ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome IV (Year 2011). ISSN 2067-3809

Emil MATIJEVICS[1.]

KNX CONTROLLED LIGHTING OVER THE DALI NETWORK

ABSTRACT:
The KNX intelligent building system is primarily made for lighting control. With the GIRA HomeServer 3 there are more possibilities to make higher level, complex lighting control over the DALI. In this paper, the dimming sequences, the solutions and the background equipments are demonstrated. The operator screen is a web based touch screen.

KEYWORDS:
KNX intelligent building system, lighting control, DALI (Digital Addressable Lighting Interface)

INTRODUCTION TO THE DALI

DALI stands for Digital Addressable Lighting Interface. It is an International Standard (IEC 62386) lighting control system providing a single interface for all Electronic Control Gears (light sources) and Electronic Control Devices (lighting controllers)
The DALI Standard enables dimmable ballasts, transformers, relay modules, emergency fittings and controllers from different manufacturers to be mixed and matched into a single control system. A DALI system provides designers, installers, building owners, facility managers and end-users a powerful and flexible digital lighting system with security of supply from many sources.
The DALI Standard is overseen by the AG-DALI activity group comprising engineers, manufacturers and institutions working in the field of digital lamp/luminaire control. DALI is effectively an enhancement on DSI control with the added advantages it has interoperability, status feedback and advanced control.

THE DALI LINE

A DALI Line is a network of up to 64 DALI light sources (ballasts, transformers, emergency fittings etc.), addressed from 0 to 63. DALI ballasts are controlled by commands that can be sent to individual ballasts, to groups of ballasts or broadcast to all ballasts on the line.
DALI ballast is an intelligent device that can be configured to remember its power-on level, maximum level, minimum level, system failure level, fade rate and fade time. Ballast can belong to up to 16 groups and store up to 16 preset scene levels.
A true DALI lighting system can report the level of every ballast and the status of every ballast and lamp. It can automatically test emergency fittings and report their status. True DALI systems also enable controllers from multiple vendors to be used on the DALI Line.

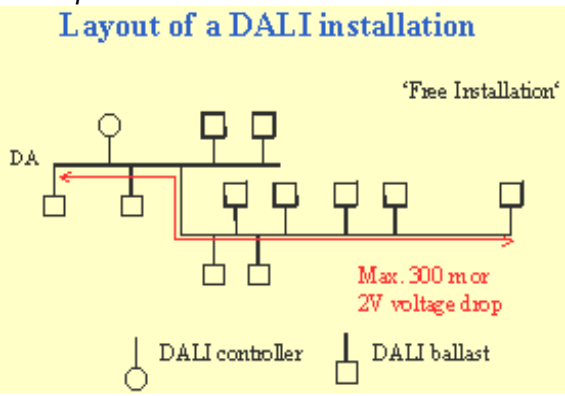

Figure 1. The DALI installation

A DALI Line consists of the following components:

- *One or more DALI Power Supplies to a maximum current of 250mA*
- *From one to sixty-four DALI ECGs ie. ballasts, transformers, inverters, relay modules, EXIT signs etc.*
- *One or more DALI ECDs ie. Line controller, group controller, sensor, switchplate etc.*

THE DALI SYSTEM

DALI Control lighting systems can be scaled from single rooms to complete buildings and campuses.
A simple system could consist of a few light fittings and a switch connected to a DALI group controller. The switch provides on/off control and up/down dimming of the fittings. Minimal configuration is required and ballasts do not need to be individually addressed.
A grouped system consists of multiple ballasts individually addressed on a DALI Line. Addressing of the ballasts takes approximately 15 minutes for random addressing and 30 minutes for sequential addressing. Inputs on a Line Controller or a group controller can be

configured to provide switching and dimming as required. The functionality of the inputs depend on the controller's capabilities however typical examples include switches, pushbuttons, occupancy sensors and light level sensors.

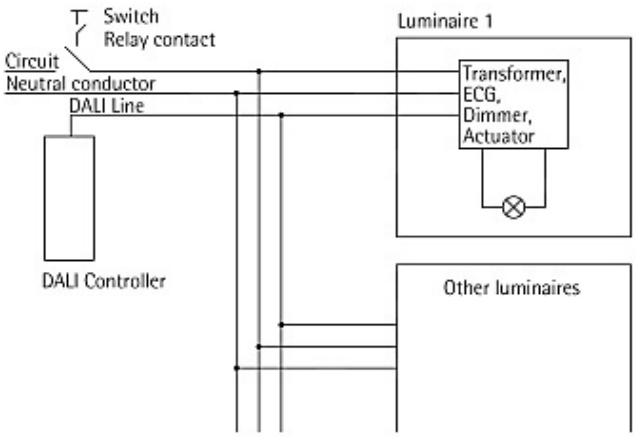

Figure 2. The DALI system

Multiple DALI Lines can be linked together with DCBM DALI Line Controllers that combine DALI Lines onto an Ethernet backbone.

ADVANTAGES OF DALI

- *For lighting designers and consultants*
- *Distributed intelligence for flexible and reliable control*
- *Control of individual lights, groups and DALI Lines*
- *Easy configuration & reconfiguration for changing circumstances*
- *Simple interface with building management systems*
- *Logarithmic dimming behavior matching the human eye*
- *Increased energy savings*
- *Options for emergency lighting*
- *For installers and electrical contractors*
- *Simple 5-core wiring, no special control cable, no polarity, no termination and no segregation required*
- *Easy base-building commissioning*
- *Easy commissioning for tenancies*
- *Building lighting and emergency lighting on the one system*
- *No need to switch the mains voltage (handled internally by the ballasts)*
- *For facilities managers & maintenance contractors*
- *Status reporting of lamps and ballasts*
- *Simple modification - no need to rewire for changing tenancies*
- *Lower maintenance costs*
- *Increased energy savings due to dimming and control capabilities*
- *For building occupants & tenants*
- *Customized lighting preferences*
- *More comfortable lighting*
- *Individual control*
- *Easy modification*

THE INSTABUS EIB KNX SYSTEM

At the end of the 1980s years five manufacturers developed the intelligent building system, called instabus. This system is based on bus communication, which bus system has equal participants. These participants usually are sensors and actuators. The sensors receives the events from outside world (for example: pressing a button, motion, raining, twilight etc.) and sends a telegram to a bus. The actuators receive telegrams from the sensors and perform the physically act of switching, dimming, valve moving etc. The bus topology is tree. All participants have their own, individual physical addresses, which identify the device. The telegram contains the physical address of the sender, the group address, routing counter, flags, parity, and the sending data. Those participants receive the telegrams, which contains that particular group address denoted in the telegram. Using the group addresses means that creating logical wires between the devices. At the beginning of the 1990s years several manufacturers joined to this building standard, and the name of the standard was changed to EIB (European Installation Bus), and has been developed the EIBA (EIB Association) in Brussels. At the end of the 1990s years, EIB became KNX, because three more building standards EHS and BatiBUS to joined the EIB. The programming, designing and installing the KNX system is made possible by ETS (Engineering Tool Software).

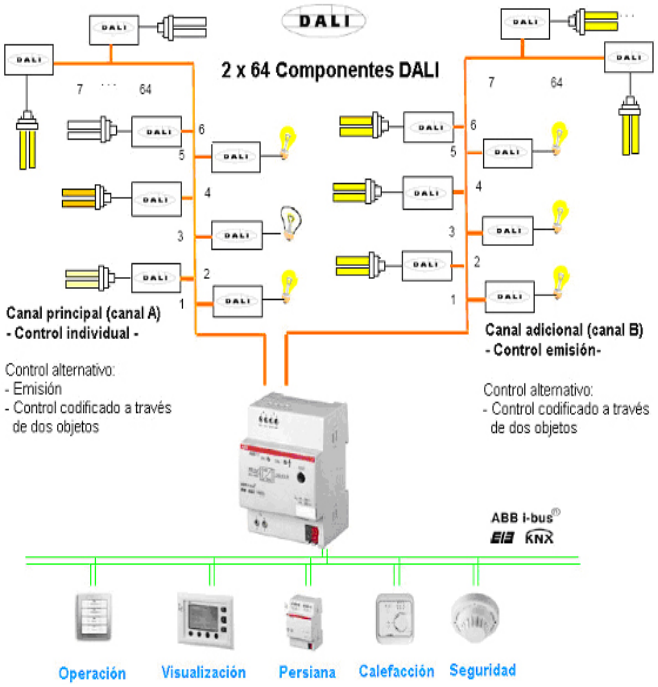

Figure 3.T he KNX and DALI network

THE GIRA HOMESERVER 3

The Gira company developed a server, which operates 24 hours in a day. This server is made to control the KNX systems on the high level. The HomeServer is a management over the KNX systems. It is possible to connect to the LAN, to the ISDN and to the KNX system. The connection of LAN or ISDN makes the chance to control a building from all over the world.

Web based visualizations, alarming, archives, SMS alarming, e-mail alarming, dial alarming are the main possibilities. Logical modules can program, scenes, sequences, timers etc.

USAGE THE LIGHTING CONTROL THROUGH A TOUCH SCREEN

The usage of the lighting control is possible through a touch screen, which is a screen of a simple personal computer, or it is an industrial PC. There are several colored buttons, which have to be pressed and pressing those causes state modifications in the KNX system and in the GIRA's HomeServer 3. Pressing the light bulb button, the HomeServer 3 dims the light by 100%, at a rate of 10% a second. (The speed of the dimming is 10%/second.) Then, the light's brightness is at the maximum.

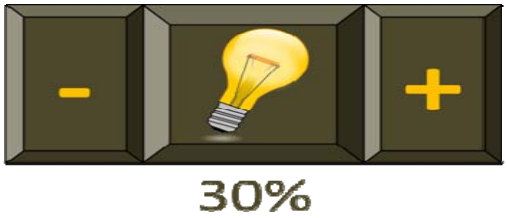

Figure 4. The light bulb button

Pressing the light bulb button again, the light is dimmed to 0%, at a rate of 10% a second. Pressing the plus button, the brightness of the light is raised to 10%. Each time the plus button is pressed the brightness is increased by 10%. If the minus button is pressed, it is decreases by 10%. When the last press of the plus button is followed by a press of the light bulb button, the HomeServer 3 gives a dimming command to the maximum, 100% brightness. If the last press was the minus button and then light bulb button, the dimming value is decreased to 0%. The dimming value is shown below the light bulb button.

CREATING THE KNX PROJECT IN THE ETS 3 FOR THE DIMMING

The first step to create the project in the ETS 3, is to find a sufficient KNX based DALI controller and a sufficient ECG. The sufficient ECG depends on the lamp's load capacity pretension and on the voltage. The choice is the SIEMENS DALI controller.

Figure 5. The Siemens DALI controller

In the ETS 3, the product's application data must be imported, and parameterized. In this project the used communication object is the "circuit set value" which is 1 Byte object. The dimmer gets the dimming value on the KNX bus, to this object, and controls the requested value. For example: if the dimmers communication object gets 50%, then the lamps brightness will be half of the maximum brightness. The communication object "circuit set value" has to be linked to a group address. In this case, the group address is: 0/0/1 and called: "DIMM1". This group address has to be exported to the specific file (lighting_control.esf), and the file has to be imported into the GIRA's HomeServer 3 Experte 2.3 software.

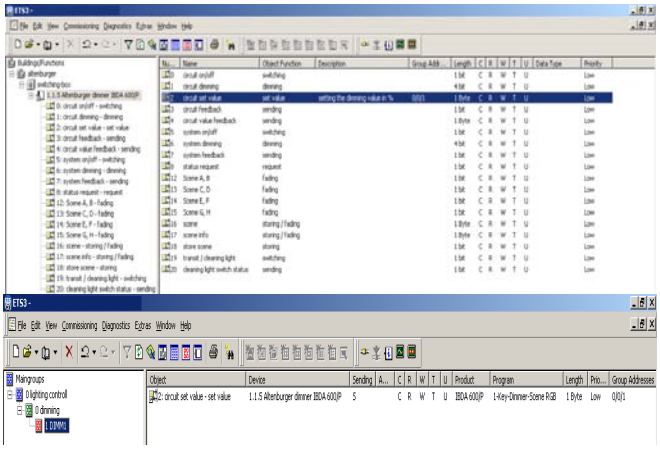

Figure 6. GIRA's HomeServer 3 Experte 2.3 software

PROGRAMMING THE LIGHTING CONTROL IN THE GIRA'S HOMESERVER 3 EXPERTE 2.3

After the importing the group addresses from the ETS 3 to Experte 2.3, it is necessary to create logical modules with logical gates are necessary. These logical modules make the control of the lighting, depending on the input group addresses. It is necessary to create internal group addresses, which are not part of the KNX system, only part of the HomeServer 3 program. When the icon light bulb is pressed, the internal group address "pressing_the_light_bulb_DIMM1"'s state is 1, which is the one input of the logical module. By the command "state_DIMM1" the Dimmi's state changes, depending on the previous state. If the "state_DIMM1"s (internal group address) previous state was 1, then after the changing become 0, and reverse. In the logical module, there is an AND gate (ID:940), which has 2 inputs. The one input is the "state_DIMM1", and the other input is the "pressing_the_light_bulb_DIMM1". After pressing the light bulb and if the "state_DIMM1" has changed to 1, on the AND gate's output it will be 1, because it gets 1 at (to) each input.

The AND gate's output is linked to the command, which is activated when it turns to 1. The command is the dimming down. The AND gate's output is 1 only when there is a change on the output. If the AND gate's output was 1 before, and based on the new inputs, the output should be 1 again, that will not be 1 again, only if it was 0 before. There is another AND gate (ID:941), which operates like the ID:940, it means that the inputs are the same, except that the "state_DIMM1" is

inverted. Therefore, if the "state_DIMM1" is 0, this AND gate's output is 1, and the command - which is linked to the output - is the dimming up. After this process (dimming up or down), the "pressing_the_light_bulb_DIMM1"'s state returns to 0. There is a binary trigger (ID:937) which detects the "pressing_the_light_bulb_DIMM1"'s 1 state and after a time delay the binary triggers output (which is 1) is sent to the command, which changes "pressing_the_light_bulb_DIMM1"'s state to 0. The time delays (ID:936 and ID:939) used in this module to avoid the hazardous operation, and to wait previous process to take effect, and arrive to the end. If the "DIMM1[0/0/1]" group address - which is part of the KNX system - becomes 100%, the state of "state_DIMM1" becomes 0. The logical gate "Equal To" (ID:952) compares the value of "DIMM1 [0/0/1]" and if the value becomes 100, the command is that the "state_DIMM1" becomes 0. If, the "DIMM1[0/0/1]" becomes 0, the "state_DIMM1" becomes 1. This operation, is because the "DIMM1 [0/0/1]"'s value reaches the 100% dimming level, and the light bulb is pressed after it, the dimming should go down. The output of the "Equal To" is 1 if the previous state was 0, and reverse.

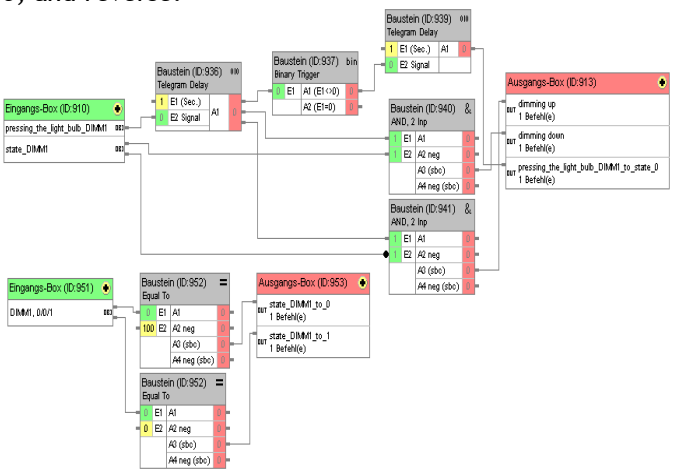

Figure 7. Logical modules with logical gates

If the plus symbol was pressed, the HomeServer 3 increases the dimming value by 10%. Then the commands are: add 10% value to the group address "DIMM1 [0/0/1]" and "state_DIMM1"'s state become 1. If the "state_DIMM1"'s state is 1, and the light bulb is pressed, the dimming up command is activated. If the minus symbol was pressed, the dimming value is decreases by 10%, and the "state_DIMM1"'s state become 0. After it, if the light bulb is pressed, the dimming down command is activated.

CREATING THE DIMMING SEQUENCE IN THE GIRA'S HOMESERVER 3 EXPERTE 2.3

In the logical module the main outputs are the "dimming up" and the "dimming down". These outputs are the parts of the HomeServer 3 Experte 2.3's sequence module. The "dimming up" sequence means, that the HomeServer sends brightness values to the dimmer's "brightness value" communication object in every seconds with higher value by 10% through the group address "DIMM1". In the sequence every 10 commands are "Schritt+" or "Schritt-" which means increase or decrease.

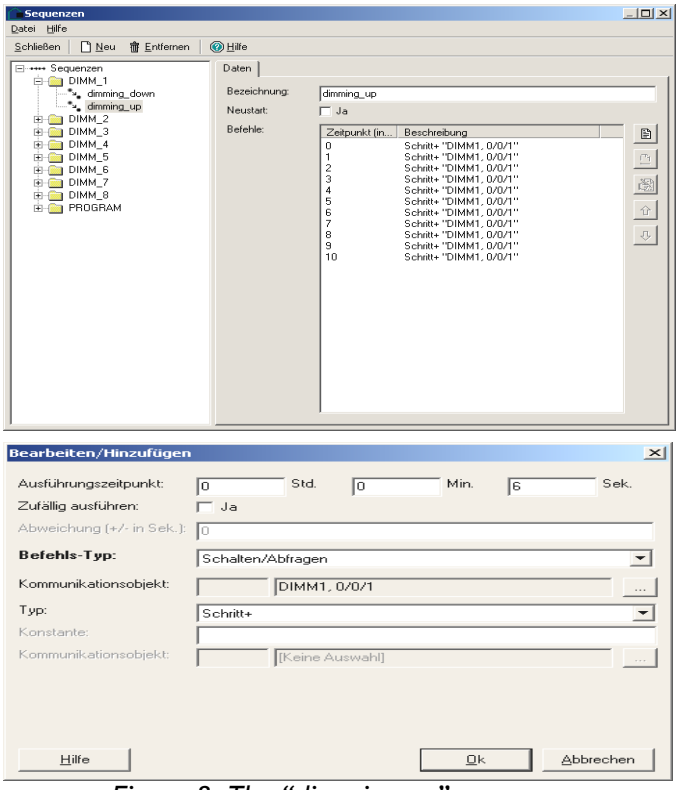

Figure 8. The "dimming up" sequence

The step size is set up in the group address's setup:

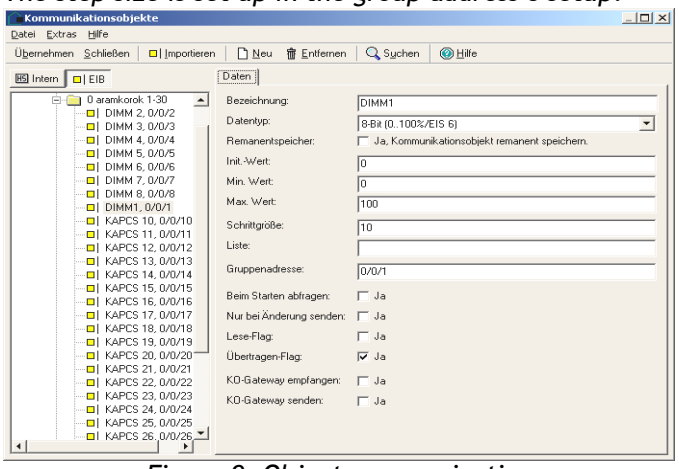

Figure 9. Object communication

Also set up the type of the group address which must be 8 bits, EIS 6 (the value range is 0% to 100%), the default value (Init.), minimum value (Min.) and maximum value (Max.).

DEVELOPING POSSIBILITIES

Using this lighting control it is possible to create more complicated lighting controls, lighting systems. Several lighting circuits can be managed: dimming, switching, organizing in groups etc. Where can such advanced lighting circuits are implemented?
Their application is wide-spread, including in large buildings, for example: theatres, cinemas, conference halls, show rooms, concert-halls, auditoriums, congress halls, hotels, restaurants, cafés, salons, and so on.

With the HomeServer 3 enables the user to control all lighting from within a particular location as well as from outside that location.
The HomeServer 3 allows a maximum of 200 users to be logged in, therefore the authorities can be separated to several sections. Each user can manage that part of the building which was assigned to them.
The HomeServer 3 has Ethernet port, it means that it can connect to the Internet. Users can log in through the Internet and to manage their job from any place, either from a personal computer or from a mobile phone it is all the same.
The HomeServer 3 offers alarm functions, which are very beneficial. The server can notify the user about anomalous behavior. The anomalous states can be bad illuminators (this function can be programmed, if the dimmer actuator or switching actuator offers the observation of the prefect consumption), forgotten lamps, low bus voltage, low electrical voltage, disabled UPS etc.
In the HomeServer 3, there are archives, in which users can register actions, measured values, reasons of alarms, and so on. A (big) significant amount of lighting scenes, lighting sequences, event-based lighting behaviors can program in this server and perform high level control over the KNX systems.

REFERENCES

[1] http://www.clipsal.com/dalicontrol/about_dali/what_is_dali
[2] Gira HomeServer 3 Comissioning manual, Giersiepen GmbH & CO. KG, Radevormwald
[3] Dr. Kovács Károly, Az instabus EIB épületüzemeltetési és felügyeleti rendszer, EIB felhasználói Club, Budapest, 1998
[4] Handbuch Gebäudesystemtechnik, ZVEI, Frankfurt AM, 1997
[5] Rainer Scherg, EIB planen und installieren, Vogel Buchverlag, Würzburg, 1995
[6] Balogh Zoltán, KNX beavatkozó elemek – aktorok, Villanyszerelők Lapja, Budapest, 2009
[7] KNX/EIB oktatási anyag, Siemens Hungary
[8] EIB: User's View, 1999
[9] M. Mevenkamp, M. Mayer: "Energy efficiency in educational buildings using KNX/EIB", KONNEX Scientific Conference, Pisa, 09/2005
[10] J-C Juang, H-C Wang, C-L Lu, W-M Chen, C-W Hsu, "A Touch-Dim Network for the Dimming Control of Lighting System", 2010 International Conference on Computational Aspects of Social Networks
[11] Yuan Ma; Wobschall, D.; "A Sensor Network for Buildings Based on the DALI Bus", Sensors Applications Symposium, 2007. SAS '07. IEEE
[12] S-C Wang; Y-H Liu; Y-L Chen; J-Y Che; "Development of DALI-based electronic ballast with energy saving control for ultraviolet lamps", Industrial Informatics (INDIN), 2010 8th IEEE International Conference on
[13] H Li; M Wu; Y Zhong; "Development and research of lighting system based on DALI", Industrial Electronics and Applications, 2008. ICIEA 2008. 3rd IEEE Conference
[14] E. Matijevics, "KNX based lighting control solutions with GIRA HomeServer 3", SISY'09, 2009. 7th International Symposium on, pp.263 - 266.
[15] Contenti, C.; "Digitally addressable DALI dimming ballast", Applied Power Electronics Conference and Exposition, 2002. APEC 2002. Seventeenth Annual IEEE
[16] Gyula Mester, "Distance Learning in Robotics", Proceedings of The Third International Conference on Informatics, Educational Technology and New Media in Education, pp. 249-245, Sombor, Serbia, 2006
[17] Gyula Mester: "Converting Traditional Courses to E-learning", Proceedings of the Informatika a Felsőoktatásban, pp. 1212-1216, Debrecen, Hungary, 2002

AUTHORS & AFFILIATION

Emil MATIJEVICS[1.]

[1.] UNIVERSITY OF SZEGED, HUNGARY

ACTA TECHNICA CORVINIENSIS
– BULLETIN of ENGINEERING
ISSN: 2067-3809 [CD-Rom, online]