

LineRunner IS-3400 Family

Communication for telecontrol, telemetering und smart grids

The LineRunner IS-3400 family consists of a group of devices, which are designed as multilayer switches and multifunction devices especially adjusted to the characteristics of telecontrol communication. The devices are used in next generation energy networks, for remote meter reading, remote monitoring and control with regard to renewable energies as well as smart grids.

- Four Ethernet ports (IEEE 802.3) for LAN connection
- Up to two SDSL interfaces for data communication over 2-wire copper cable, reaching distances up to 25 km with transmission rates between 192 and 11400 kbps.
- Up to two pluggable optical transmission facilities for communication over fiber optics. Realization as SFP (Small Form-factor Pluggable) to enable easy mounting of different kinds of transceivers, reaching distances up to 180 km at 100 Mbps.



LineRunner IS-34x0 with plastic housing

Additionally the devices come with up to two serial interfaces for configuration purposes or alternatively for tunneling serial telecontrol protocols. In order to enable remote monitoring the devices support management tools like Syslog, SNMP, SSH, Telnet as well as an integrated webserver for easy device access, along with extensive self-monitoring functions, supervising for example the signal quality on copper and fiber optic cable. The devices' support to build redundant structures like rings and/or backup routes enables high network availability.

These qualities highlight the LineRunner IS-3400 family as ideal transmission technology for telecontrol communication using IEC 60870-5-104, IEC 61850 or IEC 60870-5-101. Existing copper lines used by voice frequency modems can become high performance IP networks without changing RTUs. Existing telecontrol systems can be kept in service using mixed mode operation, while new extended technology can be added gradually using the same connection cables (examples: mixed IEC 60870-5-104 and -101 networks, VoIP for remote stations).



LineRunner IS-34x1 with metal housing

Device	Ethernet interfaces	SDSL interfaces	Optical SFP equipment	RS232 interfaces
LR IS-3410/3411	4	1	-	1
LR IS-3420/3421	4	2	-	2
LR IS-3430/3431	4	1	(up to) 1	2
LR IS-3440/3441	4	-	(up to) 2	2

For fiber optic devices the following SFPs are available:

Fiber type	Up to 2 km	Up to 15 km	Up to 40 km	Up to 180 km
Multimode	available	-	-	-
Singlemode	-	available	available	on request

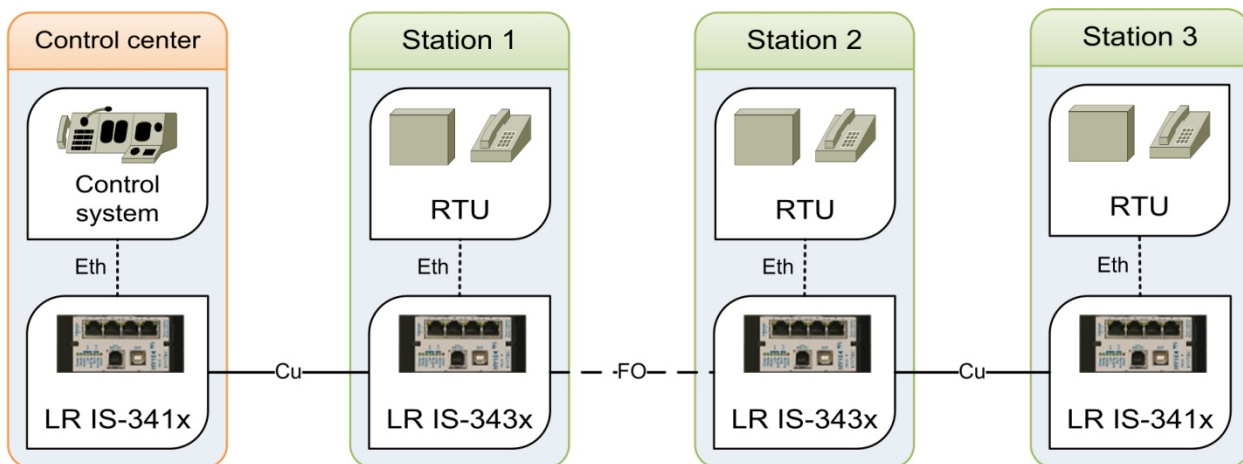
Features like the compact case without movable parts for easy installation on DIN rail, a wide area power supply (20...72V) with small power consumption, extended temperature range and integrated overvoltage protection complete the concept of the LineRunner IS-3400 family.

LineRunner IS-3400 – Network structures

Network structures

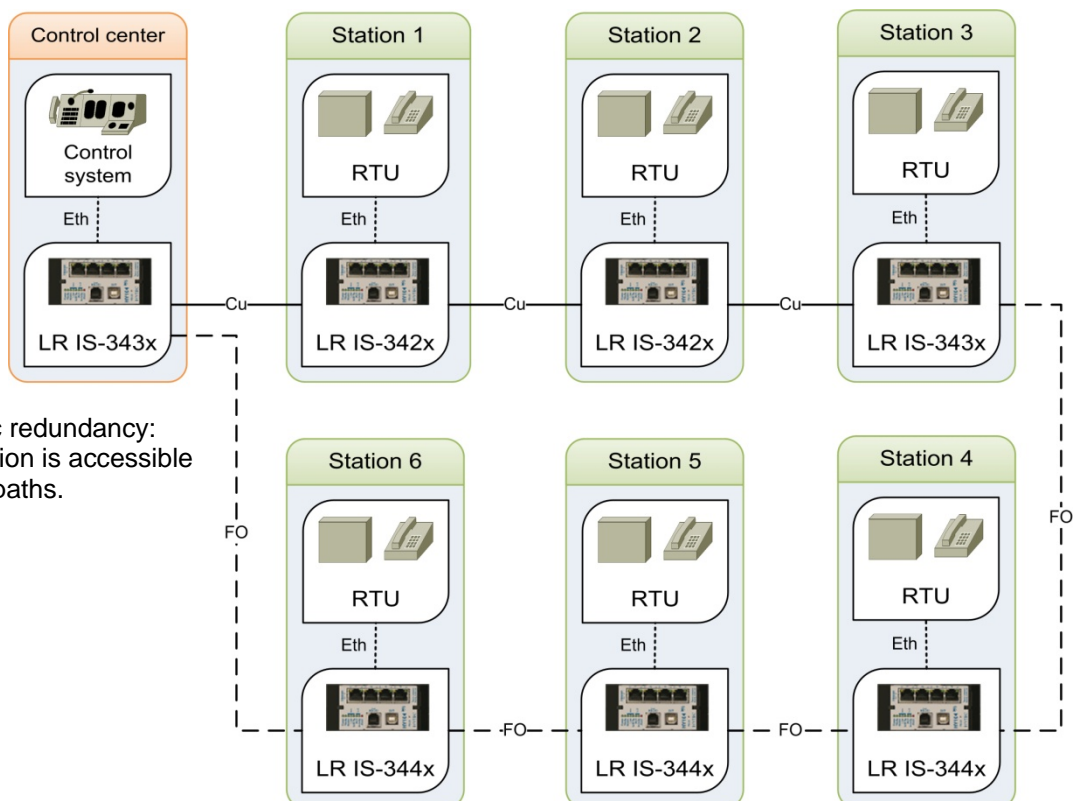
Numerous network structures like point-to-point connections, lines, rings, stars, branches and arbitrarily meshed networks can be realized with the devices of the LineRunner IS-3400 family. A small overview with exemplary interconnection shall be given in the following.

Example 1 – Line



- Multiple transmission media: SDSL transmission using copper wires (Cu), optical transmission using fiber optic cable (FO).
- All remote stations are coupled to the transmission line via Ethernet (Eth).

Example 2 – Ring

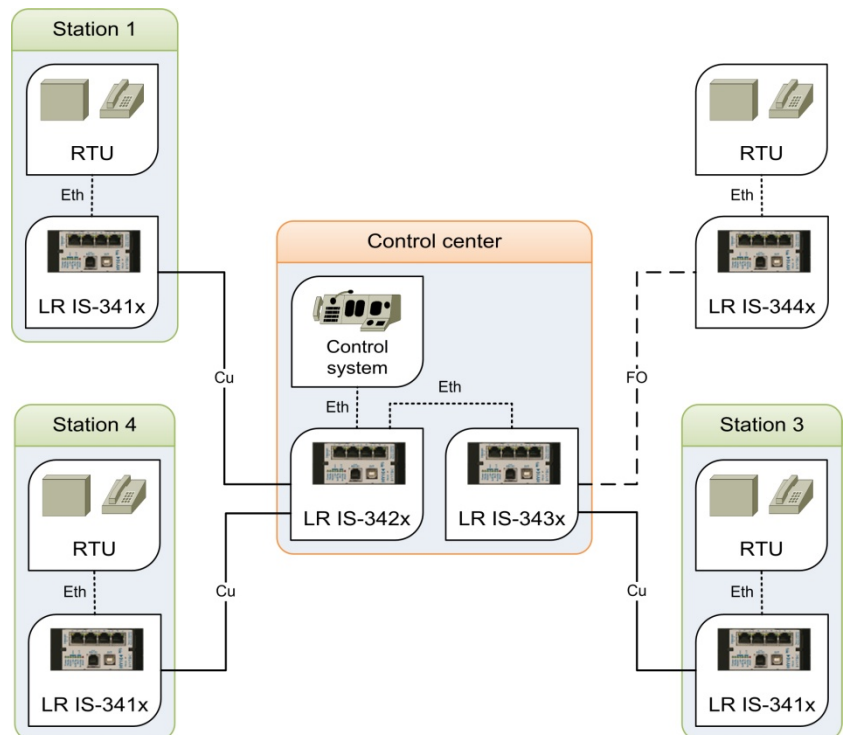


- Automatic redundancy: every station is accessible over two paths.

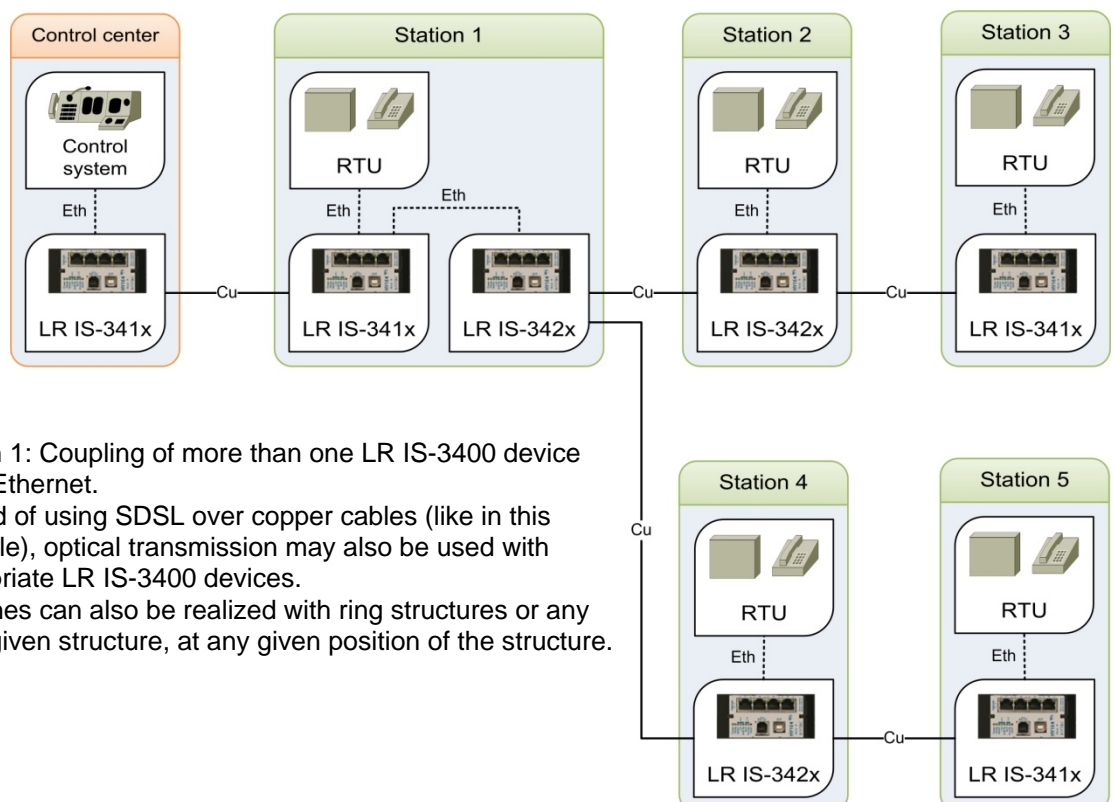
LineRunner IS-3400 – Network structures

Example 3 – Star

- Control center: Coupling more than one LR IS-3400 device using Ethernet.
- Station 2: The LR IS-344x device is equipped with only one optical SFP.



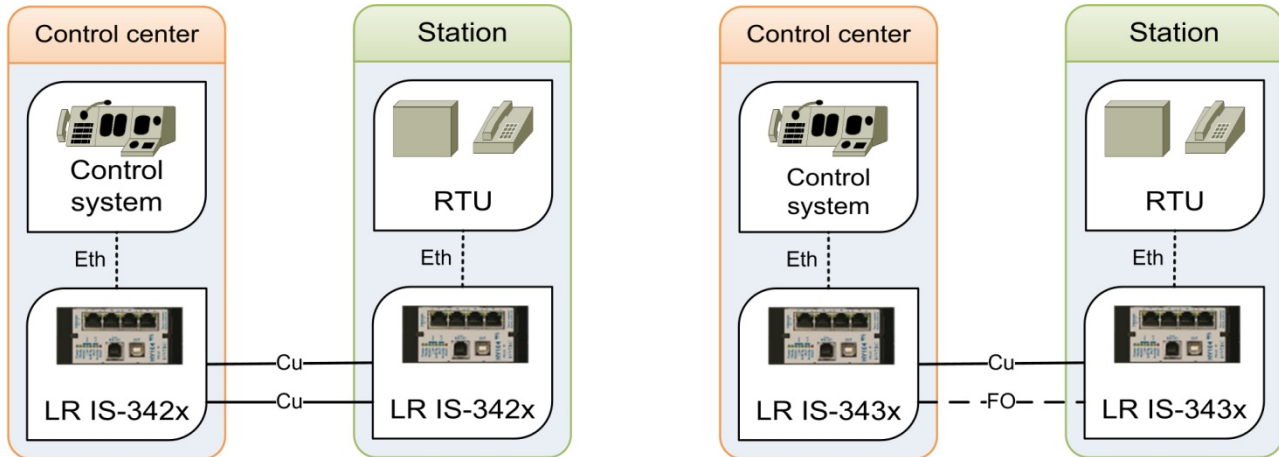
Example 4 – Line with branches



- Station 1: Coupling of more than one LR IS-3400 device using Ethernet.
- Instead of using SDSL over copper cables (like in this example), optical transmission may also be used with appropriate LR IS-3400 devices.
- Branches can also be realized with ring structures or any other given structure, at any given position of the structure.

LineRunner IS-3400 – Network structures

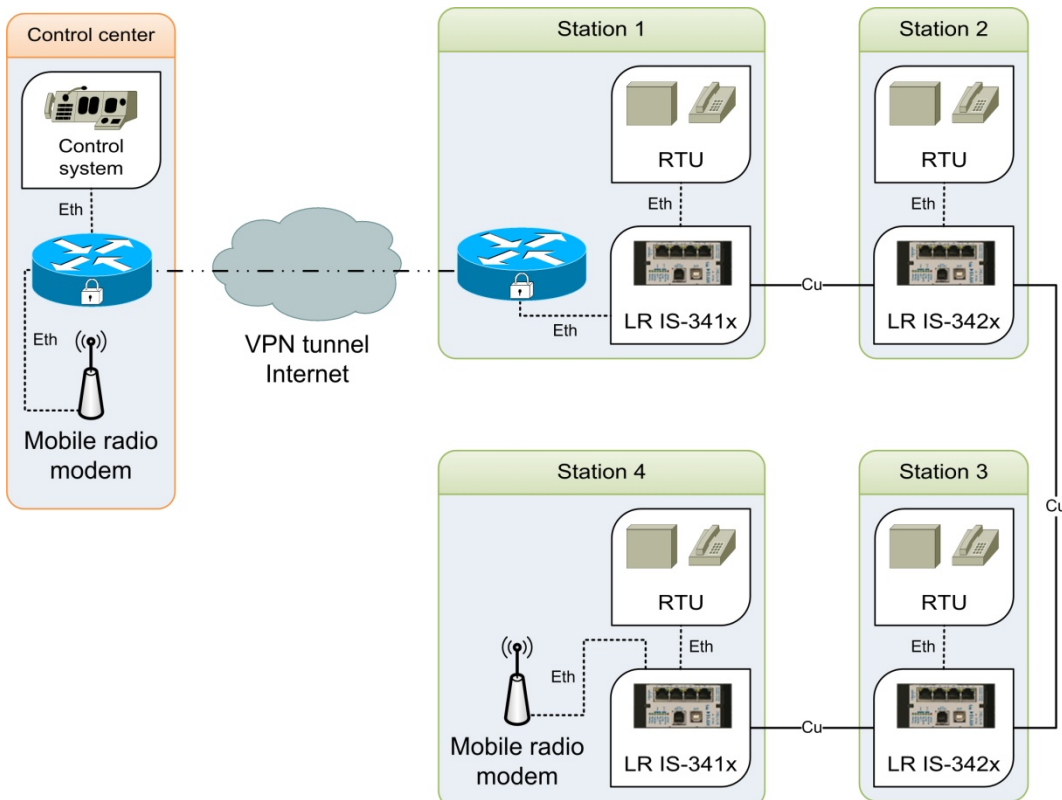
Example 5 – Redundant point-to-point connection



Connections between stations can be implemented as redundant links, using either SDSL over copper lines, or fiber optics transmission, or both. The LR IS-3400 devices will automatically use the best connection available, thus achieving a higher operating reliability (also see *Switching und Spanning Tree*).

Example 6 – Line with redundant uplink using mobile radio communication

The monitor functionality of the LR IS-3400 devices can be used to monitor the operational state of the network's uplink. Upon breakdown of the primary uplink (here: VPN tunnel through the Internet) the LR IS-341x device in station 4 activates the secondary uplink (dial-in connection using a mobile radio modem). By placing the uplink points on opposite ends of the line, failover is not only enabled when the VPN tunnel breaks down, but also whenever any connection between stations 1 to 4 breaks down.



LineRunner IS-3400 – Switch features

IEC 60870-5-101 and -104 / Transmitting legacy telecontrol protocols / mixed operation

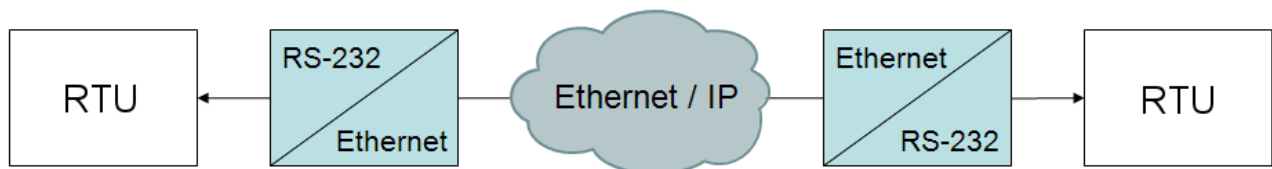
Through the support of the LineRunner IS-3400 devices for both TCP/IP-based protocols such as IEC 60870-5-104, as well as legacy RS-232-based serial protocols such as IEC 60870-5-101, it is possible to transmit these (and other) protocols in the same network at the same time. Using this mixed operation, existing telecontrol networks can be gradually modernized and extended, while retaining telecontrol devices in place and updating only the transmission devices to future-proof IP technology.

Numerous legacy serial protocols can be transferred using this technique, including amongst others IEC 60870-5-101, Modbus, RP570/571, SEAB-1F and many more. Also sub-rate multiplexed SRM64K data streams can be transmitted transparently over IP networks.

By using the serial tunneling, existing serial networks can be supplemented with the advantages of packet-oriented IP networks: failover to redundant links (rings, backup connections), surveillance and monitoring, as well as fast transmission via modern DSL or fiber optic connections. Multiple serial lines can be tunneled over a single IP connection.

The native support for IEC 60870-5-101 and -104 makes the devices particularly suitable for future-oriented, gradual extension of networks for the purpose of modernization: the integrated converter functionality between IEC 60870-5-101 and IEC 60870-5-104 enables the operation of a modern IEC 104 control center and the reorganization of the network to a packet-oriented IP transmission technology, while existing IEC-101 RTUs can be kept employed momentarily. The required transmission technology for a future exchange of these RTUs with modern IEC-104 devices is already in place then.

The IEC 60870-5-104 support of the LineRunner IS-3400 devices enables IEC 60870-5-104 control centers to include the communication network in the monitoring.



Serial protocols transmitted over the RS-232 interface can be transported over packet-oriented IP networks with the help of the LineRunner IS-3400 devices. The serial data stream is converted into individual packets and sent to one or more remote stations. There, the packets are reassembled into a serial data stream. To avoid data loss due to lost packets, an error-correcting protocol can be activated.

Monitor and Interface Dependencies

The LineRunner IS-3400 devices can monitor the presence of an IP address in the network. Alternatively an entry in the routing table can be observed. This functionality is called *monitor*. The *monitor* checks if a certain IP address is reachable with ICMP echo requests (ping). The query interval can be set between 100ms and 60s.

Using the interface dependencies function port states can be coupled to other port states or the *monitor* state respectively. Inverse coupling is also supported (link1-up-when-link2-up vs. link1-up-when-link2-down). Thus a breakdown of the primary connection can cause the establishment of a secondary (backup) connection, for example using a dial-up modem / mobile radio device.

LineRunner IS-3400 – Switch features

Switching and Spanning Tree Protocol

The primary application of the LineRunner IS-3400 devices is the role of a layer 2 switch. Since the devices are not limited to operating in the data link layer (layer 2 of the OSI model) but are also able to process data of the network layer (layer 3, routing), they are labeled as multilayer switches.

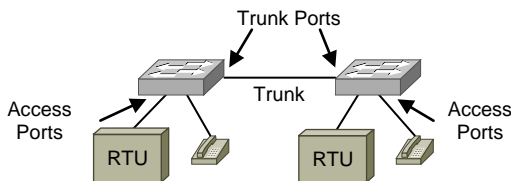
In the operation mode of a (layer 2) switch a device processes incoming Ethernet frames by forwarding them to certain ports, depending on the destination MAC address. During this process the MAC table of the device learns the source MAC address of the frame in conjunction with the port. Ethernet frames with known destination addresses are only forwarded to the respective port. Thus a network can be expanded self-learning. An automatic aging process in the MAC table will ensure that once learned network structures can also be changed again and removed.



To avoid illegitimate duplication of Ethernet frames that subsequently force the network into a deadlock situation (so-called broadcast storm), a loop-free topology without active alternative routes must be guaranteed. For this purpose the LineRunner IS-3400 devices support the Spanning Tree, Rapid Spanning Tree and Multiple Spanning Tree Protocol (IEEE 802.1D-2004 and IEEE 802.1Q-2011). These protocols are able to activate/deactivate redundant paths by creating one or more logical trees, such that every destination is only reachable over one route.

Virtual LAN (VLANs)

VLANs provide a way for a physical network to be divided into multiple logical subnets. By this means, without adding hardware, additional sub-segments can be created that are isolated from each other. The LineRunner IS-3400 devices support VLANs according to the standard IEEE 802.1q.



In the example pictured here, two networks are using the same infrastructure for connection, while being completely isolated from each other: RTUs and IP telephones cannot see each other. A distinction is made in access and trunk ports. Access ports form the outer edge of the VLAN infrastructure, while trunk ports are used to interconnect the VLAN-enabled network devices to each other.

IP Routing

The LineRunner IS-3400 devices support IP routing (layer 3 of the OSI model). For this purpose IP packets are forwarded to other routers according to the content of the devices' routing table. Thus the construction of routed networks based on the LineRunner IS-3400 family is possible, as well as networks with mixed operating modes.



For the automatic creation of routing tables and the mutual adjustment of these the LineRunner IS-3400 devices implements the Routing Information Protocol (RIPv2, RFC2453). Classless Inter-Domain Routing (CIDR) is supported. Upon topology changes usually switchover times of less than one second can be achieved with the extensions *triggered update* and *split horizon*.

Line Runner IS-3400 – Management

SNMP

The Simple Network Management Protocol is a network protocol for monitoring and controlling network devices remotely. It enables a Network Management Station (NMS) to query the runtime parameters of the network infrastructure and by means of this information signal a deviation from nominal conditions. The protocol is machine readable and transmitted encoded, other than for example the Syslog protocol, which sends messages in plain text. SNMP packets are typically transmitted over UDP/IP.

The devices of the LineRunner IS-3400 family implement SNMP versions SNMPv1 (RFC 1155, RFC 1156, RFC 1157) and SNMPv2c (RFC 1901, RFC 1905, RFC 1906).

The content and scope of the objects accessible via SNMP (OIDs) consist of different MIB modules (Management Information Base). These are standardized and include: MIB-2 (SNMPv2-MIB, RFC 3418), Bridge MIB (RFC 4188), Interface MIB (RFC 2863) IP MIB (RFC 4293), TCP MIB (RFC 4022), UDP (MIB RFC 4113) and LLDP-MIB (IEEE-802.1AB). Furthermore the LineRunner IS-3400 devices implement a vendor-specific MIB (MIB KEYMILE), whose objects enable a more advanced device management and provide detailed access to internal parameters. The KEYMILE MIB file is provided on request.

Syslog

Syslog is a network protocol to communicate log entries in an IP network. Transmission usually takes place over UDP/IP and consists of human-readable messages in plain text, tagged with a field regarding the origin and severity of the message, along with a timestamp.

The LineRunner IS-3400 devices provide a log directory on the device itself. If a SNTP server is configured (Simple Network Time Protocol) the timestamp contains a real date, otherwise the system uptime at occurrence is displayed. Additionally these log entries can be sent to a central Syslog server. The LineRunner IS-3400 devices provide a variety of Syslog messages, to allow an assessment of the operating condition.

Alarm System

The LineRunner IS-3400 devices are equipped with a three-step alarm model that distinguishes between the levels *Notice*, *Warning* and *Alarm*. In case of an alarm event a log entry is generated and a Syslog message is sent if applicable. In the critical level *Alarm* a relay is switched. Contrary to spontaneous events that don't change the operating state, alarms are triggered by critical events that also change the operating state during the time they persist. The level signals the severity of the restriction that the operating state suffers through the alarm condition. For some events the alarm level is adjustable by the administrator, others are predefined in the system.

- | | |
|---|---|
| • System overtemperature – <i>Alarm</i> | • Link state down – <i>Alarm</i> |
| • System boot – <i>Alarm</i> | • Link aggregation mismatch – <i>Alarm</i> |
| • SSH not ready – <i>Warning/Alarm</i> | • SFP is not inserted – <i>Notice</i> |
| • Link speed mismatch – <i>Warning</i> | • SHDSL encapsulation mismatch – <i>Alarm</i> |
| • Link duplex mismatch – <i>Warning</i> | • Ethernet remote fault – <i>Alarm</i> |
| • Signal quality low – <i>Warning/Alarm</i> | • Monitor is up – <i>Alarm</i> |
| • Link state up – <i>Alarm</i> | • Monitor is down – <i>Alarm</i> |

LineRunner IS-3400 – Management

SSH/Telnet Console

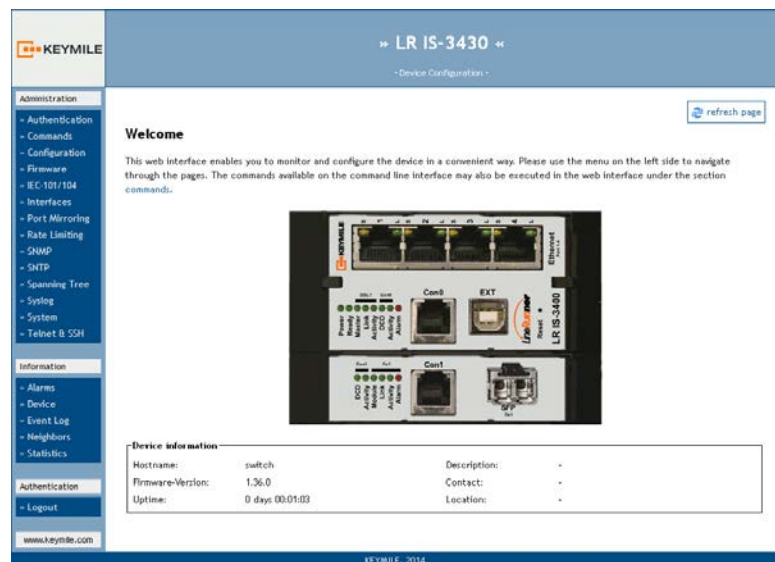
The devices of the LineRunner IS-3400 family provide a SSH and Telnet server, through which a command line interpreter is accessible. Telnet is a network protocol for accessing a console of a remote device, SSH additionally provides encryption. Both protocols are transmitted over TCP/IP.

The command interpreter of the LineRunner IS-3400 family converts user input into machine settings. Different access levels are available: the *Display* mode enables the user to show information about the system and to survey parameters. It is intended as read-only mode. The *Configuration* mode provides full access to the whole system and enables the user to change the configuration and alter all system details.

Webserver

As an alternative to the character-oriented access via the command line interpreter, the webserver of the LineRunner IS-3400 devices provides a comfortable user interface. Provided there is an IP connection, the device can be fully configured and monitored using any common web browser.

Additionally the web user interface includes a Java applet for Telnet access, providing a Telnet client within the web browser.



RADIUS

RADIUS (Remote Authentication Dial-In User Service) is a network protocol to authenticate login procedures. For this purpose a central RADIUS service is run for example in the control center. When a user performs a login on a RADIUS-enabled network device, the entered username and password will be sent to the RADIUS server that will advise the device whether the login procedure is legitimate. Only then access to the network device is granted.

The LineRunner IS-3400 devices offer RADIUS authentication support for services like Telnet, SSH and the webserver.

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