

# ELF2-MEEV

E1/V.35 multiplexer

## User's manual

Software release 1.11

**Attention! It is not recommended to use the multiplexer on physical lines without lightning protectors.**

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ELF2-MEEV MULTIPLEXER USER'S MANUAL  
RELEASE 1.11, MAY 2005

PARABEL LIMITED  
P.O. BOX 126  
NOVOSIBIRSK-90  
RUSSIAN FEDERATION  
Web: [eng.parabel.inc.ru](http://eng.parabel.inc.ru)  
Email: [info@parabel.inc.ru](mailto:info@parabel.inc.ru)  
Phone: +7-3832-138707  
Fax: +7-9139139603

## CONTENTS

FIGURES.....	5
TABLES .....	5
1. Introduction.....	6
2. Specifications.....	8
2.1. General.....	8
2.2. E1a, E1b ports parameters .....	8
2.3. V.35 port parameters .....	8
2.4. Console port parameters (RS232).....	8
3. Installation of the multiplexer.....	9
3.1. Front Panel Controls, Connectors, and Indicators .....	9
3.2. Sockets description .....	10
4. Multiplexer configuration.....	13
4.1. Console attaching.....	13
4.2. The main configuration menu.....	13
4.3. General settings .....	14
4.4. E1a port configuration .....	14
4.5. E1b port configuration.....	15
4.6. V.35 port configuration .....	15
4.7. Testing modes.....	15
5. Monitoring the multiplexer ports.....	17
6. Functional description .....	18
6.1. The interface converter mode .....	18
6.2. Drop-insert mode .....	19
6.3. CRC4 handling .....	20
6.4. CAS signaling.....	20
6.5. DTE emulation mode of V.35 port.....	20
7. Upgrading firmware.....	22
8. Multiplexer delivery .....	22
9. Package.....	22
Appendix A. Applications .....	23

## FIGURES

Figure 1. ELF2 block schematics .....	6
Figure 2. Drop-insert mode.....	7
Figure 3. Front panel.....	9
Figure 4. Rear panel.....	9
Figure 5. The main menu.....	13
Figure 6. Lloop mode .....	15
Figure 7. Rloop mode .....	16
Figure 8. E1 slave synchronization.....	18
Figure 9. E1 master synchronization .....	18
Figure 10. Drop-insert switching.....	19
Figure 11. Drop-insert mode.....	19
Figure 12. DTE mode example.....	20
Figure 13. Connecting two LAN over SDH .....	23
Figure 14. Using drop-insert mode .....	24
Figure 15. "Last mile" with DTE mode and external DSL modem .....	25

## TABLES

Table 1. Socket E1A .....	10
Table 2. Socket E1B .....	10
Table 3. Socket V.35 (DTE mode) .....	11
Table 4. Socket V.35 (DCE mode).....	12
Table 5. Console socket.....	12
Table 6. Status of E1 ports.....	17
Table 7. V.35 port status.....	17

## 1. Introduction

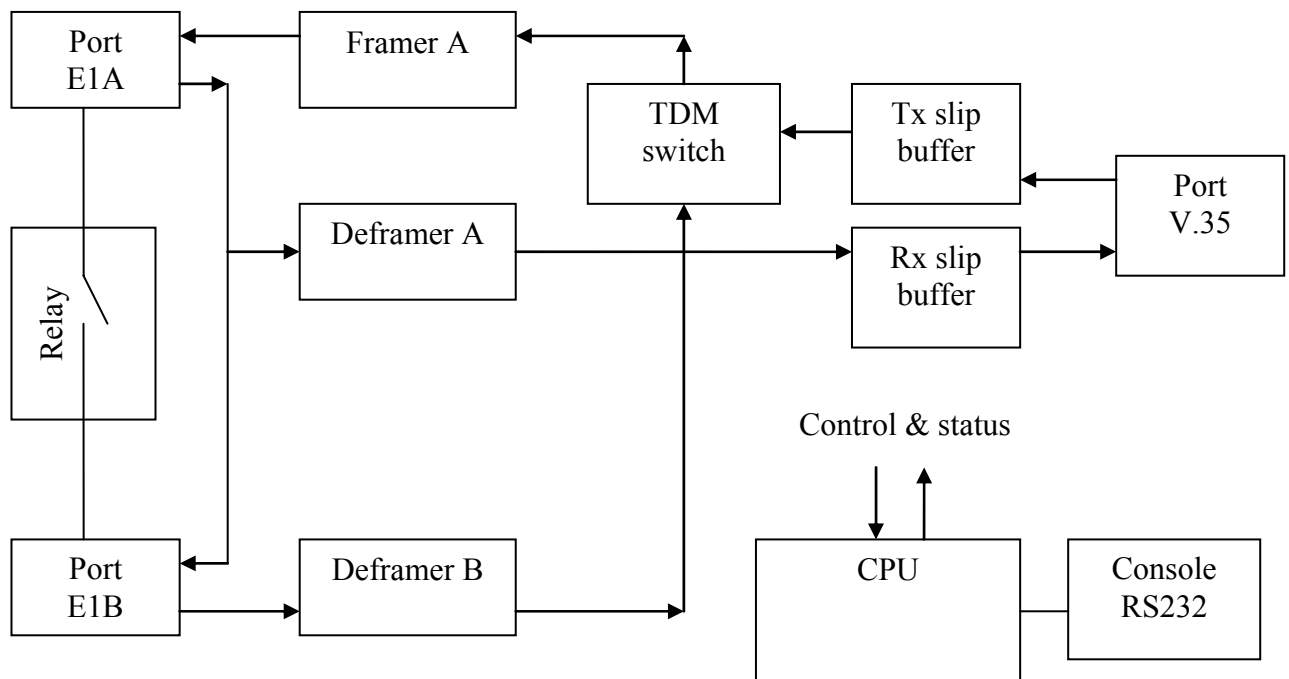
Multiplexer ELF2-MEEV can be used on the primary E1 channels as TDM multiplexer, interface converter, or drop-insert multiplexer. As distinct from competitor products, the ELF2 multiplexer has the following advantages:

- Port V.35 has mode of DTE emulation, so other multiplexers or modems can be attached to V.35 port without risk of clock slip.
- The embedded elastic buffer compensates difference in data rates on V.35 port.
- The second E1 port can be used in drop-insert configurations and daisy chain connections of the ELF multiplexers
- The extended capabilities of CAS signalization in timeslot 16

The multiplexer ELF2-MEEV has the following physical ports:

- Digital port V.35 with DTE or DCE modes
- Port E1A framed/unframed/drop-insert
- Port E1B framed/unframed/drop-insert
- Console port (RS232 interface)

The block schematics of the multiplexer is presented on Figure 1.



**Figure 1. ELF2 block schematics**

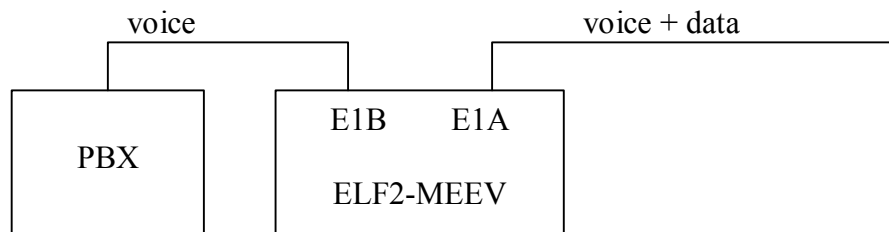
The multiplexer supports two working modes: interface converter mode and drop-insert mode.

**In the interface converter mode** port V.35 and port E1A are used for data transmission. Port E1B is not used. Input signal of the E1A port connected to the de-framer A, where it is processed according to ITU recommendations G.703 и G.704. Extracted in the de-framer timeslots are sent to the receiver slip buffer. From the slip buffer data is transmitted to digital port V.35.

In the other direction, data from V.35 port is pushed to the transmitter slip buffer. From the slip buffer data is sent to TDM switch, then to the framer of channel A. The framer A forms G.704 cycle structure.

Port E1A can function in unframed or framed modes. In the first case whole E1 stream is used for data transmission, including timeslots 0 and 16. This results to data rate 2048 Kbit/s. In the second case user can chose timeslots for data transmission. The chosen timeslots form united data channel with data rate  $N \times 64$  Kbit/s, where  $N=1..30$ . Timeslot 0 is used for G.704 synchronization.

**In the drop-insert mode** port V.35 and port E1A are used for data transmission as before, but additionally, port E1B is used for non-data timeslots routing. Framed E1 mode should be set for both E1 ports. Presence of the second E1B port enables connections like shown on the Figure 2. The multiplexer is connected between PBX and central office equipment.



**Figure 2. Drop-insert mode**

In the output stream E1A non-data timeslots will be filled by corresponded timeslots from the input stream E1B. Data timeslots will be extracted by multiplexer from the input stream E1A. Non-data timeslots from the input stream E1A will be routed to the output stream E1B. Note, that E1A and E1B ports are not symmetrical – data received and transmitted only through port E1A. Port E1B is used only for voice timeslots.

**Port V.35** can be set to DTE or DCE modes, independently of multiplexer mode. In the DCE mode port V.35 forms signals of synchronization for an external device. In DTE mode port V.35 receive synchronization signals from an external device.

**Relay** is intended for direct switching E1A and E1B ports in case of power fail. If relay is turned off, the E1A receiver is connected to the E1B transmitter, the E1B receiver is connected to the E1A transmitter. So, in the drop-insert mode E1 line will function even without multiplexer power. In the interface converter mode relay can isolate E1 port from line.

## 2. Specifications

### 2.1. General

Parameter	Value
dimensions	140x110x35 mm
weight (without power source)	0.35 kg
power consumption	5 w
ambient temperature	от +5°C до +45°C
storage temperature	от -40°C до +70°C
humidity	80% or less
power voltage (on DC socket)	15V +- 20%

### 2.2. E1a, E1b ports parameters

Parameter	Value
socket type	RJ45, 8 pins
line type	symmetrical twisted pair, 120 Ohm
impulse voltage	3 V +- 10%
data rate	2048 kbit/s +- 50 ppm
coding	AMI/HDB3
signal attenuation, (E1a)	-40 дБ
signal attenuation, (E1b)	-6 дБ
standarts	ITU G.703, G.704, G.706, G.732, G.823
impulse form	rec. G.703
jitter	rec. G.823
frame structure	rec. G.704

### 2.3. V.35 port parameters

Parameter	Value
socket type	26 pin DB type
mode	synchronous
data rate, kbit/s	Nx64
electrical parameters of signals 105-107, 109	rec. ITU V.28
electrical parameters of signals 103, 104, 113-115	rec. ITU V.35
coding	NRZ

### 2.4. Console port parameters (RS232)

Parameters	Value
mode	asynchronous, 8N1
data rate, kbit/s	38400
flow control	no
electrical parameters of signals	rec. ITU V.28



### 3. Installation of the multiplexer

#### 3.1. Front Panel Controls, Connectors, and Indicators

There is following controls on the front panel::

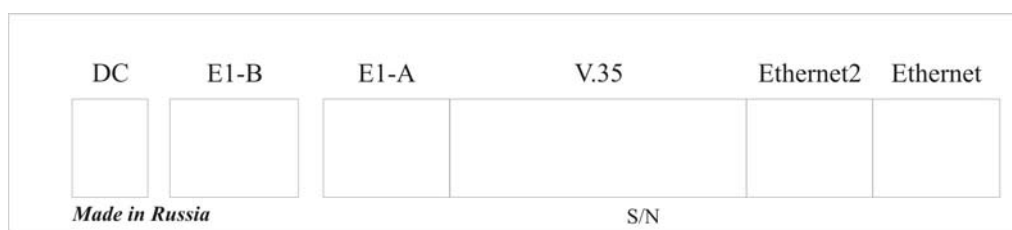
- Reset button
- Power led
- Ethernet 100 Mbit led \*
- Ethernet2 link led\*
- Ethernet link led \*
- E1 led, port a (E1-a)
- E1 led, port b (E1-b)
- E3 led \*
- Console socket RJ-11



**Figure 3. Front panel**

There is following sockets on rear panel:

- Twisted pair Ethernet socket RJ-45 \*
- Twisted pair Ethernet socket RJ-45, channel 2 \*
- Port V.35 socket (26-contacts, DB type)
- E1A socket RJ-45
- E1B socket RJ-45
- DC input socket



**Figure 4. Rear panel**

\* is not used in this multiplexer model

### 3.2. Sockets description

Contact	Net
1	RX+
2	RX-
3	
4	TX+
5	TX+
6	
7	GND
8	GND

**Table 1. Socket E1A**

Contact	Net
1	RX+
2	RX-
3	
4	TX+
5	TX+
6	
7	GND
8	GND

**Table 2. Socket E1B**

Contact	Net	Direction
1	GND	
2		
3		
4	RTS	output
5	CTS	input
6	DTR	output
7	GND	
8	CD	input
9	GND	
10	RxCa	input
11	RxCb	input
12	TxCa	input
13	TxCb	input
14	RxDB	input
15	RxDa	input
16	GND	
17		
18		
19	TxDa	output
20	TxDB	output
21		
22		
23		
24		
25		
26		

**Table 3. Socket V.35 (DTE mode)**

Note: IC-V35-DTE cable should be used in DTE mode

Contact	Net	Direction
1	GND	
2		
3		
4	CTS	output
5	RTS	input
6	CD	output
7	GND	
8	DTR	input
9	GND	
10		
11		
12	TxCa	input
13	TxCb	input
14	TxDb	input
15	TxDa	input
16	GND	
17		
18		
19	RxDa	output
20	RxDb	output
21	RxCa	output
22	RxCb	output
23	TxCa	output
24	TxCb	output
25		
26		

**Table 4. Socket V.35 (DCE mode)**

Note: IC-V35-DCE cable should be used in DCE mode

Contact	Net	Direction
1	RXD	input
2	TXD	output
3	GND	
4	GND	
5		
6		

**Table 5. Console socket**

## 4. Multiplexer configuration

### 4.1. Console attaching

The console port is connected to the serial port of PC by adapter cable RJ-11  $\leftrightarrow$  DB-9. Multiplexer is controlled by terminal program with parameters: 38400, 8b, 1s, np, flow control=off (use Teraterm, for example).

### 4.2. The main configuration menu

After power on (or reset) the multiplexer prints main menu on the console and waits input from user. The multiplexer is configured by modification of parameters in hierarchical menus. After configuration is finished, settings can be saved in the flash memory.

Screen is divided to two parts.

There is the following information in the upper screen part:

- Software release number
- Firmware release number
- The main configuration settings and line status

The following menu is resided in the lower screen part (see Figure 5):

```

ELF2-MEEV monitor, v1.13 08/04/2005, Updates: http://parabel.inc.ru/

Firmware: ELF2-MEEV (2*E1, V.35){0x0}, Revision: 0x2
E1/A is LongHaul, E1/B is ShortHaul, Drop-Insert=Off, Swap=Off, DTE=Off
E1/A Cfg: Framing=On , MultiFraming=On , Line code=HDB3, Clock=Internal
E1/A status: LOS=On , LOF=On , LOM=On , LOC=Off, RAIS=Off, FrErr=0/0
E1/B status: LOS=On , LOF=On , LOM=On , LOC=Off, RAIS=Off, FrErr=0/0
V35 status: DTR(CD)=Off, RTS(CTS)=Off
                1 3 5 7 9 1 3 5 7 9 1 3 5 7 9 1
Timeslots E1/A: #####.....

1. Configuration >>
3. Test >>
9. Reset
    
```

**Figure 5. The main menu**

To choose a submenu, press keys 1-9.

To abandon submenu, press key 0.

Other keys are ignored.

### 4.3. General settings

**Configuration/Common/Relay** – turn on or turn off the bypass relay. When turned off, the output E1a signal is connected to the input E1b signal, and the input E1a signal is connected to the output E1b signal. When turned on, E1a and E1b signals are connected to the ports of the multiplexer.

**Configuration/Common/Drop-insert** – turn on or turn off drop-insert mode. If drop-insert mode is off, the multiplexer is function like interface converter between ports E1a and V.35, port E1b is not used. If drop-insert mode is on, data stream from V.35 port is received and transmitted through the E1a port. Data timeslots are defined in the E1a port submenu. Non-data timeslots from the E1a port are routed to the E1b port.

**Configuration/Common/Swap A/B** – swap E1a and E1b sockets. In the state “On” ports E1a and E1b are exchanged, that is equivalent cable swapping in E1a and E1b sockets. In this case data transmission goes through port E1b.

### 4.4. E1a port configuration

**Configuration/E1/Framing** – turn on framed mode of the E1a port. In the framed mode bit stream is formatted according the recommendation ITU G.704. Port V.35 data is encapsulated to the defined E1 timeslots with data rate  $N \times 64$  kbit/s (N is number of used timeslots). Timeslot 0 is used for synchronization anyway.

In the unframed mode V.35 port data is encapsulated to the unformatted G.703 stream with fixed data rate 2048 kbit/s.

**Configuration/E1/MultiFraming** – turn on or turn off CAS multiframe in the timeslot 16. The multiframe generation is used only for compatibility with some telephone equipment. This mode is not impact on the data transmission capabilities of the multiplexer.

**Configuration/E1/Line code** – line code settings (AMI or HDB3).

**Configuration/E1/Clock source** – line synchronization setting. **Line** – synchronize on received E1a signal (slave). **Internal** – synchronize on internal clock source (master).

**Configuration/E1/Timeslots** – define timeslots used for data transmission (data timeslots are marked by # symbol).

**Configuration/E1/ts16 ABCD** – hex digit 0..f, which is define ABCD bits in CAS multiframe. ABCD bits, defined here, are inserted in the timeslot 16 if it is not used for data transmission.

**Configuration/E1/CRC4** – turn on or turn off CRC4 generation in the transmit direction.

#### 4.5. E1b port configuration

E1b port is used only in drop-insert mode. There are no special configuration options for this port. While enabled, E1b works in the framed mode and synchronized to line (slave). Line coding (AMI/HDB3) and timeslots settings for port E1b are used the same as for port E1a.

#### 4.6. V.35 port configuration

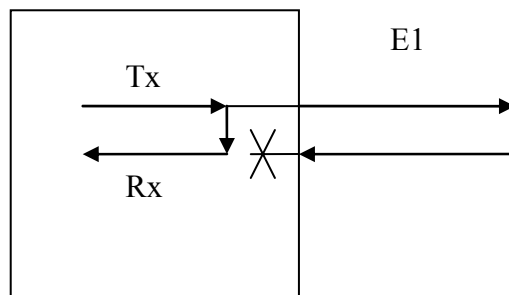
**Configuration/V35/DTE** – turn on or turn off DTE mode of the V.35 port. In DTE mode data synchronization signals (TxC, RxC) are inputs and they are formed by external equipment. DTE mode can be used for connecting modem or other multiplexer to V.35 port. If DTE mode is turned off, synchronization signals TxC and RxC are outputs and they are formed by the multiplexer.

**Configuration/V35/Inverse clock** – inverse data synchronization signal RxC (DCE mode only). This option is used for attaching non-standard equipment. Usually this option is off.

**Configuration/V35/Inverse data** – inverse data signals TxD, RxD. This option is used for attaching non-standard equipment. Usually this option is off.

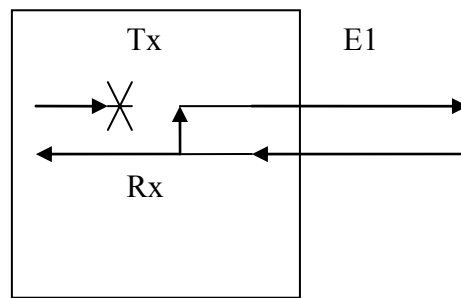
#### 4.7. Testing modes

**Test/E1/Lloop** – turn on internal loopback on the corresponding E1 port (Figure 6Figure 6).



**Figure 6. Lloop mode**

**Test/E1/Rloop** – turn on remote loopback on the corresponding E1 port (Figure 7).



**Figure 7. Rloop mode**

**Test/E1/TAOS** – send all ones (alarm signal) on E1 port

**Test/E1/Freq** – measure and print E1 carrier frequency (relative to internal oscillator).



## 5. Monitoring the multiplexer ports

Status of the E1 port is displayed in the **E1 status** string in the main menu heading.  
The status field legend is shown in Table 6.

Field	Meaning	Values	Comment
LOS	Lost Of Signal	On	No E1 signal carrier
		Off	E1 signal present, no alarm
LOF	Lost Of Frame	On	No G.704 frame detected
		Off	G.704 frame present
LOM	Lost Of Multiframe	On	CAS multiframe absent
		Off	CAS multiframe present
LOC	Lost Of CRC4	On	CRC4 frame absent
		Off	CRC4 frame present
FrErr	Frame Errors	XX/YYYY	XX – 8 bit counter of frame errors YYYY – 16 bit counter of CRC4 errors

**Table 6. Status of E1 ports**

Notes:

1. In the unframed mode LOF, LOM, LOC is not errors
2. To refresh the status press space bar on keyboard
3. To reset error counters choose **Test/E1\_A/Freq** menu of the corresponding E1 port

Status if the V.35 port is displayed in the **V.35 status** in the main menu heading.  
The status field legend is shown in Table 7.

Field	Value	Comment
DTR(CD)	On	DTR signal (CD in DTE mode) is active
	Off	DTR signal (CD in DTE mode) is not active
RTS(CTS)	On	RTS signal (CTS in DTE mode) is active
	Off	Сигнал RTS (CTS in DTE mode) is not active

**Table 7. V.35 port status**

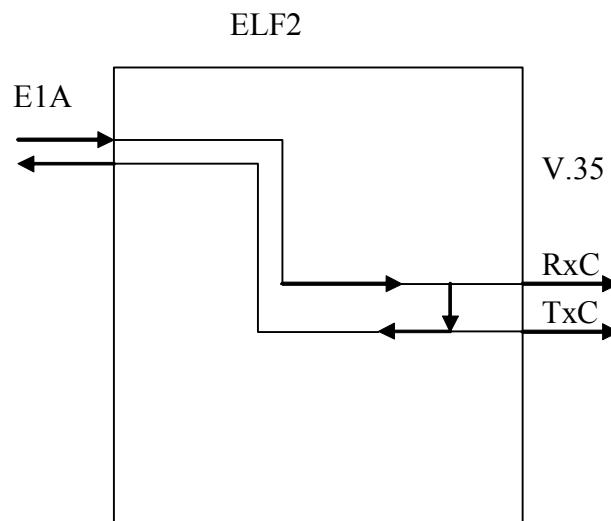
## 6. Functional description

### 6.1. The interface converter mode

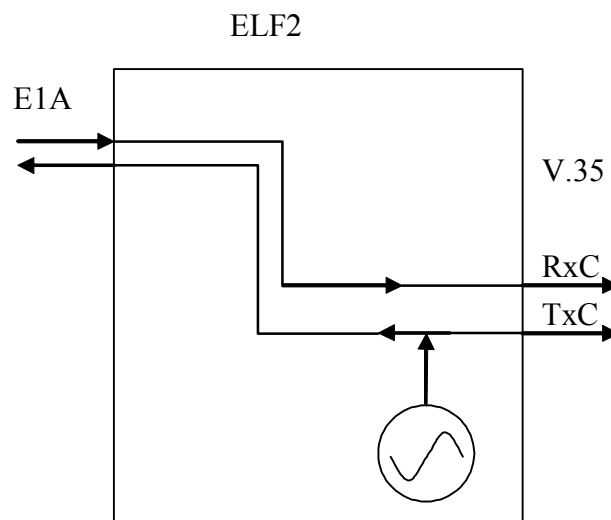
If **Configuration/Common/Drop-insert** is off, multiplexer works in the interface converter mode between E1 and V.35 port. In this mode data from V.35 port is encapsulated to E1a stream. Data streams in V.35 port and E1a port are considered as synchronous bit streams. Bit order in the V.35 stream corresponds to the E1a stream bit order. E1b port is not used.

In the converter mode E1a port can be set to unframed mode (**Configuration/E1/Framing: off**) with data rate 2048 kbit/s. In framed mode (**Configuration/E1/Framing: on**) data rate is  $N \times 64$  kbit/s, where  $N$  – number of data timeslots.

In the converter mode multiplexer is terminating E1 equipment with internal synchronization (E1 master) or data line synchronization (E1 slave).



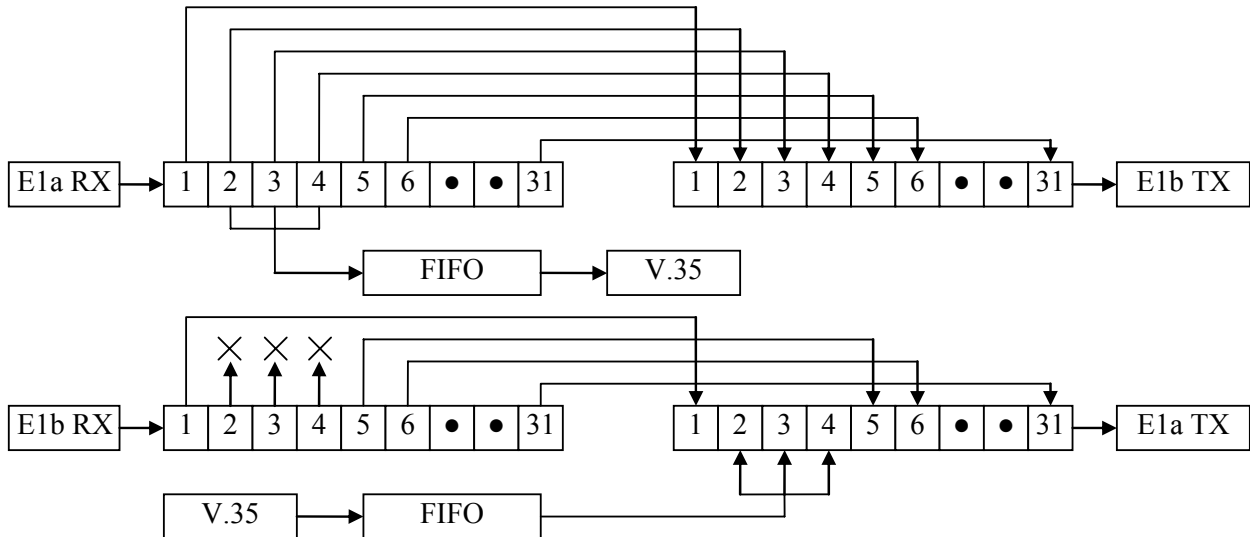
**Figure 8. E1 slave synchronization**



**Figure 9. E1 master synchronization**

## 6.2. Drop-insert mode

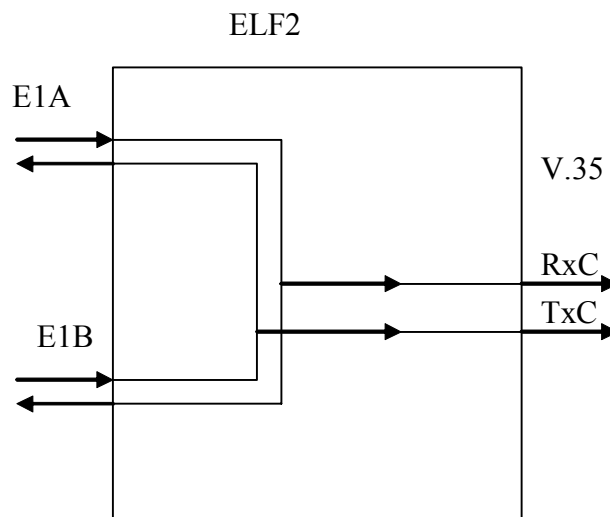
If **Configuration/Common/Drop-insert** is on, multiplexer works in drop-insert mode. In this case both E1 port are used. Timeslots switching scheme is shown on the Figure 10.



**Figure 10. Drop-insert switching**

E1a and E1b ports are set to the drop-insert mode. Timeslots 2,3,4 are used for data transmission in this example. In the «E1a -> E1b» direction E1 stream is passed without changes. Data timeslots are extracted from E1 stream and pushed to the V.35 port. In the «E1b -> E1a» direction timeslots 2,3,4, coming from E1b port are ignored. Multiplexer inserts V.35 data in their place. Other timeslots are passed without changes.

Synchronization scheme in the drop-insert mode is shown on Figure 11.



**Figure 11. Drop-insert mode**

### 6.3. CRC4 handling

On receive, CRC4 is checked in both E1a and E1b streams, independently of port mode. Result of CRC4 comparing is shown in the port status field (LOC). Invalid CRC4 in the input E1 stream is not affects frame synchronization.

On transmit, CRC4 is calculated for E1a port if corresponding mode is set (**Configuration/E1/CRC4: on**). For the E1b port CRC4 is not calculated as E1b output stream is equivalent to the input E1a stream. On this reason CRC4 on E1b output is calculated by equipment, attached to the E1a input.

### 6.4. CAS signaling

Multiplexer is able to form CAS super-frame in the timeslot 16 with fixed ABCD bits. CAS signalization is used by some telephone protocols, like R2. For correct work of telephone switches and PBX, attached to the common E1 channel with multiplexer, data timeslots must be accompanied by the neutral state code in the timeslot 16. The neutral state code should correspond to the given telephone protocol. To turn on CAS super-frame, set **Configuration/E1/MultiFraming** menu to state **on**. ABCD bits code is defined in the **Configuration/E1/ts16 ABCD** menu.

In the interface converter mode ABCD bits are formed in timeslot 16 for channels 1-15, 17-31. In the drop-insert mode ABCD bits are formed only for data channels. For other channels ABCD bits are passed without changes, i.e. they are formed by equipment, attached to the E1b port.

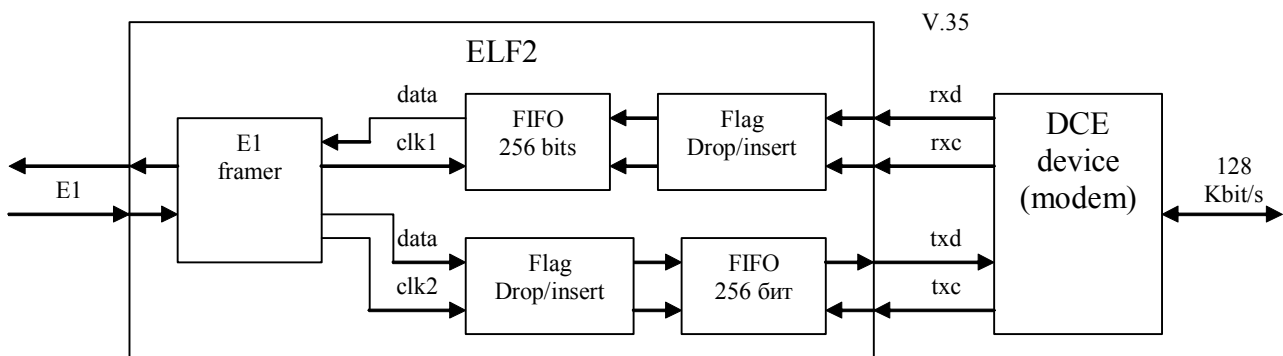
Anyway CAS signalization is formed by the multiplexer only if timeslot 16 is not used for data transmission. In opposite case CAS super-frame and ABCD bits are absent in E1 framing.

CAS super-frame and ABCD bits are not used on the receive side. In the drop-insert mode CAS signaling is passed from the E1a port to E1b port transparently.

If multiplexer is set to the drop-insert mode and telephone equipment use common channel signaling, CAS super-frame must be turned off (**Configuration/E1/MultiFraming:off**).

### 6.5. DTE emulation mode of V.35 port

DTE emulation mode permits connecting DCE devices to the V.35 port of the multiplexer, for example - modems, multiplexers, TDM switches. The signal scheme of external modem attaching is shown on the Figure 12. Synchronization signals TXC and RXC of the V.35 port are formed by modem and connected to ELF2 inputs. E1 port synchronization is locked to the receive E1 stream. So, multiplexer is synchronized by two independent sources – modem and E1 line.



**Figure 12. DTE mode example**

Multiplexer will works correctly if data rate in the both ports will be equivalent. On this reason E1 port in this example must use two timeslots for data transmission (128 kbit/s). Note, that data from E1 framer is pushed to the FIFO not evenly in time, but in 16 bit packages with 125 us period and 2048 kbit/s rate.

FIFO smooth data stream from the E1 framer. FIFO length is 256 bits, that guarantee correct FIFO behavior with any timeslots combination.

FIFO is also participates in bit rate alignment. Bit rate alignment mechanism is based on the HDLC flags manipulation. It is supposed, that data transmitted on the E1 channel is organized to HDLC frames. Most of the modern data link protocols are based on HDLC – for example, PPP, FR, Cisco HDLC. Start and end of the HDLC frame are marked by flag – 0x7E octet. The pause between packets is consist of flags also. Except marking frame edge, flags are not transfer useful information and can be deleted or inserted without doubt. Multiplexer deletes flags if FIFO is full on 75% of length or more. Flag deletion is stopped when FIFO is full on 50%. Multiplexer inserts flags if FIFO is empty on 25% of length or less. Flag insertion is stopped when FIFO is full on 50%.

Bit rate alignment is correct in case, when synchronization frequencies on E1 and V.35 ports are differed not more then value:

$$dF = NF/(MTU + 1),$$

where

MTU – maximum packet length (octets)

NF – number of flags between packets, except stop flag

MTU and NF are defined by router, connected to data channel. Wide used values are MTU=1500 and NF=1. In this case  $dF=666$  ppm, that is well less then typical frequency deviation in the telecom equipment (100 ppm).

## 7. Upgrading firmware

For upgrading the multiplexer firmware do the following:

1. Download the multiplexer firmware
2. Connect console cable and reset multiplexer
3. Program firmware by command **flashrs232 -i /dev/ttyS0 -w -f elf.bin** (where elf.bin - firmware file). This command programs firmware through PC com1.
4. Check firmware release. String «Firmware: ELF2-MEEV (2\*E1, V.35){0x0}, Revision: XXX» must present in the menu heading.
5. Multiplexer is ready for work.

## 8. Multiplexer delivery

Multiplexer is shipped with the following accessories:

- Multiplexer – 1
- Console cable (RJ11-DB9) – 1
- CD disk with documentation – 1

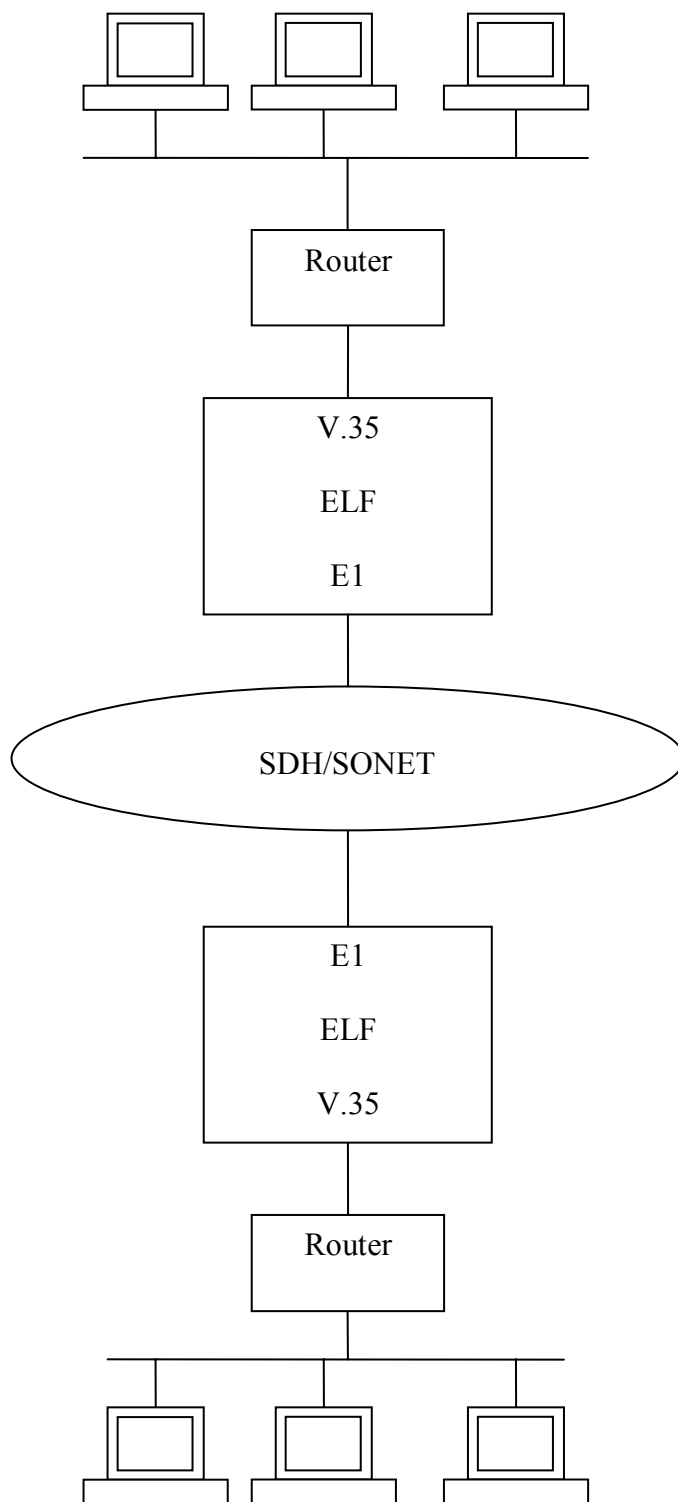
The following accessories can be shipped separately:

- Power source AC 220V
- Power source DC 36..72B
- V.35 cable IC-V35-DTE
- V.35 cable IC-V35-DCE

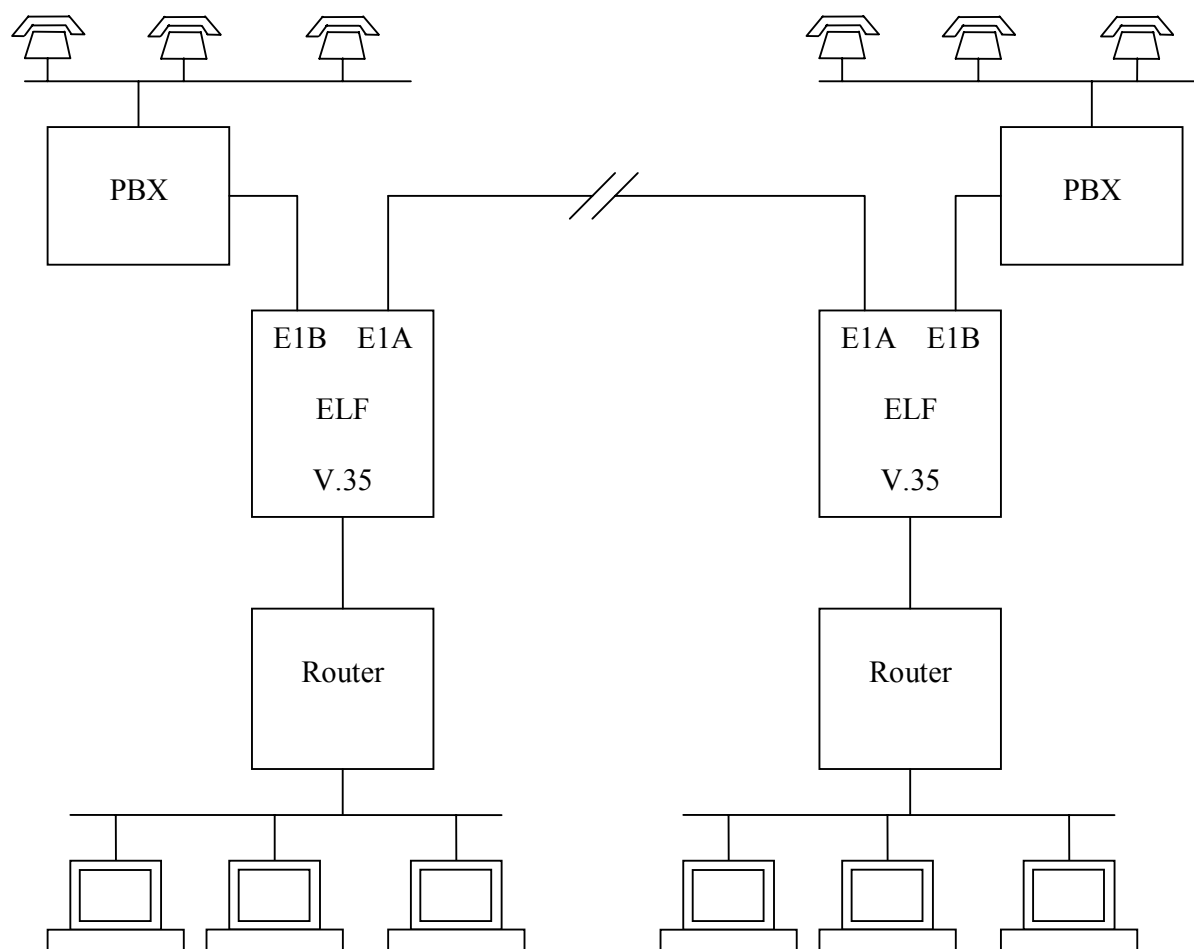
## 9. Package

Multiplexer is packaged to the carton box with dimensions 26x21x6.5 cm.

## Appendix A. Applications

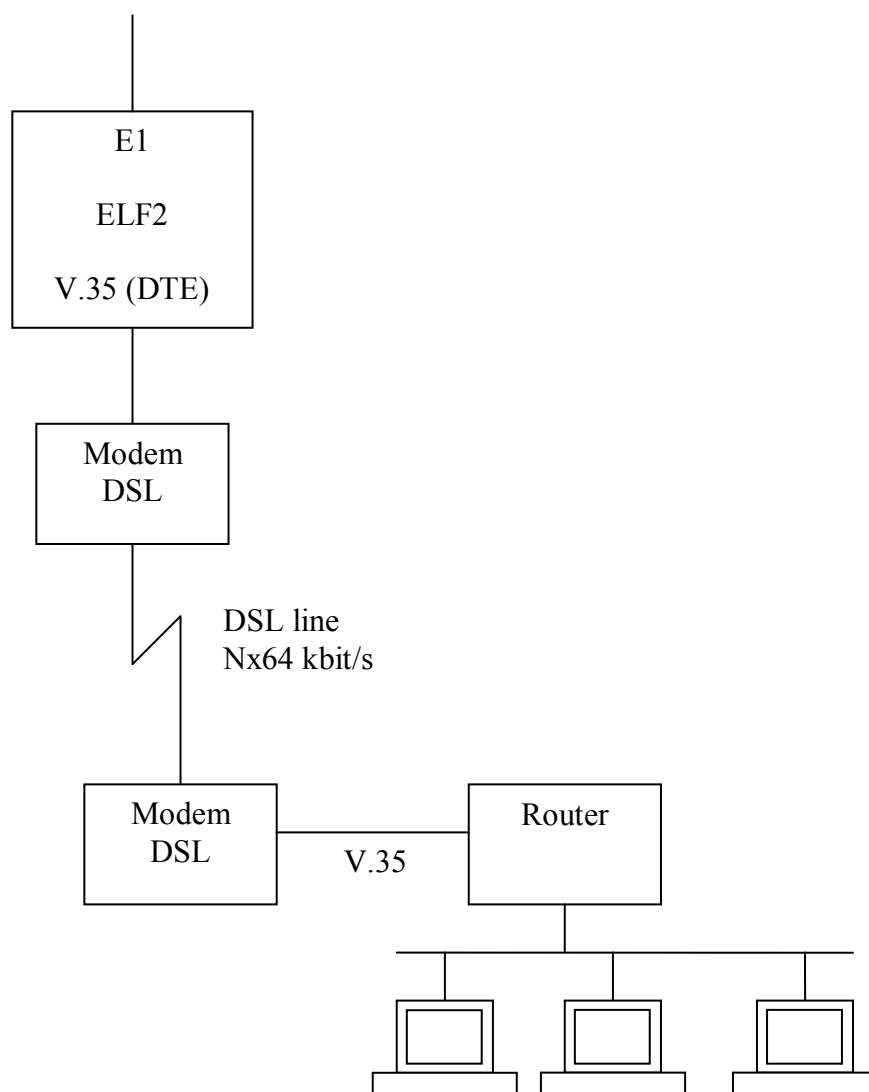


**Figure 13. Connecting two LAN over SDH**



**Figure 14. Using drop-insert mode**





**Figure 15. “Last mile” with DTE mode and external DSL modem**