Application Note DK9222-0411-0038
I/O, Building Automation

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TwinCAT
Building Automation
KS2000
LON
Line coupler
SNVT
Transceiver

Integration of LON networks into a PC-based building automation system

This application example from the 'Building Automation Sub-bus Systems' series conveys the basic principles of LonWorks (LON for short) and the integration of LON devices into the PC-assisted building automation system via the Beckhoff KL6401 LON Bus Terminal. LON is a local sensor/actuator network in which the devices communicate directly with one another via network variables (SNVTs). The typical area of use of LON is the trade-spanning automation of functional buildings, in which the modular structure of LON allows flexible changes and conversions. Besides the KS2000 configuration software for the parameterization of the SNVTs, the LON user requires a LON tool in order to establish the 'binding' between the individual devices.

1. LON

LonWorks (Local Operating Network: LON for short) is a decentralized network for intelligent sensors, actuators and operating devices with a large field of application; its main use is in the automation of functional buildings. Through transmission media such as twisted pair wires, sensors and actuators can communicate with one another as desired from any point to any other point on the basis of network variables (SNVTs, **S**tandard **N**etwork **V**ariable **T**ype). Each LON device contains a microprocessor, the neuron, which controls the communication. Each neuron has a unique identification number, the neuron ID, which corresponds to the physical address and is set in the factory.

LON is typically used for trade-spanning networking within the building automation; a LON network consists of up to 32,000 intelligent network nodes. LON is an international standard on account of its widespread use worldwide. It is mainly used in the automation of functional buildings, since devices developed by different manufacturers from different systems and trades

can be integrated in one system. Further areas of application are industrial and process automation, supply and disposal, energy technology, traffic control, etc.

2. Master versions

LON is a typical multi-master system, in which each device on the bus can have event-controlled transmission. The neuron controls communication

3. Topologies

LON is a classic line bus, but it can follow any topology. Since it is possible to choose between star, ring, tree or classic line structures, this often gives rise in practice to free topologies that are oriented to existing structures in buildings or plants. The following are used for segmenting such free topologies:

- Repeater | for physical amplification with no processing function
- Router | for the connection of subnetworks
- Bridges | connection of domains

LON devices communicate via different transmission media; as a result, the range of a LON network depends directly on the transmission medium. If all guidelines are taken into account in the topology structure, a LON network can have a virtually unlimited size. With the classic TP wiring (twisted pair – two-wires twisted together) the maximum bus length is 1300 m.

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3.1 Network structure

A LonWorks network is divided into the domain, subnet and nodes. There may be a maximum of 255 subnets (subnetworks) in the domain – a subnet in turn may consist of a maximum of 127 nodes (LON nodes). Additionally, a domain may consist of a maximum 32385 LON nodes, i.e. LON devices. Several domains can be connected if necessary. In principle, however, only nodes within a domain can communicate directly with one another. Each node in a network has a unique logical address, which is divided into these three hierarchical levels: Domain ID, Subnet ID and Node ID.

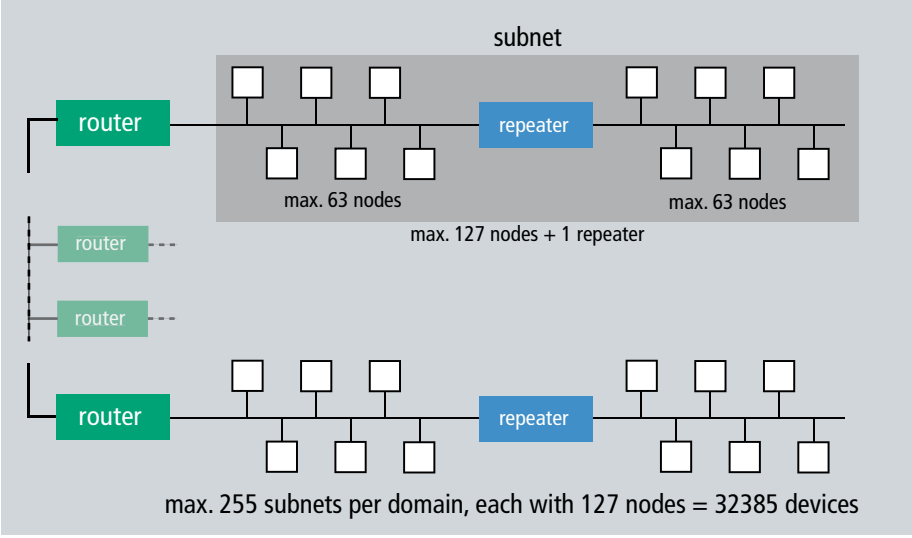

Fig. 1 Structure of LON networks

Components such as routers, bridges and repeaters are used for the construction of LON networks.

Repeaters are physical amplifiers with no processing function. They are used to achieve greater transmission distances and/or to extend the maximum permissible number of nodes of 64 nodes per 2-wire segment when using FTT-10-transceivers.

Routers are devices with several bus connections, which are used to interconnect several subnetworks. Telegrams received on one side are normally transmitted again on the other side by the router – and vice versa, of course. The router can also perform the function of a filter, a pathfinder or a post distributor.

4. Communication

LON nodes communicate directly with one another on the basis of the LonTalk® protocol, without going through a central control unit. Data exchange takes place by means of SNVTs: they form the logical interface between two nodes. SNVTs consist of three sections: unit, range of values and resolution, which must be configured identically in both nodes for unambiguous interpretation of the data.

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5. Power supply

Two types of power supplies are possible in the LON network structure: FTT and LPT.

Transmission type	Physical layer	Bit rates	Tranceiver	Max. Number of devices	Max. extent
TP/FT-10	Twisted Pair Free/Bus topology optional Linkpower	78 kbps	FTT-10 FFT10A LPT-10	64...128	500 m (free topology) 2200 m (bus topology)
TP/XF-1250	Twisted pair Bus topology	1.25 Mbps	TPT/XF-1250	64	125 m
PL-20	Power line	5.4 kbps	PLT-20 PLT-21 PLT-22	depending on the environment	depending on the environment
IP-10	LonWorks-over-IP	depending on IP network	depending on IP network	depending on IP network	depending on IP network

Table 1 Transmission types in LON

6. KL6401 LON Bus Terminal

The KL6401 LON Bus Terminal enables the direct connection of LON devices for the binding of LON networks to the PLC. It supports the transmission standard TP/FT-10 or can be used under FTT-10 and LPT-10 transceivers (TP – **T**wisted **P**air, FT – **F**ree **T**opology). Data exchange between the most diverse systems and a LON network is simplified, since the network variables of the connected devices are available to the Bus Coupler or the higher level bus system. The LON terminal thereby works independently of the bus system employed and the use of several KL6401 on one Bus Coupler or on one Bus Terminal Controller is possible. 62 SNVTs are supported per KL6401 LON Bus Terminal. All SNVT types are configurable as input or output variables using KS2000 software. The KS2000 software generates the required XIF file that is integrated in a LON tool.

Information on the use of the KL6401:

The KL6401 can only be used in conjunction with TwinCAT software and the TwinCAT library. No Bus Couplers from the BK series are supported if the KL6401 is used under a controller other than TwinCAT. The use of the KL6401 LON Terminal in combination with an Embedded PC from the CX series is possible only in conjunction with TwinCAT PLC. The TwinCAT PLC library LON is included (free of charge) in the TwinCAT installation package.

7. Software

The KL6401 terminal offers the possibility to configure a maximum of 62 SNVTs. These 62 SNVTs can be configured in any combination and as inputs and/or outputs as well. The SNVTs are configured using the KS2000 configuration software, which, apart from configuration, is also necessary for the operation of the KL6401 LON Bus Terminal. In addition, a LON tool (e.g. Echelon 'LonMaker') is needed in order to carry out the 'binding' of the corresponding SNVTs.

It should be noted when binding that, as a matter of principle, only SNVTs of the same type and with an identical parameterization can be connected to each other. For example, a temperature value will only be transmitted correctly from one node to another if the resolution and the unit of the temperature value are identically parameterized in both nodes. The complete configuration sequences are described in detail in the documentation for the KL6401 terminal.

7.1 KS2000

For the commissioning of a LON application, the KL6401 LON Terminal is parameterized accordingly using the KS2000 terminal configuration software. This is followed by the parameterization of the necessary SNVTs using KS2000 and loading to the terminal. After the activation of the project, the terminal must be switched off once in order to ensure that all data in the terminal's internal memory are deleted. After switching off, the XIF file for the LON tool can be exported. In addition, the parameterization carried out can also be saved as a BLC file (backup). The existing configuration can be easily duplicated; furthermore, a backup of the SNVTs is saved.

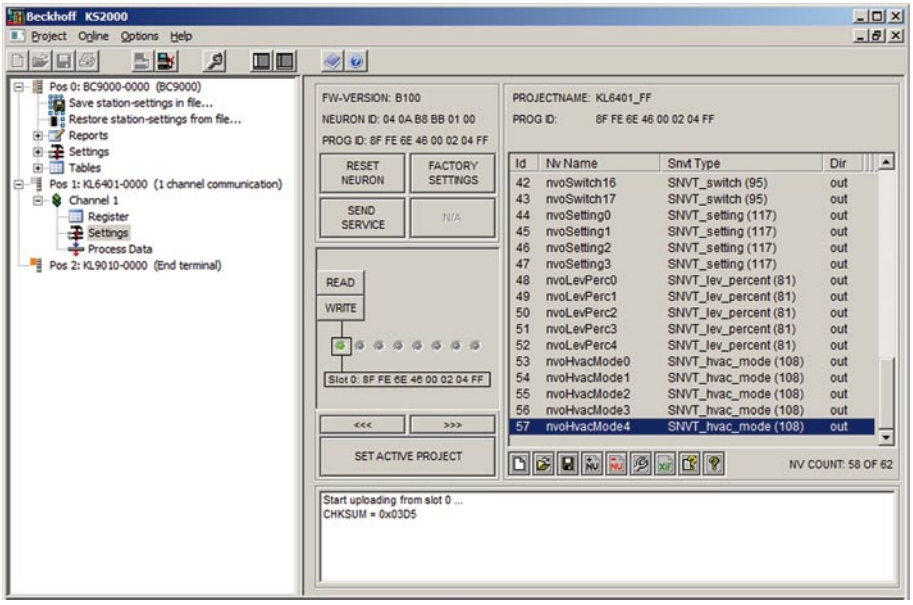

Fig. 2 View of the configuration dialog in the KS2000 terminal configuration software

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7.2 LON tool

A LON tool is required in order to create the binding (e.g. 'LonMaker integration tool' by Echelon). The LON tool serves the development, installation, operation and maintenance of open control networks from various manufacturers. Since the SNVTs are pre-specified function blocks, the binding is a kind of input/output assignment in which the user specifies which actuators are triggered by which sensors.

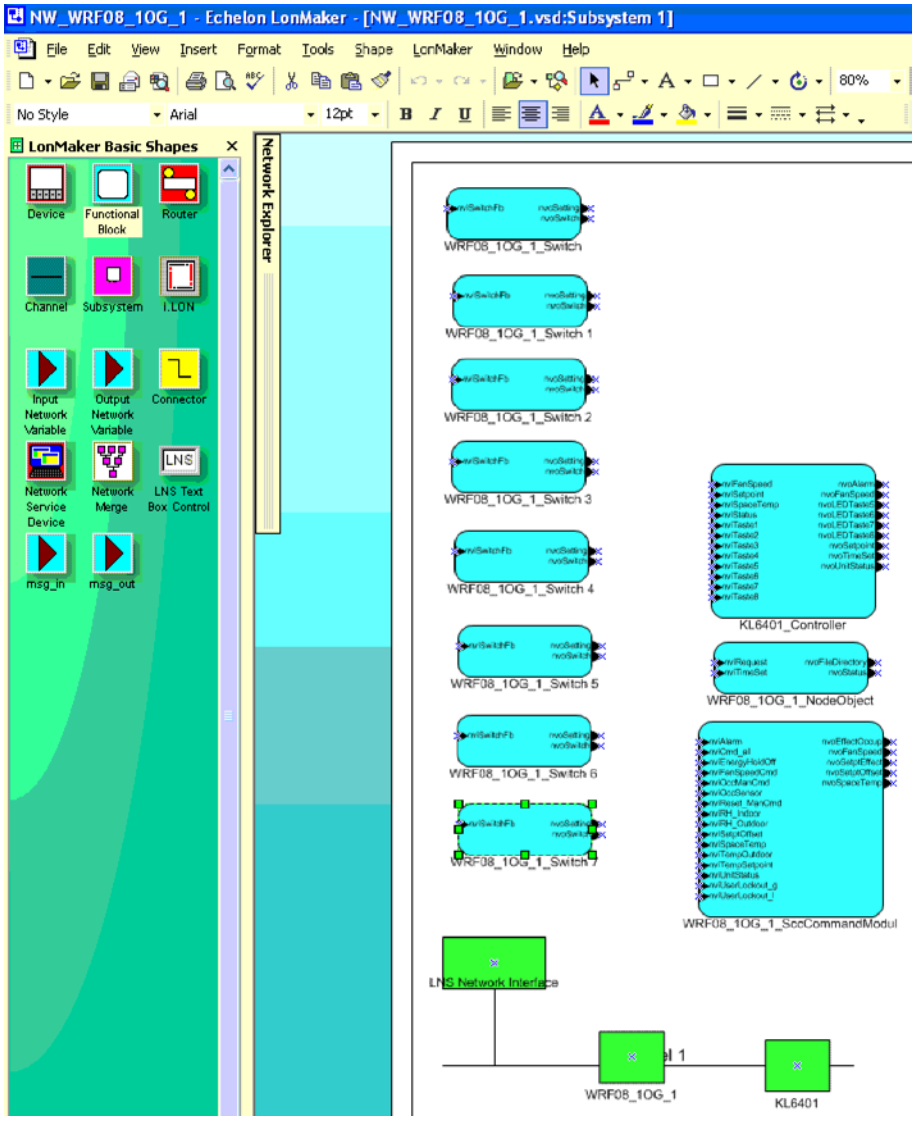

Fig. 3 View of the LonMaker® 'binding' tool by Echelon

7.3 TwinCAT

For integration in TwinCAT, the function block FB_LON_KL6401 is called once in the PLC cycle. The documentation contains further information.

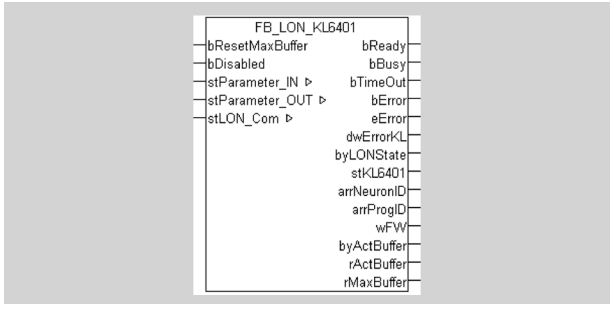

Fig. 4 Function block for LON communication in the KL6401 via TwinCAT

8. Practical example

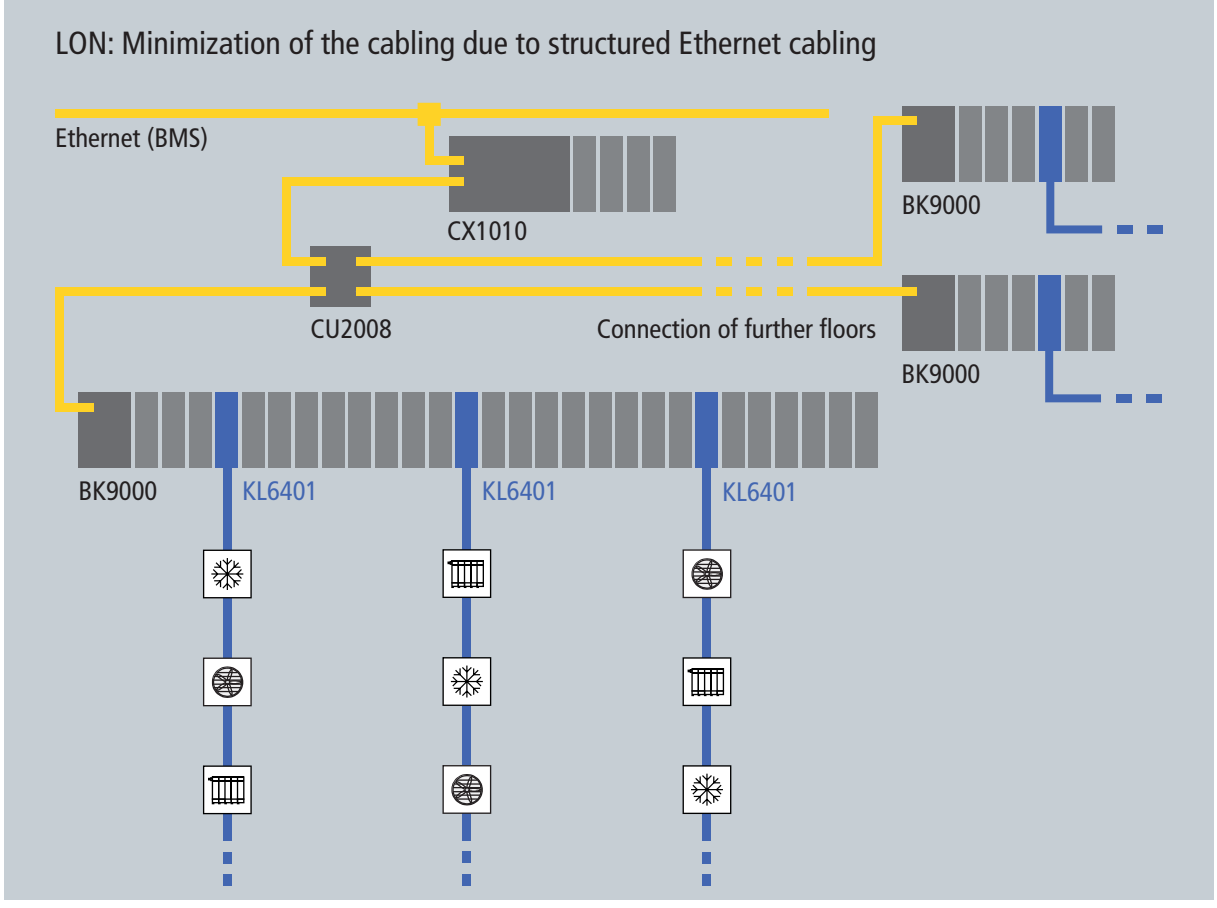

Fig. 5 Connection of LON peripheral devices for trade-spanning communication

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The use of LON enables efficient, trade-spanning and flexible automation solutions to be achieved, whose structure can be changed with little programming. A typical area of application for LON, among others, is the control of HVAC peripheral devices in offices and production facilities. Apart from low material costs, the use of Ethernet to connect the individual subnets within a domain allows longer ranges and enables the passing of error and status messages to the BMS via the fast Ethernet protocol.

– LON Bus Terminal **www.beckhoff.com/KL6401**
– TwinCAT PLC library LON **www.beckhoff.com/english/twincat/twincat_plc_lon.htm**
– Configuration software **www.beckhoff.com/KS2000**
– Beckhoff Building Automation **www.beckhoff.com/building**
– Web page of LonMark International **www.lonmark.org**