper message box on right operation (Frequency Error, Frequency Recovery, Time Recovery, TPS Decoder - OK), but the chain of demodulation breaks here, and Demodulation – false will be displayed.

Hierarchy

In the theoretical description it was discussed, that in hierarchical mode two separate transport streams would be transmitted by the DVB-T system. These both paths have to be handled separately. The OFDM demodulator module demodulates one or the other path according to its setting. If the signals of both paths are needed, two demodulator modules of the quad have to be used. One of the demodulator modules has to be set to demodulate the high priority path, the other the low priority path. In these days the Non-Hierarchical mode is widely used yet. Its demodulated signal is retrieved in the high priority path.

The parameters of the Hierarchical mode are set in the roll-down list. Auto mode can be accessed using the TPS.

HFEC, LFEC

In the HFEC and LFEC roll-down lists the mode of the Viterbi decoder has to be set. HFEC is the setting list for the high priority path, LFEC is the setting list for the low priority path.

In non-hierarchical mode the HFEC box has to be used. Auto mode can be accessed with using the TPS. With wrong setting of the hierarchical mode and the FEC, Demodulation – false will be displayed, alike as with wrong setting of the QAM constellation.

Output Stream

The transport stream output of the OFDM demodulator and the connected ASI output can be set to deliver diverse output signals. Selecting the desired output signal is the task of the user. When selecting the demodulated transport stream, the signal of the high priority and the low priority demodulator path can be selected. In non-hierarchical mode the high priority TS has to be set.

Instead of the transport stream the demodulator can be set to deliver the x, y coordinates of the constellation diagram. In this case the coordinate data will be delivered built in a series null bytes as OFDM symbols, which have to be interpreted as signed bytes. This mode permits professional users to calculate numerous transmission parameters, and using the device as a special measuring instrument. The 1.0 version of the software has not been made complicated with delivering more kinds of data.

The output signals of the OFDM demodulators always appear at the output in packets by symbols (burst format) due partly to the guard interval, partly to the mathematical methods used at the demodulation. In order to deliver the ASI output signal in the most possible continuous form, the parallel output of the demodulator is made free of burst using the signal of the 53 MHz sampling oscillator. The applied procedure results in a quite continuous output signal, with a jitter identical with the period time of the clock signal. Of course, the ASI transmission adds to this value its own jitter, which is even larger. In spite of the jitters, this parameter of the device's output signal can be said to be eminently good as the DVB-T technology is regarded.

Pulse Killer

The manufacturer of the OFDM demodulator chip worked out an algorithm for decreasing the effect of strong but short impulse like disturbances in the transmission. The efficiency of this algorithm referred to as Pulse Killer can be seen in the improvement of the BER and the decrease of hitches in picture and sound. Adequacy of its use under the given conditions can be justified in experimental way. The Pulse Killer can be switched on by checking its checkbox.

Loading the program into the device

At starting, the software sets the operation mode of all 4 demodulators to Read Only. This assures that connecting the computer to an operating device its operation will not be disturbed. For querying the actual status of the device it is advisable to make at least two queries in single mode or to switch continuous querying.

When setting some of the demodulator modules to programming, the querying will be stopped and the module waits for receiving the user's instructions. Select any of the M1 … M9 user storage areas, if necessary, modify the data stored here, and then load the program with clicking the Load Program button. The data of the memory cell will be modified in the memory of the computer and will be written in file at exiting the software only.

Storing the operating program in the device

In most of the applications the user would like the device to continue working in the preset state after power switch off and switch on. For this, the settings have to be stored in the device's EEPROM, too. For saving the parameters in EEPROM, set them to the desired value, click the Store button and only after having made this load the program with clicking the "Load Program" button. Execution of the saving procedure is indicated by turning the inscription of the Store button to black.

The four demodulators can be programmed independently from each other. Experienced users may program more than one module at the same time, but at first programming one by one is recommended. After having finished programming return to Read Only mode and query the result of the programming. Query cannot be requested until any of the modules is set to programming.

Entering the identifier of the setting

The software permits attaching identifiers of at most 200 characters to the settings stored in the memory cells M1 … M9. The text is to be written in the uppermost textbox after having been selected any of the M1 … M9 cells in programming mode. When starting to write, the colour of the textbox changes to bluish. Saving is made with the Enter button; after saving the colour of the box changes to white again.

The first 40 characters of the text written in the box will be saved in the device, too. When querying the settings, the box already shows these characters.

Standby – Power on

In several applications it may happen that one or more OFDM demodulator modules are provisionally not used. When setting these modules to Standby mode, the current consumption of the Digital Signal Processor decreases by 105 mA. The 350 mW decrease in the power consumption of the DSP considerably increases its duration of life, thus for not used modules setting Standby mode is recommended.

Note: Operation of the DVB-T systems considerably differs from that of analogue systems. For operating the OFDM demodulator, a large set of mathematic formulas and data have to be given to the processor. The demodulator makes efforts by using these to go ahead step-by-step and produce the output signal. When due to the break of the input signal or to other disturbances the procedure of demodulation breaks, the operation can be continued with a full restart only. The internal processor automatically provides for launching the restart but the procedure takes considerable time (<1 sec).

After switching on the supply voltage the microprocessors are reset, and loading of the operating code of the FPGA circuits follow. Then the microcontrollers load the operating program of the DSPs and configuration of the OFDM demodulators can start. Appearance of the actual ASI output signal can be expected after 10 sec only.

Reset

From the computer a global Reset instruction can be sent out to the devices, on which except for a single microcontroller controlling the procedure, all FPGAs, DSPs and microcontrollers receive a reset instruction, their program will be loaded again, and the device starts operation quite as if it would have been switched on now.

If the user would like to make sure about the mode the device starts working after a voltage break and the procedure of recovery, it can be tried out with a Reset instruction sent out from the computer. Since in this case the power supply does not need to recover, the recovery time will be less than 10 seconds but longer than 6.5 … 7 seconds.

3. Querying the operating state of the demodulators from the device

The user has to accustom to the fact, that in case of devices controlled from computer through bus, the computer has no continuous contact with the device, thus change of the parameters displayed on the screen is not continuous. Query of the data has to be initiated by the user. With setting continuous querying, which repeats in every 1 second, the feeling of the continuity can be restored, but this mode may disturb others' work or the run of our software working simultaneously.

The operational data read out of the OFDM demodulator can originate from following sources:

- Parameters set by the user (e.g. B = 8 MHz) will be distinguished in the display with the „R" or „Read" prefix.
- There are parameters, whose setting can be allotted to the automat built in the demodulator, by selecting Auto mode. Parameter values set by the automat are displayed with „Auto" prefix, values set manually are marked with „M", „Man" or „Manually" prefix.
- The third group of parameters can be set also by using the TPS. Parameters set with using the TPS data, the displayed value is marked with the „T" or „TPS" prefix.

Quick information about the operating status of the OFDM demodulator is given in the colour field on the left of the Measuring Platform button. Depending on the stage of establishing the demodulation procedure the display colours are:
- Red field with „Unlocked" inscription indicates that no stage of the demodulator can process the signal.
- As the FFT can process the signal, the field changes to yellow and the „Locked" inscription appears.
- When the TPS decoder considers processing of the TPS data successful, the inscription changes to „TPS Locked".
- The field changes to green if the whole demodulation procedure seems to be successful.

More detailed information about the demodulation procedure is given in the upper message box, which informs of following data:

Frequency Error

The input signal has to be transposed for the OFDM demodulator to the 36.166 MHz intermediate frequency. If due to DSP frequency discrepancy the demodulator cannot demodulate the signal, it displays the detected difference with the values $\pm1/6$, $\pm2/6$ and $\pm3/6$ MHz. These fractional numbers are displayed as 166, 333 and 500 kHz.

Frequency Recovery

In the theoretic description it was discussed that in the digital technology conversion has often to be made between the time and frequency domain. When in the demodulator the Frequency Recovery Algorithm is synchronized successfully, "OK" inscription appears in the display.

Time Recovery

When the Time Recovery Algorithm is synchronized successfully, "OK" inscription appears in the display.

TPS Decoder

When the OFDM demodulator succeeds in converting the data series of the input A/D converter from the time domain in the frequency domain, the possibility opens to demodulate those carriers carrying TPS data. The TPS decoder indicates the successful demodulation with "OK" inscription.

Demodulation

When entering the frequency domain, prior to retrieving the transport stream numerous circuitries have to be operated correctly. If all of them are set properly and all of them send "OK" reports to the DSP, the overall report for the whole demodulation procedure will be "OK", too.

Output signal

Setting this parameter will cause the most trouble to those not much experienced in the OFDM technology, especially because the efforts for miniaturizing required the multipurpose use of the transport stream output. The message box shows the task the DSP has been programmed to. In the most frequently used Non-Hierarchical mode, transport stream is delivered at the ASI output if the inscription appearing here is "High Priority TS".

Estimated VBER

After this inscription quick information is given about the BER at the input, before the Viterbi error corrector. In the message box – being read out of a table – an inscription describing any of 26 different ranges can be expected. Do stand for achieving the lowest possible value in the display.

Estimated S/N

Quick display of the S/N value. In the best case the measuring circuitry reads 24.1 dB, do stand for achieving this value. The S/N values between 0 … 24 dB are calculated with merely mathematical methods, the resolution is coarse, but in the digital technology the user has to get accustomed to these kinds of technique. The designers of the software did their best to display the most possible numerical data, which may be needed in professional applications.

DVB-T transmitter identifier

After reading out the data of the device, in the uppermost textbox displayed are the first 40 characters of the identifier text entered by the user.

Preset data of the OFDM demodulator

After the readout cycle the whole message box area reads the data having been read out of the device. The data will be written also in the M0 memory cell, thus in programming mode these data can be found in the M0 cell.

4.   Measuring the transmission parameters

The SW-4875 software permits the OFDM demodulator to be used as measuring instrument. The measuring functions can be accessed with one demodulator module at the same time, but all four modules provide this function. Except for the constellation diagram, all parameters even the analysis of the transport stream can be carried out without disturbing the operation of the OFDM demodulator, without disturbing the continuity of the output signal.

Note: Displaying the constellation diagram requires stopping the operation of the demodulator and modification of the settings. When displaying the constellation diagram, the device cannot deliver transport stream.

Output Selector

In front of the four independent ASI outputs a selector is built. The signal of the output selected with this selector, can be transmitted via CW-Net in the computer to be analysed, recorded, reproduced etc. there or even converted in IP environment. The details are to be found in the descriptions of the CW-Net system and the use of the pieces of software.

For analysing the transport stream etc. stop the repeated queries, set the selector in the desired position, and now by the IP address the selected signal is available for any other piece of software. The output selector can be set also with other pieces of software, e.g. the TS Analyzer, TS Remultiplexer software etc.

When at opening the Measuring Platform the software senses the selector being set not to the output of the selected demodulator, it stops the repeated queries and reprograms the output selector.

In order to have the output selector always in the preset position also without computer (e.g. the signal of one output should continuously be converted in IP environment) click the Store Selector button.

Note: Through the CW-Net system at the same time one device can work with one piece of software only. If a part of the software is set e.g. to continuous query, the other part of the software (Query, Output Selector etc.) can only access the device if it stops the queries and takes over the control over the device. This applies also when running pieces of software parallel. When instructing the SW-4811 TS Analyzer software to play the TS, the SW-4875 software cannot be instructed to continuously query the data. The computer is allowed to run multiple pieces of software at the same time, multiple pieces of software can be open at the same time, but only one of them is allowed to give the device instructions at the same time.

TS Off

Mainly beginner users may set the OFDM demodulator using another software to "Send TS" mode (e.g. for reproducing the picture and sound) and later they forget to switch off this mode (e.g. they disconnect the CW-Net cable or get lost between the pieces of software etc.). In this case the device cannot react to instructions until the Send TS mode is switched off. With clicking the "TS Off" button sending TS can be stopped.
(Note: this operation sends the „Do not Send TS" CW-Net instruction, which can be used to other devices, too.)

Measuring Platform

Clicking the Measuring Platform button opens a new user interface. Here querying the data can be initiated in the same way as in the previous one. When setting the Output Selector is not required, the preset state does not change. The Measuring Platform offers following three display modes to the user:

- TS + BER: Displaying the BER data without disturbing the output transport stream.
- TS + TPS: Displaying the TPS data without disturbing the output transport stream.
- Constellation: Displaying the constellation diagram with stopping the output TS.

TS + BER

In this mode the device displays in a diagram the BER values before the Viterbi and Reed-Solomon error corrector circuitries. In the Viterbi error corrector examination of the data is made in $1.3 \times 10E6$ packets, the measuring circuit gives displays between $1 \times 10E-1$ and $1 \times 10E-6$. In the Reed-Solomon error corrector examination of the data is made in $1 \times 10E7$ packets. In case of errorless data packet the display will be $0 \times 10E-7$.

Resolutions better than $0 \times 10E-7$ can only be achieved with averaging repeated measurings. In case of detecting 10 successive errorless data packets the BER can be stated being better than $0 \times 10E-8$, after 100 packets $0 \times 10E-9$, and so on. This averaging is made by the computer for the user, the results of the calculations are shown in the diagram with thin red line.

The diagram stores the results of 1200 measurements; after this amount the computer automatically clears the diagram and starts the series of measurements from the beginning again. The whole BER measuring system can be cleared to zero with the Clear BER button. The average of the R/S BER and the extreme values of the series of measurements are shown in the bottom table.

Repetition time of the measurements can be set to 1 or 3 second. 1 s repetition time permits the transmission and recording of a period of 20 minutes, 3 s repetition time permits the transmission and recording of a period of 1 hour. The diagram can be dragged with the mouse. A square drawn with pushed left mouse button enlarges or restores the original size according to the direction of drawing (see in the description of Windows XP).

The Reed-Solomon error corrector examines packets of $1 \times 10E7$ size. The repetition time has to be set to leave at least 100 ms time after passing the packets for carrying out the read cycle. E.g. at an OFDM transmission of 5 Mbit/s data rate passing of just 10,000,000 bits need 2 seconds, thus a repetition time of 1 s cannot be used. At extremely low data rates use the Single mode.

TS + TPS

From BER measuring it can freely be switched to view the data displayed by the TPS Analyzer and the Demodulation Analyzer.

TPS Analyzer

The software permits the examination of the whole amount of TPS data. The data are to be interpreted according to the ETSI EN 300 744 v1.4.1 standard.

Demodulation Analyzer

In the course of OFDM transmission, the required information can be retrieved from the obvious input signal by using complicated mathematical techniques only. These techniques require the physical parameters of the input signal to comply accurately with the postulations given in the mathematical formulas. The Demodulation Analyzer signalises in both the time domain and the frequency domain the difference between the theoretical data and the effective physical quantities. The time error is displayed in ppm ($1 \times 10E-6$), the frequency error in Hz.

The S/N reading of the Demodulation Analyzer is identical with those displayed in other platforms. The Digital Gain display reads the gain adjusted by the DSP after the various corrections before the FFT. Try to keep this value at the less possible value (e.g. with adjusting the antenna position, removing the reflections etc.).

Constellation

Displaying the constellation diagram requires the output of the demodulator to be programmed to deliver the constellation data instead of the transport stream. If not doing so, the TS data go to the display and a mess of dots will be seen only, what otherwise does not cause any error. Selecting the proper constellation mask is the task of the user.

The dots of the constellation diagram get to the display through the TS line. Through the ASI output the user can use these data for calculating further transmission parameters. These data can be accessed in the simplest way by the TS Analyzer software.

A too large amount of constellation points can draw huge smudges to the display. Usually 3-10 readout cycles are enough for a suitable display. The constellation diagram can be cleared with the Clear button even during being drawn. The "Measured Parameters" selector can be switched over also during repeated readouts. Until the constellation diagram is being drawn drawing the BER diagram is pausing.

Note: In lack of measuring signal, the constellation mask for the hierarchical mode has not yet got ready, thus its functioning has not been tested.

After examining the constellation diagram it is practical to set back the demodulator to deliver transport stream not to impede the further signal processing.

5. General information

Dear User!

With designing the CW-Net system we wished to give a tool to your hands, which permits you to be as familiar with the digital television technology as you were earlier in the analogue technology. With developing the Quad receiver family we offer advanced and economic receivers for receiving the DVB-S, DVB-C and DVB-T signals. Beyond the FTA versions we have in our range also the versions equipped with Common Interface (CI) for receiving scrambled transmissions. For programming these CI modules we designed special software, thus if you finished programming the receiver, change to the CI programmer software and set the required parameters of the CI.

With our software we aspire to go to meet your demands. The pieces of CableWorld software constitute a large system and nearly any of them can be used with any device. After you finished setting up the OFDM Demodulator and the transport stream has just appeared at an output, run the SW-4811 TS Analyzer software and analyze the TS, reproduce the picture or examine the PCR. If you feel like, run the TS Remultiplexer software and using its analyzer part make a protocol of the TS. If you are connected to a computer network, transmit an output signal of the just started OFDM Demodulator to your colleagues so that they can enjoy the programs on their computers.

We hope to have succeeded in arousing your interest in our system and we will meet and work together in more fields in the near future. If you feel like to write own software for controlling CableWorld products, you can reckon with our utmost support. Your questions, ideas and suggestions are always welcomed at cableworld@cableworld.hu.

The CableWorld team.