

Asteroid

The channels bank for Asterisk/CallWeaver

User's manual

Version 1.2

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ASTEROID USER'S MANUAL
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Attention! It is not recommended to use this product on physical lines without lightning protectors.

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1. Introduction

The channel bank is a 19", 1U height unit. It consists of four 8 port FXS or FXO modules.

Asteroid can be used for attaching up to 30 telephone clients to the traditional PBX or to the **Asterisk/CallWeaver**. It can be connected to the traditional PBX with the help of E1 interface.

Connection with **Asterisk** can be made through Ethernet port, using **TDMoE** protocol. In both cases the channel bank realizes Loop Start signaling, subset of **CAS** family signalizations.

Further in the text we assume **Asterisk** and **CallWeaver** to be equivalent.

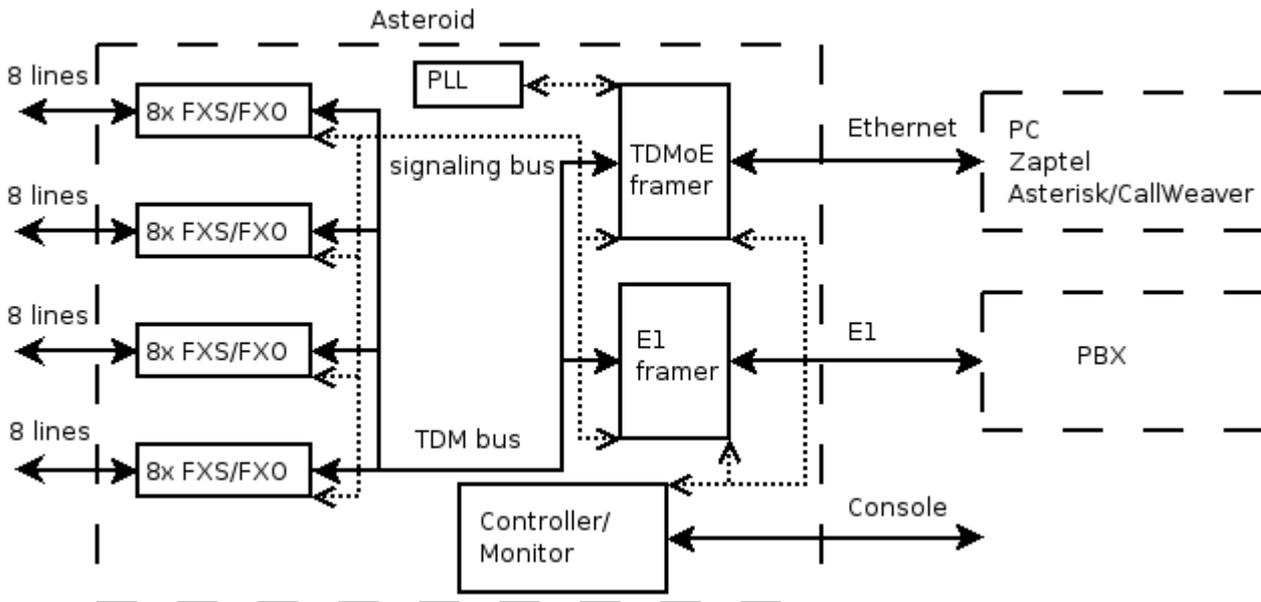


Figure 1. Internal Asteroid architecture

Consider internal architecture of the bank in detail (Figure 1).

Internal modules of Asteroid are interconnected by several buses: a control bus, a signaling bus, data bus. The control bus is used for initialization and monitoring of modules. The signaling bus is used for transportation of telephone signaling between FXO/FXS modules and framers. The data bus is used for voice transmission and synchronization.

The E1 or **TDMoE** framers provide interfaces for Asteroid attaching to PBX or **Asterisk**. In the receive direction framer processes digital data, arriving from PBX or **Asterisk**. It synthesizes voice and signaling streams on buses. In the transmit direction framer forms the digital stream to be sent to the PBX or **Asterisk**.

Synchronization obtained by the framer is used for syncing all Asteroid modules. If Asteroid is slave relative to the Ethernet port, **TDMoE** framer adjust its frequency to the packets rate, using phase locked loop technique.

Signalization from data and signaling buses follows to FXS/FXO modules. In correspondence with this information, modules set up the telephone ports states and decode the A/m law encoded data stream. In the reverse direction, these modules process the analog lines modifications and encode the voice to data stream.

FXS modules can recognize the hook off state, the pulse dialing. They form the ring signal. FXO modules can recognize the ring signal from PBX and dial number. The tone dialing is passed through without processing.

Microcontroller is used for setting parameters, displaying the status information and firmware loading.

Consider Asteroid and **Asterisk** interaction over Ethernet. Asteroid transmits **TDMoE** packets through Ethernet. Packets received by the server go to the **Zaptel** driver. If necessary, it cancels the echo and passes the voice and signalization to **Asterisk**. Processing these data, **Asterisk** functions like a traditional PBX or VOIP. In the reverse direction, **Zaptel** driver receives voice and signalization from **Asterisk**, packs them to **TDMoE** packets and transmits the packets to Ethernet.

To sum up, Asteroid delivers voice and signalization between FXS/FXO and Ethernet (E1) ports, not touching the signalization logic itself. The signaling logic is processed by **Asterisk** or by any other PBX connected to Asteroid.

The four 8-channel FXS/FXO cards provide 32 telephone ports, but only 30 ports are available. The reason is the structure of E1 frame. E1 stream uses channel intervals 0 and 16 for frame signaling and ABCD bits (encoded state of telephone lines). The corresponded ports 0 and 16 can't be used.

It is worth mentioning that, while using Ethernet connection, the channel bank can be hot replaced without **Asterisk** server restarting. If **Asterisk** server is reserved by the second server, both of them can use common pull of Asteroid banks. This reduces the total system cost.

Asteroid order codes:

Asteroid-0L4S-DC	30 FXS ports, -36..-72V DC
Asteroid-4L0S-DC	30 FXO ports, -36..-72V DC
Asteroid-1L3S-DC	8 FXO ports, 22 FXS ports, -36..-72V DC
Asteroid-0L4S-AC	30 FXS ports, 220 V AC
Asteroid-4L0S-AC	30 FXO ports, 220 V AC
Asteroid-1L3S-AC	8 FXO ports, 22 FXS ports, 220 V AC
Asteroid-0L4S-DC-E1	30 FXS ports, -36..-72V DC, E1 port
Asteroid-4L0S-DC-E1	30 FXO ports, -36..-72V DC, E1 port
Asteroid-1L3S-DC-E1	8 FXO ports, 22 FXS ports, -36..-72V DC, E1 port
Asteroid-0L4S-AC-E1	30 FXS ports, 220 V AC, E1 port
Asteroid-4L0S-AC-E1	30 FXO ports, 220 V AC, E1 port
Asteroid-1L3S-AC-E1	8 FXO ports, 22 FXS ports, 220 V AC, E1 port

Table 1. Order codes

In all variants Ethernet port is present.

1.1 TDMoE module internals

For converting TDM bus to packets, data is collected in one of two **DB** buffers (see Figure 2). The data from other previously filled buffer is passed to Ethernet using **TDMoE** format. One Ethernet packet contains 8 TDM frames. The corresponded packet rate is 1 kHz.

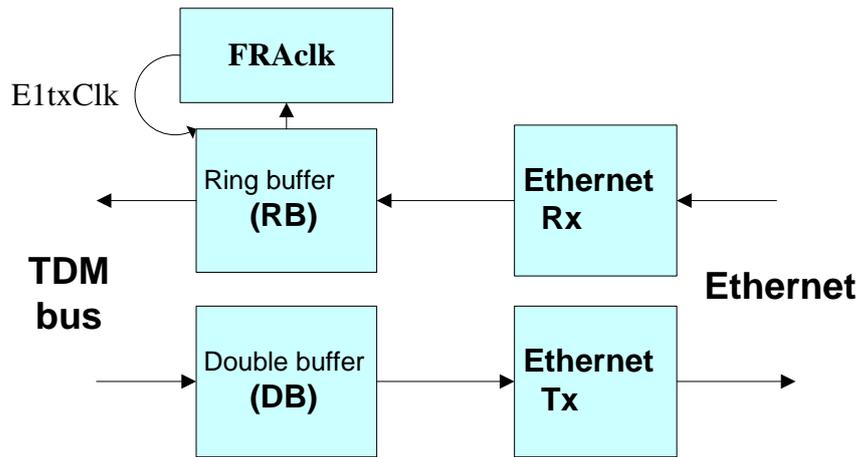


Figure 2. TDMoE module structure

For reverse conversion, **TDMoE** packets are collected in the ring buffer **RB** with volume of 8 packets (8* 30 * 8 bits). The structure of the buffer is shown on Figure 3. The **PntW** pointer marks the following free buffer for writing and incremented by one when the new packet is received.

In the same time the data is extracted from the ring buffer and passed to the TDM bus. The **PntR** pointer marks the following packet for reading and incremented by one after current buffer transmitting to the TDM bus.

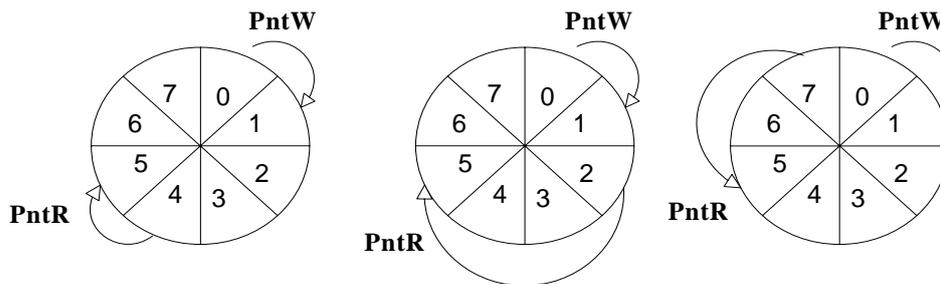


Figure 3. Ring buffer

For **PntW** to work perfectly, it should pass ahead **PntR** by half of **RB** buffer volume. But in reality, the average rate of Ethernet packets differs from the TDM packets rate. The last one is defined by the internal frequency **E1txClk**.

If **PntR** pointer reaches **PntW+1** value, **PntR** is incremented by 3. As a result, two packets (one E1 multiframe) will be lost. This occasion is named a skip and is displayed in error counter $SkipErr=SkipErr+1$.

If **PntR** pointer reaches **PntW-1** value, **PntR** is decremented by 2. As a result, two packets (one E1 multiframe) will be transmitted twice. This occasion is named a slip and is displayed in error counter $SlipErr=SlipErr+1$.

The slip (skip) rate is defined by the difference between the packets reception rate and TDM bus transmit frequency **E1txClk**. For example, if the difference is 15 ppm, the slip rate is equal to one per minute. This slip will be detected as a click in sound channel. If the channel is occupied by a fax or a modem, the lost of data portion may occur. Effective speed of connection will be lower.

To eliminate slips **Asterisk** should be synchronized to Asteroid.

The second possibility to eliminate slips is to enable **PLL** regulator **FRAClk**. In this case **E1**¹ port should have 'clock=internal' setting. The regulator is controlled by ring buffer pointers. If **PntW** and **PntR** difference is equal to 4, **E1txClk** is equal to the internal quartz frequency divided by 12 (24576/12 = 2048 kHz). When the difference has other values, the **E1txClk** period is shortened or extended once per

¹ In the mode 'TDM Over Ethernet' **TDM** bus takes role of internal E1 port.

millisecond by value $40 \text{ ns} * \text{VCO}$. The configuration parameter VCO^1 can be defined by user as **0** (no regulation), **1** (regulation with frequency difference less than 40 ppm) or **2** (regulation with frequency difference less than 80 ppm).

If $\text{VCO}=1$, the jitter (at 125 hz) of the transmit stream is equal to 0.08UI , if $\text{VCO}=2$, then jitter equals 0.16UI . Both values satisfy ITU recommendation G.823.

The VCO parameter has one more diagnostic application. If $\text{VCO}=80$, the statistic field `SkipErr` will display the maximal period between Ethernet packets in microseconds. When **Asterisk** is first time started or there are problems with bank synchronization, it is recommended to measure this period. If the period is more than 1500, the jitter of Ethernet packets is large. This can be caused by software components, incompatible with real time applications like **Asterisk** (for example, X11). Also large jitter can cause the slip or skip errors increment.

As a rule, in synchronized systems one of devices is the clock master.

Example. Let us have two banks of channels (`Asteroid_1`, `Asteroid_2`) and **Asterisk** server. `Asteroid_1` should be configured as `clock=internal`, $\text{VCO}=0$, TDM over Ethernet. **Asterisk** should be synchronized from the **TDMoE** stream of `Asteroid_1`. The second bank `Asteroid_2` should be configured as `clock=internal`, $\text{VCO}=2$, TDM over Ethernet. `Asteroid_2` will be leaded by `Asteroid_1`.

1.2 The Ethernet connection notes

The **TDMoE** protocol is realized on Ethernet MAC level. On this reason, routers are not allowed between Asteroid and server. Switches and hubs can be used for connection only.

There are high demands to QoS discipline – packets delay jitter must be less than 1.5 ms.

In practice it is necessary to use the separate port Ethernet in the server, which can be connected to several channel banks. The other network traffic is undesired in this segment. The number of nodes in the 100 Mbit network is restricted by 20. But the real number of banks attached to the server is defined by performance of the server.

2. Technical characteristics

2.1. General parameters

Parameter	Value
Dimensions	430x250x45 mm
Weight	2.5 kg
Power consumption	50 wt
Ambient temperatures	+5°C to +45°C
Storage and transportation temperatures	-40°C to +70°C
Humidity	Less then 80%
Power voltage (DC socket)	48-72V
Power voltage (AC socket)	220V +- 20%
'Dry' contacts	0.2A 72V DC

2.2. E1 parameters

Parameter	Value
Connector type	RJ45, 8 pins
Cable type	Symmetrical twisted pair, 120 ohm
Nominal pulse voltage	3 V +- 10%
Data transmission speed	2048 kbit/s +- 50 ppm
Coding	AMI/HDB3
Signal attenuation, not more	-40 db

¹ See 4.3. General settings

Corresponding standard	ITU G.703, G.704, G.706, G.732, G.823
Pulse form	Rec. G.703
Phase jitter	Rec. G.823
Frame structure	Rec. G.704

2.3. Ethernet parameters

Parameter	Value
Connector type	RJ45, 8 pins
Cable type	Symmetrical twisted pair (UTP)
Data transmission speed, mbit/s	100
Corresponding standard	IEEE 802.3
Work modes	Duplex, Half duplex, Auto negotiation

2.4. FXS and FXO ports parameters

Coding	PCM A-law (ITU-T G.711) PCM μ -law (PUB-43801)
Nominal signal level	0 dBm +/- 0.5 dB
Nominal line impedance	600 Ohm
Echoed signal (300..3400 Hz), FXS	Less than -20 dB
Echoed signal (300..3400 Hz), FXO	Less than -12 dB
Gain-frequency variation (respectively to 1 kHz) in range 300..3400 Hz	+/- 1 dB
Noise level	Less than -47 dBm
Loop current (FXS)	20 mA
Ring voltage (FXS)	100 V (peak-to-peak), 20 Hz

2.5. Console port parameters (RS232)

Parameter	Value
Work mode	Asynchronous, 8N1
Data speed, kbit/s	38400
Flow control	No
Electrical signals parameters	Rec. ITU V.28

3. Bank installation

3.1. Sockets, indicators, switches

There are the following features on the face panel (left to right):

- 4 FXS/FXO modules, J1-J4
- Reset switch
- Alarm led, red light - alarm
- 6-pin console socket RJ-11
- 8-pin Ethernet socket RJ-45
- Ethernet link led
- Ethernet Activity led
- 8-pin E1 socket RJ-45

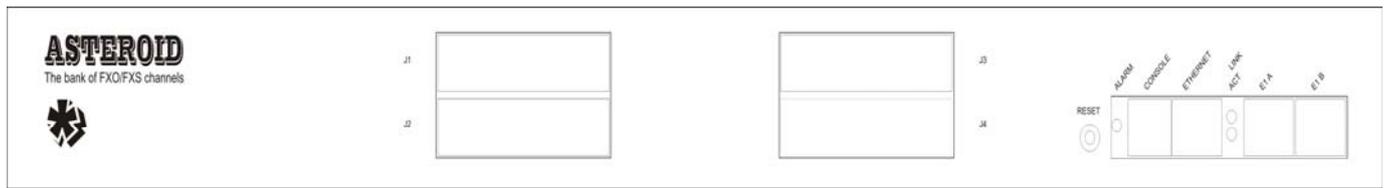


Figure 4. Face panel

There are the following features on the back panel (left to right):

- Power socket (AC, 220V)
- Fuse
- Power switch
- Fan
- Grounding contact
- Power socket (DC, 48-72V)

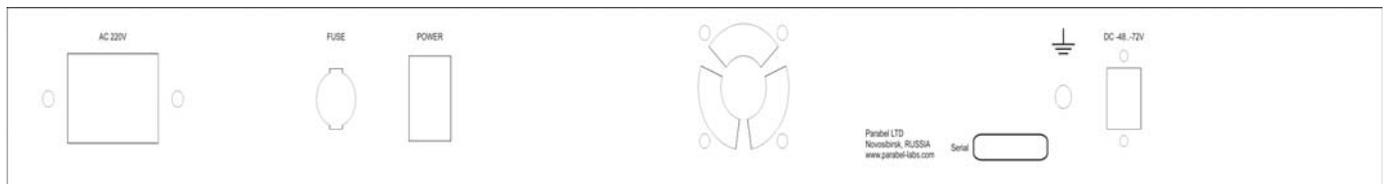


Figure 5. Back panel

3.2. Sockets description

Pin	Net
1	RX+
2	RX-
3	
4	TX+
5	TX+
6	
7	
8	Ground

Table 2. E1 pinout

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

Table 3. Ethernet pinout

Net	Pin
Line 0, tip ³	1
Line 0, ring	14
Line 1, tip	2
Line 1, ring	15
Line 2, tip	3
Line 2, ring	16
Line 3, tip	4
Line 3, ring	17
Line 4, tip	5
Line 4, ring	18
Line 5, tip	6
Line 5, ring	19
Line 6, tip	7
Line 6, ring	20
Line 7, tip	8
Line 7, ring	21
Ground ⁴	13
Ground	25

Table 4. J1-J4 pinout (FXS/FXO modules)

Warning! Do not use the port 0 of jacks J1 and J3 (FXS/FXO lines 0 and 16). See “4.5. FXS/FXO ports settings” for the details.

Pin	Net	Direction
1	RXD	Out
2	TXD	In
3	GND	
4	GND	
5		
6		

Table 5. Console pinout

Pin	Net	Direction
1,5	0V	In
2,6	-48..72V	In
3,7	Relay 1	Out
4,8	Relay 2	Out

Table 6. DC socket pinout

³ J1 pinout is presented. For J2 line numeration is started from line 8, for J3 – from line 16, for J4 – from line 24.

⁴ Protecting ground.

4. Device configuration

4.1. Connecting console

The console port is connected to COM port of compute with the help of the converting cable RJ-11 \leftrightarrow DB-9. The terminal program should be started on the computer with parameters 38400, 8b, 1s, np, flow control=off.

4.2. The main configuration menu

After the power is on (or reset) Asteroid prints the main menu to the console and waits for a command. To configure the channel bank, user should walk through the hierarchical menu system and choose the necessary parameters. After parameters modification, settings should be saved in non-volatile memory. There is the dedicated menu point for this.

Screen is separated into two parts.

In the upper part the following information is displayed:

- Software release
- Firmware release
- The major settings and lines status

In the lower part of the screen the current menu is printed (see Figure 6).

```
Asteroid monitor, v0.30 19/11/2007, Updates: http://parabel.ru/

Firmware: Asteroid{0xB}, Revision: 0x3, Temperature(C): 27
E1/A Cfg: Line code=HDB3, Clock=Internal, CRC4=On
Slots {0: ALaw,FXS 1: ALaw,FXO 2: ALaw,FXS 3: ALaw,FXS}
E1/A status: LOS=Off, LOF=Off, LOM=Off, LOC=Off, RAIS=Off, FrErr=0/0
TDMoE {status : SkipEr=0, SlipEr=0, RxNuEr=0 <> mac: 00555555500}
          1 3 5 7 9 1 3 5 7 9 1 3 5 7 9 1
FXO/FXS state:  BBBB...

1. Configuration >>
2. Status >>
3. Test >>
8. Start bootloader
9. Reset
```

Figure 6. The main menu

To choose menu points, use number 0-9. Other keys are ignored.
For exit to the upper menu level, press 0.

4.3. General settings

Configuration/Common/VCO – setting PLL parameters.

VCO = 0 – no frequency regulation

VCO = 1 – frequency regulation with +-40 ppm limit.

VCO = 2 – frequency regulation with +-80 ppm limit

VCO = 80 – diagnostic mode: SkipErr field will display maximal interval between Ethernet packets in microseconds.

PLL nominal frequency 2048000 Hz

PLL works only with TDMoE stream, and if “**Configuration/E1/Clock source = Internal**”.

Configuration/Common/MAC – setting Ethernet MAC address

Configuration/Common/Relay – is not supported in this release.

Configuration/Common/Full duplex – turn on or turn off the full duplex mode for Ethernet port.

Configuration/Common/E1 Over Ethernet – turn on or turn off E1 transmitting over Ethernet (with the help of TDMoE protocol). Diagnostic mode, for factory tests only. ‘Off’ value must be set.

Configuration/Common/TDM Over Ethernet – choosing the main data port for connection with PBX. ‘On’ – Ethernet port with TDMoE stream, ‘Off’ – E1 port.

4.4. E1 port settings

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

Configuration/E1/Clock source – E1 master (Internal) or E1 slave (Line) choosing.

Configuration/E1/CRC4 – turn on or turn off CRC4 generation

4.5. FXS/FXO ports settings

FXS = Foreign Exchange Subscriber = the ring and loop current generating port

FXO = Foreign Exchange Office = telephone line port

Slot	Socket	Port numbers	E1 projection (Channels starts with 0)	TDMoE projection (channels starts with 1)
Slot 0	J1	0	absent	absent
		1-7	1-7	1-7
Slot 1	J2	8-15	8-15	8-15
Slot 2	J3	16	absent	absent
		17-23	17-23	16-22
Slot 3	J4	24-31	24-31	23-30

Table 7. FXS/FXO ports projection to E1/TDMoE

As shown in the table, FXO/FXO port isn't used. The reason is that the E1 uses timeslot 0 for framing, and timeslot 16 for ABCD signaling.

Configuration/Slots/Slot N – choosing module type (FXS or FXO), for corresponding socket J1-J4. It is necessary to choose modules types, correlated with the real hardware configuration. FXS modules have a 25 pin female socket, FXO modules have a 25 pin male socket.

Configuration/Coding law/Slot N – coding law for corresponding module (A-law or μ -law).

4.6. Saving and restoring parameters

Configuration/Factory – restoring factory settings (the current settings will be lost)

Configuration/Restore – loading settings from flash memory

Configuration/Save – saving current settings to flash memory

4.7. Testing and diagnostic tools

Test/E1/Loop – turn on internal loopback on E1 port (Figure 7).

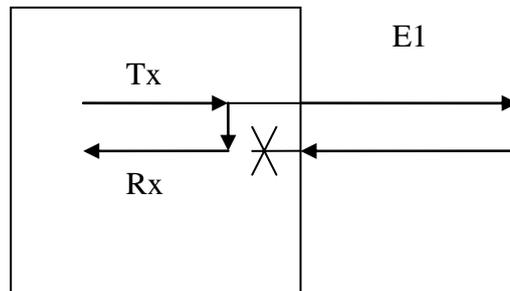


Figure 7. Loop mode

Test/E1/Rloop – turn on remote loopback on the E1 port (Figure 8).

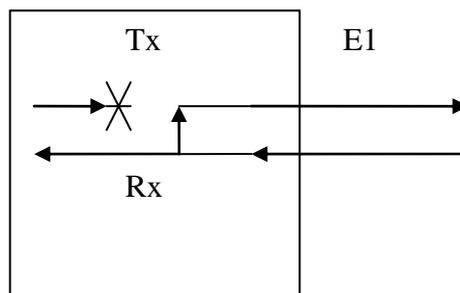


Figure 8. Rloop mode

Test/E1/TAOS – transmit E1 alarm signal (all “1”)

Test/E1/Freq – measure E1 receive carrier relative to internal oscillator

Test/Port/Port #N – choosing FXS/FXO port for tests. Port 0 must be set after tests.

Test/Port/Line ring – Turn on ring (for FXS modules).

Test/Port/Line hook – Hook on (off) (for FXO modules).

Test/Port/E1 tx hook – send to the E1 or Ethernet(**TDMoE**) ports the hook on (off) signaling.

5. Device monitoring

The status information is displayed in heap of screen menu.

Field	Transcript	Values	Comment
LOS	Lost Of Signal	On	No E1 carrier
		Off	E1 carrier is present, no alarm

LOF	Lost Of Frame ⁵	On	No E1 framing
		Off	E1 framing is present (G.704 frames)
LOM	Lost Of Multiframe	On	No CAS multiframe
		Off	CAS multiframe is present
LOC	Lost Of CRC4	On	Bad CRC4 framing
		Off	CRC4 framing ok
RAIS	Remote Alarm Indication Signal	On	No E1 frame at peer side
		Off	E1 frame ok at peer side
FrErr	Frame Errors	XX/YYYY	XX – 8 bits frame errors counter YYYY – 16 bits CRC4 errors counter

Table 8. E1 status information

Field	Transcript	Comment
SkipErr	Skipped errors	The number of TDMoE packets (the average rate of TDMoE is higher than internal TDM rate)
SlipErr	Slipped errors	The number of doubled TDMoE packets (the average rate of TDMoE is below than internal TDM rate) ⁶
RxNuErr	Received Numeration Errors	The number of TDMoE sequence mismatches
mac	MAC address	The (Ethernet)MAC address of Asteroid

Table 9. TDMoE status information

Field	Transcript	Comment
B	Busy	Hook off on the FXS port
R	Ringing	Ring from FXO port

Table 10. FXS/FXO ports status

The general device status and E1 (**TDMoE**) stream presence is signaled by relay contacts (see Table 6. DC socket pinout).

Notes:

1. Status is refreshed after pressing the key on the keyboard
2. Error counters are cleared after choosing menu /Status/Clear

⁵ When using Ethernet port, LOS/LOF fields are corresponded to TDMoE stream, converted to the internal E1.

⁶ SkipErr or SlipErr counters are incremented because of erroneous clock source for **zaptel** and Asteroid.

Simultaneous increment of SlipErr and SkipErr points to the high Ethernet loading or incorrect interrupts processing in PC.

6. Attaching to PBX/Asterisk

6.1 Introduction

As was said earlier, Asteroid is a bank of channels and can be connected to the PBX by E1 port, or to **Asterisk** by Ethernet port.

Consider PBX and **Asterisk** settings in the following pages.

Asteroid can be attached to the **Asterisk** by E1 link too, but this is a variation of the first case.

It is worth to note that we mean **Zaptel** version 1.4.9.2 with patches of Parabel company, see [<http://parabel.ru/download/>]. See “6.7 Patches for zaptel” chapter for details.

6.2 Attaching Asteroid to Asterisk by Ethernet

Physical connection between Asteroid and **Asterisk** server is performed by Ethernet link with the help of **TDMoE** protocol. On the kernel level, **Asterisk** and telephone equipment is interacted through **zaptel** driver. For example, **TDMoE** support is realized in the **ztdynamic** and **ztd-eth** modules, parts of **zaptel** package.

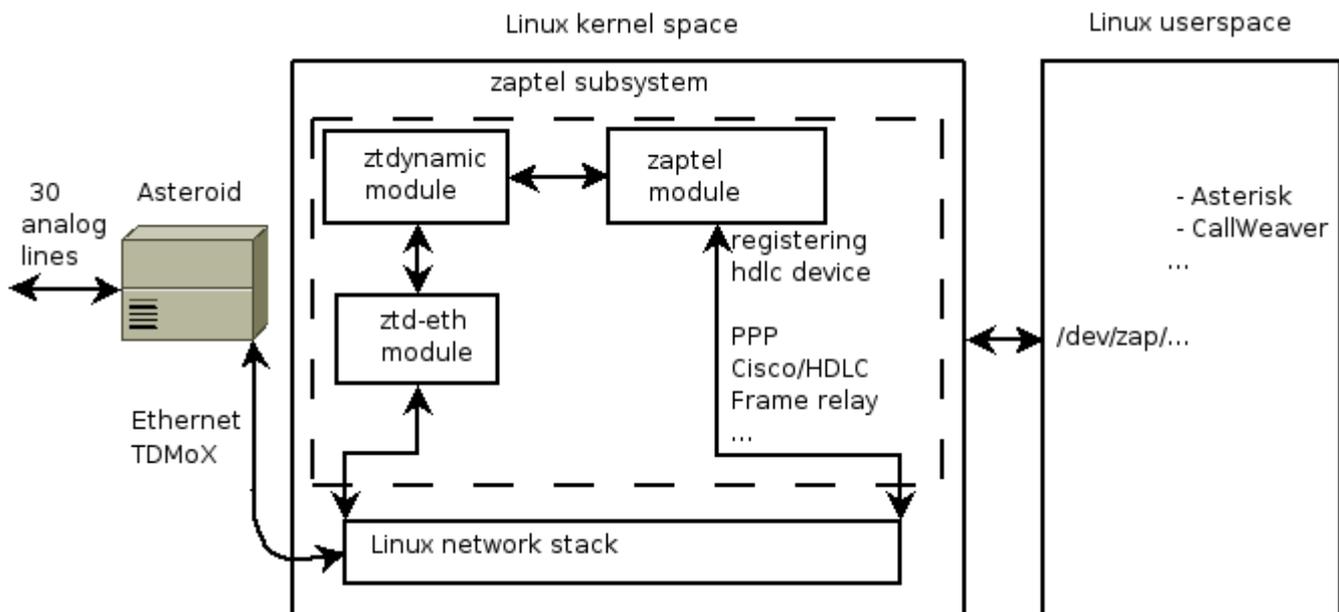


Figure 9. Internal zaptel architecture

The Asteroid device corresponds **Dynamic SPAN** – the timeslots range, described by the keyword **dynamic** in the **zaptel.conf** file. Unlike **SPAN**, **Dynamic SPAN** is dynamically registered, after starting **ztcfg** utility. **SPAN** is registered after loading device driver. The **dynamic** field describes connection with Asteroid and data packaging order to **TDMoE** packets. Parameters are separated by commas. The example of **dynamic** field is shown in Appendix B.

The first parameter of **dynamic** field is the name of network interface, which should be used for connection with Asteroid.

The second parameter defines MAC (Ethernet) address of Asteroid device. This address must be the same as defined in console menu. If the server is connected to several Asteroid devices, each of them must have a separate MAC address and a separate **dynamic** field.

The third parameter defines the number of channel intervals provided by Asteroid. Note that anytime the same number of voice channels is transmitted between **Asterisk** server and Asteroid. This number is 30, even if some channels are not used for telephony. The value of the third field also defines the format of signaling bits in **TDMoE** packets.

The fourth parameter defines the device priority as a synchronizing source for **ztdynamic** driver.

Note that timeslots in **Asterisk** have global enumeration. For example, two Asteroid devices correspond to channels 1-30 and 31-60.

The previously defined configuration is stored in **zaptel.conf** file. To write configuration **ztcfg** program is used. After receiving settings, **zaptel** starts data transmitting to Asteroid using MAC address, defined in the configuration. After receiving data stream from the server, Asteroid starts transmitting in the opposite direction.

6.3 Zaptel synchronization

The following basic terms are used:

- Adapter - is a board, installed in PCI slot, for PC connection with several data streams (E1, FXO/FXS)
- **SPAN** – is the range of timeslots, corresponding to the given data port in **zaptel** driver. **SPAN** is created by the driver of hardware device. **SPAN** is configured in the file **zaptel.conf** by string 'span='.
- **Dynamic SPAN** – is the range of timeslots, corresponding to the given **TDMoE** device. **Dynamic SPAN** is created dynamically by **ztcfg** utility and configured by 'dynamic=' string in **zaptel.conf** file.

Zaptel driver has two functions – it provides data and synchronization for **Asterisk**. **Asterisk** needs synchronization mainly for conferences.

Zaptel synchronization is one of the most important moments for the successful **Asterisk** installation. The true **Zaptel** configuration means choosing the main and reserve clock sources.

In **Zaptel** driver the voice is processed as streams, not as packets. This circumstance defines the importance of synchronization tuning. For example, if two streams are not synchronized, the data passed between them will be lost. It is not acceptable for faxes and modems especially. The speed of errors depends on frequency mismatch for the given data streams.

Zaptel synchronization for a given channel is not very important in one case – if the channel is included in the network device (see '**nethdlc**' string in the **zaptel.conf**).

For correct data processing **Zaptel** driver needs a reliable primary clock source. The clock source is a hardware device. It can be a (**dynamic**) **SPAN** or an internal PC timer. In the latter case the timer is presented as a virtual **SPAN**, produced by **ztdummy** driver.

Ztdummy driver functions as a virtual hardware card, submitting 0 channels to the **Zaptel**. The **ztdummy** uses **RTC** interrupts with even clock rate. So, for smooth synchronization it is recommended to load **ztdummy** with parameter `rtc_rate=4096`⁷.

The algorithm of choosing clock source is the following.

1. Each **SPAN** configuration (for example, adding **SPAN**, removing **SPAN**) produces a new arbitrage. The first registered **SPAN** without errors and with a valued number of timeslots is assigned as a new master.
2. In other cases **ztdummy SPAN** is assigned as master.

Note that.

1. The timing field in the string '**span=...**' has no influence on master arbitrage. This field is a recommendation for the adapter driver how to configure the adapter synchronization.
2. The hardware adapters with **SPANs** have higher priority than **ztdynamic** devices.
3. The **ztdynamic** devices can be clock masters or clock slaves.

Now consider the **TDMoE** devices synchronization. These devices are serviced by **ztdynamic** and **ztd-eth** drivers. The **ztdynamic** driver has a separate synchronization system.

⁷ In Linux >= 2.6.22 **ztdummy** uses high resolution timer, parameter `rtc_rate` is not necessary

The algorithm of choosing data synchronization for **ztdynamic** is the following.

1. Just after loading, the **zaptel** driver is the source of synchronization for **ztdynamic**. In other words, at first it is synchronized from **SPANs** (adapters or **ztdummy**).
2. After creation of the **dynamic SPAN** device, the new clock master is searched. The active **dynamic SPAN** device (without Alarm signal) with the smallest priority (not equal to 0) becomes the new clock master for **ztdynamic**. Also, only this device can be clock master for the **Zaptel** driver.
3. If step 2 device can not be found, **zaptel** becomes the clock master.

The **ztdynamic** transmits data to the Ethernet channel using internal data clocks. To start data exchange with the Asteroid, the start condition must exist (step 1 of algorithm).

The timing settings of **TDMoE** devices are described in the “timing” field of “dynamic=” string, in the **zaptel.conf** configuration file. The smaller digit is equal to the higher priority. The 0 value means don't use the device as a synchronization source of **ztdynamic**. In this case **TDMoE** device must adjust its internal clocks to the incoming **TDMoE** packets.

If the timing configuration is incorrect, the packets can be lost (SkipErr) or repeated (SlipErr). To avoid these errors, the general rule should be followed – timing master should be connected with slave.

6.3.1 Synchronizing Zaptel – Asteroid is master

Consider configuration when Asteroid is master. In **zaptel.conf** file the channel bank should be described by the string:

```
dynamic=eth,eth1/00:55:55:55:55:00,30,1
```

It corresponds to **TDMoE** device, attached to the Ethernet port eth1 with the address “00:55:55:55:55:00”.

Asteroid itself should be configured:

```
Configuration/Common/MAC = 00:55:55:55:55:00
Configuration/Common/TDM Over Ethernet = On
Configuration/E1/Clock source = Internal
Configuration/Common/VCO = 0
```

After starting and configuring **zaptel**, **ztdynamic** does not receive packets from Asteroid, because Asteroid does not know the server address. The device status is RED ALARM. On this reason just after start **zaptel** is synchronized from **ztdummy** and **ztdynamic** is synchronized from **zaptel**.

After receiving synchronization, **ztdynamic** starts transmitting data to Asteroid. Then, after receiving addressed packets, Asteroid starts packets transmitting back to the server. After receiving Asteroid response, **ztdynamic** chooses the bank as a clock source. The device status becomes OK. **Ztdynamic** becomes clock source for **zaptel**.

As a result, both **ztdynamic** and **zaptel** are synchronized from Asteroid.

6.3.1 Synchronizing Zaptel – Asteroid is slave

Consider configuration when asteroid is slave. In the **zaptel.conf** file the channel bank should be described by the string:

```
dynamic=eth,eth1/00:55:55:55:55:00,30,0
```

It corresponds to **TDMoE** device, attached to the Ethernet port eth1 with the address “00:55:55:55:55:00”.

Asteroid itself should be configured:

Configuration/Common/MAC = 00:55:55:55:55:00

Configuration/Common/TDM Over Ethernet = On

Configuration/E1/Clock source = Internal

Configuration/Common/VCO = 1 or 2

After starting and configuring **zaptel**, **ztdynamic** does not receive packets from Asteroid, because Asteroid does not know the server address. The device status is RED ALARM. On this reason just after start **zaptel** is synchronized from **ztdummy** and **ztdynamic** is synchronized from **zaptel**.

After receiving synchronization, **ztdynamic** starts transmitting data to Asteroid. Then, on receiving addressed packets, Asteroid starts packets transmitting back to the server. The device status becomes OK. As a result, **zaptel** and **ztdynamic** are synchronized from **ztdummy** (or any other **SPAN**).

In the above example, Asteroid adjusts its internal clocks to **TDMoE** packets rate with the help of **PLL** technique. If the difference between internal clock and packet rate is too large, slip/skip errors will be incremented.

6.4 **zaptel/ztdynamic statistics**

The statistics of **zaptel** driver is shown in `/proc/zaptel/x` files, where `x` is the number of **SPAN**.

- (MASTER) means that **SPAN** is clock source for **zaptel**
- ClockSource means that **SPAN** is clock source for other channels in adapter

The statistics of **ztdynamic** driver is shown in `/proc/zaptel/ztdynamic_stats` file.

- **taskletrun**, **taskletsched**, **taskletexec** – are tasklet counters (software irq)
- **txerrors** – is a counter of missed tasklets. The increments of this counter indicate the high system load or glued Ethernet packets
- **slip** – is a repeated packets counter. The counter is incremented if the transmit **TDMoE** packets rate is higher than the receive **TDMoE** rate.
- **skip** – is a missed packets counter. The counter is incremented if the transmit **TDMoE** packets rate is lower than the receive **TDMoE** rate.
- **rxnuerr** – is a counter of the packets numeration errors. Each loss of Ethernet packet causes increment of this counter.

The values of these counters are not mandatory 0. The synchronization is not correctly configured only if these counters are incremented.

6.5 **Attaching bank to the Asterisk**

For attaching Asteroid to **Asterisk** via Ethernet port, it is necessary to do the following:

1. Connect Asteroid to **Asterisk** server (See 3. Bank installation). Be sure that Link Led is light up.
2. Configure Asteroid, save configuration (See 4. Device configuration).
3. Configure **zaptel** and **Asterisk**

Consider Asteroid configuration in detail. First, assign MAC address for the Asteroid. The address should be unique. Then set **TDMoE** mode (**Configuration/Common/TDM Over Ethernet** =

On), select synchronization mode (**Configuration/E1/Clock source** and **Configuration/Common/VCO**), choose types of installed modules (**Configuration/Slots/Slot N = FXS/FXO**) and codecs law (**Configuration/Coding law/Slot N = A-law / μ -law**). The law, selected in the Asteroid configuration must match zaptel configuration in **zaptel.conf** file.

Consider **zaptel** configuration. We should inform the **zaptel** driver about some parameters, for example, MAC address of Asteroid, number of channels (30 any case), priority (see 6.3 Zaptel synchronization).

The example of **Zaptel** configuration can be found in “Appendix B. Example of zaptel.conf file”. In this configuration it is supposed that Asteroid is directly attached to the eth1 interface. Asteroid has the address “00:55:55:55:55:00”, all ports use A-law, ports 8-15 – FXO with Loop Start signaling, ports 23-30 – FXS with Loop Start signaling, time zone is France. Also, Asteroid is slave device relative to **zaptel**. It means that for a given configuration, Asteroid should be configured with parameters Clock source=Internal, VCO=1 or 2.

After above steps **Zaptel** parameters can be passed to the driver with the help of **ztcfg** command. **zttool** utility can show the state of all devices. If **TDMoE** device is in RED ALARM status, it means that no packets were received from this device. A possible reason can be unmatched addresses in the **zaptel** and Asteroid configurations. The second possible reason is incorrect master/slave configuration in **Zaptel** (see 6.3 Zaptel synchronization).

To make sure of absence of lost packets, inspect Asteroid's monitor, reset statistics and refresh screen several times. The error counters should not increment.

Remind again about the FXO/FXS ports translation to the **TDMoE** channels. FXS/FXO ports (1-15, 17-31) correspond to **TDMoE** channels (1-15, 16-30). So, ports 0 and 16 are not available.

The data flow from **zaptel** to **Asterisk** is configured in zapata.conf file. It is a general rule in **Asterisk** to select the FXS/FXO signalization type as in peer side. For example, Asteroid's FXO port should have the fxs_ls type.

```
callerid="From PSTN"  
echocancel=yes  
;rxgain=3.0  
;txgain=6.0  
signalling=fxs_ls  
context=call_from_pstn  
channel=8-15
```

In the above example of Zapata.conf file **Asterisk** will process calls from channels 8-15 with FXS Loop Start configuration, with echo cancel off. The calls will be processed in the call_from_pstn context.

In the reverse direction settings are configured in the **extensions.conf** file. “Dial(Zap/2)” macros make call to the channel 2.

6.6 Attaching bank to PBX

With the help of E1 port, Asteroid can be connected to the PBX or **Asterisk**. In E1 stream Asteroid uses Loop Start signalization – a variation of **CAS** signalization family (Channel Associated Signaling).

Asteroid should be configured for E1 mode (see 4. Device configuration). Also, FXS/FXO modes should be configured, A/u law, master/slave and so on.

Then, PBX should be configured to support Loop Start. FXO/FXS modes should be selected for the corresponding ports.

6.7 Patches for zaptel

The download page (<http://www.parabel-labs.com/download/>) contains patched version of **zaptel**, recommended for smooth work with **TDMoE** devices. These patches are not mandatory, if you have installed only one **TDMoE** device. So, you can use standard **zaptel** package for one Asteroid device.

7. Updating firmware

To update firmware:

1. determine your device modification (the upper string of the monitor screen)
2. download the correspondent firmware and programmer software
3. attach console cable and reload the device, wait for 5 seconds
4. on the host PC use command **flashrs232 -i /dev/ttyS0 -w -f asteroid.bin** to upload the new firmware
5. check the firmware release. For example, in the heap of the monitor screen, the following string should be displayed: Firmware: Asteroid {0xB}, Revision: XXX
6. if the previous step is successful, the device is updated with a new firmware and is ready for work

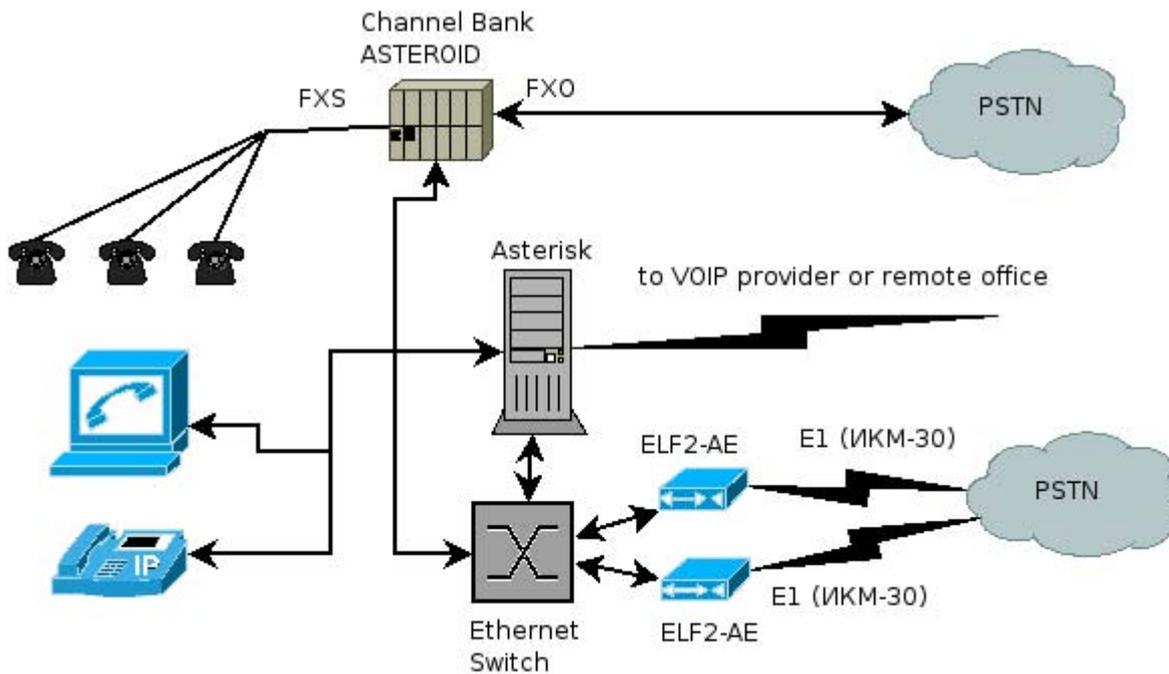
8. Asteroid delivery

The device is shipped with the following accessories:

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

Appendix A. Application schemes

Corporate PBX with VOIP connection



In this scheme the office can be connected to the IP telephony provider or corporate VOIP network. The advantages of VOIP can be exploited. The following dial plan can be supposed. Local consumers make international calls. Asterisk software analyzes these calls and forwards them to VOIP provider. Legacy calls are forwarded to PSTN network.

Appendix B. Example of zaptel.conf file

```
# Next come the dynamic span definitions, in the form:
# dynamic=<driver>,<address>,<numchans>,<timing>
#
# Where <driver> is the name of the driver (e.g. eth), <address> is the
# driver specific address (like a MAC for eth), <numchans> is the number
# of channels, and <timing> is a timing priority, like for a normal span.
# use "0" not to use this as a timing source, or prioritize them as
# primary, secondard, etc. Note that you MUST have a REAL zaptel device
# if you are not using external timing.
#
dynamic=eth,eth1/00:55:55:55:55:00/0,30,0
alaw=1-30

# FXS/FXO channels (1-15,17-31) are mapped to TDMoE channels (1-15,16-30)

#1
fxs1s=8-15
#3
```

fxols=23-30

loadzone=fr

defaultzone=fr

Appendix C. Asteroid + zaptel – steps to check

1. Attach Asteroid to PC server. See “3. Bank installation”.
The Link LED should light up.
2. Configure the device. See “4. Device configuration”
3. Prepare and load **zaptel** configuration (**ztcfg** with **zaptel.conf**)
4. Start **zttool** utility (**SPAN** should have OK status).
5. Refresh Asteroid screen (Space button) -
Counters SlipErr, SkipErr, RxNuErr, FrErr should not increment.

If **SPAN** has RED alarm status:

1. Check, that MAC address in the Asteroid match with **zaptel.conf**
2. Check Ethernet cable.

If **SPAN** has OK status, the following step is **Asterisk** configuration.