Safe Guidance

Single Lamp Control and Monitoring
Traditionally designed power supplies for airfield lighting systems require separate series circuits when switching. For safety reasons these systems are very often divided up over two or three series circuits. This results in high installation and material costs, especially in the case of lighting systems with a small number of lights, such as stop bars or segments of the taxiway centerline. Normally, such series circuits are equipped with monitoring systems for the summery detection of lamp failures. These systems are only able to detect the number of failed lamps, but not their exact location. The single lamp control and monitoring system developed by Honeywell Airport Systems now permits the control and monitoring of single lamps and groups of lamps within one series circuit. This opens up entirely new perspectives for a cheaper and safer construction of airfield lighting systems. Monitoring according to the recommendations of the ICAO (Recognition of failure of neighboring lamps) is now possible due to the accurate pinpointing of the location of the lamp failures. Lamp control is effected by addressable switching units that are plugged in between the lamp transformer and the lamp and controlled via signals on the series circuit cable.

**Benefits**

- Information on lamp failures with indication of location
- Low-cost new installation and extension
- Full integration into any control and monitoring systems
- Utilization of series circuit cable for data transmission
- Short response times thanks to optimized transmission procedures
- No manual settings of individual switching modules necessary
- “Software-download” for future functions of switching modules

**Fig. 1** Controller and cable requirements are set at 100% in the configuration above. Failure of a controller affects all lamps in a section.

**Fig. 2** Controller requirements are 40% and cable requirements are 66% in the configuration above. Failure of a controller affects only every second lamp. Guidance information for the pilot is not lost.
With regard to modern taxiing guidance systems, in which the taxiway lighting is used as a guidance instrument, a finely segmented control in large lighting circuits can be achieved by the direct control of single lamp groups. As the individual switching ranges are now determined exclusively by the software, new divisions of the circuit that are often required will be a thing of the past, even when there are changes in the taxiway. In this way, considerable cost savings can be achieved not only during the initial installation but also for ongoing work. The beam direction of the centerline lighting can be switched over using the single lamp control in the area of runway lighting as well. This saves additional series circuits for the second beam direction.

Single lamp control is most economically utilized where many smaller series circuits can be gathered into larger units and the separate control takes place via the lamp control. Stop bar lighting and taxiway lighting are two such examples. An additional advantage of single lamp control and monitoring is the possibility - depending on operating level - of varying the number of centerline lamps switched on for the runways and the taxiways. Here the equipment for the operating level CAT II and CAT III requires distances between lamps of down to 7.5 m. Under favorable weather conditions, the distance between the lighting points can be doubled by switching off every other lamp, thereby saving power and increasing the life of the lamps.

Application examples
With regard to modern taxiing guidance systems, in which the taxiway lighting is used as a guidance instrument, a finely segmented control in large lighting circuits can be achieved by the direct control of single lamp groups. As the individual switching ranges are now determined exclusively by the software, new divisions of the circuit that are often required will be a thing of the past, even when there are changes in the taxiway. In this way, considerable cost savings can be achieved not only during the initial installation but also for ongoing work. The beam direction of the centerline lighting can be switched over using the single lamp control in the area of runaway lighting as well. This saves additional series circuits for the second beam direction.

Benefits
- Control and monitoring of individual lights
- Display of the individual lights that have failed in a monitoring system with exact indication of their location
- Switching of the lights in varying distances depending on the category level (shorter distances in bad weather conditions and thus a higher category)
- Control of the groups via software settings instead of changes to the hardware
- Many small circuits for taxiways can be combined, so that taxiway crossings (depending on the number of lights) only need two circuits (due to the redundancy) instead of the previous 24!
- Each light of directionally dependent lighting such as runway centrelines can be switched with one serial circuit transformer and one ASD with two outputs, which means that the circuits can work at half power.
- Example stop bar control: increases safety!
- Taxiway guidance can be effected with a lot fewer circuits
- Automatic taxiway guidance can be achieved in combination with traffic sensors
In addition to the cost-saving effect, the safety aspect can be dramatically increased vis-à-vis the traditional installation when using the single lamp control and monitoring. In the past the individual sections of the taxiway centerline were often operated with only one single series circuit due to the costs involved. This resulted in the failure of the whole section when the circuit broke down and as a consequence a high safety risk, particularly in critical areas such as the quick run-off way. Now, if some of those series circuits that are saved by using single lamp control and monitoring are used to divide the entire lighting into at least two circuits, when one circuit breaks down the pilot only loses every second lamp and is therefore still able to navigate safely. This procedure can also be used in the area of the stop bars. If, in the future, the stop bars are supplied with four series circuits (a maximum of two from the same station) instead of only two series circuits from the same station, then the safety risk in case of a breakdown is reduced considerably independent of its control function, the single lamp control and monitoring can also be used as a pure lamp failure monitoring system. This monitoring system also works in circuits in which not all lamps are controlled individually.
The development of the single lamp control and monitoring system was carried out with a view to higher operational safety and ease of handling. The series circuit cable is used for data transmission. This permits a simple installation, particularly in case of a retrofit or expansion of the system. Secure data transmission is thereby achieved by a current modulation on the basis of the enhanced E-FSK procedure (Enhanced-Frequency Shift Keying). This procedure is insensitive to single and periodic disturbances on the power cable and even allows for secure data transmission in case of an earth fault of the series circuit as well. Even for the constant current regulators used, there are no particular requirements for data transmission. The lamp monitoring functions both when the lamps are switched on and when they are switched off. The monitoring of the most varied factors (Multi Parameter Monitoring) permits reliable lamp failure recognition, even when there is a short-circuit in a connected light.

To protect the secondary circuit of the lamp transformer from the effects of periodic extremely high voltage peaks where there is no load to the lamp, the ASD (Addressable Switch Device) short-circuits the lamp transformer when a lamp failure is recognized. This corresponds to the normal switching off of the lamp by the ASD. A lamp change is automatically recognized and the new lamp is switched back on. In addition to the ASD switching unit for the operation of one lamp, there is also a unit for the operation of two lamps. Both lamps are operated at one lamp transformer but are switched separately. The switching units are entirely coated in polyurethane and have highly effective overvoltage protection and are thus suitable for rough operation in water-flooded transformer shafts in tropical or arctic conditions on the airfield. No mechanical settings are required on the device. Each unit is already marked with a unique device address (series code) at the factory. This is inputted at the control system together with the assembly location of the lighting for control. When the constant current regulators are switched on, the system from Honeywell Airport Systems has a response time of less than one second for the switching times from the input in the tower to switching of the lamps in the field. The system therefore meets all current and future requirements regarding switching times for airfield ground lighting systems to the full. The short switching times of under one second are achieved by an optimized control technology.

Here, a combination of “Broadcast Communication” and “Time Slot Communication” is applied in addition to a Dynamic Multiple Addressing of the switching units.
The single lamp control and monitoring system can be integrated in Honeywell Airport Systems’ own control and monitoring system as well as that of competitor’s systems. In combination with the Honeywell Control System, the following features are supported:

- Control of all lamp groups and switching scenarios
- Powerful local control for the control and monitoring of lamps from all technical work stations
- Acceptance of all monitoring results from the single lamp monitoring
- Display of lamp failures with their positions on a scale model of the airport
- Display on failure of neighboring lamps
- A time meter for 8 operating levels for each lamp
- Creation of configuration data with automatic download to the switching units

This addressing method comprises a short position address and up to 104 group addresses and for each switching unit. In addition to the control and monitoring of lamps, the system also offers other operating modes for the configuration and a software download. This allows all switching units integrated into the series circuit with new addresses, standard switching modes or a new operational software to be loaded via the series circuit cable. To simplify the maintenance of the system, a running light can be activated over the position addresses. A constant continuous light thereby indicates a flawless configuration. The switching units can output their device addresses via a flash code on the lighting. In this way, any address that might have been wrongly included can be subsequently determined without having to open the shafts. In a next step, the system will be expanded to incorporate the transmission of sensor signals (induction loops, microwave beacons, magnetic field sensors, etc.). A complete high-performance data transmission system via series circuits will then be available.
The new features and the flexibility gained by single lamp control and monitoring also place some new demands on the total control system. For example the total number of monitoring results at an international airport with 20,000 to 25,000 lights can quickly exceed the 100,000 mark. This amount of data is administered by the Control System from Honeywell Airport Systems without performance degradation and is documented at the work stations clearly and intelligibly. It will no longer be possible to operate any future segmentation of the areas around the taxiway by simple switches on the tower desk.

The Honeywell Airport System Control System offers new features for this such as computer-aided routing. Further information is provided in the documents for the control and monitoring system for airfield lighting systems.

Design
The system comprises a control unit (LCM), one series circuit coupler for the series circuit (SCC) and the switching units (ASD) - between the normal lamp transformers and the lamps. The LCM can – if required – control the regulator and communicates with the switching units in the field.

For the communication, a control signal created by a digital frequency synthesis and with matched transmitter power is modulated by the series circuit coupler (SCC) on the series circuit current. This signal is received by the switching units (ASD) and evaluated via a digital frequency analysis.

There is a TCP/IP or parallel I/O interface available for communication with the superordinate Control and Monitoring System (CMS).

The lamps are switched off by the ASD with a semiconductor switch that effects a short-circuit of the lamp transformer. This short-circuit is also automatically activated in case of lamp failure to reduce voltage peaks. If the ASD controls and monitors two lamps on one transformer, then these lamps are switched in series. The lamp that is not required or that has failed can be bridged via the semiconductor switch if so required.

Lamp failure monitoring is effected via an impedance analysis and also functions when the lamp is switched off. As the physical characteristics of the lamp coil change considerably depending on the operating temperature, several parameters are evaluated during monitoring (Multi Parameter Monitoring). This procedure even guarantees safe monitoring in case of short-circuits in the lighting.

Between the control processes, the ASDs permanently transmit their monitoring results to the control unit in the station on the basis of a Time Slot Communication Procedure (TSCP).