CiA Draft Standard Proposal 419

Device Profile for Battery Charger

This is a draft standard proposal and may be changed without notification

Version 1.0

15 March 2003

HISTORY

Date	Changes
2003-03-15	First public release

CONTENTS

1 Scope

This device profile defines the battery charger communication and application objects in order to obtain sufficient information from the battery module (see CiA DSP 418) 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 /1/. Programmable charger modules may use communication techniques, which conform to those described in the framework for CANopen programmable devices /2/. These specifications should be consulted in parallel to this device profile specification.

2 Normative references

/1/: CiA DS 301 V4.02, CANopen application layer and communication profile (February 2002)

/2/: CiA DSP 302 V3.2, Framework for programmable CANopen devices (January 2003)

/3/ ISO FDIS 11898-1:2002, Road vehicles - Controller area network (CAN) - Part 1: Data link layer and physical signaling

/4/ ISO FDIS 11898-2:2002, Road vehicles - Controller area network (CAN) - Part 2: High-speed medium access unit

/5/ ISO 646:1983, ISO 7-bit coded character set for information exchange

/6/ CiA DR 303-1 V1.1.1: CANopen cabling and connector pin assignment (December 2001)

/7/ CiA DSP 418 V1.0: CANopen device profile for battery modules (September 2002)

3 Definitions, acronyms and abbreviations

CAN

Controller Area Network: Data link layer protocol for serial communication as specified in ISO FDIS 11898-1:2002.

RPDO

Receive Process Data Object: Communication object of a device, which contains output data.

SDO

Service Data Object: Peer-to-peer communication with read or write access to the Object Dictionary of a CANopen device.

TPDO

Transmit Process Data Object: Communication object of a device, which contains input data.

4 Operating principles

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.

4.1 Physical layer

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.

4.1.1 CAN transceiver

The CAN bus shall use standard high-speed differential transceivers compliant to /4/. The charger shall support at least the 125 kbit/s default baud rate. A termination resistor of 124 Ohms 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 autobaud detection and shall not use a termination resistor. The maximum length of the stub length cable is given in /6/.

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 (see /1/). 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 /1/. Additional error codes specific to the battery charger are given in the following table.

Error Code	Meaning
-	No additional error codes are defined

6 Pre-definitions

6.1 Introduction

The default RPDOs and TPDOs shall be not valid 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 /2/. The in-vehicle CANopen manager shall support dynamic establishment of SDO connections, too.

6.2 Pre-defined communication objects

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 /1/.

6.2.1 Object 1000_h: Device type

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

31 16	15 0
Additional information	*General information*

MSB LSB

General information:

Device profile number: 419_d

Additional information:

Reserved (0_h)

6.2.2 Object 1001_h: Error register

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

6.2.3 1st RPDO definition

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

Default COB-ID

31	30	29	28 ... 11	10 ... 0
0	X	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	180_h + battery node-ID

MSB LSB

Index	Sub-index	Name	Default value
1400_h	0_h	Largest sub-index supported	2_h
	1_h	COB-ID	See above
	2_h	transmission type	255_d

Index	Sub-index	Name	Default value
1600_h	0_h	Number of mapped objects	2_h
	1_h	Temperature	6010 00 10_h
	2_h	Battery status	6000 00 08_h

6.2.4 1st TPDO definition

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

Default COB-ID

31	30	29	28 ... 11	10 ... 0
0	1	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	200_h + battery node-ID

MSB LSB

Index	Sub-index	Name	Default value
1800_h	0_h	Largest sub-index supported	5_h
	1_h	COB-ID	See above
	2_h	Transmission type	255_d
	3_h	Inhibit timer	0_d
	4_h	reserved	-
	5_h	Event timer	200_d

Index	Sub-index	Name	Default value
$1A00_h$	0_h	Number of mapped objects	1_h
	1_h	Charger status	6001 00 08_h

6.2.5 2nd RPDO definition

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.

Default COB-ID

31	30	29	28 ... 11	10 ... 0
0	X	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	280_h + battery node-ID

MSB LSB

Index	Sub-index	Name	Default value
1801_h	0_h	Largest sub-index supported	5_h
	1_h	COB-ID	See above
	2_h	Transmission type	255_d

Index	Sub-index	Name	Default value
$1A01_h$	0_h	Number of mapped objects	3_h
	1_h	Temperature	6010 00 10_h
	2_h	Battery status	6000 00 08_h
	3_h	Battery voltage	6060 00 20_h

6.2.6 2nd TPDO definition

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.

Default COB-ID

31	30	29	28 ... 11	10 ... 0
0	1	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	300_h + battery node-ID

MSB LSB

Index	Sub-index	Name	Default value
1401_h	0_h	Largest sub-index supported	2_h
	1_h	COB-ID	See above
	2_h	Transmission type	255_d
	3_h	Inhibit timer	0_d
	4_h	reserved	-
	5_h	Event timer	200_d

Index	Sub-index	Name	Default value
1601_h	0_h	Number of mapped objects	2_h
	1_h	Charger status	6001 00 08_h
	2_h	Ah returned during last charge	6052 00 10_h

6.2.7 3rd RPDO definition

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.

Default COB-ID

31	30	29	28 ... 11	10 ... 0
0	X	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	380_h + battery node-ID

MSB LSB

Index	Sub-index	Name	Default value
1802h	0_h	Largest sub-index supported	5_h
	1_h	COB-ID	See above
	2_h	Transmission type	255_d

Index	Sub-index	Name	Default value
$1A02_h$	0_h	Number of mapped objects	2_h
	1_h	Charge current requested	6070 00 10_h
	2_h	Battery state of charge	6081 00 08_h

6.2.8 3rd TPDO definition

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.

Default COB-ID

31	30	29	28 ... 11	10 ... 0
0	1	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	400_h + battery node-ID
MSB				LSB

Index	Sub-index	Name	Default value
1402_h	0_h	Largest sub-index supported	2_h
	1_h	COB-ID	See above
	2_h	Transmission type	255_d
	3_h	Inhibit timer	0_d
	4_h	reserved	-
	5_h	Event timer	200_d

Index	Sub-index	Name	Default value
1602_h	0_h	Number of mapped objects	3_h
	1_h	Charger status	6001 00 08_h
	2_h	Ah returned during last charge	6052 00 10_h
	3_h	Chargers state of charge	6080 00 08_h

7 Object dictionary

7.1 Introduction

Charger module specific mandatory and optional objects are listed in the following table. Detailed object specifications are given in the following sections.

Index	Object	Name	Type	Access	M/O
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	M[1]
6060_h	VAR	Battery voltage	Unsigned32	rw	M[1]
6070_h	VAR	Charge current requested	Unsigned16	rw	M[1]
6080_h	VAR	Charger state of charge	Unsigned8	ro	M[1]
6081_h	VAR	Battery state of charge	Unsigned8	rw	M[1]

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

7.2 Detailed specification of object entries

7.2.1 Introduction

OBJECT DESCRIPTION and ENTRY DESCRIPTION attributes are specified in /1/. 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.

7.2.2 Object 6000_h: Battery status

This object shall indicate readiness of the battery to accept a charge—i.e., ready or not-ready.

VALUE DESCRIPTION

The status byte shall have the following format:

7	1	0
reserved (=0)		0/1
MSB		LSB

Bit 0 = 1 ready
Bit 0 = 0 not ready

OBJECT DESCRIPTION

Index	6000_h
Name	Battery status
Object Code	VAR
Data Type	Unsigned8
Category	Mandatory

ENTRY DESCRIPTION

Sub-index	0_h
Access	rw
PDO Mapping	Default
Value Range	0_h to 1_h
Default Value	0_h

7.2.3 Object 6001_h: Charger status

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

VALUE DESCRIPTION

The status byte has the following format:

7	1	0
reserved (=0)		0/1
MSB		LSB

Bit 0 = 1 ready
Bit 0 = 0 not ready

OBJECT DESCRIPTION

Index	6001_h
Name	Charger status
Object Code	VAR
Data Type	Unsigned8
Category	Mandatory

ENTRY DESCRIPTION

Sub-Index	0_h
Access	ro
PDO Mapping	Default
Value Range	0_h to 1_h
Default Value	No

7.2.4 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 DESCRIPTION

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 $FFFF_h$ indicates an invalid measurement.

OBJECT DESCRIPTION

Index	6010_h
Name	Battery temperature
Object Code	VAR
Data Type	Integer16
Category	Mandatory

ENTRY DESCRIPTION

Sub-Index	0_h
Access	rw
PDO Mapping	Default
Value Range	$FEC0_h$ to $02A8_h$
Default Value	$FFFF_h$

7.2.5 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 $FFFF_h$ indicates an invalid value.

VALUE DESCRIPTION

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	Mandatory: if TPDO2 is supported

ENTRY DESCRIPTION

Sub-Index	0_h
Access	ro
PDO Mapping	Default if TPDO2 is supported
Value Range	Unsigned16
Default Value	$FFFF_h$

7.2.6 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 $FFFF_h$ indicates an invalid measurement.

VALUE DESCRIPTION

The resolution shall be 1/1024 V per bit.

OBJECT DESCRIPTION

Index	6060_h
Name	Battery voltage
Object Code	VAR
Data Type	Unsigned32
Category	Mandatory: if RPDO2 is supported

ENTRY DESCRIPTION

Sub-Index	0_h
Access	rw
PDO Mapping	Default if RPDO2 is supported
Value Range	Unsigned32
Default Value	FFFF $FFFF_h$

7.2.7 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 DESCRIPTION

The resolution shall be 1/16 A per bit. $FFFF_h$ means invalid value.

OBJECT DESCRIPTION

Index	6070_h
Name	Charge current requested
Object Code	VAR
Data Type	Unsigned16
Category	Mandatory: if RPDO3 is supported

ENTRY DESCRIPTION

Sub-Index	0_h
Access	rw
PDO Mapping	Default if RPDO3 is supported
Value Range	Unsigned16
Default Value	$FFFF_h$

7.2.8 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 DESCRIPTION

Resolution shall be 1 % per bit. FF_h means invalid value.

OBJECT DESCRIPTION

Index	6080_h
Name	Charger state of charge
Object Code	VAR
Data Type	Unsigned8
Category	Mandatory: if TPDO2/3 is supported

ENTRY DESCRIPTION

Sub-Index	0_h
Access	ro
PDO Mapping	Default if TPDO2/3 is supported
Value Range	0_h to 64_h and FF_h
Default Value	No

7.2.9 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 DESCRIPTION

Resolution shall be 1 % per bit.

OBJECT DESCRIPTION

Index	6081_h
Name	Battery state of charge
Object Code	VAR
Data Type	Unsigned8
Category	Mandatory: if RPDO3 is supported

ENTRY DESCRIPTION

Sub-Index	0_h
Access	rw
PDO Mapping	Default if RPDO3 is supported
Value Range	0_h to 64_h and FF_h
Default Value	FF_h

8 Appendix A (informative): Battery type parameter

The battery type parameter accessible via SDO at the battery modules object dictionary is given in the following format:

cccc wxyz

where cccc gives the chemistry, and wxyz describes the sub-types.

A.1. Lead acid (PbA)

cccc	0001
w	0 for flooded 1 for maintenance free

A.1.1 Flooded

x	reserved
y	0 for normal 1 for high gravity
z	0 for flat plates 1 for tubular

A.1.2 Maintenance free

x	reserved
yz	00 for AGM 01 for gel 10 for hybrid 11 not used

eg. flooded, normal gravity, flat plate PbA: 00010000

A.2. Nickel cadmium

cccc	0010
w	0 for vented 1 for sealed
x	reserved
y	reserved
z	0 for pocket plate 1 for sintered plate

A.3. Nickel zinc (NiZn)

cccc	0011
wxyz	reserved

A.4. Nickel iron (NiFe)

cccc	0101
wxyz	reserved

A.5. Silver oxide

cccc	0110
wx	reserved
yz	00 for AgZn 01 for AgCd 10 for AgFe 11 not used

A.6. Nickel hydrogen (NiH2)

cccc	0111
wxyz	reserved

A.7. Nickel metal hydride (NiMH)

cccc	1000
wxyz	reserved

A.8. Zinc/Alkaline/Manganese dioxide

cccc	1001
wxyz	reserved

A.9. Lithium ion (LiI)

cccc	1010
wxyz	reserved

A.10. Zinc bromine

cccc	1011
wxyz	reserved

A.11. Metal air

cccc	1100
wxyz	reserved

A.12. Lithium/Iron sulfide

cccc	1101
wxyz	reserved

A.13. Sodium beta

cccc	1110
wxyz	reserved

9 Appendix B (normative): Pilot signal

The diagram below shows a schematic of the pilot circuit, which may be used to allow the charger and battery module to detect each other's presence without any of the latency involved in checking that a communication link is active. Its main purpose is to allow the charger to quickly reduce its output current when the connection to the battery is lost in order to limit arcing between the connector contacts.

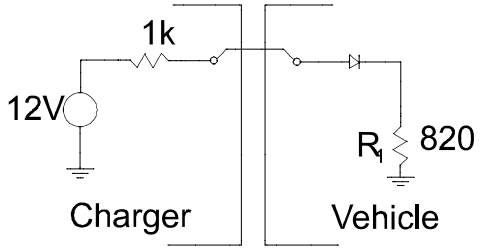

Fig. 1: Connection between charger and vehicle battery