Error Proofing Assembly Processes
Manufacturing with ongoing quality and productivity
Error Proofing Assembly Processes

Commitment to ongoing quality
Total quality management
Error Proofing: Key to Quality

Quality demands on manufacturers have been high for years, and the future will see those demands continue to rise. It is no longer good enough just to produce a high quality product. Expectations have climbed to a point where that high quality product also has to be delivered Just-in-Time (JIT), in the proper sequence (mainly for sub components), and provide a level of traceability that enables visibility to all stakeholders.

There is no mistake – quality is an ongoing, fundamental part of any manufacturing process. It means continuous improvement. It also means that quality is everyone’s responsibility, it’s not just one department or only done at the end of the process. Error proofing devices, referred to as Poka-Yoke devices, such as sensors, need to be integrated into the process with complete traceability throughout. Also, provisions have to be in place to quickly and easily add new Poka-Yoke devices and additional traceability as requirements evolve.

Error Proofing is:

- **Quality**
  - Bearing
  - Bearing Grease
  - Spring Washer

- **Sequencing**

- **Just-in-Time**

- **Traceability**
The Process

Error proofing is a simple 1-2-3 process: Identify, Detect, and Contain

During the development of the manufacturing line, trouble spots are projected based on experience. However, during the life of a manufacturing line, additional trouble spots will inevitably surface. Simply identify those spots, implement a detection method, and develop a means to contain it.

1: Identify Trouble Spots
Errors in manufacturing and assembly processes happen and need to be identified or predicted before you can take action.

2: Implement Detection
Active error-proofing uses sensors and vision systems to actively verify that a process is completed correctly.

3: Contain Discrepancies
There are three main ways to contain discrepancies: scrap, reclassify, or rework the part.
1: Identify Trouble Spots

In the world of error proofing, any manual operation has the potential to induce human error. This includes any manual assembly operation and manual machine setup tasks. These areas require evaluation to ensure they meet appropriate quality standards such as Total Quality Management (TQM). As a general rule, every manual assembly operation should have at least two Poka-Yoke checks.

Some Common Trouble Spots Include:

- **Missing or wrong parts:** Many parts are small with little visible distinction. Operators have trouble if systems are not in place to detect the wrong or missing parts.

- **Missing or incomplete threads:** Threads are a common problem in manufacturing. Missing or incomplete treads can occur with bolts, studs and tapped holes.

- **Installation sequence:** Repetitive installation sequences are often identified as troublesome areas. Most common are operations where multiple parts such as washers, spacers, O-rings and fastening devices are stacked on a common component.

- **Evaluating color:** Over a short period of time, an operator becomes desensitized to colors. Color sensors are proven reliable in situations where repetitive color selection is required.

- **Manual data entry:** The average error rate for keystroke entry is 1%, or one error in every 100 keystrokes. The best method to prevent errors is to eliminate data entry by using RFID or bar code systems.

- **Manual machine setup problems:** Mistakes with manually switched over machine change parts or manual entered configuration data can cause immediate machine malfunction, but worse yet are the ones not caught immediately. These errors can make their way down the process, compounding the error costs. Automatic identification with RFID or bar code is a simple and effective means to ensure the machine is set up correctly before the machine goes back into production.

- **Critical fastener torque and sequence:** Electric torque controllers are a step in the right direction, but issues can still arise. The main problem is in knowing the exact bolt that a specific torque is being applied to and the tightening sequence. Spatial positioning for torque tools has proven effective to handle this situation.

- **Products being mislabeled or mismarked:** Anytime there is manual marking or labeling, there is potential for errors. These possible errors can be avoided with a simple traceability system.

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2: Implement a Detection Method

There are two types of error proofing used in manufacturing – passive and active. Passive error proofing uses mechanical keying that ensures a process cannot be performed incorrectly. This is an effective and economical option; however, it’s not very flexible.

Active error proofing uses sensors and vision systems to actively verify that a process is completed correctly. Active error proofing is much more flexible and can provide more data than a passive device. Furthermore, traceability is easily integrated with active error proofing. Implementing active error proofing is accomplished by using either a discrete or analog sensor, color sensor, or a vision based sensor. Sensors are simple and cost effective, while vision based sensors are capable of more detailed inspections.

Implementing Sensors

Sensors provide standardized outputs that are either discrete (yes/no) or analog (measurement). Which one to use depends on the level of error proofing needed. Discrete sensors are simple and extremely easy to integrate. Analog sensors are able to convey actual measurements or product position information. Either of these outputs can interface directly to a modular expandable I/O system that interfaces to the lockout or rework diverter functions. Simple indicator lights, panel meters, or a man machine interface can also be used.

- Discrete sensors provide an on-off signal to indicate non-conformance.

- Analog sensors take an actual measurement ideal for highly flexible applications or statistical process control.
Implementing Vision

Vision based sensors take over where traditional sensors leave off. Vision can be generally divided into two basic categories: Vision Sensors and Vision Systems. Vision sensors such as Balluff’s BVS line are ideal for error proofing applications. They are simple, cost effective, and flexible. Vision systems are designed for complex operations such as robot guidance, image analysis, and image capture and storage.

Situations that require the use of vision include:

■ **Parts are not well fixtured**
  If the part is not contained in a fixture, or there is no opportunity to bring the part into an inspection station that has better tolerance, then a vision system is the best choice. Example: parts directly on moving conveyor belt.

■ **Multiple inspection points per part**
  If there are multiple details on the part to error proof, vision systems are recommended. Example: inspecting multiple pins in a connector.

■ **Location of detail is not known or is random**
  If the location of the detail on the part in question is not constant or its location is random, then vision systems are an ideal choice. Example: random location of bolt on stud.
Sensor Based Detection
Yes/No – discrete sensors

Simple and effective, discrete sensors provide yes/no results for many applications. These sensors are ideal when parts are fixtured well.

**Thread detection**
Standard diffuse laser is used to look for the threaded surface.

**Trim install**
Standard diffuse laser is used to see the shade and/or texture difference of an install trim piece.

**Part position**
Laser retro-reflective sensor is used to ensure fastener is completely seated in place.

**Missing part**
Laser though-beam is used to ensure critical component is in position.

**Missing part**
Background Suppression (BGS) laser is used to detect small component on close background.

**Installation sequence**
Standard diffuse laser is used to see the shade difference between the metal washer and the black sealing washer.
Specialty sensors

**Sealant/grease detection**
When UV tracers are present in the sealant or grease, detection of proper material and amount is easily accomplished.

**Color matching**
The color sensor is taught a known good color and is then ready to detect that color based on a tolerance factor.

**Measurement sensors**
By using a measurement sensor, the correct part or component can be verified. This also aids in flexible manufacturing.

**Size verification – Part seated**
With multiple fasteners and possible depths, a measurement sensor can provide all the details needed for verification.

**Tool position – Linear**
Spacial position applications with linear movement are reliably and economically solved by linear position traducers.

**Tool position – Rotary**
Spacial position applications with rotary movement are reliably and economically solved by magnetic tape encoders.
The Perfect Error Proofing Tool

Vision simplifies complex sensing applications

In most production situations, vision systems can be overkill – too expensive, too much functionality, and just too complex. Instead, Balluff vision sensors are easy to set up, simple to use, and quicker to return your initial investment.

The Balluff vision sensor is a powerful error proofing tool that can be used in almost any area of your manufacturing process. It provides reliable part or feature presence/absence and position detection, plus dimension verification and accurate barcode reading with crisp and reliable resolution. The Balluff vision sensor has far more functionality than any discrete sensor, sensor array, or vision product in its class.

Increases Product Quality
- Eliminates unreliable manual inspection
- Allows 100% quality checking instead of audit checking
- Provides the resolution needed for reliable quality inspection
- Enables automated barcode reading

Reduces Costs
- Single-unit operation replaces expensive, cumbersome multi-sensor solutions
- Three models with multiple performance levels to choose from provide multiple price points based on functionality
- An easy to use software package minimizes setup time and cuts startup costs
- Provides vision performance at smart sensor pricing

Increases Productivity
- Improves line speed and error proofing by eliminating the need for manual inspection
- Minimizes false code reads with very high code resolution for greater reliability
- Catches errors sooner to reduce unplanned downtime and scrap
- Reduces planned downtime with greater functionality and flexibility
Balluff Vision Sensor Series Application Examples

The Balluff Vision Sensor can replace many different discrete and analog sensor functions along with entire sensor arrays in a single error proofing device.

**Automotive – Standard Version**

**Dimensional gauging/component inspection**
Inspect fuel injector for verification/presence of electrical cap, injector nozzle, o-ring, and gauging for the proper injector width.

- Verify presence of components and proper injector width
- Missing o-ring
- Missing cap

**Automotive – Advanced Version**

**Geometric pattern matching – searches X, Y, and 360° rotation for geometric features**
Verify presence of bearings and size of gaps.

- Bearings present; gaps correct
- Incorrect gap

**Electronics – Standard Version**

**Assembly verification**
Inspect a circuit board to ensure that all connectors are present and verify the correct orientation of all the capacitors.

- All connectors are present and capacitors are in correct orientation
- Bad orientation
- Missing connector

**Packaging – ID Version**

**Verify barcodes**
- Codes are read irrespective of slight changes in position
- High detection rate

**Verify data matrix codes**
- Codes are read irrespective of the position
- High detection rate
- ECC 200 compliant
Color Sequencing

With flexible manufacturing, product color is constantly changing on the same production line. Over time, humans have difficulty identifying color. This fact has driven true color sensors to become vital Poka-Yoke devices. These devices are simple and effective... just teach all possible colors and then the sensor will signal if your intended specific color is present.

To address sequencing challenges, true color sensors verify the components when preparing the shipment as well as verifying the shipment once it has arrived. When multiple color combinations are required, true color sensors match the sub-component color to the main component color signaling a match.
Traceability for Just-in-Sequence

Just-in-Sequence (JIS) is a subset of Just-in-Time (JIT) material flow. Common in flexible manufacturing assembly lines, JIS not only brings sub-components to the line at the right time, but also in the correct sequence. By sequencing the sub-components to match the assembly sequence, critical automation equipment always pull the correct parts.

Traceability is the method by which multiple vendors can ensure delivery of sequenced products. By using Ultra High Frequency (UHF) Radio Frequency Identification (RFID) in combination with a multi-barcode scanner, part shipping pallets and containers can be tracked with exact pocket location. The specific build data on the part from the 2D barcode can be combined with other parts into a database logged with the RFID tag. By using RFID, vendors’ systems do not have to be highly integrated to achieve error proof sequencing.
Traceability is an integral part of containment. In flexible manufacturing environments, traceability data identifies and tracks the specific version to be manufactured. This is accomplished with build data, which is a complete description of the intended part. For example, if the build data calls out a dark blue part, the color sensor must confirm this. Thus, the Poka-Yoke devices verify what the build data is asking for.

Discrepancies occur when build data and Poka-Yoke device data does not match. There are 3 main ways to deal with discrepancies:

■ **Scrap the part**
  Containment is a major issue. Care must be taken to immediately destroy the part or mark it in some way that it cannot be used downstream. Use of a traceability system to contain the part is essential.

■ **Reclassify the part**
  In very select applications, products not meeting eligible parameters can be reclassified into different products. This type of application requires tight traceability controls.

■ **Rework the part**
  One method of rework is to stop production and fix the part on the spot, in station. However, this can have repercussions throughout the plant. A better method is to incorporate a rework area. Rework areas are common when sequential conveyors are used to move product through various assembly operations. When an error is detected, downstream processes can be bypassed and the repair technician is shown the exact nature of the error. After repair, traceability data allows the reworked part to start over again, skipping steps that have already been performed.
Take Control of Your Rework Area

Reworking a nonconforming part is challenging. Rework areas often have limited controls making it possible for a part to enter with one problem and leave with a new one. Fortunately, traceability enables tighter controls.

Based on the actual problem with the part, constraints are placed over the rework area to limit the access of rework technicians. This can be done by locking out certain tools using spatial positioning to constrain tools to the affected areas. Spatial positioning monitors the tool’s actual position using linear or rotary position sensors to ensure the correct area is being worked. More common are electric tools that are simply disabled if in the wrong position.

When rework is complete, traceability information will guide the part back through existing in-process inspections as deemed appropriate by the process. These records are also maintained for future training and process improvements.
Add Complete Visibility to your Assembly Systems

**RFID enables complete traceability in flexible manufacturing systems**

Manufacturing plants utilizing automated assembly have unique requirements when it comes to tracking their Work-in-Process (WiP). Accurate, real-time tracking brings complete visibility to processes. Tracking can also include all the lineage information from all the components used in the final assembly. Most automated manufacturing lines also utilize flexible manufacturing where multiple product versions are made on one line. When looking at automated assembly in total, there are three primary areas of tracking: Build, Process, and Lineage Information.
Traceability – A Key to a Strong Containment Strategy

When looking at traceability in assembly plants, there are three primary areas of tracking: Build, Process, and Lineage Information.

- **Build information**
  Used heavily in flexible manufacturing environments, build information fully describes all variables in producing a specific part. It is essentially a build sheet that instructs the assembly process what is required to produce that unique version. Build information can be held locally on an RFID tag or in a centralized database identified by the tag.

- **Process information**
  With dual uses, process information is critical to the manufacturing process. It holds the results from all the in-process tests and Poka-Yoke devices. There are two main uses; flow control and archiving. With flow control, in-process test results are conveyed downstream so the process flow can be adjusted accordingly. If a particular part failed a test, downstream processes can be bypassed and the part can be sent to a rework area, where the exact problem is then presented to rework technicians. Archiving is used for postproduction tracking. Process data is stored for later use in recall, liability, and regulatory situations.

- **Lineage information**
  Similar to archiving process data, lineage data adds the additional step of tracking each component used in the final assembly. By consolidating all component data with the process information, a part’s complete construction is documented. This is vital in the event of a product recall, and to maintain regulatory compliance.
Control architectures have significant impact on how a total error proofing and traceability program is implemented. Having a system that works well initially is somewhat easy. The real test is how well it works as time goes on. In an error proofing environment, easy expandability is a unique requirement.

It is important to specify the appropriate control architecture during the initial design and build phase. This requires an architecture that easily integrates Poka-Yoke devices and traceability devices, such as Radio Frequency Identification (RFID), into one seamless system that allows easy and low cost expansion for the future.

Balluff has developed expandable architecture built around the open standard of IO-Link. This architecture seamlessly integrates Poka-Yoke devices and industrial identification devices. By keeping a few IO-Link ports open, future expansion is easy and cost effective. And the best part is the ability to implement the expandable architecture on popular control platforms from Allen-Bradley, Siemens, Mitsubishi and others.
Endless Error Proofing Possibilities – With Just One Network Connection

Continuous process improvement often means adding to your existing control system. Fortunately, Balluff’s IO-Link technology is the perfect balance between plant engineering and continuous improvement groups.

**IO-Link Masters**
- 4 port and 8 port versions
- Parameter server functionality
- Fully programmable display

**Smart Light**
- Stack light Mode: 1-5 zones
- Level Mode: high/low level
- Configure: colors, brightness, levels, etc.

**Smart Sensors**
- Photoeye, Prox, Ultrasonic, Pressure Sensors
- Software storable and programmable parameters
- Diagnostics and digital measurements

**RFID Traceability**
- Simple to implement, easy to use
- 8 byte or 30 byte read/write versions
- Enables flexibility and visibility in the machine

**Linear Transducers**
- No shielded cable runs and 32 bit signed integer
- Programmable stroke and set points
- Available from 2" to 180"

**Discrete Sensors**
- Up to 16 laser sensors
- IP67 metal or plastic, M8 or M12
- Inputs, outputs, configurable

**Laser Measurement Sensors**
- Take measurements up to 6m away
- Ideal for flexible manufacturing
- Laser light is visible for targeting

**True Color Sensors**
- For color sequencing and matching
- Teach up to 3 colors
- Ideal for flexible manufacturing

**Vision Sensor**
- Simple and effective error proofing tool
- Poka-Yoke checks and ID in one
- Simple 1, 2, 3 programming

**Consult factory for connection options**

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### Fieldbus modules

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## LED Signal Tower Light

<table>
<thead>
<tr>
<th>Model</th>
<th>BNI001W</th>
<th>BNI001Y</th>
<th>BNI0022</th>
<th>BNI0006</th>
<th>BNI005T</th>
<th>BNI008C</th>
<th>BNI0041</th>
<th>BNI0042</th>
<th>BNI005M</th>
<th>BNI0043</th>
<th>BNI007F</th>
<th>BNI0072</th>
<th>BNI0074</th>
<th>BIC0070</th>
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<td>Part number</td>
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## Inductive Couplers

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<thead>
<tr>
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<th>BNI001W</th>
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<th>BNI005T</th>
<th>BNI008C</th>
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<th>BNI0042</th>
<th>BNI005M</th>
<th>BNI0043</th>
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<tr>
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</table>
# Industrial Identification

## Industrial RFID and Vision Sensors for production visibility

### Field components

#### IO-Link

<table>
<thead>
<tr>
<th>Type</th>
<th>Ordering code</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO-Link</td>
<td>BIS00LW</td>
<td>BIS M-402-002-07-S4</td>
</tr>
<tr>
<td>IO-Link</td>
<td>BIS0105</td>
<td>BIS M-402-002-07-S4</td>
</tr>
<tr>
<td>IO-Link</td>
<td>BIS00M1</td>
<td>BIS M-402-002-07-S4</td>
</tr>
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<td>IO-Link</td>
<td>BIS0106</td>
<td>BIS M-402-002-07-S4</td>
</tr>
<tr>
<td>IO-Link</td>
<td>BIS0UY</td>
<td>BIS M-402-002-07-S4</td>
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<tr>
<td>IO-Link</td>
<td>BIS0107</td>
<td>BIS M-402-002-07-S4</td>
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<td>IO-Link</td>
<td>BIS0108</td>
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<td>IO-Link</td>
<td>BIS0109</td>
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**IO-Link version**: 1.1 only

### Ordering code

#### Part number

<table>
<thead>
<tr>
<th>Model</th>
<th>BVS ID-3-005-E</th>
<th>BVS ID-3-001-E</th>
<th>BVS ID-3-003-E</th>
<th>BVS ID-3-105-E</th>
<th>BVS ID-3-101-E</th>
<th>BVS ID-3-103-E</th>
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<tbody>
<tr>
<td>Vision Sensors</td>
<td>BVS001R</td>
<td>BVS0001</td>
<td>BVS000T</td>
<td>BVS001C</td>
<td>BVS0019</td>
<td>BVS001A</td>
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<tr>
<td>Standard</td>
<td>BVS001R</td>
<td>BVS0001</td>
<td>BVS000T</td>
<td>BVS001C</td>
<td>BVS0019</td>
<td>BVS001A</td>
</tr>
</tbody>
</table>

**Specifications**

- **Light type**: red, LED
- **Light type**: infrared, LED
- **Lens**: 6 mm, 8 mm, 12 mm
- **Working distance**: Reading the barcode and data matrix code
- **Verifying manufacture and expiration dates (OCV)**
- **Checking brightness and contrast**
- **Checking part position, diameter and width**
- **Detect patterns**
- **Detect 360 °C patterns**
- **Detect 360 °C contour**
- **Ethernet interface**
- **RS232 port**
- **Degree of protection as per IEC 60529**: IP 54, IP 54, IP 54, IP 54, IP 54, IP 54, IP 54, IP 54, IP 54, IP 54, IP 54, IP 54, IP 54
### Object Detection

**Photoelectric sensor technology for miniaturized modules and standard applications**

**True-Color-Sensor for color detection applications**

#### BIS M tags

<table>
<thead>
<tr>
<th>Model</th>
<th>True-Color-Sensor</th>
<th>Plastic fiber</th>
<th>Adapter lugs</th>
<th>M8 to 9 pin Dsub interface cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>BFS000L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BFS000C</td>
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<tr>
<td>BFS000J</td>
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<tr>
<td>BFS000K</td>
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<tr>
<td>BFS000M</td>
<td></td>
<td></td>
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<tr>
<td>BFS000N</td>
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<tr>
<td>BFS000P</td>
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#### Ordering code

<table>
<thead>
<tr>
<th>Part number</th>
<th>Number of colors detected</th>
<th>Output function</th>
<th>Sensing range</th>
<th>Length</th>
</tr>
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<tbody>
<tr>
<td>BFS000L</td>
<td>7</td>
<td>3 bit output</td>
<td>n/a</td>
<td>2 m</td>
</tr>
<tr>
<td>BFS000C</td>
<td></td>
<td>Push/Pull</td>
<td>130 mm</td>
<td>2 m</td>
</tr>
<tr>
<td>BFS000J</td>
<td></td>
<td>NO/NC</td>
<td>400 mm</td>
<td>2 m</td>
</tr>
<tr>
<td>BFS000K</td>
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<td></td>
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<tr>
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</tr>
<tr>
<td>BFS000P</td>
<td></td>
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</tr>
</tbody>
</table>

#### Vision Sensors

- **BVS001M**: IP 54
- **BVS001N**: IP 54
- **BVS001L**: IP 54
- **BVS001H**: IP 54
- **BVS001F**: IP 54
- **BVS001J**: IP 54
- **BVS001K**: IP 54

#### Universal

- **BVS001M**: 8 mm, 12 mm, 6 mm, 8 mm, 12 mm, 6 mm, 16 mm
- **BVS001N**: 8 mm, 12 mm, 6 mm, 8 mm, 12 mm, 6 mm, 16 mm
- **BVS001L**: 8 mm, 12 mm, 6 mm, 8 mm, 12 mm, 6 mm, 16 mm
- **BVS001H**: 8 mm, 12 mm, 6 mm, 8 mm, 12 mm, 6 mm, 16 mm
- **BVS001F**: 8 mm, 12 mm, 6 mm, 8 mm, 12 mm, 6 mm, 16 mm
- **BVS001J**: 8 mm, 12 mm, 6 mm, 8 mm, 12 mm, 6 mm, 16 mm
- **BVS001K**: 8 mm, 12 mm, 6 mm, 8 mm, 12 mm, 6 mm, 16 mm

#### Specifications

- **Sensing range**: n/a, 130 mm, 400 mm
- **Length**: 2 m, 2 m, 2 m
### Object Detection

**Photoelectric sensors with discrete and analog outputs**

#### Discrete

<table>
<thead>
<tr>
<th>Type</th>
<th>BOS 08M</th>
<th>BOS 12M</th>
<th>BOS 18M</th>
<th>BOS 18M</th>
<th>BOS 18M</th>
<th>BOS 18M</th>
<th>BOS 18M</th>
<th>BOS 18M</th>
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<tbody>
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<td>Supply voltage</td>
<td>10...30 V DC</td>
<td>10...30 V DC</td>
<td>10...30 V DC</td>
<td>10...30 V DC</td>
<td>10...30 V DC</td>
<td>10...30 V DC</td>
<td>10...30 V DC</td>
<td>10...30 V DC</td>
</tr>
<tr>
<td>Output function</td>
<td>PNP NO/NC</td>
<td>PNP NO/NC</td>
<td>PNP NO/NC</td>
<td>PNP NO/NC</td>
<td>PNP NO/NC</td>
<td>PNP NO/NC</td>
<td>PNP NO/NC</td>
<td>PNP NO/NC</td>
</tr>
<tr>
<td>Connection</td>
<td>Connectors/ cables</td>
<td>Connectors/ cables</td>
<td>Connectors/ cables</td>
<td>Connectors/ cables</td>
<td>Connectors/ cables</td>
<td>Connectors/ cables</td>
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<td>Connectors/ cables</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-10...+60 °C</td>
<td>-10...+50 °C</td>
<td>-5...+55 °C</td>
<td>-5...+55 °C</td>
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<td>-10...+50 °C</td>
<td>-25...+55 °C</td>
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<tr>
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<td>IP 67</td>
<td>IP 67</td>
<td>IP 67/IP 67</td>
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**Housing material**

| Metal | Metal | Metal | Metal | Plastic | Plastic | Metal | Plastic |

Many other products are included in our complete object detection product line.

#### Analog

<table>
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<tr>
<th>Type</th>
<th>Working range</th>
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<tr>
<td>BOD 6K</td>
<td>20...80 mm</td>
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<td>BOD 21M</td>
<td>20...200 mm</td>
</tr>
<tr>
<td>BOD 26K</td>
<td>30...100 mm</td>
</tr>
<tr>
<td>BOD 26K</td>
<td>80...300 mm</td>
</tr>
<tr>
<td>BOD 63M</td>
<td>200...2000 mm</td>
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<tr>
<td>BOD 63M</td>
<td>200...6000 mm</td>
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</table>

**Ordering code**

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<thead>
<tr>
<th>Part number</th>
<th>BOD000H</th>
<th>BOD000F</th>
<th>BOD000M</th>
<th>BOD000G</th>
<th>BOD000S</th>
<th>BOD0006</th>
<th>BOD000E</th>
<th>BOD000U</th>
</tr>
</thead>
</table>

**Light type**

| Red light | Laser light |

**Output**

| RS485 interface | PNP transistor | IO-Link | 2x PNP transistor | Alarm output |

**Ordering code**

| Part number | BOD000W | BOD0010 | BOD0012 | BOD000U |

**Output signal**

| 0...10 V | IO-Link | 4...20 mA |

**Degree of protection as per IEC 60529**

| Red light | Switching output PNP |

---

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### Linear Position Sensing and Measurement

The appropriate measuring principle for the optimal solution

**Optical, magneto-inductive and inductive**

<table>
<thead>
<tr>
<th>Model</th>
<th>Principle</th>
<th>Voltage</th>
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</thead>
<tbody>
<tr>
<td>BOS 5K laser</td>
<td>10...30 V DC</td>
<td>PNP/NPN NO/NC</td>
</tr>
<tr>
<td>BOS 6K laser</td>
<td>10...30 V DC</td>
<td>PNP NO/NC</td>
</tr>
<tr>
<td>BOS 21M laser</td>
<td>10...30 V DC</td>
<td>PNP NO/NC</td>
</tr>
<tr>
<td>BOS 28K laser</td>
<td>10...30 V DC</td>
<td>PNP/NPN NO/NC</td>
</tr>
<tr>
<td>BOS 5K</td>
<td>10...30 V DC</td>
<td>PNP/NPN NO/NC</td>
</tr>
<tr>
<td>BOS 28K</td>
<td>10...30 V DC</td>
<td>PNP/NPN NO/NC</td>
</tr>
<tr>
<td>UV sensor</td>
<td>3x PNP</td>
<td>PNP/NPN NO/NC</td>
</tr>
<tr>
<td>Through-foot sensor BGL</td>
<td>12...28 V DC</td>
<td>PNP/NPN NO/NC</td>
</tr>
<tr>
<td>Angle sensor BWL</td>
<td>10...30 V DC</td>
<td>PNP/NPN NO/NC</td>
</tr>
</tbody>
</table>

**Connectors/cables**

- IP 67
- Laser, red light

**Materials**

- Plastic
- Metal

**Physical Specifications**

- Temperature range: -10...+55 °C
- Laser: red light
- Teach-in Interchangeable optics
- Fluid/Transparent detection
- ABS/Metal

**Additional Features**

- Magnetic displacement sensors
- Working range: 256 mm, absolute, resolution 1 μm, read distance 0.35 mm
- Output signal SSI
- Magnetic detection
- Working range: 2 mm, output signal HTL
- 0..1 V, read distance 0.1 mm, output signal HTL

**Examples**

- BIP0002
- BIP0004
- BIP0005
- BIL004
- BAW0003
- BGL0004
- BML-SH...
- BML-S1C...
- BTL6-U...
- BTL6-M...
- BTL6-AD2...
- BTL6-C20...
- BTL6-G600...

**Manufacturer**

BALLUFF
Next Steps
Few process improvements can impact your bottom line like a well-executed error proofing strategy. By utilizing an infrastructure of modular expandable I/O for Poka-Yoke devices and an effective traceability program, you will be far ahead of the game. The rest is as easy as 1, 2, 3 – Identify, Detect, and Contain.

Rely on Balluff’s in-plant assistants when trouble spots are identified. There are often a few different methods to detect errors and Balluff has experts that can suggest the best method for almost every situation. Also, plant-wide audits are a valuable means to address multiple issues at one time.

As your error proofing partner, Balluff is uniquely positioned to assist you in all phases of your error proofing strategy. Balluff’s modular expandable I/O systems establish a strong architectural foundation for years to come. This I/O system perfectly integrates our traceability products as well as our wide line of Poka-Yoke devices. No single supplier is more capable of supplying a complete and more integrated error proofing strategy.

Contact Balluff to take the next step in your continuous improvement.
A successful error proofing project requires a competent partner for the life of the system. This includes conception, planning, testing, and training.

Balluff has experience in assisting customers develop the architecture for their unique needs. Additionally, Balluff works with partners, such as qualified systems integrators and machine builders, that can provide complete error-proofing solutions or simply help with integration or more advanced automation.

Application advice through our Tech Support
Discuss your technical requirements and take advantage of our expertise.

Real-world examples
- Assist in defining data maps and data locations – central vs. decentralized
- Review tracking technologies – bar code and LF, HF and UHF RFID
- Architecture layout to ensure the most cost-effective system
- Component selection assistance

Customized software for handhelds
Balluff can custom-configure the software for handhelds for your mobile tracking needs.

As a user of industrial RFID or barcode, you need a handheld that speaks your language. Balluff engineers can program the handheld screens to convey the tracking information in your terms. That means a data field will appear in real language, such as “Tool Usage Counter”, and not an obscured address reference within an RFID data tag.

The advantages
- Access to all tracking information
- Intuitive interface drastically reduces learning curve
- Maintain process and corporate names throughout the plant floor
- No additional resources required

Individually programmed RFID tags
Balluff can pre-program your data tags to get you up and running faster.

For centralized data systems utilizing read-only functionality, the data tags only require a serial number or a special code. Balluff offers a service to pre-program your data tags at the factory with exactly what you need. They are ready to install and require no writing hardware or user intervention. Just leave the programming to us!

The advantages
- Cost-effective – no need for separate hardware
- Time-saving – programming of write routines can be eliminated completely
- Easy to place a repeat order – data tags with the same specifications can always be obtained again

Workshops
Make use of Balluff’s vast knowledge in error-proofing solutions.

Have one of our regional tech engineers meet with your project team to discuss your error-proofing project.

Target learning areas
- Vision systems
- Sensor fundamentals
- Modular expandable architectures
- Dedicated RFID systems
- RFID based traceability solution
- Vision sensor based barcode
- Mobile handheld solutions

www.balluff.com