Wherever a human operator must share workspace with a robot, there’s no question that safety is the highest priority. When a person enters a robotic work cell, the robot must be safely idled. But this idle time results in a loss of the robot’s productivity. Enter Balluff’s robot zone limit systems. These pre-engineered hardware kits let you recapture that lost productivity, while maintaining complete operator safety. Finally, you don’t have to sacrifice productivity to keep your floor team safe.

The Finest and Most Reliable ANSI/RIA Dynamic Limiting System Available Anywhere

Balluff zone limit systems are hardware kits that provide diverse, complementary, and redundant position monitoring for up to three robot axes. Designed to interface with a user-supplied safety monitoring relay or safety PLC, Balluff zone limit systems include all mounting hardware, complementary redundant cams, and the proven Balluff multiple position limit switch, available in either mechanical or non-contact inductive configurations. These robust systems install easily and provide the flexibility to adjust zone angles and zone location, while providing a control-reliable means to mute personnel sensing devices when the robot is safely out of the way.

“Control Reliability” is defined by ANSI/RIA R15.06-1999 –Section 4.54 as “…any single component failure shall not prevent the stopping action of the robot.” When properly installed and monitored, the Balluff system is single point fault tolerant and prevents the robot from entering a zone if the following conditions are present:

- Broken, missing, or stuck switch actuators
- Missing cams
- Cams that may have slipped out of position
- Open or short circuits
- Switch contacts welded together
- Broken internal switch spring
- Switch disconnected
- Switch actuator not touching cams
Balluff Zone Limit System Components
Designed for safety, durability, and long operational life

All mounting hardware is included in the kit. Mounting hardware can consist of: cam tray, mounting plates, switch bracket, connector plates, angle brackets, and hubs or spacers as required, including all nuts, bolts, screws and washers.

Inductive Non-Contact Switch (see part description on page 8)

Non-Contact Cams for Inductive Sensors
Non-Contact rotary trip cams are made from tubular mild steel. They mount to the T-slot cam ring with a cleverly-designed “speed” T-nut for easy installation. Tamper resistant spanner screws are included to semi-permanently fix the cams to the ring for additional installation integrity.

Mechanical Cams for Mechanical Limit Switches
Mechanical rotary trip cams are made from hardened steel with a burnished and hard-chromed surface for extra long life. The cams mount with either friction wedges for U-slots or T-nuts for T-slots. Self-tapping screws are also provided to semi-permanently fix the cams to the ring to guard against slippage or inadvertent re-positioning.

Cam Sets
Segmented cam sets (one set required per zone) are supplied with everything needed to create complimentary angles totaling 360°. The cam set typically includes one 180° segment, one 90° degree segment, one 45° degree segment, and three 15° segments. By attaching different combinations of cam angles together, two complementary cam sets can be created – for example 90° and 270°, in minimum increments of 15°. The cams that are supplied for axis 2 and 3 are typically two 180° segments that are positioned around the cam ring to set the boom back or flip over switch point.
Two Channels Per Zone
Balluff zone limit systems consist of a multi-channel ring that holds switch-actuating cams. Each zone is monitored by two adjacent yet complementary cams. The differential status of two separate switches must be confirmed to prove that the robot is safely out of the operator-occupied zone, before muting of the presence-sensing device is allowed. For example, an Axis 1 system with six channels and six switches allows up to three independent zones to be monitored with diverse, complementary redundancy. Segmented cams allow configuration of the angular size of the zones in 15° increments from 15° to 345°. Each zone can be independently and infinitely located 360° around the circumference of the cam ring.

Typical Robotic Work Cell
(Without Robot Zone Limit System)
In the first example, when the operator breaks the light curtain, the robot immediately stops working – no matter where it is positioned in the cell. Robot productivity is lost as long as the operator is present.

Typical Robotic Work Cell
(Without Robot Zone Limit System)
The second example shows a typical light curtain robot limiting application. Two extra sets of robot-detecting light curtains are employed. As long as the robot does not break the light curtain at the station where an operator is present, the robot can continue working elsewhere in the cell.

Although this method delivers some improvement in robot productivity, the space occupied by the additional light curtains restricts the robot motion and may cause interference with transport of large parts or sizable end-of-arm tooling. The additional robot moves required to remain clear of hitting the light curtains add to increased cycle time, which steals back some of the productivity gains resulting from adding the light curtains in the first place.
Balluff Axis 1 Zone Limit System

In the third example, the Axis 1 position of the robot is directly detected by the Balluff zone limit system. As long as the robot is safely away from the operator-occupied area of the cell, the safety light curtain is muted and the robot remains operational.

The operator can enter the work cell to load or unload parts into a fixture, replenish raw materials, or perform other tasks – without stopping the robot. However, if the robot finishes its task and tries to enter the operator’s zone before the operator leaves the area, the zone limit system detects the intrusion. The safety light curtains are instantly reactivated and the robot is stopped.

Balluff Axis 2 Zone Limit System

Some applications may require the robot arm to traverse past an operator to go to another area of the cell. By implementing a zone limit system on Axis 2 (commonly called “boom back”), the robot can pass in front of the operator with the arm safely retracted without shutting down the robot, even though the operator is present. If the robot should unexpectedly come off of the boom back switch while the operator is present in the station, the safety light curtains are re-enabled, stopping the robot.

Another application for an Axis 2 zone limit system is to prevent a gantry (or “track”) robot from reaching back under itself, or to ensure that the robot arm is safely retracted before the robot is allowed to traverse the length of the gantry.

Balluff Axis 3 Zone Limit System

Axis 3 zone limit systems are sometimes referred to as “flip over” switches. Some robots have the capability to reach backwards. In these cases, an Axis 1 zone limit system is not sufficient to determine the actual position of the robot arm.

In this example, if an operator is working on the right and the robot suddenly tries to flip the upper arm over into that zone, the safety light curtains are re-enabled and the robot is stopped.
**Balluff Zone Limit Systems**
More efficient, less costly, save space

Rather than single workstations in two robot cells working without zone limits, a single robot/dual workstation setup using a Balluff zone limit system can reduce the number of robots and floorspace needed by half.

Work cell size reduction is another big benefit. Since the size of the area guarding must be larger than the maximum operational envelope of the robot and its payload, a Balluff robot zone limit system can be used to dynamically restrict the operating envelope of the robot, allowing a much smaller area to be guarded. The reduced guarded area also saves a substantial amount of money by reducing the amount of perimeter guard fencing per work cell.

The enhanced productivity of several robot cells may free up enough capacity to eliminate the need for additional robotic work cells, saving significant capital investment costs.

**Linear Zone Limit Systems**

**RTU Systems**
Robot Transfer Units, floor-mounted tracks that convey robots between multiple work stations, can benefit from linear zone limit system implementation.

A multi-channel linear zone limit system can eliminate multiple sets of robot-detecting light curtains while increasing zoning flexibility. This cuts initial cost, simplifies work cell design, speeds workflow changes, and reduces clutter on the factory floor.

**Linear Toploaders (Track or Gantry Robots)**
Gantry-mounted robots travel back and forth delivering parts and products. Balluff linear zone limit systems can provide up to four independent zones along the full length of robot travel.

When used in conjunction with an Axis 2 system, linear zone limit systems ensure that the robot can be safely interlocked with automatic machine doors, gates, operator-occupied areas, and other robots mounted on the same track or working within the same physical envelope.
Balluff Zone Limit Systems
Robot installation

Easy to Install, Easy to Maintain, and Totally Effective

- **Flexible**
  Zones can be easily changed by maintenance or trade personnel.

- **Reliable**
  Proven ganged mechanical switches or wear-free inductive sensors.

- **Productive**
  Robot doesn’t need to wait for operator to load or unload components.

- **Space-Saving**
  Reduces area guarding requirements.

- **Cost-Saving**
  Reduces capital costs for unnecessary robots and perimeter guarding.

- **User-Friendly**
  Provides direct visual indication of zone sizes and locations.

- **Convenient**
  Fully pre-engineered, kitted hardware solutions eliminate guesswork.

- **Specified**
  Meets automotive manufacturers’ requirements.

- **Safe**
  Hardware conforms to ANSI recommended practices.

Axis 1
The main rotational axis (Axis 1) system can monitor up to three fully independent diverse complimentary redundant zones. Each zone can be infinitely located 360° around the axis of rotation. The angular zone can be configured in 15° increments from 15° to 345°, or the cams can be user-modified to create smaller increments.

Axis 2
The boom forward/back (Axis 2) switch monitors a single zone using two channels with two 180° cams. Some available systems can monitor up to three zones with six channels. This axis is used to ensure boom is retracted, allowing the robot more freedom to move safely past operator-occupied areas.

Axis 3
Similar to an Axis 2 system, the flip over (Axis 3) switch monitors a single zone using two channels with two 180° cams. An Axis 3 system provides protection against the robot flipping over 180°, without the need to restrict the robot’s motion with permanent hard stops that might interfere with required program movements.

SAFETY NOTICE:
The components supplied with Balluff Zone Limit Systems are suitable for use in personnel safety applications only when installed and used in compliance with all applicable provisions of American National Standards Institute / Robotics Industries Association American National Standard for Industrial Robots and Robot System – Safety Requirements ANSI/RIA R15.06-1999 or subsequent editions thereof, and all other relevant industrial and governmental standards and requirements.

www.balluff.com
Balluff Precision Multiple Mechanical Limit Switch
Balluff developed the precision ganged limit switch in the 1950's and it’s still going strong decades later. Overbuilt to exceptionally high standards of German engineering, this legendary switch has remained the international benchmark for reliability and accuracy in its class.

The Balluff mechanical switch features an anodized-aluminum housing with up to six stainless steel plungers, using high-speed ball bearing rollers rated for speeds up to 80 m/min. Each electrical switch element has both normally open and normally closed positive-break, force guided mechanical dry contacts in accordance with VDE 0113. Switches can be pre-wired with either circular or Harting-style quick-disconnects. Either standard style plungers or quick-change plungers can be provided. As plunger rollers inevitably wear over time, the quick-change plunger block allows single-trade preventive maintenance with no internal re-wiring of the switch.

Balluff Precision Multiple Position Inductive Non-Contact Switch
For environments with mechanically abrasive particulates in the atmosphere, or for high-speed applications above 80 m/min, these non-contacting, wear-free ganged inductive sensors offer an ideal 4 mm nominal sensing range. The sensing coils are individually tuned to different oscillator frequencies, allowing them to be closely spaced on 12 mm centerlines without danger of crosstalk or mutual interference.

Complementary solid-state outputs deliver both normally-open or normally-closed logic. The sensors also feature a defined power-on and power-off delay time, intended for use with solid-state safety monitoring relays and safety PLCs that employ a pulsing “heartbeat” sensor power supply. Such safety monitoring devices detect the presence or absence of the input pulse train on the sensors’ outputs to verify their proper operation (no shorted or open outputs) for an added measure of security.

To select the Balluff Zone Limit System for your robot application, visit:

www.balluff.com/BZL

Find part number, data sheet, and installation manual for your system.