Anti-Collision
System Information
# Table of Contents

- Display Panel .................................................................................................................. 3
- Drill Line Payout ............................................................................................................. 5
- Crown Saver ....................................................................................................................... 7
- Bail Angle .......................................................................................................................... 9
- Block Extend Sensor ........................................................................................................ 11
- Elevator Rotational Sensor ............................................................................................... 13
- Angle Sensor ..................................................................................................................... 15
- Proximity Sensor ................................................................................................................ 17
- Alarm Hub .......................................................................................................................... 19
- Power Converter ............................................................................................................... 21
- Power Disconnect ............................................................................................................. 22
- Air Kill ............................................................................................................................... 23
- Throttle Limiter .................................................................................................................. 24
- Auxiliary Brake Controller ............................................................................................... 25
- Functional Design Description Electronic Brake Controller ........................................... 26
- Functional Design Description Pneumatic Brake Controller ........................................... 28
- Electronic Throttle Limiter ............................................................................................... 30
- Functional Design Description Electronic Throttle Limiter ............................................ 31
- PLC Integration ................................................................................................................ 33
- Anti-Collision Logic ......................................................................................................... 35
- Installation and Commissioning ....................................................................................... 38
- Commissioning, Testing and Training ............................................................................ 41
Display Panel

Description of Function:

The panel is the main display, wireless receiver and control module for the Rigsmart Anti-Collision System. Sensor transmissions are received through the panel and clearly displayed for the operator. The panel is where anti-collision logic is loaded, and is the main controller for applying the rig brakes before a collision occurs.

Location:

The panel is located in the doghouse or at the driller’s station on the rig floor and can be mounted to any fixed surface. It is designed for outdoor use in all weather conditions.

Rig Requirements:

*Rig Status* – The panel can be installed while the rig is functioning or racked, without disrupting operations. A $12_{\text{VDC}} - 24_{\text{VDC}}$ power source from the rig to the Rigsmart power disconnect is required, and technicians must have access to the doghouse or driller’s station.

*Crew Responsibilities* – The Rig Manager should provide a location preference for the panel.

*Time Required* – 30-60 minutes is required for panel mounting and setup. Antenna and configuration requirements may vary according to the chosen panel location.

<table>
<thead>
<tr>
<th></th>
<th>QUICK FACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Install Time</strong></td>
<td>30-60 Minutes</td>
</tr>
<tr>
<td><strong>Rig Status</strong></td>
<td>Racked, Moving or Operating</td>
</tr>
<tr>
<td><strong>Requirements</strong></td>
<td>Location selected by Rig Manager. $12_{\text{VDC}} - 24_{\text{VDC}}$ power</td>
</tr>
</tbody>
</table>

Install Time: 30-60 Minutes

Rig Status: Racked, Moving or Operating

Requirements: Location selected by Rig Manager. $12_{\text{VDC}} - 24_{\text{VDC}}$ power
Display Panel Data Sheet

Overview
The panel is the main display, wireless receiver and control module for the Rigsmart Anti-Collision System. It receives sensor transmissions and displays them clearly for the operator. The Panel is also where anti-collision logic is loaded and is the main controller for applying the rig brakes before a collision occurs. The panel is typically mounted in the driller’s field of vision.

Operating time
100% (continuous duty)

Voltage type
12-24 VDC, 7.5A normal operating range
(can accept 11-32 VDC)

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber,
60 durometer shore-A, compound # SIM40160

Connection
Woodhead, bulgin or amphenol connections are available.

Mounting options
Bolt on bracket

Hazardous locations
Class 1 Division 2
Ex nA IIB+H2 T4
Certified to: IEC CAN/CSA E60079-15:02

Environmental Ingress Protection
IP67

Application
Drilling or service rigs

*Rigsmart Systems, Inc.
4908 97 St.
Edmonton, AB
T6L 4B2
Ph: 780.438.9475
Email: info@rigsmart.com*
Drill Line Payout

Description of Function:

The drill line payout calculates block height and can also be used as a crown and floor saver. It comes with 2 separate components: a drawworks encoder and a transducer box. The drawworks encoder is fitted onto the drumshaft and counts the revolutions of the drum in both directions. It sends a signal to the transducer, which then wirelessly transmits data to the display panel.

Location:

The drawworks encoder is mounted on the drumshaft of the drawworks. The transducer box is placed nearby.

Rig Requirements:

**Rig Status** – Installation can take place while the rig is operating or racked, but drilling must be stopped and the drawworks locked out while the encoder is mounted. The transducer also requires power from the power disconnect box.

**Crew Responsibilities** – Approval for the mounting location, as well as the drawworks lockout procedure is required from the Rig Manager.

**Time Required** – Mounting of the drawworks encoder may take up to 1 hour, depending on how many guards and enclosures must be removed to access the axle. Mounting of the transducer takes approximately 1 hour.

<table>
<thead>
<tr>
<th>QUICK FACTS</th>
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<tbody>
<tr>
<td>Install Time</td>
</tr>
<tr>
<td>Rig Status</td>
</tr>
<tr>
<td>Requirements</td>
</tr>
</tbody>
</table>
Drill Line Payout Data Sheet

Overview
The drill line payout monitors block height. The block height can then be combined with information from the bail, block, crown, stabbing board and additional wireless sensors to establish an anti-collision routine. It comes with two separate components: a drawworks encoder and a transducer box. The drawworks encoder counts the turning revolutions of the drum as it reels in or out drill line, and sends a corresponding signal to the transducer box for brake and/or speed control.

Operating time
100% (continuous duty)

Voltage type
12 VDC or 24 VDC supplied by the rig

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber, 60 durometer shore-A, compound # SIM40160

Connection
A power connection from the Rigsmart power supply is required. The component provides a wireless signal.

Mounting options
Custom brackets are made to fit the drawworks skid.

Hazardous locations
Ex ia IIB T4 Cl 1, Div 2 CD T4
Certified to: CSA C22.2 NO.213-87M(99)

Environmental Ingress Protection
IP67

*Information subject to change without notice. Consult the factory for the most current data and part numbers.*

Rigsmart Systems, Inc.
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Edmonton, AB
T6L 4B2
Ph: 780.438.9475
Email: info@rigsmart.com
Crown Saver

Description of Function:

The crown saver detects when the travelling blocks are near the crown and sends a wireless signal to the panel for brake application. It is made up of two main components: the transducer and the counter weight. The transducer is hard mounted to a fixed point and the counter weight is suspended from the bottom of the transducer, around a slow speed line. The counter weight hangs freely, pulling down on an internal strain gauge. If the travelling block nears the crown and lifts the counter weight, an alarm condition is triggered, and the rig brakes are applied. The Rigsmart crown saver is designed to be more safe and effective than conventional drawworks-based crown savers. It is safety cabled, and it’s stainless steel mounting hardware prevents corrosion.

Location:

The crown saver sensor is mounted to the inside of the derrick, near the bottom of the crown. It may be attached to a weld bar or bolted to a threaded hole.

Rig Requirements:

**Rig Status** – The crown saver is easily installed while the derrick and crown are on the ground.

**Crew Responsibilities** – Approval is required for mounting location, drill and tap, or a weld bar. If necessary, the rig must also supply a welder for instalment.

**Time Required** - The crown saver takes approximately 1 hour to install, if the derrick is on the ground. More time may be required if the work is done at height.

### QUICK FACTS

<table>
<thead>
<tr>
<th>Install Time</th>
<th>30 Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rig Status</td>
<td>Derrick laid over, not drilling</td>
</tr>
<tr>
<td>Requirements</td>
<td>Welded on bracket or threaded hole in crown</td>
</tr>
</tbody>
</table>
Crown Saver Sensor Data Sheet

Overview
The crown saver is a sensor used to monitor a counterweight attached to the slow speed line of a rig travelling block. When the travelling block makes contact with the counterweight, the crown saver sends a signal to apply the rig brakes.

Operating time
100% (continuous duty)

Voltage type
Powered by a 3.6 volt D cell lithium battery

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber, 60 durometer shore-A, compound # SIM40160

Connection
No connection is required – the component provides a wireless signal.

Mounting options
A variety of custom-fit welds, clamps or brackets are available. All three options provide secondary containment.

Hazardous locations
Exia IIB T4 Intrinsically Safe per IEC CAN/CSA E60079-11:02

Environmental Ingress Protection
IP67

Application
Drilling or service rigs

*Information subject to change without notice. Consult the factory for the most current data and part numbers.*
Bail Angle

Description of Function:

The bail angle sensor detects the angle at which the bail is positioned and wirelessly transmits angle information to the panel. The angle is combined with block height and rotational information to determine potential collision zones. Pre-set limits determine when an alarm is triggered.

Location:

The bail angle sensor is bolted to the side of one of the bail arms.

Rig Requirements:

* Rig Status – The bail angle can be mounted during a rig service.

* Crew Responsibilities – Approval for mounting location is required.

* Time Required – Mounting time for the bail angle sensor is approximately 30 minutes.

**QUICK FACTS**

<table>
<thead>
<tr>
<th>Install Time</th>
<th>15 Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rig Status</td>
<td>Racked, Moving or Rig Service</td>
</tr>
<tr>
<td>Requirements</td>
<td>Top Drive</td>
</tr>
</tbody>
</table>
Bail Angle Sensor Data Sheet

Overview
The bail angle sensor is a wireless component which mounts on to a top drive bail and transmits positional information to an anti-collision system.

Operating time
100% (continuous duty)

Voltage type
Powered by a 3.6 volt D cell lithium battery

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber,
60 durometer shore-A, compound # SIM40160

Connection
No connection is required – the component provides a wireless signal.

Mounting options
Mounting brackets are custom fit to the bail size.

Hazardous locations
Exia IIB T4 Intrinsically Safe per IEC CAN/CSA E60079-11:02

Environmental Ingress Protection
IP67

Application
Drilling rigs with top-drives

*Information subject to change without notice. Consult the factory for the most current data and part numbers.*
Block Extend Sensor

Description of Function:

The block extend sensor detects the position of a top drive block-extend and wirelessly transmits information to the display panel. This data is combined with block height and rotational information to determine potential collision zones. Pre-set limits determine when an alarm is triggered.

Location:

The block angle sensor is bolted to the top drive block-extend frame.

Rig Requirements:

**Rig Status** – The sensor may be mounted during a rig service.

**Crew Responsibilities** – Approval for the mounting location is required.

**Time Required** – Mounting time for the block angle sensor is approximately 30 minutes.

<table>
<thead>
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<th>QUICK FACTS</th>
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</thead>
<tbody>
<tr>
<td>Install Time</td>
</tr>
<tr>
<td>Rig Status</td>
</tr>
<tr>
<td>Requirements</td>
</tr>
</tbody>
</table>
Block Extend Sensor Data Sheet

**Overview**
The block extend sensor is a wireless component which detects how far away the top drive body is from the track.

**Operating time**
100% (continuous duty)

**Voltage type**
Powered by a 3.6 volt D cell lithium battery

**Operating temperature**
-40°C to +60°C

**Operating Frequency Range**
900-928 MHz in North America
868-870 MHz in Europe

**Material**
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber, 60 durometer shore-A, compound # SIM40160

**Connection**
No connection required - the component provides a wireless signal.

**Mounting options**
Mounting brackets are custom made to fit the top drive make and model.

**Hazardous locations**
Exia IIB T4 Intrinsically Safe per IEC CAN/CSA E60079-11:02

**Environmental Ingress Protection**
IP67

**Application**
Drilling rigs with top-drives
Elevator Rotational Sensor

Description of Function:

The elevator rotational sensor (ERS) detects the direction the top drive is rotated (drill, trip or to the side). RFID technology is used to read tags placed on the top drive.

Location:

The sensor is mounted to the top drive, with mounting brackets custom fitted to the top drive make and model.

Rig Requirements:

Rig Status – The ERS is most easily installed while the rig is racked or moving. Installation can also be done during drilling operations on a rig service or any time the top drive can be safely accessed.

Crew Responsibilities – Approval is required for the mounting location. The top drive must be operational, for testing purposes.

Time Required – Approximately 2 hours is required to install the ERS. Depending on the specific top drive and any additional brackets required for RFID tag mounting, the time may be increased by up to an additional 2 hours.

QUICK FACTS

<table>
<thead>
<tr>
<th>Install Time</th>
<th>2 - 4 Hours</th>
</tr>
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<tbody>
<tr>
<td>Rig Status</td>
<td>Racked, Moving or Rig Service</td>
</tr>
<tr>
<td>Requirements</td>
<td>24VDC Source on Top Drive</td>
</tr>
</tbody>
</table>
ERS Radio Link Data Sheet

Overview
The ERS (Elevator Rotation Sensor) radio data link uses RFID technology to detect the direction the top drive is rotated; whether it is in drill, trip, or in an unsafe position.

Operating time
100% (continuous duty)

Voltage type
24 VDC supplied from the top drive

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber, 60 durometer shore-A, compound # SIM40160

Connection
The link uses a Woodhead connection to the ERS tag reader and to the top drive supplied power. It provides positional information via a wireless signal.

Mounting options
Mounting brackets are custom made to fit the top drive make and model.

Hazardous locations
Class 1, Div 2, C&D T4
Ex nA IIB T4

Environmental Ingress Protection
IP67

Application
Drilling rigs with top drives

*Information subject to change without notice. Consult the factory for the most current data and part numbers.*
Angle Sensor

Description of Function:

The angle sensor monitors various positions of equipment such as the diving board, stabbing board, and iron roughneck. It sends a signal for alarm once position set points are breached.

Location:

The angle sensor bolts to any fixed point that requires level measurement.

Rig Requirements:

**Rig Status** – The sensor is most easily installed while the rig is racked or moving, but it may be mounted during drilling operations, if safe to do so.

**Crew Responsibilities** – Approval for the mounting location is required.

**Time Required** – Mounting time for the angle sensor is approximately 1 hour.

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<thead>
<tr>
<th>QUICK FACTS</th>
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<tbody>
<tr>
<td>Install Time</td>
<td>15 Minutes</td>
</tr>
<tr>
<td>Rig Status</td>
<td>Racked, Moving or Rig Service</td>
</tr>
<tr>
<td>Requirements</td>
<td>None</td>
</tr>
</tbody>
</table>
Rig Angle Sensor Data Sheet

Overview
The rig angle sensor monitors various positions of equipment such as the diving board, stabbing board, and iron roughneck. It sends a signal for alarm once a position set point is breached.

Operating time
100% (continuous duty)

Voltage type
Powered by a 3.6 volt D cell lithium battery

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber, 60 durometer shore-A, compound # SIM40160

Connection
No connection is required - the component provides a wireless signal.

Mounting options
Various brackets are available to meet application requirements.

Hazardous locations
Exia IIB T4 Intrinsically Safe per IEC CAN/CSA E60079-11:02

Environmental Ingress Protection
IP67

Application
Drilling or service rigs

*Information subject to change without notice. Consult the factory for the most current data and part numbers.*
Proximity Sensor

**Description of Function:**

The proximity sensor is a wireless transducer that detects its distance from a target. This target is mounted in relation to any piece of equipment that is to be monitored for position. If positional set points are breached, an alarm is triggered and (if necessary) the rig brakes are applied. The sensor system can utilize multiple targets to establish ‘home’ (safe) or ‘away’ (unsafe) working zones.

**Location:**

The sensor is installed on the piece of equipment to be monitored. It is custom fitted, usually on a mount provided by the customer.

**Rig Requirements:**

*Rig Status* - The monitored equipment needs to function after installation, for testing purposes.

*Crew Responsibilities* - Some minor assistance from the crew may be required in testing operations, and creating a mount location.

*Time Required* - Sensors can be installed in approximately 1 hour, once the mounts are fabricated.

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<tr>
<td>Install Time</td>
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<tr>
<td>Rig Status</td>
</tr>
<tr>
<td>Requirements</td>
</tr>
</tbody>
</table>
Proximity Sensor Data Sheet

Overview
The proximity sensor monitors various positions of equipment such as the diving board, stabbing board, and iron roughneck. It sends a signal for alarm conditions once an alarm set point is breached.

Operating time
100% (continuous duty)

Voltage type
Powered by a 3.6 volt D cell lithium battery

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Ultramid 8333G Hi-Polyamide 6
Seals – ROHS compliant silicon rubber, 60 durometer shore-A, compound # SIM40160

Connection
No connection is required - the component provides a wireless signal.

Mounting options
Various brackets are available to meet application requirements.

Hazardous locations
Exia IIB T4 Intrinsically Safe per IEC CAN/CSA E60079-11:02

Environmental Ingress Protection
IP67

Application
Drilling or service rigs
Alarm Hub

Description of Function:

The alarm hub provides outputs to rig controls via 5 discrete outputs. It can control such items as an air kill for applying the brakes, or drive relays to provide inputs to a PLC.

Location:

The alarm hub can be mounted on the component stand or inside a PLC cabinet.

Rig Requirements:

* **Rig Status** – Installation can occur while the rig is operating or racked. Mounting may only suspend drilling if connection to a PLC is required. Technicians must have access to the mounting location.

* **Crew Responsibilities** – Approval for the mounting location is required.

* **Time Required** – Mounting the alarm hub takes approximately 30 minutes. The time required for wiring the hub to outputs is dependent on the number of output devices and their locations.

### QUICK FACTS

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Install Time</td>
<td>30 Minutes- 1.5 Hours</td>
</tr>
<tr>
<td>Rig Status</td>
<td>Racked, Moving or Operating</td>
</tr>
<tr>
<td>Requirements</td>
<td>Location near outputs</td>
</tr>
</tbody>
</table>
Alarm Hub Data Sheet

Overview
The alarm hub provides 5 discrete outputs to rig controls. It can control such items as an air kill for applying the brakes or feed digital inputs to a PLC.

Operating time
100% (continuous duty)

Voltage type
12-24 VDC, 7.5A normal operating range (can accept 11-32 VDC)

Operating temperature
-40°C to +60°C

Operating Frequency Range
900-928 MHz in North America
868-870 MHz in Europe

Material
Body material – Die-cast Aluminum Alloy w/ Powder Coat
Seals – Pre-formed Silicon Rubber Gasket

Connection
Woodhead, bulgin or amphenol connections are available.

Mounting options
Bolt on bracket

Hazardous locations
Class 1 Zone 2
Ex nA IIB, Groups T3
Certified to: CSA C22.2 NO. 142-1987
CSA C22.2 NO. 60079-0:07 IEC E60079-15:02, UL std 1604, 508

Environmental Ingress Protection
IP67

Application
Drilling or service rigs

*Information subject to change without notice. Consult the factory for the most current data and part numbers.*

Rigsmart Systems, Inc.
4908 97 St.
Edmonton, AB
T6L 4B2
Ph: 780.438.9475
Email: info@rigsmart.com
Power Converter

Description of Function:

The Rigsmart system runs on 24\text{VDC}. If a 24\text{VDC} source is not readily available, a 120\text{VAC} - 240\text{VAC} source may be used in conjunction with a power converter box. The power converter box converts the AC signal to 24 VDC.

Location:

The power converter should be placed near the power disconnect switch, and can be mounted to the side of a cabinet, or on an exterior Rigsmart component stand.

Rig Requirements:

\textit{Rig Equipment} – The rig must supply a 120\text{VAC} - 240\text{VAC} source.

\textit{Rig Status} – Installation can occur while the rig is operating or racked. For safety, the installer may require a breaker to be shut off before connecting to the power source.

\textit{Crew Responsibilities} – Approval is required for the mounting location, as well as shutting off breakers.

\textit{Time Required} – Mounting time for the power converter box is approximately 30 minutes.

\begin{table}[h]
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\begin{tabular}{|l|l|}
\hline
\textbf{QUICK FACTS} & \\
\hline
\textbf{Install Time} & 15 Minutes \\
\hline
\textbf{Rig Status} & Racked, Moving or Operating \\
\hline
\textbf{Requirements} & 120\text{VAC} Source \\
\hline
\end{tabular}
\end{table}
Power Disconnect

Description of Function:

The power disconnect is the main ‘on/off’ switch for the Rigsmart system. The box requires a 24\textsubscript{VDC} power source provided from either the rig, or a Rigsmart power converter box.

Location:

The power disconnect is located between the power source and the panel or alarm hub. It is usually positioned closer to the panel and alarm hub for easy operation.

Rig Requirements:

\textbf{Rig Equipment} – The rig must supply a 24\textsubscript{VDC} source (or use a Rigsmart power converter).

\textbf{Rig Status} – Installation can occur while the rig is operating or racked, with no disruption to operations.

\textbf{Crew Responsibilities} – Approval is required for the mounting location, as well as shutting off breakers.

\textbf{Time Required} – Mounting time for the power disconnect box is approximately 15 minutes. This time may be increased if longer cables are required.

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<thead>
<tr>
<th>QUICK FACTS</th>
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<tbody>
<tr>
<td>Install Time</td>
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<tr>
<td>Rig Status</td>
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<tr>
<td>Requirements</td>
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</tbody>
</table>
Air Kill

Description of Function:

The air kill applies the rig’s brakes. It is switched on and off via the alarm hub or directly from the panel. The box can either apply the rig brakes directly, or it can be installed in parallel with an existing crown-o-matic system. The air kill engages and disengages air to the brake system based on programmed alarm points.

Location:

The air kill enclosure is usually mounted on the Rigsmart component stand or close to the brake actuator.

Rig Requirements:

**Rig Status** – Mounting can occur during drilling operations, although connection to the air supply requires approximately 30 minutes of down time. A clean, dry air supply from the rig is also required.

**Crew Responsibilities** - Some minor assistance from the crew may be required in locating air lines and shutting down air flow. A drawworks lockout is required during installation.

**Time Required** - The air kill takes approximately 1 hour to install.
Throttle Limiter

Description of Function:

The throttle limiter is a transducer and pneumatics box that can reduce or kill an air controlled engine throttle. This control monitors the block speed and slows the blocks down as collision points are approached. The throttle limiter can be paired with the auxiliary brake controller to slow the traveling blocks in both the up and down directions. Both can be adapted to be used with PLC controlled rigs.

Location:

The pneumatics box and transducer is usually located near the engine it’s controlling.

Rig Requirements:

Rig Status- The engine being controlled must be shut down for safe installation.

Crew responsibilities - Some minor assistance from the crew may be required to identify air lines.

Time Required- The throttle limiter takes approximately 1 hour to install.

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<tr>
<td>Install Time</td>
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<tr>
<td>Rig Status</td>
</tr>
<tr>
<td>Requirements</td>
</tr>
</tbody>
</table>
Auxiliary Brake Controller

Description of Function:

The Rigsmart auxiliary brake controller slows down the blocks using the rig’s existing auxiliary brake. It's used before coming to a hard stop when a limit is breached, ascending or descending. The rig’s auxiliary brake signal is wired through the controller and braking force is increased when the system identifies an imminent collision. The auxiliary brake controller can be paired with the throttle limiter to slow the traveling blocks in both the up and down directions.

Location:

The controller is typically located near the driller’s control panel.

Rig Requirements:

**Rig Status** – The auxiliary brake controller must be installed when the auxiliary brake is not required.

**Crew responsibilities** - Final calibration of the control should be performed with the rig’s maintenance personnel.

**Time Required** - The auxiliary brake controller takes approximately 2 hours to install and 1 hour for calibration.

<table>
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<th>QUICK FACTS</th>
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<tbody>
<tr>
<td>Install Time</td>
<td>3 Hour</td>
</tr>
<tr>
<td>Rig Status</td>
<td>Racked or Moving</td>
</tr>
<tr>
<td>Requirements</td>
<td>Aux Brake Control Signal recalibration</td>
</tr>
</tbody>
</table>
Functional Design Description Electronic Brake Controller

This document serves as the functional design specification for the Rigsmart Electric Auxiliary Brake controller.

The Electric Auxiliary Brake Controller is designed to work with Eddy Current aux brakes.

The Control voltage signal generated by the driller’s control is passed through the Rigsmart controller.

The Rigsmart controller passes this signal through to the aux brake control board un-modified, unless a potential collision is determined while the blocks are descending.

At this point, the driller’s aux brake signal voltage will be modified by the Rigsmart system to engage the aux brake. In this way, the aux brake can be used to slow down the blocks before initiating a hard stop.

The Rigsmart system constantly monitors the speed and position of the blocks with reference to pre-defined zones within the derrick.

The brake controller signal will always override the driller’s signal on any system fault, or if the Rigsmart system is powered down for any reason.
**Functional Design Description Pneumatic Brake Controller**

This document serves as the functional design specification for the Rigsmart Pneumatic Auxiliary Brake controller.

The Pneumatic Auxiliary Brake Controller is designed to work with Eaton/Wichita style aux brakes.

The controller sends a variable signal to the aux brake based on speed and position of the blocks, with reference to pre-defined zones within the derrick.

This signal to the controller is outputted by the Rigsmart alarm hub.

The Rigsmart alarm hub is controlled by the Rigsmart panel/receiver which monitors block speed, position and any other auxiliary equipment such as top drive bails, etc.

The controller can be pre-set to a specific output pressure which matches the pressure range of the aux brake it is used with. In this way, the aux brake can be used to slow down the blocks before initiating a hard stop.
**Electronic Throttle limiter**

**Description of Function:**

The Rigsmart electronic throttle limiter slows down the blocks by cutting the throttle signal when the blocks are ascending. It’s used before coming to a hard stop when a limit is breached. The throttle signal is wired through the controller and the throttle is reduced when the system identifies an imminent collision. The controller is inserted in-line between the driller’s foot throttle and the throttle controller. The throttle limiter can be paired with the auxiliary brake controller to slow the traveling blocks in both the up and down directions.

**Location:**

The controller is typically located near the driller’s control panel or in the driller’s SCR control box.

**Rig Requirements:**

**Rig Status** – The control must be installed when the rig is not performing any drilling or tripping operations.

**Crew responsibilities** - Final calibration of the control should be performed with the rig’s electrician.

**Time Required** - The electronic throttle limiter takes approximately 2 hours to install and 1 hour for testing.

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**QUICK FACTS**

<table>
<thead>
<tr>
<th>Install Time</th>
<th>3 Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rig Status</td>
<td>Racked or Moving</td>
</tr>
<tr>
<td>Requirements</td>
<td>Throttle Control Signal Testing</td>
</tr>
</tbody>
</table>
This document serves as the functional design specification for the Rigsmart Electric Throttle Controller.

The Electric Throttle Controller is designed to work with electronic throttle signals which are fed into a PLC or SCR system.

The throttle control voltage signal is passed through the Rigsmart controller.

The Rigsmart controller passes this signal through to the throttle control board unmodified, unless a potential collision is determined.

At this point the driller’s throttle signal will be cut back to reduce speed while the blocks are ascending, before initiating a hard stop.

The Rigsmart system constantly monitors the speed and position of the blocks with reference to pre-defined zones within the derrick.

The brake controller signal will always override the driller’s throttle signal on any system fault, or if the Rigsmart system is powered down for any reason.
System Information

WHITE WIRE, TB1 NC ON THE RELAY (NORMALLY CLOSED CONTACT)
THROTTLE POWER
THIS IS POWER TO THE PEDAL WHICH DOES NOT CHANGE WHEN THE DRILLER
DEPRESSES THE FOOT PEDAL.
POSSIBLE VOLTAGES ARE:
- 0 VOLTS DC
+ 15 VOLTS DC
+ 1 VOLTS DC

BLACK WIRE, TB1 NO ON THE RELAY (NORMALLY OPEN CONTACT)
THROTTLE RETURN
THIS IS THE 0 VOLTS SIGNAL WHICH DOES NOT CHANGE WHEN THE DRILLER
DEPRESSES THE FOOT PEDAL.
VOLTAGES ARE:
0 VOLTS DC

RED WIRE, TB1 COM ON THE RELAY (COMMON CONTACT)
THROTTLE SIGNAL OUT
THIS IS THE 0 VOLTS SIGNAL WHICH CUTS THRUSTILE IN AN ALARM CONDITION.
POSSIBLE VOLTAGES ARE:
0 VOLTS DC

The control will always pass through the drillers signal unless:
The drill is in a collision zone and above the speed limit.
In the above case the alarm hub will turn its output on and energize the coil of the relay which will
out the throttle signal to 0 volts until either of the 2 conditions cease.
In the event of the rigsmart system being powered down the relay will fail to its fail state and
pass through the drillers signal.

Notes

NOTE 1:
CONNECT TO OUTPUT #2 ON ALARM HUB ONLY (NORMALLY CLOSED)

System Details

Date: 13-06-2014

Title: RIGSMART ELECTRONIC THROTTLE CUTOUT 900-5545

Drawing 01 of 01 Rev: 03
PLC Integration

Description of Function:

The Rigsmart system can communicate with a rig's existing PLC. Discrete alarms from Rigsmart can be input to a PLC and the Rigsmart system can accept discrete alarms from a PLC. Analog signals can also be outputted and accepted between systems. The Rigsmart system can communicate through various protocols, such as: Profibus, RS-485, RS-232, etc.

The advantage of integrating the Rigsmart system with an existing PLC is that no additional components are required, since the PLC already manages control of the throttle and braking functions. In this respect, Rigsmart’s wireless technology can act as the sensory system for any existing zone management system.

Location:

The connection can be wired into any of the rig’s PLC cabinets.

Rig Requirements:

**Rig Status** - Drilling operations must be stopped while interfacing with the PLC. There may be other requirements specified by the manufacturer of the PLC.

**Crew responsibilities** – An electrician or technician from the PLC manufacturer must direct the interface to the PLC. The details and responsibilities for this are agreed upon after Rigsmart has received the rig survey and specifications of the PLC.

**Time Required** – Connection to the PLC takes only several minutes. Testing the operation with the new input parameters may take up to 2 hours.
Rigsmart Component Stand

Rigsmart components are typically installed on a stand (pictured below) that is mounted near the rig drawworks. Typical components which are mounted on this stand are: alarm hubs, air-kills, speed control components, and power supplies.

The location of the stand is typically decided upon with the rig crew, with the intent of avoiding the need of cables or airlines during rig up or rig down operations.
System Information

Anti-Collision Logic

Collision points and travelling equipment change according to each rig. A functional design specification for the anti-collision system is provided for each individual rig and approved by the customer, prior to the system being manufactured.

The following is an example of that functional design specification.

Introduction

This document serves as the functional design specification for the Rigsmart Anti-Collision system.

The Anti-Collision system comprises multiple wireless sensors mounted on specific pieces of equipment. The sensors will transmit to a central receiver/display panel mounted in the doghouse. The Rigsmart system will then output signals which will interface with the rig’s Baylor brake, drawworks band brake and drawworks foot throttle.

Description

The Rigsmart anti-collision system will monitor the following equipment:

- **Top drive bails** (Rigsmart will continuously monitor the bail angle on 1 set of bails.)
- **Block position and speed** (Rigsmart will continuously monitor block position and speed via an encoder mounted on the drum shaft of the 1320 UE drawworks.)
- **Hardware crown saver switch** - mounted to the deadline at the crown and triggered when the travelling blocks lift a counterweight. (Failsafe crownsaver)
- Rig air supply pressure
**System Outputs:**

- **Throttle cut-out** integrated with the drawworks foot throttle
- **Electronic brake control** integrated with the Baylor brake
- **Standard redundant air-kill** integrated with the crown saver pneumatic stop.

**Collision ‘stop’ limits will be broken down to the following (refer to limits drawing):**

- **Hardware crown saver stop** (this is triggered when the blocks contact the counterweight attached to the deadline, while ascending.)

- **Racking board upper limit stop** (this is triggered when the top drive bails are tilted past the boards limit and the blocks have breached the elevation limit, while descending.)

- **Racking board lower limit stop** (this is triggered when the top drive bails are tilted past the boards limit and the blocks have breached the elevation limit, while ascending.)

- **Link tilt limits** (this is the maximum the bails can extend without contacting the monkey board.)

- **Software floor saver stop** (this is triggered when the blocks have breached the elevation limit, while descending.)

All limits and elevations are field-adjustable and will be set with the crew during commissioning.

All stop signals and operator functions are logged with a time stamp in the receiver and can be retrieved at any time.
Collision ‘speed control’ limits will be broken down to the following (refer to limits drawing):

- **Crown saver speed control zone** (this ‘slow down’ signal will be triggered when the top drive has entered the speed control zone and has exceeded the speed limit, while ascending.)

- **Racking board speed control zone** (this ‘slow down’ signal will be triggered when the top drive has entered the speed control zone and has exceeded the speed limit ascending or descending, with the bails extended past the safe limit.)

- **Floorsaver speed control zone** (optional) (this ‘slow down’ signal will be triggered when the top drive has entered the speed control zone and has exceeded the speed limit, while descending.)

All limits and elevations are field-adjustable and will be set with the crew during commissioning.

If any speed controls limits are breached by the top drive while ascending, the system will cut the foot throttle signal prior to the hard stop.

If any speed controls limits are breached by the top drive while descending, the system will apply the Baylor brake prior to the hard stop.

All ‘slow down’ signals and operator functions are logged with a time stamp in the receiver and can be retrieved at any time.
Installation and Commissioning

The system can be installed in 2 days (dependant on rig access). 85% of the installation will not affect rig operations. Down time will be required to install the following equipment:

- Drawworks installation – 3 hours
- Top drive installation – 2 hour
- Crown saver installation – 3 hours

Commissioning of the system will take approximately 4 hours.
Commissioning, Testing and Training

**Description of Function:**

Commissioning, testing and training are considered the most important part of the installation procedure. Calibrations are vital to optimal system performance, and each component must be proven to interact with the panel software as it was designed, for each specific rig.

It is Rigsmart’s goal is to train operators and crews to use and maintain their own systems safely and effectively. Collision and zone management limits are set and adjusted with the rig crew’s input and cooperation. Post installation service is available 24/7, but through adequate training many service related issues can be avoided.

**Rig Requirements:**

**Rig Status** – The rig must be operational and able to provide a full function test.

**Crew Responsibilities** – A driller or Rig Manager is required to operate the different functions of the rig such as raising or lowing the blocks, link-tilt or moving the top drive. The crew will also be required to provide input on collision limits for the system.

**Time Required** - Testing each component can take up to 30 minutes per component. Commissioning the full system may take up to 4 hours, depending on the situation. Training the Rig Manager and crew may take anywhere between one hour of instruction to several days of operational-drilling tutorials.