INTERNATIONAL STANDARD

ISO 17215-3

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Road vehicles — Video communication interface for cameras (VCIC) —

Part 3: Camera message dictionary

Véhicules routiers — Interface de communication vidéo pour caméras (ICVC) —

Partie 3: Dictionnaire de message de caméra

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 17215 consists of the following parts, under the general title *Road vehicles — Video communication interface for cameras (VCIC)*:

— *Part 1: General information and use case definition*

— *Part 2: Service discovery and control*

— *Part 3: Camera message dictionary*

— *Part 4: Implementation of communication requirements*

Introduction

Driver assistance systems are more and more common in road vehicles. From the beginning, cameras were part of this trend. Analogue cameras were used in the beginning because of lower complexity of the first systems. With increasing demand for more advanced functionality, digital image processing has been introduced. So-called one box design cameras (combining a digital image sensor and a processing unit) appeared in the vehicles.

Currently, the market demands such systems with multiple functions. Even different viewing directions are in use. It seems to be common sense that 6 up to 12 cameras in a single vehicle will be seen in the next future. Out of this and the limitation in size, power consumption, etc. it will lead to designs where the cameras are separated from the processing unit. Therefore, a high performance digital interface between camera and processing unit is necessary.

This International Standard has been established in order to define the use cases, the communication protocol, and the physical layer requirements of a video communication interface for cameras, which covers the needs of driver assistance applications.

The video communication interface for cameras

— incorporates the needs of the whole life cycle of an automotive grade digital camera,

— utilizes existing standards to define a long-term stable state-of-art video communication interface for cameras usable for operating and diagnosis purpose,

— can be easily adapted to new physical data link layers including wired and wireless connections by using existing adaption layers, and

— is compatible with AUTOSAR.

This part of ISO 17215 is related to the general information and use case definition. This is a general overview International Standard which is not related to the OSI model.

To achieve this, it is based on the Open Systems Interconnection (OSI) basic reference model specified in ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the protocol and physical layer requirements specified by this International Standard, in accordance with Table 1 are broken into following layers:

— application (layer 7), specified in ISO 17215-3;

— presentation layer (layer 6), specified in ISO 17215-2;

— session layer (layer 5), specified in ISO 17215-2;

— transport protocol (layer 4), specified in ISO 17215-4, ISO 13400-2;

— network layer (layer 3), specified in ISO 17215-4, ISO 13400-2;

— data link layer (layer 2), specified in ISO 17215-4, ISO 13400-3;

— physical layer (layer 1), specified in ISO 17215-4, ISO 13400-3.

Table 1 — Specifications applicable to the OSI layers

Applicability	OSI 7 layers	Video communication interface for cameras		Camera diagnostics
Seven layers according to ISO 7498–1 and ISO/IEC 10731	Application (layer 7)	ISO 17215-3		
	Presentation (layer 6)	ISO 17215-2		
	Session (layer 5)	ISO 17215-2		
	Transport (layer 4)	ISO 17215-4	Other future interface standards	ISO 13400-2
	Network (layer 3)			
	Data link (layer 2)	ISO 17215-4		ISO 13400-3
	Physical (layer 1)			

ISO 17215-1 has been established in order to define the use cases for vehicle communication systems implemented on a video communication interface for cameras; it is an overall International Standard not related to the OSI model.

ISO 17215-3 covers the application layer implementation of the video communication interface for cameras; it includes the API.

ISO 17215-2 covers the presentation layer implementation of the video communication interface for cameras.

ISO 17215-4 is the common standard for the OSI layers 1 to 4 for video communication interface for cameras. It complements ISO 13400-2 and ISO 13400-3 and adds the requirement for video transmission over Ethernet.

ISO 17215-2 and ISO 17215-3 (OSI layer 5 to 7) services have been defined to be independent of the ISO 17215-4 (OSI layer 1 to 4) implementation. Therefore, ISO 17215-4 could be replaced by other future communication International Standard.

Road vehicles — Video communication interface for cameras (VCIC) —

Part 3:
Camera message dictionary

1 Scope

This part of ISO 17215 specifies the standardized camera messages and data types used by a VCIC camera (OSI Layer 7).

The scope of the camera application interface (API) and its context are shown in Figure 1.

Applications hosted on ECUs want to communicate with one or more cameras (e.g. “Ask camera for parameters.”). If the applications can use standardized services supported by the cameras (API layer 7), the development of a vision application should be independent of the camera used. The services can be implemented by general libraries.

The definition of streaming data are not an issue of this API.

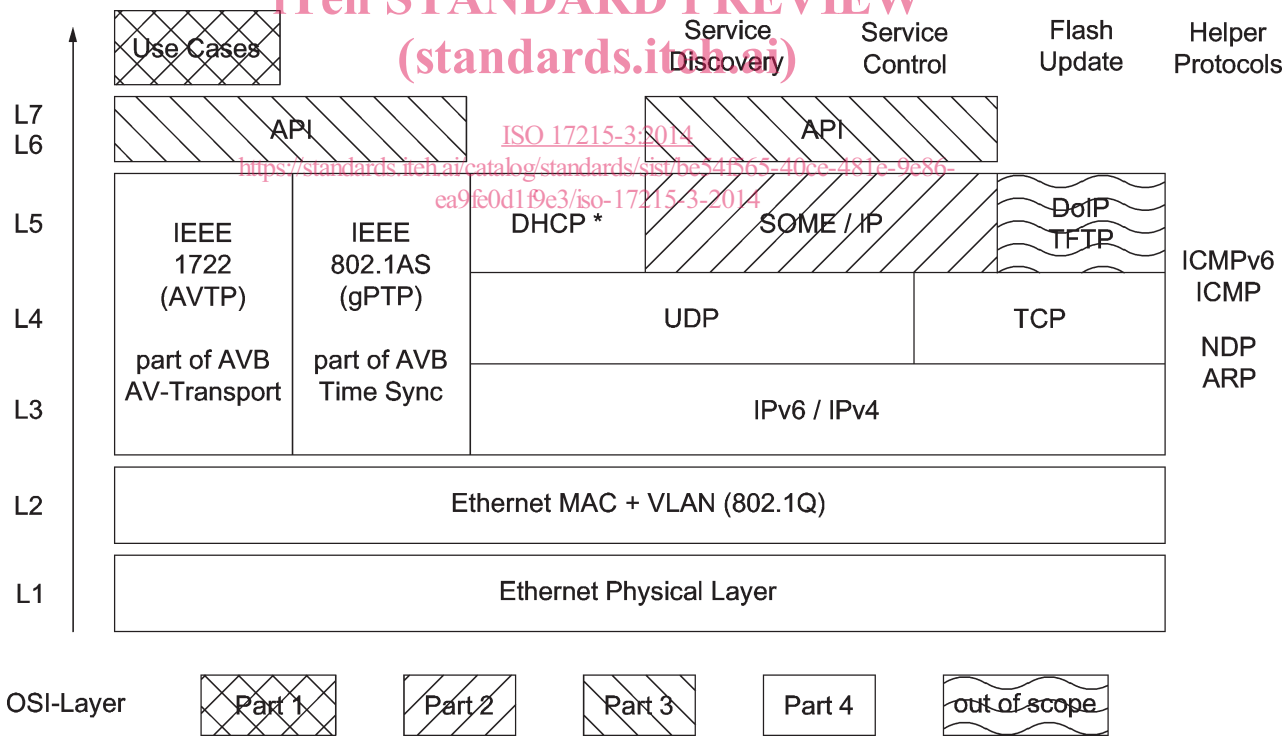

Figure 1 — Overview of ISO 17215

The general terminology defined in ISO 17215-1 is also used in this part of ISO 17215.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO°7498-1, *Information processing systems — Open systems interconnection — Basic reference model*

ISO/IEC 10731, *Information technology — Open Systems Interconnection — Basic Reference Model — Conventions for the definition of OSI services*

ISO 17215 (all parts), *Road vehicles —Video communication interface for cameras (VCIC)*

3 Terms and definitions, symbols, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
camera identification number
individual camera identification number that identifies the supplier, camera type, and individual camera (e.g. MEE-32140-194565432-DD2RT supplier, camera type, serial number)

3.1.2
camera register
internal HW registers of the camera

3.1.3
extrinsic parameters
denotes the coordinate system transformations from 3D world (vehicle) coordinates (m,°) to 3D-camera coordinates (m,°)

3.1.4
focal length
distance over which initially collimated rays are brought to a focus

3.1.5
frame rate
update rate per time of camera images

3.1.6
global shutter
exposure that exposes all pixels at the same time

3.1.7
histogram
type of histogram that acts as a graphical representation of the tonal distribution in a digital image

3.1.8
intrinsic camera parameters
denote the coordinate system transformations from 3D camera (m) to 2D pixel coordinates (pixel)

3.2 Abbreviated terms

Term	Description
API	Application Programming Interface
AEC	Automatic Exposure Control
AGC	Automatic Gain Control
DAS	Driver Assistance System
ECU	Electronic Control Unit
HDR	High Dynamic Range
HMI	Human Machine Interface
ISO	International Organization for Standardization
LDR	Low Dynamic Range
MAC	Media Access Control
OSI	Open Systems Interconnection
PSE	Persistent storage entry
ROI	Region of Interest, i.e. sub-part of overall image
RPC	Remote Procedure Call

4 Conventions

This International Standard is based on the conventions specified in the OSI service conventions (ISO/IEC°10731) as they apply for physical layer, protocol, network, and transport protocol and diagnostic services.

5 Overview of ISO 17215

5.1 General

This International Standard has been established in order to implement a standardized video communication interface for cameras on a communication data link.

The focus of this International Standard is using existing protocols.

— Figure 1 specifies the relation to the other parts of this International Standard.

— Figure 2 specifies the relation of this International Standard to existing protocols.

5.2 Document overview and structure

This International Standard consists of a set of four sub-documents, which provide all references and requirements to support the implementation of a standardized video communication interface for cameras according to the standard at hand.

— ISO 17215-1 provides an overview of the document set and structure along with use case definitions and a common set of resources (definitions, references) for use by all subsequent parts.

— ISO 17215-2 specifies the discovery and control of services provided by a VCIC camera.

— ISO 17215-3 specifies the standardized camera messages and data types used by a VCIC camera (OSI Layer 7).

— ISO 17215-4 specifies standardized low-level communication requirements for implementation of the physical layer, data link layer, network layer, and transport layer (OSI Layers 1 to 4).

5.3 Open Systems Interconnection (OSI) model

This International Standard is based on the Open Systems Interconnection (OSI) basic reference model as specified in ISO/IEC 7498 which structures communication systems into seven layers.

All parts of this International Standard are guided by the OSI service conventions as specified in ISO/IEC 10731 to the extent that they are applicable to diagnostic services. These conventions define the interaction between the service user and the service provider through service primitives.

The aim of this subclause is to give an overview of the OSI model and show how it has been used as a guideline for this part of ISO 17215. It also shows how the OSI service conventions have been applied to this International Standard.

The OSI model structures data communication into seven layers called (from top to bottom) the application layer (layer 7), presentation layer, session layer, transport layer, network layer, data link layer, and physical layer (layer 1). A subset of these layers is used in this International Standard.

The purpose of each layer is to provide services to the layer above. The active parts of each layer, implemented in software, hardware, or any combination of software and hardware, are called entities. In the OSI model, communication takes place between entities of the same layer in different nodes. Such communicating entities of the same layer are called peer entities.

The services provided by one layer are available at the Service Access Point (SAP) of that layer. The layer above can use them by exchanging data parameters.

This International Standard distinguishes between the services provided by a layer to the layer above it and the protocol used by the layer to send a message between the peer entities of that layer. The reason for this distinction is to make the services, especially the application layer services and the transport layer services, reusable also for other types of networks than the video communication interface for cameras. In this way, the protocol is hidden from the service user and it is possible to change the protocol if demanded by special system requirements.

5.4 Document reference according to OSI model

Figure 2 illustrates the document references.

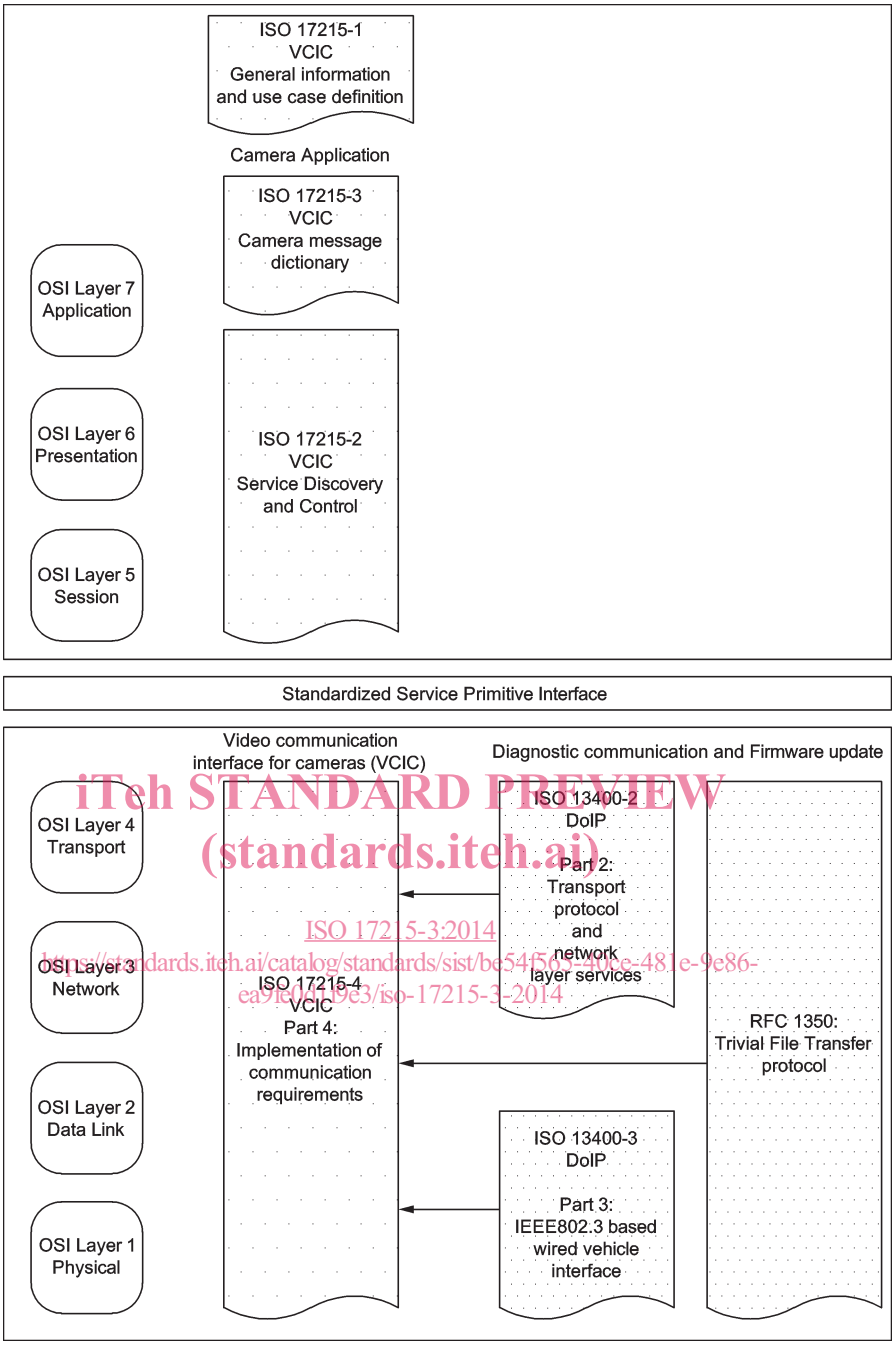

Figure 2 — Document reference according to OSI model

6 Camera application interface (OSI layer 7)

6.1 Specific properties

In the automotive environment, the network topologies are semi-static and the characteristics of all components, including cameras, are bound to a specific car platform design. Components and characteristics of components not included in the design need not to be supported.

There is no requirement for a least common video mode. The minimum compatibility requirement is to recognize the reason of unexpected behaviour. Compatibility is ensured during the design phase. Incompatibility will be detected during development, assembling, or repair of a car.

Consequently, the standard specifies the interface to an automotive camera, but doesn't specify the characteristics of automotive cameras.

For instance, no mandatory or standard video formats are specified. However, all provisions are made to implement standard video formats.

6.2 API principles

The camera API consists of a variety of data structures describing video modes, camera controls, and stored items and a set of API functions.

The API is independent of specific programming languages. It is an abstract list of data structures and functions to be offered by all implementations. A fundamental principle of all camera API functions is the usage of remote procedure calls (RPC).

The addressing of multiple cameras can be expressed by:

Camera_function = f { camera instance, api_function { MethodID, arg1, .. argn } }.

The implementation depends highly on the programming language used. Therefore, this part of ISO 17215 only covers the api_function itself.

Camera data structures can be read, written, and deleted using the associated camera API functions.

Camera API functions can be grouped by the mechanism they are using in

— set, get, and erase functions, and

— subscribe and unsubscribe functions.

All API functions starting with set, get, and erase are used to modify the cameras data structures and the underlying functionality, for instance setting the exposure time of the imager. They are using a request/response mechanism. A request is followed by a single response.

Functions are generally identified by its Method ID.

The Method IDs are specified in 6.5.1.

All API functions starting with unsubscribe/subscribe are used to acquire cyclically data from the camera, for instance, a video stream. They are using subscribe/notification mechanism. After subscribing an event, multiple notification packages will follow.

Events are identified by its respective Eventgroup ID.

The Eventgroup IDs are specified in 6.5.2.

The SOME/IP protocol defined in ISO 17215-2 provides the mechanism for such a RPC-based implementation.

Camera functions and the associated structures can be grouped in functional context in

— general camera functions (MethodID 0x0001 – 0x00FF),

— video format functions (MethodID 0x0101 – 0x01FF),

— image control functions (MethodID 0x0201 – 0x02FF), and

— imager functions (MethodID 0x0301 – 0x03FF).

6.2.1 Image cropping and windowing

The definition of the image windows are shown below.

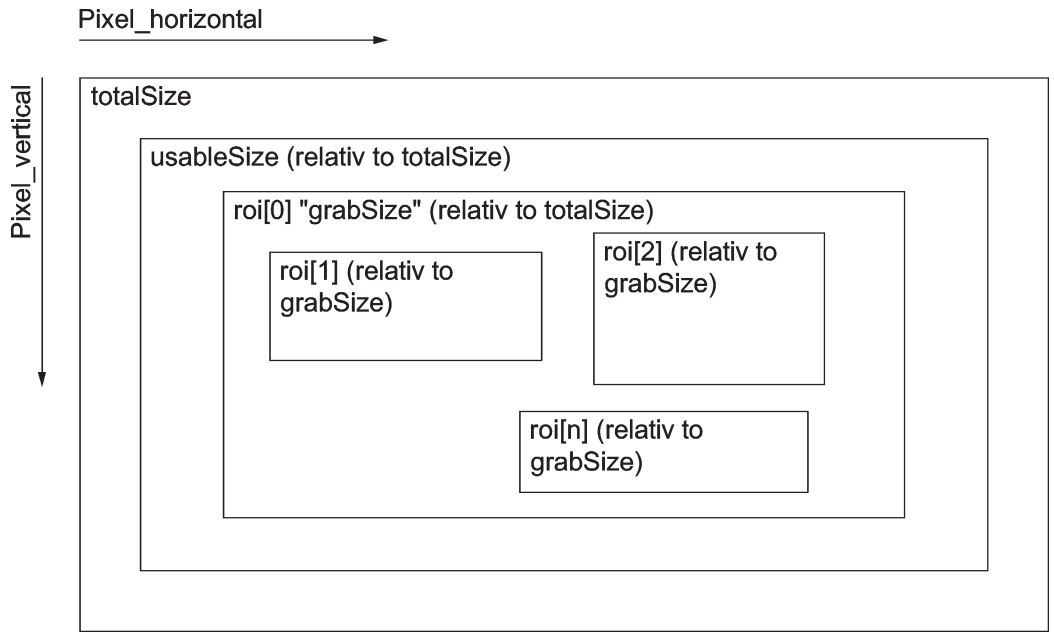

Figure 3 — Image cropping and windowing

6.3 API data types

All used data types are specified in 6.3.1 of ISO 17215-2.

6.4 API Return codes

Each function of the API returns a byte (8 bits) to signalize the status of the operation.

— The return codes (0x00 to 0x1F) are defined in 6.1.1.7 of ISO 17215-2.

— The return codes (0x20 to 0x3F) are function-specific and are described in 6.5.3.

6.5 API enumerations

6.5.1 enumeration eMethodID

Purpose: This enumeration is used to identify the methods supported by the camera.

This enumeration is based on uint16 data type.

Table 2 — enumeration eMethodID

Name	Value	Description
getDataSheet	0x0001	returns the datasheet of the camera
getCamStatus	0x0002	returns the current status of the camera
setCamMode	0x0003	start, stops, and restarts the camera application in the camera
setCamExclusive	0x0011	assigns the control of the camera exclusively to the requesting client
eraseCamExclusive	0x0019	removes the exclusive control look for the requesting client
setHostParameters	0x0022	sets the host parameters using persistent storage entries
getHostParameters	0x0024	the requested host parameter by reading persistent storage entries
eraseHostParameters	0x0029	forces the camera to erase the requested host parameters addressed by the PSE ID

Table 2 *(continued)*

Name	Value	Description
setRegionOfInterest	0x0101	sets the parameter for a region of interest addressed by index
setRegionsOfInterest	0x0102	sets the parameter for all supported regions of interest
getRegionOfInterest	0x0103	returns the parameter for region of interest addressed by ROI index
getRegionsOfInterest	0x0104	returns the parameter for all supported region of interest
eraseRegionOfInterest	0x0109	erases all parameter for the requested ROI
setVideoFormat	0x0111	sets the video format for a ROI addressed by ROI index
getVideoFormat	0x0113	reads the parameter of the current video format, addressed by the ROI index
eraseVideoFormat	0x0119	erases all video format parameter for the requested ROI
setHistogrammFormat	0x0121	the histogram format parameter for a ROI addressed by ROI index
getHistogrammFormat	0x0123	the parameter of the current histogram format, addressed by the ROI index
eraseHistogrammFormat	0x0129	erases all histogram format parameter for the requested ROI
SubscribeROIVideo	0x0131	starts the transmission of a video stream for the requested ROI
UnSubscribeROIVideo	0x0132	stops the video streaming for the requested ROI
SubscribeROIHistogram	0x0133	starts the transmission of the histograms for the requested ROI
UnSubscribeROIHistogram	0x0134	the transmission of the histograms for the requested ROI
setCamControl	0x0201	sets the parameter for a camera control addressed by the control index
setCamControls	0x0202	sets the parameters for all camera controls
getCamControl	0x0203	returns the current parameter for a camera control addressed by the control index
getCamControls	0x0204	returns all current camera control parameter
setCamRegister	0x0301	writes the content of a register of the cameras imager addressed by physical register address
setCamRegisters	0x0302	writes (atomic access) the content of a register block of the camera imager
getCamRegister	0x0303	reads the content of a register of the camera imager address by the physical register address
getCamRegisters	0x0304	reads the content of a register block of the camera imager
setUsedRegisterSet	0x0305	forces the camera to write the imager register set stored in the requested PSE to the imager

6.5.2 enumeration eEventGroupType

Purpose: This enumeration is used to identify the event groups supported by the camera.

This enumeration is based on uint16 data type.

Table 3 — enumeration eEventGroupType

Name	Value	Description
AllEvents	0xB000	Event group ID for all events
VideostreamEvents	0x9000	Event group ID for video streams
HistogrammEvents	0xA000	Event group ID for histograms

6.5.3 enumeration eCamErrorCodes

Purpose: This enumeration defines the camera API specific return codes. The values are in the range of 0x20 to 0x3F.

Table 4 — enumeration eCamErrorCodes

Name	Value	Description
E_LOCKED_BY_FOREIGN_INSTANCE	0x20	Camera service is already locked by another client
E_LOCK_ EXPIRED	0x21	The camera lock has expired
E_NOT_LOCKED	0x22	Camera is not locked
E_INVALID_PS_ENTRY	0x24	The requested PSE ID is unknown
E_INVALID_PS_OPERATION	0x25	The requested PSE operation is not allowed, e.g. store on a RO PSE
E_INVALID_PS_DATA	0x26	The PSE contains a CRC16 error
E_NO_MORE_SPACE	0x27	No more space available to store the PSE
E_INVALID_ROI_INDEX	0x30	The requested ROI is out of range
E_INVALID_ROI_NUMBER	0x31	The requested number of ROIs is out of range, defined by sDatasheet.numOfRegionOfInterest
E_INVALID_VIDEO_FORMAT	0x32	Invalid value in video format
E_INVALID_HISTOGRAM_FORMAT	0x33	Invalid value in histogram format
E_INVALID_CONTROL_INDEX	0x35	The requested camControlIndex is out of range or not supported by the camera
E_INVALID_CONTROL_MODE	0x36	The requested control mode is not supported by the camera
E_INVALID_CONTROL_VALUE	0x37	The requested control value is out of the range, defined in sCamControl
E_INVALID_REGISTER_ADDRESS	0x38	The register address is not supported by the imager
E_INVALID_REGISTER_VALUE	0x39	The value for the given register address is not supported by the imager
E_INVALID_REGISTER_OPERATION	0x3A	The requested operation (read or write) for the given register address is not supported by the imager

6.5.4 enumeration eCameraMode

Purpose: This enumeration type defines the camera operating modes which can be set by using the setCamMode method.

Table 5 — enumeration eCameraMode

Name	Value	Description
StartCameraService	1	The camera application shall be started
StopCameraService	2	The camera application shall be stopped. Power-intensive components like imager should be switched off.
ReStartCameraService	3	The camera application shall restart. When restarting, the camera application shall use the PSE ‘UseAtBootTime’
StopCamera	4	The camera device shall enter standby mode (uC OFF, Communication-Controller OFF) and stores the settings. This state can only left by repowering or wake up on LAN

6.5.5 enumeration eControlIndex

Table 6 — enumeration eControlIndex

Name	Value	Description
exposureTime	1	Controls the integration time
Brightness	2	Controls the black level offset