VESC 6 CAN Formats

Version 0.1
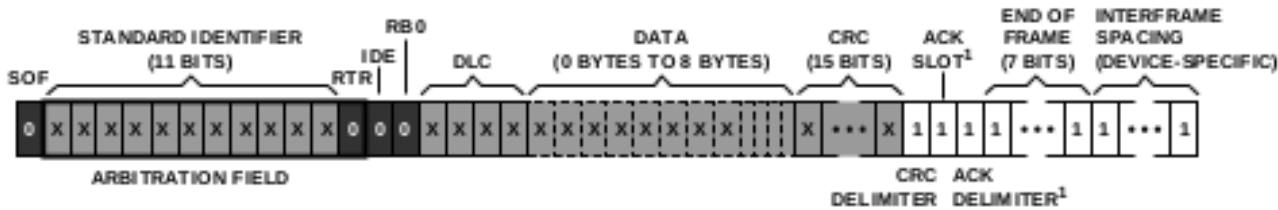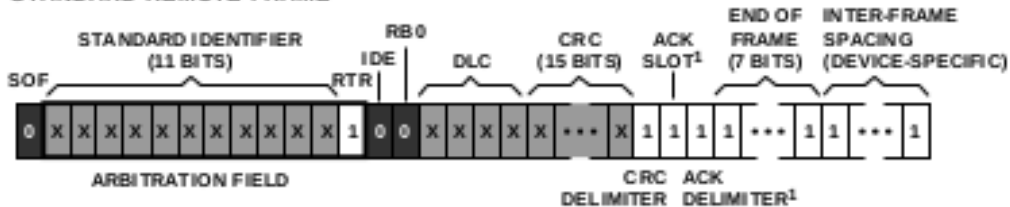
Figure 4. CAN Standard Message Frame Fields
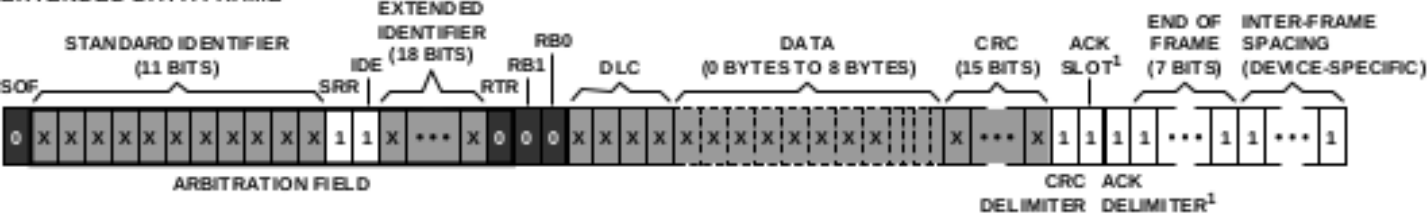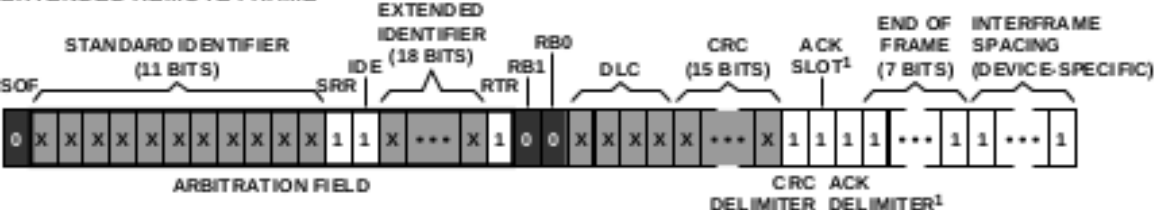
- CAN Frame Definitions
  - Standard frames have 11 bit IDs
  - Extended frame have 29 bit IDs
- CRCs are usually calculated in hardware for many microprocessors
- VESC6 commands use extended frames
- Looks like an error in extended data frame (non remote) SRR should be 0

Command Formats Extracted from VESC6 SW

```c
typedef struct {
 struct {
  uint8_t        DLC:4;      /**< @brief Data length.      */
  uint8_t        RTR:1;      /**< @brief Frame type.       */
  uint8_t        IDE:1;      /**< @brief Identifier type.  */
 };
 union {
  struct {
   uint32_t        SID:11;      /**< @brief Standard identifier.*/
  };
  struct {
   uint32_t        EID:29;      /**< @brief Extended identifier.*/
  };
 };
 union {
  uint8_t        data8[8];    /**< @brief Frame data.        */
  uint16_t        data16[4];    /**< @brief Frame data.       */
  uint32_t        data32[2];    /**< @brief Frame data.       */
 };
} CANTxFrame;
```

```c
typedef struct {
 struct {
  uint8_t        FMI;        /**< @brief Filter id.        */
  uint16_t        TIME;       /**< @brief Time stamp.       */
 };
 struct {
  uint8_t        DLC:4;      /**< @brief Data length.      */
  uint8_t        RTR:1;      /**< @brief Frame type.       */
  uint8_t        IDE:1;      /**< @brief Identifier type.  */
 };
 union {
  struct {
   uint32_t        SID:11;      /**< @brief Standard identifier.*/
  };
  struct {
   uint32_t        EID:29;      /**< @brief Extended identifier.*/
  };
 };
 union {
  uint8_t        data8[8];     /**< @brief Frame data.        */
  uint16_t        data16[4];     /**< @brief Frame data.        */
  uint32_t        data32[2];     /**< @brief Frame data.        */
 };
} CANRxFrame;
```

List of Command Numbers

CAN_PACKET_SET_DUTY = 0,
CAN_PACKET_SET_CURRENT = 1,
CAN_PACKET_SET_CURRENT_BRAKE = 2,
CAN_PACKET_SET_RPM = 3,
CAN_PACKET_SET_POS = 4,
CAN_PACKET_FILL_RX_BUFFER = 5,
CAN_PACKET_FILL_RX_BUFFER_LONG = 6,
CAN_PACKET_PROCESS_RX_BUFFER = 7,
CAN_PACKET_PROCESS_SHORT_BUFFER = 8,
CAN_PACKET_STATUS = 9,
CAN_PACKET_SET_CURRENT_REL = 10,
CAN_PACKET_SET_CURRENT_BRAKE_REL = 11,
CAN_PACKET_SET_CURRENT_HANDBRAKE = 12,
CAN_PACKET_SET_CURRENT_HANDBRAKE_REL = 13,
CAN_PACKET_STATUS_2 = 14,
CAN_PACKET_STATUS_3 = 15,
CAN_PACKET_STATUS_4 = 16,
CAN_PACKET_PING = 17,
CAN_PACKET_PONG = 18,
CAN_PACKET_DETECT_APPLY_ALL_FOC = 19,
CAN_PACKET_DETECT_APPLY_ALL_FOC_RES = 20,
CAN_PACKET_CONF_CURRENT_LIMITS = 21,
CAN_PACKET_CONF_STORE_CURRENT_LIMITS = 22,
CAN_PACKET_CONF_CURRENT_LIMITS_IN = 23,
CAN_PACKET_CONF_STORE_CURRENT_LIMITS_IN = 24,
CAN_PACKET_CONF_FOC_ERPMS = 25,
CAN_PACKET_CONF_STORE_FOC_ERPMS = 26,
CAN_PACKET_STATUS_5 = 27

- These command numbers are put in the second byte of the 29 bit ID for the extended CAN frame. You need an extended frame (29 bits) vs. standard frame (11 bits) since bits 0-7 are reserved for numbering the individual speed controllers (0-255). With only 3 bits left, only 8 commands would be available if you used a standard frame.

Command Duty Cycle (-1 to 1)

Start	Top 11 Bits Of ID		SRR	Frame Type	Bottome 18 Bits			Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	SET_DUTY=0	0-255 Unit ID	0		4	0	0	0	0	Duty Cycle * 100000			
															Int 32			

- Command a duty cycle from -1 (-100%) to 1 (100%)
  - This is direct command of MOSFET PWM modulation
  - Is this limited by temperature and current limits?

Command Set Current

Start	Top 11 Bits Of ID		SRR	Frame Type	Bottome 18 Bits			Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	SET_CURRENT=1	0-255 Unit ID	0		4	0	0	0	0	Current * 1000			
															Int 32			

- Command a current in milliamps (any level up to +/-2e6 amps)
  - This is direct command of the current control loops
  - Is this limited by temperature and current limits?

Command Set Current Brake

Start	Top 11 Bits Of ID		SRR	Frame Type	Bottome 18 Bits			Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	SET_CURRENT_BRAKE =2	0-255 Unit ID	0		4	0	0	0	0	Current * 1000			
															Int 32			

- Command a current brake in milliamps (any level up to +/-2e6 amps)
  - This is direct command of the current control loops
  - Is this limited by temperature and current limits?

Command Set RPM

Start	Top 11 Bits Of ID		SRR	Frame Type	Bottome 18 Bits			Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	SET_RPM = 3	0-255 Unit ID	0		4	0	0	0	0	RPM			
															Int 32			

- Command angular velocity in rpm
  - This is command of the closed loop PID angular velocity
  - How is this limited by temperature and current limits?

Command Set POS

Start	Top 11 Bits Of ID		SRR	Frame Type	Bottome 18 Bits			Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	SET_POS = 4	0-255 Unit ID	0		4	0	0	0	0			Pos	
																	Int 32	

- Command position
  - This is command of the closed loop PID position, but what are the units? Encoder steps? Hall sensor steps?
  - How is this limited by temperature and current limits? Are the gains backed off or is the torque limited?

Command Relative Current (-1 to 1)

Start	Top 11 Bits Of ID		SRR	Frame Type		Bottome 18 Bits		Remote	Spare	Data Length		Data Field						
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits		data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	SET_CURRENT_RELATIVE = 10	0-255 Unit ID	0		4		0	0	0	0	Ratio (-1 to 1) * 100000		
																Int 32		

- Command a relative current from -1 (-100%) to 1 (100%)
  - -1 is equal to the lower current limit, +1 is equal to the upper current limit
  - NOTE that if the upper and lower current limits are not symmetric, sending 0 will NOT result in 0 current.
  - Is this limited by temperature?

Command Relative Brake Current (-1 to 1)

Start	Top 11 Bits Of ID		SRR	Frame Type	Bottome 18 Bits				Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15		bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	SET_CURRENT_RELATIVE_BRAKE = 11		0-255 Unit ID	0		4	0	0	0	0	Ratio (-1 to 1) * 100000			
																Int 32			

- Command a relative brake current from -1 (-100%) to 1 (100%)
  - -1 is equal to the lower current limit, +1 is equal to the upper current limit
  - NOTE that if the upper and lower current limits are not symmetric, sending 0 should NOT result in 0 current.
  - Is this limited by temperature?

Set Current Limits

Start	Top 11 Bits Of ID		SRR	Frame Type				Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_CONF_CURRENT_LIMITS = 21	0-255 Unit ID	0		8	Max Current Limit * 1000				Min Current Limit * 1000			
											Int 32				Int 32			

Start	Top 11 Bits Of ID		SRR	Frame Type				Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_CONF_STORE_CURRENT_LIMITS = 22	0-255 Unit ID	0		8	Max Current Limit * 1000				Min Current Limit * 1000			
											Int 32				Int 32			

- Command a set of current limits
  - There are two versions of this command, command 21 sets the operating current limits, command 22 sets the operating current limits and sends them to EEPROM

Set Input Current Limits

Start	Top 11 Bits Of ID		SRR	Frame Type				Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_CONF_CURRENT_LIMITS_IN = 23	0-255 Unit ID	0		8	Max Current Limit * 1000				Min Current Limit * 1000			
											Int 32				Int 32			

Start	Top 11 Bits Of ID		SRR	Frame Type				Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_CONF_STORE_CURRENT_LIMITS_IN = 24	0-255 Unit ID	0		8	Max Current Limit * 1000				Min Current Limit * 1000			
											Int 32				Int 32			

- Command a set of input current limits
  - There are two versions of this command, command 23 sets the operating current limits, command 24 sets the operating current limits and sends them to EEPROM

Telemetry Data Structures On Microprocessor

```
typedef struct {
        float v_in;
        float temp_mos1;
        float temp_mos2;
        float temp_mos3;
        float temp_mos4;
        float temp_mos5;
        float temp_mos6;
        float temp_pcb;
        float current_motor;
        float current_in;
        float rpm;
        float duty_now;
        float amp_hours;
        float amp_hours_charged;
        float watt_hours;
        float watt_hours_charged;
        int tachometer;
        int tachometer_abs;
        mc_fault_code fault_code;
} mc_values;
```

- There are up to five different telemetry messages that are available from the unit
  - You can chose 1, 1&2, 1&2&3, 1&2&3&4, and all

Status Message 1

Start	Top 11 Bits Of ID		SRR	Frame Type		Bottom 18 Bits		Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_STATUS = 9	0-255 Unit ID	0		8	Duty Cycle * 1000		Toal Current * 10		rpm			
											Int 16		Int 16		Int 32			

- Automatically sent telemetry message #1
  - Three states are packed in this message
    - RPM – 32 bits probably because int16 is +/- 32k which may be less than needed for some high speed motors
    - Total Current – Current in all units summed together with a scale factor of 10 – assumed amps
    - Duty cycle – latest duty cycle (-1 to 1) multiplied by 1000

Status Message 2

Start	Top 11 Bits Of ID		SRR	Frame Type	Bottom 18 Bits				Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15		bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_STATUS_2 = 14		0-255 Unit ID	0		8	Amp Hours Charged * 10000				Amp Hours * 10000			
												Int 32				Int 32			

- Automatically sent telemetry message #2
  - Two states are packed in this message
    - Amp hours – total amp hours consumed by unit
    - Amp hours charged – total regenerative amp hours put back in battery

Status Message 3

Start	Top 11 Bits Of ID		SRR	Frame Type		Bottom 18 Bits		Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_STATUS_3 = 15	0-255 Unit ID	0		8	Watt Hours Charged * 10000				Watt Hours * 10000			
											Int 32				Int 32			

- Automatically sent telemetry message #3
  - Two states are packed in this message
    - Watt hours – total watt hours consumed by unit
    - Watt hours charged – total regenerative watt hours put back in battery

Status Message 4

Start	Top 11 Bits Of ID		SRR	Frame Type		Bottom 18 Bits		Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_STATUS _4 = 16	0-255 Unit ID	0		8	PID Pos * 50		Toal Current In* 10		Motor Temp * 10		FET Temp *10	
											Int 16		Int 16		Int 16		Int16	

- Automatically sent telemetry message #4
  - Four states are packed in this message
    - MOSFET temperature * 10 – assumed deg C?
    - Motor temperature *10 – assumed deg C?
    - Total input current *10 – assumed amps
    - Current PID Position – not sure about units

Status Message 5

Start	Top 11 Bits Of ID		SRR	Frame Type		Bottom 18 Bits		Remote	Spare	Data Length	Data Field							
1 bit	bits 26-28	bits 18-25	1 bit	1 bit	bits 16-17	bits 8-15	bits 0-7	1 bit	2 bits	4 bits	data 7	data 6	data 5	data 4	data 3	data 2	data 1	data 0
	0	0	0	1	0	CAN_PACKET_STATUS_5 = 27	0-255 Unit ID	0		8	Reserved		Input Voltage * 10		Tachometer value			
											Int 16		Int 16		Int 32			

- Automatically sent telemetry message #5
  - Three states are packed in this message
    - Tachometer – assumed rpm?
    - Input Voltage * 10
    - Reserved