

FLASH LED

Interface ModBus Table



LED FLASH SYSTEM

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Editions				
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1 Introduction

1.1 Purpose

Purpose of this document is to supply a *quick reference* about the modbus/jbus table in order to interface a remote control system to OCem LED FLASH equipment.

1.2 System overview

The elements of OCem LED FLASH system are

- a master control unit, name FMCU, acting as the supervisor of the flash system;
- up to 64 flashing units, named FFU, each one located near its own flashing light on the airfield;
- a touch panel HMI acting as local configuration and maintenance interface, located in the same rack of the FMCU unit.

The FCMU supervisor unit communicates with FFU flashing units by a power line communication protocol, handled by specific chips on involved hw boards;

- information about used power line communication protocol is out of the scope of the current document.

The local HMI touch panel

- communicates with the FMCU supervisor unit via internal RS-485 serial link
- allows interfacing the Led Flash system with a remote control system via Modbus TCP protocol.

A remote control system is allowed to interface the Led Flash system only for functional and operative sessions and *not* for configuration purposes.

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1.3 Conventions

“Modbus” and “jbus” are de facto synonymous [RD1]; anyway the described address table has 0-based starting address as jbus strictly has.

1.4 Reference Documents

Ref.	Title	Code / Identifier	Date	Vers.
RD1	Modbus messaging on tcp/ip Implementation guide	www.modbus.org	May 8, 2002	Rev. 1.0
RD2	OCEM Flashing System Manual	UT-MT-0940	March 2023	Rev. 2.0

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2 Interface definition

The described interface

- is “operation oriented”, for general control and monitoring activities;
- does not support configuration session: the Ocem Led Flash equipment must be configured by a local operator using its “configuration and maintenance” front panel.

The Led Flash can be accessed via modbus TCP using the following two modbus Functional Code [RD. 1]

- read multiple registers, decimal value 3
- write multiple registers, decimal value 16

No 'coils-oriented' registers are supported.

2.1 The communication link with the ALCMS

LED flash system is a modbus slave waiting for requests, so tcp connection is handled as listener.

In general, the following elements must be taken into account in order to correctly interface the ALCMS to the LED flash system:

- The control system is a master for modbus and a client for tcp connection,
- If the communication link falls, the control system has to re-connect the tcp link,
- a maintenance operator can locally perform some checks using the front touch pad TPD panel [RD. 2]. During these operations, the led flash interface enters in a “*local maintenace/diagnostic mode*” during which
 - modbus tcp requests/commands are not served
 - the tcp link persistence is not guaranteed, therefore the ALCMS has to check periodically the tcp link connection and, if the link is down, try to reconnect.

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2.2 The jbus table

2.2.1 General status information

Current functioning status can be read at table address 2;

- this word is the main status request a control system should periodically poll, **with period not lower than 1s**.

Please note that the meaning of the general status word bits is different based on the different versions of the LED flash system¹, as reported in the following tables.

Table 1: main status word for flash system version 6.x

ADDRESS (dec)	R/W	Fields / values / bits	Description
LED FLASH SYSTEM version 6.3			
Main Status Info			word
2	R	bits 0-1	current flash step
		bit 2	current intensity mode
		bits 3-4	current period
		bit 5	on/off flashing state : 1 for “currently flashing”
		bit 6	general alarm : when 1 at least one FFU unit is alarmed
		bit 7	general warning : when 1 at least one FFU unit is warned
		Bit 8	last command failed : when 1, the last command sent to master unit was rejected or invalid

¹ the “flash system version” can be checked on the left upper corner on the front TPD touch-pad panel display of flash main cabinet [RD. 2].

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Table 2: main status word for flash system versions 7.0 - 7.1 - 7.2

ADDRESS (dec)	R/W	Fields / values / bits	Description
LED FLASH SYSTEM versions 7.0 – 7.1 – 7.2			
Main Status Info			word
2	R	bits 0-1	current flash step
		bit 2	current intensity mode
		bits 3-4	current period
		bit 5	on/off flashing state : 1 for “currently flashing”
		<i>bit 6</i>	<i>on/off RTIL state : 1 for “currently flashing”</i>
		bit 7	general alarm : when 1 at least one FFU unit is alarmed
		bit 8	general warning : when 1 at least one FFU unit is warned
		Bit 9	last command failed : when 1, the last command sent to master unit was rejected or invalid

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Table 3 : main status word for flash system version 7.3 and later.

ADDRESS (dec)	R/W	Fields / values / bits	Description
LED FLASH SYSTEM version 7.3 and following			
Main Status Info			word
2	R	bits 0-1	current flash step
		bit 2	current intensity mode
		bits 3-4	current period
		bit 5	on/off overall flashing state: when 1, main approach lights or rttil lights are currently flashing
		bit 6	general alarm : when 1 at least one FFU unit is alarmed
		bit 7	general warning : when 1 at least one FFU unit is warned
		Bit 8	last command failed : when 1, the last command sent to master unit was rejected or invalid
		Bit 9	when 1, main approach lights are flashing
		Bit 10	when 1, RTIL lights are flashing (if configured)
		Bit 11	do not use : test mode
		Bit 12	do not use : test mode
		from version 7.4.4	
		Bit 13	RTIL alarmed
		from version 7.4.5	
		Bit 14	LFD/lamp fault detection L1 warning level
		Bit 15	LFD/lamp fault detection L2 alarm level

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Notes about general alarm indication

The “general alarm” bit indication (bit 6) is a generic cumulative flag indicating that one of the following two conditions is met:

- at least one FFU has detected an internal electrical issue, such as LED failures, voltage/current anomalies, etc.
- at least one FFU is temporary not responding to the FMCU.

When the “general alarm” bit is set to 1 the ALCMS is allowed to check the full alarm context, by requesting:

- the ‘FFU units alarmed map’ (four words at modbus table addresses 40-43, as described in par. 2.2.6);
- the ‘FFU units presence map’ (four words at modbus table addresses 52-55, as described in par. 2.2.6).

Note about RTIL alarm

If RTIL/REIL lights are configured, RTIL alarmed bit means that one RTIL/REIL light is alarmed, then all RTIL/REIL lights have been automatically switched off.

Note about LFD alarm levels

If LFD/light faults detection thresholds are configured [par. 2.2.7]

- LFD L1 *warning* indication bit is true/1 if the number of faulted lights is higher than the LFD L1 threshold configured value;
- LFD L2 *alarm* indication bit is true/1 if the number of faulted lights is higher than the LFD L2 threshold configured value; in this case also LFD L1 bit is true/1.

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2.2.2 Main flash command

The main operative command occupies two words starting at decimal address 0:

- first word at address 0: it contains an integer value specifying the operative command
- second word at address 1: it contains details about the main command value above

Table 4 Main flash command codes

ADDRESS (dec)	R/W	Fields / values / bits		Description		
				Version ² ≤ 6.3	7.0 ≤ Version ≤ 7.3	Version 7.4 and later
Main Command / flashing mode				Word of two integer fields		
0	W	bits 0-8 mapping an integer value	1	Turn ON all flash lights	Turn ON the sequential approach flash lights	
			2	Turn OFF all flash lights	Turn OFF the sequential approach flash lights	
			5	Do not use	Turn ON the RTIL lights	
			6	Do not use	Turn OFF the RTIL lights	
			20	Do not use		Turn OFF <i>both</i> sequential approach and RTIL lights
			21	Do not use		Turn ON <i>both</i> sequential approach and RTIL lights
			Other values	Do not use		
		bits 9-15 mapping an integer value	0	Mandatory value		

When a “turn ON command” is written at address 0 (that is through values 1, 5 or 21 according to the version) the flashing system checks what is specified at address 1 in order to set the corresponding flashing parameters.

² the “flash system version” can be checked on the left upper corner on the front TPD touch-pad panel display of flash main cabinet [RD. 2].

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When a “turn OFF command” is written at address 0 (that is through values 2, 6 or 20 according to the version) the system switches off of the flashing light regardless of the values written at address 1.

Please note that only some options are currently supported, as marked as “mandatory” in the following table.

Table 5 Command qualifiers

ADDRESS (dec)	R/W	Fields / values / bits		Description
Main Command Details				bitfields
1	W	when main command value is 1 (flash on) or 5 (rttl on)		
		bits 0-1	00	flash step: 100% intensity (high)
			01	flash step: 30% intensity (medium)
			10	flash step: 10% intensity (low)
		bit 2	0	future use
			1	intensity mode: ICAO (mandatory)
		bits 3-4	00	period: 0.5 sec / 2 Hz (mandatory)
			01	future use
			10	future use

More notes about command

- values marked as “future use” or values not described should not be used;
- note about RTIL command
 - when front Touch Pad Display shows version number 7.4 or higher, a flash system having **RTIL lights only** can be controlled **also** using Address 0 “main command/flashing mode” values “1 for switching on” and “2 for switching off”, as it was a SFL/normal serial flash system
 - this is supported for backward compatibility.

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2.2.3 Category command setting

Modbus table address 73 is used to select the CATegory operations, in case more than 20 sequential flashing lights are used in the system;

- If RTIL lights are configured, they are not affected by this command.

Please note that, in order to change the CATegory value and make it effective, it is always necessary turn off the flash system *before emitting this CATegory command itself*.

Table 6 Category setting

ADDRESS (dec)	R/W	Fields / values / bits		Description
Only available with LED FLASH SYSTEM version 7.0 and later				
Select CAT				Integer field
73 (dec)	W	word	1	Enable CAT I (all sequential flashing lights are activated)
			2	Enable CAT II/III (only the first 20 sequential flashing lights are activated)
			255	Disable CAT

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2.2.4 General configuration information

Basic configuration information can be read at the addresses shown in the following table

Table 7 General configuration data

ADDRESS (dec)	R/W	Fields / values / bits		Description
Flash units total number				integer
4	R	bits 0-15		Max number of configured FFU units
Flashing groups total number				integer
5	R	bits 0-15		Max number of configured flashing groups
Power grid frequency				bitfield
6	R	bit 0	0	50 Hz configured
			1	60 Hz configured
		bits 1-15		unused

NOTES:

- a “flashing group” value is assigned to each FFU during the system configuration phase, as described in the system manual [RD. 2];
- units having the same “flashing group” value flash contemporary.

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2.2.5 Configured flashing group array

The following set of registers shows the configured “flashing group” assigned to each configured FFU:

- each address word entry carries the above information for two units
- the modbus request can specify the proper number of registers related to the actual number of configured units.

Table 8 Configured groups

ADDRESS (dec)	R/W	Fields / values / bits		Description
Configured flashing group array				byte array
8 - 39 (dec)	R	j -th word ³	low byte	flashing group of FFU numbered ($2 \times j$)
			high byte	flashing group of FFU numbered ($2 \times j + 1$)

NOTES:

- max FFU number is 64, so the above array is mapped on max 32 table entries ($0 \leq j \leq 31$)
- the flash group value of 0xEF (hex) means that the unit itself was not configured and is ignored by the FMCU master unit.

³ the table entry at address $8 + j$ contains the flashing groups of the two FFUs with indexes $n = (2 \times j)$ and $n+1$, mapped on low and high byte of the entry respectively

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2.2.6 Flashing unit status array

The following sets of registers represent arrays of FFUs general alarm status information:

- every FFU unit is represented in each of the following arrays by 1 bit
- four consecutive sets of addresses represent bitfields of cumulative conditions, as described in the following table:

Table 9 Flashing units states arrays

ADDRESS (dec)	R/W	Fields / values / bits	Description
Alarmed flashing units array			bitfields array
40 - 43 (dec)	R	bits in each word	if 1, the corresponding FFU unit is alarmed
Warned flashing units array			bitfields array
44 - 47 (dec)	R	bits in each word	if 1, the corresponding FFU unit is warned
Configured units array			bitfields array
48 - 51 (dec)	R	bits in each word	if 1, the corresponding FFU is set and configured, otherwise the FMCU ignores the unit
Alive presence array (not responding units' map)			bitfields array
52 - 55 (dec)	R	bits in each word	if 0, the corresponding configured FFU unit is alive and correctly communicating with the FMCU master unit

NOTES:

- each set of 4 addresses' word entries represents a max number of 64 flashing units
- the flashing unit of index k is represented by bit $(k \bmod 16)$ in the $(k \div 16)$ address entry of each 4-word set in the table above.
- as already noted at par. 2.2.1, if “general alarm” bit is set at address 2 “Main Status Info”, the ALCMS control system is allowed to poll
 - the “Alarmed flashing units array” to get the map of alarmed units
 - the “Alive presence array” to get the map of units correctly responding to the FMCU.
- if “general warning” bit is set in address 2 “Main Status Info”, the control system is allowed to poll the “Warned flashing units array” to get the map of units in warning state
 - when RTIL/REIL feature is present and alarmed, all its lights are switched off
 - flashing unit *directly alarmed* appears in “alarmed units’ map”
 - flashing units *not directly alarmed* appear in “warning units’ map”.

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2.2.7 Configuring LFD thresholds

From flash system version 7.4.5, light faults detection thresholds can be set

Table 10 LFD Thresholds

ADDRESS (dec)	R/W	Fields / values / bits	Description
LFD L1 warning level			integer value
84 (dec)	R/W		LFD L1 bit in in status word will be set if actual failed lights number is greater than this LFD L1 threshold value (higher than 0).
LFD L2 alarm level			Integer value
85 (dec)	R/W		LFD L2 bit in in status word will be set if actual failed lights number is greater than this LFD L2 threshold value (higher than 0).

General note

A flash system can *not* be configured by ALCMS apart the two above threshold values.

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2.2.8 Current LFD value

From flash system version 7.4.5, faulted lights' number can be read

Table 11 Current faulted lights number

ADDRESS (dec)	R/W	Fields / values / bits	Description
LFD actual value			integer value
86 (dec)	R		Number of actual faulted lights, independently from above LFD thresholds

Notes

- a flash unit is considered faulted if its flashing LED light is alarmed or its controller does not communicate with the FMCU master unit;
- this value is related, and it is an alternative, to “alarmed lights map” (addresses 40-43) and to “not responding units’ map” (addresses 52-55).

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3 Appendix: usage short notes

Note about state polling

ALCMS supervisor usually polls flash system current state asking the state word (address 0);

- “alarmed lights map” (addresses 40-43) is usually intended to be asked if “general alarm” bit is raised in status word, along with “not responding units’ map” (addresses 52-55);
 - as alternative, if flash system version is 7.4.5, the number of failed units (address 86) can be asked;
- “RTIL/REIL alarmed” bit can be check as quick feedback instead of parsing above alarms’ maps.

Note about command’s retransmission

It is generally a good practice, for a ALCMS, actuating a “command retransmission policy” on field units, *usually* when the commanded target state (e.g. on/off or step level) is not reached in a given time interval (depending on ALCMS specific system considerations).

About this LED flash system, please consider that

- *flash system already performs an its own internal command retransmission policy*

thus, *in order to avoid overlapping of command retransmission scenarios*

- a ALCMS should *avoid* to retransmit a command “forever” (till the next different one, and forever again);
- so, a retransmission policy should limit command retransmission to few emissions (for example time spaced by few seconds).

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3.1 Modbus messages' examples

Following descriptions at tables 3, 4 and 5 [par. 2.2.1 and 2.2.2], some modbus messages are presented as examples about command and state polling scenarios.

- modbus packets' examples are shown as byte stream;
- more meaningful bytes are described.

Serial Flashing Lights/SFL only switch on command and subsequent state request

```
CMD : ledFlashCmd : ____ raw pkt: len 17
byte index 0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16
           00 00 00 00 00 0b 01 10 00 00 00 02 04 00 01 00 04
```

where

- byte 14 value 1 command is for SFL only
- byte 16 value 4 100%, standard icao mode

subsequent flash status polling request

```
REQ : status polling req : ____ raw pkt: len 12
byte index 0  1  2  3  4  5  6  7  8  9  10 11
           00 00 00 00 00 06 01 03 00 02 00 01
```

where

- byte 7, function code 3, read multiple register (even if only one is required..)
- bytes 8, 9 : starting address 2, for flash current status
- byte 10, 11 : 1 word required

then following status polling response is

```
RXD : status polling resp : ____ raw pkt: len 11
byte index 0  1  2  3  4  5  6  7  8  9  10
           00 00 00 00 00 05 01 03 02 02 24
```

Where

- byte 9 value 02 SFL is flashing
- byte 10 value 24 hex generally flashing, 100% level, standard icao mode

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RTIL only switch on command and subsequent state request

CMD : ledFlashCmd : ____ raw pkt: len 17
byte index 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
 00 00 00 00 00 0b 01 10 00 00 00 02 04 00 05 00 04

where

- bytes 13, 14 value 5 command is for RTIL only
- byte 16 value 4 100% step level, standard "icao mode"

then, following status polling request will receive

RXD : status polling resp : ____ raw pkt: len 11
byte index 0 1 2 3 4 5 6 7 8 9 10
 00 00 00 00 00 05 01 03 02 04 24

Where

- byte 9 value 4 rttil only flashing
- byte 10 value 24 hex generally flashing, 100% step level

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Serial Flashing Lights and RTIL switch on command and subsequent state request

CMD : ledFlashCmd : ____ raw pkt: len 17
 byte index 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
 00 00 00 00 00 0b 01 10 00 00 00 02 04 00 15 00 05

in which

- byte 7 is function code 16, write multiple register
- bytes 8, 9 : starting address 0, for flash command
- byte 10, 11 : 2 words to write
- two payload command words are specified from byte 13
- from table 3, par. 2.2.2
 - o byte 14 value 15 hex turn on both SFL and RTIL lights
 - o byte 16 30% step level

subsequent flash status polling request

REQ : status polling req : ____ raw pkt: len 12
 byte index 0 1 2 3 4 5 6 7 8 9 10 11
 00 00 00 00 00 06 01 03 00 02 00 01

where

- byte 7, function code 3, read multiple register (even if only one is required..)
- bytes 8, 9 : starting address 2, for flash current status
- byte 10, 11 : 1 word required

following status response

RXD : status polling resp : ____ raw pkt: len 11
 byte index 0 1 2 3 4 5 6 7 8 9 10
 00 00 00 00 00 05 01 03 02 06 25

where bytes 9,10 contains status response

- o bytes 9 value 6 SFL and RTIL lights are flashing
- o byte 10 value 25 hex generally flashing, 30% step level

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Alarmed RTIL indication

Following above case, an alarmed RTIL is represented in the status response as follows

```
RXD : status polling resp : ____ raw pkt: len 11
byte index 0 1 2 3 4 5 6 7 8 9 10
           00 00 00 00 00 05 01 03 02 22 E5
```

Where

- byte 9 value 22 hex SFL is still flashing, RTIL is alarmed, RTIL is off
- byte 10 value E5 hex still generally flashing (SFL), general warning, alarm

Moreover

- “general alarm” (byte 10, bit 6) is anyway present even if “RTIL alarmed” (byte 9, bit 13);
- “general warning” (byte 10, bit 7) means “a RTIL correctly working unit was switched off due to its alarmed RTIL mate unit”;
- again about “general alarm” in this alarmed RTIL scenario
 - o byte 10 could contains value A5 hex for a certain number of status responses without indicating “general alarm” bit, that will be notified later
 - o this is due to a sort of “alarm filtering” in order to avoid “general alarm flickering”
 - o anyway, in this scenario, “RTIL alarmed” bit is used first, for “flash system version 7.4.4” as reported in Table 3.

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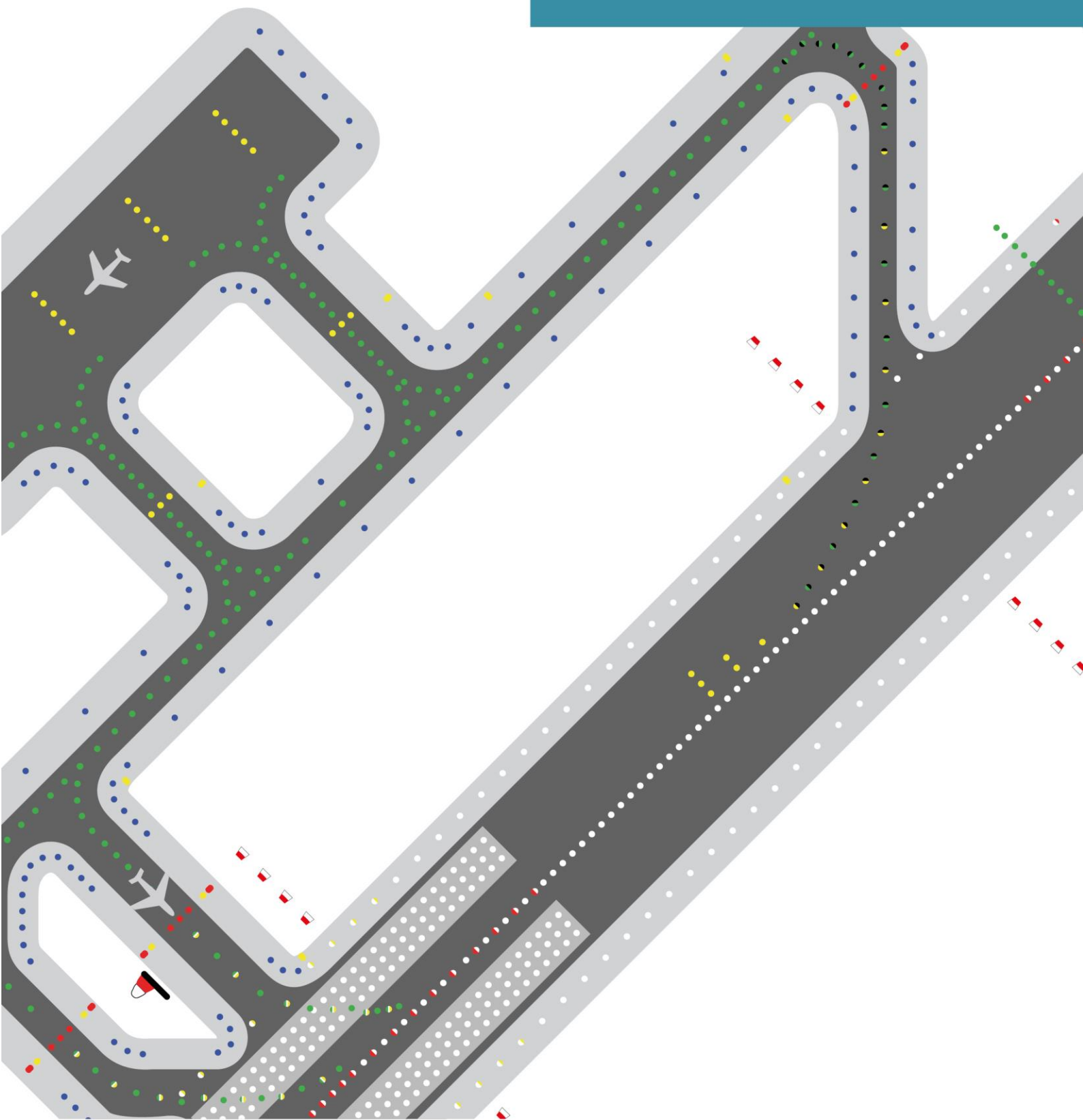
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