

## Application Report

### Mega logistics at high speed

**Sensors from Leuze electronic control branches in the gigantic luggage logistics area at the Frankfurt Airport**



Source: Fraport AG

**As a transfer airport, the Frankfurt Airport is one of the most important air traffic hubs in the world. In its center, a highly-complex luggage logistics area for check-in and transfer luggage spans the entire airport. New readers from Leuze electronic on the branches of the transport paths contribute significantly to the passengers' luggage reaching its destination quickly and reliably.**

9:25 a.m.: Flight DL 106 from New York on approach to the Frankfurt am Main Airport. Passenger Michael Edwards has already stowed his book in his hand luggage and, with a glance at the clock, affirms that the plane will land on time. He doesn't have much time to make his connecting flight to Vienna. Luckily, he doesn't have to worry about his luggage. The friendly woman at the check-in counter promised him that it would be forwarded automatically. But will it really happen?

At the same time, Franz Regner, Graduate Engineer at Fraport AG, the operating company of the Frankfurt Airport international air traffic hub, remains calm. He doesn't know Edwards or any of the other passengers on flight DL 106. But he knows that their luggage - like all luggage of connecting passengers - will reach the respective connecting flight on time. On average, more than half of the annual 53 million passengers at the Frankfurt hub change flights with luggage.

### **The fastest hub airport in the world**

Along with his colleagues, Regner is responsible for the luggage conveyor system (LCS), the heart of luggage handling and therefore one of the most important services at the Frankfurt Airport. Fraport guarantees connection times of a minimum of 45 minutes in which the transfer luggage is unloaded, sorted, transported and reloaded. In this time span, multi-stage automatic luggage screening is performed.

With the short connecting times for passengers and luggage, the gigantic Frankfurt Airport (FRA) is one of the fastest hub airports in the world. When you consider that an arriving flight contains passengers for up to 85 connecting flights, it really is a one-of-a-kind logistical achievement to uphold the minimum connection time for all simultaneous connections spread throughout the entire airport.

### **High reliability with Leuze electronic sensors**

The highly complex logistic system is a high-speed sorting center which manages up to 120,000 pieces of luggage a day at peak times – even with all the security regulations. *"Our luggage conveyor system for check-in and transfer luggage has been running like clockwork for decades, although with constant adaptation to growing requirements",* says Regner.

What originally started with conveyor paths of around 26 km in length has grown today into a container conveyor system spanning the entire airport with 77 km of conveyor paths. One of the most recent improvements is taking place in sensor technology along the conveyor paths, Regner's actual area of responsibility. *"Thousands of sensors control the branches of the giant system to bring suitcases and bags between Terminal 1 and 2 as well as the airport ramp station to their destinations",* reports Regner.

With the newest version of the KA 973 reader from Leuze electronic, he works on optimizing the reliability rate which, with an impressive 99.83 %, has already almost reached 100 %. The readers are part of a sophisticated container recognition system and consist of three PRK 3B Reflection Light Beam Devices with polarization filters and an additional HRTR 3B reflection light scanner with background suppression.

### **Optimization on the highest level of performance**

The so-called polarization filter Light Beam Devices in the new readers, compared to the designs used up to now, minimize ambient light problems. This prevents possible erroneous readings due to reflective surfaces of the containers on the LCS. In addition, an easily-adjustable range prevents a sensor reaction which can otherwise occur when detecting adjacent containers in parallel lanes very close to one another. *"Teaching the ranges using the teach button is simple and, at the same time, fulfills our requirements regarding a robust device version",* adds Regner.

The type HRTR 3B reflection light scanner integrated into the readers lends an additional functional improvement. It is attached 50 mm above the Light Beam Device used for reading codes and additionally checks for the presence of a container. The reason for this is based on experience: basically, there is a chance that a container stops briefly in front of a reader, thereby causing a time-out of the Light Beam Devices, and consequently an erroneous reading. With the additional container detection system, such faults, as rare as they occur, are prevented.

### **Reading binary code at high speeds**

The switching frequency of the Reflection Light Beam Devices and the light-spot size required result from the enormous conveyor speeds and the characteristics of the binary coding on the identification carriers. These coding bars are found on the roughly 18,000 containers which circulate continuously.

Each coding bar attached to the side of the container has two lines: a clock track and an information track below it. Both track contains 21 fields (bits). On the clock track, zeros and ones alternate in equal distances from one another. In this way, 21 clock signals are received which are used to detect the presence of a container as well as synchronize the information track. An information bit is assigned to each clock bit. The sequence of these bits (ones and zeros) ultimately represents the container number.

If a container passes a reading point, the pre-clock Light Beam Device is dampened by the clock track. In this way the presence of the container is detected. Then, the information and clock Light Beam Device is dampened by the respective track. This counts for the three above-mentioned Reflection Light Beam Devices in one reader. Due to this arrangement, the information signal passes ahead of the clock signal by 90°. Therefore, the info signal is valid when a rising edge of the clock signal is present, i.e. the light spot of the info Light Beam Device is located directly in the center of the info field of the coding bar. This is 780 mm long, and its reflection fields (high signal) 20 and the dark fields (low signal) in-between are 18 mm wide. If these are put into the context of the conveyor speeds, immense reading frequencies result. Commenting on this, Regner states: *"In some areas, such as through long, straight tunnel paths, the containers move at speeds of 5 m/s, at some times even 10 m/s".*

However, where changes in direction occur, such as in curves or branches, the speed must be drastically reduced due to the enormous centrifugal forces. In spite of this, an average transport speed of 2.5 m/s is achieved. To be prepared for the future, the reading point has been set at 5 m/s. Mathematically, 4 milliseconds remain for reading a bit at 5 m/s. The switching frequency of the PRK 3B Reflection Light Beam Devices from Leuze electronic is 1,000 Hz – this requirement is therefore fulfilled.

Even in regard to the required light-spot size, the PRK 3B is optimal. Franz Regner specified a size of 5 to 6 mm so that the respective contact surface is covered to the greatest possible extent to ensure reliable detection even when damage or soiling is present. This guarantees that two contact surfaces are never covered simultaneously.

Other requirements such as the housing design of the read stations arise primarily from the application and harsh environmental conditions. The particularly robust design of the Leuze electronic sensors with high shock and vibration resistance fulfill the requirements set. The metal housing has been equipped with a special vibration-proof aligning mechanism for the sensors.

All in all, the particularly compact size of the 3B sensor series is beneficial when it comes to housing design and sensor arrangement. The read stations are completely equipped and delivered to Fraport aligned with a midpoint deviation of  $\pm 1$  mm at a distance of 120 mm. They fit 1:1 in the existing reading point mounting brackets and can be aligned easily.

#### **Arriving at the destination reliably**

12:15 p.m, Vienna Airport (VIE) baggage claim: Michael Edwards picks his suitcase up from the conveying belt and, relieved, heads towards the exit. He doesn't know Franz Regner or any of his roughly 6,000 colleagues at Fraport who make sure in the ground handling system at Frankfurt Airport that airplanes are handled smoothly and luggage as well as passengers can "connect" on time. However, at times like this, he suspects that a great logistical feat is behind it all.

*"The new readers with polarization filter Light Beam Devices and light scanners from Leuze electronic contribute significantly to that fact that we can successfully manage the most intensive hub luggage handling system worldwide",* sums up Franz Regner.

## Figures and captions



**P3313095, P3313096:** Fail-safe container detection with Leuze electronic sensors in the high-speed logistics system at the Frankfurt Airport.



**P3313087, P3313089, P3313090:** Three polarization filter Light Beam Devices and above an additional light scanner are contained in the compact housing of the new read stations.



**P3313054:** On the back of the read stations, operating states such as voltage supply, warning signal, pre-clock signal, clock signal, and info signal are displayed via LED.



**P3313047, P3313048, P3313049:** Read stations from Leuze electronic regulate the branches in the conveyor paths of the luggage conveyor system at the Frankfurt Airport.



**DCP\_0798:** All information merges in the Baggage Control Center, the central operational control point of the luggage conveyor system at the Frankfurt/Main Airport.  
*Source: Fraport AG*



**2011\_reb\_0400:** The luggage conveyor system currently consists of 77 km of conveyor paths, spanning across the entire Frankfurt/Main Airport.  
*Source: Fraport AG*



**LCS:** In some areas, containers move at speeds of up to 10 m/s. *Source: Fraport AG*

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