

Runway Safety Area Monitoring System

Introduction

The RSAMS system monitors the target movements (aircrafts and vehicles) on the Runway/Taxiway intersection in order to:

- detect Runway incursions (i.e. unauthorized runway entries)
- detect manoeuvre errors (i.e. unauthorized exits from RWY).

Each violation is notified to the Ground Controller (GC) through an acoustic alarm and **appropriate** visual signals displayed on the RSAMS HMI (Human Machine Interface) in TWR.

Moreover each event notified by the system is recorded on a database to be consulted after if required.

The monitoring of the of target movements is extended also to vehicles that move on the peripheral roads that enter directly the runways, where the system also controls traffic lights to prevent possible errors of the drivers.

Detection section

RSAMS uses double microwaves sensors that , consist in a Transmitter (TX) and a Receiver (RX), both installed and located near the holding point of the RW/TW intersection or near the marker of the holding position of the roads.

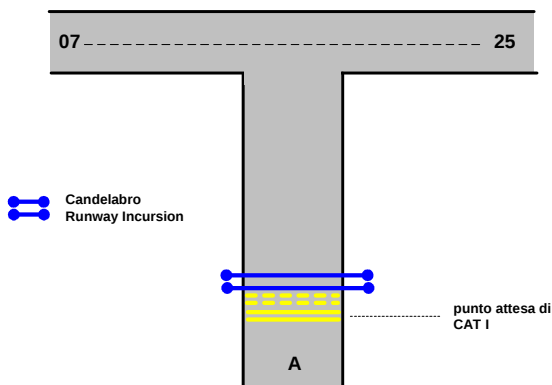


Figure 1: Guarded intersection

Each couple of TX and RX are mounted on a metallic structure, called candelabro. The use of a single structure, for each couple of TX and RX, allows installations not excessively invasive nor requiring great civil work on the manoeuvring area.



Figure 2: Candelabro

The TX radiates continuously a signal in X band that is received by the corresponding RX. When a target crosses the microwave barrier, the RX detects an attenuation of the signal transmitted by the TX determining in such way the state of "target presence".

Every RX mounted on a candelabro operates in a condition of absolute independence, detecting the crossing of a target independently of the state of the second RX. Therefore according to the sequence of the "target presence" status detected by the two RXs of the same candelabro, a local micro-controller, called RCU, placed in the RX cabinet, determines the direction of the movement of the target that crossed the same candelabro

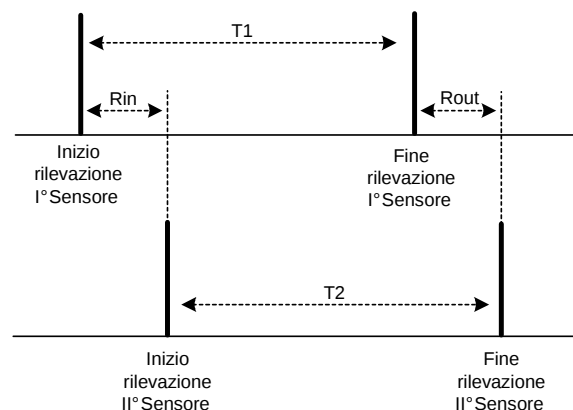


Figure 3: Candelabro processing data

Moreover knowing the distance D between the two RX, represented by the length of the candelabro, and calculating the time interval between the corresponding states of the two sensors, at the target entry (Rin) and exit (Rout) of each sensor, the RCU is able to determine the speed of the target at the beginning and at the end of the barrier crossing.

Considering constant the kinematic characteristics of the target during the entire crossing due to the reduced length of the candelabro (approximately 2 meters), the target speed V can be assumed as the average of the V_{in} and of the V_{out} , and the time interval T of sensors crossing as average of the time interval T_1 at which the first sensor detects the target and the time interval T_2 at which the second sensor detects the target, the RCU provides the length L of the target.

It is important to note that by using couples of sensors, the RCU is able to perform a check on the information of target presence and in particular:

- to recognize sensor false alarms;
- to detect the target presence also in case of unavailability of one of the two sensors.

Road sign section

In order to inform the driver about the authorization to enter into the Runway, RSAMS uses traffic lights. In particular, the traffic light, installed in such a way that the driver finds it on his right-hand side normally switched red, turns green when the vehicle is authorized from the CTA to enter the Runway.

As soon as the candelabro installed on the marker detects a target entry, the traffic lights become red. These changes are realized by the same RCU that controls the RX couples of the candelabro.



Communication section

The communication between the RCU and the processing units in the control tower is made by an optic fiber ring, that uses the cable ducts and manholes of the existing AVL system.

The connection of the RCU on the field and of the servers in the tower to the optic fiber ring is realized by means of appropriate interface modules able to realize a redundant communication channel, thus guaranteeing the availability of the connection between field and tower also in case of interruption of the ring at any point. In fact by means of the STP communication protocol (Spanning Tree Protocol), the interface modules are able to set themselves up independently, modifying the transmission direction of the information on the net.

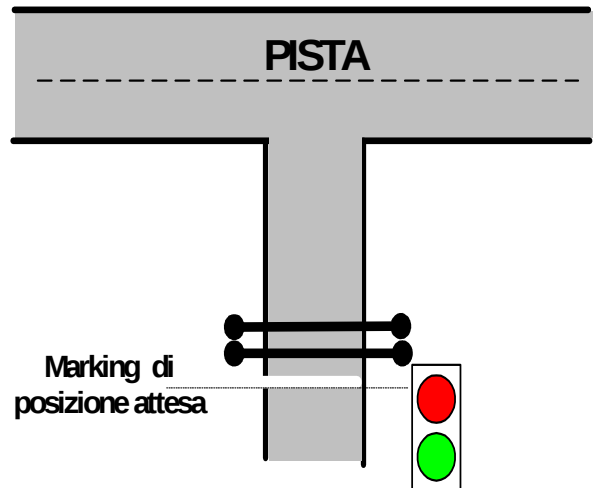


Figure 4: RW/TW guarded

If the deployment of a fiber optic cable it is not possible due to unavailable cable ducts, RSAMS foresees as communication system the use of a UHF radio channel, with static assignment TDMA type access to the radio channel, and therefore with no conflicts, with refresh time equal to 1 second. Such solution guarantees therefore that each candelabro can send its own information at least once per second.

Power supply section

The TX / RX couples and the traffic lights used for the airport are power supplied by a module connected through a secondary cable and relevant isolation transformer, to a dedicated primary circuit supplied by a URCC unit (Control Unit of Constant Stream), installed in the power cabin.

If the deployment of the primary power line cable is not possible due to absence or unavailability of preexisting cable ducts, the RSAMS units will be connected to an existing AVL circuit.

To guarantee the correct operation of candelabro even in case of absence of the primary power (in case of failure or in presence of maintenance activities), a local back-up battery system is foreseen. In this case, the units are supplied by a battery, guaranteeing an operating time of at least 24 hours. The batteries will be recharged by the restart of the primary circuit, through an appropriate battery charger.

Power supply, battery and charger are positioned in the following units:

- in the TX cabinet called Slave installed behind the candelabro;
- in the RX cabinet called Master, installed behind the candelabro, in which the RCU is placed on the door and the fiber optics interface module in the lower part of the cabinet.



Figure 5: Slave cabinet



Figure 6: Master cabinet

Processing section

The Processing Section includes the followings SW modules:

- **DMST** (Distributed Microwave Sensor Tracker), that has to:
 - detect the violations caused by the targets on the RW/TWY intersection according to the information sent by the “candelabro” and to the setting of the GC;
 - control the switching ON and OFF of the traffic lights on the RW/TWY intersection;
 - apply the operational configurations in which the airport must operate following the settings of the GC;
- **SINCRO**: it has the task to guarantee the time alignment of the system processing units using the UTC time acquired by a GPS receiver;
- **LOG**: it has the task to record on file the events detected by the RSAMS system.

Such modules are implemented on a redundant server, realizing a typical Client-Server architecture that guarantees that all the operative positions show the same information.

Presentation section

The processing results are made available on the presentation section to be therefore shown on the interfaces of RSAMS system. To simplify to the CTA the command of authorizing the entrance to the Runway, the system uses a transportable keyboard, called RSAMS remote control, composed of functional buttons, each associated to a protected intersection. In this way the authorization to enter the Runway will be sent by selecting the button referred to the associated intersection. Every button shows the identification of the intersection to which it is associated. The button will be:

- **OFF** if the associated intersection is not operative for entry into the runway;
- **ON Red** if the associated intersection is operative for entry into the runway and no traffic has been authorized;
- **ON Green** if a target has been authorized to enter the runway;
- **Red blinking**, if a Runway Incursion is present on the RWY/TWY intersection;

- **Green blinking**, if the time interval of the authorization of a target to enter the runway is expiring.

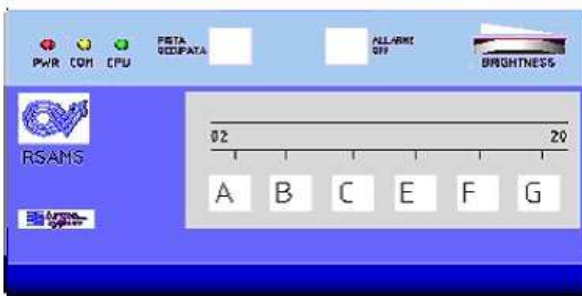


Figure 7: RSAMS remote control

Moreover, on the RSAMS remote control two buttons are available:

- the button “Occupied runway”, that if pressed blinks red in order to inform the GC about the occupied state of the runway; in order to reset this status, GC will have to press again the button that will remain white;
- the button “Alarm Off” to reset the emission of an acoustic alarm.

The above mentioned controls, apart from the RSAMS keyboard, can be sent also from the operative console in TWR, on the main display of which are shown:

- the microwaves sensors, represented with different colors depending on the functional status;
- the traffic lights, represented with different colors depending on the functional status;;
- the target detected by the candelabro by using the symbol .

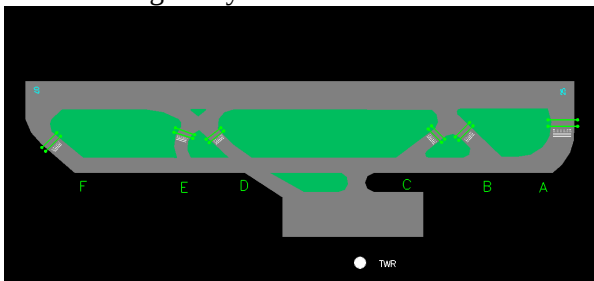


Figure 8: Operative Menu

From the operative point of view for each intersection:

- the candelabro of Runway Incursion is armed to detect runway incursions and manoeuvre errors;
- In the event of a Runway Incursion or manoeuvre error, the following occurs:
 - emission of an acoustic alarm in vocal synthesis showing the intersection where the violation has occurred;
 - display of a visual signal on the operative console and on the RSAMS keyboard;
- as a consequence of the authorization to enter the runway:
 - the Runway Incursion candelabro is temporarily disarmed;
 - the button of the RSAMS keyboard related to intersection is switched on to green;
 - the symbol on the RSAMS HMI related to the configuration of the intersection is green;

as soon as the target crosses the Runway Incursion candelabro :

- the Runway Incursion candelabro is armed again;
- the button of the RSAMS keyboard related to the intersection is switched on to red;
- the symbol on the RSAMS HMI related to the configuration of the intersection is gray;
- after authorization to enter the runway, if no target is detected by the Runway Incursion candelabro within a prefixed time interval:
 - the Runway Incursion candelabro is armed;
 - the button of the RSAMS keyboard related to the intersection is switched on to red;
 - the symbol on the RSAMS HMI related to the configuration of the intersection is gray.

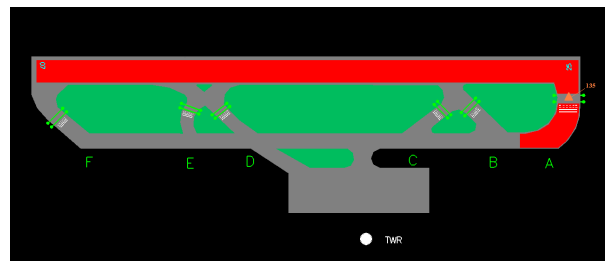


Figure 9: Runway Incursion

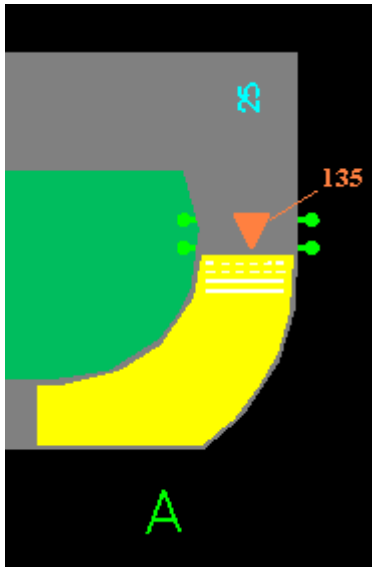


Figure10: Manoeuvre Error

From the operative point of view, the menu allows the GC to select for every single intersection the operational use as a function of how the airport must operate. In order to reduce the work load, the system allows to define some airport standard configurations, in which the use of every intersection is predefined.

Besides the operative menu, the work station foresees the menu:

- BITE, that reports through synoptic colored panels, the status of the units on the field and of the processing units in the tower, as well as the state of communication between field and Tower;
- LOG, that allows the ground controller to examine the events recorded by the system.

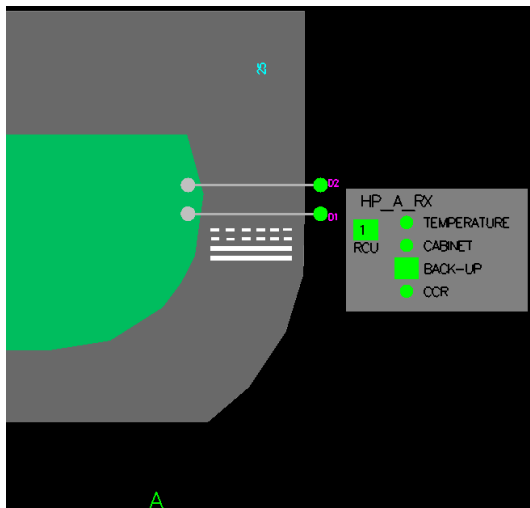


Figure 41: BITE Menu

53	19/07/2007 09:51:28	DMP01	O Sensor D11	is ON
54	19/07/2007 09:51:28	DMP01	O Sensor D12	is ON
55	19/07/2007 09:51:28	DMP01	O New track 141	on A
56	19/07/2007 09:51:28	DMP01	O A	engaged
57	19/07/2007 09:51:28	DMP01	O Track 141	authorized entry in runway from A
58	19/07/2007 09:51:29	DMP01	O Sensor D11	is OFF
59	19/07/2007 09:51:29	DMP01	O Sensor D12	is OFF

Figure 52: LOG Menu

Usually the RSAMS configuration has 3 operative stations:

- in the operative room of the control Tower for GC;
- in the electric cabin, for maintenance personnel ;
- in the event room for supervision personnel.

According to the position of the operative station, some commands and functions of the RSAMS system are available only by preliminary insertion of a password.

Integration with di stop bar systems

The RSAMS system, integrated with the stop bar system, besides what has been described above, has the task to switch on and off, according to the position of the target, the stop bar and lead-on, in case of authorized entry.

For this purpose the RSAMS system, integrated with the stop bar, foresees on every intersection:

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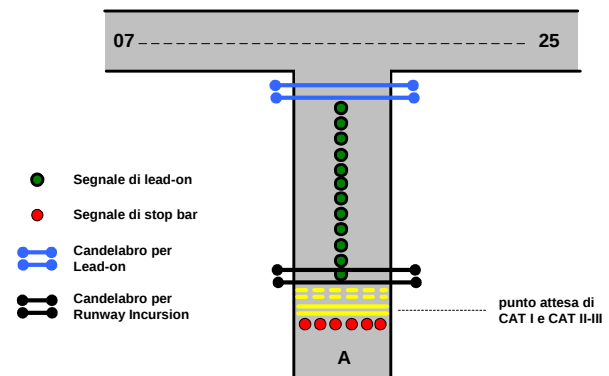


Figure13: stop bar and lead-on

- a stop bar on the holding pointt:
 - o switched on, if no target is authorized to enter the runway

- switched off, if a target is authorized to enter the runway
- lead-on, composed by lights that follow the center line of the RW/TWY intersection:
- switched, if no target is authorized to enter the runway;
- switched off, if a target is authorized to enter the runway;
- TX and RX sensors located on the holding point and in correspondence to the end of the RW/TWY intersection.

From the operative point of view for every RW/TWY intersection:

- the Runway Incursion candelabro is armed;
 - the candelabro with lead-on is armed in order to detect manoeuvre errors;
 - as a result of currently selected AVL configuration, the stop bar system can be operative (stop bar on and lead-on off) or not operative (stop bar off and lead-on off);
 - as a result of the authorization to enter the runway:
 - the stop bar, if operative, is switched on;
 - the Runway Incursion candelabro is temporarily disarmed;
 - the lead-on, if operative, is switched on;
 - the RSAMS keyboard button of relevant intersection is green;
 - the symbol of RSAMS HMI related to the RW/TWY intersection configuration is green;
- As soon as the target is detected by the Runway Incursion candelabro:

- the Runway Incursion candelabro is armed;
- the stop bar, if operative, is switched on;
- the button of RSAMS keyboard related to the RW/TWY intersection is red;
- the symbol of the RSAMS HMI related to the RW/TWY intersection configuration is gray;

As soon as the target entering the target is detected by the Lead-On candelabro or after a prefixed time interval of the target detection by the Runway Incursion candelabro, the lead-on, if operative, is switched off.

- after the authorization to enter the runway, if no target is detected by the Runway Incursion candelabro within a prefixed time interval:
- the Runway Incursion candelabro is armed;

- the stop bar, if operative, is switched on;
- the lead-on, if operative, is switched off;
- the button of the RSAMS related to the intersection is red;
- the symbol on the RSAMS HMI related to the intersection configuration is green.

RSAMS integrated with stop bar HMI is shown in the following figure.

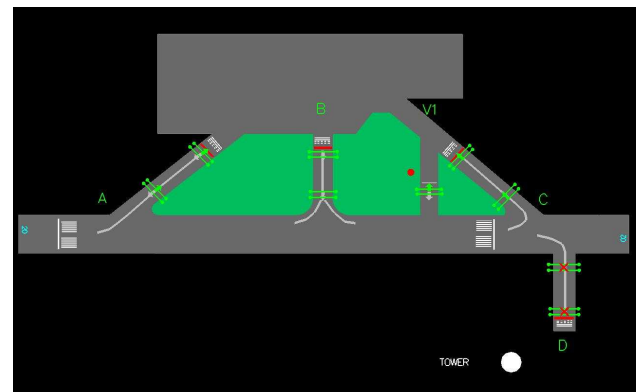


Figure14: Operative menu