ADVANCED SWITCHING SOLUTIONS

GIGAVAC Contactors J1939 Protocol

Documentation Revision: 7

See the last page for different revisions change-history and apply to the firmware revisions to each update.

Product Models: GXCAN15/16, MXCAN15/16.

It is assumed that the reader is familiar with J1939 protocol and hardware requirements of the CAN-BUS. For more information consult the SAE documents and CAN-BUS specification in more details.

GIGAVAC J1939 products have 4 types of messages to communicate with the controller: Command, Settings, requests and report. Command is a message to send to the contactors for controlling its operations. Settings (configurations) is to change the unit's operational characteristics. User can get data or settings back from the contactors by sending a request message. While in normal operation, the contactors send out report-data regularly on the CAN-bus with updated information, and this report's repetition-rate is changeable by the users. If report-update-rate is set to zero the report stops, but it will output a single report by a control command. Setting or configuration data will store in nonvolatile memory automatically.

Default baud-rate is 250K/s. It is changeable using setting message of "Delays, Report-Repetition & Baud Rates" PDU format 178_{10}. Change baud-rate will take effect immediately and what changed can be read-back from "Request Contactor Parameters" message PDU format 234_{10}. If the master device has different baud-rate, read-back message will not work. When the master device has the same known baud-rate to communicate with the unit, this will make read-back undesirable.

At first power-up, the unit joins the CAN bus and tries to claim a J1939 address of 0xC8 on the network. If no other devices using the same address, it will keep it as the operational address. If other device has the same address with higher name, this unit will win the address, or other devices has the same address with lower name, this unit will lose the address of 0xC8 and change to 0xFE. After losing the address, it will not transmit or receive messages as normal until someone changes its address without overlapping other device's addresses.

Proper Configuration before Deployment:

These contactors need to be practically configured before connected to the J1939 network. In order to save time and avoid unnecessary troubleshooting, details configuration is preferred:

- J1939 address: This is the most important. The address has to be unique on the network. Incase address conflict, you can change it while connected to the BUS, but it is much easier to have an address for itself at first.
- Trip points: These are over current protection points. You can have the current-levels of your choice up to 3 points. If you need only one trip-point of over-current protection, set the unused trip-points to be highest level which is the unit's maximum current.

Caution:

- Power supply limit is 32V max. If input power is over this voltage could cause permanent damage to the control circuit.
- Input to the contact voltage sensing on each terminal A1 or A2 is 60V max. Do not exceed this limit.
- If you set trip-point to 0 Amp, it will trip all the time at no current as soon as the contact is closed.
- Trip-delay: The time to delay in seconds before the contactor trips.
- Low-voltage protection shutoff: make sure this setting is at the realistic level below the power supply.
- BUS-BAR over voltage protection should be high enough for your bus-bar max voltage.
- J1939 name: be sure to have no name conflict and no address conflict.
- There are more settings depend on your needs in the following messages.
- BUS-BAR voltage sensing is referenced to pin2; the same GND as the control circuit.

Commands

Control Contactor: This command is the combination of the following controls:

Contactor on/off (A): This command is to turn-on or turn-off the contactor. 'C' (x43) is for close or turn-on and 'O' (0x4F) is for open or turn-off. Incase over-current trip, bus-bar over voltage protection or power supply under voltage shutoff, use this control to send a contact-off command after all causes of contact -open had been cleared in order for the contact to be able to close again.

One time report (B): If data report-repetition rate is zero, set this value 'R' (0x52) will force the contactor to send out only 1 report. If repetition rate is nonzero, this command has no effect.

Power-up Contactor State (C): When first power-up, the contactor state can be closed or opened depends on this value. Set this value to 'C' (x43) to close or turn on and 'O' (0x4F) to open or turn off. Power up state in this command qualifies as setting message, and setting message will save to EEPROM. The next power-up, the controller will use this bit to decide open or close the contact.

Note: if you need to set only 1 value on this command, use meaningful value for the command that you want to set and use meaningless value to the others commands that you don't need to set. Example: meaningful value for contactor on/off is 'C' or 'O', but anything else is meaningless.

Control data:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0

not used, don't care	C	B	A	ID bytes	
	'C' / 'O'	'R'	'C' / 'O'	'G'	'V'

Send J1939 control message: **[**priority: 6**]**, **[**PDU format: 181_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 5 bytes data length, see above definitions.

Example: send a command to only turn on the contactor byte1 & byte0 = "GV", byte2 = 'C', byte3 = 0 and byte4 = 0.

Setting (Configuration):

Trip-Points & Low-Volts-Shutoff:

There are 3 trip-points to protect over current condition. If the current goes through the contact is greater than any of these settings, the contactor will trip. Trip-point-1 should be set to lowest value and trip-point-3 should be the highest. Trip point 1 default to 200A (170 counts) for factory testing and the other defaults are in the maximum values (600A, 512 counts). If you are using 350A contactors, it is better to set trip-points max to (350A, 298 counts); this will provide protection for the maximum rating of the contactor.

Low-voltage-shutoff is when power supply voltage drops to <= the low volts setting; contactor will turn off (open its contact). The default low-volts is 21V (617 counts) for factory verification. Make sure to set the low-volts to a realistic value for your application. If no need to use this feature, set this value to zero.

When a contactor was opened by trip or by low-volts-shutoff protection, it will not accept contact-close command even no trip or no low-volts happens until a contact open-command is received to reset the protection condition and also make sure no trip and no LV-shutoff states exist in order for it to close again.

Trip point & low volts shutoff data:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
unused	Shared	LV-Off	Trip 3	Trip 2	Trip 1	ID bytes	
free byte	4x2 bits	8+2 bits	8+2 bits	8+2 bits	8+2 bits	'G'	'V'

Byte 6 share-bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

2 bits MSB: LV-Off	2 bits MSB: Trip-3	2 bits MSB: Trip-2	2 bits MSB: Trip-1

Trip-point calculation: the equation of trip-point setting is count-per-Amp = 512 counts/600.

Trip-point example: To set a trip-point for 200A, the value to enter using the equation above will be: (512/600) * 200 = 170 counts.

Low-volts shutoff calculation: Shutoff counts = shutoff voltage * (4.02/28.02) * (1024/5)

Low-volts shutoff example: To set shutoff-Voltage for 18.6V. The number to set is = 18.6 * (4.02/28.02) * (1024/5) = 546 counts.

Trip-points & LV shutoff J1939 message: **[**priority: 6**]**, **[**PDU format: 180_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Note: This unit's default address is 0xC8. If you change the address, you need to use the new address that you had changed. You can get this unit's name & address by sending a "request for address claimed" message. In case you forget what address you changed to the unit, just use address 0xFF. Using 0xFF the global address will cause all devices on the BUS to respond.

J1939 message example for trip-points & LV-shutoff: User's address is 125_{10} and this unit's address is 200_{10}, using a 600A contactor, Set trip-point1 to 120A, trip-point2 to 350A, trip-point3 to 450A and set low-voltage shutoff to 20.5V. See command and data below:

The CAN extended address becomes J1939 PGN:

Byte 3	Byte 2	Byte 1	Byte0
Priority & data page	PDU format	Destination	User-source address
0x18	180_{10}	200_{10}	125_{10}

CAN data byte is the same as J1939 data:

The 6th byte shares 2 most significant bits of each data. Trip-point1=120A (0x66 counts), trip-point2=350A (0x12A counts) and trip-point3=450A (0x180 counts). Low-volts shutoff=20.5V (0x25A counts). Shared byte=0x94.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
unused	Shared	LV-Off	Trip 3	Trip 2	Trip 1	ID bytes	
don't care	0x94	0x5A	0x80	0x2A	0x66	'G'	'V'

Delays, Report-Repetition & Baud Rate: When over current or LV-shutoff condition occurs; time to delay before contact opens. The delay unit is 1 second per count. There are 3 trip-points-delays and 1 low-volts-shutoff delay. In practice, set delay 1 to longest

because trip-point-1 is lowest current. The higher current get hot quicker and should delay shorter time. CAN baud can accept 25 or 50 only.

The report-repetition (RP rate) is the interval of the regular message that the contactor send out to report operational status (see report massage). R-P rate default is 800ms, and it is changeable in 100ms per count.

Baud Rate fits in byte 7. Send 25 will change baud rate to 250K/s and send 50 will change baud rate to 500K/s. If none of these (25/50) is entered, the value will be discarded. Change baud-rate will take effect immediately. Start to use CAN-BUS baud change from firmware version 3 and later.

Delay & repetition data:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
CAN Baud	Report Repetition	LV Delay	Delay 3	Delay 2	Delay 1	ID bytes	
8 bits	8-bits	8-bits	8-bits	8-bits	8-bits	'G'	'V'

Trip-delays range is from 0 to 255 (each count = 1 second of delay)

Report repetition rate is also ranging from 0 to 255, each count is = 100ms.

The value to change baud rate has to be 25 or 50 to represent 250K/s or 500K/s. If this value is neither 25 nor 50, it will be ignored.

Delay & RP-rate, J1939 message: **[**priority: 6**]**, **[**PDU format: 178_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

BUS-BAR Over Voltage Protection: (This setting starts from firmware version 5 and later)

There are 2 bus-bar terminals labeled A1 and A2. If any of the voltage at these terminals goes over the setting value, the contact will open. If the contact has not been closed, over voltage will not cause any actions.

The sensing inputs at A1 & A2 are limited to 60V max.

Bus-bar over voltage protection data:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
unused	unused	unused	unused	OVP-H	OVP-L	ID bytes	
don't care	don't care	don't care	don't care	H-2-bits	L-8-bits	'G'	'V'

The OVP-H has 2bits, bit 1 and bit 0 will become the bit9 and bit8 of the protection value. The combination of OVP-H (2bits) plus OVP-L (8bits) will become 10bit integer value to compare with the bus-bar voltage.

BUS-BAR over voltage protection calculation: protection counts = protection voltage * (2.74/32.74) * (1024/5)

Example: to set a protection of over 40V on the bus-bar to open contact = 40 * (2.74/32.74) * (1024/5) = 40 * 17.14 = 685 counts.

Bus-bar over voltage protection, J1939 message: **[**priority: 6**]**, **[**PDU format: 183_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 4 bytes data length, see above definitions.

Change Name: The lower 4 bytes [3:0] name of this device is defined by manufacture and cannot be changed. For flexible use on many different industries, the upper 4 bytes [7:4] can be changed by users using the following J1939 data format:

Byte 7			Byte 6	
Bit 8 (should be 0)	Bite 6, 5, 4	Bit 3, 2, 1, 0	Bit 7, 6, 5, 4, 3, 2, 1	Bit 0
Arbitrary Address Cap.	IND Group	VE-Sys Instance	Vehicle System	Don't care

Byte 5	Byte 4	
Functions	Bits 7, 6, 5, 4, 3	Bits 2, 1, 0
	ECU Instance	Function Instance

Because bytes [3:0] are not changeable, use "GVAC" for identification.

Byte 3	Byte 2	Byte 1	Byte0
Identification Bytes			
'G'	'V'	'A'	'C'

Send J1939 change-name message: **[**priority: 6**]**, **[**PDU format: 177_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Change Address: These models of contactors are not arbitrary address capable, but the address of these units will change with this command. This command uses more than 8 bytes of data. Therefore, it must use Multi-Packet Broadcast Message. This command requires the use of

contactor's device name. Send a "request for address claimed" message to retrieve this unit's device name.

8 Bytes data 1: Broadcast Announce Message (BAM) indicates 9 bytes and 2 packages.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
0	0xFE	0xD8	0xFF	2	0	9	32_{10}

Send J1939 change address message 1: **[**priority: 7**]**, **[**PDU format: 236_{10}**]**, **[**destination: 255_{10}**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

8 Bytes data 2: CA Name of this unit (7 bytes) and package number 1.

Byte 7 to byte 1	Byte 0
Use byte 6 to byte 0 from the name of this unit. Name[6-0]	1

Send J1939 change address message 2: **[**priority: 7**]**, **[**PDU format: 235_{10}**]**, **[**destination: 255_{10}**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

8 Bytes data 3: The unused bytes filled with 0xFF, new address, 1 byte name [7], package number 2.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
0xFF	0xFF	0xFF	0xFF	0xFF	New Address (0-253)	Name[7]	2

Send J1939 change address message 3: **[**priority: 7**]**, **[**PDU format: 235_{10}**]**, **[**destination: 255_{10}**]**, **[**source address: user unit's address**]**. Data 8 bytes see above definitions.

Change Report Message PS (PGN): The report message regularly sent out on the J1939 network by this unit using fixed PDU format (PF) value (255_{10}) and default PDU specific (PS) value (255_{10}). The user can change the PDU specific ranging from 0 to 255 by this command.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
don't care		PF	New PS	Identification Bytes			
0xFF	0xFF	0xFF (fixed)	range (0-255)	'G'	'V'	'A'	'C'

Send J1939 change report PGN message: **[**priority: 6**]**, **[**PDU format: 179_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Request:

Request for Address Claimed: Send this request to get back the address and name of this unit. When this message is received, it will report back its J1939 address and its name to

the users for communication purposes. If you don't know this unit's address use 0xFF a global address. Remember, use global address will cause all devices on the network to respond.

Request for address claimed format:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
not used, don't care					0x00	0xEE	0x00

Send J1939 request for address claimed message: **[**priority: 6**]**, **[**PDU format: 234_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 3 bytes data length, see above definitions.

Return if address successfully claimed: It returns this unit's address embedded in the CAN extended ID and the 8 bytes data contains the name of this unit.

Return if address cannot claim: It will return the NULL address (254) in the CAN extended ID bytes and the 8 bytes data with the name of this unit.

Return address data format:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
Name[7]	Name[6]	Name[5]	Name[4]	Name[3]	Name[2]	Name[1]	Name[0]

- The 21 bits of the lower bytes name also the serial number of this unit.

Return J1939 address claimed message: **[**priority: 6**]**, **[**PDU format: 238_{10}**]**, **[**destination: 255**]**, **[**source address: return-ADDR (claimed address or 0x254)**]**. 8 bytes data length, see above definitions.

Request Contactor Parameters: Send this message is for getting back the settings or configurations of this unit. The return data include: trip-points, shutoff-low-volts, delays, repetition-rate, CAN-BUS-baud rate, power-up contactor-state and 24bits contactor-on/off cycle-log (3 bytes: byte 2 to byte 0) and bus-bar over voltage protection.

After the "request contactor parameters" message is received, it will send back the report using multi-packet broadcast message transport protocol.

Request contactor parameters J1939 format:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
not used, don't care					0x00	0xEA	0x00

Send J1939 message request parameters: **[**priority: 6**]**, **[**PDU format: 234_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 3 bytes data length.

Request contactor parameters return: The first 8 bytes contain J1939 PGN. The second 8 bytes signal the multi-packet number 1. The third 8 bytes has packet number 2 and the forth 8 bytes is also the final 8 bytes show package number 3.

Return first 8 bytes: Broadcast announce message (BAM) shows 3 packages, 17 bytes, byte4 is reserved value (0xFF) and PGN 65240 (0x00FED8).

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
0x00	0xFE	0xD8	0xFF	3	0	17_{10}	32_{10}

Return J1939 first message: **[**priority: 7**]**, **[**PDU format: 236_{10}**]**, **[**destination: user's ADDR**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Return second 8 bytes: Contactor on/off cycle-log byte0, contactor power-up default, shared bits, shutoff volts, trip-points and package number 1 indicator.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
Cycle	C_PW-St	shared	LV-Off	Trip 3	Trip 2	Trip 1	Package#
Byte 0	C/O	4x2 bits	8+2 bits	8+2 bits	8+2 bits	8+2 bits	1

Definition of byte-5 second package:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2 bits MSB: LV-Off		2 bits MSB: Trip-3		2 bits MSB: Trip-2		2 bits MSB: Trip-1	

Return J1939 second message: **[**priority: 7**]**, **[**PDU format: 235_{10}**]**, **[**destination: user's ADDR**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Return Third 8 bytes: Contactor on/off cycle-logs bytes 2 & 1, repetition-rate, delays and package number 2 indicator.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
Cycle	Cycle	RP-rate	LV-Delay	Delay 3	Delay 2	Delay 1	Package#
Byte 2	Byte 1	8 bits	8 bits	8-bits	8-bits	8-bits	2

Return J1939 third message: **[**priority: 7**]**, **[**PDU format: 235_{10}**]**, **[**destination: user's ADDR**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Return Forth 8 bytes: The unused bytes contain 0xFF, CAN-Baud Rate and package number 3 indicator. This is also a final byte of the package. 25=250K/s, 50=500K/s

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0

unused	unused	unused	unused	OVP-H	OVP-L	CAN-Baud	Package#
0xFF	0xFF	0xFF	0xFF	H-2-bits	L-8-bits	25_{10} or 50_{10}	3

Return J1939 forth & final message: [priority: 7], [PDU format: 235_{10}], [destination: user's ADDR], [source address: user unit's address]. 8 bytes data length, 1 byte used, see above definitions.

Request Firmware Version, Report PS & A1-A2 Volts: Send this request will return this unit's firmware version and the PS (PGN) of report message that regularly send out on the BUS. Also the non-isolated contact-voltage-sensing at the bus-bar terminals labeled A1 and A2 on the contactor. If this unit has no contact-voltage sensing option, the A1 and A2 values will be irrelevant.

Request firmware, PS (PGN), A1, A2 Volts format:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
not used, don't care					0x00	0xFE	0xDA

Send request firmware RP rate A1, A2 Volts J1939 message: [priority: 6], [PDU format: 234_{10}], [destination: this unit's address], [source address: user unit's address]. 3 bytes data length, see above definitions.

Return of request firmware PS (PGN) & A1 A2: 8 bytes data combination of firmware version, report PS (PGN) and A1 A2.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Shared bits	A2 Volts	A1 Volts	Report PS	FW Minor	FW Major	ID bytes	
See below	8+2 bits	8+2 bits	PGN #	Alphabet	Numeric	'G'	'V'

Byte 7 shared bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not used				2bits MSB: A2_V		2bits MSB: A1_V	

Return J1939 Firmware, RP rate, A1-A2 Volts message: [priority: 6], [PDU format: 254_{10}], [destination: 218_{10}], [source address: this unit's address]. 7 bytes data length, see above definitions.

Byte 5 & 6 (A1 & A2) Volts: A1 & A2 voltages are 10 bit unsigned integer. A1 or A2 Volts = (5/1024) * Reading ADC counts * (32.74/2.74).

A1 & A2 Volts example: Reading ADC value of 0x1EA = (5/1024) * 0x1EA * (32.74/2.74) = 28.59V.

Request Product Model BAR Code Data: Send this request to the unit will return the product model and date code total of 64 bytes. This type of data is mainly for factory record keeping, troubleshooting and provides tractability information.

Request Product Model & Date-code J1939 format:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
not used, don't care					0x00	0xFE	0xEB

Send J1939 message BAR code request: **[**priority: 6**]**, **[**PDU format: 234_{10}**]**, **[**destination: this unit's address**]**, **[**source address: user unit's address**]**. 3 bytes data length, see above definitions.

Request Product Model & Date-code return: Using Multi-Packet Broadcast message transport protocol.

Return first 8 bytes: Broadcast announce message (BAM) shows 10 packages, 64 bytes, byte4 is reserved value (0xFF) and PGN 65240 (0x00FED8).

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
0x00	0xFE	0xD8	0xFF	0x0A	0	64_{10}	32_{10}

Return J1939 first message: **[**priority: 7**]**, **[**PDU format: 236_{10}**]**, **[**destination: user's ADDR**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Return second 8 bytes: 7 bytes bar-code data from array index 0 to index 6 and package number 1.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
D6	D5	D4	D3	D2	D1	D0	1

Return J1939 second message: **[**priority: 7**]**, **[**PDU format: 235_{10}**]**, **[**destination: user's ADDR**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Return third 8 bytes: 7 bytes bar-code data from array index 7 to index 13 and package number 2.

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
D13	D12	D11	D10	D9	D7	D7	2

Return J1939 third message: **[**priority: 7**]**, **[**PDU format: 235_{10}**]**, **[**destination: user's ADDR**]**, **[**source address: user unit's address**]**. 8 bytes data length, see above definitions.

Continue package number 3 ….to the end of package 10.

Report:

Contactor Data Report: The unit sends out reports regularly on the J1939 BUS every 800ms (default), repetition rate can be changed by users with the "Delays, Report-Repetition & Baud Rate" command. These report types have only temperature is signed integer. The rests are unsigned integers. Report data will have the following format:

Current: the total current going through the contact.

Temperature: the temperature inside the contactor in degree C.

Power-supply-V: Voltage of the power supply.

Status: Bus-bar over voltage protection will set OVP bit, power supply under-voltage protection will set UVP bit, over current protection will set TRIP bit and contactor-on will set STATE bit.

Countdown (Timer to trip): time in seconds to open the contact.

Note: there are 3 trip-points delays and 1 under-volt delay, a total of 4 different delay-times to countdown. Incase multiple countdown times happen, the one to countdown is the shortest one.

Report data output format:

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte0
Trip time 10 bits		Status	Shared bits	PS-V	Temperature		Current
countdown (sec)		OV/UV/Trip/St	Below	8+2 bits	Signed 16 bits		8+2 bits

Byte 4 definition: 2 bits MSB of Power supply & current data.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
not used, don't care				2 bits MSB: PS-V		2 bits MSB: Current	

Byte 5 status definition: OVP is bus-bar over voltage protection; it will opens the contact and set bit7 (firmware version 5 and later) if bus-bar voltage higher than protection setting. If power supply is <= low volts shutoff, the under-voltage-protection (UVP) will open the contact and bit 5 will set. The TRIP-state is over current protection trip (set bit3). The contact-STATE is the contactor opened or closed status (bit0).

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OVP	unused	UVP	unused	TRIP	unused	unused	STATE

Byte 6 & byte 7:

Count down to trip: when over current or under voltage condition happens, the number of seconds to count-down before the contactor trips, also called delay to trip. The time to trip is changeable on the delay command. When there is no over-current or under-voltage, this countdown value is 0xFFFE.

Report J1939 message: **[**priority: 6**]**, **[**PDU format: 255_{10}**]**, **[**destination: PS**]**, **[**source address: this unit's address**]**. 8 bytes data length, see above definitions.

Note: PDU format is always 255, and destination address default is 255, and the destination address can be changed by sending "Change Report Message PS (PGN)" command.

How to interpret the report values:

Current: Current is 10 bit unsigned integer combines byte0 with 2 bits from byte 4. Current in Amp = reading of ADC counts * (600/512).

Current example: Reading current value of 220 counts = 220 * 1.17 = 258A

Byte 1 & 2 Temperature: Temperature is 16 bit signed integer.

Temperature value in °C = ((reading data – 3) / 128)

Temperature example 1: reading data 0x3E83 the temperature is = 125°C

Temperature example 2: reading data 0xF383 the temperature is = -25°C

Byte 3 Power Supply Voltage: Supply-Voltage is 10 bits unsigned integer combines with 2 bits from byte4, the equation is:

Supply Volts = (5/1024) * ADC counts * (28.02 / 4.02).

Supply voltage example: If read-back ADC counts = 0x198. You have supply voltage of (5/1024) * 408 * (28.02/4.02) = 13.89V.

Appendix: J1939 format

CAN	29 bit ID						Data
J1939	PDU (Protocol Data Unit)						
	P	**R**	**DP**	**PF**	**PS**	**SA**	Data
Bits	3	1	1	8	8	8	0-64
	24 bit PGN (Parameter Group Number) (1st 6 bits are 0)						

Abr.	**Full Name**	**Description**
PGN	Parameter Group Number	
P	Priority	Priority of command.
R	Reserved	
DP	Data Page	Use 0. 1 reserved for future expansion.
PF	PDU Format	Command
PS	PDU Specific	Address of recipient
SA	Source Address	Address of sender

Revision history:

R1: to **R3.**

Prototype initial completion.

R4.

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For firmware version 2 and later.

- First release.
- Data format of firmware version 2 or later.
- Add LV-shutoff delay and all delays ranges are 8-bits.
- Add firmware version major and minor numbers.

R5:

- No change to the core date format.
- Reorganized command and setting, split into 2 groups.
- There are total of 4 messages types.
- A note for the baud-rate info.

R6:

For firmware version 3 and later.

- Add Changeable CAN-BUS baud-rate into configuration-message “Delays, Report-Repetition & Baud Rate” PDU format $178_{10.}$
- Change CAN-BUS baud-rate message affects the message of “Request Contactor Parameters” PDU format: 234_{10}. This message will return 1 more value, the CAN-BUS baud-rate setting 25 or 50.

R7:

For firmware version 5 and later.

- Add A1 & A2 over voltage protection. This feature starts from firmware version 5 and later, and it is not available for the older versions of firmware.
- Firmware add “BUS-BAR over Voltage Protection” setting message. PDU format 183.
- “Request Contactor Parameters” PDU format: 234_{10}. This message will return 1 more value, the over voltage value to protect the bus-bar in 10 bits integer (OVP).
- Report data will set bit7 if over voltage protection of the bus-bar is activated.
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