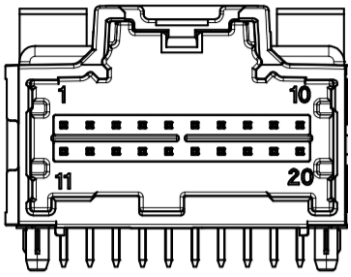
8 Channel Fixed Frequency Constant Current Control Board

Table of Contents

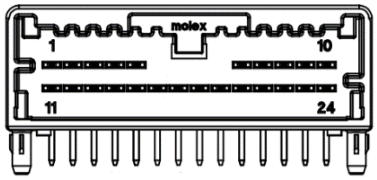
Package Pinout

Power Side



Pin	Description	Pin	Description
1	Ground	11	Ground
2	Low Side Ch4	12	Low Side Ch5
3	Low Side Ch3	13	Low Side Ch6
4	Low Side Ch2	14	Low Side Ch7
5	Low Side Ch1	15	Low Side Ch8
6	High Side	16	High Side
7	High Side	17	High Side
8	High Side	18	High Side
9	High Side	19	High Side
10	12 V Input	20	12 V Input

CAN Side



Pin	Description	Pin	Description
1	Analog Input	13	Sensor Supply(5V)
2	Analog Input	14	Ground
3	Analog Input	15	Sensor Supply(5V)
4	Analog Input	16	Ground
5	Digital Input	17	Sensor Supply(5V)
6	Digital Input	18	Ground
7	Digital Input	19	Sensor Supply(5V)
8	Digital Input	20	Ground
9	CANL	21	Sensor Supply(5V)
10	CANH	22	Ground
11	Sensor Supply(5V)	23	Sensor Supply(5V)
12	Ground	24	Ground

Message #1 Current Set (Channels 1-4)

CAN ID: 3F (Extended ID)

Length: 8 bytes

63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
ON/ OFF	NU	NU	NU	NU	Current Set Point CH 1										

47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
ON/ OFF	NU	NU	NU	NU	Current Set Point CH 2										

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
ON/ OFF	NU	NU	NU	NU	Current Set Point CH 3										

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ON/ OFF	NU	NU	NU	NU	Current Set Point CH 4										

**nu = not used*

Field	**Bits**	**Description**
ON/ Current Control	64, 47, 31, 15	***Mode of Operation for the Corresponding Channel*** *0 = Current Control Operation* *1 = CHx is fully ON (100% Duty Cycle)*
Current Set Point CH X	58:48, 42:32, 26:16, 10:0	***Average Current Set Point for corresponding channel*** *Resolution = 1.5625 mA/bit*

$$Current_{setpoint}[mA] = Current\ Set\ Point\ CHx * 1.5625$$

If, for example, we need 1A at CH1, the Current Set Point for CH1 is 640(in decimal)/280(in hex)

Example:

CH1: Current Control Operation and Current Set Point = 640 (in decimal)/280 (in hex)/ 1 A

CH2: Current Control Operation and Current Set Point = 320 (in decimal)/140 (in hex)/ 500 mA

CH3: Current Control Operation and Current Set Point = 160 (in decimal)/A0 (in hex)/ 250 mA

CH4: Fully ON (100% Duty Cycle)

CAN-ID	Typ	Länge	Daten
0000003Fh		8	02 80 01 40 00 A0 80 00

Message #2 Current Set (Channels 5-8)

CAN ID: 3E (Extended ID)

Length: 8 bytes

63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
ON/ OFF	NU	NU	ON	NU	Current Set Point CH 5										

47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
ON/ OFF	NU	NU	ON	NU	Current Set Point CH 6										

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
ON/ OFF	NU	NU	ON	NU	Current Set Point CH 7										

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ON/ OFF	NU	NU	ON	NU	Current Set Point CH 8										

**nu = not used*

Field	**Bits**	**Description**
ON/ Current Control	64, 47, 31, 15	***Mode of Operation for the Corresponding Channel*** *0 = Current Control Operation* *1 = CHx is fully ON (100% Duty Cycle)*
Current Set Point CH X	58:48, 42:32, 26:16, 10:0	***Average Current Set Point for corresponding channel*** *Resolution = 1.5625 mA/bit*

$$Current_{setpoint}[mA] = Current\ Set\ Point\ CH\ X * 1.5625$$

If, for example, we need 1A at CH1, the Current Set Point for CH5 is 640(in decimal)/280(in hex)

Example:

CH5: Current Control Operation and Current Set Point = 640 (in decimal)/280 (in hex)/ 1 A

CH6: Current Control Operation and Current Set Point = 320 (in decimal)/140 (in hex)/ 500 mA

CH7: Current Control Operation and Current Set Point = 160 (in decimal)/A0 (in hex)/ 250 mA

CH8: Fully ON (100% Duty Cycle)

CAN-ID	Typ	Länge	Daten
0000003Fh		8	02 80 01 40 00 A0 80 00

Message #3 Period Set (Channels 1-8)

CAN ID: 3D (Extended ID)

Length: 4 bytes

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	not used							

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
not used		Period Divider													

Field	**Bits**	**Description**
CHx	31:24	***Channel X will receive the new Period value*** *0 = CHx Period will not change* *1 = CHx Period will take the new value*
Period Divider	13:0	***New value for the Period of the selected channels***

$$F_{PWM}[kHz] = \frac{20 * 10^3}{32 * Period\ Divider}$$

If, for example, we want a new period at 2 kHz, then the Period Divider = 312(in decimal)/138(in hex)

Example: *In this example the Period Divider of channels 3,4,5,8 take the new value: 138(in hex)/ 312(in decimal)/ Period = 2 kHz.*

CAN-ID	Typ	Länge	Daten
0000003Dh		4	39 00 01 38

Initial Period for all channels is set to 4 kHz.

Message #4 Kp/Ki Set (Channels 1-8)

CAN ID: 3C (Extended ID)

Length: 4 bytes

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	Kp							

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Kp				Ki											

Field	**Bits**	**Description**
CHx	31:24	**Channel X will receive the new Period value** 0 = CHx Kp/Ki will not change 1 = CHx Kp/Ki will take the new values
Kp	23:12	**New value for the Kp of the selected channels**
Ki	11:0	**New value for the Ki of the selected channels**

Calculating the values of Kp and Ki

Choose a value for ζ: 0.707 < ζ < 1

The smaller the ζ is, the faster the PI will be and with bigger overshoot.

The bigger the ζ is, the slower the PI will be and with smaller overshoot.

$$\omega_n = \frac{F_{PWM}}{5 * \zeta}$$

$$Kp' = \left(2 * \zeta * \omega_n - \frac{Rc}{Lc}\right) * \frac{Lc}{V_{bat}}, \qquad Ki' = \frac{Lc}{V_{bat}} * \omega_n^2$$

$$Kp = Kp' * \frac{0.04*20*10^3}{0.1*F_{PWM}}, \qquad Ki = Ki' * \frac{0.04*20*10^3}{0.1*F_{PWM}^2}$$

Initial value for F_{PWM} is 4 kHz.

Example: *In this example the Kp and Ki of channels 3,4,5,8 take the new values:*

Kp = 35A(in hex)/ 858(in decimal)

Ki = 195(in hex)/ 405(in decimal)

CAN-ID	Typ	Länge	Daten
0000003Ch		4	39 35 A1 95

Initial values for all channels are set to: Kp = 700(in hex)/1792(in decimal), Ki = 300(in hex)/768(in decimal).

Message #5 Diagnostics Read (Channels 1-8)

CAN ID: 3B (Extended ID)

Length: 0 bytes

Response Message:

ID: 4F (Extended ID)

Length: 8 bytes

63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
not used						SG8	OFF-TST8	SB8	SB-TST8	OL-OFF8	OL-ON8	SG7	OFF-TST7	SB7	SB-TST7

47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
OL-OFF7	OL-ON7	SG6	OFF-TST6	SB6	SB-TST6	OL-OFF6	OL-ON6	SG5	OFF-TST5	SB5	SB-TST5	OL-OFF5	OL-ON5	nu	nu

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
not used						SG4	OFF-TST4	SB4	SB-TST4	OL-OFF4	OL-ON4	SG3	OFF-TST3	SB3	SB-TST3

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OL-OFF3	OL-ON3	SG2	OFF-TST2	SB2	SB-TST2	OL-OFF2	OL-ON2	SG1	OFF-TST1	SB1	SB-TST1	OL-OFF1	OL-ON1	nu	nu

**nu = not used*

Field	**Bits**	**Description**
SGx	57, 51, 45, 39, 25, 19, 13, 7	**Short to Ground – Fault**
OFF-TSTx	56, 50, 44, 38, 24, 18, 12, 6	**Short to Ground & Open Load (Gate Off) – Tested**
SBx	55, 49, 43, 37, 23, 17, 11, 5	**Short to Battery – Fault**
SB-TSTx	54, 48, 42, 36, 22, 16, 10, 4	**Short to Battery – Tested**
OL-OFFx	53, 47, 41, 35, 21, 15, 9, 3	**Open Load (Gate Off) – Fault**
OL-ONx	52, 46, 40, 34, 20, 14, 8, 2	**Open Load (Gate On) – Fault**

Message #6 Current Read (Channels 1-4)

CAN ID: 3A (Extended ID)

Length: 0 bytes

Response Message:

ID: 5F (Extended ID)

Length: 8 bytes

63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
nu	nu	Current Read CH1													

47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
nu	nu	Current Read CH2													

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
nu	nu	Current Read CH3													

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
nu	nu	Current Read CH4													

**nu = not used*

$$Current_{CHx}[mA] = \frac{Current\ Read\ CHx * 320}{2^{14} * 0.1}$$

Message #7 Current Read (Channels 5-8)

CAN ID: 39 (Extended ID)

Length: 0 bytes

Response Message:

ID: 6F (Extended ID)

Length: 8 bytes

63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
nu	nu	Current Read CH5													

47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
nu	nu	Current Read CH6													

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
nu	nu	Current Read CH7													

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
nu	nu	Current Read CH8													

**nu = not used*

$$Current_{CHx}[mA] = \frac{Current\ Read\ CHx * 320}{2^{14} * 0.1}$$

Message #8 Verification Message

ID: 7F (Extended ID)

Length: 2 bytes

This message is SENT by the MCU every 1 sec.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data															

Field	***Bits***	***Description***
Data	*15:0*	***Error Message*** *0000 = the board is running correctly* *FFFF = the communication between MCU and TLE is lost*