SW-4872   Conditional Access Module Analyzer and Programmer
CA Module set-up and control software for DVB demodulators with Common Interface (CI)

Instruction manual

The Conditional Access Module Analyzer and Programmer software has been designed for managing all versions of the Quad demodulator/descrambler series equipped with Common Interface (CW-4872, CW-4874, CW-4876, CW-4878). The software permits **analysing the input transport stream, then compiling from the stream components a CA-PMT, which can be used for configuring the connected CA module channel by channel to descramble the desired program(s).**

The messages sent to the CA module and received from the CA module are forwarded by the host device's control processor (host processor) to the user's computer through the CW-Net Data Transmission and Device Control System.

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.

All software and application materials concerning the CW-Net and operating the CableWorld devices are available free of charge at www.cableworld.hu for download and for free use at own responsibility. 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 in 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 start working with the device study in the Using_CW_Net.pdf description the general instructions for putting devices in operation, and then read the instruction manual delivered along with the particular device. The instruction manuals are available at the CableWorld web site, too.

The pieces of device control software have been designed and tested in Windows XP environment, but they can be run in other operation systems, too.

Supposedly these pieces of software will be operated on the own desk-top or notebook computer, but system control computers are also included in our product range: a 19" version (CW-4891 DataBoss) and a notebook (CW-4892 DataChief). However using these latter dedicated computers is not necessary for operating the system.

After starting the software, click the "Main Platform - Device Controller" tab and set the IP address of the device (if you want to use the CW-Net IP address range check the „Use CW-Net" checkbox) then click the "Query" button. On clicking "Query" the software establishes connection with the addressed device, and displays its name, type and serial number. In the course of operation information is given at the left side of the header about the serial number of the CA module selected to communicate with and at the left side of the footer about the transmission of the transport stream.

Description of the CAM analyzer and its operation

The new device series developed by CableWorld are not equipped with a computer. For accomplishing the particular tasks, the devices use dedicated integrated circuits of CableWorld's own design thus their operation speed and efficiency are high multiple of that in the customary devices, while the power consumption is a few Watts only. The operation modes of these dedicated integrated circuits will be set by programming files prepared in the computer, and then the circuits work according this programming until the device will be reprogrammed again. The devices are allowed to be reprogrammed up to a 1.000.000 times, otherwise the date and frequency of reprogrammings is not limited. The low power consumption results in a better reliability and longer lifetime. The devices are suitable for continuous service.

Note: The devices' CI circuitries and the connected CA modules cannot be damaged by programming through the CW-Net, both the software and the device can be reset to its factory settings in a simple way.

1. Main Platform – Device Controller

Function: This is the starting page of the program. Here, the IP address of the device equipped with the CA modules to be configured can be set. After correct setting of the IP address, the connection between the computer and the device can be established and checked up anytime by clicking the Query button. When starting to work with the device, always begin with clicking Query so that the software gets information about the device, which is to be programmed. The program displays the name, type and serial number of the addressed device, the version of the device control software, the options included in the device as well as the version of the software running in the CW-Net Controller unit.

Controls:
1.1. Query
        Button for checking up the presence of connection with the device, and for querying the parameters. The button permits anytime to make sure of the connection between the computer and the device.

1.2. CAM selector
        The CW-Net permits to send any of the independent input signals of the four CA modules in the computer for processing. The desired transport stream is selected with the buttons of the CAM selector (CAM 1 … CAM 4).

1.3. Save Selector Position
        This button saves the actual position of the CAM Selector, thus at switching on the device next time, the software makes it to go automatically to the saved position.

1.4. Project Name
        In larger systems more than one or even several dozens of CAM analyzers may be used. For facilitating the documentation of the job performed with the particular devices, an identifier can be typed in the Project Name text box, which permits clear orientation even years later. The maximum length of the name is 180 characters.

1.5. Current Directory
        The Current Directory text box displays the folder from which the software was started and the folders to which the files are saved.

The software offers several ways to support handling the data of multiple devices that is, operating multiple CAM analyzators from a single computer. For those less experienced in the computer technology we recommend following solution:

Download from www.cableworld.hu the **setup_xy.exe** file and install the software by running this file. The installation occurs by default in the C:\Program Files\CableWorld\SW_xy folder. The installer puts also an icon on the desktop. Maintain the installed files and folders as a basis, and do not work with them. Create in the computer an arbitrary job library and copy the SW_xy folder along with its whole content here. Rename the SW_xy folder so that it identifies your activity and put its icon of exe extension on the desktop. For the best identification rename also the icon. Repeat copying SW_xy and rewriting both names as many times as many analyzer are to be operated. The pieces of software will run independently, they will not see and disturb each other's setting. Any piece of software can be removed entirely by deleting the icon and the relating folder.

1.6. Use CW-Net

When checking this check box, the program will use the IP address range of the CW-Net system (10.123.13.xxx) only, and the IP address can be set within this range using the last byte.

1.7. User Defined IP Address

In this text box the IP address within the IP address range defined by the user can be typed. This may become necessary if the device has been set in another IP address range, or the device is used in another environment because the system used there requires this.

1.8. Save Settings and Exit

On clicking this button, prior to exiting the program the actual settings are saved, thus at the next start of the device the program starts with the saved settings. Such settings are the IP address, the sample size for analysing etc.

Further information on the page:

- Sample size is displayed in the right side of the page footer.
- The connection between the computer and the device is indicated in the left side of the footer.
- Simple informative messages are displayed in the centre of the footer.

2. Transport Stream Analyzer

Function: The software samples and analyses the transport stream arriving to the CA modules. Based on the result of the analysis, the user can select the desired components and enable and disable their descrambling on the Conditional Access Module Controller page.

The Transport Stream Analyzer function permits to get all information of the input signal, which are necessary at selecting programs or their components for descrambling. Sample the input signal with clicking the Get Sample button and wait until the software performs the evaluation. Details of measuring by sampling technique are discussed in the help file of the SW-4811 software. The sample size can be set with the Sample Size scroll bar to values between 1 and 20 Mbytes. With small sample size several data may not become available but the measuring will be fast. With larger sample size the measuring will be slower but more measured data may be expected. Start measuring with at least 8 - 10 Mbytes sample size.

The analyzer function prepares a report upon the sample, which can be saved in file. When sampling again, the old results will fully be erased and a new report will be prepared: the memory stores the results of the last measuring only.

Note: The report on the input signal includes beyond the data of the transport stream also the data of the performed steps of selection and enabling.

The transport stream analyzer function of the software is built of software modules, and these modules one by one examine the sample and write their measuring results in the report. Depending on how many module could not perform its assigned task, the report may still be usable, but some data may be missing. By repeating the sampling and enlarging the sample size according to the necessary extent, the user has to assure that the report will be complete.

The result of the sampling is shown in the left side message box in a clearly arranged form. On clicking the individual services, the most important properties of the components are shown.

Controls:

2.1.   Get Sample
On clicking this button, the transport stream arriving to the input of the selected module is sampled.

2.2.   Sample Size
Using this scroll bar the sample size can be set between 1 and 20 Mbytes. If the analysis of the sample is not complete (e.g. the names of the services are missing), enlarge the sample size.

The software modules, which perform the analyses:
- Sampling Unit
  The Sampling Unit obtains the general data of the sample. It records the input where the sampling was made, the sample size and the duration of the sample, calculates the data rate for both 188 and 204 byte format and displays the format of the packets in the sample. The measuring results are shown in the top of the right side message box.

- PAT Analyzer
  The PAT Analyzer finds and evaluates the sections of the PAT tables in the sample. The module displays the number of the PAT tables found in the sample, the successfulness of assembling the sections, the identifier of the transport stream, version of the table, size of the section, repetition time of the PAT tables, the number of services (programs) included in the stream and the PID values of their associated PMT tables.

```
PAT Analyzer                    PID=0
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Number of Packets:          19
Section Implementation      OK
Transport Stream Id         1279
Version Number              0
Section length              69
PAT Repetition Time         102 ms
Number of Services          15

        Service             PMT PID
1       0                   16
2       20327               100
3       20328               150
4       20329               200
5       20330               250
6       20331               300
7       20332               350
8       20333               400
9       20334               450
10      20335               500
11      20336               550
12      20337               600
13      20338               650
14      20339               700
15      20340               750
```

- PMT Analyzer
Upon the data gathered by the PAT Analyzer, the PMT Analyzer searches for all services (programs) the associated PMT table, analyses and displays their headers, and reports on the data of the components, the elementary streams. For evaluating the results, basic knowledge of the structure of the transport stream is absolutely necessary. As described, the PMT Analyzer uses the data gathered by the PAT Analyzer; it cannot work without them. Possible errors in the streams may prevent the particular analyzer modules from finishing their jobs successfully, thus finishing the stream analysis at least partially successfully.

```
PMT Analyzer        PMT PID   100
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Number of packets          22
Sevice Id                  20327
PCR PID                    101
Version Number             0
Section Length             41
Program Info Length        6
Section Implementation     OK
-------------------------------------------
Elementary PID             101
Stream Type                2
>Video Stream ISO/IEC 13818-2
ES info length             3
ES info: Rʀʀ
-------------------------------------------
Elementary PID             110
Stream Type                4
>Audio Stream ISO/IEC 13818-3
ES info length             9
ES info:
ᴶhunʀRn
-------------------------------------------
```

- CAT Analyzer
Configuring the CA module does not need the detailed data of the CAT tables, thus the CAT Analyzer displays on the screen a few data of the header only. Filtering and processing of the CAT tables is made in the CA module.

- SDT Analyzer
Operation of the SDT Analyzer is similar to that of the PAT and PMT Analyzer. For the operation of the CA module the data of the SDT tables are not directly needed either. However they contain useful information for the user, e.g. the names of the service providers and the particular services (programs).

The simple messages sent to the user are displayed also in this page in the usual place in the centre of the footer.

3. Conditional Access Module Controller

Function: Upon the program components selected by the user, this software module compiles and sends to the CA module those CA-PMT messages, necessary for configuring the CA module.

Descrambling the selected programs is made upon the CA-PMT table sent by the host processor to the CA module. The software produces the CA-PMT table automatically by deleting the superfluous descriptors from the PMT tables found in the course of the sampling. Due to technical and efficiency reasons, one CA module is usually required to descramble more than one program. In such case the CA-PMT tables of all programs to be descrambled have to be sent to the CA module.

Note: The descrambling capability of the CA module is given by the number of elementary streams it can descramble. This number depends on the module's type, hardware version (serial number), software version etc. and is usually between 8 and 24. E.g. if a module is capable of descrambling 8

ESs at the same time, this means the descrambling capability of 4 programs (calculating with one video and one audio per program). Some kinds of CA modules do not support at all descrambling more than one program at the same time. Therefore prior to purchase CA modules obtain the relating information.
Overstepping the above limits of ES processing may cause the random break of particular streams or whole programs!

Hint: When selecting the program components, spare on the module's descrambling capacity by not selecting for descrambling not necessary private streams, superfluous sound tracks and teletext streams (this latter are often not scrambled). By this technique the number of CA modules necessary for descrambling the desired amount of programs may be lowered.

Controls:

3.1.   "CA Module Instructions" block

- Start Descrambling button: On clicking this button the CA-PMT tables compiled from the selected streams are sent to the CA module and their descrambling starts automatically.

- Save to EEPROM: On checking this checkbox the device saves the actual settings in its non-volatile memory. By this, after switching on or after power line break and recovery with unattended operation the device automatically loads the saved settings and configures the CA modules, which then start descrambling the preset programs.

- CAPMT Update Enabled: When checking this option, the CA-PMT tables carrying the descrambling information will be sent periodically again and again to the CA modules. If due to any disturbance descrambling of one or more elementary streams often breaks in the module, with this resending of the data recovery of the descrambling may succeed.

- CAPMT Update Period: With this scrolling bar the repetition time of resending the CA-PMT tables can be set between 10 s and 1280 s.

- Reconfigure CA Module: When checking this option, prior to being loaded with the descrambling information, the CA module receives a hardware reset, thus a whole initialisation process will occur. If the components of a program are changed at the transmission side during transmission (dynamic content switching), such as with the regional programs of the ORF packet, by the CA-PMT tables sent by the host processor, the CA module will be set for descrambling the newly added elementary streams. With some modules this procedure causes break in the descrambling, therefore in this case these modules must be reinitialised and reconfigured.

- Auto Reset on CI Error: The host processor and the CA module communicate directly through the Command Interface. This is used for sending the messages to the module, reading out the module's messages and the synchronisation of the whole process of data traffic. The interface is built of four 8-bit registers: data register, command / status register, upper byte of the size register and lower byte of the size register.
- If some disturbance occurs in the operation of the interface, the communication with the module breaks. When this option is selected, the CAM will be reset after about 6 s and the communication will automatically be recovered. In such case the module will be loaded from the PC with the latest settings and not from the EEPROM with the data stored there.

- Auto Reset on PMT Version Ch(ange): In case of any change in the structure of the program (service) (PID change, adding or removing ES etc.) the receivers will be informed by the PMT table of changed content. The new PMT table will be implanted in the transport stream with a changed version number. The technique of PID change is used e.g. by ORF for the periodical transmission of regional programs (dynamic content switching). The change in the version number is detected by the Common Interface software and according to the standard it sends a new CA-PMT table to the module. By experience, the modules having been configured earlier to descrambling (partly) other ESs, cannot follow this change in any case, and cause freezing. When using the "Auto Reset on PMT Version Ch(ange)" option, the software performs the complete initialising of the module prior to sending out the new CA-PMT, preventing the freezing caused by above reason.

- Use SmartCADR: The keys for the descrambling algorithms are contained in private elementary streams, the ECMs (Entitlement Control Message). The identifiers (PIDs) of the packets of these private streams are contained in the CA descriptors in the PMT table.
  The scrambling can be of program level, (all components of the program as video, audio, data, etc. are scrambled) or of elementary stream level (within the program some ESs are scrambled, some not). The CA module is notified of the program level or ES level scrambling by the location of the CA descriptors in the CA-PMT table.
  Scrambling at both level at the same time has no sense, but there are programs, where both locations of the PMT table contain CA descriptor. In such case the CA module decides the descriptor carrying valid data for the actual setting (according to the standard in such case the ES level descriptors should be regarded).
  According to our experience not all modules can perform this check-up, and these modules cannot descramble the given program.
  The Use SmartCADR option tries to solve this problem by removing the ES level descriptors from the CA-PMT table if program level CA descriptors are also present.

- Refresh Crypt Information: After starting descrambling the desired programs with clicking „Start Descrambling", the CA module examines by CA-PMT tables if descrambling is possible and sends a message about this in the PC through the host processor. This message can be queried with the „Refresh Crypt Information" button, and the result will be displayed in the last row of the left side message box (Crypt Info).
  Possible answers are:

  - No CAPMT reply
  - Descrambling possible
  - Descrambling possible under conditions (purchase)
  - Descrambling possible under conditions (technical)
  - Descrambling not possible (no entitlement)
  - Descrambling not possible (technical)
  - No CAM Inserted
  - Initializing CAM
  - Query in process
  - PMT process error
  - PMT not found in the stream
  - Unknown

Hint: After starting descrambling wait 3 … 4 seconds prior to querying, because the speed of the modules is very different and also the module - host communication is relatively slow. „No CAPMT reply" message does not mean that the given program cannot be descrambled. According to our experience in many cases it only concerns that the module does not answer this question at all or it answers but not in the format as given in the standard.

Beyond the above descrambling information, the stream list contains following further data:
* PIDs of the elementary streams (PID).
* PIDs of the PMT tables (PMT).
* Service identifiers of the programs (Service).
* Types of the elementary streams (Stream Type).
* Names of the programs (Service Name).
* The status of the given component of being appointed to descrambling or not (Descramble).

3.2.   "Descrambler List Constructor" block
* Do not Modify Descrambler List
* Add to Descrambler List
* Remove from Descrambler List

In the message box mentioned above, the stream list compiled upon the last sampling is displayed. The streams to be descrambled are to be appointed from this list by clicking them (regarding the technical limitations of the CAM). On this, the given row(s) change(s) to green (in switch position „Add to Descrambler List").
The appointed rows can be cancelled with the „Remove from Descrambler List" button. On this, the colour of the row returns to the original one.
With „Do not Modify Descrambler List" selected, clicking the list is non-effective.

3.3.   Selector Mode block

* Select All Streams in Service: With this switch position on clicking any row (elementary stream) in the list, the actual operation (highlighting or recall highlighting) will be valid for all further components of the given program (service).

* Select Elementary Stream: With this switch position highlighting or recall highlighting will be valid for the given elementary stream only. This mode permits compiling descrambling lists by leaving out the unconcerning elementary streams thus the number of CA modules needed for descrambling the desired programs will be lower.

4.   Menu Handler

Function: This software module reads out the menu system of the Conditional Access Module placed in the PCMCIA slot, and performs the desired changes in the settings according to the offered options.

Controls:
4.1.   Enter Menu
        Clicking this button instructs the CA module to send the message describing its menu structure. The structure of the menu and the menu items are displayed in the left side message box. The structure of the menu depends on the software of the module and can be very different by module type.

The menu structure is designed basically for being displayed on the TV screen. Therefore it always starts with a Title and a SubTitle, which are then followed by the menu items, differing in their numbers by modules. In the bottom of the screen messages are displayed (Bottom:). From a selected menu item, the submenu belonging to it can be accessed by clicking the „Select" button in its row. Moving backwards by level by level is made with the „Back (OK)" button. The „Root Menu" button permits direct return to the main menu.

4.2. Exit Menu

When exiting the menu system of the CA module, the module has to be informed with the proper message sent out by the „Exit Menu" button. The handler software assures that the screen cannot be left without doing this, and at the same time a warning in the header reminds of using the „Exit Menu" button.

On this, the module closes the so-called Man Machine Interface (MMI) session, which enables the communication concerning the menu. Communication is only possible with opened MMI session. Opening the session is made by the „Enter Menu" button mentioned earlier. Information about the actual state of the MMI session and the manufacturer of the module is given in the message box below the „Reset CA Module" button.

4.3. Reset CA Module

As experienced, in the course of navigating between the menu items some modules do not give proper responses and in some cases they freeze. In such a case restart the module with the „Reset CA Module" button and then start communication again with „Enter Menu".

5. Conditional Access Module Analyzer

Function: This software module gives information about the internal operation of the CA module, and about the parameters otherwise hidden from the user. This information supports locating the cause and troubleshooting at freezing.

For better understanding the concerned terms, in depth study of the Common Interface standard (EN 50221: 1997) is recommended.

Controls:

5.1. Refresh

After selecting the desired module, for querying the actual information always use the „Refresh" button! Do the same after having changed the settings of the module (e.g. sending new streams in the module) to check the effect of the changes.

5.2. Reset CA Module

On clicking this button the module will be fully initialised and the descrambling parameters set for the last time will be reconfigured. The effect is identical with that of the Reset button in the Menu Handler.

5.3. Save report

Using the „Save Report" button, a report of content identical with the test results of the module displayed on the screen can be generated. For saving the generated file, the desired folder and a file name have to be specified.

Structure of the test results, explanation of the applied parameters

The report indicates the serial number of the module and the date and time of the test.
Then the list of the main internal operational parameters in a logical grouping follows:

- CARD SOCKET
  The main parameters concerning the connector of the CAM:
  driver version, result of the self-test, the actual working mode and the data rate of the transport stream.

- GENERAL CARD INFORMATION
  General information about the module: existence of a connected module and its supply voltage requirement.

- CARD INFORMATION STRUCTURE (CIS)
  Here the most important components of the card's information structure are listed.
  According to the PC card standard (PCMCIA: PC Card Standard V8) all PC cards must contain the CIS. The CIS is a memory area within the card, consisting of data blocks (tuples) grouped by their content e.g. Configuration tuple, Control tuple etc.
  Since the CA module is in fact a special PC card, the list of the tuples, which are compulsorily to be included in the CIS and their content is prescribed in the Common Interface standard.
  (For details see: EN 50221: 1997 Annex A.5.6)
  The tuple list is followed by the list of the configuration registers.

- COMMAND INTERFACE
  The function of the Command Interface has already been described in connection with the „Automatic Reset on CI Error" button. This part of the report contains the main parameters measured during operation, e.g. recovery time after reset, size of buffer memory used during the communication, and particular response times. (For details see: EN 50221: 1997 Annex A.2.2)

- TRANSPORT LAYER INFORMATION
  The main task of the Common Interface communication software is organizing in layers the logically related activities. The standard defines following layers: physical layer, link layer, transport layer, session layer and application layer.
  The transport layer is responsible among others for establishing the transport link between host and module, transmitting the messages, periodical query of the module etc.
  In this part of the report the number of transport connections and their identifiers are included.

- SESSION LAYER INFORMATION
  The CA module and the host processor can use each other's resources through the session layer. Prior to use each resource, the host opens a session and marks it also with a Session Number. In this part of the report the list of the sessions being opened for the existing resources can be inspected.

- APPLICATION LAYER INFORMATION
  Among the pieces of the application layer information the data delivered by the Application Info resource about the CA module are given here: kind of the module, manufacturer code, module name and the list of the identifier of those CA systems supported by the module.

- HOST-MODUL MESSAGE INFORMATION
  Here, the last 14 message exchanges between the host and the module can be checked, e.g. request for session opening and request for using certain resources. (For details see: EN 50221: 1997, 8.4)

- ACTUAL DECODING INFORMATION
  The detailed data of the CA-PMT tables sent to the module at last are shown here: number of the tables, their PID values, if there was a change in their version numbers, if there was an error at filtering or processing the original PMT. Further the optional switches set in the Conditional Access Module Controller platform can be checked.

- TEXT-ENQUIRY-MENU INFORMATION
  Here, the text messages coming from the module are displayed by the Menu Handler in the course of navigating between the menu items.

- ERRORS
  This parameter serves the check-up of the error-free operation of the module.
  In case of possible error in the operation the error message is shown here.

Instructions from the „Main Platform – Device Controller" page

1. Establish connection between the computer and the device as described in the Using_CW_Net.pdf file. Check the communication using the „Query" button. Fill in the „Project Name" and the „Current Directory" text boxes with your data. Select the module to be set (CAM 1…CAM 4).
2. Enter the „Transport Stream Analyzer" page and sample the incoming stream. Check the result. In case of error repeat sampling; enlarging the sample size may also be necessary.
3. Enter the „Conditional Access Module" page and from the components found in the course of sampling by clicking the desired ones compile the list of programs to be descrambled. Prior to doing this, in the „Decode List Constructor" block on the "Conditional Access Controller" page set the „Add to Decoder List" option and set the desired operation mode in the "Selector Mode" block.
4. After having compiled the programs to be descrambled, in the „CA Module Instructions" block set the proper switches, and then send the data in the CA module using the „Start Descrambling" button. At compiling the list mind the number of the elementary streams appointed to be descrambled. Click „Refresh Crypt Information" to check the module's answer about its capacity of descrambling them.
5. With the „Enter Menu" button in the „Menu Handler" page the module's menu system can be entered. Here the module's settings and the data of the SmartCard (serial number, authorizations, passwords, parental codes) can be checked. Always exit the menu with the „Exit Menu" button. If the module freezes and gives no response use the „Reset CA Module" button.
6. For the detailed analysis of the module go to the „Conditional Access Module Analyzer" page. For obtaining valid data always click „Refresh". The data can be saved in file with clicking „Save report".