

5 Efficient line driver device for dataflow control

The present invention relates to a line driver device which makes it possible, for example in a system arrangement for actuating execution units, for a first
10 or second communication path to be selected for onward dataflow, with low technical outlay. Moreover, the proposed line driver device is particularly error-tolerant, and is suitable among other things for use in an automobile.

The present invention further relates to a corresponding system arrangement and to a method for operating or producing the line driver device. Moreover,
15 a computer program product is proposed, comprising control commands which carry out the proposed method or produce or operate the line driver device.

WO 2017/162 323 A1 discloses an efficient control arrangement and a control
20 method in which sequentially arranged execution units are actuated by means of a command unit.

WO 2018/103 880 A1 discloses a compact LED arrangement, which can be used generically but, as a result of the compact construction, is advantageous
25 in particular for use in a vehicle.

WO 2017/153 026 A1 discloses a method for brightness compensation in at least one LED.

30 In conventional methods, a plurality of options are known for addressing control units connected in series. Generic approaches exist, which may be

disadvantageous in specific application scenarios, as well as highly specialised approaches, which are no longer usable generically. For example, the CAN bus is known, which was developed in relation to cable harnesses and is intended to implement networking of control devices in particular.

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In general, the complexity of the CAN protocol is much greater than for ISELED (registered trade mark) and thus more expensive. However, the greatest drawback of CAN and LIN is that because of the bus architecture they do not offer a natural (automatic) addressing option. In these cases, the address has to be configured. For ISELED (execution units), and also for segmented ISELED (line driver unit and execution units), there is a physically predetermined string, resulting in one option for assigning addresses automatically.

15 From the prior art, system arrangements are known which serve to operate a plurality of execution units. This means that the corresponding execution units have to be addressed by means of control commands or data have to be read out from these execution units. In daisy-chaining, execution units are connected in series and addressed by means of individual command units. If the actual command unit fails, rather than just an execution unit failing, this can result in more far-reaching malfunctions occurring.

Moreover, it is a problem that in general the error susceptibility is increased as a result of a plurality of command units being connected in series. There is thus merely one serial communication path in each case between the individual command units, on the one hand, and between a plurality of execution units, on the other hand. This results in the dataflow to the further command units being cut off. Thus, the whole of the rest of the system comes to a standstill.

Further, in the application scenario in an automobile, there is the problem that installed components have to be fail-safe, but at the same time only low technical outlay can be provided, which has to lead to a reduction in costs. It is thus necessary to find a balance between failure safety and technical complexity. However, this is disadvantageous in the prior art, since the customer will not accept reductions in failure safety, and manufacturers do not show any inclination towards expensive circuitry. As a result, there is a need for cost-efficient components which are still fail-safe.

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Thus, an object of the present invention is to propose a line driver unit which works efficiently and is also error-tolerant. A line driver device should in particular be fail-safe, or not bring about any further ramifications in the event of a failure. Further, an object of the present invention is to propose a system arrangement in which the line driver device is advantageously used. Moreover, a method which provides or operates the line driver device is to be proposed. It is also an object of the present invention to provide a computer program product comprising control commands which produce or operate the line driver device and carry out the proposed method.

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The object is achieved by the features of the independent claims. Further advantageous embodiments are specified in the dependent claims.

Accordingly, a line driver device for efficient and error-tolerant dataflow control in an automobile is proposed, comprising a first interface unit, set up for communication with a command unit or a further line driver device, a second interface unit, set up for communication with a further line driver device, and a third interface unit, set up for communication with a plurality of execution units, a first communication path being arranged between the

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first interface unit and the second interface unit, and a second communication path being arranged between the first interface unit, the second interface unit and the third interface unit, a transistor being arranged on the first communication path, and the dataflow being divertable via the first communication path or the second communication path by means of a transistor actuation.

A line driver device may for example be a device which is provided in a system arrangement and thus communicates with further line driver devices. In general, communication with further components is advantageous, the line driver device being the component which communicates for example with a plurality of execution units. An execution unit is a component which implements commands which originate directly or indirectly from the line driver device. Thus, an execution device or execution unit may be in the form of an LED unit which actuates LEDs. LEDs typically take the form of red, green or blue LEDs, it also optionally being possible to provide a white LED.

The line driver device thus communicates with a plurality of execution units, and may itself be set up to receive commands from a further unit, for example a command unit. Thus, a command unit may take the form of a microcontroller, and the line driver device may also take the form of a microcontroller or in general simply of a unit which has means for dataflow control and additionally for command processing.

Typically, the line driver device is connected in series, and a plurality of line driver devices of this type are coupled in series along a data line. As a result, there are typically a plurality of line driver devices which are connected to a control unit. A first line driver device connected in series is coupled to the command unit directly, and the further line driver devices are coupled to the

command unit indirectly. In the prior art, there is the problem that, in series coupling, if one line driver device fails then all further line driver devices in the series fail. Thus, in the prior art, failure or an inactive state of one line driver device means that a plurality of further components fail. This is overcome according to the invention in that the proposed line driver device has a communication path or data path which simply connects signals through in an inactive state.

As a result, even if a single line driver device fails, the further line driver devices connected in series are not excluded from the dataflow, but rather, if a line driver is in an inactive state, an incoming signal is outputted again at the output without any processing. This is described hereinafter as passing through or connecting through.

Thus, overall, the proposed line driver device is error-tolerant, and this takes effect in particular in interplay with further line driver devices. The line driver device can already be described as a system arrangement in and of itself, and so the terminology for the line driver device can also be changed so that it is already referred to as a system arrangement in and of itself. The proposed line driver device is in general based on structural features which are merely installed in the line driver device itself. As regards external components, the line driver device has the capacity for communication, and so the proposed line driver is not described with reference to external features. Rather, the line driver device is suitable for embedding in a system arrangement which also has further components.

Moreover, the line driver device is also efficient, since the dataflow control is implemented using simple technical means. In one aspect of the present invention, merely a first communication path, a further communication path, a

transistor are required for dataflow control. The data lines or communication paths may be individual conducting paths or simple electrical connections. As a result, the proposed line driver device is to be arranged on a single circuit board or packed into a housing in a single piece.

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For communication with further devices, the line driver device has at least three interface units. Thus, the first interface unit acts as an interface for communication with a further line driver device. This interface is also suitable for communication with a command unit. The command unit is an instance which is superordinate to the line driver device and which provides commands to the line driver device. The command unit can thus act as a master unit for the line driver device, which then acts as a slave unit or client unit.

15 The second interface unit may be designed analogously to the first interface unit, and is at least suitable for communication with a further line driver unit or line driver device. Thus, for example, the first interface unit is designated as an input of the line driver device and the second interface as an output. However, the line driver device may also be coupled bidirectionally to further devices, for example the command device or a further line driver device, and this means that bidirectional communication is also made possible, and as a result the second interface unit is present as an input and the first interface unit as an output. As a result, the two interface units may take on the role of an output or of an input, depending on the directions of communication.

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The third interface unit serves for communication with execution units, which may for example be coupled in series. Thus, the third communication interface or interface unit serves for communication with further external

components, the line driver device behaving as a master unit in relation to these further components. The components coupled by means of the third interface units may be designated as execution units, which receive and execute commands. Moreover, it is possible for the interface unit to be set up to receive return values from these execution units.

A first communication path is arranged between the first interface unit and the second interface unit. This communication path connects the two interfaces, and serves to convey signals. Further components, such as a transistor unit may be arranged on this communication path, which is implemented for example as a data line. As a result, the communication path need not progress continuously from the first interface unit to the second interface unit, but can convey data from the first interface unit to the second interface unit indirectly, it also being possible for intermediate components to be installed.

A second communication path is arranged between the first interface unit, the second interface unit and the third interface unit, and may likewise connect the interface units directly or indirectly. Typically, it is advantageous to configure the communication path in such a way that it connects the first interface unit to the third interface unit and then connects the third interface unit to the second interface unit. As a result, the second communication path is configured analogously to the first communication path, but with the third interface unit also being arranged on the second communication path. The second communication path may also comprise further components, such as receiver modules or transmitter modules.

The second data line or second communication path coupling the first interface unit to the third interface unit and the third interface unit to the second interface unit in terms of communication is merely one aspect of the present

invention. Thus, the arrangement between the interface units may also be based on structurally selecting a different construction for the progression of the logical communication between the proposed interface units.

5 Moreover, a processing unit, which processes the incoming signals and then outputs them again, may be arranged on the second communication path. In this context, a person skilled in the art will recognise that for the technical implementation further components can be installed.

10 The first communication path has a transistor.

The transistor serves to set the communication path, it being possible in general to select between the first and the second communication path. If a current is present at the line driver device, data signals are received, and this is
15 followed by processing of the corresponding signals in the internal logic unit and subsequent transmission of the processed signals. This corresponds to the second communication path. By contrast, if there is no voltage, signals are passed through in analogue, and this corresponds to the first communication path.

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A fault scenario, namely the situation where the line driver device is defective or has been deactivated, is also treated in this way. In this case, the transistor is closed (self-conducting transistor) and there is a conductive through-path. Thus, in an active state of the line driver device, the incoming signals
25 are processed and then outputted again. In a deactivated state, signals are merely passed through passively. In this context, passing through actively via the second communication path involves data processing, and this corresponds to the active state of the line driver device. For the further components, the line driver device is not visible when no voltage is present. As a

result, the line driver device switches to be passive if it fails, and still passively passes signals through, without thus impairing further components. No voltage is present at the line driver device if it is not being operated or is broken, and thus signals are passively passed through.

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In a further aspect of the present invention, the third interface unit is set up for communication with execution units connectable in series. This has the advantage that the interface unit communicates with various execution units, and in each case this need not occur directly. Rather, it is possible for the plurality of execution units to be connected in series, and thus the line driver device preferably communicates with a single execution unit directly via the third interface unit and with the further connected execution units indirectly. In general, the third interface unit can convey commands to the further execution units and receive return values.

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In a further aspect of the present invention the transistor control can be carried out by means of an applied electrical voltage or an electrical current. This has the advantage that the transistor control acts as a circuit and can select the first or second communication path. This creates a technically simple but efficient structure for selecting the communication path.

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In general, it is possible for the first communication path and the second communication path not to be implemented separately from one another, but rather the communication paths may overlap in part. It is thus possible to provide merely one communication line in structural terms, the transistor position setting whether the first logical path or the second logical path is selected.

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In a further aspect of the present invention, a logic unit is connected upstream from the third interface unit. This has the advantage that incoming communication signals or commands can be passed through the logic unit using the second communication path and can thus be processed. A logic
5 unit which processes signals is thus present on the second communication path. Thus, the processed signals can either be outputted to the execution units using the third interface unit or else applied to the output, in other words the second interface unit.

10 In a further aspect of the present invention, the logic unit controls the second interface unit and/or the third interface unit. This has the advantage that the corresponding commands or processed signals can be applied to either one or two further units. It is thus possible for the logic unit to output a command which is conveyed to the plurality of execution units.

15 According to a further aspect of the present invention, the switch is in the form of a field effect transistor. This has the advantage that an existing module can be used in a new context and the circuit can be implemented particularly easily. In addition, an advantageous alternative to known switches is
20 proposed.

According to a further aspect of the present invention, the transistor is in the form of a normally on field effect transistor. This has the advantage that an arrangement is proposed which comprises only a small number of components and is therefore efficient and error-resistant.
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According to a further aspect of the present invention, when the line driver device is in an inactive state, the first communication path is set in such a way that signals which are present at the first interface unit are to be output

without processing at the second interface unit. This has the advantage that if a line driver device fails, the line driver device is deactivated without interrupting the further flow of communication.

- 5 In a further aspect of the present invention, the first communication path takes the form of a passive communication path. This has the advantage that if the line driver device is deactivated the communication path merely passes the signals through passively, and thus a defective line driver device has no effect on further components. In particular, the deactivated or defective line
10 driver device does not impair the further flow of communication, but rather the signal is passed through via the passive communication path.

- In a further aspect of the present invention, the second communication path takes the form of an active communication path. This has the advantage that
15 in a normal scenario, in other words when the line driver device is operated, the communication path is set to be active, and then the second communication path is used to process the signals. A logic unit may preferably be provided for this purpose.

- 20 In a further aspect of the present invention, the line driver device is formed in a single piece. This has the advantage that the line driver device can be installed in a system arrangement particularly easily and for example can be arranged on an individual circuit board or can be installed in an individual housing. Thus, the line driver device can be provided individually and sub-
25 sequently installed in further processing steps.

The object is also achieved by a system arrangement comprising a line driver device as described above.

The object is also achieved by a method for efficient and error-tolerant data-flow control in an automobile, comprising providing a first interface unit set up for communication with a command unit or a further line driver unit, providing a second interface unit set up for communication with a further
5 line driver device, providing a third interface unit set up for communication with a plurality of execution units, a first communication path being arranged between the first interface unit and the second interface unit, and a second communication path being arranged between the first interface unit, the second interface unit and the third interface unit, a transistor being ar-
10 ranged on the first communication path, and the dataflow being divertable via the first communication path or the second communication path by means of a transistor actuation.

In this context, a person skilled in the art will recognise that the individual
15 method steps may be carried out iteratively and/or in a different order. In particular, individual method steps may have sub-steps.

The object is also achieved by a computer program product comprising control commands which operate the proposed method or operate or produce
20 the proposed line driver device.

According to the invention, it is particularly advantageous that the method provides method steps which can also be functionally imitated by the structural features of the line driver device. The line driver device and system ar-
25 rangement provide structural features suitable for carrying out the method.

Further advantageous configurations are described in greater detail with reference to the accompanying drawings, in which:

Fig. 1 shows a schematic arrangement, comprising a command unit and a plurality of execution units connected in series, in accordance with the prior art;

5 Fig. 2 is a block diagram including a line driver device for efficient, error-tolerant dataflow control, in accordance with an aspect of the present invention; and

10 Fig. 3 is a schematic flow chart of a method for efficient, error-tolerant dataflow control in accordance with a further aspect of the present invention.

The left side of Fig. 1 shows a microcontroller which acts for example as a command unit. Moreover, a plurality of execution units, in this case implemented as LED controllers, are arranged with bidirectional communication. This is indicated by reference sign MLED CTRL. For some application scenarios, the prior art has the drawback that, if a controller fails, all further controllers connected in series also fail, since communication is suppressed.

20 Fig. 1 shows a possible configuration of a system or communication arrangement according to the prior art. Thus, in this case, the command unit BE, which is connected to three control units, can be seen on the left side. Since the three control units are connected in series, the command unit is directly connected to a control unit and indirectly connected to the further control units. The control units may be multi-LED controllers. This is denoted in 25 Fig. 1 as MLED CTRL. The unitary reference sign is intended to illustrate in particular that the control units are typically configured identically. As can be seen here, the LEDs are RGB (red, green, blue) LEDs. These are set up to set a particular colour value by means of a mixing ratio of the individual

LED units. Further, it can be seen in this drawing that further components are to be provided as required. For example, it may be necessary to provide a power supply. In this context, it is also possible, however, to provide these components, for example the power supply, externally and merely to connect
5 them.

The data line is in this case in the form of a plurality of data line segments, which are indicated as bidirectional arrows SIO1, SIO2. Control units may also be referred to as execution units.

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Fig. 2 shows the line driver device LTV according to the invention. As is shown therein, three interface units are provided, specifically the first interface unit A, the second interface unit B and the third interface unit C. In addition, a logic unit LE is connected upstream from the third interface unit C.

15 The third interface unit C is set up to communicate with a plurality of further execution units AE. Moreover, there may be further components to be installed, such as a receiver Rx and a transmitter Tx. Here, R stands for receiver and T stands for transmitter.

20 The first communication path is illustrated by means of a dashed line, and connects the first interface unit A to the second interface unit B. This takes place indirectly, wherein the transistor is arranged in between. The second data line is illustrated using the dotted line, and extends between the first interface unit A, the second interface unit B via the third interface unit C. The
25 logic unit LE, which is also located on the second data line, is connected upstream from the third interface unit.

The first data line, being the dashed data line, and the second data line, being the dotted data line, may be configured in such a way that at least the first

sub-portion is implemented jointly. Both the first communication path and the second communication path are then coupled into this data line. Physically, a single line system may be present as a whole, the transistor setting whether the first logical communication path or the second logical communication path is selected. Thus, either the corresponding signals flow horizontally from the first interface unit A via the transistor to the second interface unit B, or alternatively the second data line may be selected, in which case it progresses via the third interface unit C.

10 Either further line driver devices LTV may be arranged on the left and/or right, and can thus communicate by means of the interface units A or B, or else it is also possible for a plurality of execution units AE connected in series to be provided at the top of Fig. 2. The system arrangement proposed according to the invention may thus comprise not just one line driver device LTV,
15 but a plurality thereof connected in series as well as a plurality of execution units AE likewise connected in series. In addition, a command unit may be provided, which communicates with the line driver device LTV, for example by means of the interface A. A command unit of this type may be implemented as a microcontroller.

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Fig. 3 is a schematic flow chart of the proposed method for efficient, error-tolerant dataflow control in an automobile, comprising providing 100 a first interface unit A set up for communication with a command unit BE or a further line driver unit LTV, providing 101 a second interface unit B set up for
25 communication with a further line driver device LTV, providing 102 a third interface unit C set up for communication with a plurality of execution units AE, a first communication path being arranged 103 between the first interface unit A and the second interface unit B, and a second communication path being arranged 104 between the first interface unit A, the second inter-

face unit B and the third interface unit C, a transistor being arranged on the first communication path 105, and the dataflow being divertable 106 via the first communication path or the second communication path by means of a transistor actuation.

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In this context, a person skilled in the art will recognise that the individual method steps may be carried out iteratively and/or in a different order, and may have sub-steps.

Claims

1. A line driver device (LTV) for efficient, error-tolerant dataflow control in an automobile, comprising:
 - 5 - a first interface unit (A), set up for communication with a command unit or a further line driver device (LTV);
 - a second interface unit (B), set up for communication with a further line driver device (LTV);
 - 10 - a third interface unit (C), set up for communication with a plurality of execution units (AE), wherein a first communication path is arranged between the first interface unit (A) and the second interface unit (B), and a second communication path is arranged between the first interface unit (A), the second interface unit (B) and the third interface unit (C), a transistor (T) being arranged on the first communication path, and the dataflow being divertable via the first communication path or the second communication path by means of a transistor actuation.
- 20 2. The line driver device (LTV) according to claim 1, characterised in that the third interface unit (C) is set up for communication with execution units (AE) connectable in series.
3. The line driver device (LTV) according to claims 1 or 2, characterized that the transistor actuation is performed using an applied electric
25 voltage or an electric current.
4. The line driver device (LTV) according to any of the preceding claims, characterised in that a logic unit (LE) is connected upstream from the third interface unit (C).

5. The line driver device (LTV) according to claim 4, characterised in that the logic unit (LE) actuates the second interface unit (B) and/or the third interface unit (C).
- 5 6. The line driver device (LTV) according to one of the preceding claims, characterized in that the transistor (T) is present as a field-effect transistor.
- 10 7. The line driver device (LTV) according to claim 6, characterized in that the transistor (T) is present as a self-conducting field effect transistor.
8. The line driver device (LTV) according to one of the preceding claims, characterized in that, when the line driver device (LTV) is inactive, the first communication path is set in such a way that signals which are present at the first interface unit (A) are not processed are to be output at the second interface unit (B).
- 15 9. The line driver device (LTV) according to any of the preceding claims, characterised in that the first communication path takes the form of a passive communication path.
- 20 10. The line driver device (LTV) according to any of the preceding claims, characterised in that the second communication path takes the form of an active communication path.
- 25 11. The line driver device (LTV) according to any of the preceding claims, characterised in that the line driver device (LTV) is formed in a single piece.

12. A system arrangement comprising a line driver device (LTV) according to any of the preceding claims.

5 13. An automobile comprising a system arrangement according to claim 12.

14. A method for efficient, error-tolerant dataflow control in an automobile, comprising:

- 10 - providing (100) a first interface unit (A) set up for communication with a command unit or a further line driver unit (LTV);
- providing (101) a second interface unit (B) set up for communication with a further line driver device (LTV);
- 15 - providing (102) a third interface unit (C) set up for communication with a plurality of execution units (AE), a first communication path being arranged (103) between the first interface unit (A) and the second interface unit (B), and a second communication path being arranged (104) between the first interface unit (A), the second interface unit (B) and the third interface unit (C), a transistor (T) being arranged (105) on the first communication path, and the dataflow being divertable (106) via the first communication path or the second communication path by means of a transistor actuation.
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15 15. A computer program product comprising control commands which carry out the method according to claim 14 when they are executed on a computer.

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