SW-4871 QPSK Demodulator *Quad*

Set-up and control software for the CW-4871, CW-4872, CW-4971 and CW-4872 QPSK Demodulator Quads, the version 1.02 for the CW-4871-S2, CW-4872-S2, CW-4971-S2, CW-4972-S2 DVB-S2 Demodulator Quads and the CW-4871-S2S, CW-4872-S2S single Demodulators. The changeover of the demodulator functions between the former (QPSK) and the new (S2) can be selected in the View menu. If there are both QPSK (DVB-S) and DVB-S2 demodulator modules inside the equipment please first of all use the "Read from Device" command to get information on the actual configuration. The program recognizes the type of each modules automatically and sets the correct programming environment.

Instruction Manual

The SW-4871 QPSK Demodulator Quad Controller has been designed for controlling the CW-4871 FTA version and the CW-4872 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 on 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. Installing the SW-4871 software is simple; running the setup exe. It needs no more software.

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

- Install the software on the computer by running SW_4871_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.   Main features of the QPSK signal transmission

The satellite signal transmission according to the DVB-S standard uses QPSK (**Q**uaternary **P**hase **S**hift **K**eying) modulation for transmitting the base-band MPEG2 data. The main point of this kind of modulation is creating bit pairs from the data, whose four possible variations are represented by the four phase position of the carrier, referred to as symbol (the resulting constellation diagram is shown in Figure 1).

Upon the above, e.g. the widely used 27.5 MSy/s symbol rate corresponds to 55 Mbit/s data rate.

In order to prevent the distortion of the information due to the noise of the transmission channel, the data to be transmitted are previously supplemented with data, which (within certain limits) permit the correction of the errors at the reception side. This technique is referred to as **F**orward **E**rror **C**orrection (FEC). The FEC is the complex of the external (Reed - Solomon) and the internal convolution (Viterbi) error correction procedures.

The efficiency of the convolution error correction procedure can be adjusted to the expectable noise by choosing the proper value of the five code ratios allowed by the standard. E.g. the Viterbi code ratio of 3/4 means that from 3 input bits the procedure generates 4 output bits. However, the larger tolerance against noise has to be paid for with the decrease of the useful bandwidth.
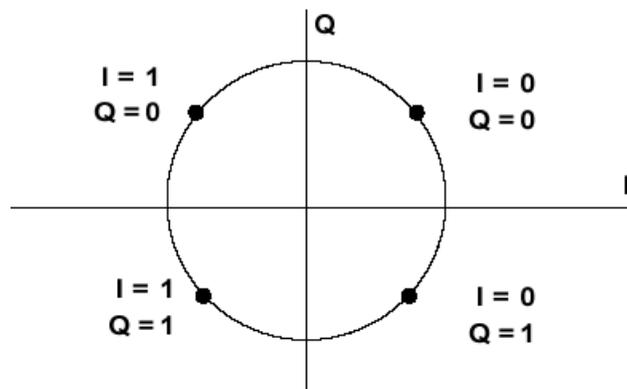

Figure 1
Constellation diagram of the QPSK signal

When qualifying the QPSK transmission the most important and most accurately measurable parameter is the Bit Error Rate (BER), which is the ratio of the bits becoming erratic in the course of the transmission and the total of the transmitted bits. For quantifying the BER, the counters of the error correction circuitries can be used. The QPSK demodulator first tries to remove the errors of the transmission path using the Viterbi error correction circuit thus the first value is delivered by this circuit. The Viterbi BER-measuring circuit shows the grade, at which the processed signal was found erratic. This value is often referred to as BER before Viterbi.

The output signal of the Viterbi error correction circuit is processed by the Reed-Solomon error correction circuit, which has to correct the remained errors. It is able to correct at most 8 erratic bytes per packet. This circuit also has a counter, which indicates the number of corrections. In case of good transmission the output signal here does not contain a single error, therefore the Reed-Solomon BER value is the BER value between both error correctors, that is, before the Reed-Solomon error corrector.

At measuring both kinds of BER value, the crucial point is the duration of the measurement process. The data rate of the QPSK transmission is between 4 and 90 Mbit/s, thus passing of just 100 Mbits of data needs more than one second. 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 2 … 3 seconds. Measuring even better BER values needs the severalfold of this duration.

2.   Setting the reception parameters of the QPSK demodulator

On clicking the SW-4871 icon on the desktop, first the user interfaces of the four demodulators appear beside each other. 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 and the version number of the CW-Net Controller are displayed.

The QPSK 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 QPSK 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 2 sec" button, the software reads out and displays on the screen the actual data in every 2 seconds. 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-4871 software provides four separate memories of 10 cells each with M0 … M9 numbering for storing the preset data of the four QPSK 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 QPSK transmitters the demodulator needs to get a set of data, which must not include any error.
For receiving a satellite channel following data have to be given to the QPSK demodulator:

- Local oscillator frequency of the applied LNB (in MHz).
- Frequency of the transponder to be received (in MHz).
- Symbol rate (in kS/s).
- Code ratio of the Viterbi error corrector (auto mode is also available).
- Identification data of the channel (e.g. name or other data, not absolutely needed).

The user is recommended to gather the data of the satellite channels to be received most frequently in the M1 … M9 cells, and retrieve them from here when programming. The M0 cell always stores the data set read out of the device for the last time. The data of the M0 … M9 cells are stored by the computer in the QPSKdata.dat and QPSKdstr.dat files. Of course, operators using multiple devices can use this

database for any of the devices. The interconnection of the memory cells is shown in Figure 2.
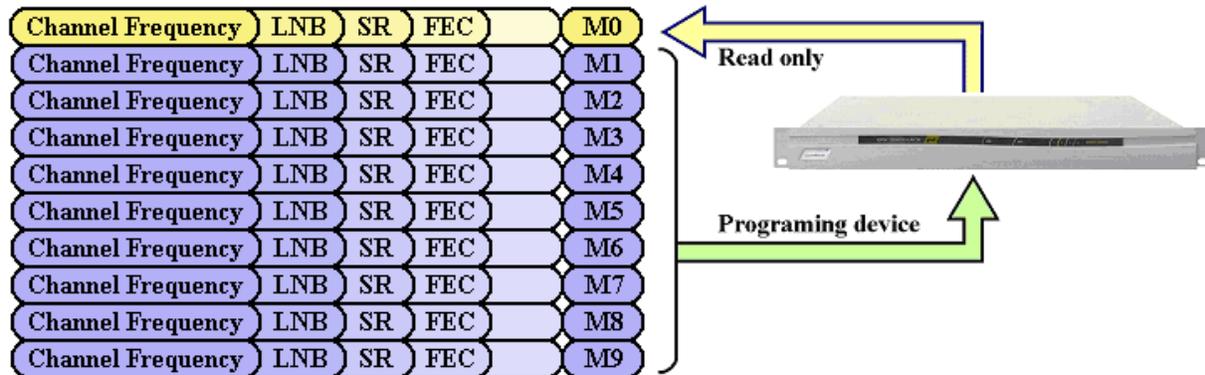

Figure 2
Interconnection of the memory cells storing the data of one QPSK demodulator module each.

Note: The data storage cells can be selected by clicking the Channel Frequency pull-down list. All of the stored data are associated with the input signal frequency. To any of the settings an identifier text can be attached, too.

Setting the Channel Frequency

At the receiving side the block converter (LNB) transposes the QPSK signal in the 950 … 2150 MHz frequency band of the demodulator (SAT IF). It is the user's task to set the frequency of the LNB for transposing the channel to be received in this frequency band. The demodulator is suitable for receiving both the Ku and the C band. Due to the applied advanced technology, the device contains no further internal IF stage, the signal is transposed directly in the base-band.

The SW-4871 software provides 9 memory cells to each of the four QPSK demodulators for storing the parameters of the channels to be received. For setting the Channel Frequency, first click one of the M1 … M9 cells, to select the memory for storing the parameters.). The stored parameters will be available here, by clicking the row of the cell.

After selecting the storing place type the frequency value in MHz. When typing, the colour of the data box changes to yellow. For storing and processing the data hit „Enter".

In the uppermost text box an identifier text of max. 200 characters can be attached to the actual setting. The first 50 characters of the identifier will be stored in the device, too. Remember to hit „Enter" for entering each data, otherwise the data will not be processed!

Setting the LNB frequency

After having selected the storage place for the Channel Frequency, set the LNB frequency. The software permits setting following five frequency values:
1.   9,750 MHz
2.   10,000 MHz
3.   10,600 MHz
4.   10,750 MHz
5.   User defined value.

When typing a data in the data box, it will be written in the 5th row of the pull-down list. Processing and storing the data is initiated by hitting „Enter". The fixed LNB frequency values are selected by

clicking the referring row of the list.

For checking up the correct data entry, click the desired item of the Channel Frequency pull-down list.

Checking up the correct entry of LNB Frequency and Channel Frequency

Setting of the LNB Frequency is correct if the channel to be received will be transposed in the 950 … 2150 MHz frequency band. After setting any of these data, the software always checks up if this condition is fulfilled. In case of error the colour of both boxes changes to red. Removing the error by setting the correct data is the task of the user.

Setting the Symbol Rate

After setting the Channel Frequency type the symbol rate of the signal to be received.
This value must be between 2,000 and 45,000 kS/s. The typed data will be entered by hitting the „Enter" key.

Setting the FEC value

For setting the FEC value, click the desired item of the pull-down list. When selecting a fixed value, the QPSK demodulator tries to demodulate the signal in manual mode using the preset FEC value. In Auto mode it automatically searches the right value.

Note:

Since due to theoretical reasons the automatic search of the FEC value can only be done with trials therefore in Auto mode the recovery of the demodulator is longer. In Auto mode the demodulator tries to demodulate the signal with all FEC values successively, and stops at the value, where the best BER is resulted. In case of good signal quality these trials lead quickly to the right result, but with poor reception and disturbances at the limit of reception the drop-outs are much shorter with manually set FEC.

It is practical to use Auto mode at the first setting for searching only, and after having found the right parameters, finalize the setting in manual mode.

The length of time needed for the synchronisation of the demodulator's internal circuitries to the input signal (lock) highly depends on the symbol rate. At very low symbol rates (2000 … 5000 kS/s) lock can need last even 25…30 sec; with high symbol rates lock occurs within 1 sec.

For the stable operation and reliable lock of the demodulator (especially with low symbol rates) use high quality low noise LNB.

Standby / Power On

It may occur that from the four independent demodulators one or two are temporarily not needed. For both saving energy and increasing reliability, the not used QPSK demodulator modules should be switched to Standby mode. The demodulator module is to be switched on and off from the GUI, and the switched state has to be saved with the Store button.

Loading the software in the device

At starting the software sets all four demodulators to Read only mode. This assures, that connecting the computer to the operating device, its operation will not be disturbed. The actual state of the device can be queried in Single mode or setting the Continuous mode.

When setting any of the demodulator modules to programming mode, 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 to Device 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.

On clicking the Load Program to Device button, the device starts to operate with the loaded data but it does not save in its EEPROM. This kind of program loading is very useful at experimenting and trying different variants.

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. On clicking the Store button, the setting will be written in the EEPROM too, and at switching on the device, it will start operation with these data. The EEPROM can be rewritten 1,000,000 times. For finalizing the settings this way of program loading is recommended.

Both ways of program loading effects those QPSK demodulator modules set to programming mode, and not for those being in Read Only mode. The Store button saves the data at one module only at the same time. Program loading without saving can be made also at multiple modules at the same time.

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 selected any of the M1 … M9 cells in programming mode. When starting to write, the colour of the textbox changes to yellow. Saving is made with the Enter button; after saving the colour of the box fades.

The first 50 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.

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 circuitries 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 of 5 … 6 seconds can be expected.

Output Selector

The CW-Net system permits any of the output streams of the four QPSK demodulators to be directly inspected and reproduced using the computer. From the four output signals the one selected with the Output Selector is transmitted to the computer upon the instruction of the software running in the computer.

The output signal to be converted to IP environment also can be selected with the Output Selector.

TS Off

When inspecting, reproducing or sending in IP environment the output streams, it may happen that the device is left in sending transport stream mode. In this mode the parameters cannot be queried or modified. This state, sending transport stream can be ceased with the TS Off button. This button is needed in exceptional cases only.

Using the AFC

In the course of locking, the demodulator changes the values of the symbol rate and the carrier frequency in determined steps starting from their preset nominal values until the full locked state will be achieved. In most cases this does not mean that these parameters were set to the centre of the hold-in ranges in the course of the locking procedure. The AFC function, which gets active after lock, will set the symbol rate and the carrier frequency to their optimum values, check up them periodically and modify them if necessary. In this way the demodulator can follow the changes in the LNB oscillator frequency due to changes in the temperature and assure the stable operation even at noisy reception.

Due to the structure of the applied circuitry, optimising the parameters causes short breakdowns in the demodulation procedure, where the output transport stream breaks for a moment, too.

All these occur after a few seconds after lock. Later the AFC function gets only active at a considerably change in the LNB oscillator frequency (approx. +/- 500 kHz) or at the change in the symbol rate.

Should the AFC work too often, due to some external disturbance, its operation can be disabled by unchecking the AFC checkbox.

Transport Error Indicator

The header of the transport packet, after the sync byte, includes the transport error indicator bit. Its "1" value indicates at least one not correctable error in the given packet. The demodulator is able to set this bit automatically. For this check the „Transport Error Indicator" checkbox in the GUI. If doing so, in the case of a not correctable packet the demodulator module sets the in the header the indicator bit to "1", marking the erratic packet for the further signal processing units, which expectably will be discarded by them.

In certain cases discarding the packet would cause larger visible error in the picture, then processing it; in such cases this feature should be switched off.

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. On clicking the Read from Device button one querying occurs. With setting continuous querying, which repeats in every 2 second, the feeling of the continuity can be restored, but this mode may disturb others' work or the run of our software working simultaneously. It depends on the applications running parallel, which querying mode should be used.

At querying following parameters will be displayed:

- Frequency of the applied LNB (in MHz).
- Frequency of the received transponder (in MHz).
- Actual frequency of the input signal in satellite IF (in MHz)
- Symbol rate (in kS/s).
- FEC code ratio (in Auto mode the value considered right).
- Channel identification data (the first 50 characters of the identification text having been entered by the user).
- Standby / Power On operational state.

Signal Strength and Input Level

The QPSK demodulator indicates the amplitude of the input signal with a number between 0 and 255. This value depends on numerous parameters (noise, number of further channels etc.) therefore it should be regarded as an informative data only. Its task is to support adjusting the antenna, indicate the decrease of the usual signal amplitude etc. The number is displayed in the uppermost line of the message box (Input level ....). The Signal Strength bar diagram displays this number, too.

QPSK carrier indicator

The colour of this display changes to green if the demodulator detects QPSK signal at its input. Without QPSK signal at its input this display changes to red. In the demodulation procedure this display should be regarded as pre-indicator, it indicates the starting phase of the demodulation procedure.

Sync byte indicator

This display changes to green if the demodulator has found the h47 sync bytes in the data stream,

that is, the lock process has been finished successfully. Until the colour of this indicator is not green, there is no sense in inspecting the reception parameters.

Data in the message box

With succeeded demodulation procedure, in the second line of the message box the „Input BER" value is displayed. This data is delivered by the Viterbi decoder upon comparing the input data stream and the output data stream of the Viterbi error corrector. The measuring circuit gets samples of 2 Mbits and their measuring data will be displayed.

In the next line the BER value according to the errors detected by the Reed-Solomon error corrector. This value is the BER between both error correctors and is measured using also samples of 2 Mbits. At reception with acceptable quality the data stream at the output of the Reed-Solomon error corrector can be regarded quasi free of errors. It may occur that the Reed-Solomon error corrector is not able to correct all errors, and errors remain in the data stream. The number of such errors is displayed in the next „Uncorrected Packets" line, related to samples of 2 Mbits.

At the modulation types used in the digital technology there is a close connection between the values of the BER and the SNR (Signal to Noise Ratio); the theoretical values are well approached in the practice. The displayed SNR value is of informative character, too but it is very useful at adjusting the antenna, the LNB etc.

4. **Useful hints**

The ASI outputs of the QPSK Demodulator Quad are built insulated from the earth. Therefore possible static discharges may disturb the operation of the ASI interface.
Due to the above-mentioned facts it is strongly recommended to make cabling always with switched off devices only. Switch on the devices and set the operational parameters after having finished cabling only. Do not change in the cabling with operating devices.

The SAT IF inputs of the tuners are of loop-through types; between the input and output a stage of a gain of 0…1 dB is built-in. In case of necessity the output can be used for supplying signal to a further tuner, but in systems of high standard, for avoiding modulation and other distortions using a high quality IF distributor is recommended.

Due to the low supply voltage used in the demodulator, the device is not equipped with a circuitry for powering the LNB. For powering the LNBs and distributing the input signals using the CW-4010 Satellite IF Distributor is recommended.

5. Special features

With the wide use of the Internet Protocol and spreading of IP TV, more and more user would like to use the CableWorld devices outside the 10.123.13.x address range, as used by the CW-Net. The devices are able for being used in this way just from the beginning, but upon our users' wish the usability of arbitrary IP addresses also with the software will be introduced now.

In case of the SW-4871 software, with checked Use CW-Net checkbox the commands will be sent out in the 10.123.13.x address range, thus the IP addresses of the devices must be in this address range.

If the Use CW-Net checkbox is unchecked, the commands will be sent out in the address range defined by the user. The user can freely type in the box the first three bytes, and the fourth byte is set further on with the stepping buttons. The value of the three bytes must be given in decimal format, and the points must be included, too. Unnecessary characters must not be in the box, the whole address is displayed below the box.

The IP address of the device can be changed to addresses outside the CW-Net's range using the SW-4841 software. Erratic or forgotten addresses can be reset to the factory setting using this software, too.

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 QPSK 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 QPSK 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.