CiA Draft Standard 419

CANopen®

Device profile for battery chargers

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History

Date	Version	Changes
2003-03-15	*1.0*	*Released as Draft Standard Proposal*
2005-01-01	*1.0.1*	*Publication as Draft Standard*
		- *Partly re chaptered*
		- *Minor editorial corrections*
		- *Detailed description of PDO parameters*

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Contents

1 Scope

This device profile defines the battery charger communication and application objects in order to obtain sufficient information from the battery module to allow a charge to be carried out. Optional data is a selection of data commonly used in the industry to provide enhanced features. Chargers compliant to this standard shall use communication techniques, which conforms to those described in the CANopen application layer and communication profile.

2 References

/CiA301/	CiA 301, CANopen application layer and communication profile
/CiA302/	CiA 302, Framework for programmable CANopen devices (not published)
/CiA303-1/	CiA 303-1, CANopen cabling and connector pin assignment
/CiA418/	CiA 418, CANopen device profile for battery modules
/ISO11898-2/	ISO 11898-2, Road vehicle – Controller area network (CAN) – Part 2: High-speed medium access unit

3   Abbreviations and definitions

3.1 Abbreviations

CAN   Controller area network

CAN-ID   CAN identifier

COB-ID   Communication object identifier

PDO   Process data object

RPDO   Receive process data object

SDO   Service data object

TPDO   Transmit process data object

3.2 Definitions

The definitions given in /CiA301/ apply to this specification, too.

4   Operating principles

4.1   General

The purpose of the charger is to provide information to a battery module sufficient to allow a charge to be carried out. All devices conforming to this specification shall provide the mandatory objects in the manner defined. Optional objects may be implemented in the manner defined.

One default RPDO is defined to receive the battery temperature and status information. Optional RPDOs are defined for receive battery voltage, current requests and state of charge. One default TPDO is defined to transmit charger status. One optional TPDO adds charge returned to the data received. Charger parameter information may be configured by SDO services.

The charger module shall support the heartbeat function, and may optionally be a time-stamp producer.

4.2   Physical layer

4.2.1   Connector

The charger shall have a 5-wire interconnect. The communications bus shall use three of these lines (CAN_L, CAN_H, and ground), and two shall be used for the pilot signal. The actual connector used and its pin configuration will vary depending on the charger's application, and thus is outside of the scope of this document.

4.2.2   CAN transceiver

The CAN bus shall use standard high-speed differential transceivers compliant to /ISO11898-2/. The charger shall support at least the 125 kbit/s default bit-rate. A termination resistor of 124 Ohm shall be included in the default charger configuration if the charger is connected to a single battery module.

In case the charger device is hooked up to the in-vehicles CANopen network, it shall support automatic bit-rate detection and shall not use a termination resistor. The maximum length of the stub length cable is given in /CiA303-1/.

5   Error handling

5.1   Principle

Emergency messages are triggered by internal errors in the device, and are assigned the highest possible priority to minimize latency on access to the bus. The emergency message contains the emergency error code and the error register object /CiA301/. Additional data bytes are included in the message, which may be used for manufacturer-specific information.

5.2   Error behavior

If a serious device failure is detected, the module shall enter the pre-operational state by default. If object 1029_h is implemented, the module may be configured to enter the stopped state or remain in the current state as alternatives. Device failures shall include the following communication errors:

- CAN bus-off condition
- Heartbeat event with the state 'occurred'

Device failure may also be caused by internal module failures, e.g. missing the pilot signal.

5.3   Additional error code meanings

The CANopen standard error codes are given in /CiA301/. There are no additional error codes defined.

6   Communication object definitions

6.1   Introduction

The default RPDOs and TPDOs shall be not valid (bit 31 of COB-ID is 1) because of the not pre-defined COB-ID parameters. These COB-ID parameters shall be configured dynamically. In order to achieve that, the charger module scans the network for the battery module by reading the object 1000_h of all nodes. If the battery module is detected, the charger module reads the configured COB-IDs of the PDOs and assigns these values to its PDOs correspondingly. In order to request dynamically an SDO connection to the battery module, the charger device shall support dynamic SDO requests as defined in /CiA302/. The in-vehicle CANopen manager shall support dynamic establishment of SDO connections, too.

6.2   Detailed object definitions

Battery charger modules compliant with this device profile shall have default values for some communication objects (1000_h to $1FFF_h$), which are not fully specified in /CiA301/.

6.2.1   Object 1000_h: Device type

This object describes the type of battery charger and its functionality.

VALUE DEFINITION

31 16	15 0
Additional information	*Device profile number*

MSB   LSB
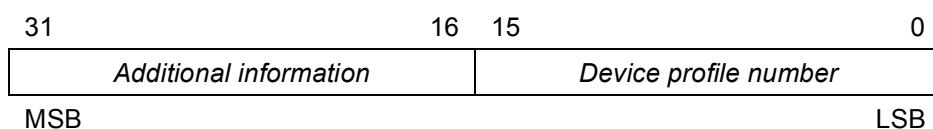
Device profile number: 419_d

Additional information: Reserved (00_h)

OBJECT DESCRIPTION

　　See /CiA301/.

ENTRY DESCRIPTION

　　See /CiA301/.

6.2.2   Object 1001_h: Error register

The device specific bit of the error register is reserved for future use.

6.2.3   1st RPDO

6.2.3.1   General

This RPDOs shall receive asynchronously the value of the battery status and temperature information. The battery charger may trigger this RPDO by remote frame.

6.2.3.2   Object 1400$_h$: Communication parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1400$_h$
Name	RPDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	No

Sub-index	01$_h$
Description	COB-ID
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	bit 31=1 (other bits =don't care)

Sub-index	02$_h$
Description	transmission type
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	255$_d$

Sub-index	05$_h$
Description	Event timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	Unsigned16
Default value	0$_d$

6.2.3.3   Object 1600$_h$: Mapping parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1600$_h$
Name	RPDO mapping
Object code	RECORD
Data type	PDO mapping
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	w
PDO mapping	No
Value range	*see* /CiA301/
Default value	02$_h$

Sub-index	01$_h$
Description	temperature
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6010 00 10$_h$

Sub-index	02_h
Description	Battery status
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6000 00 08_h

6.2.4　　1st TPDO

6.2.4.1　　General

The charger module shall transmit periodically status information, if this TPDO has been enabled. The data shall be updated before transmission.

6.2.4.2　　Object 1800_h: Communication parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1800_h
Name	TPDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00_h
Description	highest sub-index supported
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	05_h

Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	ro or rw (if PDO linking is supported)
PDO mapping	No
Value range	*see* /CiA301/
Default value	Bit 31=1 (other bits = don't care)

Sub-index	02h
Description	transmission type
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	255d

Sub-index	03h
Description	inhibit timer
Entry category	Mandatory
Access	w
PDO mapping	No
Value range	Unsigned16
Default value	0d

Sub-index	05h
Description	event timer
Entry category	Optional
Access	ro
PDO mapping	No
Value range	Unsigned16
Default value	200d

6.2.4.3 Object 1A00h: Mapping parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1A00h
Name	TPDO mapping
Object code	RECORD
Data type	PDO mapping
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00_h
Description	highest sub-index supported
Entry category	Mandatory
Access	w
PDO mapping	No
Value range	*see* /CiA301/
Default value	01_h

Sub-index	01_h
Description	charger status
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6001 00 08$_h$

6.2.5   2nd RPDO

6.2.5.1   General

This RPDO is an optional substitute for the 1st RPDO and adds the battery voltage to the transmission of the temperature and status. If the battery module supports the corresponding TPDO, the charger may disable the 1st RPDO and enable this one if desired. The battery charger may trigger this RPDO by remote frame.

6.2.5.2   Object 1401$_h$: Communication parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1401$_h$
Name	RPDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	Optional

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	No

Sub-index	01$_h$
Description	COB-ID
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	Bit 31 = 1 (other bits = don't care)

Sub-index	02$_h$
Description	transmission type
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	255$_d$

Sub-index	05$_h$
Description	event timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	Unsigned16
Default value	0$_d$

6.2.5.3   Object 1601$_h$: Mapping parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1601$_h$
Name	RPDO mapping
Object code	RECORD
Data type	PDO mapping
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	03$_h$

Sub-index	01$_h$
Description	temperature
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6010 00 10$_h$

Sub-index	02$_h$
Description	battery status
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	see /CiA301/
Default value	6000 00 08$_h$

Sub-index	03$_h$
Description	battery voltage
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	see /CiA301/
Default value	6060 00 20$_h$

6.2.6 2nd TPDO

6.2.6.1 General

This TPDO is optional and contains in addition to the charger status the Ah returned during the charge in progress. The data shall be updated before transmission.

6.2.6.2 Object 1801$_h$: Communication parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1801$_h$
Name	TPDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	Optional

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	05$_h$

Sub-index	01$_h$
Description	COB-ID
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	Bit 31 = 1 (other bits = don't care)

Sub-index	02$_h$
Description	transmission type
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	255$_d$

Sub-index	03$_h$
Description	inhibit timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	Unsigned16
Default value	0$_d$

Sub-index	05$_h$
Description	event timer
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	Unsigned16
Default value	200$_d$

6.2.6.3   Object 1A01$_h$: Mapping parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1A01$_h$
Name	TPDO mapping
Object code	RECORD
Data type	PDO mapping
Category	Optional

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	02$_h$

Sub-index	01$_h$
Description	charger status
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6001 00 08$_h$

Sub-index	02$_h$
Description	Ah returned during last charge
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6052 00 10$_h$

6.2.7 3rd RPDO

6.2.7.1 General

This RPDO is an optional additional object with which the charger can receive a requested current value and the battery status of charge. The battery charger may trigger this RPDO by remote frame.

6.2.7.2 Object 1402$_h$: Communication parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1402$_h$
Name	RPDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	Optional

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	No

Sub-index	01_h
Description	COB-ID
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	Bit 31 = 1 (other bits = don't care)

Sub-index	02_h
Description	transmission type
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	255_d

Sub-index	05_h
Description	event timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	Unsigned16
Default value	0_d

6.2.7.3 Object 1602_h: Mapping parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1602_h
Name	RPDO mapping
Object code	RECORD
Data type	PDO mapping
Category	Optional

ENTRY DESCRIPTION

Sub-index	00_h
Description	highest sub-index supported
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	02_h

Sub-index	01_h
Description	charge current requested
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	$6070\ 00\ 10_h$

Sub-index	02_h
Description	battery state of charge
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	$6081\ 00\ 08_h$

6.2.8   3rd TPDO

6.2.8.1   General

This TPDO is optional and shall contain the charger status the Ah returned during the charge in progress to the transmission of the charger status and the charger state of charge. The data shall be updated before transmission.

6.2.8.2   Object 1802$_h$: Communication parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1802$_h$
Name	TPDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	Optional

ENTRY DESCRIPTION

Sub-index	00$_h$
Description	highest sub-index supported
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	02$_h$

Sub-index	01$_h$
Description	COB-ID
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	Bit 31 = 1 (other bits = don't care)

Sub-index	02$_h$
Description	transmission type
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	255$_d$

Sub-index	03$_h$
Description	inhibit timer
Entry category	Optional
Access	rw
PDO mapping	No
Value range	Unsigned16
Default value	0$_d$

Sub-index	05h
Description	event timer
Entry category	Madatory
Access	rw
PDO mapping	No
Value range	Unsigned16
Default value	200d

6.2.8.3   Object 1A02h: Mapping parameter

VALUE DEFINITION

See /CiA301/.

OBJECT DESCRIPTION

INDEX	1A02h
Name	TPDO mapping
Object code	RECORD
Data type	PDO mapping
Category	Optional

ENTRY DESCRIPTION

Sub-index	00h
Description	highest sub-index supported
Entry category	Mandatory
Access	rw
PDO mapping	No
Value range	*see* /CiA301/
Default value	03h

Sub-index	01h
Description	charger status
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6001 00 08h

Sub-index	02_h
Description	Ah returned during last charge
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6052 00 10$_h$

Sub-index	03_h
Description	chargers state of charge
Entry category	Mandatory
Access	ro
PDO mapping	No
Value range	*see* /CiA301/
Default value	6080 00 08$_h$

7   Application object definitions

7.1   Introduction

Object description and entry description attributes are specified in /CiA301/. The default value attribute defines the value of an object with access attribute of the value 'rw' and 'wo' after power-on or application reset

7.2   Detailed object definition

7.2.1   Object 6000$_h$: Battery status

This object shall indicate readiness of the battery to accept a charge.

VALUE DEFINITION

The status byte shall have the following format:

7	1	0
Reserved (0)		Bit 0
MSB		LSB

Bit 0   0= not ready
         1= ready

OBJECT DESCRIPTION

Index	6000$_h$
Name	battery_status
Object code	VAR
Data type	Unsigned8
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	rw
PDO mapping	Default
Value range	See *value definition*
Default value	00$_h$

7.2.2   Object 6001$_h$: Charger status

This object shall provide readiness of the charger to deliver a charge to the battery.

VALUE DEFINITION

The status byte has the following format:

7	1	0
Reserved (0)		Bit 0
MSB		LSB

Bit 0   0 = not ready
           1 = ready

OBJECT DESCRIPTION

Index	6001$_h$
Name	charger_status
Object code	VAR
Data type	Unsigned8
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	ro
PDO mapping	Default
Value range	See *value definition*
Default value	No

7.2.3   Object 6010$_h$: Temperature

This object shall indicate the temperature of the battery pack as measured by a temperature reading device physically mounted somewhere on the battery module.

VALUE DEFINITION

Temperature shall be given in °C with resolution 0.125 °C per bit. The minimum range of values shall be -320 to +680 (i.e. -40.0 °C to +85.0 °C). A value of FFFF$_h$ shall indicate an invalid measurement.

OBJECT DESCRIPTION

Index	6010$_h$
Name	battery_temperature
Object code	VAR
Data type	Integer16
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	rw
PDO mapping	Default
Value range	FEC0$_h$ to 02A8$_h$
Default value	FFFF$_h$

7.2.4   Object 6052$_h$: Ah returned during last charge

This object shall provide the number of Ampere-hours delivered to the battery by the charger during the last charge event. The charger device reads the previous value from the battery module by SDO and writes back the current value at the completion of charge. A value of FFFF$_h$ shall indicate an invalid value.

VALUE DEFINITION

The resolution shall be 0.125 Ah per bit.

OBJECT DESCRIPTION

Index	6052$_h$
Name	ah_returned_during_last_charge
Object code	VAR
Data type	Unsigned16
Category	Conditional: if TPDO2 is supported

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	ro
PDO mapping	Default if TPDO2 is supported
Value range	Unsigned16
Default value	No

7.2.5 Object 6060$_h$: Battery voltage

This object shall indicate the instantaneous voltage across the battery terminals as measured by a voltage-measuring device on the battery or charger. A value of FFFF FFFF$_h$ shall indicate an invalid measurement.

VALUE DEFINITION

The resolution shall be 1/1024 V per bit.

OBJECT DESCRIPTION

Index	6060$_h$
Name	battery_voltage
Object code	VAR
Data type	Unsigned32
Category	Conditional: if RPDO2 is supported

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	rw
PDO mapping	Default if RPDO2 is supported
Value range	Unsigned32
Default value	FFFF FFFF$_h$

7.2.6   Object 6070$_h$: Charge current requested

This object shall indicate the electrical current in Amperes requested by the battery module to be delivered by the charger to the battery.

VALUE DEFINITION

The resolution shall be 1/16 A per bit. FFFF$_h$ shall indicate an invalid value.

OBJECT DESCRIPTION

Index	6070$_h$
Name	charge_current_requested
Object code	VAR
Data type	Unsigned16
Category	Conditional: if RPDO3 is supported

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	rw
PDO mapping	Default if RPDO3 is supported
Value range	Unsigned16
Default value	FFFF$_h$

7.2.7   Object 6080$_h$: Charger state of charge

This object shall provide the charger's estimation of the amount of energy contained in the battery, expressed as a percentage of the total amount of energy the battery can store.

VALUE DEFINITION

The resolution shall be 1 % per bit. FF$_h$ shall indicate invalid value.

OBJECT DESCRIPTION

Index	6080$_h$
Name	charger_state_of_charge
Object code	VAR
Data type	Unsigned8
Category	Conditional: if TPDO2/3 is supported

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	ro
PDO mapping	Default if TPDO2/3 is supported
Value range	00$_h$ to 64$_h$ and FF$_h$
Default value	No

7.2.8   Object 6081$_h$: Battery state of charge

This object shall indicate the battery's measurement of the amount of energy contained in the battery, expressed as a percentage of the total amount of energy the battery can store.

VALUE DEFINITION

Resolution shall be 1 % per bit.

OBJECT DESCRIPTION

Index	6081$_h$
Name	battery_state_of_charge
Object code	VAR
Data type	Unsigned8
Category	Conditional: if RPDO3 is supported

ENTRY DESCRIPTION

Sub-index	00$_h$
Access	rw
PDO mapping	Default if RPDO3 is supported
Value range	00$_h$ to 64$_h$ and FF$_h$
Default value	FF$_h$

Appendix A (informative): Battery type parameter

See /CiA418/

Appendix B (normative): Pilot signal

See /CiA418/

Appendix C (informative): Overview on application objects

Charger module specific mandatory and optional objects are listed in following table:

Table 1: Overview on application objects

Index	Object code	Name	Data type	Access	Category
6000_h	VAR	Battery status	Unsigned8	rw	M
6001_h	VAR	Charger status	Unsigned8	ro	M
6010_h	VAR	Battery temperature	Integer16	rw	M
6052_h	VAR	Ah returned during last charge	Unsigned16	ro	C[1]
6060_h	VAR	Battery voltage	Unsigned32	rw	C[1]
6070_h	VAR	Charge current requested	Unsigned16	rw	C[1]
6080_h	VAR	Charger state of charge	Unsigned8	ro	C[1]
6081_h	VAR	Battery state of charge	Unsigned8	rw	C[1]

[1] Mandatory if PDOs are implemented that maps this object by default