FTR-100 Fault Transient Recording System User Manual

Kehui International Ltd.
2 Centrus, Mead Lane, Hertford
Hertfordshire, SG13 7GX
United Kingdom
Phone: (+44) 1920 358990
Fax: (+44) 1920 358991
Website: http://kehui.com

Legal Notices

This product complies with the design requirements for environmental protection and personal safety.

This product is a professional instrument specially designed for power cable faults. Please do not use it for any other purpose. The company assumes no responsibility or loss if it is used for other purposes.

The safety regulations in this user manual should be strictly adhered to.

The storage, use and disposal of the product should be in accordance with the product manual, relevant contracts or relevant laws and regulations.

As part of Kehui's continual product development this product is subject to design or technical changes without prior notice. When product improvement or technical changes occur, you can check the information through Kehui International Ltd. website http://www.kehui.com.

Disclaimer: *Every effort has been made to make this material complete, accurate, and up-to-date. In addition, changes are periodically added to the information herein; these changes will be incorporated into new editions of the publication. Kehui International Ltd reserves the right to make improvements and/or changes to the product(s) and/or the program(s) described in this document without notice, and shall not be responsible for any damages, including but not limited to consequential damages, caused by reliance on the material presented, including but not limited to typographical errors.*

NOTE: Windows is a registered trademark of Microsoft.

Revision history:

Version	Revision date	Revision reason	Person
V2.1 (Drafts 001-5)	2018.03-2019.10	Technical updates, new template	TonYip, BilKib, DiaKib
V2.2	2020.06.17	Additional sections	BilKib
V2.3 (Draft 001)	2020.09.10	Sec. 8 – Screenshot, New Sec. 8.6, New Sec. 8.7	TonYip

Document number: FTR-100_V2.3_UM_EN

Table of Contents

Safety Instructions

Safety Note: This user manual is the basic commissioning and on-site operation guide for the FTR-100 Fault Transient Recording System. All operators of the FTR-100 should read the contents of this manual in advance. The manufacturer of this product is not responsible for any loss caused by the operator's failure to comply with the operating procedures of this manual or for violation of the safe working procedures of the operator.

Meaning of the manual symbols Important instructions concerning personal safety, operating procedures, technical safety, etc., are marked with the following symbols:

Symbol	Meaning
	Indicates a potential hazard that could result in serious or fatal injury
	Indicates a potential hazard which, if not avoided, may result in minor personal injury or property damage.
	Indicates that it contains important information and useful guidance for using this product. Failure to heed this information may result in the test not functioning properly.
	Indicates that this is a useful guideline based on field practice.

Use of accessories: Please be sure to use Kehui's spare parts to ensure the safe and reliable use of this instrument. Using accessories made by other companies will make any warranty null and void.

Repair and maintenance: This instrument must be repaired and maintained by Kehui or an agent authorised by Kehui. If you have any questions concerning the product and its operation, please contact the company at info@kehui.com.

Terminology Throughout the document, the word Earth has been used, this term is considered synonymous with Ground and is used as the electrical reference point.

1. General

The FTR power system fault transient recorder automatically and accurately records the electrical quantities on a system when it is triggered by an event such as a fault. Through analysis of the waveforms and the events, the correctness of the system's response, particularly the protection operation, can be verified. This provides information to improve the safe and reliable operation of the power system. Information provided by a single intelligent electronic device (IED), will only give information which is limited to the section of the system it is protecting. However, the transient fault recorder automatically records the complete event, showing variations in the electrical quantities when a fault or a disturbance occurs and the operation of all elements of the protection system.

The requirements for power system automation and supply quality continue to evolve and the introduction of optical transducers and intelligent switchgear, on-line monitoring of generators, transformers, transmission lines and circuit breakers have led to the power system becoming increasing sophisticated. Using Ethernet technology, the information transfer within the substation is becoming more network-based, so that the equipment required to capture information in the substation must be capable of working under the framework of IEC 61850.

The FTR-100 power system fault transient recorder is applicable to both conventional and digital substations. It supports the IEC 61850 standard, both for the process bus and the station bus. The recorder provides transient, steady state and continuous recording for primary equipment. For conventional substations, it can monitor AC/DC analogue quantities and digital status information through its associated interface unit (RAU) which converts them in to Goose and sampled value (SV) signals and communicates with the central unit via optical fibres. This allows them to be situated in convenient places which may be some distance away from the FTR. When used with digital systems, the FTR monitors, captures and records Sample Values (SV) and GOOSE messages on the process bus, and communicates using MMS messages on the station bus. The integrity of the messages is checked for abnormalities and error-reporting is performed. Through SV and GOOSE messages, it provides

2. FTR-100 Functionality and Technical Data

2.1 Description

2.1.1 Application

The FTR-100 power system transient fault recorder is applicable to conventional and digital substations. It supports IEC61850 standard, both for the process bus and the station bus. In a conventional substation, the recorder performs transient, steady state and continuous recording of the AC/DC analogue quantities and digital status from the primary equipment using up to three external interface units (RAU). In a digital substation, it monitors, captures and records Sample Values (SV) and GOOSE messages on the process bus, and communicates using MMS messages on the station bus. It checks the integrity of the messages for abnormality and perform error-reporting. Through SV and GOOSE messages, it provides monitoring of the analogue quantities and circuit breaker status information within the substation.

FTR-100 can monitor two or more 3-phase power systems simultaneously, even if they are not synchronous to each other, The FTR-100 uses the 3-phase voltages at a busbar to track the power system frequency. If the two three-phase systems are set up separately at two busbars independent from each other, the FTR-100 can monitor both of them

2.1.2 FTR-100 Design architecture

FTR-100 has a modular design architecture, using powerful embedded processors as the core to handle various real-time functions. It consists of the central control system (CSS), a data sampling unit (DSU) and a back stage local analysis system (LAS), see Figure 2.1.3-1. External remote data acquisition units (RAUs) are used to sample analogue quantities and digital status. The RAUs provide the interface to the primary equipment in a conventional substation.

2.1.3 Input signals

The device captures and records SV and GOOSE messages from the process bus of the digital substation. It checks for data abnormality and provides recording of such events. The size of the input data is as follows:

- Numerical data input: maximum 32 SV control blocks, 64 GOOSE Control blocks
- Analogue data input: Maximum 160 analogue input signals (including AC Voltages and currents, DC Voltages), maximum 576 digital status inputs
- Numerical and analogue data inputs can be mixed.

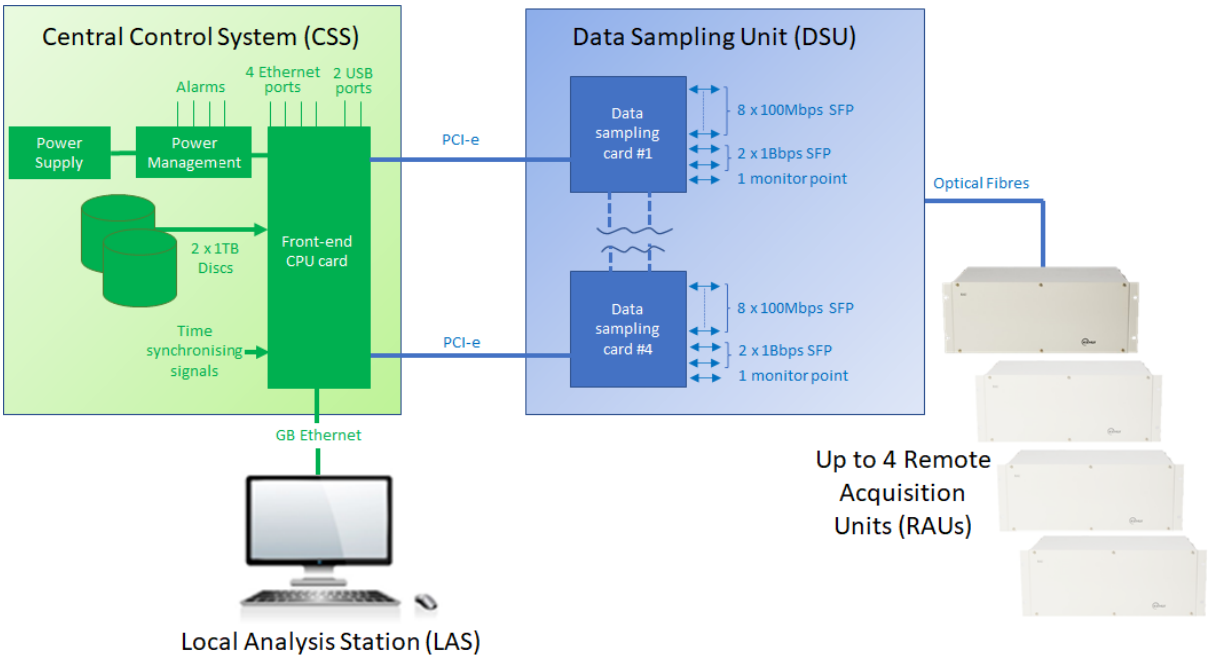


Figure 2.1.3-1 FTR-100 Topology Block diagram

2.2 Advanced Design

The device uses a distributed and modular design architecture. Efficient Linux real-time multi-tasking operating system

2.2.1 High Speed PCI Express Bus (PCI-e)

The core central control system (CCS) uses an advanced COM-Express embedded CPU module, provides the FTR-100 with an ideal solution for embedded application. Powerful FPGA technology is used for the front-end processor increasing the speed, reliability and stability of the device. Inter-processor communication is through the high-speed serial computer expansion bus standard PCI-e (Peripheral Component Interconnect Express), which provides high bandwidth point-to-point data transfer, supports active state power management, error reporting, reliable communications and quality of service. The design satisfies a digital substation's high-speed data through-put requirements

2.2.2 Operating System

The FTR-100 uses an embedded 64-bit Linux operating system, which improves the safety and reliability of the equipment. The Linux real-time multi-tasking system splits the software into several processes, which makes software development and maintenance easier and more secure. The rich network communication resources available with Linux, also make the communication of the FTR-100 with other work stations more efficient.

2.2.3 Mass Storage plus Server Level Communications

The network server IC, provides the FTR-100 with two optical and two electrical GHz Ethernet ports. It supports MMS and file service, supports station bus IEEE1588 time synchronisation, provides a maximum of two 2.5-inch hard disc and supports TByte data storage capacity. Substantial data storage for network messages and disturbance records results, ensuring integrity of the recording data.

2.2.4 Proprietary Database Engine

The FTR-100 supports sample data compression during storage, with sample data timing accuracy up to 60ns. Sample data is managed by a proprietary database engine, which controls storage of the hard disk directly. This avoids filing system control, thus increasing the storage efficiency.

2.3 Technical Data

- Recording and Monitoring

  The FTR is capable of connecting with 3 RAU units. Each RAU can accommodate 32 analogue channels allowing the system to measure 96 analogue channels. On digital systems the FTR can accommodate up to 32 merging units, 64 GOOSE control blocks,

  MMS messaging capable of connecting up to 512 IP addresses

- SV continuous recording

  No less than 24 hours

- Continuous recording of GOOSE and MMS messages

  No less than 14 days

- Types of message recording

  MMS – Manufacturing Message Specification

  SV – Sampled Values (IEC 61850-9-2)

  GOOSE – Generic Object-Oriented Substation Event (IEC 61850) ,

  PTP – Precision Time Protocol

- Time tag resolution

  Message received timing resolution 60ns

- Real-time clock accuracy

  Clock synchronisation resolution <±1us

  Real-time clock accuracy <±50ms/24h

- Time synchronisation method

  The system supports an IRIG-B, optical signal and DC signal from an external clock source.

- Sampling rate

  DFR (Disturbance Fault Recording) ： 4K/10K

  CFS (Continuous fast Speed) recording： 1KHz。

  CSS (Continuous slow speed) recording： 50Hz。

- Trigger method

  Standard trigger method: threshold value, change value and window threshold, applicable to RMS values of voltages and currents.

  Calculated value trigger method: threshold value, change value, window threshold, applicable to harmonics, phase angles, single phase P & Q, 3-phase P & Q, sequence components, power factor

- Standard analogue value accuracy

  0.5%, using 16-bit A/D converter

- Standard digital input timing resolution

  0.1ms

- Recording methods

  i. DFR (Disturbance Fault recording)

  Pre-fault trigger Time (A period): 100ms – 500ms

  Post fault trigger time (B period): 1s to 10s. If a new trigger occurs within the B period, an additional B period is added. This is repeatable until the time limit is reached.

  Record Time limit: Greater than twice the A and B period combined. The recording will stop at the record time limit under repeated trigger conditions.

  ii. CSS - Continuous Slow Speed recording

  The FTR100 continuously records the selected analogue values and the calculated values such as frequency, harmonics. sequence components, power, angle etc. The sampling rate is 50Hz

  iii. CFS – Continuous Fast Speed recording

  The functionality is the same as the CSS except that the sampling frequency is 1kHz.

- File transfer format

  Conforms to IEC61850 standard for information exchange in the power system

- Storage capacity

  >2000M Bytes

- Hard disc capacity

  >2000GB (2TB)

- Communication method

  RJ45 with 100M/1000M Ethernet

- Contact Rating

  Resistive load (cosφ = 1); 5A @250VAC, 5A @ 30VDC, 1,250VA

  Inductive load (cosφ = 0.4, L/R = 7ms); 1.5A @250VAC, 1.5A @ 30VDC, 375VA, 80W

- Power supply

  AC: 85V - 264V DC: 88V - 264V

- Dimensions

  800mm x 600mm x 2260mm(2360mm)

2. 4 Model number definition

FTR - 100 – XX - X

| | | | |_____ Designation

| | |_____ Input signal type

| |_____ Model number：100

|_____ Fault Transient Recorder

2. 5 Models available

FTR-100-G： Analogue Input Fault Transient Recorder

FTR-100-DA-G： Numerical Input Fault Transient Recorder

FTR-100-DG-G： Hybrid Input Fault Transient Recorder

3. FTR-100 Front Panel Functions

3.1 FTR-100 Front panel

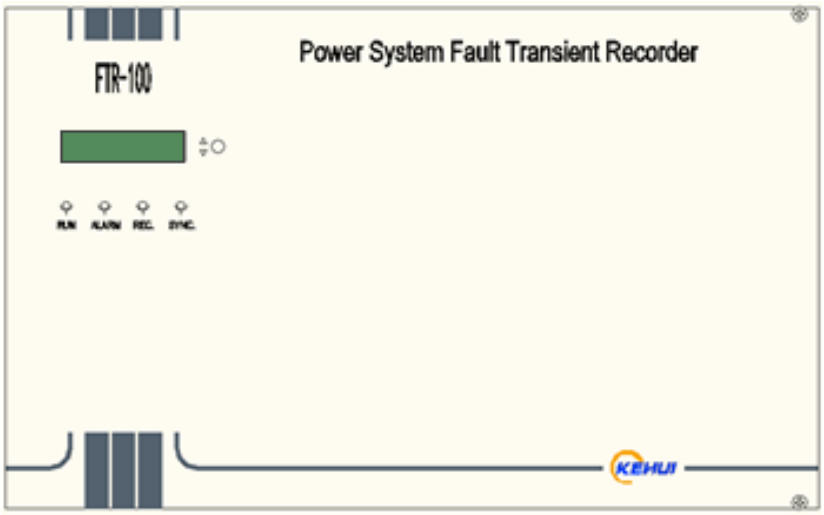


Figure 3.1-1 FTR-100 Front Panel

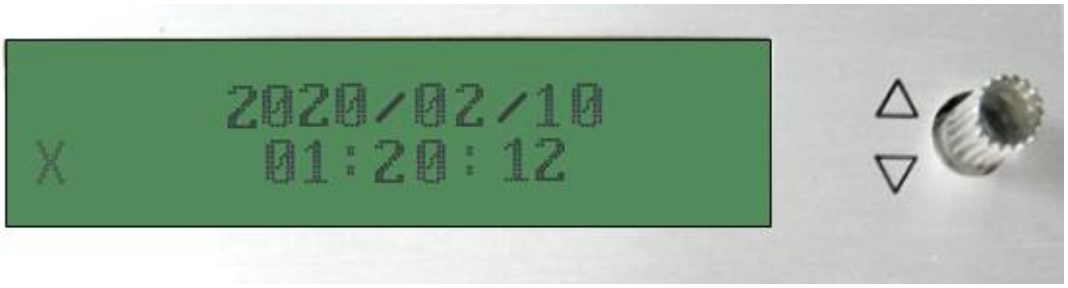
FTR-100 front panel consists of an LCD display, LED indications and a rotary switch for functional selection. It can be used to examine the IP address setting, the date and time information, and to do a manual trigger.

3.2 Front panel functions

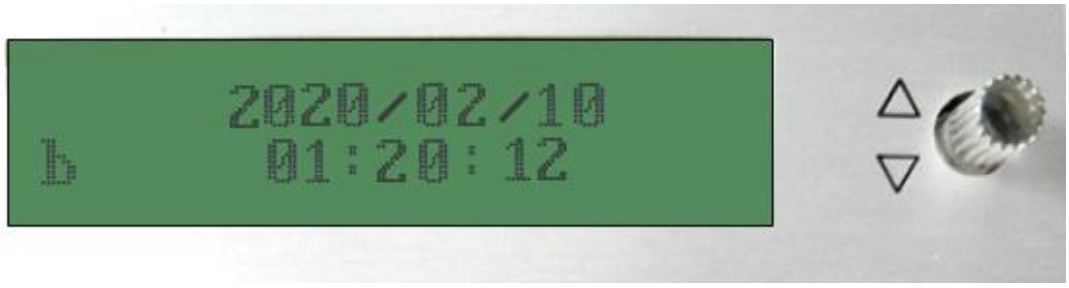
The rotary switch/push button adjacent to the LCD selects the required display function

3.2.1 LCD: date, time and IRIG B synchronisation

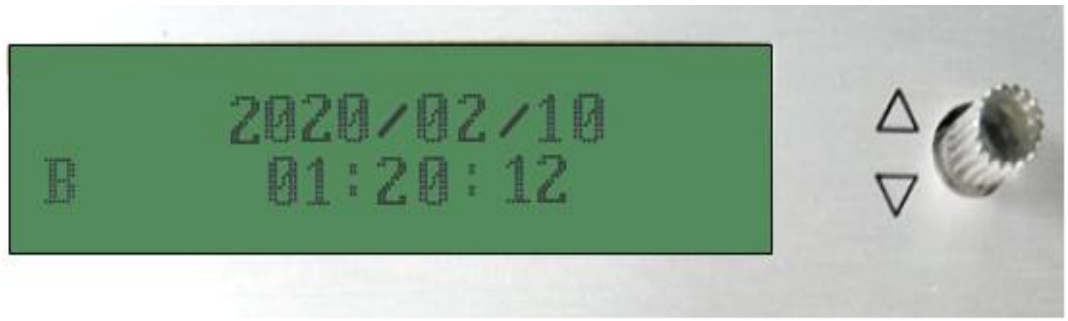
When the FTR is energised, the front panel LCD interface shows the date and the time. The "X" in the lower left corner indicates that the IRIG-B signal for clock-synchronisation is not available. The LCD defaults to the date and time display after 5 seconds of inactivity.



When the correct IRIG-B signal is connected, the "X" in the lower left corner changes to "b".



When the IRIG-B clock source is stable after approximately 5 minutes, the "b" in the lower left corner changes to "B".

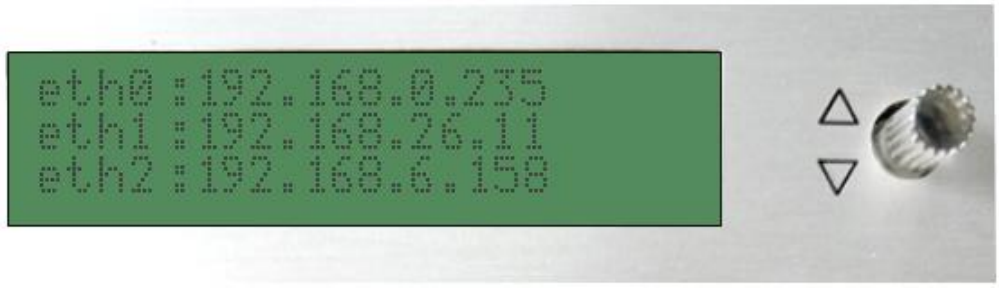


3.2.2 LCD: Firmware and cyclic redundancy check (CRC) code

Pressing the rotary switch once, causes the firmware version number and a CRC code to appear on the LCD.

3.2.3 Ethernet port IP addresses

Rotate the switch clockwise, the LCD shows the IP addresses of the three Ethernet ports in FTR-100.



3.2.4 Manual trigger

Rotating the switch further clockwise, results in "MANUAL TRIGGER" appearing on the LCD. At this point, press the switch for the recorder to start a manual trigger operation. Rotating the switch clockwise again, will return the screen to the IP addresses. This and the "MANUAL TRIGGER" screen will appear alternately as the switch is rotated.

3.2.5 LED status indication

The LEDs from left to right read as follows:

- RUN (Green): This is On when the unit is energised and is operational
- ALARM (Red): On provides a warning that a self-checking procedure has failed This means:
    i. The communications with the RAU through the optical fibre is not available. In this case, the failure will also be logged in the ReplayD software's ”Real-time events"
    ii. The main processor of FTR-100 is not working normally.
- REC. (Green): When this is On, the unit is recording,
- SYNC. (Green): This LED is On when the unit is correctly time-synchronised

4. FTR-100 INPUT CONNECTIONS

4.1 SV, GOOSE and RAU input connections

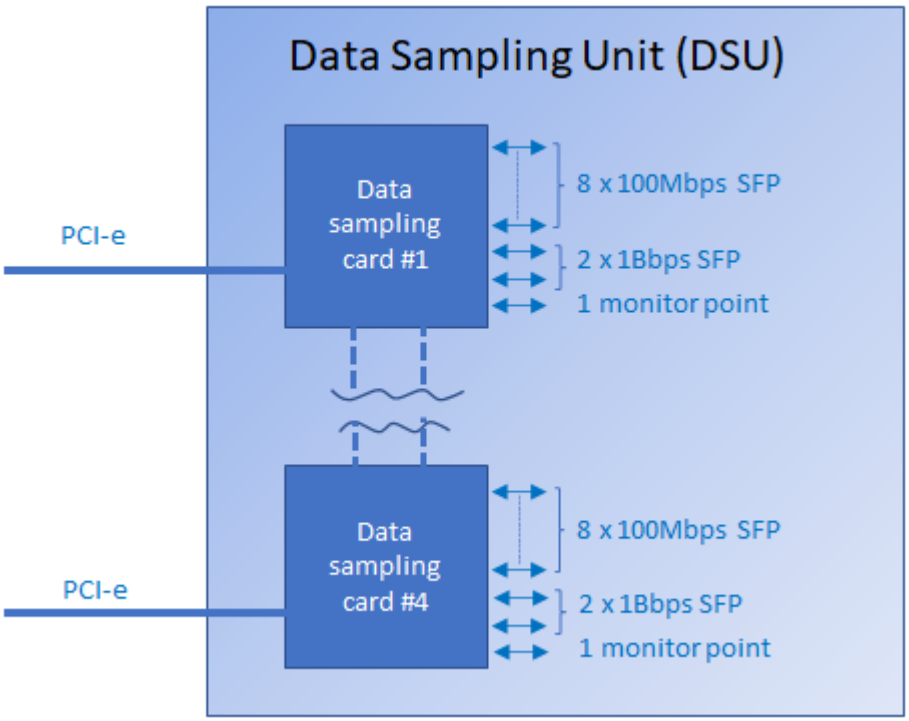


Figure 4.1-1 Data Sampling Module

The data sampling unit can accommodate a maximum of 4 data sampling modules, each module consists of 8 x 100MHz Ethernet ports and 2 x GHz ethernet ports. The details of each data sampling module are as follows:

1. 8 x 100MHz SFP (Small Form-factor Pluggable) optical transceivers, applicable for IEC 61850 9-2, GOOSE and data from the RAU analogue input unit, representing the raw signals
2. 2 x 1GHz SFP optical transceivers, applicable for IEC 61850 9-2 and GOOSE. They are also applicable for multiple merging units amalgamated through routers to provide large amounts of data.

5. FTR-100 Backplane functions

FTR-100 backplane arrangement is as shown in Figure 5-1.

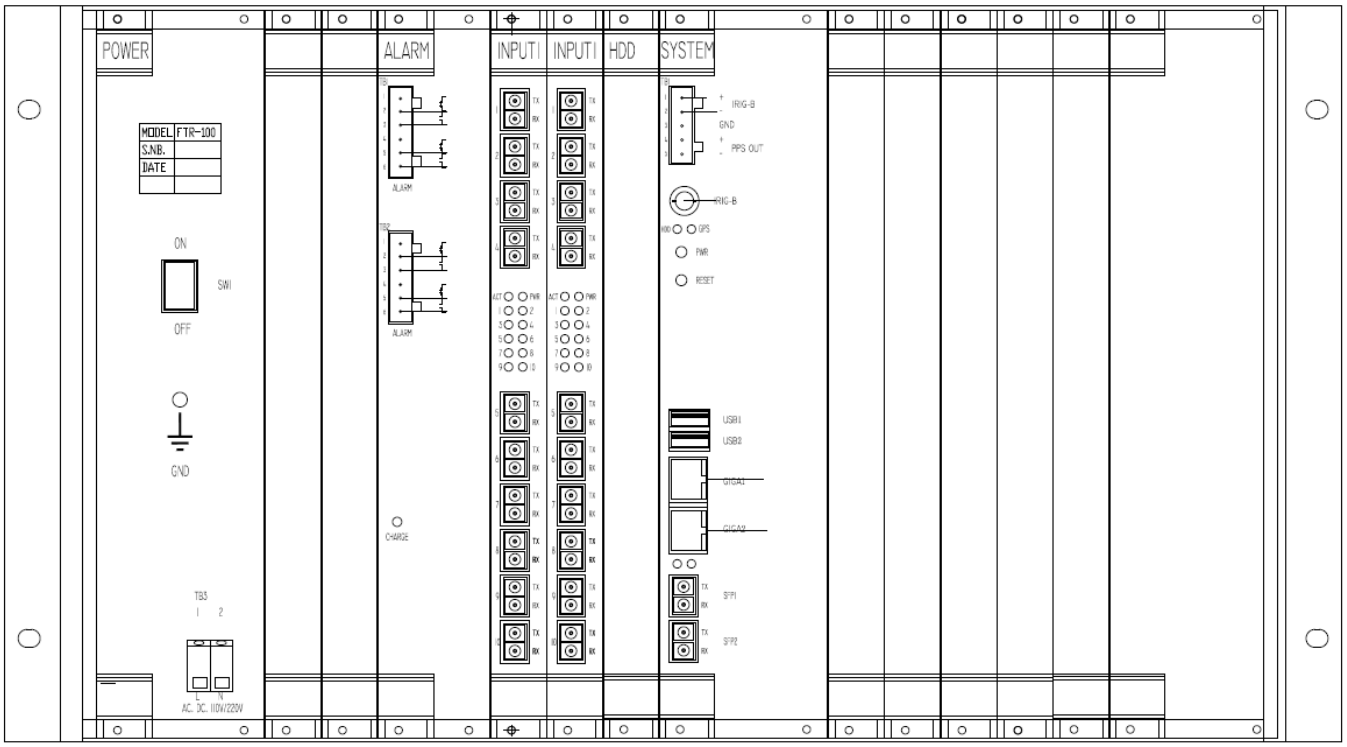


Figure 5-1 FTR-100 Backplane

The key modules are: hard disk module (HDD). CPU card (SYSTEM), data sampling cards (INPUT), alarm card (ALARM) and power supply module (POWER)

5.1 FTR-100 backplane functions

CPU card

1) Two optical and two electrical GHz Ethernet ports, support MMS model service and file service

2) Two USB ports, for USB mouse or memory stick

Data Sampling card(s):

8 x 100MHz, 2 x GHz Ethernet ports, suitable for sampling IEC61850 9-2 and GOOSE messages

Alarm card:

4 alarm outputs: (1) trigger alarm, (2) device failure alarm (3) reserved, (4) loss of power alarm.

6. RAU functions and backplane

Up to three RAU units (figure 3-3) are supported, providing analogue inputs to the FTR system.

Figure 6.1 RAU unit

6.1 RAU Functions

The RAU (Remote Acquisition Unit) samples the analogue input signals and digital status and converts them into data. The data is transmitted serially through optical fibres to the main data sampling module in the FTR.

The digital circuitry of the RAU is configured as a finite state device. When receiving a trigger, it executes all the sampling required and then stop and wait for the next trigger. It is designed such that it will still be capable of sampling all the inputs under the worst timing scenario,.

The data sampling unit is isolated from the RAU through optical fibres, which ensure that the core processing units are not affected by noise and disturbances from the external environment.

6.2 RAU backplane

The RAU is housed in a 4U case. The backplane is as shown in Figure 6.2-1.

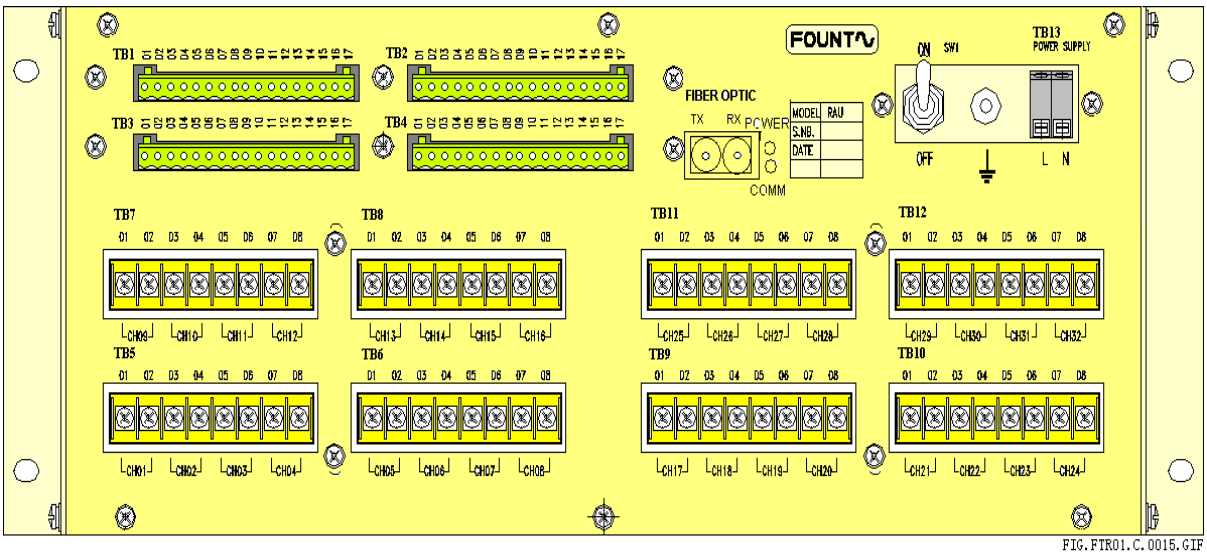


Figure 6.2-1 RAU Backplane

From the backplane, terminal blocks TB5 to TB12 provide the analogue input channels CH01 to CH32.

The RAU backplane consists of TB1 - TB4 digital status input terminal blocks, TB5 - TB12 analogue input blocks, a pair of optical connections (TX and Rx), two indicators (Power and COMM) and the power supply switch.

In TB1 to TB4, each terminal block consists of 16 digital inputs and a common return. Figure 6.2- shows 64 digital inputs.

In TB5 to TB12, each terminal block consists of 4 analogue inputs. Figure 6.2- shows a total of 32 analogue inputs.

The optical fibre connections are used to connect to the data sampling unit.

The POWER indictor shows that the power is on and the COMM indicator shows that the optical fibre communications are working properly.

6.3 RAU connection diagrams

6.3.1 RAU Digital inputs

The digital inputs are grouped into groups of 16, accommodated by a terminal block with a common return.

Users can provide dry contacts to energise the inputs. The FTR-100 provides an internal 24V DC supply to drive the inputs.

Alternatively, users can select 110V DC or 220V DC as the source voltage.

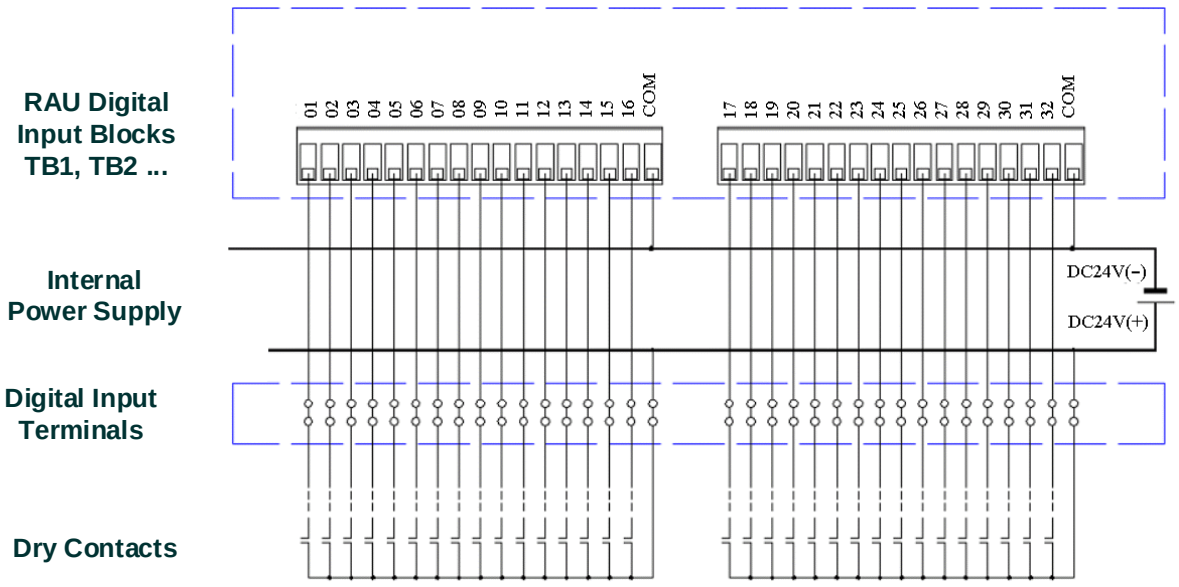


Figure 6.3-1 Digital Input Arrangement

The detailed terminal arrangement is shown in figure 6.3-2

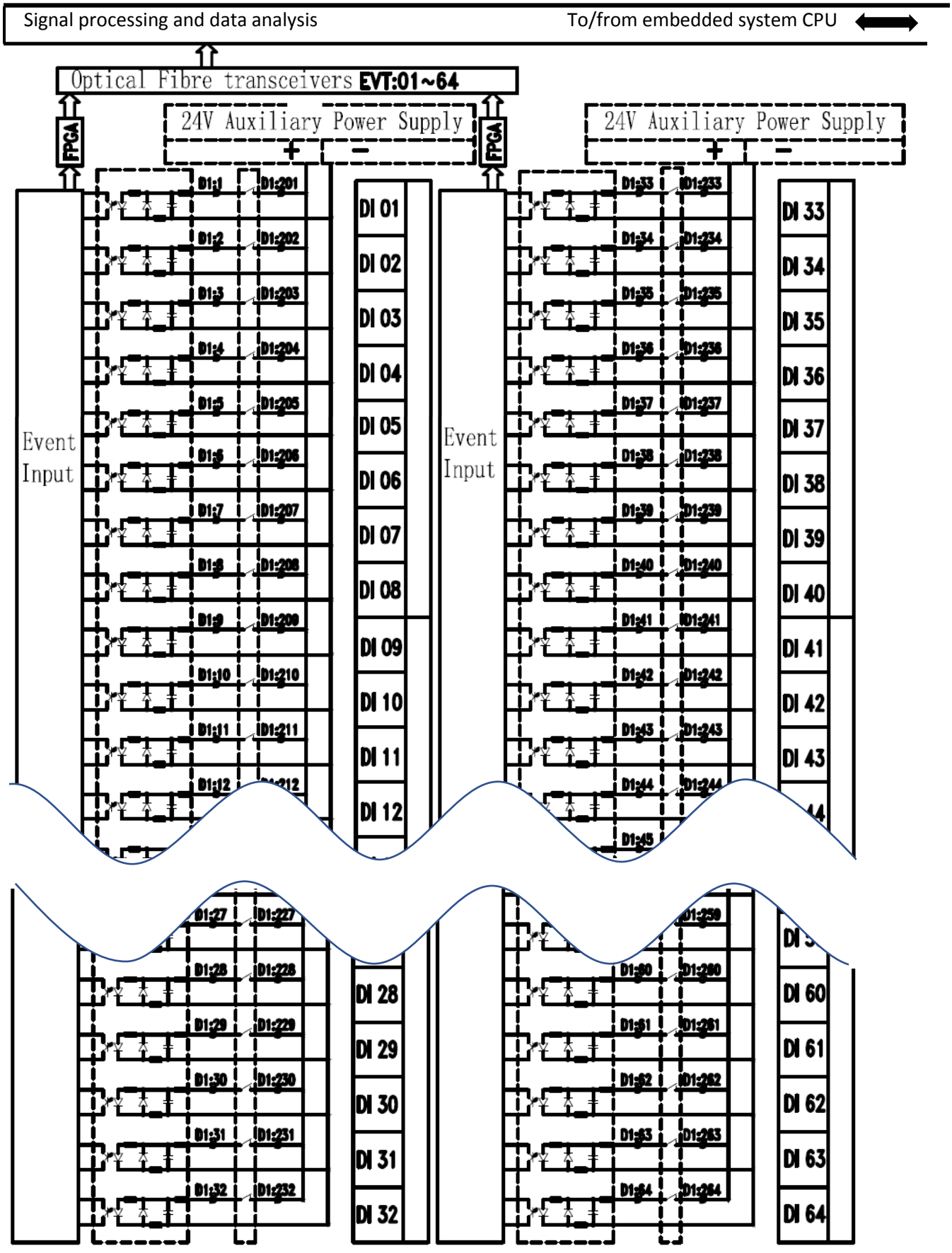


Figure 6.3-2(i): Data Acquisition Unit (RAU) digital arrangement

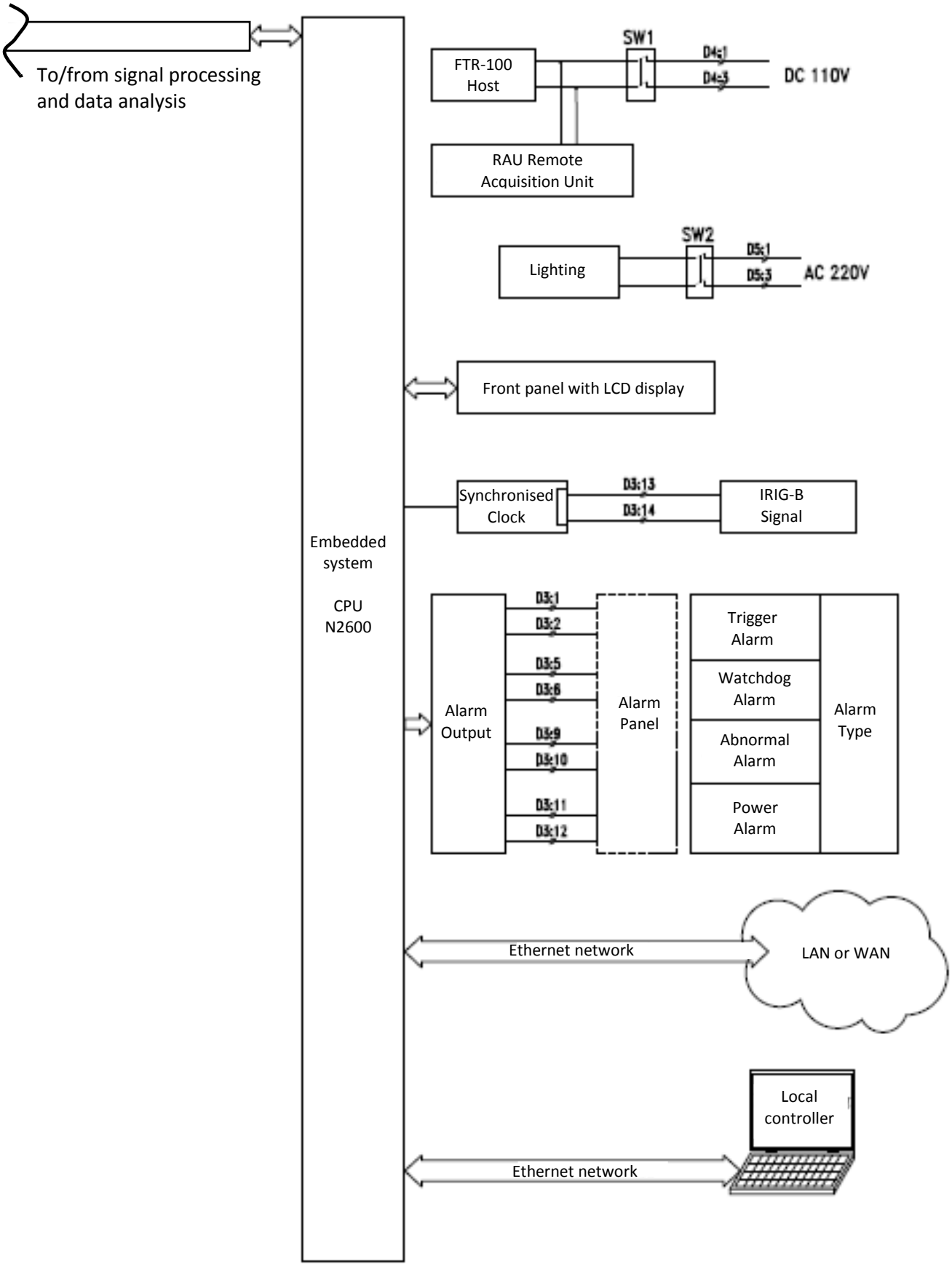


Figure 6.3-2(ii): Data Acquisition Unit (RAU) digital arrangement (ii)

6.3.2 RAU terminals (Analogue and Digital) for the maximum three RAU units

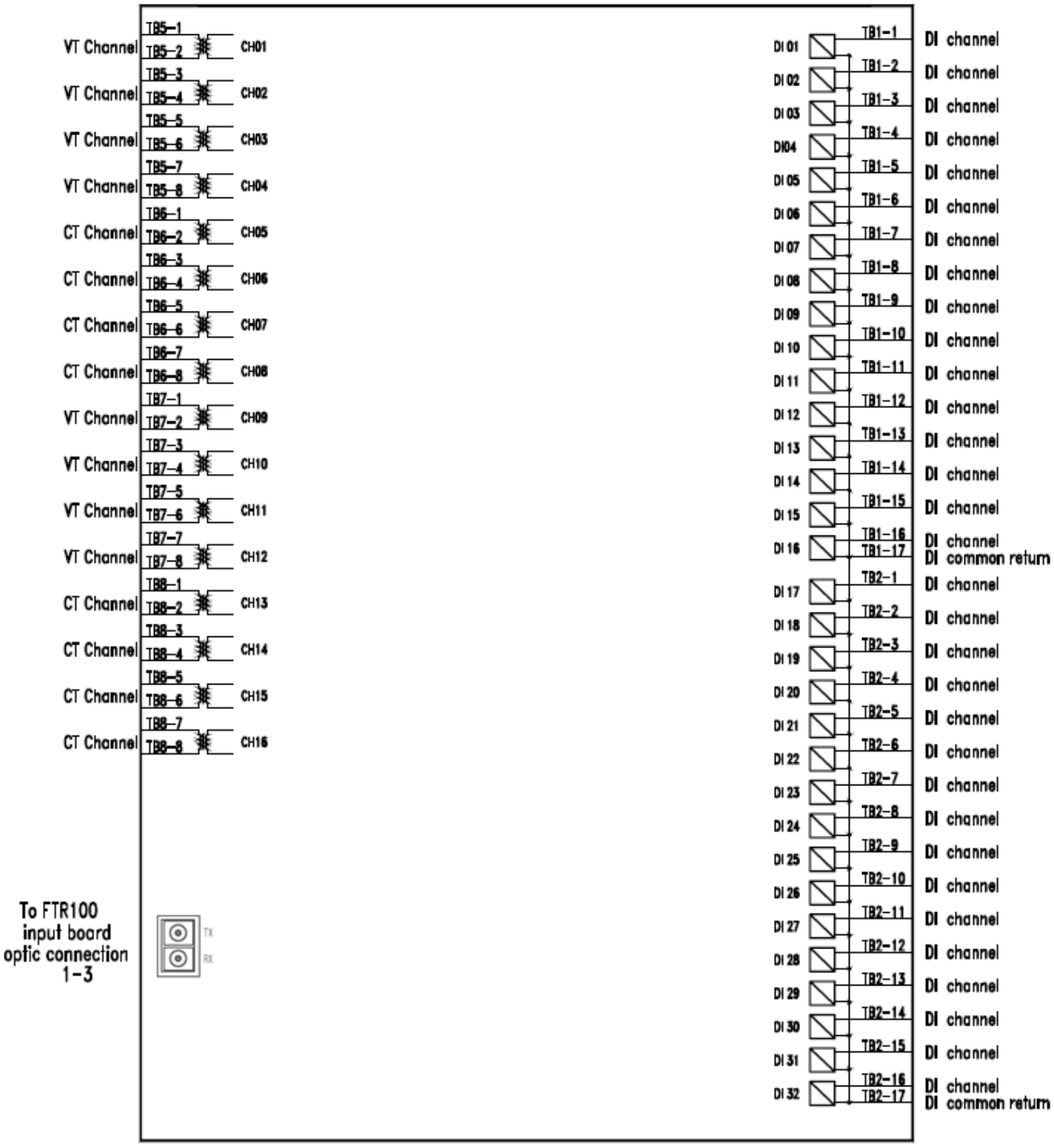


Figure 6.3-3(i): Data Acquisition Unit
(RAU unit 1) connection diagram

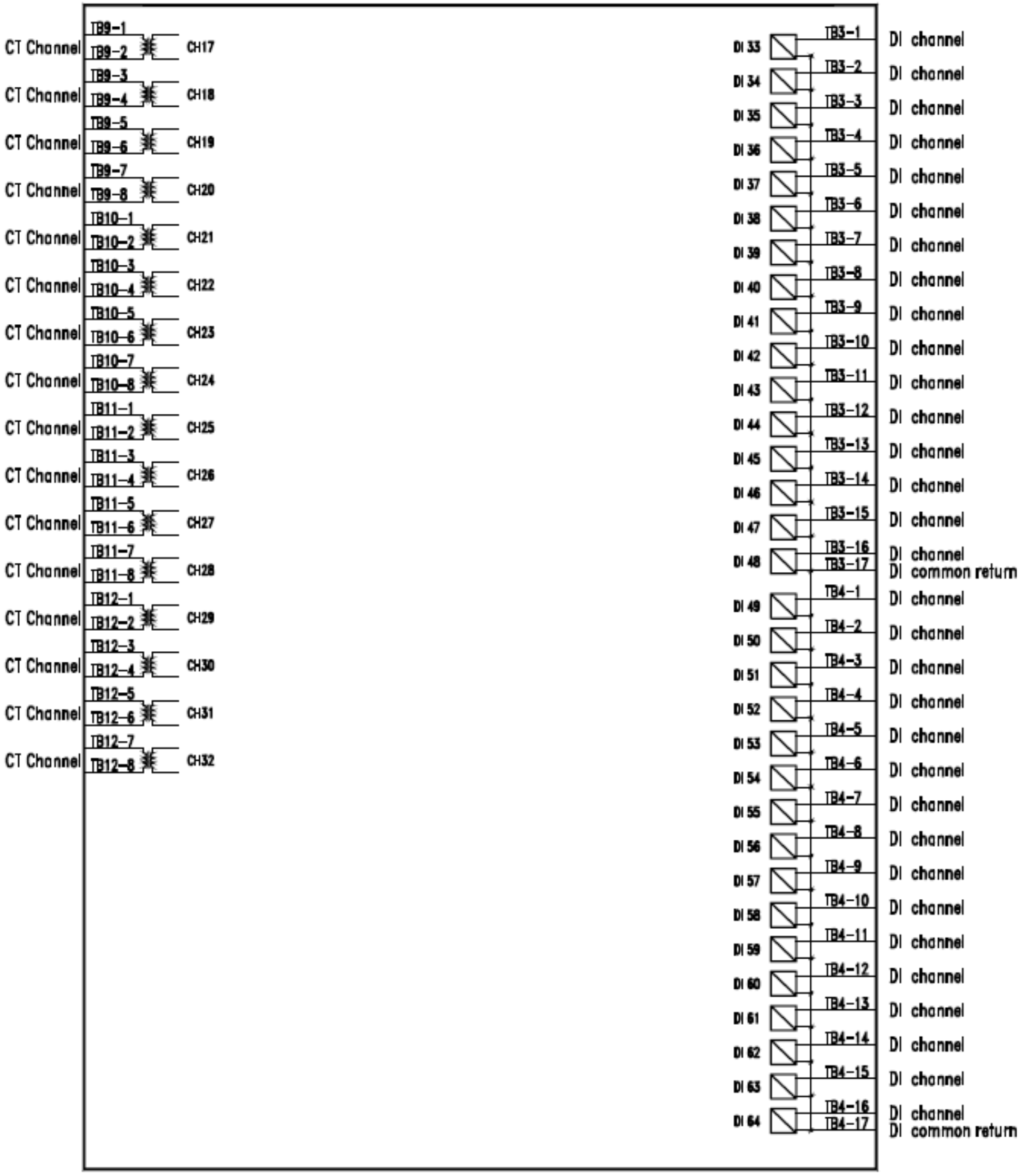


Figure 6.3-3(ii): Data Acquisition Unit
(RAU unit 1) connection diagram

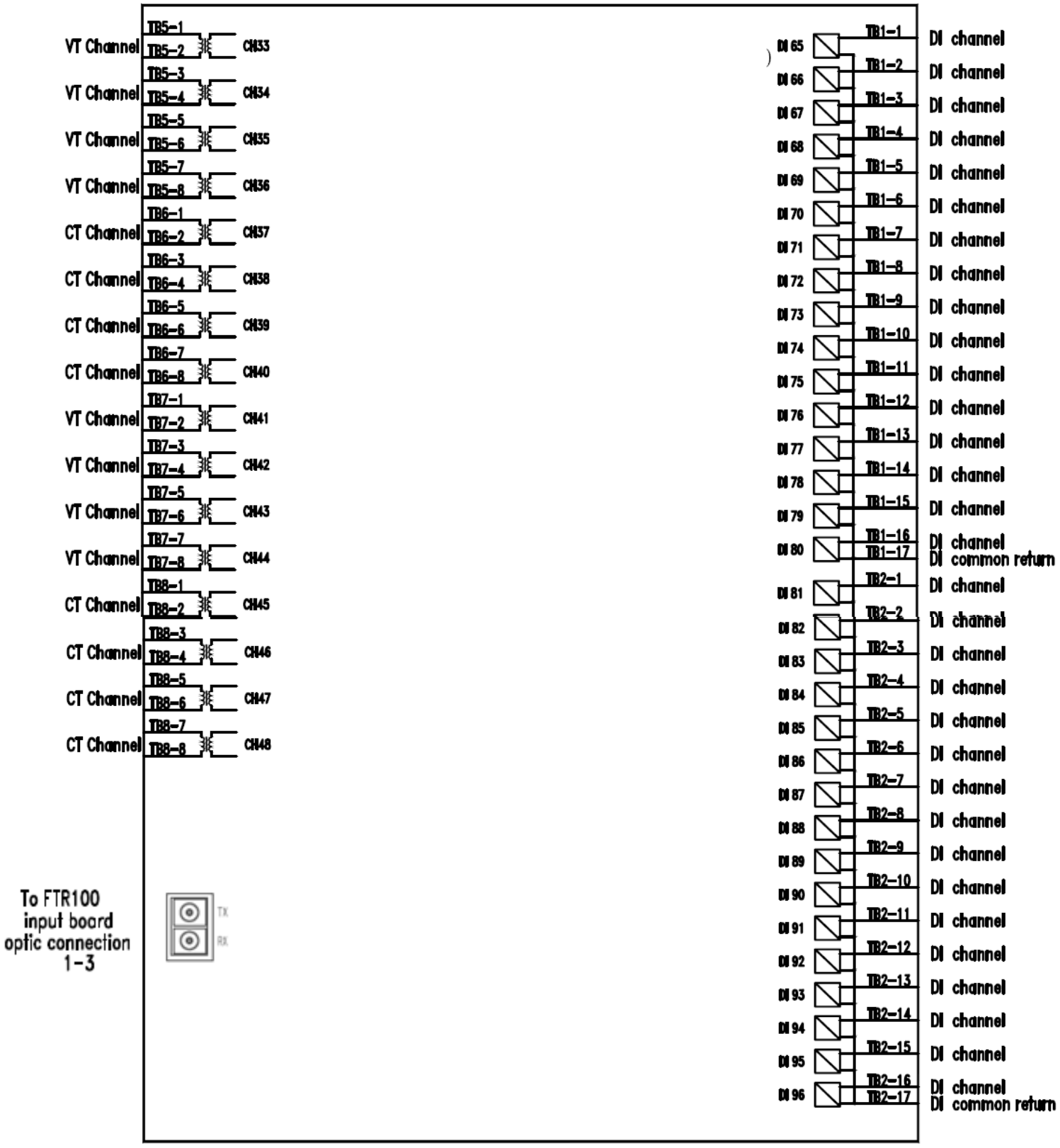


Figure 6.3-4(i): Data Acquisition Unit
(RAU unit 2) connection diagram

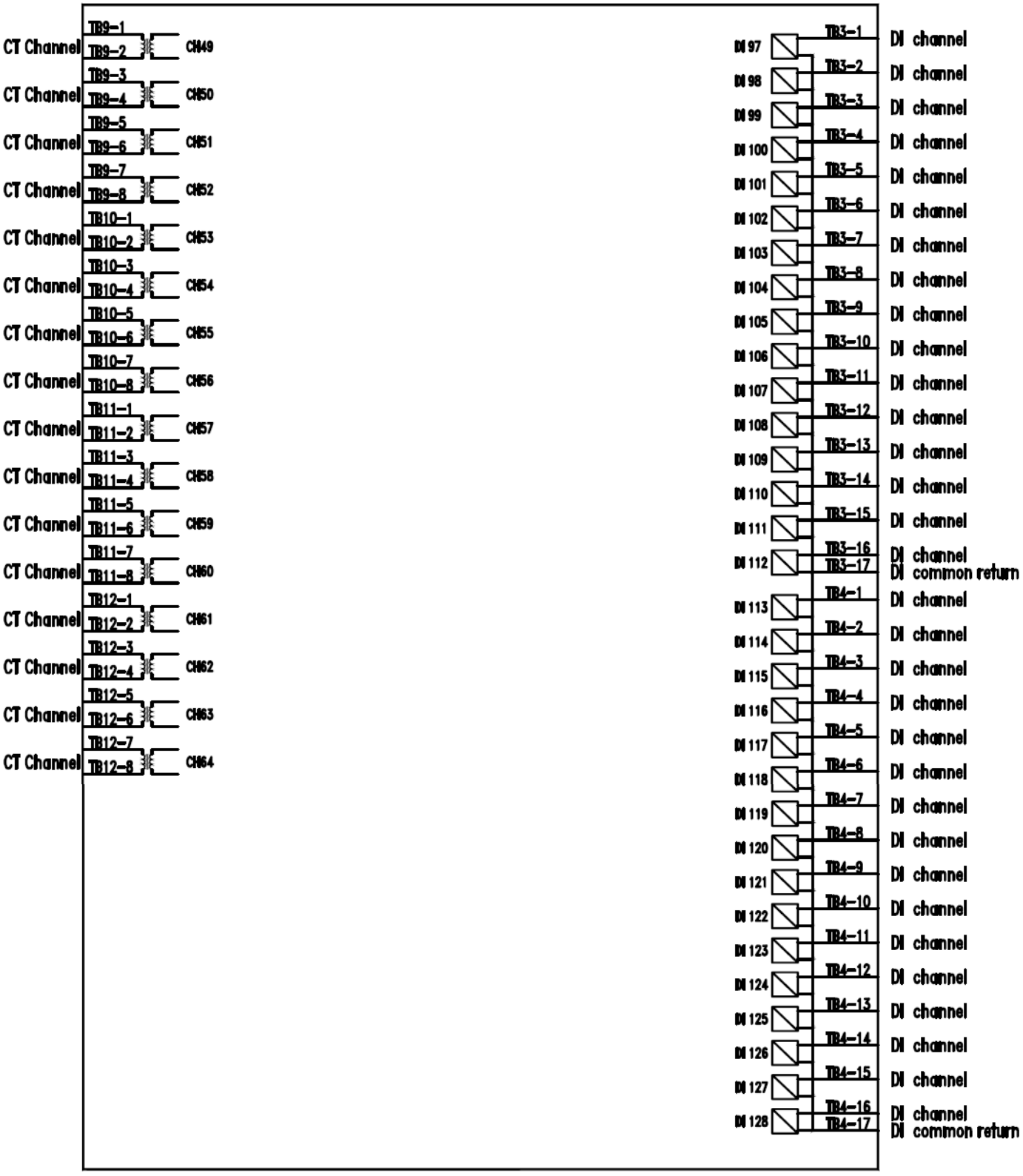


Figure 6.3-4(ii): Data Acquisition Unit
(RAU unit 2) connection diagram

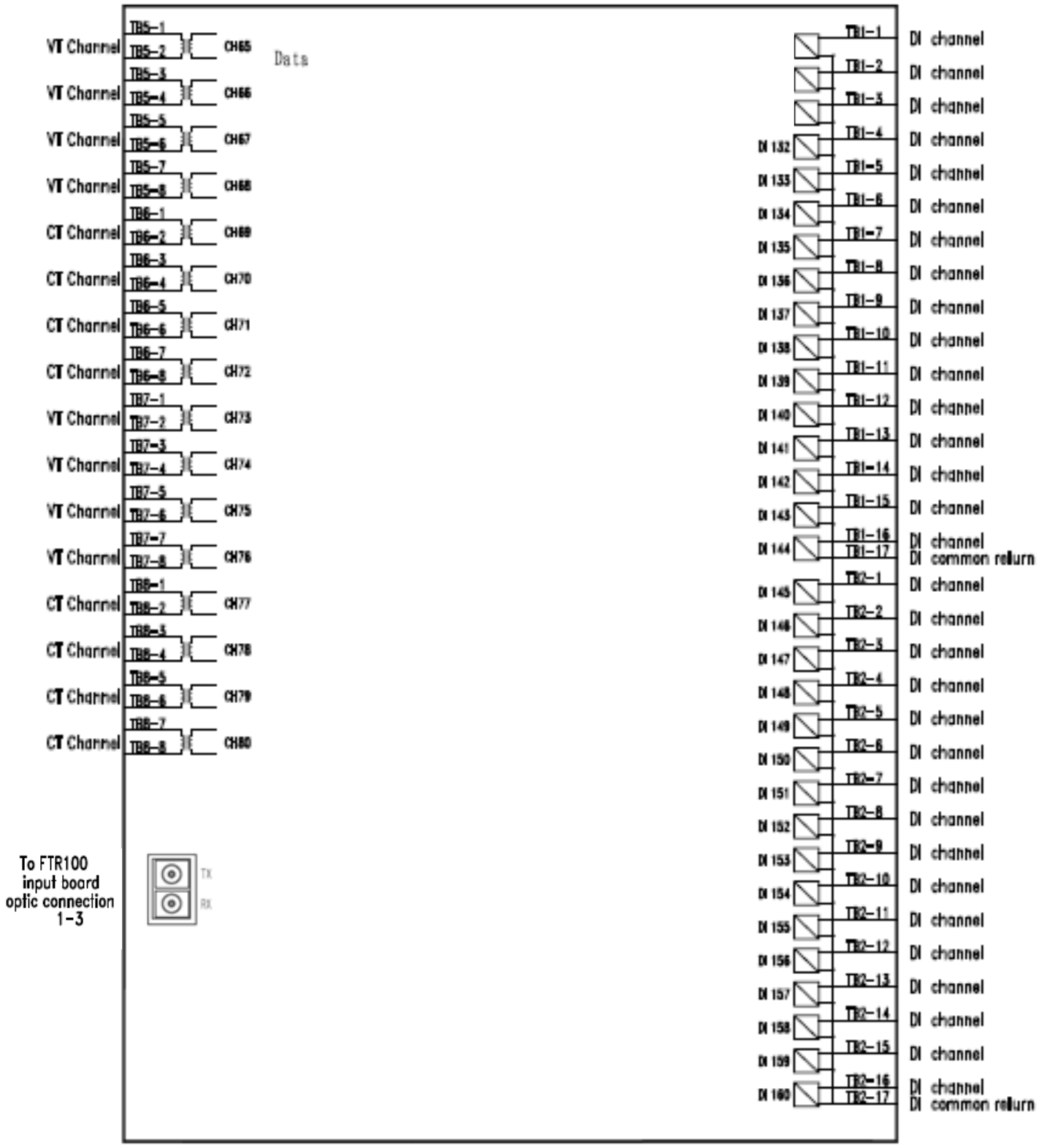


Figure 6.3-5: Data Acquisition Unit
(RAU unit 3) connection diagram - (i)

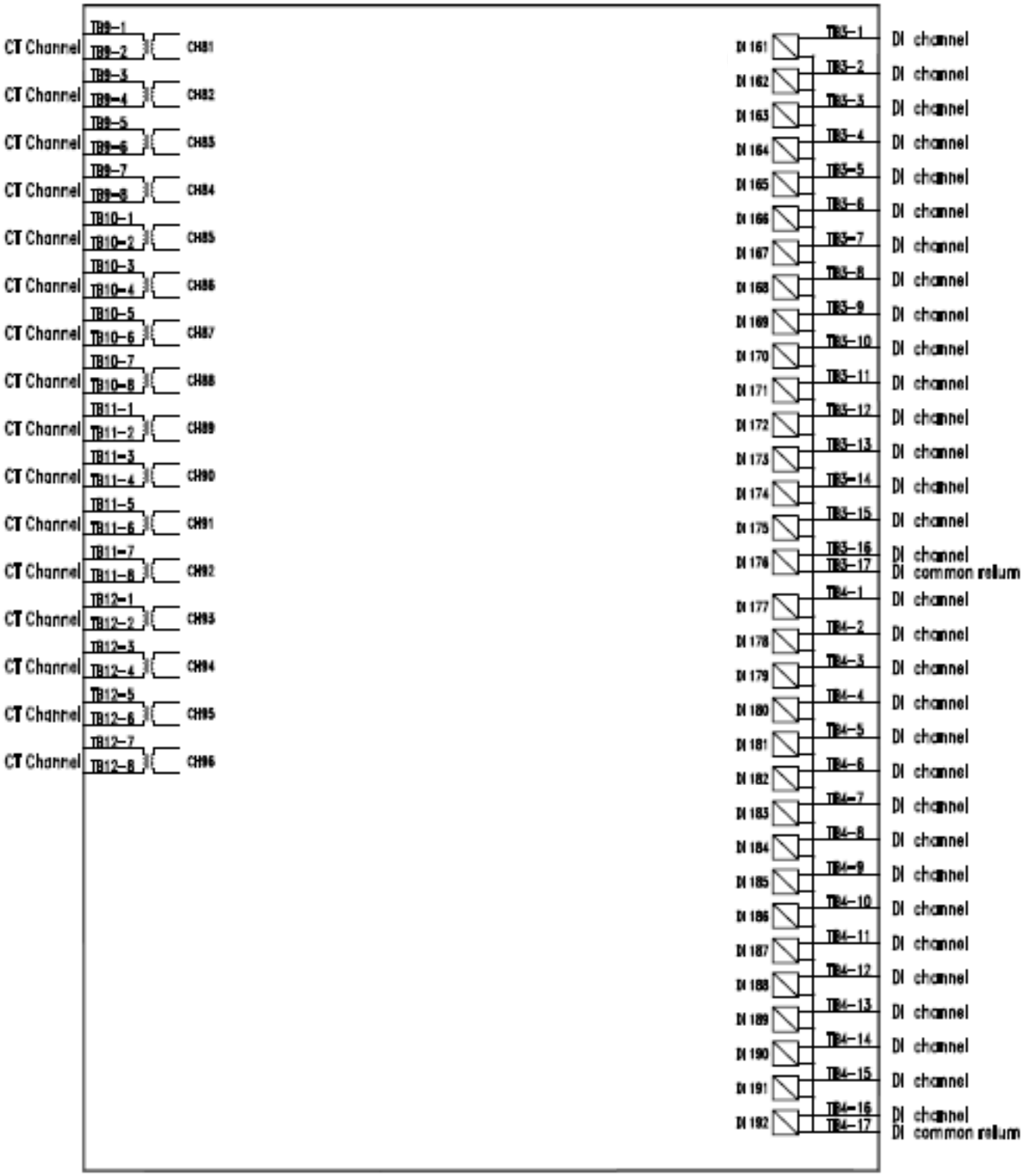


Figure 6.3-5(ii): Data Acquisition Unit
(RAU unit 3) connection diagram

6.3.3 RAU input range jumper connection

To change the input range of the RAU, open the front panel of the RAU, 4 PCBs will be shown, each PCB consists of either 8 CTs or 8 VTs.

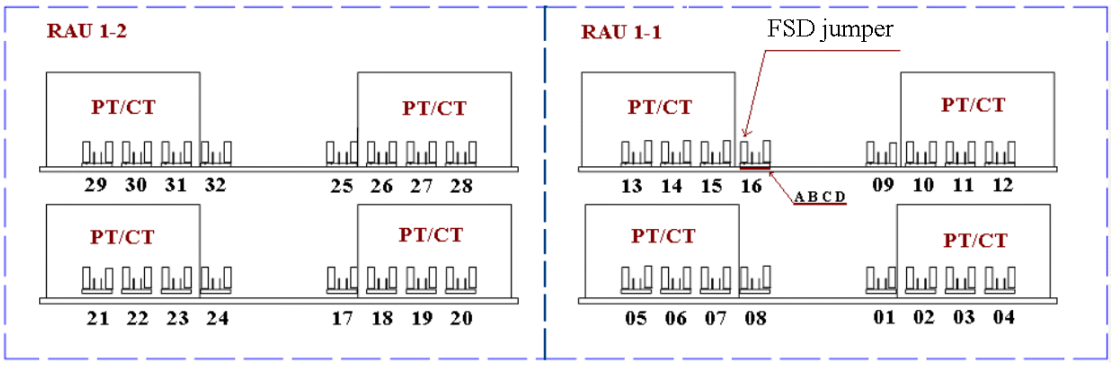


Figure 6.3-6 RAU input module PT/CT positioning

Numbers 01-32 are the jumpers corresponding to the analogue channels.

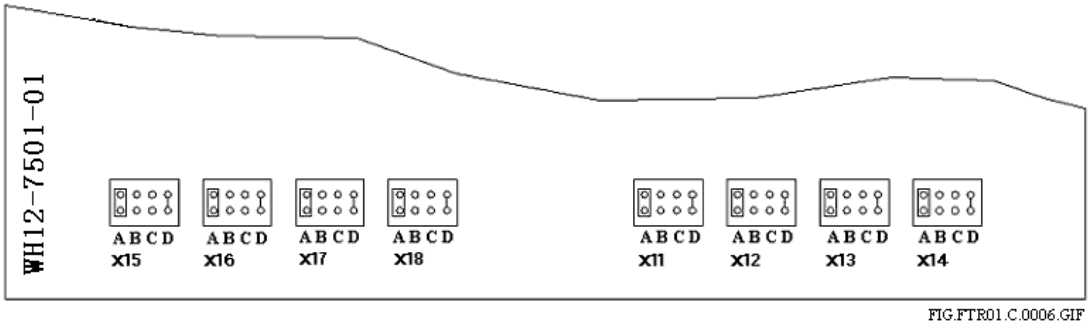


Figure 6.3-7 Analogue channel jumper connections

As shown in Figure 6.3-7 for PCB WH12-7501-01, each jumper lead has three positions; A, B and C, with D as the common return. Depending on whether this is a voltage channel or a current channel, the range selected by jumper positions A, B or C is as shown in Table 6.3.1.

The user should examine the jumper positions to ensure that the range is as expected.

Table 6.3.1 Analogue Input Jumper Position

Jumper Position	Voltage	Current
A	80V rms	-
B	130V rms	-
C	260V rms	20 (or 100) A rms

7. FTR Management System

7.1 Description

The FTR Management System is a powerful software package consisting of two software components: ReplayD and CmdView (COMTRADE Viewer), running under a Windows or Linux operating system. The software can be delivered as a Zip file.

It communicates with the FTR-100 to perform remote configuration and remote operation. It retrieves, processes, analyses and stores records from the FTR-100 and uploads and downloads its settings configuration files. It also performs real-time clock alignment and provides alarms, an events list and real-time monitoring.

7.2 Operating Environment

The software is compatible with Windows XP and above and Linux Mint 17.2 and above.

It runs on a Pentium 1GHz, 1G RAM, 320G hard disk or better PC environment.

Communication with the FTR-100 is through a high-speed Ethernet port using TCP/IP protocol.

7.3 FTR-100 connection to the Management System

7.3.1 Network Physical Connection

The PC communicates to the FTR-100 through one of the RJ45 port at the back of the CPU card.

7.3.2 Network Connection Testing

Step 1: Examine IP address of the FTR-100 through its front panel LCD display e.g., IP: 192.168.0.215

Step 2: set the PC's IP address to be within the same network segment as the FTR-100, for example, IP: 192.168.0.201, Subnet mask: 255.255.255.0, as shown in Figure 7.3.2-1.

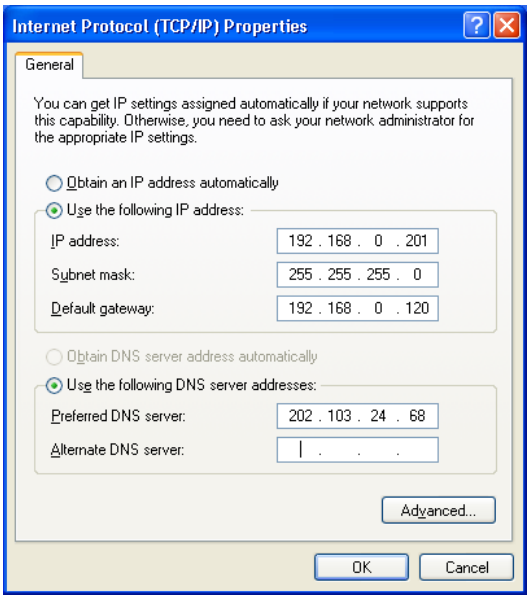


Figure 7.3.2-1 Setting up IP address at the PC

Step 3: at Windows <start> menu, type in a <cmd> command to open a DOS box. Execute <ping 192.168.0.,215> to check the Ethernet connection is operational.

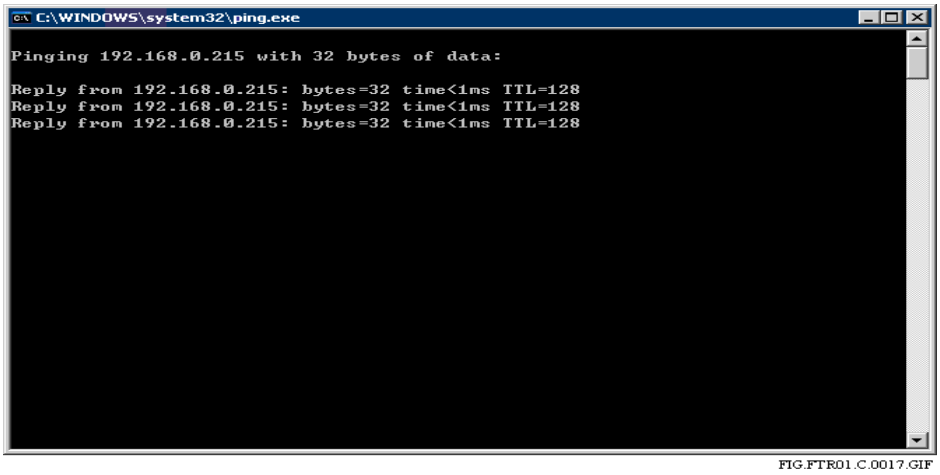


Figure 7.3.2-2 Ping command DOS box

7.4 Install and run

The FTR Management system consists of two sets of applications software: ReplayD and CmdView. Figure 7.4-1 is the main window of the applications software ReplayD.

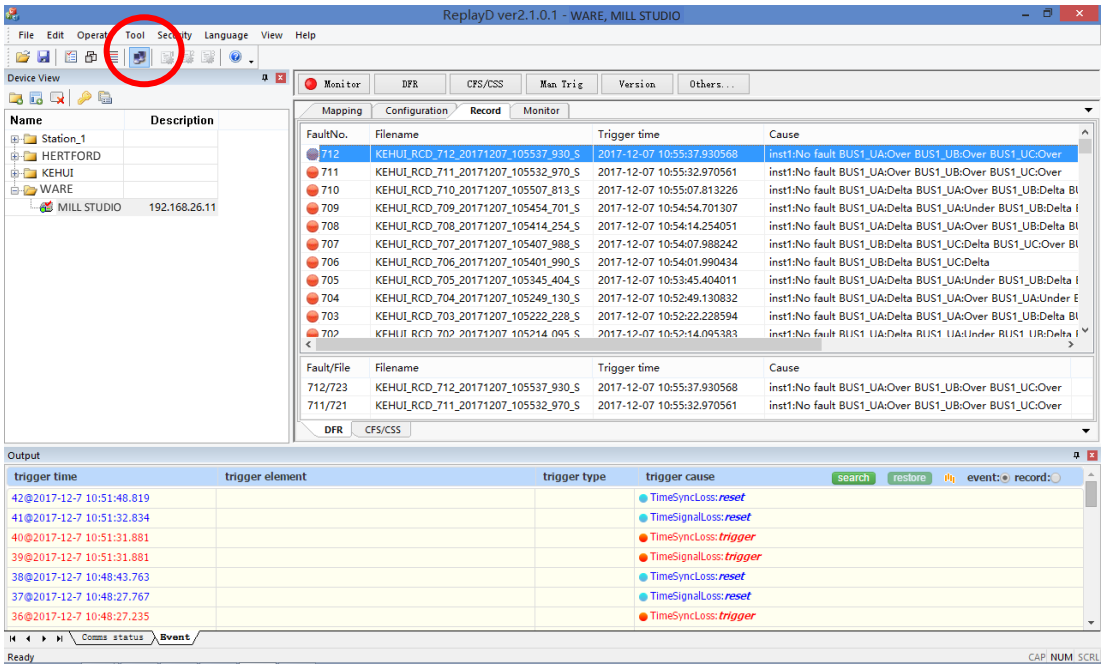


Figure 7.4-1 ReplayD software – main window interface

ReplayD software performs communications and allows the configuration of the FTR-100. It performs file transfers and displays disturbance records and also facilitates manual triggers, real-time clock alignments and real-time monitoring of measurements and events. For digital substations, it handles IEC 61850 SCD files. Connection of the PC to the FTR-100 is controlled by the <connect> icon highlighted in the main window interface.

CmdView is a general purpose COMTRADE viewer. It displays the COMTRADE records, and performs functions such as editing, merging, transforming, analysis and printing etc. The CmdView (COMTRADE Viewer) main window is shown in Figure 7.4-2.

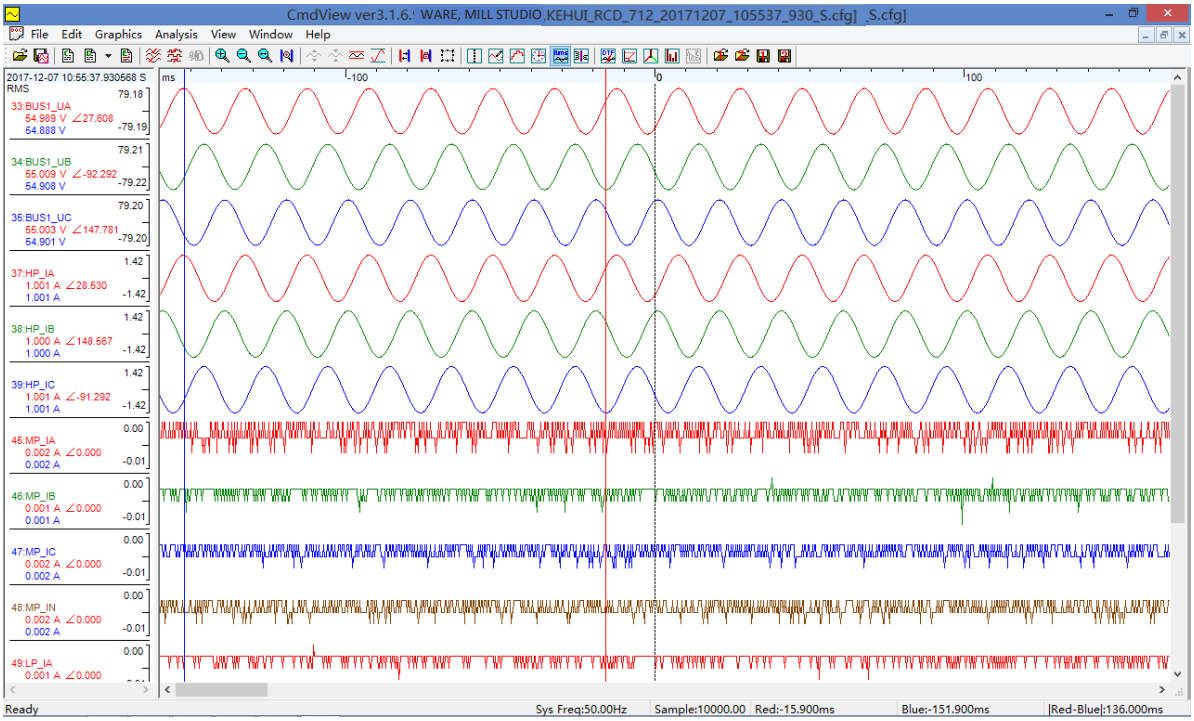


Figure 7.4-2 CmdView (COMTRADE Viewer) main window

7.5 ReplayD Introduction

The ReplayD software consists of the following four main functions:

i) Channel mapping

This configure the SV and the GOOSE control blocks from the SCD file. It also configures the analogue and digital channels from the RAU, including channel naming and setting CT/VT ratios and overload conditions.

ii) Configuration - consisting of 5 sub-modules

Basic: Configures the fundamental settings for the transient records, including pre-fault and post fault duration (A period and B period), trigger threshold settings (overcurrent and under voltage), abnormal input threshold settings (e.g. dual A/D threshold trigger)

Analogue: Using tick boxes, this selects the analogue channels to be recorded and the trigger methods.

Digital: Using tick boxes, select the digital channels to be recorded and the trigger methods (i.e., Open and/or close states).

Elements: This define the elements within a substation (busbar, line, CB, transformer) with identities. These elements will be used for defining the subsequent calculated (or derived) values.

Calculated values: Consisting of sequence components, power (P, Q, S, Power Factor), frequency, harmonics, differential current etc. The measuring location for each “instance” of the calculated value is selected from the Elements sub-module already defined.

iii) Records - consisting of two types:

DFR Disturbance fault records - These are triggered recordings.

CSS/CFS Continuous Slow Sample and Continuous Fast Sample records - These are continuous recordings stored inside a 7-day rotating buffer.

iv) Monitor - consisting of 6 sub-modules

Waveform: Providing the real-time waveform of each analogue channel

Vector: Gives the real-time 3-phase vector information of voltages and currents, including sequence components

Power: Shows the real-time 3-phase and single-phase Watts, VARs and power factor

Harmonics: Displays the real-time harmonic contents of each channel

Flow status: Provides the data flow status (e.g., bytes/s) of the SV and GOOSE messages, including error statistics. It also gives the analogue calibration parameters for the RAU.

Original value: Indicates the real-time RMS values of voltages and currents plus their phase angles.

7.6 Add Substation and Device

In the <Device View> window, right click and select the <Add station> option. A folder will be created for the new substation. Select the folder and right-click, a pop-up window will appear. Select Properties and the resulting window allows the user to change the name of the substation. This is shown in Figure 7.6-1

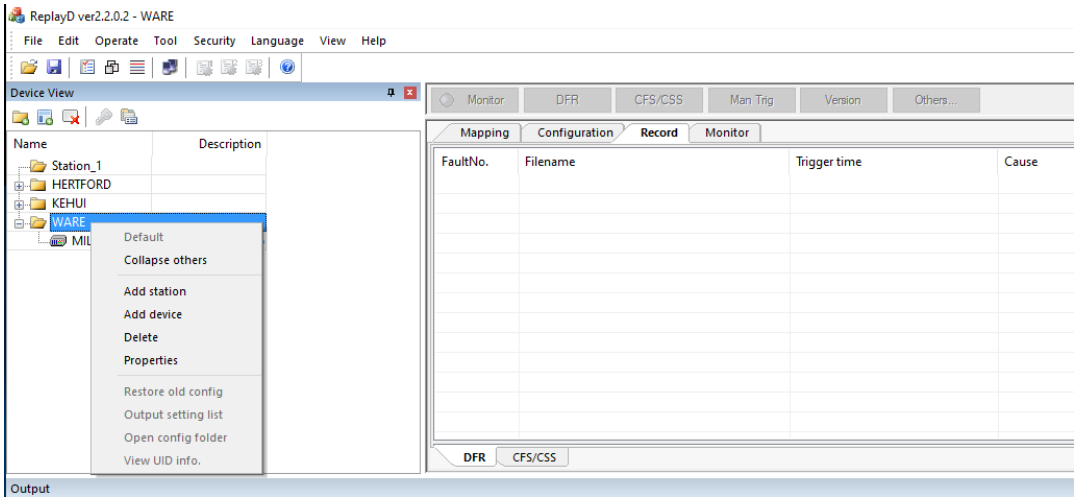


Figure 7.6-1 Add a new substation

Right-click at the new station and select <add device>, a new device will be created. Right-click on the device and select <properties>, a pop-up window appears allowing the user to edit the device name and to enter its IP address. The default password in the pop-up window can be used. This is shown in Figure 7.6-2.

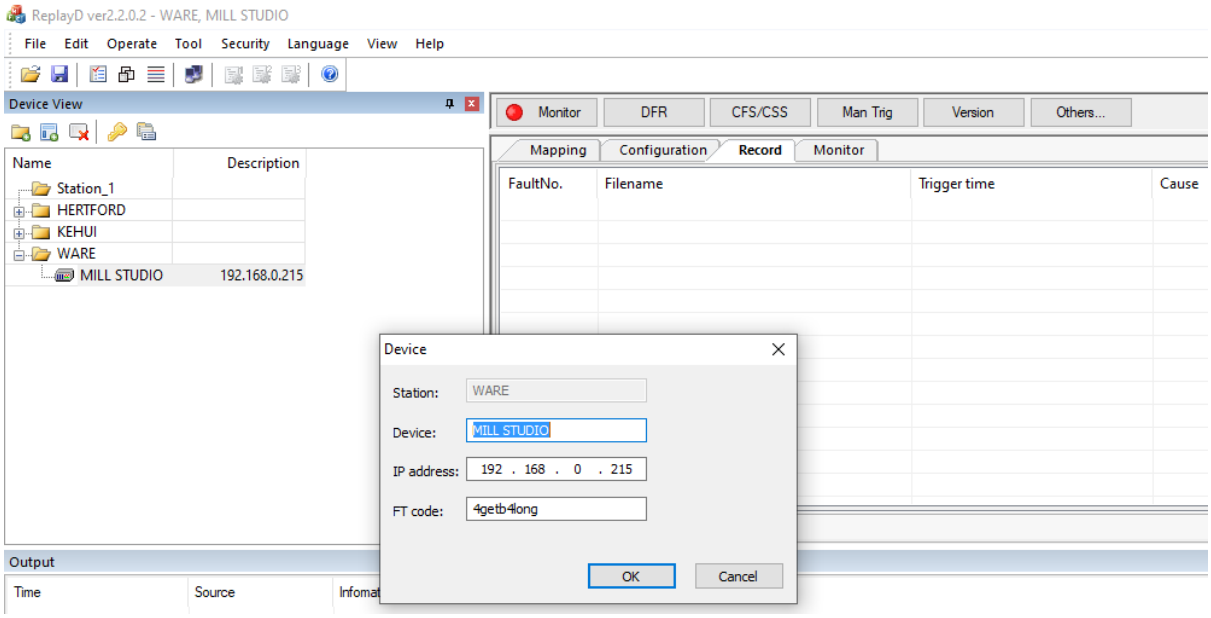


Figure 7.6-2 Add a new device

7.7 ReplayD Channel mapping

7.7.1 SCD file import

Using ReplayD, the user can import the SCD file for a substation. By selecting the required SV and GOOSE control blocks, the necessary configuration file for the FTR-100 can be created.

Click the button and open an SCD file from the PC.

After importing the SCD file, go to the <SCL model mapping> window, the necessary SV and GOOSE control blocks can be selected, as shown in Figure 7.7.1-.

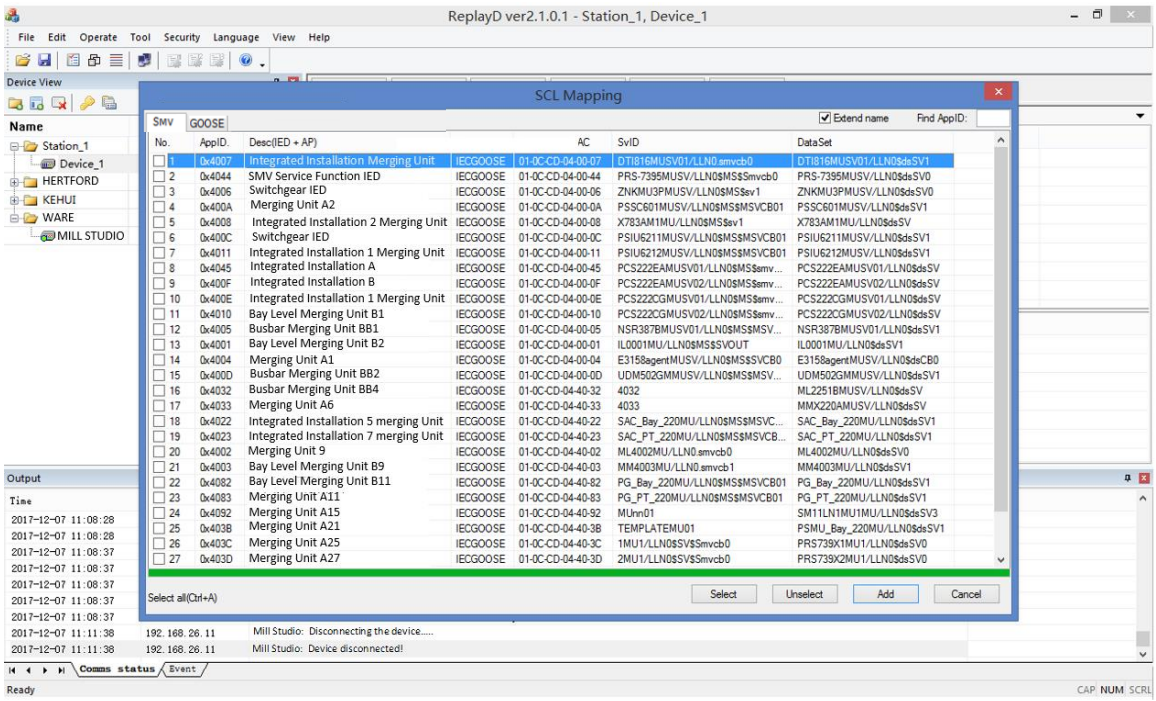


Figure 7.7.1-1 Selecting SMV and GOOSE control blocks

The selected SV and GOOSE control blocks will appear in the <Channel mapping> module of the ReplayD software.

Each SV and GOOSE node should be configured according to the actual situation e.g., cbName, MsvID

The channel for recording can be chosen by selecting the associated tick box. Afterwards, the primary and secondary ratios can be set, together with the overload conditions. This is as shown in Figure 7.7.1-.

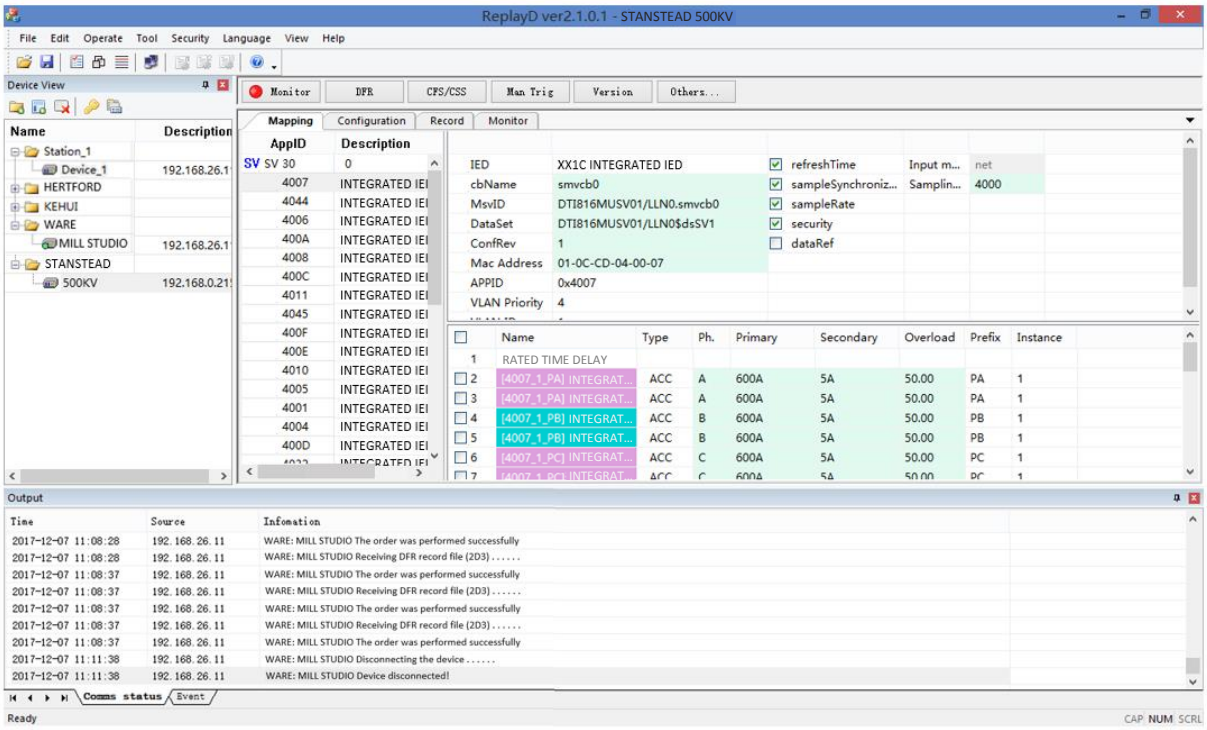
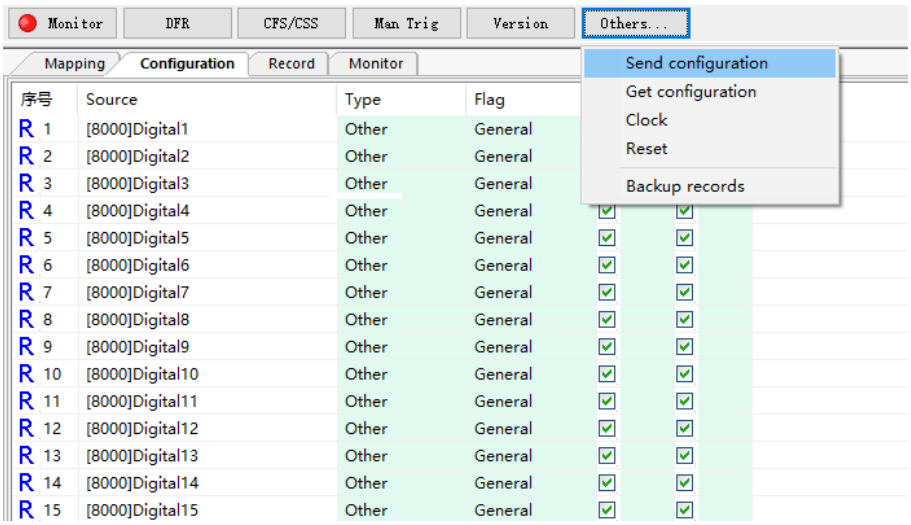


Figure 7.7.1-2 Selecting analogue channels for recording

The individual GOOSE messages in the GOOSE control block can be selected in the same way.

After the configuration is complete, <send configuration> is selected in the menu bar, to send the configuration to the FTR-100.



7.7.2 Adding a RAU

Analogue recording requires the Remote Acquisition Unit (RAU) to be installed to provide the analogue channels data. Go to <File> pull-down menu and select <ADD RAU>. A pop-up window will appear, as shown in figure 7.7-3.

The application identifier (APPID), sampling rate, phase sequence and the number of analogue and digital channels are set up according to the requirements of each RAU.

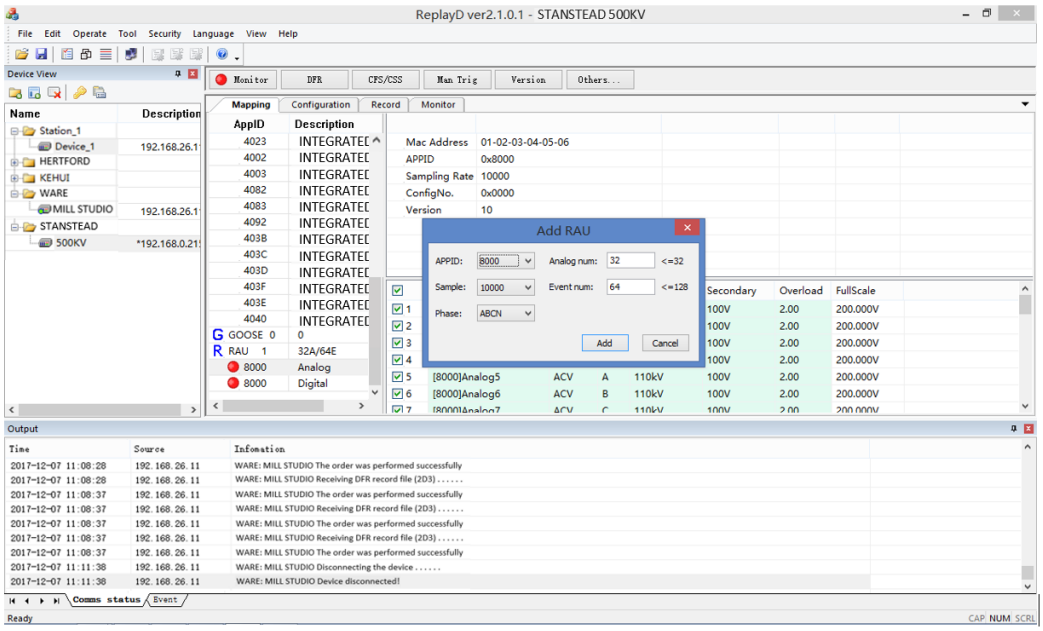


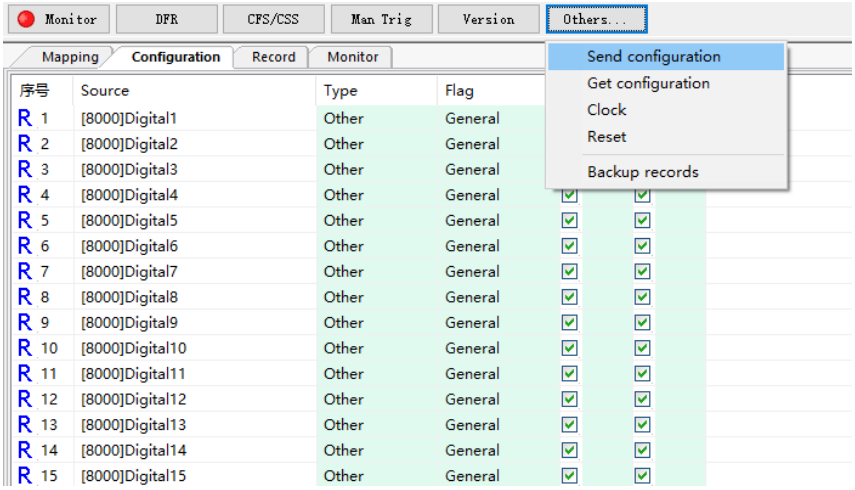
Figure 7.7.2-3 Adding an RAU unit

8. ReplayD Configuration

If the FTR-100 has already been configured, it is only necessary to select the device, go to <Others> tab, and select <Get configuration>. The configuration of FTR-100 will then be uploaded into the PC. If the FTR-100 has not been configured previously, it is necessary to go through the following process.

Select <Configuration> tab. There are 5 sub-modules at the bottom of the page within this tab: Basic, Analogue, Digital, Elements, Calculation. They are explained in details below.

All configuration changes will need to be sent to the FTR-100 for it to accept the changes. This is done in the <send configuration> command under the <Others> pull-down menu. After executing the <Send configuration> command, the FTR-100 will self-reset. This may disrupt the communications of the PC to the FTR-100. The communications can be re-established by clicking the <Connect> icon again.



8.1 Basic Configuration

The basic configuration page is shown in Figure 8.1-1. Each setting is explained below.

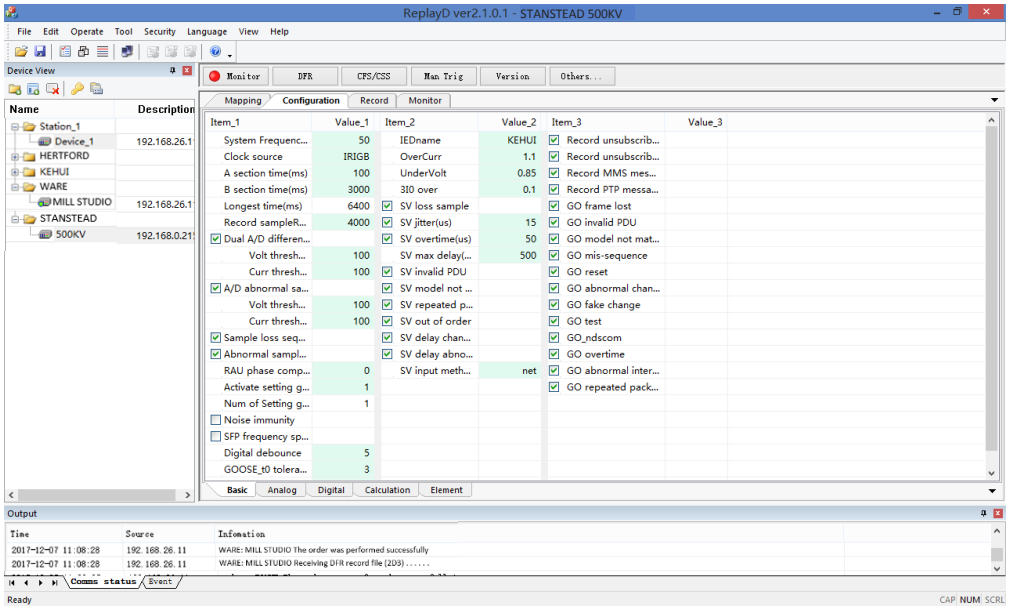


Figure 8.1-1 Basic ReplayD configuration

- Clock source: NONE, IRIG-B, PPS (Pulse per second), IEEE 1588 precision time protocol
- A period recording time: DFR (disturbance transient recorder) pre-trigger time
- B period recording time: DFR post-trigger time
- Longest recording time: The longest time allowable for a DFR record
- Record Sample rate (Hz): DFR record sampling rate
- Dual A/D sample difference trigger threshold: This triggers a record if the difference between the dual A/D samples exceeds the threshold.
- Dual A/D abnormal sample threshold: This triggers a record if either one of the dual A/D samples is abnormal and exceeds the threshold.

- Sample sequence lost trigger: Triggers a record if there are lost samples or the sample sequence is abnormal
- Sample quality abnormal trigger: Triggers a record if the sample quality flag is up
- RAU phase compensation: Compensates for the phase angle difference between the voltage and current measurement due to sample delays
- Activate setting group: Selects a setting group to activate (fixed at 1 for FTR-100)
- Number of setting groups: 1
- GOOSE_t0, GOOSE_t1 tolerance: This selects the allowable to and t1 tolerance range in GOOSE
- Fault detection trigger: Overcurrent, under voltage, neutral overcurrent.
- SV abnormal detection: SV lost, SV jitter, SV time-out
- GOOSE, MMS and PTP messages subscription and abnormal detection: recording MMS messages PTP messages, lost frame Goose messages, abnormal frame Goose messages etc.

8.2 Analogue Data configuration

In the <Channel mapping> function, the analogue channels are selected as either SV control blocks, a 1.5 breaker scheme or the RAU. These channels will now appear in this page to allow the user to select the trigger method and the trigger threshold.

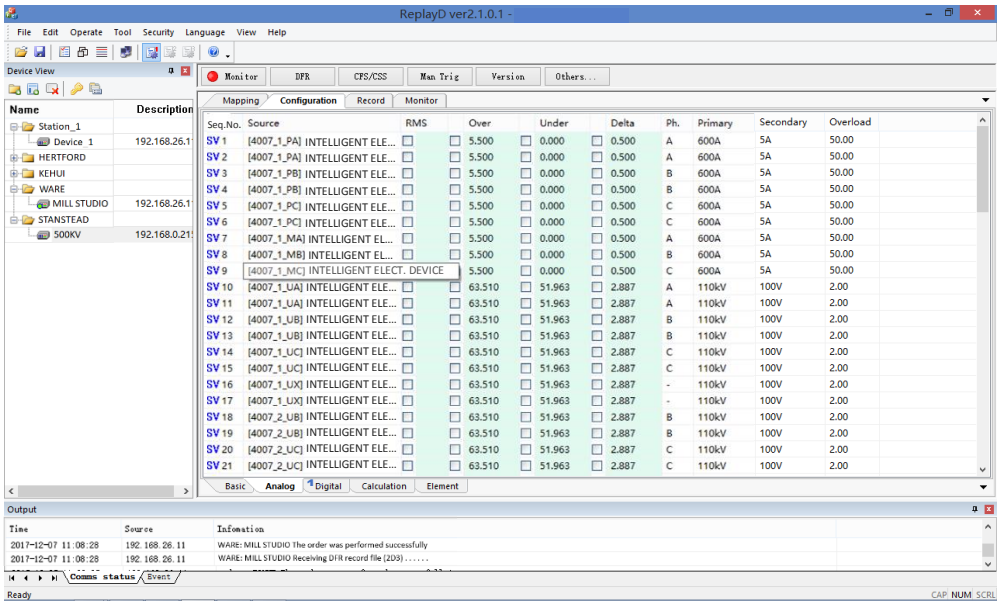


Figure 8.2-1 Analogue data configuration

<Channel source> represents the name of each SV analogue channel. It is formed by APPID + device name + phase information

The triggered quantity calculation is based on the <RMS value> selection. If the <RMS value> is selected, RMS values (including all the harmonics) will be used. If de-selected, magnitudes based on fundamental frequency will be used.

<Over>, <Under> <Delta>, if selected, they will be activated.

The example in Figure 8.2-1 shows that Channel 1 has been configured with 5.5A overcurrent, delta value 0,5A, phase A, CT ratio 600 to 5, Overload ratio 50

The above process will be repeated until all the channels have been configured.

Select <Send configuration> in the 'Others' pull-down menu to send the new settings to the FTR-100.

8.3 Digital input Configuration

FTR-100 uses either GOOSE control blocks or signals obtained through the RAU to select and configure the digital inputs, see Figure 8.3-1.

Explanations of the pull-down selections for each channel are as follows:

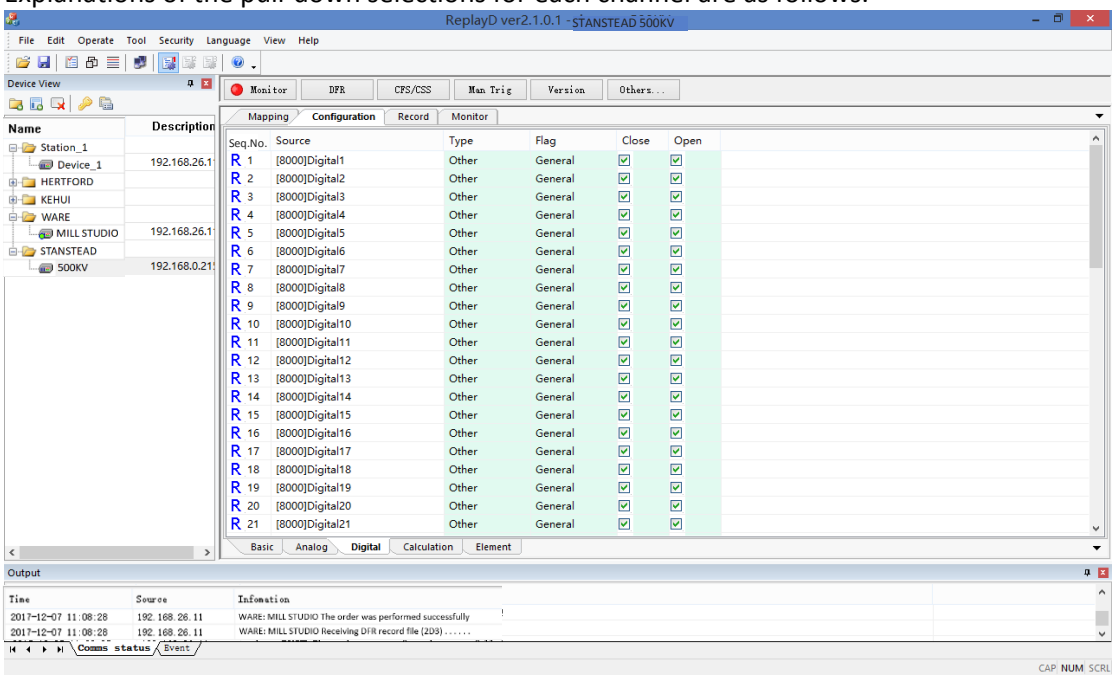


Figure 8.3-1 Digital input configuration

Type: types of digital inputs, consisting of <Protection operation>, <CB position>, <Switch position>, <Alarm>, <Others>

Labels: allow the users to enter labels for each digital input to make them more meaningful.

Flag: depending on the <Type> selected, as follows.

<Protection operation> includes <Protection trip>, <Trip A>, <Trip B>, <Trip C>, <Three phase trip>, <Auto-reclose>, <Lockout>, <Send signal>, <Receive signal>

<CB position>: includes <three phase CB close>, <three phase CB open>, <A phase CB close>, <A phase CB open>, <Transformer HV CB close>, <transformer MV CB close>, <transformer LV close>.

<Switch Position>: includes switch open and closed

<Alarms> include <VT failure>, <CT failure>, <communications alarm>, <other alarm>

Close: If selected, a closing digital input will trigger the recording

Open: if selected, an opening digital input will trigger the recording

After the configuration, press <Send Configuration> to send the settings to the FTR-100.

8.4 System Elements Configuration

Before configuring calculated (or derived) values, it is necessary to configure the power system elements, which include busbar, single breaker line, 1.5 breaker line, 2-winding and 3-winding transformers. See Figure 8.4-1

Busbar: The busbar typically provides Va, Vb, Vc and Vn for the substation. They are mapped to the corresponding voltage channels.

Line: This represents a typical transmission line with a breaker at each end. The voltages are obtained from the busbar, whilst Ia, Ib, Ic and In from the line, are mapped to the corresponding current channels. Line length and positive, negative and zero sequence impedances are parameters used for the fault location calculations.

One-and-a-half (1.5) circuit breaker line: The Ia, Ib, Ic and In currents on the line are the summation of two branch currents. The branch currents will need to be mapped to their corresponding current channels.

2-winding/3-winding transformer: the source of currents of each winding is coming from the line already configured. The user needs to set up the mode of connection (e.g., DY1, DY11) and the earthing arrangement of the transformer.

The following is an example of the 1.5 breaker line :-

Line name: AtoB

Busbar: A-BUS

Line current branch 1: Ia, Ib, Ic, In

Line currrent branch 2 : Ia, Ib, Ic, In

Line length : 100km

Primary/secondary: secondary

R1(ohm/km), X1(ohm/km)

R2(ohm/km), X2(ohm/km)

R0(ohm/km), X0(ohm/km)

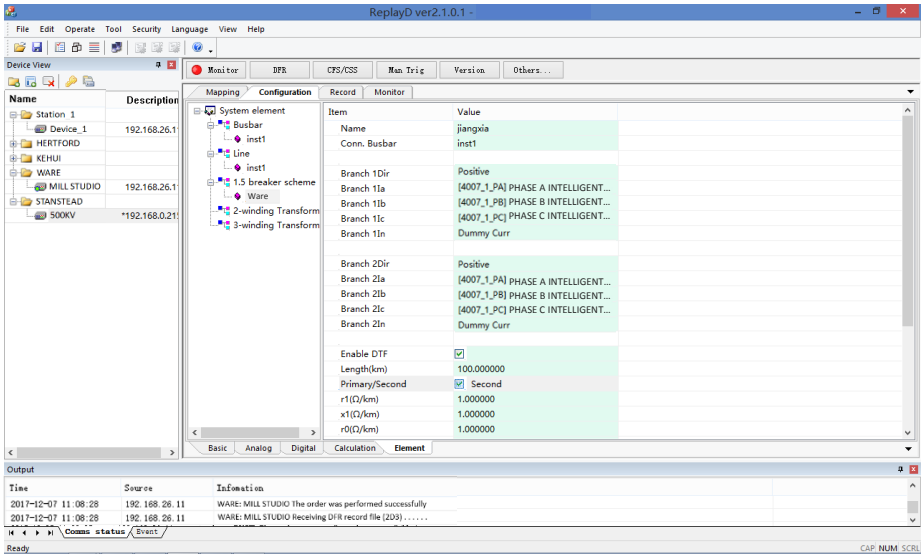


Figure 8.4-1 Systems elements configuration

8.5 Calculated (Derived) Values Configuration

Calculated values are based on one cycle of instantaneous samples from one or multiple channels, e.g., harmonics, angle, sequence components, power, power factor, etc. These values can be used to trigger recordings.

8.5.1 Calculated value configuration

In the <calculation> page, the calculated values are: Positive sequence, negative sequence, three-times zero sequence, single-phase active power, 3-phase active power, single-phase reactive power, 3-phase reactive power, power factor, frequency, harmonics, angle difference, differential current, over-excitation current and transformer differential current.

In the example in Figure 8.5.1-1, the positive sequence voltage is selected as the trigger criterion, with an over-voltage threshold set at 63.51V, with the under-voltage at 51.963V.

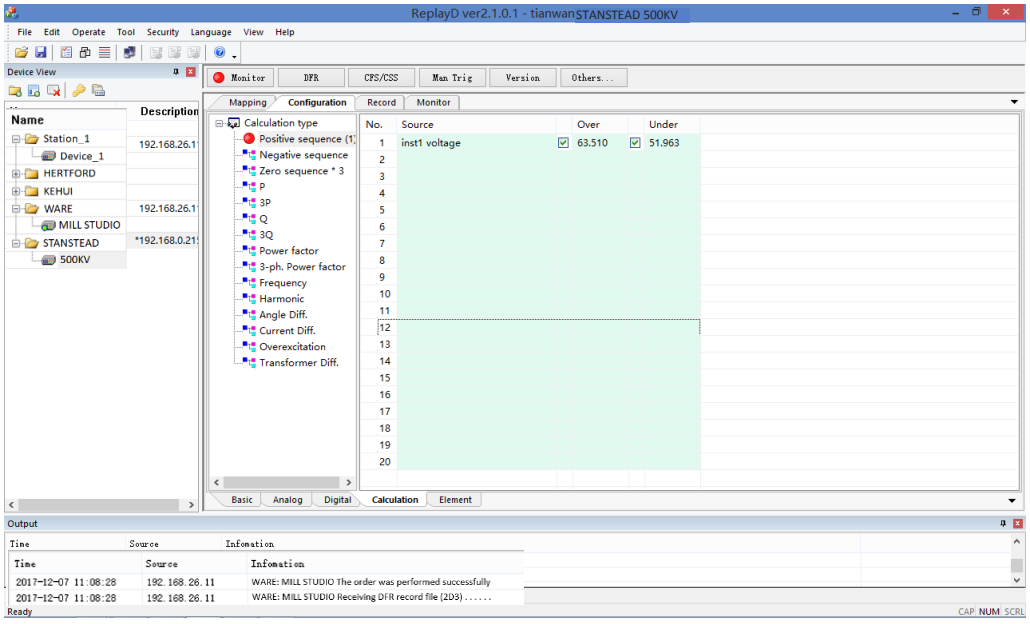
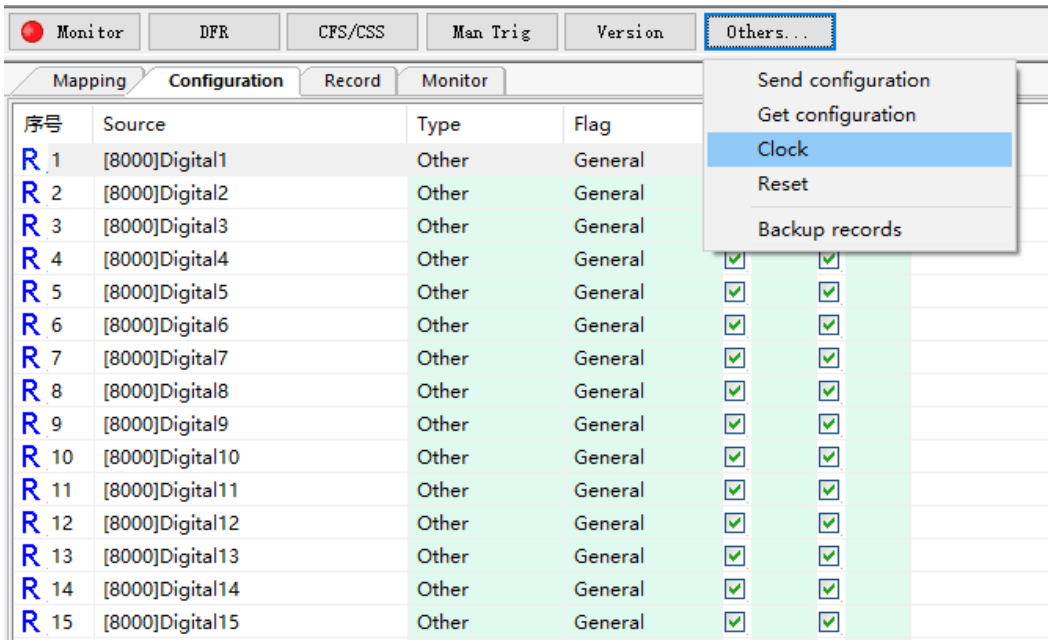


Figure 8.5.1-1 Calculated value configuration

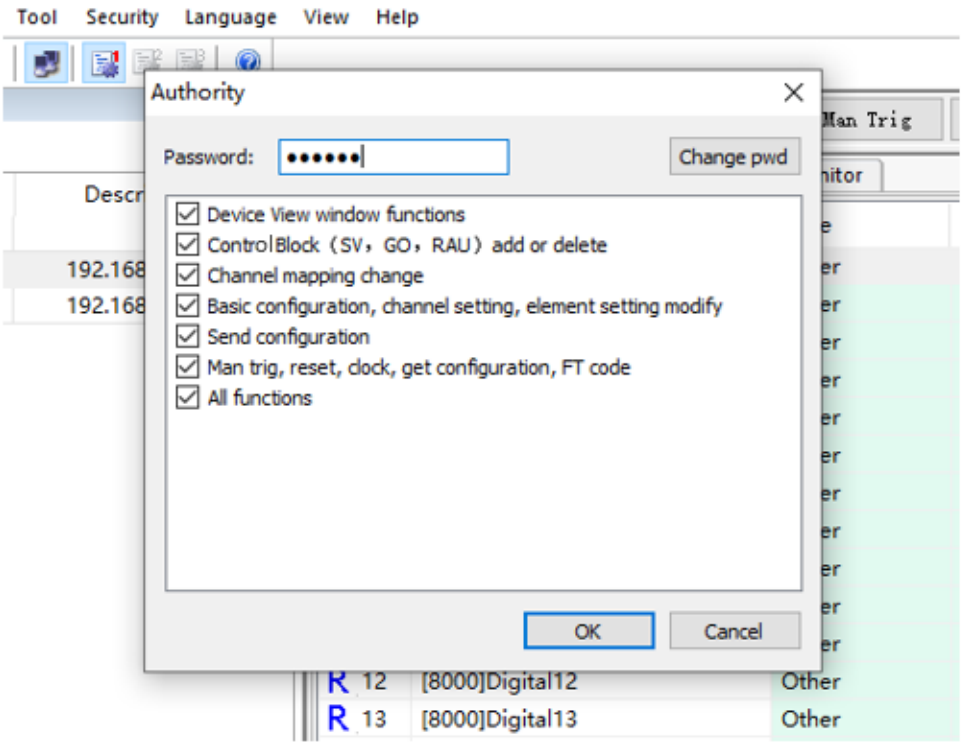
8.6 Date and time setting

The date and time of the FTR-100 can be set to be synchronised to the clock of the PC by the command <Clock> under <Others> pull-down menu.



8.7 Password protection

Under <Security> pull-down menu, select <Set authority>. A list of tick boxes appears allowing the user to enable or disable access to certain functions. For example, unticking all the boxes except 'Device View window functions" allows the user to view information, but not to change any settings. The default password for <set Authority> is 111111. This can be changed through <Change pwd> button.



9. FTR-100 Recording

The FTR-100 has three types of recording:

Fault Transient Recording (FTR) - for transient waveform recording, sampling rate is 4kHz for sample value inputs and 10KHz for analogue inputs.

Continuous Slow Speed (CSS) recording - for continuous long duration trace recording of calculated (or derived) values.

Continuous fast speed (CFS) recording - for continuous waveform recording at a lower sampling rate of 1kHz.

9.1 Digital Fault Recording (DFR)

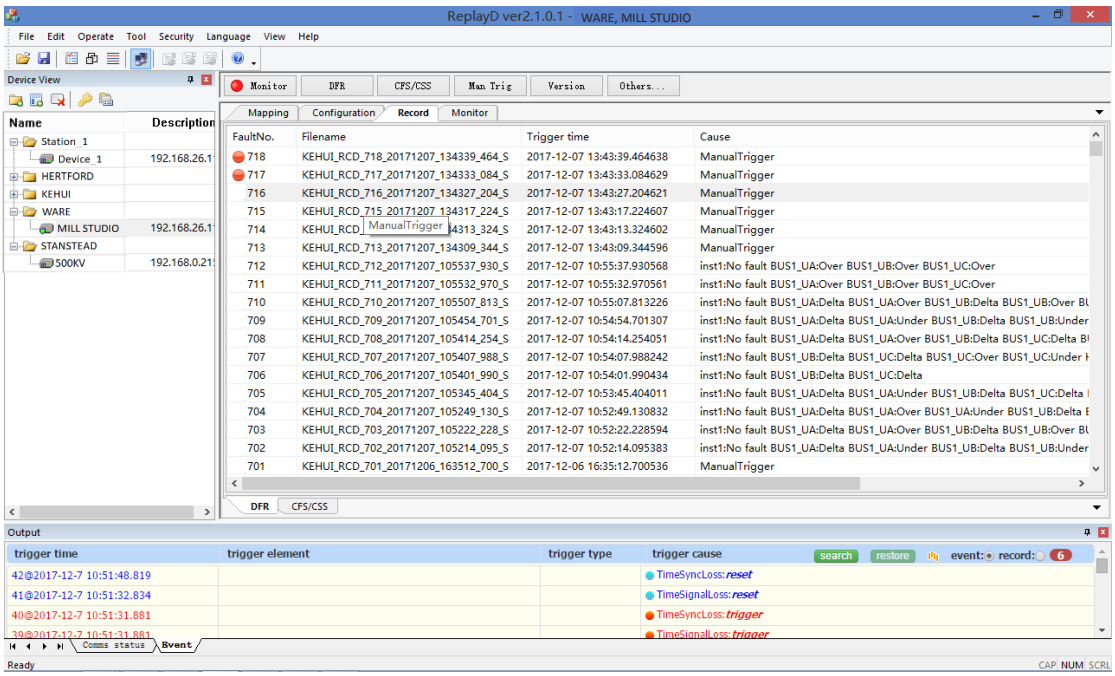


Figure 9.1-1 Digital Fault Recording (DFR)

The digital fault recording (DFR) window contains all the FTR records. As in Figure 9.1-1, in the <Record> window, right-click to select <refresh directory>, the fault record index will be refreshed.

The fault record index consists of the fault number, file name, trigger time and cause. The cause consists of the fault channel or line, fault type and fault location.

To download the fault record, double-click the file name, or right-click and select “download fault record”, the fault record can be opened and downloaded into the local PC (Figure 9.1-2).

Right-click the record and select <download all records> to download all the records into the PC. Selecting <filter records> will display the <record filter> dialogue box. There are three types of filter: filter based on trigger time period, filter on the digital I/O trigger and filter on fault trigger.

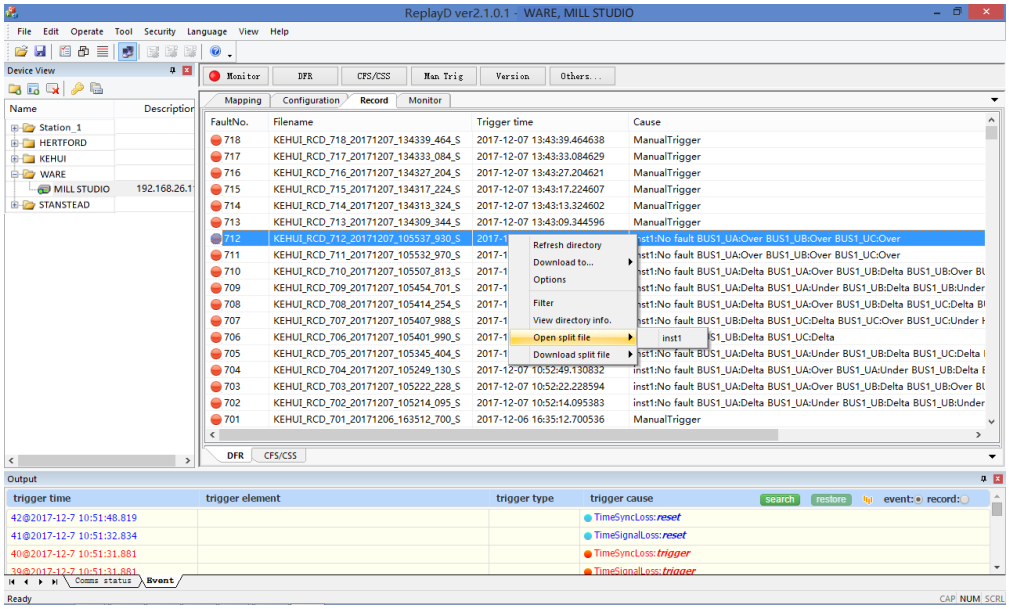


Figure 9.1-2 Download DFR records

A “red” indication at the beginning of the fault record indicates that this is a new record. The last letter of the file name contains information about the record; the letter “F” indicates a fault and “S” indicates a non-fault record.

9.2 Continuous Slow Recording (CSR)

Continuous Slow Speed (CSS) recording does not record the actual waveforms. It records the calculated (or derived) values such as magnitudes, harmonics, sequence components, phase angle, active and reactive power etc. The recording is continuous and does not require a trigger. It is used to monitor the stability of the power system. The FTR-100 can record up to 7 days of CSS records.

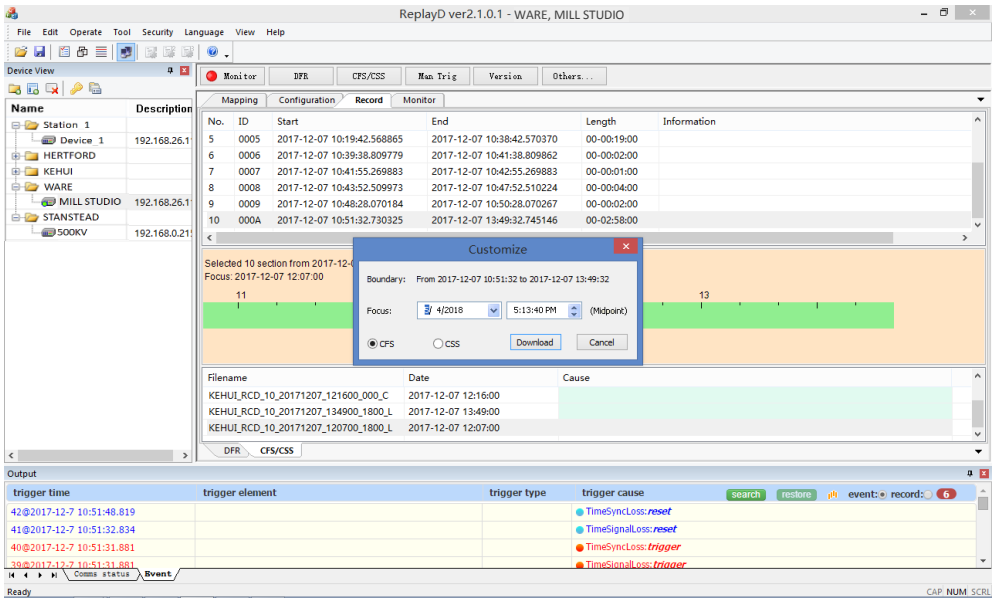


Figure 9.2-1 Continuous Slow Recording (CSR)

As shown in the figure, the green bar shows a continuous recording. A discontinued recording can only be due to the FTR100 resetting or switching off.

9.3 Continuous Fast Recording (CFR)

A continuous fast speed (CFS) recording is a continuous waveform recording using a lower sampling rate than the DFR (but faster than the CSS).

The process to download a CFS record is the same that for the CSS record. Right-click to select “download CFS record’. Each file will not exceed 40s.

Users can also select their own time to obtain the required record. Select <Customize >, then select the date and time, select CSS or CFS and then download the record.

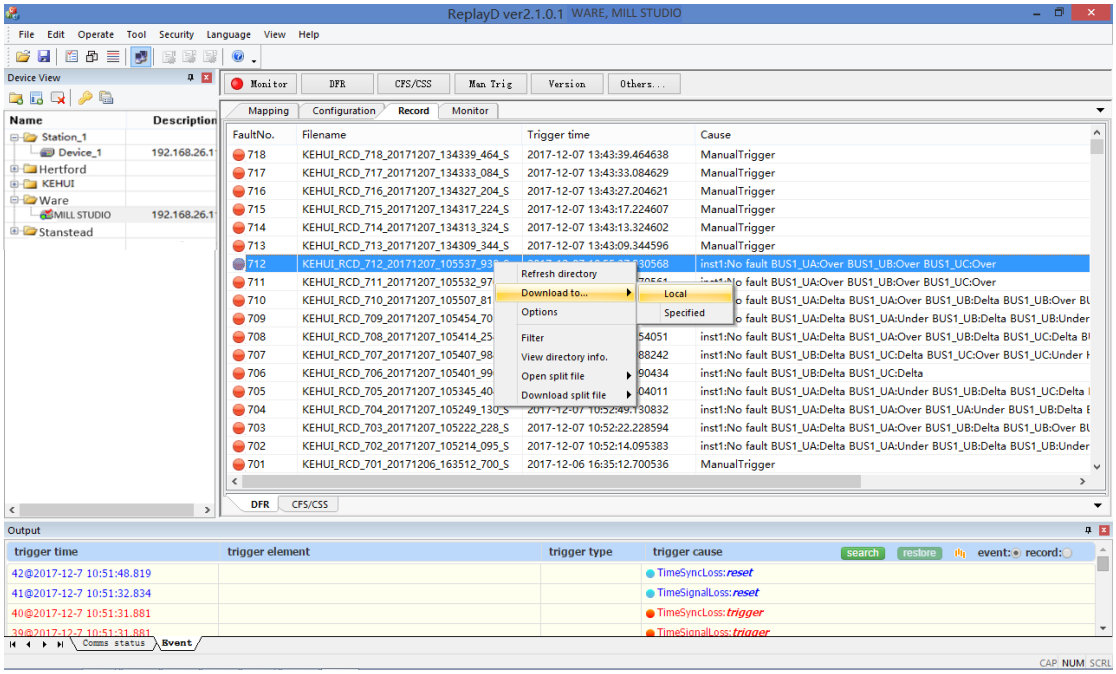


Figure 9.3-1 Continuous fast Recording (CFR)

10. Using CmdView for record analysis

10.1 Open a disturbance record

A disturbance record can only be opened after the record has been registered in the record index in the PC thorough data transfer. The record to examine is selected in the local record index, which is arranged based on substation IDs and device IDs.

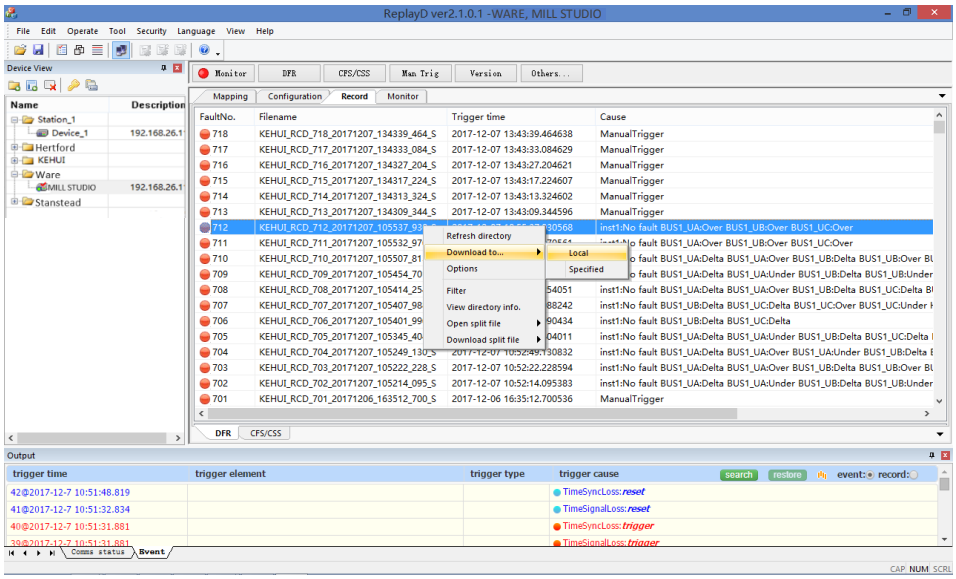


Figure 10.1-1 Open a disturbance record

As shown in Figure 10.1-1, select “Ware” ➔ “MILL STUDIO” and double-click the fault record to be to examined. The record will be downloaded to the PC and opened. Alternatively, right-click the record and select <Download to local> from the pop-up menu. The fault record waveform is viewed through the software CmdView.

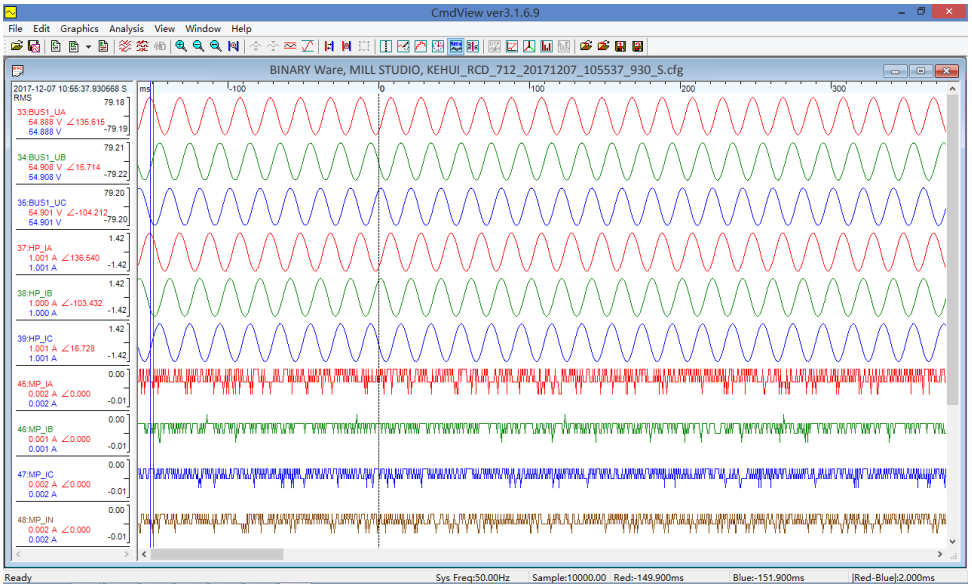


Figure 10.1-2 CmdView for viewing a disturbance record

Figure 10.1-2 shows the CmdView main window and the fault recording waveforms.
In the CmDView window, the user can display, edit, print and analyse the waveforms.

10.2 Tool bar functions

The tool bar has a number of short-cut keys, their functions are as follows:

 Open file

 Store file in COMTRADE format

 Output fault report

 Examine CFG file

 Examine DMF file

 Trigger cause analysis

 Digital input status time line

 Select Analogue channel

 Select digital channel

 Swap dual AD display

 Expand horizontally using red cursor as the centre

 Contract horizontally using red cursor as centre

 Show the entire waveform record

 Zoom into the selected area

 Expand on the Y axis

 Contract on the Y axis

 Restore the y axis magnification ratio

 Fill the Y-axis boundary

 Swap red and blue curser

 Lock the red and blue cursers relative positions and drag

 Copy the selected area

 Manually set time zero

 Connect the sample points

 Display the actual sample points

 Selected shows the absolute time, deselected shows the relative time

 Selected shows the RMS value, de-selected shows the instantaneous value

 Swap primary and secondary values

 Fault location

 Differential analysis

 Sequence component analysis

 Harmonic analysis

 Decay time constant measurement

 Restore channel selection scheme 1

 Restore channel selection scheme 2

 Save the existing channel selection as scheme 1

 Save the existing channel selection as scheme 2

10.3 Channel selection

CmdView displays the Active Channel, allowing the user to select only the analogue and digital signals which are active and relevant. This allows useful information to be displayed.

The icons  and  allows the user to select the active analogue and digital channels respectively. Selecting the icon, a pop-up window appears allowing the user to perform the active channel selection.

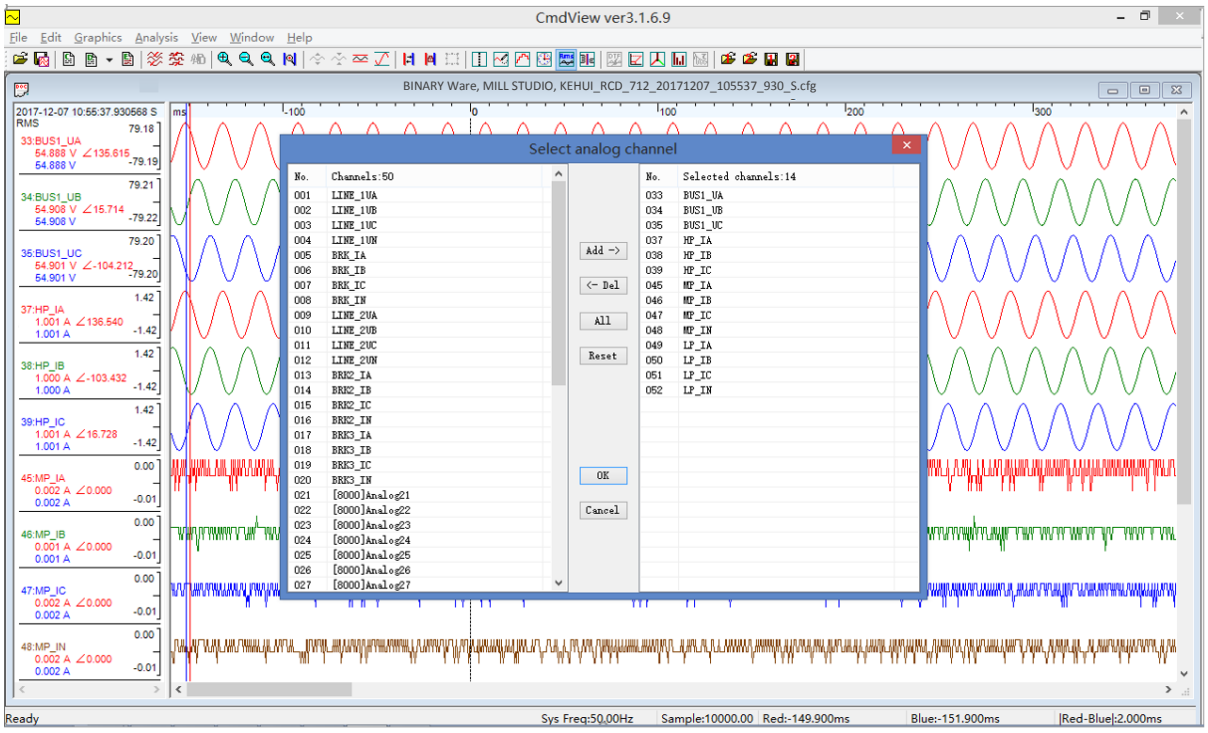


Figure 10.3-1 Active analogue channel selection

The left-hand window shows the available channels to be selected, the right-hand window shows the selected channels. Use “Add” to move the channel from left to right, and “Delete” to move the channels from right to left. Alternately, double-click a channel to move it to the opposite window. “All” means selecting all the channels to be active, “Reset” means de-selecting all the active channels. Finally, use “OK” to confirm the selection, or use “Cancel” to abort the operation.

10.4 Channel exchange positions

In the CmdView record display window, move the cursor over the title of a channel, the cursor changes to a “hand” symbol. Left click, hold and drag the channel to the position you want. This allows for flexible re-arrangement of the channel positions for ease of analysis.

10.5 Line parameter definition (Define lines)

In order to perform sequence components, impedance loci and distance to fault calculations, it is necessary to configure the line parameters. Go to <Edit> pull-down menu, select <Define lines>, a pop-up window appears allowing the parameters of each line to be entered.

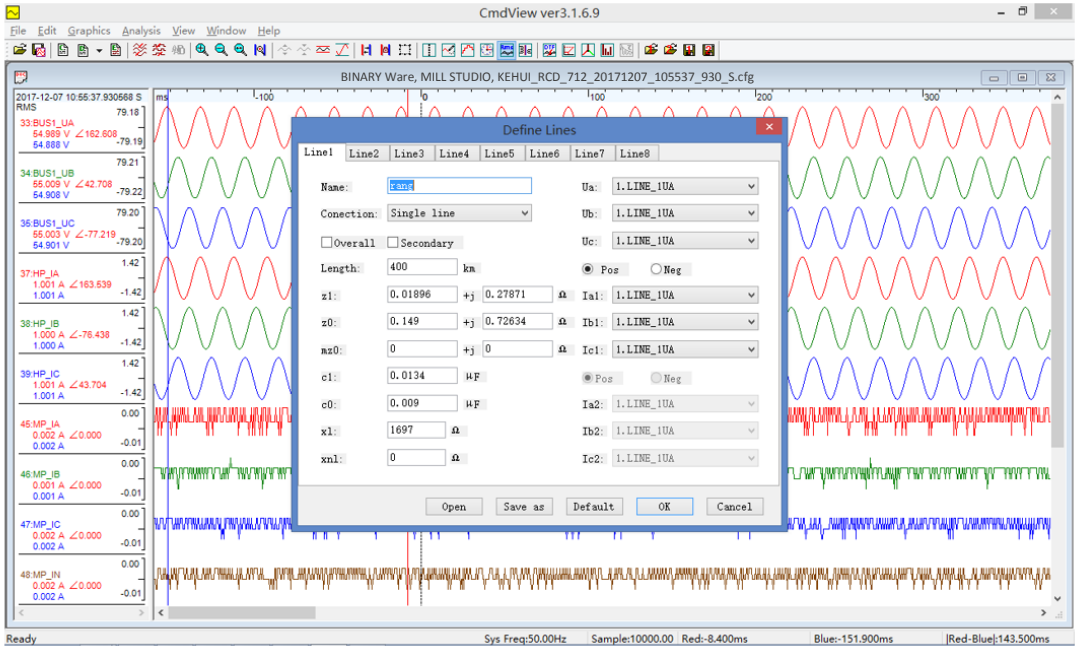


Figure 10.5-1 Entering line parameters

<Save as> allows the line parameters to be saved into a .pam file which can be named and stored according to user's choice. Select <default> will store the parameters into a <default.pam> file.

10.6 Changing waveform colours and background

As shown in Figure 10.6-1, right-click a channel ID, select <change trace colour> from the menu, a pop-up window appears allowing the user to change the colour of the trace.

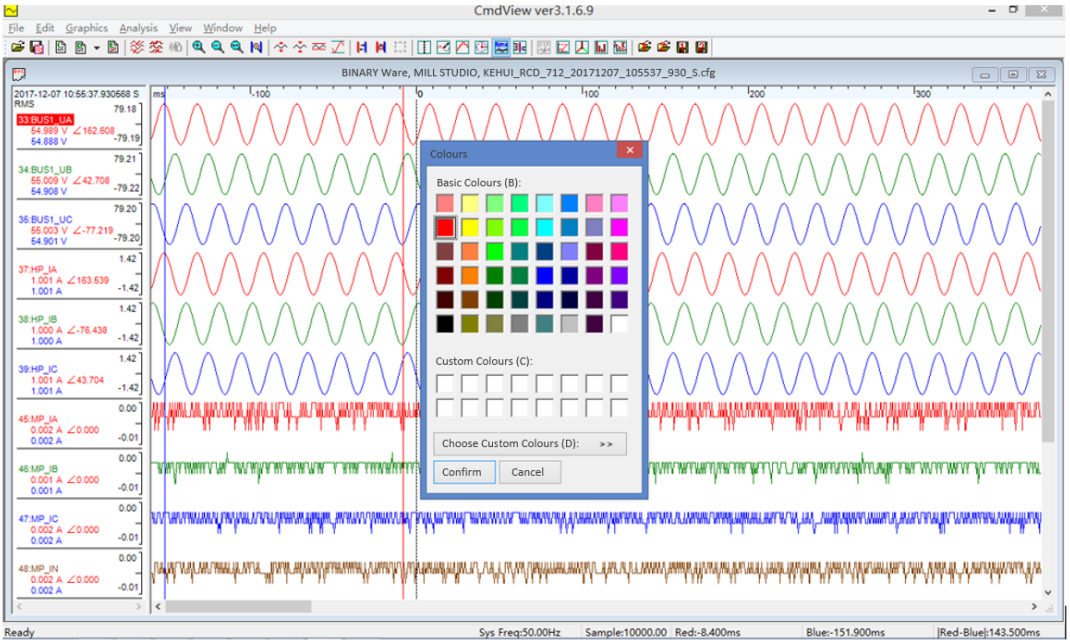


Figure 10.6-1 Changing waveform colours

10.7 Channel scaling harmonisation and superposition

When the scaling of the channels differs, it is difficult to compare their magnitudes visually. Select a channel by clicking its ID, hold down the “Cntr” key and select another channel. Repeat this process until a group of channels have been selected. Right-click one of the channels from the group and select “equalize scale”. The scaling of all the channels within that group will be equalised.

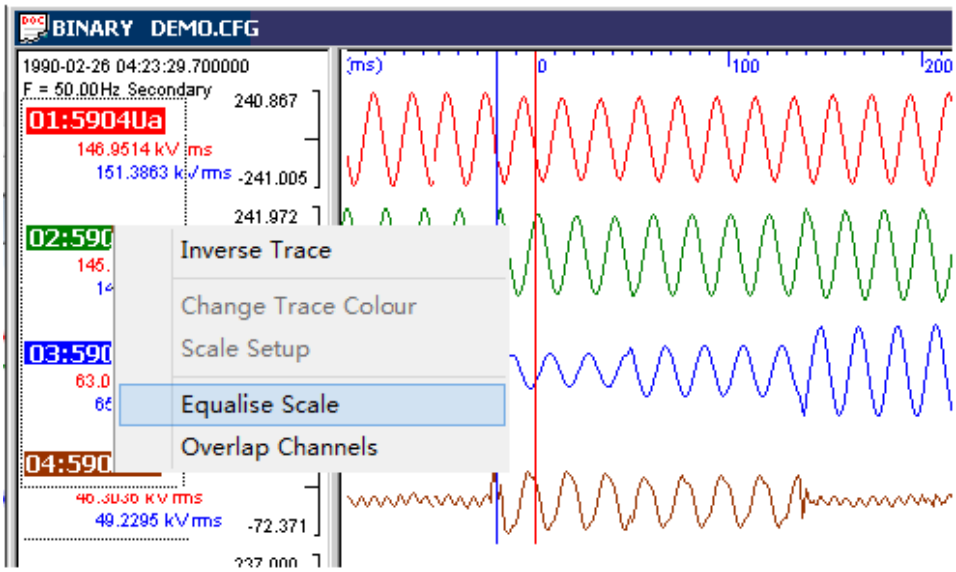


Figure 10.7-1 Equalise scale

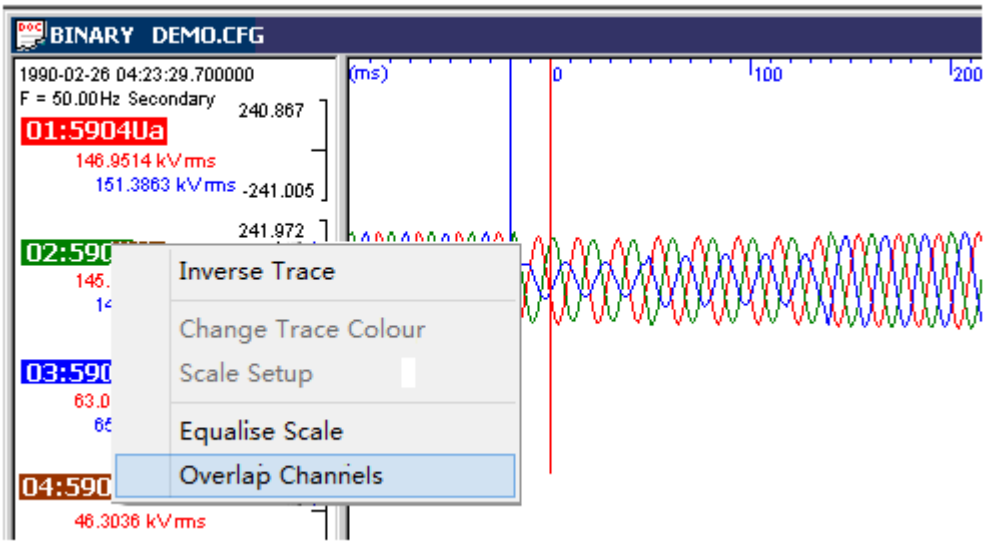


Figure 10.7-2 Superposition (overlapping)

Similarly, if the user wants to superimpose all the channels of the same group onto the same time axis, “overlap channels” is selected in the menu selection.

10.8 Moving the cursors

There are two cursors, red and blue, which allow the user to measure the time difference between two points on the record. Clicking anywhere on the record will set the red cursor to that point. The icon allows this control to be swapped between red and blue. To lock the two cursors together with a fixed time difference of, say 20ms, position the two cursors at the required separation and then click the icon. The cursors will be locked and will move together on the record.

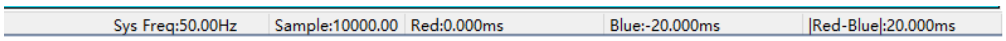


Figure 10.8-1 Status bar showing the red and blue cursor positions

10.9 Record sequence and record search

FaultNo.	Filename	Trigger time	Cause
718	KEHUI_RCD_718_20171207_134339_464_S	2017-12-07 13:43:39.464638	ManualTrigger
717	KEHUI_RCD_717_20171207_134333_084_S	2017-12-07 13:43:33.084629	ManualTrigger
716	KEHUI_RCD_716_20171207_134327_204_S	2017-12-07 13:43:27.204621	ManualTrigger
715	KEHUI_RCD_715_20171207_134317_224_S	2017-12-07 13:43:17.224607	ManualTrigger
714	KEHUI_RCD_714_20171207_134313_324_S	2017-12-07 13:43:13.324602	ManualTrigger
713	KEHUI_RCD_713_20171207_134309_344_S	2017-12-07 13:43:09.344596	ManualTrigger
712	KEHUI_RCD_712_20171207_105537_930_S	2017-12-07 10:55:37.930568	inst1:No fault BUS1_UA:Over BUS1_UB:Over BUS1_UC:Over
711	KEHUI_RCD_711_20171207_105532_970_S	2017-12-07 10:55:32.970561	inst1:No fault BUS1_UA:Over BUS1_UB:Over BUS1_UC:Over
710	KEHUI_RCD_710_20171207_105507_813_S	2017-12-07 10:55:07.813226	inst1:No fault BUS1_UA:Delta BUS1_UA:Over BUS1_UB:Delta BUS1_UB:Over E
709	KEHUI_RCD_709_20171207_105454_701_S	2017-12-07 10:54:54.701307	inst1:No fault BUS1_UA:Delta BUS1_UA:Under BUS1_UB:Delta BUS1_UB:Unde
708	KEHUI_RCD_708_20171207_105414_254_S	2017-12-07 10:54:14.254051	inst1:No fault BUS1_UA:Delta BUS1_UA:Over BUS1_UB:Delta BUS1_UC:Delta I
707	KEHUI_RCD_707_20171207_105407_988_S	2017-12-07 10:54:07.988242	inst1:No fault BUS1_UB:Delta BUS1_UC:Delta BUS1_UC:Over BUS1_UC:Under
706	KEHUI_RCD_706_20171207_105401_990_S	2017-12-07 10:54:01.990434	inst1:No fault BUS1_UB:Delta BUS1_UC:Delta
705	KEHUI_RCD_705_20171207_105345_404_S	2017-12-07 10:53:45.404011	inst1:No fault BUS1_UA:Delta BUS1_UA:Under BUS1_UB:Delta BUS1_UC:Delta

Figure 10.9-1 Record sequence

ReplayD organises the records according to the substations and the devices. After a device has been selected, the records are displayed on the right-hand window in chronological order, with the newest record at the top.

10.10 Exporting Records in Excel format

To export the data between the red and the blue cursors to EXCEL, go to the <File> pull-down menu and select <Export to Excel>. A pop-up window appears allowing the user the allocate the EXCEL columns to the channels. Click <Output> to export the data.

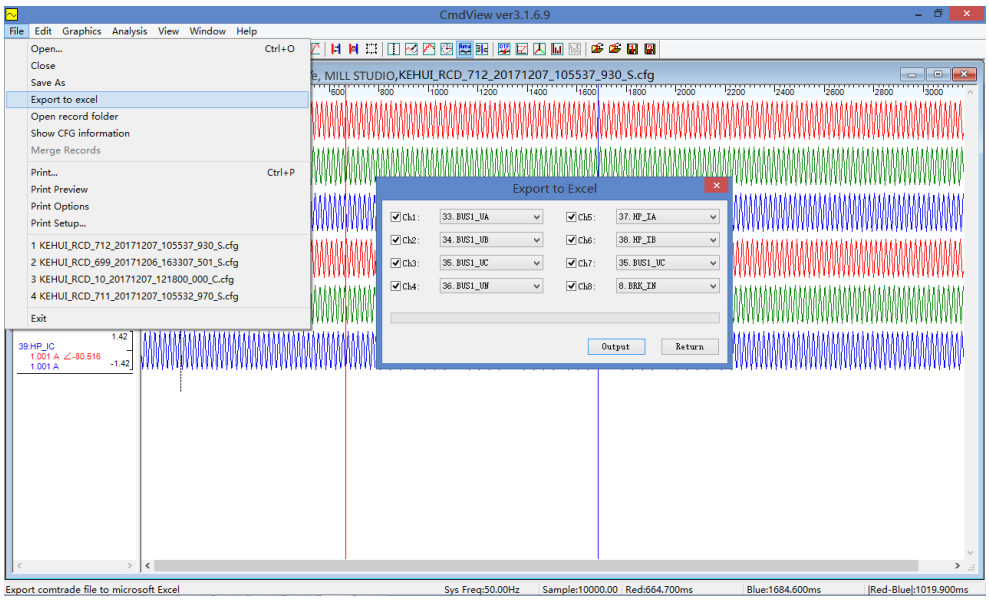


Figure 10.10-1 Exporting disturbance record data to Excel

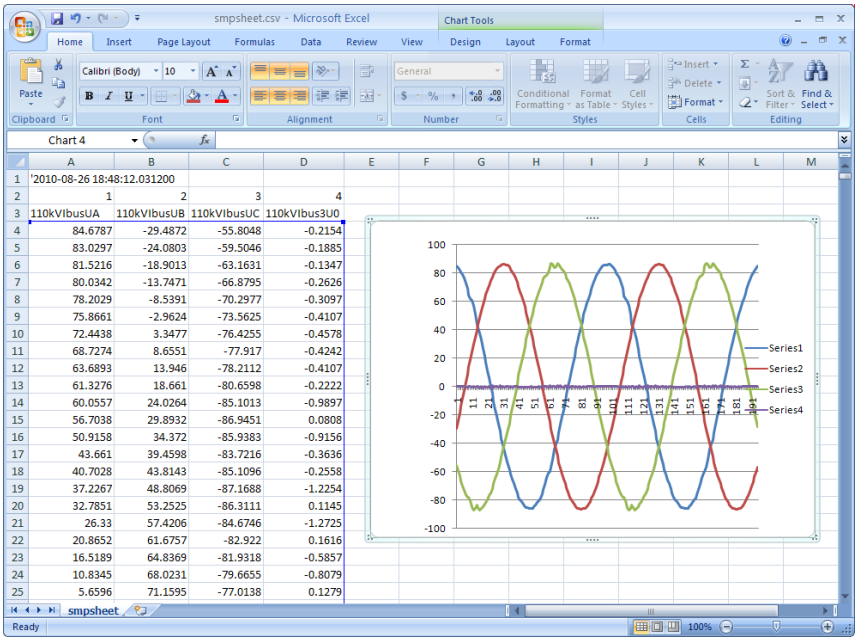


Figure 10.10-2 Disturbance record data in Excel

10.11 Export records in COMTRADE format

Go to the <File> pull-down menu and select <save as>. The record will be saved in the COMTRADE format.

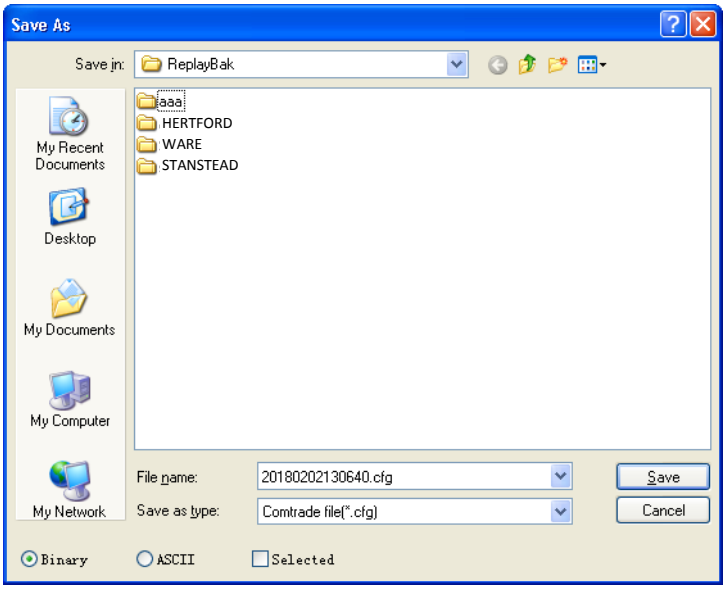


Figure 10.11-1 Exporting disturbance records in COMTRADE format

10.12 Printing the records

ReplayD uses the printer from the Windows operating system. To print hard copies, it is necessary to configure the printer in Windows first.

Arrange the waveforms on the screen according to the user's requirements. Go to "File' and select <print> for a hardcopy of the record.

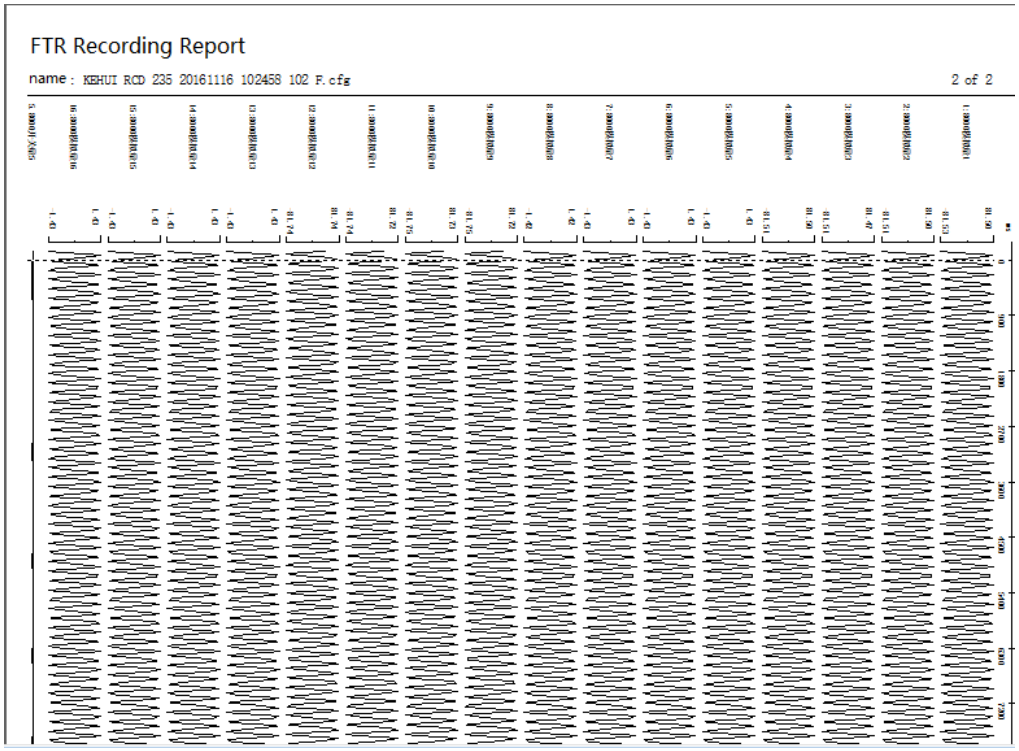


Figure 10.12-1 Print-out of a disturbance record

11. FTR Record analysis

11.1 Sequence Components analysis

To perform the sequence components analysis, click the <Analysis> pull-down menu in the CmdView window and select <Sequence Components>.

The pop-up window allows the user to group the channels into separate three-phase (A, B, C) groups. After the grouping is confirmed, the sequence components window will appear. By moving the red cursor, the sequence components at any point in the waveform, can be observed.

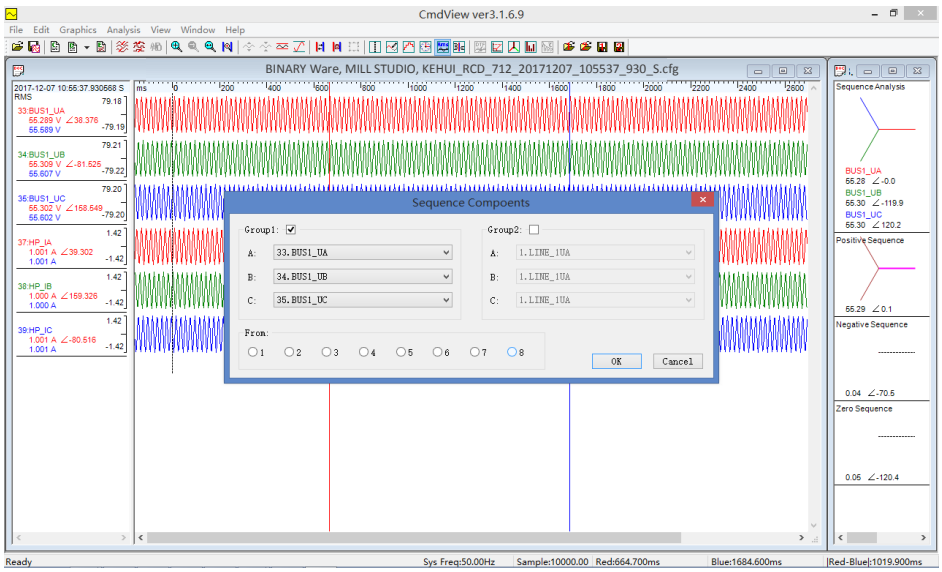


Figure 11.1-1 Sequence components analysis

11.2 Harmonics Analysis

To perform harmonics analysis, click the <Analysis> pull-down menu in the CmdView window and select <Harmonic Analysis>.

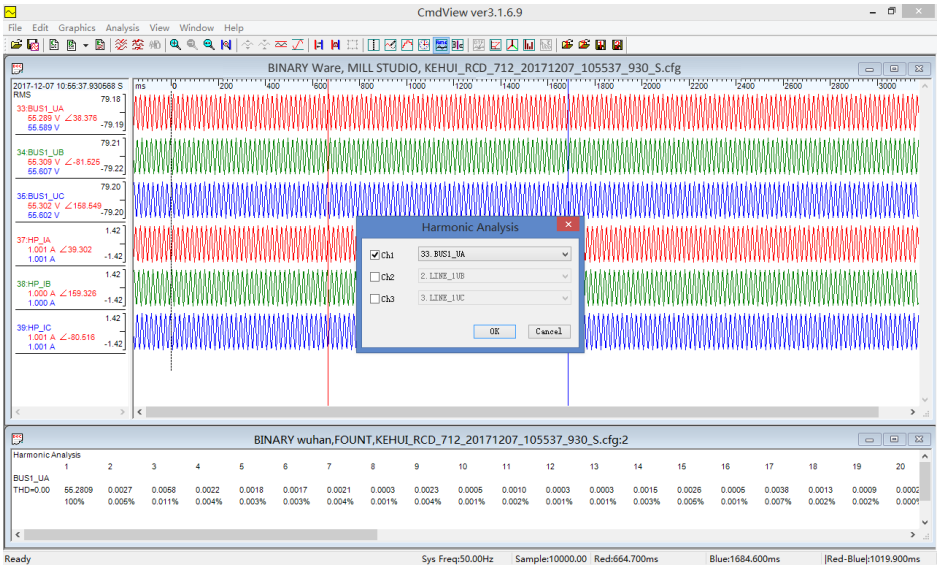


Figure 11.2-1 Harmonics analysis

CmdView allows three channels to be selected at one time for the harmonic analysis. The sampling rate of FTR-100 for triggered recording is 4kHz. According to Nyquist Criterion, the harmonics measured can be up to the 40th, although in practice the fidelity will be lost for harmonics above 28th.

11.3 Distance to Fault Location

There are two methods to perform distance to fault location. The first method is according the DMF file. Select the  icon in the toolbar to obtain a pop-up window, as shown in Figure 11.3-1. Select the faulty line and click “DFL” button at the tip right to initiate an automatic distance to fault location.

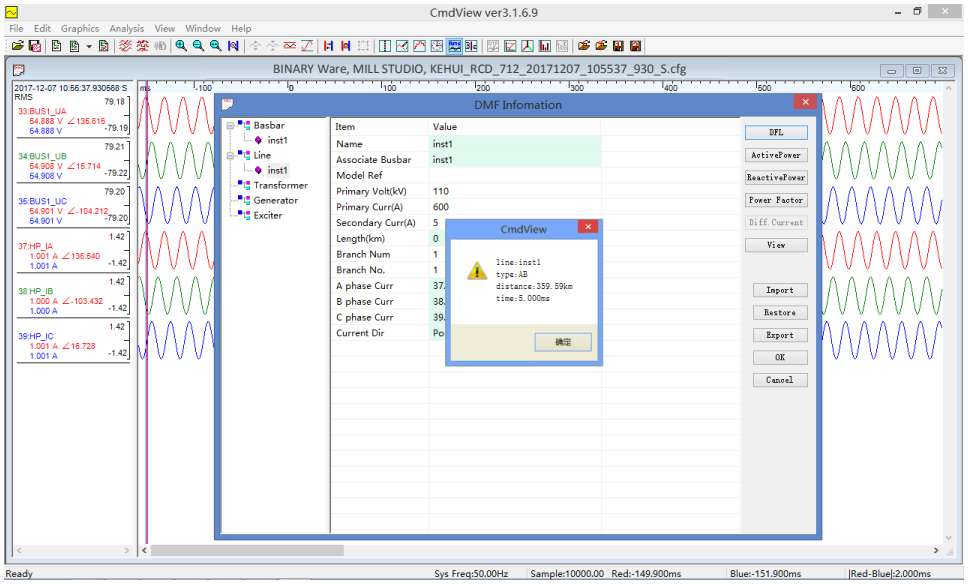


Figure 11.3-1 Distance to fault location using DMF file

The second method is to use pre-defined line parameters to perform a fault location analysis. In the <analysis> pull-down menu, select <Distance to fault>. Select one of the pre-defined lines to perform a fault location analysis.

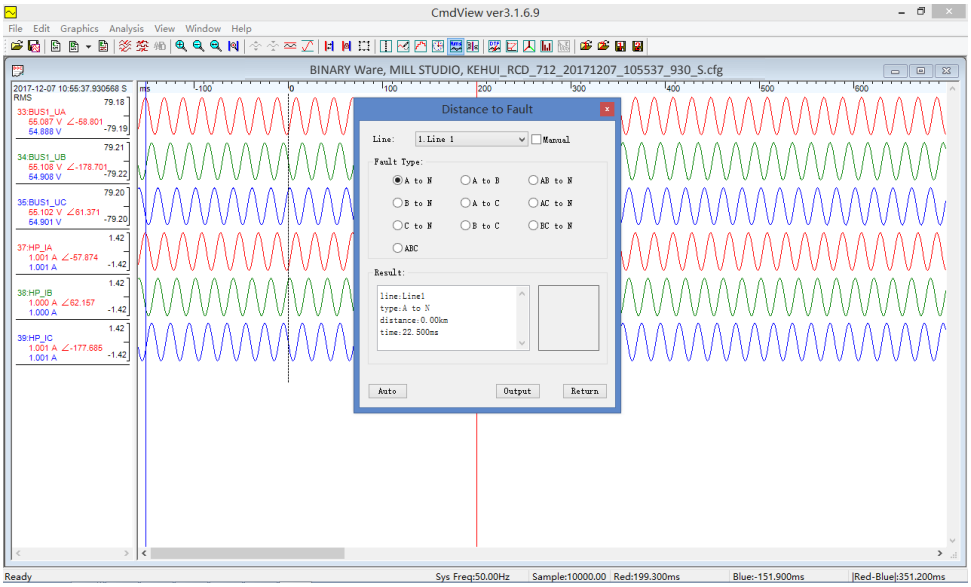


Figure 11.3-2 Distance to fault location using pre-defined line parameters

11.4 Impedance Locus Analysis

In the “Analysis” pull-down menu, select “Impedance Locus Plot”. In the pop-up window, select the line to be analysed. The positive sequence impedance locus for the line between the red and the blue cursors will be displayed.

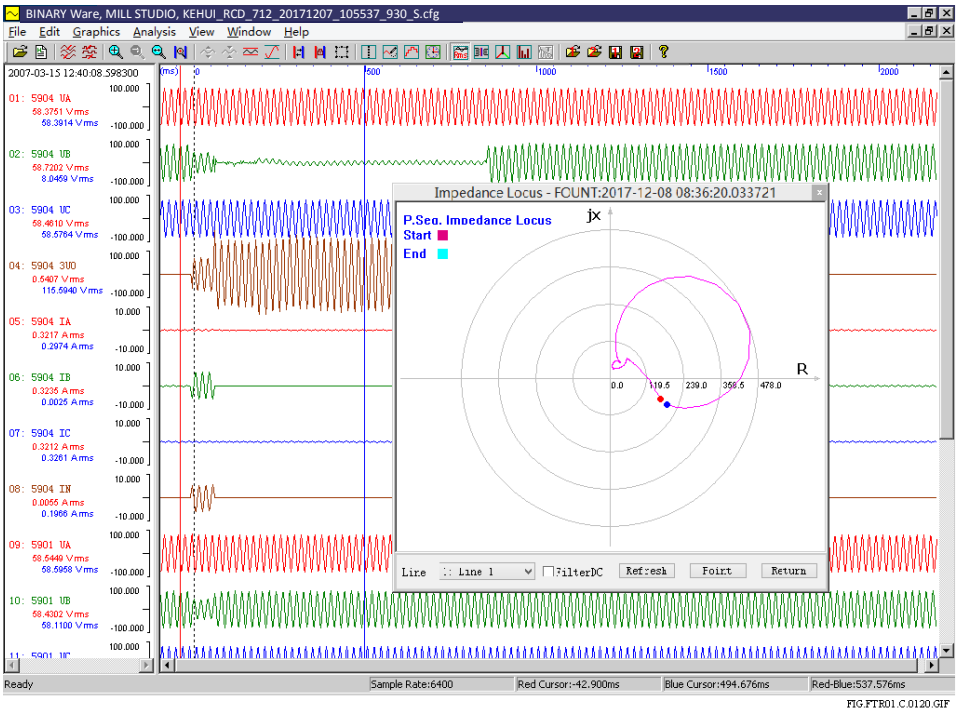


Figure 11.4-1 Impedance locus

11.5 Combination channels

In the <Analysis> pull-down menu, select <Combination Channels>, a pop-up window appears allowing the user to combined several channels together with different scaling factors if desired.

For example, by adding Ia, Ib and Ic together, $3I_0$ will be formed.

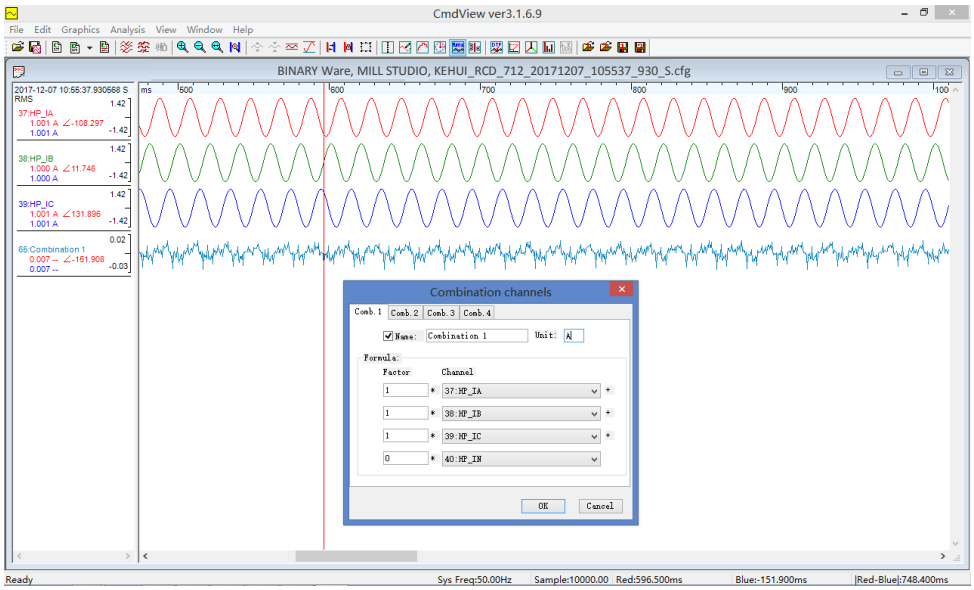


Figure 11.5-1 Combination channels

11.6 Calculated value presentation

In the <Analysis> pull-down menu, select <Calculation Channels>, a pop-up window appears. Select two channels as variables and select the calculated method (e.g., Watts, Vars, Phase angle difference etc.). The calculated values from the two channels will appear.

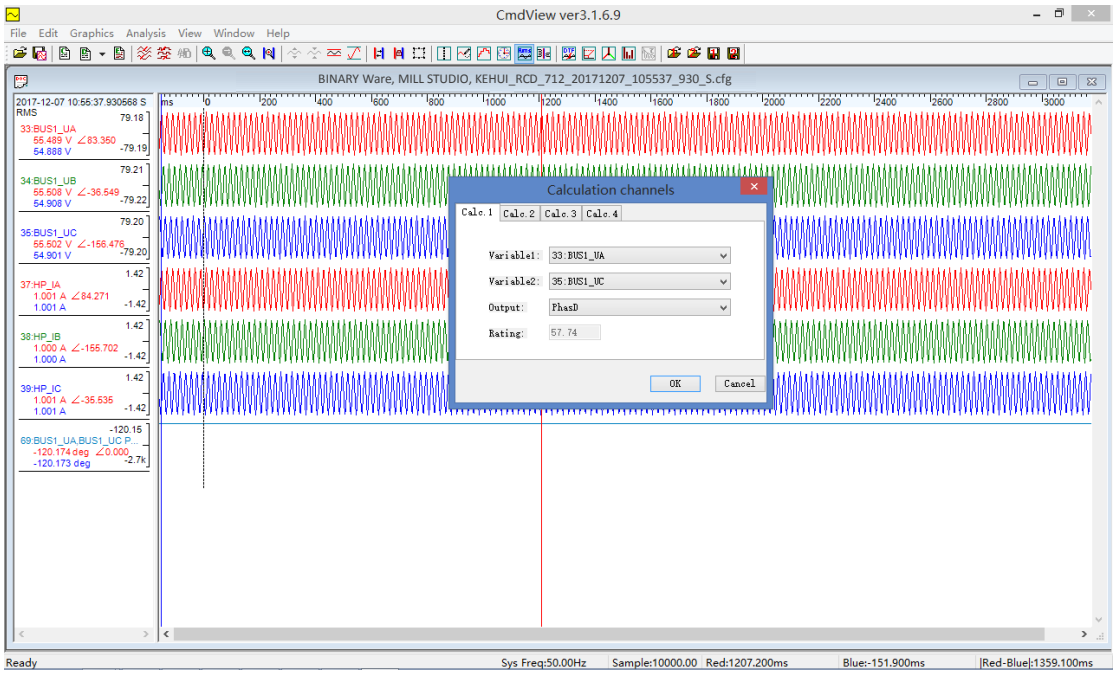


Figure 11.6-1 calculation channels

11.7 Differential current analysis

There are two methods to perform differential current analysis. The first method is to select the <DMF information> icon in the menu bar  . Select Transformer, click <Differential current> button to perform the analysis.

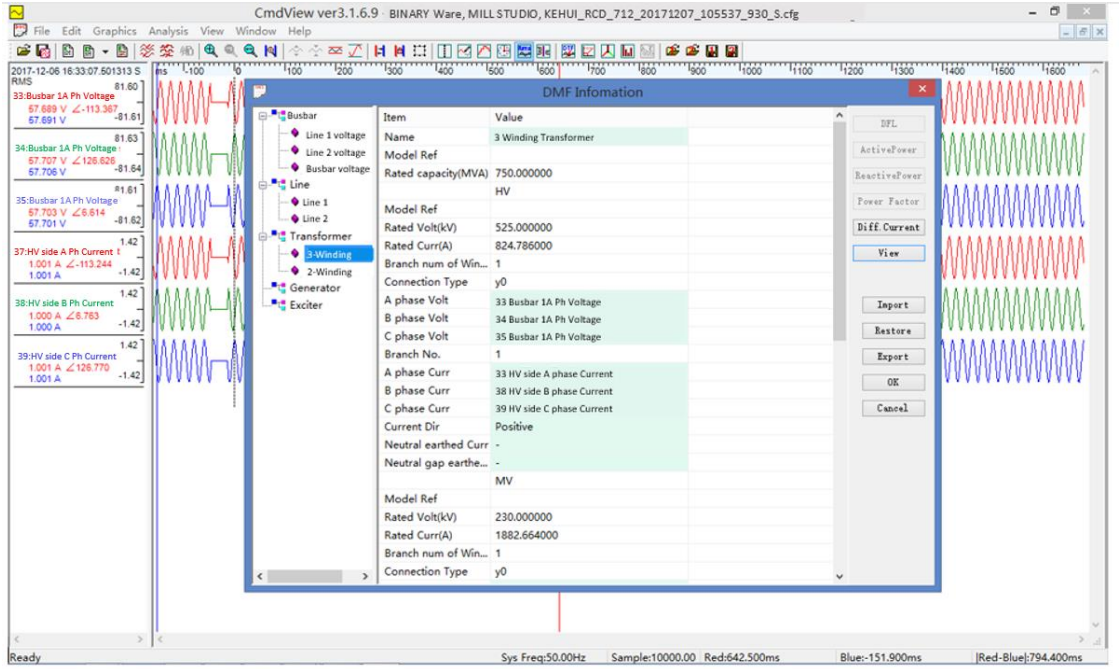


Figure 11.7-1 Differential current analysis

The second method is to select <Transformer differential currents> in the <Analysis> pull-down menu, or to click the “transformer differential currents” icon  the menu bar. A pop-up window appears allowing the user to manually set-up the channels and transformer configuration for differential current analysis.

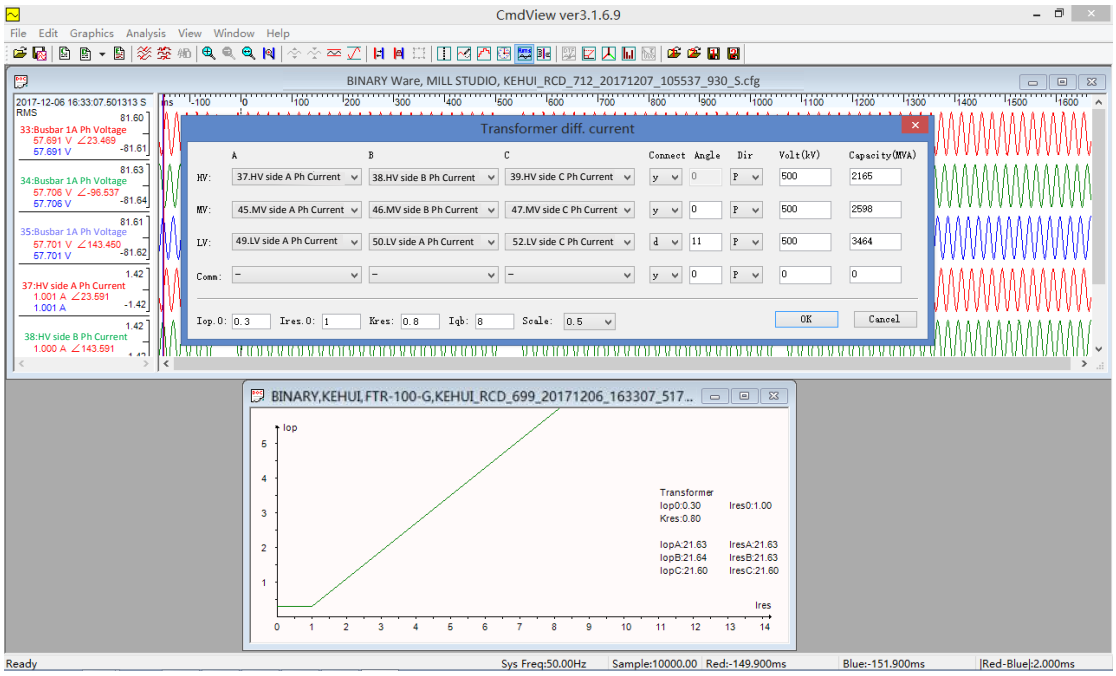


Figure 11.7-2 Transformer differential current analysis using the <Analysis> menu option

12. Real-Time Monitoring

12.1 Waveforms, phasors, power, harmonics

In ReplayD software, select <Monitor> in the toolbar. The screen shows a number of options at the bottom, allowing real-time monitoring of the channels in different formats:

<**Wave**> shows the real-time waveforms

<**Vector**> shows the positive, negative and zero sequence components in vectoral format.

<**Power**> shows the real-time single-phase and three-phase P and Q.

<**Harmonics**> shows the real-time harmonic contents up the tenth harmonics.

12.2 Fundamentals

At the bottom of the Monitor window, select the <Fundamentals> submodule, the real-time information of the analogue channels' original values (magnitudes and phase-angles), digital channel status, combined values and calculated values will all be displayed.

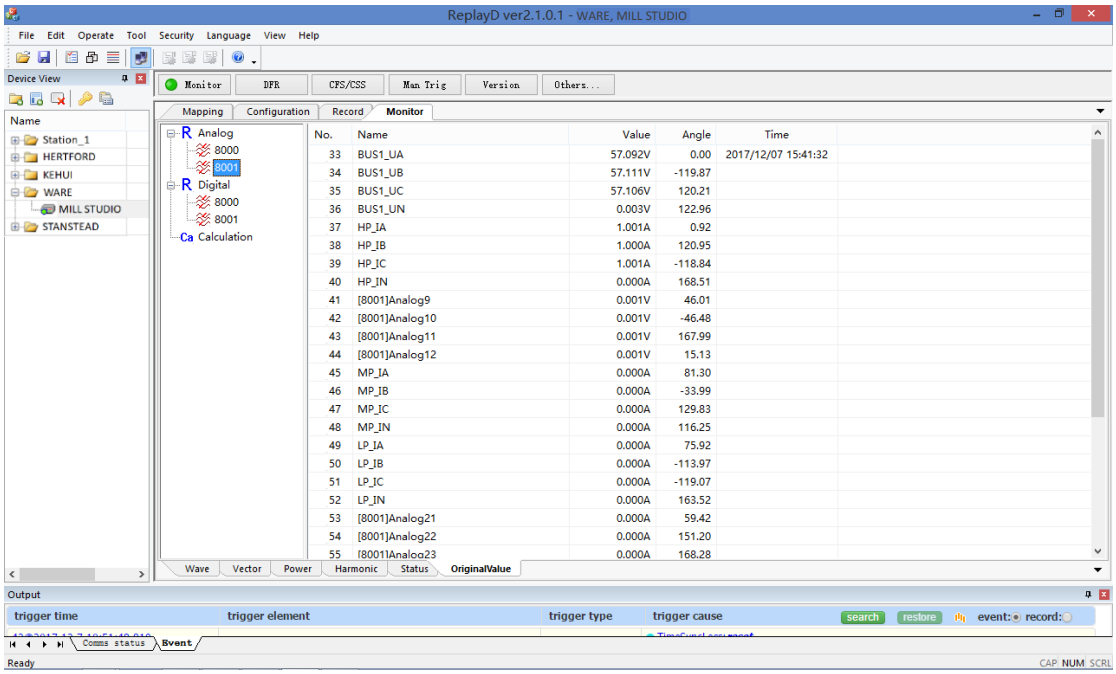


Figure 12.2-1 Real-time analogue channels' original values

Figure 12.2-2 Real-time phasor information and harmonics

12.3 Data Traffic and Device Status

At the bottom of the Monitor window, select the <Status> submodule, the real-time information of the communications traffic and the status of the FTR-100 can be displayed.

There are seven groups of information available: <Recorder info>, <SV info>, <Goose info>, <Port Info>, <Abnormal message>, <Calibrate analog> and <Network card info>.

<Recorder info> includes the working voltage, device temperature, software version, verification code, overall warnings (SV disconnect, GOOSE disconnect, RAU disconnect, time sync info etc.). Red indicates an abnormal condition.

<SV info> and <GOOSE info> include real-time indication of SV and GOOSE message abnormality, e.g. disconnect, lost packages, configuration incorrect, PDU invalid, loss of sequence, jitter, sync loss, abnormal dual A/Ds, bad data quality, abnormal single-point, value change, time-out etc. Each control block has an APPID, describing message traffic information, terminal information etc. Red indicates an abnormal condition.

<Port info> indicates the real-time data traffic in each network port of the device's process bus, wrong packages, data traffic for each data sampling card and the total data traffic. A green light before the <Port no.> indicates that there is data, grey means no data. <Message disconnect> with a red light means there is no GOOSE/SV messages at the terminal, see Figure 12.2-1.

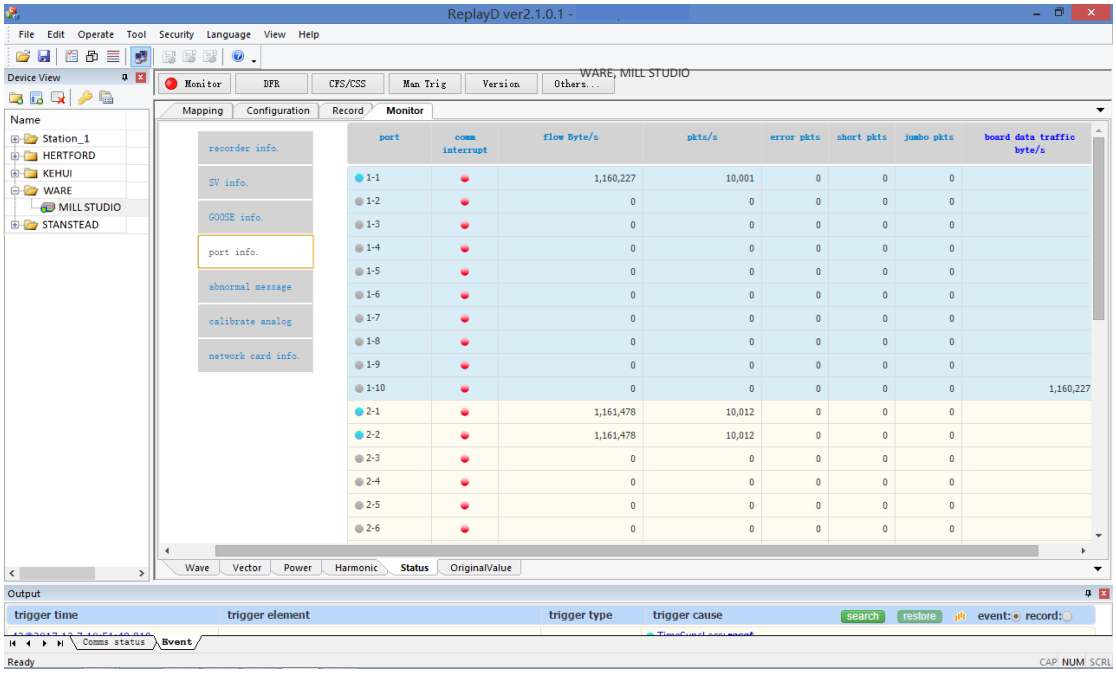


Figure 12.3-1 Port Information

<Abnormal message>: If an abnormality occurs with the SV or GOOSE messages, the FTR-100 records a packet of the abnormal messages over a time period, as shown in Figure 12.3-2.

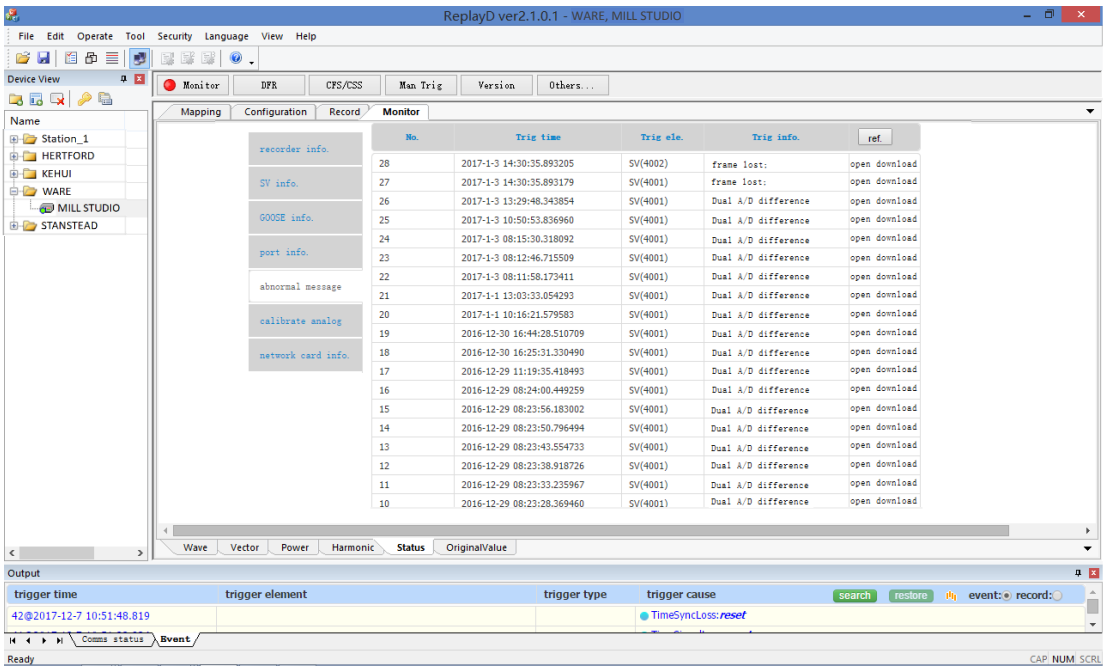


Figure 12.3-2 Abnormal Messages

When opening one of the message packets, a window appears showing all the messages in chronological order, see Figure 12.3-3. By clicking the <fault time> an option is available for the message time to be displayed as real-time, the offset time from the first message (PI), or as the time between consecutive messages (P2P).

Through the <Fault info>, the user can use the green curser to quickly move to the next abnormal message.

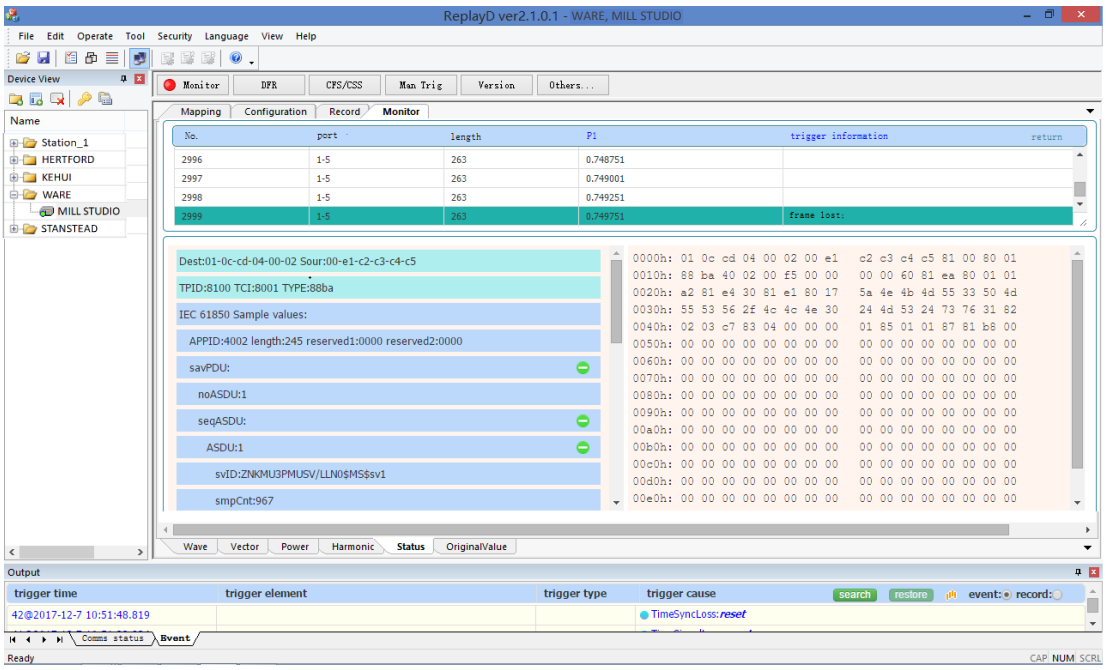


Figure 12.3-3 Message packet information

13. Real-time Events

Select the ”Events” window to examine recording logs and event logs. Fault records are shown in red. Non-fault records are shown in black.

Failures or abnormality of the FTR-100 itself are also displayed, e.g. RAU disconnected, abnormal SV/GOOSE messages etc.

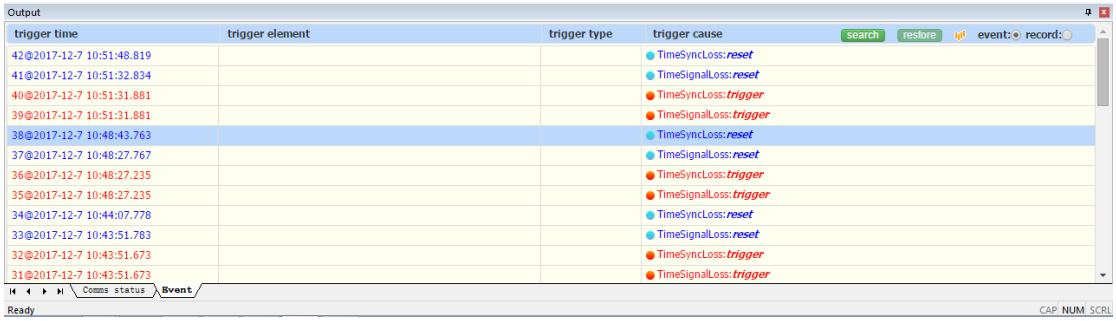


Figure 13-1 Real-time events indicating trigger cause

Through the event search function, it is possible to quickly retrieve warning messages. By selecting the type of warning messages required, the message logs will be displayed.

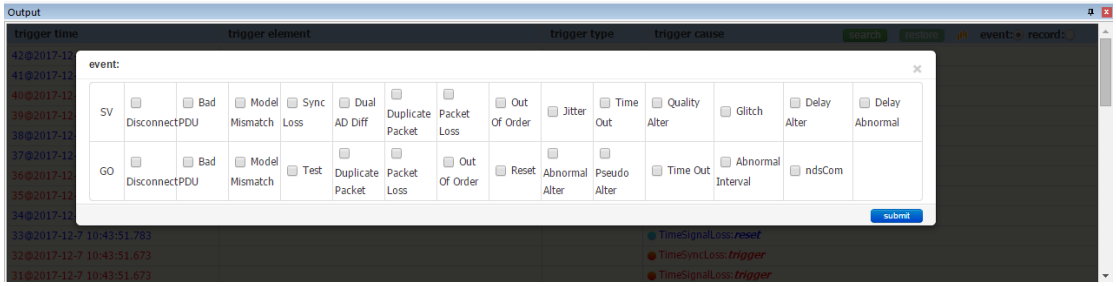


Figure 13-2 sample values (SV) and Goose messages (GO) abnormality indication

In the [cause of trigger] window’s pull-down menu, the records’ cause of trigger and distance to fault location results can also be displayed.

14. Commissioning Instructions

The FTR-100 is connected to the live electricity network, only authorised personnel, trained in working on such systems should undertake this work. It must be ensured that all the correct working precautions are taken before connecting the unit and that the testing will not interfere with the normal operation of the network. The commissioning engineer should ensure that safety signs and safety protection measures are in place on site before installing the equipment.

In addition, the engineer should be aware of simple procedures in handling electronic equipment to avoid damage due to electrostatic discharge. With the equipment in its original case and all the modules plugged-in, it is completely safe from discharges. However, if it is necessary to remove a module for inspection, simple procedure should be taken. For example, touching the earthed panel or the earthed equipment case before removing the module ensures the engineer is at the same electrostatic potential as the equipment. Modules should be handled by their front plate, frame or the edges of the printed circuit board. Touching the electronic components, printed circuit tracks or connectors should be avoided.

The following steps should be taken in the commissioning process:

i. Check the shipping list against the equipment received to ensure that all the items on the list are accounted for (see section 15).

ii. Carefully inspect the equipment to ensure that no damage has occurred during transit. If damage has been sustained during transit, a claim should be made to the transport contractor and the Kehui representative should be notified.

iii. The commissioning engineer should be familiar with the overall hardware architecture and the operation of the ReplayD software before commissioning. This information is detailed in this User Manual.

iv. Check that the FTR-100 host, RAU Remote Acquisition Unit, LAS-100 Local Analysis Station, Video display Unit (VDU), keyboard and the sealing plate (if applicable) are correctly installed on to the panel, according to the connection diagram as shown in figure 14.1 (n.b. figure 14 is for illustration purposes only, individual schemes may vary). Check that the following are connected:

- the optical fibre between the FTR host and the RAU acquisition unit(s).
- the network cable between the FTR host and LAS analysis station.
- the VDU and the keyboard to the LAS analysis station.
- the power supply cables to the power supplies.

v. Tidy-up all optical fibres, network cables, and power supply cables. Check all connecting cables to ensure that each connection is correct and reliable.

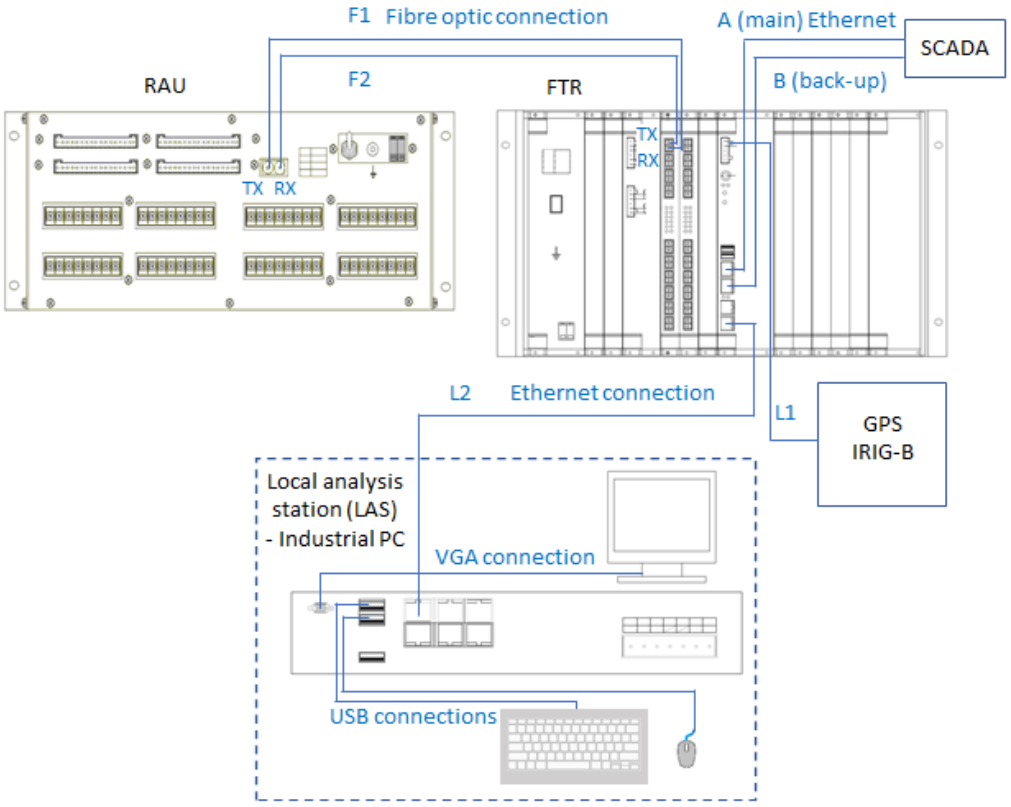


Figure 14.1 System connections

vi. After the check on the installation and wiring is completed, power-on the FTR-100 recorder system equipment for testing.

vii. Execute the ReplayD software on the LAS system according to Section 8 of the manual. Input the line name, line attribute, trigger value and other information of each channel into the FTR-100 host. After checking with the field staff that the settings are correct, each channel is individually tested by secondary injection as explained below.

viii. The inputs and outputs of the FTR-100 system needs to be isolated from the primary equipment during secondary injection testing.

Warning: During the isolation process, the secondary circuit of the current transformer must not be open-circuited since the high voltage produced may be lethal and could damage insulation.

ix. A relay tester is used to inject a fixed value AC voltage or current into each channel to ensure that the magnitude measurement of each channel is accurate. The Monitor feature of the ReplayD software allows the real-time signals of the channels to be viewed

x. After the channel testing is completed, perform a fault recording tests by triggering each individual channel by applying a signal in excess of its threshold setting. Ensure that the channel can trigger according to the intended value. Retrieve the waveform file, check the start threshold, phase sequence, amplitude, and recording duration to ensure that the recording is correct.

xi. If the recorder is to be connected to the Scada system or to a central computer in the control centre, set up the recorder's IP address network gateway and communication port assigned by the network engineer. Conduct joint testing with the network engineer for communications with the central computer. Ensure that the network communication is working well and the central computer can retrieve the recorded data smoothly.

xii. After the testing of the recorder is completed, the on-site staff can release the equipment safety measures and restore the equipment to a normal state. After the equipment is on-line and connected to the power system, manually trigger the recorder, check the waveform file, and confirm that the waveform is consistent with the power system steady state.

xiii. The field staff put the FTR-100 fault recorder device into normal operation.

15. Transportation and Storage

15.1 Transportation considerations

Use the transport boxes provided and observe the environmental conditions specified in the technical data sheet.

15.2 Storage conditions, storage period and precautions

Observe the environmental conditions specified in the technical data sheet when storing the instrument. The instrument should be stored in a dry environment providing suitable protection against mechanical damage and dust. Where the instrument is not used on a regular basis, it should be stored indoors using the original packaging, and should not be exposed to the sun or rain. The room should be air-conditioned and should not contain corrosive gas. The instrument should not be subjected to severe mechanical vibration or shock and there must not be a strong electromagnetic field. If the instrument is not used for a long time, make sure that the Receiver and Clamp are turned off and the battery removed from the Clamp. Fully charge the Receiver every 10 months.

15.3 Unpacking and Inspection

Before unpacking for the first time, follow the steps below.

i) Take out the document bag containing the instructions and packing list.

ii) Check the packing list to ensure that the contents are complete and intact.

iii) Check that the serial number is consistent with the instrument and the factory number of the warranty card.

16. Packing List

No.	Description	Photo	Quantity
1	FTR-100 Power System Transient Fault Recorder		1
2	Remote Acquisition Unit		1-3
3	LAS-100 local storage unit		1
4	ReplayD software	Provided electrtonically	
5	Display unit, 19’’		1
6	Manual		1