EXICOM POWER SOLUTIONS	**Specification** **BMS<>CHARGER HANDSHAKING PROTOCOL**	**Document No:** **EI-SW-0721-SPEC-001**

Contents

1. Document History

1.1. Disclaimer

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1.2. Revision History

Revision date	Author	Title	Version	Summary of Changes	Changes marked
08-07-2021	NK	Initial Release	V00	N/A	N/A

1.3. Approvals

This document requires the following approvals:

Date of Issue	Name	Title	Version	Signature
08.07.2021	NSM	Approved	00	NSM

1.4. Distribution

This document has additionally been distributed to:

Date of Distribution	Name	Title	Version	Status

2. Introduction

This document shall explain the charging protocol which is used to integrate Exicom BMS/ Battery Pack and Exicom chargers.

The document shall explain the sequence of activities/ steps that are carried out for successfully detecting and charging the pack using Exicom charger.

3. Overview

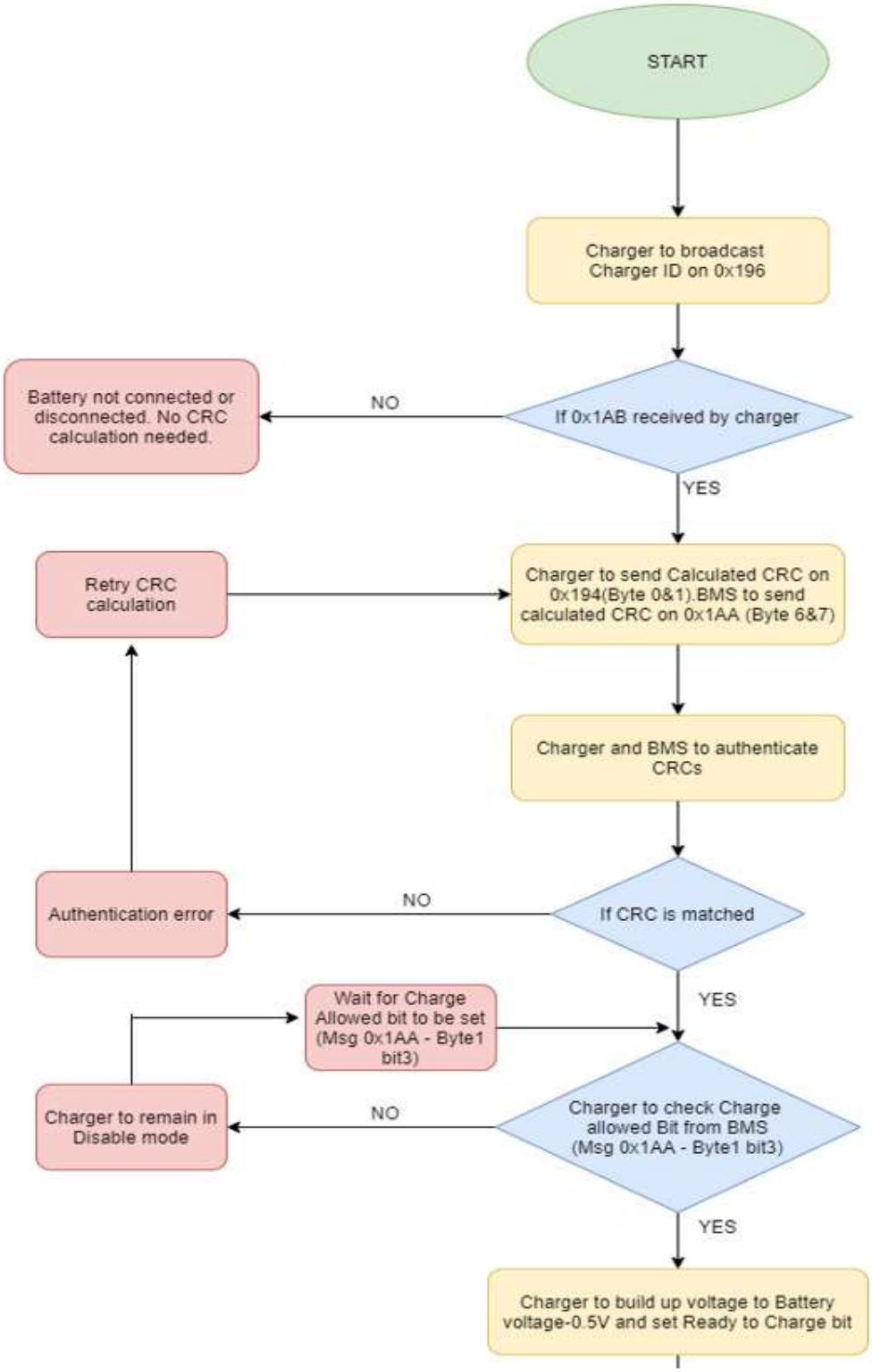
The Exicom charging protocol is based on CAN 2.0A protocol which must be supported by both charger and BMS.

The baud rate can be configured as per the requirement and shall be same in both charger and BMS.

Supported CAN baud rates: 500 kbps, 250 kbps, 125 kbps

The CAN IDs and their interpretation has been explained in the further part of the document.

Following flowchart explains the sequence of charger connection, detection, authentication and charging steps.


START
Charger to broadcast Charger ID on 0x196
If 0x1AB received by charger
NO
Battery not connected or disconnected. No CRC calculation needed.
YES
Charger to send Calculated CRC on 0x194(Byte 0&1).BMS to send calculated CRC on 0x1AA (Byte 6&7)
Retry CRC calculation
Charger and BMS to authenticate CRCs
If CRC is matched
NO
Authentication error
YES
Wait for Charge Allowed bit to be set (Msg 0x1AA - Byte1 bit3)
Charger to check Charge allowed Bit from BMS (Msg 0x1AA - Byte1 bit3)
NO
Charger to remain in Disable mode
YES
Charger to build up voltage to Battery voltage-0.5V and set Ready to Charge bit

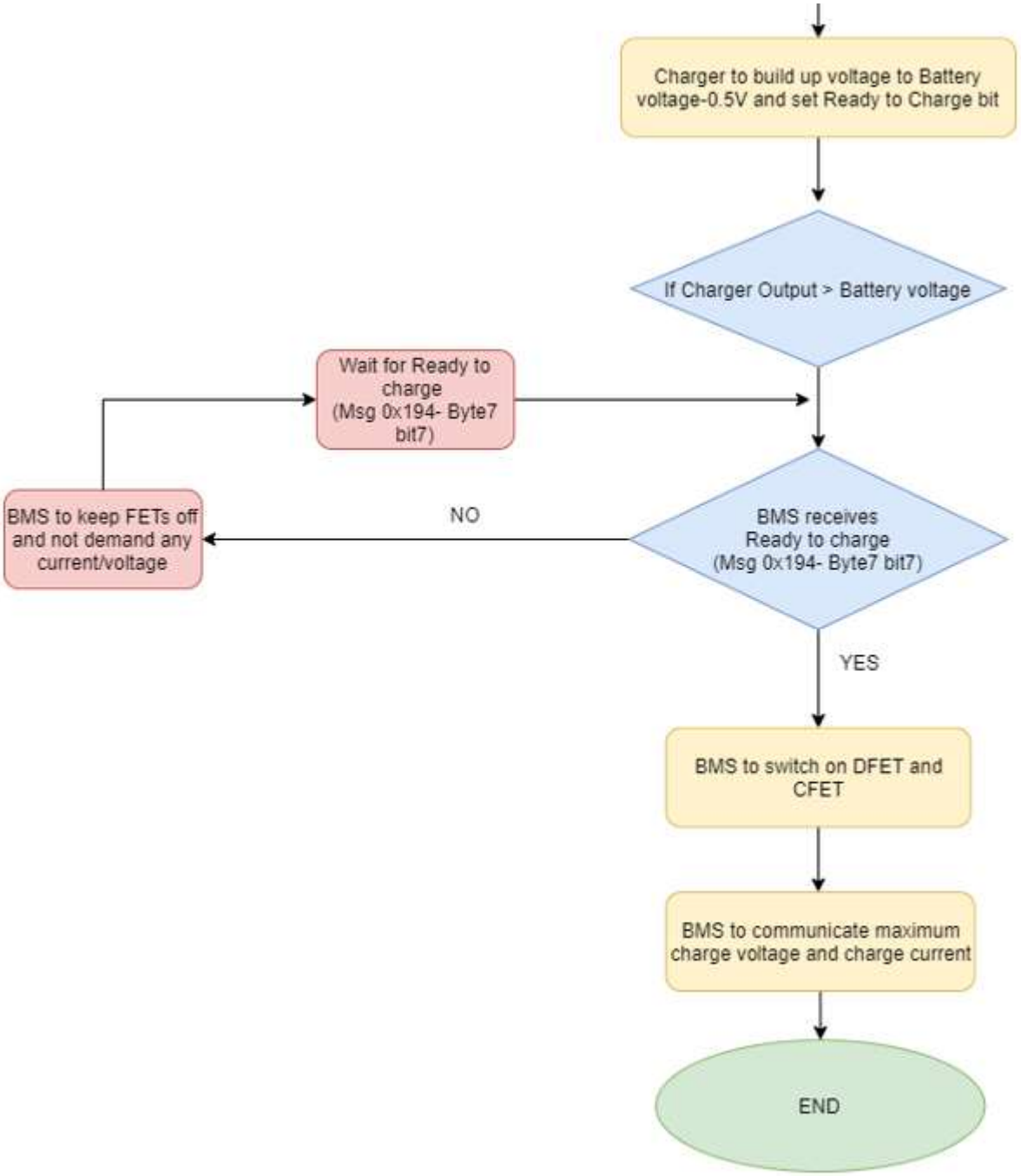


Figure 1 : Handshaking Flow Diagram

Overall charging process can be divided in following major steps:

1. Charger detection
2. Battery detection
3. Authentication
4. Charging

Charger Detection:

- When the charger is switched ON, it is supposed to transmit the CID (charger ID) in the CAN msg ID 0x196
- The charger ID shall be unique 8 character identifier which helps trace the charger uniquely
- The periodicity and information details are explained in the later part of document

Battery Detection:

- When the battery/ BMS detects the charger (using charger ID msg); it shall start transmission of its CAN data
- The charger looks for the msg ID 0x1AB (BIN: Battery Identification Number)
- BIN is again unique identified for each battery

Authentication:

- In order to start charging, the battery and charger first need to authenticate each other
- This is done using the CID and BIN data
- The authentication algorithm is explained in later part of document

Charging:

- If the authentication is successfully completed by both charger and BMS, it shall proceed to charging step
- In order to minimize the damage to BMS, the charger builds up the voltage based on the current battery voltage as informed by BMS over CAN
- Then, based on the charging current requested, the charger pumps the current to start charging

4. CAN Details

- Charger connected is identified by 0x196 packet received on CAN bus.

			CHARGER_ID (UNIQUE IDENTIFICATION)
RPDO2	Rx	0x196	Resolution: Not Applicable Datatype: uint8 (each byte) Logical Range: NA Unit: Not Applicable Remarks:

- BMS bin is sent (identified by 0x1AB packet received on CAN bus).

			BIN
TPDO5	Tx	0x1AB	Resolution: Not Applicable Datatype: uint8 (each byte) Logical Range: NA Unit: Not Applicable Remarks: - Each byte is the ASCII code of the character - e.g. If the frame has value 31 39 43 31 33 30 30 31; the BIN shall be 19C13001

- Authentication data after calculating CRC can be seen in 0x194 message from charger and 0x1AA message from BMS.

			CHARGER AUTHENTICATION DATA	CHRGR_OP_CURRENT	CHRGR_OP_VOLT	CHRGR_ALARM1	CHRGR_ALARM2
RPDO1	Rx	0x194	LSB MSB Resolution: Not Applicable Datatype: uint8 (each byte) Logical Range: NA Unit: Not Applicable Remarks: - CRC 16 calculated over CHARGER ID and BIN as applicable (16-bit CCITT-FALSE CRC16)	LSB MSB Resolution: 1/16 Datatype: sint16 Logical Range: NA Unit: A Remarks: - Shall be always +ve - Battery shall check the deviation (measured current to this value)	LSB MSB Resolution: 1/1024 (if Byte 0. bit 02 i Datatype: uint16 Logical Range: NA Unit: Volts Remarks: - Specifies the charger output curren	Bit 1, Bit 0:00: Chrgr Temperature Normal01: Bit 3, Bit 2:00: Input AC OK01: Input AC abnc Bit 6, Bit 5, Bit 4:000: Rectifier Fail001: Curre Bit 7: Authentication Failure	Bit 0: Charger operational Bit 1: Chrgr in disable mode Bit 2: Charger internal fault Bit 3: Fan Fail Alarm Bit 4: Chrgr Current Limit Alrm Bit 5: Charger OV Alarm Bit 6: Charger UV Alarm Bit 7: Ready To Charge (When charger voltage is configured to battery voltage, BMS shall close FETs based on this)

			BMS STATUS INFO 0	BMS STATUS INFO 1	BMS WARNING INFO		BMS ERROR INFO		BATTERY AUTHENTICATION DATA
TPDO1	Tx	0x1AA	Bit 0: Last Rec File Read Sts	Bit 0: IGN detected	Bit 0: Over Current	Bit 8: CHG UV	Bit 0: Current Outdate	Bit 8: Overvoltage Error	LSB MSB
			Bit 1: TCU Alive Status	Bit 1: BMS Error Detected	Bit 1 FW <> CFG version	Bit 9: CHG OV	Bit 1: PDU Failure	Bit 9: Undervoltage Error	Resolution: Not Applicable
			Bit 2: HV Pack Ind (1 if >= 60V	Bit 2: Discharging Allowed	Bit 2: Incorrect mode (par	Bit 10: CHG UT	Bit 2: PDU Overtempe	Bit 10: Over Temperature	Datatype: uint8 (each byte)
			Bit 3: Battery Full (EoC)	Bit 3: Charging Allowed	Bit 3: Dual Ignition Detect	Bit 11: CHG OT	Bit 3: PDU Lock	Bit 11: Under Temperatur	Logical Range: NA
			Bit 4: Battery Low (EoD)	Bit 4: D-FET Status	Bit 4: Reserved	Bit 12: DCHG UV	Bit 4: Data Corrupted	Bit 12: Overload Error	Unit: Not Applicable
			Bit 5: Battery Balancing	Bit 5: C-FET Status	Bit 5: Reserved	Bit 13: DCHG OV	Bit 5: BMS Activation	Bit 13: Current Short Circ	Remarks:
			Bit 6: Charge Voltage Reache	Bit 6: SD Card Error	Bit 6: TCU_timestamperro	Bit 14: DCHG UT	Bit 6: FW<>CFG Inco	Bit 14: Batt Parameter T	- CRC 16 calculated over BIN and CHARGER ID/ VIN as applicable (16-
			Bit 7: Tester Session Status	Bit 7: SD Card Init Status	Bit 7: TCU PWR PIN Stat	Bit 15: DCHG OT	Bit 7: Chrgr Authentic	Bit 15: Precharge Failure	bit CCITT-FALSE CRC16)

- Demand current and voltage can be seen in 0x2AA message from BMS.

			SOC	FULL_CAP	MAX_CHG_CURRENT	MAX_CHG_VOLTAGE	SOH
TPDO2	Tx	0x2AA	Resolution: 1	LSB MSB	LSB MSB	LSB MSB	Resolution: 1
			Datatype: uint8	Resolution: 1/8	Resolution: 1/16	Resolution: 1/1024 (if Byte 0. bit	Datatype: uint8
			Logical Range: 0 - 10	Datatype: uint16	Datatype: sint16	Datatype: uint16	Logical Range: 0 - 100
			Unit: %	Logical Range: NA	Logical Range: NA	Logical Range: NA	Unit: %
				Unit: Ah	Unit: A	Unit: Volts	
					Remarks:	Remarks:	
					- Shall be always +ve	- Max charging voltage allowed	
					- Max charging current allowed	- Battery shall cut off at this voltage	

- Charging related data (Current, BMS state) can be seen in message 0x3AA.

			BATTERY_CURRENT	BATTERY_VOLTAGE	MAX_DCHG_CURRENT	SOP	BATTERY STATE
TPDO3	Tx	0x3AA	LSB MSB	LSB MSB	LSB MSB	Resolution: 1	Resolution: 1
			Resolution: 1/16	Resolution: 1/1024 (if Byte 0. bit 02 in 0	Resolution: 1/16	Datatype: uint8	Datatype: uint8
			Datatype: sint16	Datatype: uint16	Datatype: sint16	Logical Range: 0 - 100	Logical Range: 0 - 5
			Logical Range: NA	Logical Range: NA	Logical Range: NA	Unit: %	Unit: NA
			Unit: A	Unit: Volts	Unit: A		
			Remarks: +ve: charging; -ve: discharging		Remarks:		0: INIT1: STANDBY2: DISCHA
					- Shall be always -ve or 0		
					- Max discharging current allowed		

5. Authentication Algorithm

The charger and battery both authenticate each other before start of charging.

The authentication data is transmitted by each node as follows:

- CHARGER_AUTHENTICATION_DATA
  - In msg ID 0x194 (Byte 0-1)
  - CHARGER_AUTH_DATA computation:
    - Append CID with BIN to get a 16 byte data element
    - Run the CRC16 CCITT un-reflected algorithm with initial value as defined specifically for the customer
    - The result is a 16 bit data which is sent in the signal CHARGER_AUTH_DATA
- BATTERY_AUTHENTICATION_DATE
  - In msg 0x1AA (Byte 6-7)
  - BATTERY_AUTH_DATA computation:
    - Append BIN with CID to get a 16 byte data element
    - Run the CRC16 CCITT un-reflected algorithm with initial value as defined specifically for the customer
  - The result is a 16 bit data which is sent in the signal BATTERY_AUTH_DATA