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(54) **DALI Short Address Conflict Detection**

(57) Short Address conflicts are detected in a DALI system at a particular Short Address SA by using the Binary Random Number of each conflicting device at the Short Address to distinguish between the devices. This may be repeated for all Short Addresses occupied to find all Short Address conflicts in a DALI system.

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method of detecting Short Address conflicts in a DALI (Digital Addressable Lighting Interface) system.

BACKGROUND

[0002] The basic operation of DALI systems is outlined in the DALI standard IEC 62386-102 which provides amongst other things an algorithm for Device Discovery and Short Address allocation. Whilst this algorithm provides a means of dealing with Short Address conflicts it does not provide details on how to detect such conflicts.

[0003] A DALI bus provides a 64 device Short Address space and as with most bus systems, devices are required to have a unique Short Address for the system to operate properly. It is not uncommon for two devices on a DALI bus to inadvertently end up with the same Short Address. This can happen for instance, when a device with a first Short Address on a bus is replaced with a device configured with a second Short Address which is already in use by another device on the bus. This may happen when a faulty device on a bus is replaced or a new device added. The conflict may or may not be readily noticed.

[0004] When communicating with the conflicting Short Address a framing error may occur, in which case the problem is obvious and can be readily resolved. However, if the conflicting devices are in sync with each other communication over the DALI bus may continue without any errors, however the operation of the system will most likely be undesirable. DALI devices can easily be in sync with each other if they are manufactured with constant forward to back frame timing gaps instead of introducing a random jitter for each reply. Monitoring for framing errors is thus an unreliable method for detecting Short Address conflicts; also such a method is prone to false detection of Short Address conflicts when framing errors occur for some other reason.

[0005] Another method for detecting Short Address conflicts is to query devices in such a way as to elicit a unique response from each device. This could be done for instance by querying the serial number (using the READ MEMORY LOCATION command) or reading the random address of each device (using the QUERY RANDOM ADDRESS command). When devices at the same Short Address respond with differing data they will produce a framing error, even when perfectly synchronized with each other. However, this method also has limitations: it relies on the devices being unique (which is often not the case, as some manufacturers produce devices with identical serial numbers); some devices may detect the conflict themselves and back-off from replying thus avoiding a framing error and remain unseen; not all devices are fully DALI compliant and may not implement all

the commands used; and, the method is also susceptible to false positives when framing errors occur for some other reason. Also, this method will not work at all for multi-channel DALI devices as only one device of a multi-channel device may communicate with a DALI network at any particular time and therefore a framing error cannot be generated.

[0006] In place of detecting Short Address conflicts at specific Short Addresses, if a Short Address conflict is suspected, or to just make sure that there are no conflicts a DALI system could simply have the Device Discovery and Short Address allocation algorithm repeated. This however is undesirable as it may change the Short Addresses of devices not in conflict which may necessitate further configuration actions.

[0007] It is therefore an object of this invention to provide a method for reliably detecting Short Address conflicts on a DALI bus, or at least provides the public with a useful alternative.

SUMMARY

[0008] In a first aspect, a method is provided for detecting the presence of more than one device at a Short Address SA on a DALI bus, wherein the binary random number BRN of the devices is used to distinguish between the devices.

[0009] Preferred embodiments comprise the steps of: issuing an INITIALISE command with the Short Address SA so that only devices with the Short Address SA will respond; issuing SEARCHADDRH, SEARCHADDRM and SEARCHADDRRL commands to set the DALI search address to its maximum; issuing a first COMPARE command to find if any devices are present, and if present, then; repeatedly reducing the DALI search address and issuing COMPARE commands to find the device with the lowest BRN; issuing a WITHDRAW command to remove the device with the lowest BRN from consideration; setting the DALI search address to its maximum value; issuing a further COMPARE command to detect whether any further devices are present, the presence of the further devices being determined by observing a response to the further COMPARE command.

[0010] A RANDOMISE command may be issued after the INITIALISE command so that the devices each choose a new binary random number, BRN.

[0011] Preferably a TERMINATE command is issued before the INITIALISE command to cancel any previous INITIALISE commands.

[0012] The steps of: repeatedly reducing the DALI search address and issuing COMPARE commands to find the device with the lowest BRN; issuing a WITHDRAW command; setting the DALI search address to its maximum; and issuing a further COMPARE command, may be repeated to detect the presence of all further devices.

[0013] In a further aspect, a method is provided for detecting all Short Address conflicts on a DALI bus, com-

prising repeating for each Short Address SA occupied on the DALI bus: issuing an INITIALISE command with the Short Address SA so that only devices with the Short Address SA will respond; setting the DALI search address to its maximum value; issuing a first COMPARE command to find if any devices are present and if present, then; repeatedly reducing the DALI search address and issuing COMPARE commands to find the device with the lowest BRN; issuing a WITHDRAW command to remove the device with the lowest BRN from consideration; setting the DALI search address to its maximum value; issuing a further COMPARE command to detect whether any further devices are present, the presence of the further devices being determined by observing a response to the further COMPARE command.

[0014] Each Short Address SA occupied can be determined by sending a QUERY CONTROL GEAR SA command in turn for each DALI Short Address in the DALI Short Address space and reckoning that a Short Address is occupied if a DALI Yes is received or a framing error occurs.

[0015] In a further aspect, a method is provided for detecting all Short Address conflicts on a DALI bus, comprising repeating for each Short Address SA occupied with no conflict detected on the DALI bus: issuing an INITIALISE command with the Short Address SA so that only devices with the Short Address SA will respond; setting the DALI search address to its maximum value; issuing a first COMPARE command to find if any devices are present and if present, then; repeatedly reducing the DALI search address and issuing COMPARE commands to find the device with the lowest BRN; issuing a WITHDRAW command to remove the device with the lowest BRN from consideration; setting the DALI search address to its maximum value; issuing a further COMPARE command to detect whether any further devices are present, the presence of the further devices being determined by observing a response to the further COMPARE command.

[0016] Each Short Address SA occupied with no conflict detected may be determined by sending a QUERY CONTROL GEAR SA command in turn for each DALI Short Address in the DALI Short Address space and reckoning that a Short Address is occupied with no conflict detected if a DALI Yes is received.

[0017] It should be noted that any one of the aspects mentioned above may include any of the features of any of the other aspects mentioned above and may include any of the features of any of the embodiments described below as appropriate.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0018] The following detailed description of a preferred embodiment of the invention incorporates various DALI commands, the names of which have been capitalized for ready distinction.

[0019] The invention provides a reliable method for determining when two devices on a DALI bus have the same Short Address, SA. The binary random number BRN of devices in conflict is used to distinguish between them. By detecting conflicts at a specific Short Address, the devices at that Short Address alone can have Short Addresses reassigned to remove the conflict, thus avoiding the need to totally reconfigure a system.

[0020] The method of the invention relies on the use of a minimal subset of the available DALI commands. The commands used are those normally used for device discovery and Short Address assignment and as such would be available in all DALI compliant devices and even devices that are barely DALI compatible.

[0021] The RANDOMISE command is used to make a device pick a Binary Random Number, or BRN, which is a 24 bit number. Three "Search Address" commands, SEARCHADDRH, SEARCHADDRM and SEARCHADDRL allow a 24 bit DALI Search Address to be set. The presence of a device with a BRN less than the DALI Search Address can be ascertained by a COMPARE command to which all devices with a BRN less than or equal to the DALI Search Address will respond.

[0022] To determine if there is a conflict for a specific Short Address, SA, the method of the invention first issues an INITIALISE command with the Short Address SA so that only devices with the Short Address SA will respond. The DALI search address is then set to its maximum and a first COMPARE command is issued to see if any devices are present. If any devices are present the DALI search address is repeatedly reduced and COMPARE commands issued to find the device with the lowest binary random number, BRN. This device is then removed by a WITHDRAW command. To find if another device is present the DALI search address is set to its maximum again and a further COMPARE command issued. If there is a response to the further COMPARE command or a framing error is detected it is concluded that a second device is present. Further devices can be detected by repeating the last few steps above. Optionally a RANDOMISE command is issued after the INITIALISE so that the devices each choose a new BRN. This step may be needed as non-compliant devices may not have a truly random BRN.

[0023] A thorough implementation of the method that is performed by a control device (usually software running on a hardware platform) on a DALI bus is as follows:

For each DALI Short Address SA (range 0 to 63):

1. Send Command 256 TERMINATE.
2. Send Command 258 INITIALISE to SA.
3. Send Command 259 RANDOMISE; all control gear with DALI Short Address SA will choose a binary random number (BRN) so that $0 \leq \text{BRN} \leq +2^{24}-1$.
4. Send Commands 264 SEARCHADDRH, 265 SEARCHADDRM, 266 SEARCHADDL with value

0xFF to set the DALI search address to its maximum.

5. Send Command 260 COMPARE:

If DALI No is received, go back to Step 1 with next SA.

6. The control device searches the control gear with the lowest BRN by means of an algorithm which uses commands 264 SEARCHADDRH, 265 SEARCHADDM, 266 SEARCHADDL and 260 COMPARE. The control gear with the lowest BRN is found. Any search algorithm may be used, with a binary search being preferred.

7. The found control gear is retracted from the search process by sending command 261 WITHDRAW.

8. Send Commands 264 SEARCHADDRH, 265 SEARCHADDM, 266 SEARCHADDL with value 0xFF to set the DALI search address to its maximum.

9. Send Command 260 COMPARE:

a. If DALI No is received, go back to Step 1 with next SA, else

b. A DALI Short Address conflict has been found. There are at least two DALI Devices with DALI Short Address SA. If the number of conflicting DALI Devices at this SA is required, repeat steps 4-6, adding one to the conflict count at this SA for each DALI Device found.

10. Go back to Step 1 with next SA.

11. When completed, send command 256 TERMINATE.

[0024] The above method is applied over the entire DALI Short Address space. Alternatively just Short Addresses that are known to be occupied, or just a specific Short Address where a Short Address conflict is suspected may be tested.

[0025] Just the occupied DALI Short Addresses can be determined as follows: For each DALI Short Address SA in the DALI Short Address space (0 to 63):

1. Send command 145 QUERY CONTROL GEAR SA

2. If a DALI Yes is received or a framing error is detected note the SA as being occupied.

[0026] The algorithm as described previously can then be performed using only the Short Addresses that have been noted.

[0027] A further optimization can be achieved if it is not necessary to find the number of devices in conflict at each Short Address. The test algorithm can be limited to those Short Addresses for which a DALI Yes was received, but no conflict detected.

[0028] It is possible that the method will miss a conflict if two devices have the same BRN, however the probability of this happening is very unlikely, being 1 in 2^{24} . If this probability is deemed too high it can be reduced to 1 in 2^{48} by simply repeating the method. The method will inherently produce no false positives.

[0029] The method will work with all DALI Compliant and DALI Compatible/Controllable devices as the commands used are the minimum subset of commands that a device must support in order to obtain a DALI Short Address.

[0030] As the method does not rely on framing errors it will work for multi-channel DALI devices where a single DALI connection is shared by multiple devices, each with their own Short Address.

[0031] The reader will now appreciate the invention which provides a reliable method of detecting Short Address conflicts in a DALI system by using the BRN of devices in conflict to distinguish between them. Further advantages and improvements may very well be made to the present invention without deviating from its scope. Although the invention has been shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope and spirit of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices and apparatus. Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of the common general knowledge in this field.

[0032] In the present specification and claims (if any), the word "comprising" and its derivatives including "comprises" and "comprise" include each of the stated integers but does not exclude the inclusion of one or more further integers.

Claims

1. A method of detecting the presence of more than one device at a Short Address SA on a DALI bus, wherein the binary random number BRN of the devices is used to distinguish between the devices.

2. A method as in claim 1, comprising the steps of:

- issuing an INITIALISE command with the Short Address SA so that only devices with the Short Address SA will respond;
- issuing SEARCHADDRH, SEARCHADDRM and SEARCHADDL commands to set the DALI search address to its maximum;
- issuing a first COMPARE command to find if any devices are present and if present, then;
- repeatedly reducing the DALI search address and issuing COMPARE commands to find the

- device with the lowest BRN;
 - issuing a WITHDRAW command to remove the device with the lowest BRN from consideration;
 - setting the DALI search address to its maximum value;
 - issuing a further COMPARE command to detect whether any further devices are present, the presence of the further devices being determined by observing a response to the further COMPARE command.
3. A method as in claim 2, wherein a RANDOMISE command is issued after the INITIALISE command so that the devices each choose a new binary random number, BRN.
4. A method as in claim 2 or claim 3 wherein a TERMINATE command is issued before the INITIALISE command to cancel any previous INITIALISE commands.
5. A method as in any of claims 2 to 4 wherein the steps of:
- repeatedly reducing the DALI search address and issuing COMPARE commands to find the device with the lowest BRN;
 - issuing a WITHDRAW command;
 - setting the DALI search address to its maximum; and
 - issuing a further COMPARE command, are repeated to detect the presence of all further devices.
6. A method of detecting all Short Address conflicts on a DALI bus, comprising repeating the method of any one of claims 2 to 5 for each Short Address SA occupied on the DALI bus.
7. A method as in claim 6, wherein each Short Address SA occupied is determined by sending a QUERY CONTROL GEAR SA command in turn for each DALI Short Address in the DALI Short Address space and reckoning that a Short Address is occupied if a
8. A method of detecting all Short Address conflicts on a DALI bus, comprising repeating the method of any one of claims 2 to 5 for each Short Address SA occupied with no conflict detected on the DALI bus.
9. A method as in claim 8, wherein each Short Address SA occupied with no conflict detected is determined by sending a QUERY CONTROL GEAR SA command in turn for each DALI Short Address in the DALI Short Address space and reckoning that a Short Address is occupied with no conflict detected if a DALI

Yes is received.