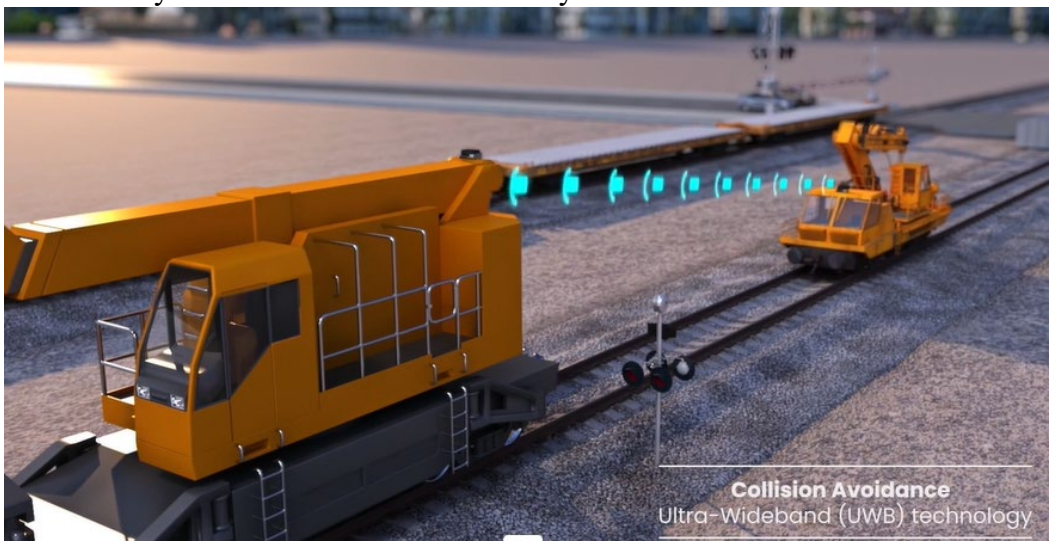
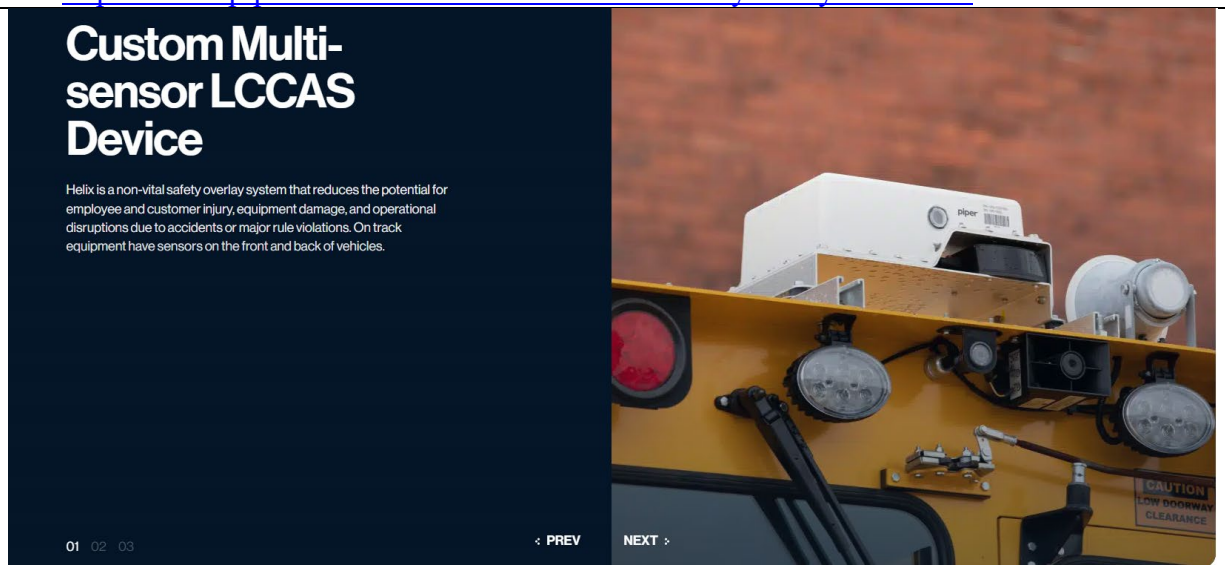
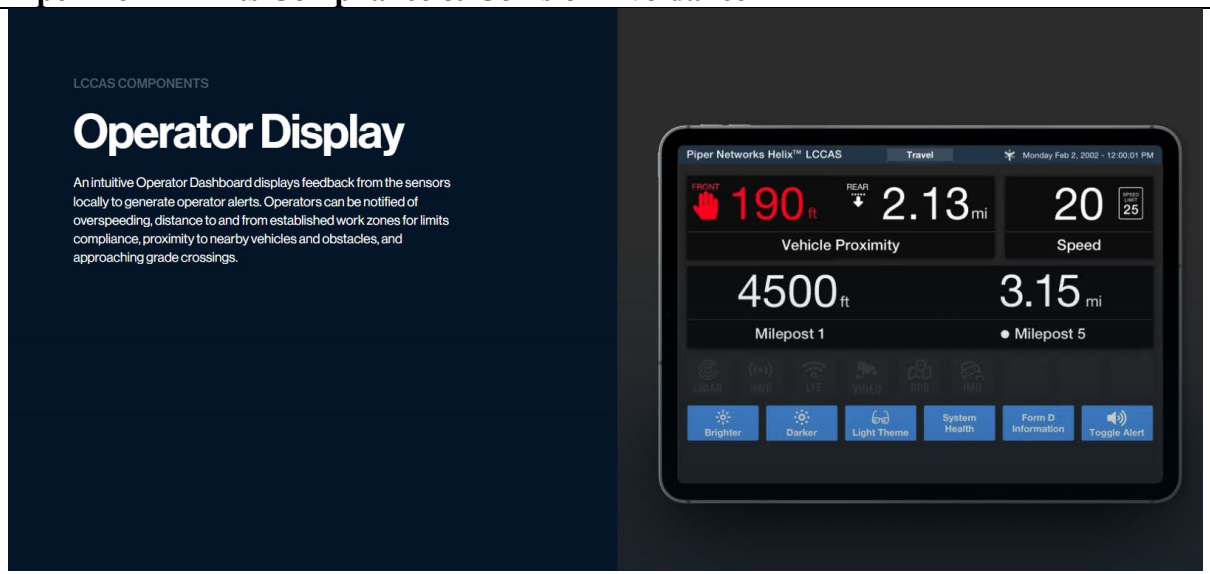
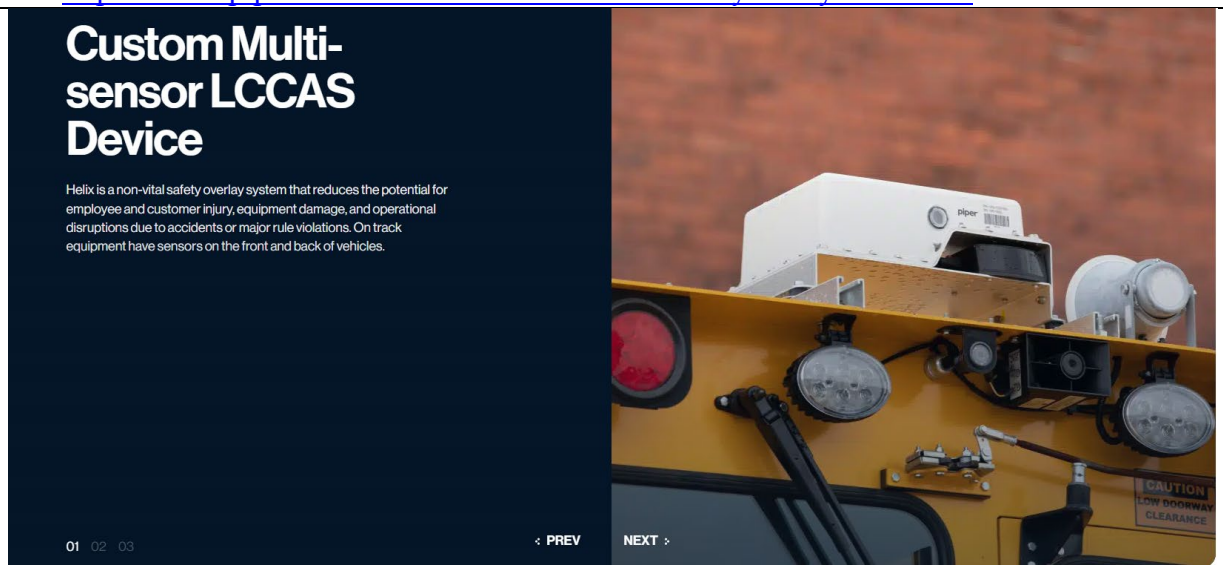
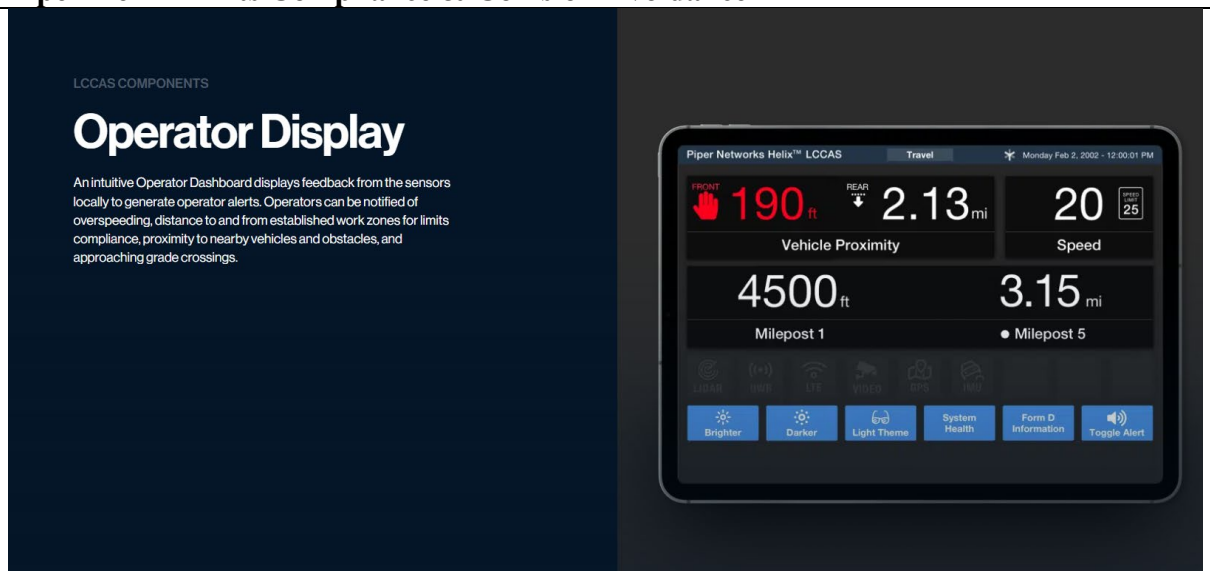
Claim Chart for Claims 1 & 7 of U.S. Patent No. 9,043,131

Claims 1 and 7	**Piper Helix Limits Compliance & Collision Avoidance**
1. A collision avoidance system	The Helix system is a collision avoidance system  See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure

Claims 1 and 7	**Piper Helix Limits Compliance & Collision Avoidance**
A first vehicle mounted module mounted on a first rail vehicle, the first vehicle mounted module comprising: A first transponder sensor module operable to send and receive data wirelessly, the first transponder sensor module comprising a first radio communication unit and a first antenna;	 See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure
a first control electronics module comprising a first processor in communication with at least the first transponder sensor module; and	 See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure

Claims 1 and 7	**Piper Helix Limits Compliance & Collision Avoidance**
a first user interface module including a first user inter face, the first user interface operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator;	 See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure (last visited June 29, 2023).
a second vehicle mounted module mounted on a second rail vehicle, the second vehicle mounted module comprising: a second transponder sensor module operable to send and receive data wirelessly, the second transponder sensor module comprising a second radio communication unit and a second antenna;	

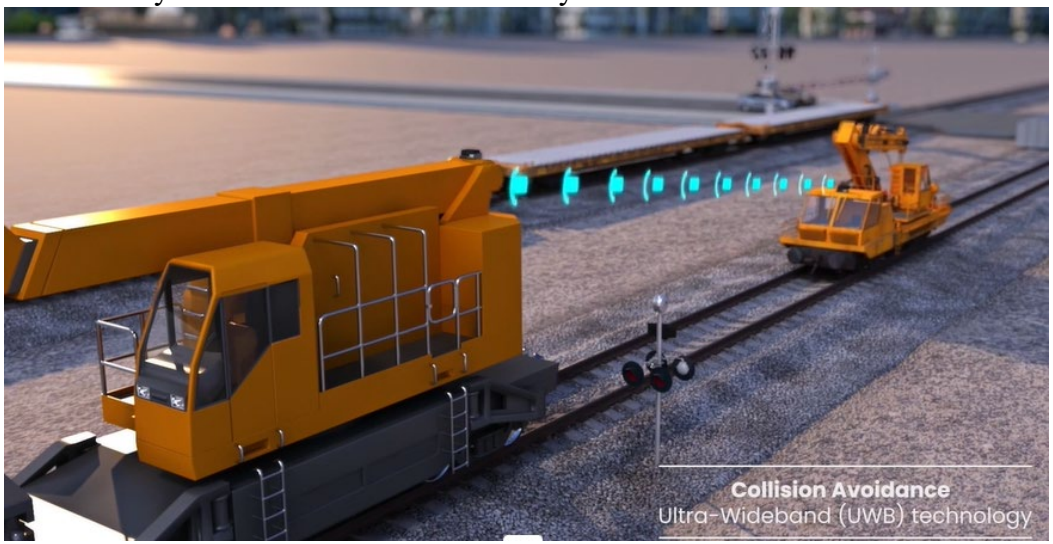
Claims 1 and 7	**Piper Helix Limits Compliance & Collision Avoidance**
	See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure
a second control electronics module comprising a second processor in communication with at least the second transponder sensor module; and	 See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure

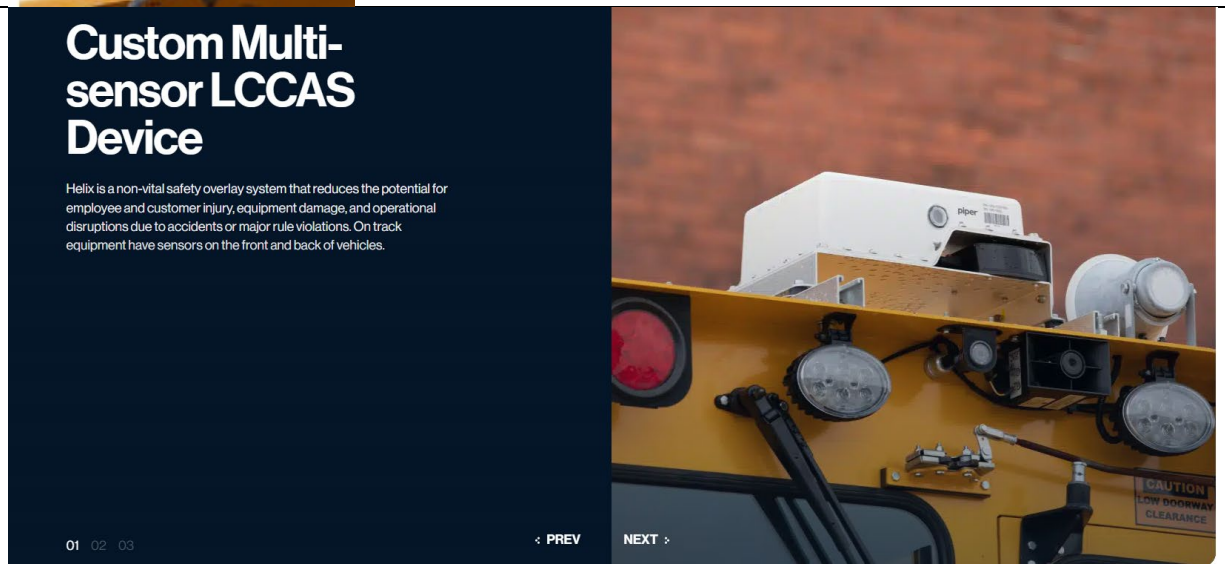
Claims 1 and 7	**Piper Helix Limits Compliance & Collision Avoidance**
a second user interface module including a second user interface, the second user interface operable to provide rail vehicle information to the vehicle operator and to receive input from the vehicle operator;	 See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure (last visited June 29, 2023).

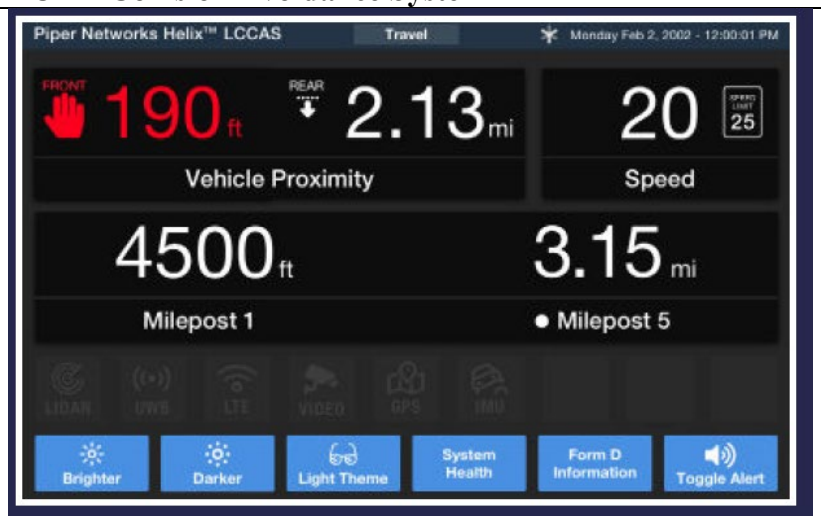
Claims 1 and 7	**Piper Helix Limits Compliance & Collision Avoidance**
wherein: the first vehicle mounted module is operable to communicate with the second vehicle mounted module mounted on the second rail vehicle; and the first vehicle mounted module and the second vehicle mounted module are operable to apply a time of flight technique to determine a separation distance between the first rail vehicle and the second rail vehicle.	**Work zones often include multiple MoW vehicles operating in close proximity to each other with bi-directional movements.** It's imperative to monitor the front and rear of each of these vehicles to prevent collisions and damage. For this function Piper deploys its field-tested UWB solution. The Helix CPU uses its knowledge of which track the vehicle is localized to and communicates with other Helix-equipped vehicles on the same track using UWB in a localized fashion. The ranging data collected from the UWB sensors allows the Helix CPU to accurately track the distance between the two vehicles and warn both operators if they begin to encroach on their safety envelopes. Operators are able to view this proximity information through the in-cab display alerts that follow the rules for safe separation of vehicles in both work and travel modes. *See* https://www.pipernetworks.com/maintenance-of-way-safety/#general-info . **01. Collision Avoidance - *Ultra Wideband*** UWB sensors deliver continuous positioning data relative to nearby MoW vehicles and personnel with in-cab alerts for operators.

Claims 1 and 7	**Piper Helix Limits Compliance & Collision Avoidance**
7. The collision avoidance system of claim 1, wherein: the first vehicle mounted module further comprises a first global positioning system unit, the global positioning system unit operable to receive information from one or more satellites to determine an absolute position of the first rail vehicle; and the first global positioning system unit is in communication with the first control electronics module.	**04. Limits Compliance - *GPS RTK*** GPS RTK technology communicates the details of MoW location and vehicle work limits with sub-meter accuracy.

Claim Chart for Claims 1 & 7 of U.S. Patent No. 8,812,227

Claims 1 and 7	**AURA Collision Avoidance System**
1. A collision avoidance system	The Helix system is a collision avoidance system  See https://www.pipernetworks.com/maintenance-of-way-safety/#brochure

Claims 1 and 7	**AURA Collision Avoidance System**
one or more vehicle mounted modules, each vehicle mounted module mountable on a rail vehicle, each vehicle mounted module comprising: a transponder sensor module operable to send and receive data wirelessly, the transponder module comprising a first ultra wideband unit and a first antenna	
a control electronics module comprising a processor in communication with at least the transponder sensor module unit; and	

Claims 1 and 7	**AURA Collision Avoidance System**
a user interface module including a user interface, the user interface being operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator; and	

Claims 1 and 7	**AURA Collision Avoidance System**
wherein each vehicle mounted module is operable to communicate with at least one other vehicle mounted module mounted on at least one other rail vehicle, and wherein each vehicle mounted module is operable to apply a time of flight technique to determine a separation distance between the rail vehicles.	**Work zones often include multiple MoW vehicles operating in close proximity to each other with bi-directional movements.** It's imperative to monitor the front and rear of each of these vehicles to prevent collisions and damage. For this function Piper deploys its field-tested UWB solution. The Helix CPU uses its knowledge of which track the vehicle is localized to and communicates with other Helix-equipped vehicles on the same track using UWB in a localized fashion. The ranging data collected from the UWB sensors allows the Helix CPU to accurately track the distance between the two vehicles and warn both operators if they begin to encroach on their safety envelopes. Operators are able to view this proximity information through the in-cab display alerts that follow the rules for safe separation of vehicles in both work and travel modes. *See* https://www.pipernetworks.com/maintenance-of-way-safety/#general-info . **01. Collision Avoidance - *Ultra Wideband*** UWB sensors deliver continuous positioning data relative to nearby MoW vehicles and personnel with in-cab alerts for operators.

Claims 1 and 7	AURA Collision Avoidance System
7. The collision avoidance system of claim 1, wherein the first vehicle mounted module further comprises a global positioning system unit, the global positioning system unit operable to receive information from one or more satellites to determine an absolute position of the rail vehicle, wherein the global positioning system unit is in communication with the control electronics module.	• **Limits Compliance** - GPS-RTK provides a high precision position & speed calculation for limits compliance and time synchronization.