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TRAILER SYSTEM AND METHOD FOR MODULATING SIGNALS FROM A VEHICLE TO A TRAILER

Abstract

A system for transmitting lighting signals from a vehicle to agricultural equipment being towed by the vehicle. An improved trailer lighting system and method uses an improved wiring harness converts output from a standard 7-pin vehicle connector for use in activating agricultural equipment lights through a standard 7-pin agricultural equipment lighting connector. When the vehicle brakes, the harness recognizes increased voltage flowing through the turn signal connectors of the vehicle and activates the brake lights of the trailer in response.

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Background/Summary

TECHNICAL FIELD

[0001] The disclosed embodiments relate generally to a system and method for modulating signals

from a vehicle to a trailer and, in particular, to providing a trailer wiring harness system that receives lighting signals from a SAE J2863 vehicle output and converts them for use by an ASABE S279 trailer input to properly operate the lights on the trailer using outputs from the vehicle.

BACKGROUND

[0002] In an agricultural environment, it is often desirable to tow agricultural equipment, such as anhydrous ammonia trailers, on the highway using typical road vehicles, such as pickup trucks. Many anhydrous ammonia providers do not have agricultural towing vehicles in their inventory. Pickup trucks increase efficiency by pulling agricultural equipment along the highway faster than they can be pulled with a tractor or similar agricultural vehicle.

[0003] One downside to using a pickup truck to tow agricultural equipment is that road vehicles typically have a road trailer vehicle lighting connector, such as a seven-pin connector meeting the SAE International J2863 standard, whereas agricultural equipment, such as anhydrous ammonia trailers, typically have an agricultural vehicle lighting connector, such as a seven-pin connector meeting the American Society of Agricultural and Biological Engineers (ASABE) S279 standard. Unfortunately, not only are the SAE International J2863 standard and ASABE S279 standard directly incompatible with one another, they are not even capable of full compatibility with a supplemental wiring harness that merely routes the wires on the vehicle to their associated function on the trailer.

[0004] It would therefore be desirable to provide a system and method for coupling a lighting connector of a vehicle to the lighting connector of agricultural equipment using a central processing unit (CPU) that receives signals from the vehicle, processes those signals, and, in response, activates the appropriate light on the trailer. One downside to such a system is that the voltage associated with a lighting connector of a vehicle is enough to damage many CPUs. It would therefore be desirable to provide a system and method for coupling a lighting connector of a vehicle to the lighting connector of agricultural equipment using a low-voltage CPU in a manner that does not damage the CPU.

SUMMARY OF THE DISCLOSED SUBJECT MATTER

[0005] To overcome the limitations in the prior art described above, and to overcome other limitations that will become apparent upon reading and understanding the present specification, the present application discloses a method, apparatus, and article of manufacture for coupling a lighting connector of a vehicle to the lighting connector of agricultural equipment. A conversion harness has a female vehicle connector and a male tractor connector coupled to relays that step down the voltage output of lighting signals emanating from the vehicle, route the stepped down voltage to a CPU for processing, and then route and step up the voltage output of the CPU to properly light the agricultural equipment in response to output from the vehicle, such as in response to stepping on the vehicle's brakes or actuating the vehicle's turn signal.

[0006] Other implementations of trailer lighting actuation are disclosed, including implementations directed to actuating trailer brake lights in response to a voltage change of the vehicle brake signal output.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention will now be described, by way of example, with reference to the accompanying drawings in which:

[0008] FIG. **1** illustrates a side elevation of a vehicle and trailer equipped with the harness system in accordance with one embodiment;

[0009] FIG. **2** illustrates a top elevation of the vehicle and trailer of FIG. **1**;

[0010] FIG. **3** illustrates a front elevation of a vehicle connector in accordance with one

embodiment;
[0011] FIG. **4** illustrates a front elevation of an agricultural connector in accordance with one embodiment;
[0012] FIG. **5** illustrates a perspective view of the improved harness of a harness system in accordance with one embodiment;
[0013] FIG. **6** illustrates a schematic of a wiring system of an improved harness of a harness system in accordance with one embodiment;
[0014] FIG. **7** illustrates a top elevation of the tractor and trailer of FIG. **1** shown with the left turn signal on the vehicle and trailer actuated; and
[0015] FIG. **8** illustrates a top elevation of the tractor and trailer of FIG. **1** shown with the brake lights on the vehicle and trailer actuated.
[0016] FIG. **9** is a chart showing the voltage measured at various points in the harness when the vehicle is in various states.

DETAILED DESCRIPTION OF THE DRAWINGS

[0017] The system of the present invention transmits lighting signals from a vehicle to agricultural equipment being towed by the vehicle. The system uses an improved wiring harness to convert output from a standard 7-pin vehicle connector to activate agricultural equipment lights through a standard 7-pin agricultural equipment lighting connector. The system steps down the voltage output from the vehicle connector, passes the stepped-down signal through a central processing unit to determine the correct output, steps the voltage back up, and directs the stepped-up signal to actuate the appropriate lights on the agricultural vehicle.
[0018] As shown in FIG. **1**, a powered wheeled vehicle, such as a pickup truck **10**, is shown mechanically and releasably coupled to agricultural equipment, such as an anhydrous ammonia tank trailer **12**, in a manner such as that known in the art. While only a single anhydrous ammonia tank trailer **12** will be shown and described, it should be noted that any desired number of agricultural equipment may be coupled to the truck **10**.
[0019] As shown in FIGS. **2-3**, the truck **10** is provided with male 7-way recreational vehicle connector **14** such as those known in the art. The vehicle connector **14** preferably meets the SAE J2863 standard, being wired with a yellow male left turn connector **16**, a white male ground connector **18**, a blue male brake connector **20**, a green male right turn connector **22**, an orange male power connector **24**, a brown male running lights connector **26**, and a grey male reverse lights connector **28**.
[0020] As shown in FIGS. **2** and **4**, the trailer **12** is provided with female 7-way agricultural trailer connector **30** such as those known in the art. The trailer connector **30** preferably meets the ASABE S279 standard, being wired with a white female ground connector **32**, a black female work lamps connector **34**, a yellow female left turn/hazard connector **36**, a red female brake connector **38**, a green female right turn/hazard connector **40**, a brown female tail connector **42**, and a blue female power connector **44**. While in the preferred embodiment the vehicle connector **14** is a blade connector and the trailer connector **30** is a pin connector, the connectors **14** and **30** may be provided with any type of connector known in the art.
[0021] As shown in FIG. **5**, a harness **46** is provided with a female 7-way recreational vehicle connector **48** preferably meeting the SAE J2863 standard and capable of fitting into releasable mating engagement with the vehicle connector **14**. The harness **46** is also provided with a male 7-way agricultural equipment connector **50**, preferably meeting the ASABE S279 standard and capable of fitting into releasable mating engagement with the trailer connector **30**. The vehicle connector **48** and agricultural equipment connector **50** are coupled to a sealed weather and shock resistant plastic housing **52**.
[0022] As shown in FIG. **6**, the harness **46** connects the battery connector **24** of the vehicle with a relay **58**. The orange connector **24** provides 12-volt power to the relays and the blue connector **44** of the male harness connector **50**. Coupled to the relay **58** is transformer **56**. The transformer **56**

and relay **58** either raise the voltage coming from the left turn connector **16** from 2.5 volts to 5 volts or reduce the voltage from 12 volts down to 5 volts, so that regardless of the input voltage, the output voltage from the relay **58** is 5 volts. The transformer **56** and relay **58** are preferably integrated into a central processing unit **54** and change the input voltage received from connector **16** to the preferred input voltage of the central processing unit **54** which in a preferred embodiment is 5 volts. Depending on the type of central processing unit used, the output voltage may be any predetermined voltage between 2-8 volts.

[0023] As shown in FIG. **6**, the central processing unit **54**, such as a Raspberry Pi 4 single-board central processing unit developed by Raspberry Pi Trading and operating on the Raspberry Pi OS, is secured within the housing **52** of the harness **46**. A voltage sensor **98** is preferably integrated into the central processing unit **54** in a manner known in the art. Alternatively, any known type of voltage sensor, such as a capacitor-type or resistive-type, may be used. The harness **46** connects the left turn connector **16** of the vehicle **10** with a relay **58**. The harness **46** also connects the right turn connector **22** to relay **60**. The relays **58** and **60**, transformer **56**, and voltage sensor **98** are coupled to inputs **62**, **66**, **64**, and **100**, respectively, of the central processing unit **54** and modify the input voltage received by the central processing unit **54** to 5 volts.

[0024] Similarly, as shown in FIG. **6**, the harness **46** connects the left turn connector **36** of the trailer with a relay **68** which changes the voltage coming from an output **70** of the central processing unit **54**. The relay **68** is preferably integrated into the central processing unit **54** and changes the output voltage of the central processing unit **54** to −12 volts, as desired, as explained below. The harness **46** connects brake connector **38** of the trailer **12** with a relay **72**. The relay **72** is coupled to an output **74** of the central processing unit **54**. The harness **46** connects right turn connector-**40** of the trailer **12** with a relay **76**. The relay **76** is coupled to an output **78** of the central processing unit **54**. The harness **46** also couples the tail connector **42** with a relay **80**. The relay **80** is coupled to an output **82** of the central processing unit **54**. The harness **46** couples the ground connector **18** of the vehicle **10** with the transformer **56**, relays **58**, **60**, **68**, **72**, **76**, and **80**, and to the ground connector **32** of the trailer **12**. The harness **46** also couples the battery connector **24** of the vehicle **10** with relays **68**, **72**, **76**, and **80** and to the power connector **44** of the trailer **12**. The relays **68**, **72**, **76**, and **80** are coupled to outputs **70**, **74**, **78**, and **82**, respectively, of the central processing unit **54** and modify the output voltage of the central processing unit **54** from 5 volts to 12 volts, as explained below.

[0025] As shown in FIG. **6**, the electrical power for a central processing unit **54** and all output to the trailer **12** passing through the male connector **50** comes from the battery connector **24**. The battery connector **24** supplies voltage to the transformer **56** and the relays **58** and **60** directing signals to the central processing unit **54**. The transformer **56** modifies to 5 volts all signals passing from the vehicle **10** through the female harness connector **48** to the central processing unit **54**. The battery connector **24** also supplies the power, at 12 volts, controlled by relays **68**, **72**, **76**, and **80**, for the output from the central processing unit **54** and to the switched power connector **44**, on the agriculture trailer **12**.

[0026] To use the harness **46**, an operator **84** secures the trailer **12** to the vehicle, the harness female connector **48** to the vehicle connector **14**, and the harness male connector **50** to the trailer connector **30**. As shown in FIGS. **7** and **9**, as the operator **84** drives the vehicle **10**, the vehicle **10** sends 2.5-volt signals to both the left turn connector **16** and right turn connector **22** of the vehicle connector **14**. No current is provided through the blue brake connector **20**. The harness **46** converts the signals to 5 volts as explained above, with the 5-volt signals being received by inputs **62** and **66**. In this state, input **100** does not receive a signal above 2 volts. In response, the central processing unit **56** sends a 5-volt signal through outputs **70**, **78**, and **82**, sending no signal through output **74**. The relays **68**, **72**, and **80** convert this output to 12-volts signal sent to left turn connector **36**, right turn connector **40**, tail connector **42**. No signal is sent to brake connector **38**. This results in the trailer hazard lights **102** flashing, the trailer tail lights **104** being on, and the trailer left turn signal **88**,

right turn signal **90**, trailer brake lights **106** being off. The orange battery connector **24** provides 12-volt power to the relays and the blue power connector **44**. (FIGS. **3-4**). The white ground connector **18** is coupled as a ground to all components needing a ground, in a manner known in the art. As shown in FIG. **6**, nothing in this embodiment is coupled to the electric brakes connector **20**, the running lights connector **26**, the reverse lights connector **28**, and the work lamps connector **34** as electric brakes, running lights, reverse lights, and work lamps on the trailer **12** are not actuated in the preferred embodiment. If desired, these functions could be added to an embodiment of the invention in a manner known in the art.

[0027] As the operation of the vehicle connector **14** during a left turn is similar, albeit a mirror, of the operation of the vehicle connector **14** during a right turn, description will be limited to the left turn operation of the vehicle connector **14**. When the operator **84** actuates the left turn signal **92** on the vehicle **10**, the vehicle **10** sends a 2.5-volt signal to the right turn connector **22** and a pulsed 2.5-volt signal to the left turn connector **16** of the vehicle connector **14** in a manner known in the art. No current is provided through the blue brake connector **20**. The harness **46** converts the signals to 5 volts as explained above, with the 5-volt signals being received by inputs **62**, **64**, and **66**, with input **64** receiving a pulsed 5-volt signal. In this state, input **100** does not receive a signal above 2 volts. In response, the central processing unit **56** sends a 5-volt signal through outputs **70**, **78**, and **82**, with the signal sent through output **70** being a pulsed signal. No signal is sent through output **74**. The relays **68**, **78**, and **80** convert the output to 12-volt signals sent to the left turn connector **36**, right turn connector **40**, tail connector **42**, and power connector **44**, with the signal sent to the left turn connector **36** being pulsed at the faster rate indicated above. No signal is sent to brake connector **38**. The operation of the hazard lights and the turn signal lights is controlled by an electronic module (not shown) such as that known in the art. Receipt of the signal by the left turn connector **36**, right turn connector **40**, tail connector **42**, and power connector **44** causes the electronic module to cause the left turn signal **88** to flash faster, preferably flashing 80-105 flashes per minute, more preferably flashing about 20 flashes per minute faster (indicated as “Flashing+” in FIG. **9**) than the trailer hazard lights' **102** normal flashing rate of 60-85 flashes per minute. This results in the trailer hazard lights **102** flashing on the left side, while remaining on but not flashing on the right side. The trailer tail lights **104** are also flashing quickly on the left side, while remaining on but not flashing on the right side. The trailer left turn signal **88** is flashing quickly, while the trailer right turn signal **90** remains on but not flashing.

[0028] When the operator **84** actuates the right turn signal **94** on the vehicle **10**, the vehicle **10** sends a 2.5-volt signal to the left turn connector **16** and a pulsed 2.5-volt signal to the right turn connector **22** of the vehicle connector **14** in a manner known in the art. No current is provided through the blue brake connector **20**. The harness **46** converts the signals to 5 volts as explained above, with the 5-volt signals being received by inputs **62**, **64**, and **66**, with input **66** receiving a pulsed 5-volt signal. In this state, input **100** does not receive a signal above 2 volts. In response, the central processing unit **56** sends a 5-volt signal through outputs **70**, **78**, and **82**, with the signal sent through output **78** being a pulsed signal. No signal is sent through output **74**. The relays **68**, **78**, and **80** convert this output to 12-volt signals sent to the left turn connector **36**, right turn connector **40**, tail connector **42**, and power connector **44**, with the signal sent to the right turn connector **40** being pulsed at the faster rate. No signal is sent to the brake connector **38**. Receipt of the signal by the left turn connector **36**, right turn connector **40**, tail connector **42**, and power connector **44** causes the electronic module to cause the right turn signal **90** to flash faster, preferably flashing 80-105 flashes per minute, more preferably flashing about 20 flashes per minute faster (indicated as “Flashing+” in FIG. **9**) than the trailer hazard lights' **102** normal flashing rate of 60-85 flashes per minute. This results in the trailer hazard lights **102** flashing on the right side, while remaining on but not flashing on the left side. The trailer tail lights **104** are also flashing quickly on the right side, while remaining on but not flashing on the left side. The trailer right turn signal **90** is flashing quickly, while the trailer left turn signal **88** remains on but not flashing.

[0029] When the operator **84** actuates the brake pedal **86** to actuate the brake controller **96** on the vehicle **10**, the vehicle **10** sends a 12-volt signal to the left turn connector **16** and right turn connector **22** of the vehicle connector **14** in a manner known in the art. No current is used by the harness **46** from the blue brake connector **20**. The harness **46** converts the 12-volt signal from the left turn connector **16** and right turn connector **22** to 5 volts as explained above, with the 5-volt signals being received by inputs **62**, **64**, and **66**. In this state, input **100** receives a signal above 2 volts, preferably 5 volts. In response, the central processing unit **56** sends a 5-volt signal through outputs **70**, **74**, **78**, and **82**. The relays **68**, **72**, **78**, and **80** convert this output to 12-volt signals sent to the left turn connector **36**, brake connector **38**, right turn connector **40**, and tail connector **42**. This results in the trailer brake lights **106** being on and the trailer hazard lights **102** flashing on both the left and right. The trailer tail lights **104** are also on, while the trailer left turn signal **88** and left turn signal **90** are off.
[0030] When the operator **84** actuates the brake pedal **86** and the left turn signal **92** of the vehicle **10**, the result is similar to that described above in relation to actuation of the left turn signal **92** alone, except that the vehicle **10** sends a pulsed 12-volt signal to the left turn connector **16** of the vehicle connector **14**, causing the input **100** to receive an input greater than 2 volts, preferably 5 volts. As shown in FIG. **9**, this causes the central processing unit **54** to trigger the tail light **104** of the trailer **12** to be on, the right hazard light **102**, right turn signal **90** and the brake lights of the trailer **12** to be on, and the left hazard light **102** and left turn signal **92** of the trailer **12** to flash faster, preferably at least 20 cycles per minute faster.
[0031] When the operator **84** actuates the lights **110** on the vehicle **10**, the vehicle **10** sends 2.5-volt signals to the left turn connector **16** and right turn connector **22** of the vehicle connector **14** in a manner known in the art. No current is provided through the blue brake connector **20**. The harness **46** converts the signals to 5-volt signals as explained above, with the 5-volt signals being received by inputs **62**, **64** and **66**. In this state, input **100** does not receive a signal above 2 volts. In response, the central processing unit **56** sends a 5-volt signal through output **82**, pulsed 5-volt signals through outputs **70** and **78**, and no signal through output **74**. The relays **68**, **72**, **78**, and **80** convert this output to 12-volt signals being sent to the left turn connector **36**, right turn connector **40**, tail connector **42**, and power connector, with the signal sent to the left turn connector **36** and right turn connector **40** being pulsed. No signal is sent to the brake connector **38**. This results in the trailer hazard lights **102** flashing on the right side and left side and the tail lights **104** to be on. The trailer left turn signal **88**, right turn signal **90**, and brake lights **106** remain off.
[0032] Although the invention has been described with respect to a preferred embodiment thereof, it is to be understood that it is not to be so limited since changes and modifications can be made therein which are within the full, intended scope of this invention as defined by the appended claims.

Claims

1. An electronic signal conversion module for coupling a vehicle to a trailer having a left turn signal light, a right turn signal light, a brake light, and a running light, the module comprising: a female seven pin connector comprising: a female left turn connector; a female right turn connector; a female ground connector; a female power connector; and a female brake connector; a male seven pin connector comprising: a male left turn connector; a male right turn connector; a male ground connector, a male power connector; a male brake connector; and a male tail lights connector; a voltage sensor coupled to the female brake connector; and a processor coupled to the voltage sensor, wherein the processor is configured to send sufficient power to the male brake connector to activate the trailer brake light when the voltage sensor detects the voltage received from the female left turn connector exceeds a predetermined voltage and to stop sending sufficient power to the male brake connector to activate the trailer brake light when the voltage sensor detects the voltage

received from the female left turn connector falls below the predetermined voltage.
2. The electronic signal conversion module of claim 1, wherein the processor is located between the female seven pin connector and the male seven pin connector.
3. The electronic signal conversion module of claim 1, wherein the female seven pin connector is a SAE Standard J2863 connector.
4. The electronic signal conversion module of claim 3, wherein the male seven pin connector is an ASABE Standard S279 connector.
5. The electronic signal conversion module of claim 1, wherein the male seven pin connector is an ASABE Standard S279 connector.
6. The electronic signal conversion module of claim 1, further comprising a first electronic power convertor coupled between the female seven pin connector and the processor and a second electronic power convertor coupled between the processor and the male seven pin connector.
7. The electronic signal conversion module of claim 6, wherein the first electronic power convertor is a transformer.
8. An electronic signal conversion module for coupling a vehicle to a trailer having a left turn signal light, a right turn signal light, a brake light, and a running light, the module comprising: a female seven pin connector comprising: a female left turn connector; a female right turn connector; a female ground connector; a female power connector; and a female brake connector; a male seven pin connector comprising: a male left turn connector; a male right turn connector; a male ground connector; a male power connector; a male brake connector; and a male tail lights connector; a processor coupled to the voltage sensor, wherein the processor is configured to send sufficient power to the male brake connector to activate the trailer brake light in response to a predetermined input from the female seven pin connector; a first electronic power convertor coupled between the female seven pin connector and the processor and a second electronic power convertor coupled between the processor and the male seven pin connector; and wherein the first electronic power convertor is configured to step down a voltage received from the female seven pin connector and send a stepped down voltage to the processor in response to receiving a predetermined voltage from the female seven pin connector; wherein the second electronic power convertor is configured to step up a voltage received from processor and send a stepped up voltage to the male seven pin connector in response to receiving the predetermined voltage from the female seven pin connector.
9. The electronic signal conversion module of claim 8, wherein the voltage received from the female seven pin connector is between 11 and 13 volts and wherein the stepped down voltage is at least 2 volts and no more than 8 volts processor is located between the female seven pin connector and the male seven pin connector.
10. The electronic signal conversion module of claim 9, wherein the processor is powered by between 2 and 8 volts.
11. The electronic signal conversion module of claim 8, wherein the processor is located between the female seven pin connector and the male seven pin connector.
12. The electronic signal conversion module of claim 8, wherein the female seven pin connector is a SAE Standard J2863 connector.
13. The electronic signal conversion module of claim 8, wherein the male seven pin connector is an ASABE Standard S279 connector.
14. The electronic signal conversion module of claim 8, wherein the male seven pin connector is an ASABE Standard S279 connector.
15. The electronic signal conversion module of claim 8, wherein the first electronic power convertor is a transformer.
16. A method for activating a turn signal and a brake light on a trailer in response to output from a vehicle, the method comprising: providing an electronic signal conversion module for coupling a vehicle to a trailer having a left turn signal light, a right turn signal light, a brake light, and a running light, the module comprising: a female seven pin connector comprising: a female left turn

connector; a female right turn connector; a female ground connector; a female power connector; and a female brake connector; a male seven pin connector comprising: a male left turn connector; a male right turn connector; a male ground connector; a male power connector; a male brake connector; and a male tail lights connector; and a voltage sensor coupled to the female brake connector; in response to a left turn signal on the vehicle being activated, sending a voltage below a predetermined voltage from the female left turn connector to the voltage sensor; in response to the voltage sensor receiving the voltage below the predetermined voltage from the female left turn connector, activating the left turn signal on the trailer and not activating the brake light on the trailer; and in response to a brake on the vehicle being activated, sending a voltage above the predetermined voltage from the female left turn connector to the voltage sensor; and in response to the voltage sensor receiving the voltage above the predetermined voltage from the female left turn connector, activating the brake light on the trailer.

17. The method of claim 16, wherein the female seven pin connector is a SAE Standard J2863 connector.

18. The method of claim 16, wherein the male seven pin connector is an ASABE Standard S279 connector.

19. The method of claim 16, further comprising coupling a processor between the female seven pin connector and the male seven pin connector.

20. The method of claim 19, further comprising coupling a first electronic power convertor between the female seven pin connector and the processor and a second electronic power convertor coupled between the processor and the male seven pin connector.