Mobileye Extended Log Data Protocol 2

Table of Contents

Additional information that may be present in the Mobileye Extended Output protocol is not supported and as so not mentioned this document.

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1 Introduction

This document describes the Extended Data Protocol of the Mobileye system. The Protocol is used to send out internal information and measurements from the Mobileye system – Vehicle Detection, Lane Departure Warning and Forward Collision Warning. The Protocol may be used by OEM's evaluating Mobileye's technologies, or by third party that wants to integrate Mobileye's system into their system (such as Fleet Management, fusion systems, Vision ACC systems, etc.…).

1.1 Purpose

The purpose of this document is to define the format of a CAN message that is used to send the results of the Mobileye system calculations outputs.

1.2 Roles

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1.3 Acronyms and Terminology

Term	Description
CAN	Controller Area Network
CIPV	Closest In Path Vehicle

2 CAN Message

2.1 CAN Parameters

- The message is transmitted in an 11bit CAN header format.
- Baud rate is 500Kbps
- The CAN message is transmitted approximately every 66-100 ms.

3 CAN Message 0x737 Details - Lane

The message contains the Lane information and measurements.

	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Byte 0	Lane Curvature (LSB)							
Byte 1	Lane Curvature (MSB)							
Byte 2	Lane Heading (LSB)							
Byte 3	NA	Left LDW Availability	Right LDW Availability	CA	Lane Heading (MSB)			
Byte 4	Yaw Angle (LSB)							
Byte 5	Yaw Angle (MSB)							
Byte 6	Pitch Angle (LSB)							
Byte 7	Pitch Angle (MSB)							

3.2 Lane Curvature

- Type: signed integer
- Units: 1/m
- Range -0.12 : 0.12 [1/m]
- Conversion: (HEX)*3.81*10^{-6}
- Invalid value: 8000h
- Note: The Curvature (a) parameter in the equation: y= ax^2 + bx+ c
- To extract the road radius (r) from curvature (a): r = 1/(2*a).

3.3 Lane Heading

- Type: signed integer
- Range: -1.0 : 1.0
- Conversion: (HEX)*0.0005
- Invalid value: 800h
- Note: The Heading (b) parameter in the equation: y= ax^2 + bx+ c

3.4 CA – construction area

- Type Boolean.

3.5 Pitch Angle

- The pitch angle information of the host vehicle (derived from lanes analysis).
- Type: unsigned 16 bits
- Unit: radians
- Range: -0.05 : 0.05
- Conversion: (HEX-0x7FFF)/1024/512

3.6 Yaw Angle

- The yaw angle information of the host vehicle (derived from lanes analysis).
- Type: unsigned 16 bits
- Unit: radians
- Conversion: (HEX-0x7FFF)/1024

3.7 Right LDW Availability

- Availability of LDW for the Right lane mark.
- Type: 1 bit, unsigned integer
- Range 0 ,1
- Invalid value: none
- 0 stands for unavailable, 1 for available.

3.8 Left LDW Availability

- Availability of LDW for the Left lane mark.
- Type: 1 bit, unsigned integer
- Range 0 ,1
- Invalid value: none
- 0 stands for unavailable, 1 for available.

4 CAN Message 0x738 Details – Obstacle Status

This message contains the number of obstacles, the timestamp and the application version. Obstacles can be vehicles, Motorcycles or pedestrians.

	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Byte 0	Number of Obstacles							
Byte 1	Timestamp							
Byte 2	Reserved							
Byte 3	Go!				Right close rang cut in	Left close rang cut in	Reserved	
Byte 4	Reserved							
Byte 5	Reserved			Failsafe				Close Car

4.2 Number of Obstacles

- Type: unsigned integer
- Range: 0 : 255

4.3 Timestamp

- Type: unsigned integer
- Unit: milliseconds
- Range: 0 : 255 [ms]
- Note: Only the lowest 8 bits of the timestamp is given. The timestamp source is from the EyeQ image grabbing.

4.4 Left close rang cut in

- Type: Boolean
- 0 false, 1 true

4.5 Right close rang cut in

- Type: Boolean
- 0 false, 1 true

4.6 Go!

•Type: Enum

•Values:
0 – Stop
1 – Go!
2 – Undecided
3 - Driver decision is required
…. [4-14 - currently unused]
15 – Not Calculated

- Current status of this signal:
  - Reports only values of 0 or 1 or 15
  - Reports Stop or Go decisions only when the own vehicle is standing (having ego speed of less than 0.1 meters per second). Otherwise, the value 15 is reported.

4.7 Close car

•Indication whether we detect a close car in front of the host vehicle or not.

- Type: Boolean
- 0 No close car
  1 Close car exists

4.8 Failsafe

- Type: 4 bits, unsigned integer
- Range 0 : 7
- Invalid value: 0
- Bitwise signal, which indicates failsafe situation in this scene.
  Values:
  0000 – No Failsafe
  0001 – Low Sun
  0010 – Blur Image
  0100 – unused
  1000 – unused

5 CAN Message 0x739 + I*3 Details – Obstacle Data A

Where I = 0: number of obstacles - 1

This message contains obstacle detection information and measurements.

Bit	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Byte 0	Obstacle ID							
Byte 1	Obstacle Position X (LSB)							
Byte 2	Reserved				Obstacle Position X (MSB)			
Byte 3	Obstacle Position Y (LSB)							
Byte 4	Cut in and out			Blinker Info			Obstacle Position Y (MSB)	
Byte 5	Obstacle Relative Velocity X (LSB)							
Byte 6	*Reserved*	Obstacle Type			Obstacle Relative Velocity X (MSB)			
Byte 7	Obstacle Valid		Reserved		Obstacle Brake Lights	Obstacle Status		

5.1 Obstacle ID

- Type: unsigned integer
- Range: 0 : 63
- Note: New obstacles are given the last used free ID.

5.2 Obstacle Position X

- Type: unsigned integer
- Unit: meter
- Range: 0 : 250 [m]
- Conversion: (HEX)*0.0625
- Invalid value: FFFh
- Meaning:

The longitude position of the obstacle relative to the reference point. This field is computed from the image position of the obstacle and from the detected width of the obstacle. The value is filtered to provide smooth measurements, and in order to avoid measurements outliers. In General, the value error is below 10% or 2 meters (the larger of the two) in ~85% of the cases.

5.3 Obstacle Position Y

- Type: signed integer
- Unit: meter
- Range: -31.93 : 31.93 [m]
- Conversion: (HEX)*0.0625
- Invalid value: 200h
- Meaning:
  The lateral position of the obstacle. This field is computed from the image position of the obstacle and from the Position X value, so that we can report real world coordinates and not just angle from the camera. The value is filtered to provide smooth measurements, and in order to avoid measurements outliers. The typical error is correlated to Position X measurement's error.

5.4 Obstacle Relative Velocity X

- Type: signed integer
- Unit: meter/sec
- Range: -127.93 : 127.93 [m/s]
- Conversion: (HEX)*0.0625
- Invalid value: 800h
- Meaning:
  The relative longitude velocity of the obstacle. This field is computed from the obstacle scale change in the image. The value is a single frame value.

5.5 Obstacle Type

- Type: 3 bits, unsigned integer
- Range 0 : 7
- Invalid value: none
- Enumerator signal, which indicates the object's classification

Enumerator values:

000 – Vehicle

001 – Truck

010 – Bike

011 – Ped

100 – Bicycle

101 – Unused

110 – Unused

111 – Unused

5.6 Obstacle Status

- Type: unsigned integer
- Unit: Enum

Value	Definition
0	Undefined
1	Standing (never moved, back lights are on)
2	Stopped (movable)
3	Moving
4	Oncoming
5	Parked (never moved, back lights are off)
6	Unused

5.7 Obstacle Brake Lights

- Type: 1 bit, Boolean
- Range 0:1
- Invalid value: 0
- Conversion: (HEX)*1
- A flag indicating that the object's brake lights are on.

0	object's brake lights are off, or not identified
1	object's brake lights are on

5.8 Cut in and out

- Type: unsigned integer
- **Enumeration :**
    - 0= undefined
    - 1= in host lane
    - 2= out host lane
    - 3=Cut in
    - 4=Cut out
- The signal is based on our estimation of where the target is now relatively to the lanes, its rate of change, and our estimation of where it is going to be within one second.

- The states are self-explanatory. For instance, cut in means target is now entering host lane, cut out means it is now exiting host lane, etc.
- The cut in and out signal does not distinguish between sides, i.e. left and right.

5.9 Blinker Info

Type: unsigned integer

Indicated Blinkers status

- Unit: Enum :
    - 0=unavailable
    - 1= off
    - 2= left
    - 3= right
    - 4=both

5.10 Obstacle Valid

- Type: unsigned integer
- Unit: Enum

1	New valid (detected this frame)
2	Older valid

6 CAN Message 0x73A + I*3 Details - Obstacle Data B

Where I = 0: number of obstacles - 1

This message contains obstacle detection information and measurements.

	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Byte 0	Obstacle Legnth							
Byte 1	Obstacle Width							
Byte 2	Obstacle Age							
Byte 3	Radar Position X (LSB)				reserved	CIPV Flag	Obstacle Lane	
Byte 4	Radar Position X (MSB)							
Byte 5	Radar Velocity X (LSB)							
Byte 6	reserved	Radar Match Confidence			Radar Velocity X (MSB)			
Byte 7	reserved	Matched Radar ID						

6.2 Obstacle Length

- Type: unsigned integer
- Units: meter
- Range: 0 : 31 [m]
- Conversion: (HEX)*0.5
- Invalid value: 3Fh
- Meaning:
  The length of the obstacle (longitude axis). Updated only for next lane vehicles that are fully seen, and only if the system has found the front edge of the vehicle. We don't have recent information regarding the signal's accuracy.

6.3 Obstacle Width

- Type: unsigned integer
- Unit: meter
- Range: 0 : 12.5 [m]
- Conversion: (HEX)*0.05
- Invalid value: FFh
- Meaning:

The width of the obstacle (lateral axis). This value is calculated from the width in the image and the obstacle distance. The value is filtered to avoid outliers. The expected performance is to have error < 10% of the width in 90% of the cases. At night, the width measured is between the obstacle's taillights.

6.4 Obstacle Age

- Type: unsigned integer
- Range: 0 : 255
- Meaning:

The age of the obstacle (in frames). This value starts at 1 when the obstacle is first detected, and increments in 1 each frame. The value reported is minimum (realAge, 254), which means that it remains 254 if the age is larger than that number.

6.5 Obstacle Lane

- Type: unsigned integer
- Unit: Enum

0	Not assigned
1	Ego lane
2	Next lane (left or right), or next next lane
3	Invalid signal

Note: This value is calculated form the obstacle position and the lane detection or the headway model (yaw rate based or vision based) of the vehicle. The lane assignment decision usually takes up to 5 frames from the first detection of the obstacle.

6.6 CIPV Flag

- Type: unsigned integer
- Unit: Enum

0	Not CIPV
1	CIPV

Note: This value is calculated from the obstacle position and the lane detection or the headway model (yaw rate based or vision based) of the vehicle. The lane assignment decision usually takes up to 5 frames from the first detection of the obstacle.

6.7 Radar Position X

- Type: unsigned integer
- Unit: meter
- Range: 0 : 250 [m]
- Conversion: (HEX)*0.0625

- Invalid value: FFFh (also in case on no radar target matched)
- Meaning:
  The longitude position of the primary radar target matched to the vision target (if applicable), distance is given in relative to the reference point and not the camera. If no radar target is matched, the value will be 0xFFFh.

6.8 Radar Velocity X

- Type: signed integer
- Unit: meter/sec
- Range: -127.93 : 127.93 [m/s]
- Conversion: (HEX)*0.0625
- Invalid value: 800h (also in case on no radar target matched)
- Meaning:
  The longitude velocity of the radar target matched to the vision targets (if applicable). If no radar target is matched, the value will be 0xFFF.

6.9 Radar Match Confidence

- Type: unsigned integer
- Range 0:5 over 3 bits
- Invalid value: 0h
- Meaning: confidence of the radar match:

0: No match

1: Multi match, radar does not describe well the vision obstacle.

2-4: vision - radar match, with bounded error between vision and radar measurements, higher match confidence yield smaller error

5: high confidence match, with small error between Radar and vision measurement

6.10 Matched Radar ID

- Type: unsigned integer
- Range 0:127
- Invalid value: 7fh
- Meaning: ID of Primary radar target matched to the vision target if applicable.

7 CAN Message 0x73B + I*3 Details - Obstacle Data C

Where I = 0: number of obstacles - 1

This message contains obstacle detection information and measurements.

Bit	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Byte 0	Obstacle Angle Rate (LSB)							
Byte 1	Obstacle Angle Rate (MSB)							
Byte 2	Obstacle Scale Change (LSB)							
Byte 3	Obstacle Scale Change (MSB)							
Byte 4	Object Accel X							
Byte 5	Reserved			Obstacle Replaced	Reserved		Object Accel X	
Byte 6	Obstacle Angle (LSB)							
Byte 7	Obstacle Angle (MSB)							

7.1 Obstacle Angle Rate

- Type: signed integer
- Unit: degree
- Range: -327.68 : 327.68 [degree/sec]
- Conversion: (HEX)*0.01
- Meaning: Angle rate of Center of Obstacle in degrees/sec. A negative angle rate indicates that the obstacle has moved to the left (clockwise axis system). This value is calculated based on delta angles reported from the reference point in two consecutive frames.

7.2 Obstacle Scale Change

- Type: signed integer
- Unit: pix/sec
- Range: -6.5532 : 6.5332 [pix/sec]
- Conversion: (HEX)*0.0002
- Invalid value: 7FFh

7.3 Object Accel X

- The longitude acceleration of the object.
- Type: 10 bit, signed integer
- Range: -14.97 : 14.97 [m/s^2]
- Conversion: (HEX)* 0.03
- Invalid value: 200h

7.4 Obstacle Replaced

- Type: Boolean

0	Not replaced in this frame
1	Replace in this frame

7.5 Obstacle Angle

- Type: signed integer
- Unit: degree
- Range: -327.68 : 327.68
- Conversion: (HEX)*0.01
- Meaning:
  Angle to Center of Obstacle in degrees. 0 indicates that the obstacle is in exactly in front of us (along the longitudinal axis); a positive angle indicates that the obstacle is to the right (clockwise axis system).
  This value is calculated from the reference point, and is based on the obstacle's location in the image and the distance estimation in order to provide measurements in the real world. The angle error can have errors with correlation to the distance measurements error.