BRIEF DESCRIPTION

[0004] Certain embodiments commensurate in scope with the originally claimed subject matter are summarized below. These embodiments are not intended to limit the scope of the disclosure, but rather these embodiments are intended only to provide a brief summary of certain disclosed embodiments. Indeed, the present disclosure may encompass a variety of forms that may be similar to or different from the embodiments set forth below.

[0005] In accordance with one aspect of the present disclosure a system may include broken wire detector circuitry that may include an optocoupler, encoder isolator circuitry that may include input voltage protection circuitry, an optocoupler, and output filtering circuitry, and compensator circuitry that may include signal conditioning circuitry. The broken wire detector circuitry and the encoder isolator circuitry may be configured to accept inputs signals (A, B) and an index signal (Z) for a single-ended and differential type incremental encoder, the broken wire detector circuitry may be configured to convert an input AC pulse train signal to an analog DC signal, the encoder isolator may be configured to protect from high input voltages, and the compensator may be configured to accept outputs of the broken wire detector circuitry and the encoder isolator circuitry and to integrate and dampen the analog DC signal that has a value representative of an operating state of the incremental encoder. The analog DC signal value output by the compensator circuitry may represent the operating state of the incremental encoder comprising whether the encoder is changing speeds during normal operation, the encoder is stalling, or if there is a broken wire for any of the three input signals to the encoder. The analog DC signal produced during normal operation may have a DC value with an attenuated ripple, the analog DC signal produced during stalling may have a fixed non-zero DC value, and the analog DC signal produced by a broken wire may have a value of zero.

[0006] In accordance with another aspect of the present disclosure a system may include encoder loss detector circuitry that may include a broken wire detector, an encoder isolator, and a compensator. The output signals from the broken wire detector and the encoder isolator may be input to the compensator, the broken wire detector may be configured to detect when there is a broken wire and convert an input pulse train signal to an analog DC signal with a value representative of the broken wire, the encoder isolator may be configured to protect from high input voltages and output a value representative of an operating state of an encoder, and the compensator may be

configured to integrate and dampen the analog DC signal and output the dampened analog DC signal with a value representative of an operating state of the encoder. The analog DC signal may have a DC value and attenuated ripple during normal operation, the analog DC signal may have a fixed non-zero DC value during a stalling state, and the analog DC signal may have a value of zero during a broken wire state.

[0007] In accordance with another aspect of the present disclosure a method may include receiving a pulse train signal from an incremental encoder at encoder loss detector circuitry that may include a broken wire detector, an encoder isolator, and a compensator, protecting, via the encoder isolator, the encoder loss detector circuitry from high input voltage, converting, via the broken wire detector, the pulse train signal to an analog DC signal, conditioning, via the compensator, the analog DC signal to be stable, outputting, via the compensator, the conditioned analog DC signal, and analyzing the conditioned analog DC signal. The conditioned analog DC signal may have a DC value and attenuated ripple during normal operation, a fixed non-zero DC value during a stalling state, and a DC value of zero during a broken wire state.

DRAWINGS

[0008] These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0009] FIG. 1 is a schematic diagram of an embodiment of a system including an encoder, in accordance with aspects of the present disclosure;

[0010] FIG. 2A is a circuit diagram of an exemplary encoder loss detector, while FIG. 2B represents an exemplary associated truth table, in accordance with aspects of the present disclosure;

[0011] FIG. 3A and 3B are block diagrams of exemplary first and second embodiments, respectively, implementing the encoder loss detector of FIG. 2A, in accordance with aspects of the present disclosure;

CLAIMS:

1. A system, comprising:

broken wire detector circuitry comprising an optocoupler;

encoder isolator circuitry comprising input voltage protection circuitry, an optocoupler, and output filtering circuitry; and

compensator circuitry comprising signal conditioning circuitry; and

wherein the broken wire detector circuitry and the encoder isolator circuitry are configured to accept inputs signals and an index signal for a single-ended and differential type incremental encoder, the broken wire detector circuitry is configured to convert an input AC pulse train signal to an analog DC signal, the encoder isolator is configured to protect from high input voltages, and the compensator is configured to accept outputs of the broken wire detector circuitry and the encoder isolator circuitry and to integrate and dampen the analog DC signal that has a value representative of an operating state of the incremental encoder;

wherein the analog DC signal value output by the compensator circuitry represents the operating state of the incremental encoder comprising whether the encoder is changing speeds during normal operation, the encoder is stalling, or if there is a broken wire for any of the three input signals to the encoder; and

wherein the analog DC signal produced during normal operation has a DC value with an attenuated ripple, the analog DC signal produced during stalling has a fixed non-zero DC value, and the analog DC signal produced by a broken wire has a value of zero.

2. The system of claim 1, wherein each input signal and the index signal for the incremental encoder is electrically coupled to separate broken wire detector circuitries and encoder isolator circuitries, the output from each compensator

circuitry is electrically coupled to separate zero comparators, the output from each zero comparator is electrically coupled to a NOR gate, and the output from the NOR gate is electrically coupled to a processor.

3. The system of claim 2, wherein the compensator circuitries output a logical low value when there is a broken wire detected and a logical high value when there is not a broken wire detected to each electrically coupled zero comparator, wherein each zero comparator outputs a high value when a broken wire is detected and a low value when a broken wire is not detected to the electrically coupled NOR gate, wherein the NOR gate outputs a high value when all three inputs from the electrically coupled zero comparators indicate a broken wire is not detected and outputs a low value when any of the three inputs from the electrically coupled zero comparators indicate a broken wire is detected.

4. The system of claim 1, wherein each input signal and the index signal for the encoder is electrically coupled to separate broken wire detector circuitries and encoder isolator circuitries and the output from each compensator circuitries is electrically coupled to an analog-to-digital converter that is further electrically coupled to a processor.

5. The system of claim 4, wherein the operating state comprises normal operation, changing speeds, stalling, or broken wire and the processor is configured to determine which state is represented by the digitally converted signal.

6. The system of claim 1, wherein the analog DC signal has a voltage with a magnitude that reflects speed.

7. The system of claim 1, wherein the broken wire detector circuitry, the encoder isolator circuitry, and the compensator circuitry are disposed on an encoder input card installed in a motor drive.

8. A system, comprising:

encoder loss detector circuitry comprising a broken wire detector, an encoder isolator, and a compensator; and

wherein output signals from the broken wire detector and the encoder isolator are input to the compensator, the broken wire detector is configured to detect when there is a broken wire and convert an input pulse train signal to an analog DC signal with a value representative of the broken wire, the encoder isolator is configured to protect from high input voltages and output a value representative of an operating state of an encoder, and the compensator is configured to integrate and dampen the analog DC signal and output the dampened analog DC signal with a value representative of an operating state of the encoder, and

wherein the analog DC signal has a DC value and attenuated ripple during normal operation, the analog DC signal has a fixed non-zero DC value during a stalling state, and the analog DC signal has a value of zero during a broken wire state.

9. The system of claim 8, wherein the operating state of the encoder comprises normal operation, changing speeds, stalling, or broken wire.

10. The system of claim 8, wherein the broken wire detector comprises a bi-directional optocoupler that is configured to convert the pulse train signal into the analog DC signal and output a one when there is not a broken wire and output a zero when there is a broken wire.

11. The system of claim 8, wherein each of an input signal and an index signal for an incremental encoder is electrically coupled to separate encoder loss detector circuitries' broken wire detectors and encoder isolators and the output from each compensator is electrically coupled to a separate zero comparator that is electrically coupled to a NOR gate and the NOR gate is further electrically coupled to a processor.

12. The system of claim 11, wherein the processor is configured to determine whether a broken wire operating state exists by analyzing the signal output by the NOR gate, wherein a logical high value input by the NOR gate to the processor indicates that there is not a broken wire detected and a logical low value input by the NOR gate to the processor indicates that there is a broken wire detected.

13. The system of claim 8, wherein each of an input signal and an index signal for an incremental encoder is electrically coupled to separate encoder loss detector circuitries broken wire detectors and encoder isolators and the output from each compensator is electrically coupled to an analog-to-digital converter that is further electrically coupled to a processor.

14. A method, comprising:

receiving a pulse train signal from an incremental encoder at encoder loss detector circuitry comprising a broken wire detector, an encoder isolator, and a compensator;

protecting, via the encoder isolator, the encoder loss detector circuitry from high input voltage;

converting, via the broken wire detector, the pulse train signal to an analog DC signal;

conditioning, via the compensator, the analog DC signal to be stable;

outputting, via the compensator, the conditioned analog DC signal; and

analyzing the conditioned analog DC signal;

wherein the conditioned analog DC signal has a DC value and attenuated ripple during normal operation, a fixed non-zero DC value during a stalling state, and a DC value of zero during a broken wire state.

15. The method of claim 14, wherein the conditioned analog DC signal has a value representative of an operating state of the incremental encoder comprising normal operation, changing speeds, stalling, or broken wire.

16. The method of claim 14, wherein the pulse train is received by both the broken wire detector, which utilizes a bi-directional optocoupler to detect when a wire is broken and to convert the pulse train into the analog DC signal, and the encoder isolator, and the outputs of the broken wire detector and the encoder isolator are input to the compensator, which is configured to integrate and condition the analog DC signal to be output with a value representative of an operating state of the incremental encoder.