CAN bus protocol for X2 RaceLink

VERSION 1.4 – NOT FOR RELEASE

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15-11-2024

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REVISION HISTORY

Revision	Date	X2Link	RaceLink	Change
1.0	06-06-2024	2.8	2.52	First release of document
1.1	18-07-2024	2.8	2.52	CAN filtering explanation added
1.2	05-08-2024	3.0	2.53	0x0E1 Firmware version message change
1.3	01-10-2024	3.0	2.53	GPS status flags table added for 0x0E0
1.4	15-11-2024	3.0	2.53	Flag ID list updated (Appendix A)

SUMMARY

This document describes the CAN Bus protocol for different versions of MYLAPS X2Link RaceLink devices. The MYLAPS RaceLink family is part of the MYLAPS X2Link ecosystem, providing ultra reliable solutions for safety, race control management, race management, GPS tracking, GPS positioning and two-way telemetry, all done via MYLAPS proprietary X2Link RF communication.
Should any questions arise after reading this document, please contact your MYLAPS Account Manager or contact MYLAPS Global Tech Support.

Please note: Any message marked with asterisk (*) is not yet implemented as of X2Link version 2.8. This information serves as a "heads-up" to 3rd parties implementing our protocol to know what's coming in the next releases.

CONTENTS

CAN BUS PHYSICAL LAYER

Thie chapter describes the physical layer of the CAN bus interface on the various MYLAPS RaceLink devices.

RaceLink "sharkfin" (2016 version)

The "sharkfin"-style racelink has been declared End-Of-Life. This document therefore does not cover any information about this product. Should you have any questions about the connections or CAN Protocol of the "sharkfin" version, please reach out to your MYLAPS reseller, MYLAPS account manager or MYLAPS Global Tech Support.

RaceLink GPS

The RaceLink GPS does not have a CAN-bus connection. The RaceLink GPS will therefore not be included in the rest of this document.

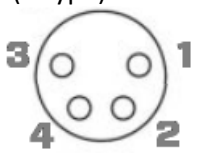
This includes RaceLink GPS (≤2024) and RaceLink GPS v2 (2025≤).

RaceLink Club (version up to and including 2024)

The original RaceLink Club can be recognized by *status LED* on top and by the center (M8) connector, which has a 4-pin layout.

CONNECTOR

M8 4-pin (A type) Male (racelink)
M8 4-pin (A type) Female (cable)



PINOUT (standard wire color)

1 – 12VDC (**brown**)
2 – CAN low (white)
3 – GND (**blue**)
4 – CAN high (**black**)

Termination resistor (120 Ohm)

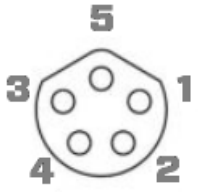
Fixed (always on)

RaceLink Club v2 (2025 onwards)

The RaceLink Club v2 can be recognized by the sticker label "*RaceLink Club v2*", the blue and red dots near the SMA connectors and by the center connector, which has a 5-pin layout.

CONNECTOR

M8 5-pin (B type) Male (racelink)
M8 5-pin (B type) Female (cable)

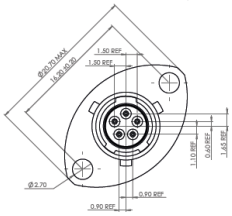


PINOUT (standard wire color)

1 – 12VDC (**brown**)
2 – CAN low (white)
3 – GND (**blue**)
4 – CAN high (**black**)
5 – 5V out for MYLAPS units (**grey**)

Termination resistor (120 Ohm)

Software selectable

<table>
<tr><td rowspan="2"> 
</td><td colspan="2">RaceLink Pro
The RaceLink Pro is made for pro series and is equipped with a Deutsch autosport connector. The Pro does not have integrated flagging LEDs.</td></tr>
<tr><td>CONNECTOR
Deutsch ASU003-05PN (racelink)
Deutsch ASU603-05SN (cable)
  </td><td>PINOUT
1 - 12VDC
2 - GND
3 - CAN low
4 - CAN High
5 – Input +/- 15V max (not used)

Termination resistor (120 Ohm)
No</td></tr>
</table>

CAN BUS SETTINGS

Racelink configuration and settings can be changed in three ways:

- Via X2Link RF connection from MYLAPS Race Control Manager software (registration tab)
- Via Bluetooth dongle from MYLAPS Race Control Manager software (X2 RaceLink tool)
- Via Bluetooth from MYLAPS Speedhive app for Android/iOS (RaceLink 2 Club only)

The configuration allows custom settings for Bus speed, Acceptance filters, Message IDs and overall enabling or disabling certain messages. The configuration is stored in non-volatile memory.

Activating Bluetooth communication

Bluetooth communication can be activated in different ways. An active BLE connection is indicated by a blinking blue LED on the racelink.

For RaceLink GPS (all types):	BLE is enabled when the racelink is in the cradle and charging 5V.
For RaceLink Club (all types):	BLE is enabled when the input voltage (pin 1) is 5V.
For RaceLink Pro:	BLE is enabled when the input voltage (pin 1) is 5V.
For RaceLink Club v2 (2025≤):	BLE can also be activated from within the Speedhive App over NFC.

Bus standard

MYLAPS RaceLink CAN interface supports 11-bit identifiers (CAN 2.0A).

Bus speed

The baud rate of the CAN bus can be selected in the RaceLink settings.
Supported baud rates are: 250kbit, 500kbit, 1Mbit. Default setting: 1Mbit

Acceptance filters

There are two configurable acceptance filters. Default, one filter is configured to receive all CAN messages, the second filter is configured to reject all CAN messages. See the table below.
Since one filter is set to allow all CAN messages, by default every CAN message received on the bus will be let through to the X2Link RF interface by the RaceLink.

#	ID	Mask
1	0x000	0x000
2	0x000	0x7FF

There are three filters associated with the reception of CAN messages. Messages that pass one of the two acceptance filters are first received by the command interface. If the command interface does not process the message, i.e. the message is not intended for the RaceLink itself, the message is passed on to the queue to be transmitted over X2Link RF communication.

Acceptance filters calculation

A CAN message passes an acceptance filter if the result of a bitwise AND operation on the ID of the received CAN message and a mask of any of the acceptance filters results in the same value as the result of a bitwise AND on the associated ID of that mask.

For example:

#	ID	Mask
1	0x080	0x788
2	0x0CD	0x7FC

The outcome of a bitwise AND operation on acceptance filter 2:

Hex	Bin	Hex
0x0CD	000 1100 1101	
	AND	
0x07FC	111 1111 1100	
	=	
	000 1100 1100	0x0CC

If we receive a CAN message with ID 0x0CE and do a bitwise AND operation with the mask 0x7FC from acceptance filter 2 this results in:

Hex	Bin	Hex
0x0CE	000 1100 1110	
	AND	
0x07FC	111 1111 1100	
	=	
	000 1100 1100	0x0CC

The outcomes of both the bitwise AND operations match in this case and thus the message will be **accepted**.

CAN MESSAGES

In this chapter, for every message that is sent over the RaceLink CAN bus, a standard CAN ID is given. Please note that all CAN message identifiers can be changed to custom IDs to adapt to any CAN bus setup (in case of conflicting ID's).
Every output message can be individually enabled or disabled on the bus. This is done through the RaceLink settings. This configuration is stored in non-volatile memory and will not reset automatically.

Units and scaling

For every value the format, scaling and unit is given. Some values that have a resolution in decimals are scaled. For example, if the scaling factor is 10 the value has been multiplied by 10. If the scaling is 1E7 the value is multiplied by 10^7.

Format

All values are in little endian / "Intel" (i.e. the least significant byte first).
Value can be expressed as signed (INT) or unsigned (UINT) integer of varying length.

STATUS (default ID: 0x0E0)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0	RF_RSSI	INT8 / 1 / dBm	RF RSSI
1	SATS	UINT8 / 1 / -	GPS Satellites
2	VIN	UINT8 / 10 / volt	Input voltage
3	BATT	UINT8 / 1 / %	Battery level percentage
4	FLAGS	UINT8 / -	See status flags table①
5	AIM	UINT8 / 1 / meters	GPS accuracy in meters

Sent every 1000ms

①Status flags for Byte4:

- Bit 0: GPS lock
- Bit 1: RaceLink sees BaseLink(s). Doesn't mean it is activated and connected to server
- Bit 2: RTK fix
- Bit 3: RaceLink using the RTCM correction data for RTK
- Bit 4: Activated on server (usually by Race Control)

VERSION (default ID: 0x0E1)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0-3	ID	UINT32 / 1 / -	Device ID
4	FW	UINT8 / -	Firmware version minor
5	HW	UINT8 / -	Hardware version
6	FW	UINT8 / -	Firmware version major

Sent in reply to RTR.
Please note: Firmware version v2.5X and lower, Byte 4 is combined FW version, Byte 6 is always 0.

LOCATION (default ID: 0x0E2)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0-3	LATITUDE	INT32 / 1E7 / degrees	Latitude coordinate
4-7	LONGITUDE	INT32 / 1E7 / degrees	Longitude coordinate

Sent every 100ms, after the initial GPS lock.

LOCATION_EXT (default ID: 0x0E4)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0-1	SPEED	UINT16 / 1 / km/h	Speed in kph
2-3	HEADING	INT16 / 1 / degrees	Heading
4-7	ALTITUDE	INT32 / 1E2 / meters	Altitude

Sent every 100ms, following the LOCATION message.

TIME (default ID: 0x0E3)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0-5	TIME	UINT48 / 1 / seconds	UTC Time

Sent on the second, after initial GPS lock. UTC Time is in seconds since Epoch (1-1-1970).

GEO_TRIGGER (default ID: 0x0E5)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0	TRIGGER_ID	UINT8 / - / -	Trigger identifier
1	AIM	UINT8 / 1 / meters	GPS accuracy in meters
2-7	TIME	UINT48 / 1 / milliseconds	Passing time in millisec

Sent after Geotrigger passing event. Time is passing time UTC in milliseconds since Epoch (1-1-1970).

Examples

Location CAN message with Latitude=52,4585246 and Longitude=4,5900476

ID	DLEN	RTR	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7
0x0E2	8	False	0x1E	0x89	0x44	0x1F	0xBC	0x62	0xBC	0x02

Time message at September 20, 14:14:45 (UTC)

ID	DLEN	RTR	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7
0x0E3	6	False	0x55	0xAB	0xA3	0x5B	0x00	0x00	-	-

FLAG (default ID: 0x200)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0	FLAG	UINT8 / - / -	Flag code

Sent by RaceLink every 100ms with current marshalling flag code. Disabled by default. Enabling message 0x200 in the RaceLink settings (for use in external displays) will disable the built-in flagging LEDs in RaceLink Club.

FLAG_CONFIRM (default ID: 0x201) (incoming message)

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0	FLAG_CONF	UINT8 / - / -	Flag code confirmation

Received by RaceLink in response to FLAG to confirm code was received by external display or LED-bar. The acknowledgement of a third-party dash receiving the FLAG status message is relayed by the RaceLink to the X2Link server / Race Control to confirm and log that the correct flag has been displayed to the driver.

RESULT (default ID: 0x202)*

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0-1	DELTA_FRONT	b15-b14: COLOR① b13-b0: TIME UINT14 / 10 / sec	Gap in front
2-3	DELTA_REAR	b15-b14: COLOR① b13-b0: TIME UINT14 / 10 / sec	Gap behind
4	POSITION	UINT8 / 1 / -	Position (overall)
5-7	LAPTIME	b23-b22: COLOR① b21-b0: TIME UINT22 / 1E3 / sec	Laptime last lap

①Any time value that has a 2-bit "color" indication, the colors are indicated as follows:

0 = Yellow (grey) (delta: worse than previous / laptime: no improvement)
1 = White (delta: same as previous / laptime: better than previous)
2 = Green (orange) (delta: better than previous / laptime: personal best)
3 = Purple (red) (delta: not used / laptime: overall best)

RESULT_EXT (default ID: 0x206)*

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0-2	LAPS	b23-b12: current lap b11-b0: total laps	Lap number
3	*spare*		
4	POS_IN_CL	UINT8 / 1 / -	Position (in class)
5-7	LAPTIME_REF	b23-b22: TYPE② b21-b0: TIME UINT22 / 1E3 / sec	Laptime (reference lap)

②Depending on how the timing/scoring software is configured, this can be a reference lap, personal best lap, overall best lap etc.

0 = Reserved
1 = Reference lap
2 = Personal best lap
3 = Overall best lap

DELTA (default ID: 0x203)*

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0	FLAG	UINT8 / - / -	Flag code
1-2	DELTA_TIME	INT16 / 10 / sec	Delta

The DELTA message is designed to be used with a Virtual Safety Car flag. It informs the driver how much time is between his position and the virtual safety car. The use case is as follows:

- The Virtual Safety Car Flag is set by Race Control
- Software determines the delta time between a competitor and the virtual safety car reference lap, for example 5.7 seconds.
- The DELTA message is sent on the CAN bus with the following payload
  - BYTE 0: 10 (MYLAPS flag code for VSC)
  - BYTE 1-2: 57 (= 5.7 seconds)
- The software updates the delta every second until the virtual safety car ends.

Notes for third-party displays:

- The COUNTDOWN message can also be used together with the DELTA message
- Any other flag than specified in the DELTA message (received via ID 0x200) must clear DELTA

COUNTDOWN (default ID: 0x204)*

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0	FLAG	UINT8 / - / -	Flag code current
1-6	TIME	UINT48 / 1 / sec	Countdown end time
7	NEXT_FLAG	UINT8 / - / -	Flag code next flag

Countdown end time is UTC in seconds since Epoch (1-1-1970). The COUNTDOWN message is designed for a flag situation change announcement. For instance, announcing the ending of Full Course Yellow or Virtual Safety Car. The use case is as follows:

- The Full Course Yellow Flag is set by Race Control.
- On 27 November 2023 at 14:32:08 (UTC), Race Control decides to end FCY in 10 seconds.
- The COUNTDOWN message is sent to the CAN bus with the following payload:
  - Byte 0: 11 (MYLAPS flag code for FCY)
  - Byte 1-6: 1701095538 (= 27 November 2023 14:32:18) *note the 10 seconds added*
  - Byte 7: 1 (CLEAR)
- The flagging display can now show a “FCY Ending” message and countdown to the UTC end time received. The advantage of this situation is that any delays in message transmission will still allow all competitors to show a synchronized CLEAR flag at the same time.

COUNTDOWN_CONFIRM (default ID: 0x205) (incoming message)*

DATA RANGE	NAME	FORMAT / SCALING / UNIT	DESCRIPTION
0	FLAG	UINT8 / - / -	Flag code current
1-6	TIME	UINT48 / 1 / sec	Countdown end time
7	NEXT_FLAG	UINT8 / - / -	Flag code next flag

After reception of the COUNTDOWN message, the third-party display will echo the exact payload (default ID 0x205) back to RaceLink.

APPENDIX A: FLAG LIST

Applicable
The list below is updated and applicable to X2Link / RaceControl Manager version 2.8. Please note, again, any item marked with asterisk (*) has not yet been implemented in the current release.

Flag ID 0-32 subset FIA/FIM
Hex 0x00-0x20
Please note, flag IDs 0-32 in bold+blue are the standard flags as homologated by FIA/FIM per 2024. We advise any 3rd party dash integrating with X2Link to at least include this set into their display.

Flag ID 0-159 subset: MYLAPS standard
Hex 0x00-0x9F
Flag ID 0-159 are MYLAPS standard flag IDs, which are standardized and frozen in any X2Link installation around the world.
The IDs starting from 33 can be region, sport, class or organization specific. Here you might find alternative flags that serve the same purpose as FIA/FIM flags in ID 0-32.

As an example:
This also means that this list includes multiple variations of the blue flag. Depending on the possibilities of the specific display in such an instance, for the sake of simplicity, 3rd party dash integrators could opt to condensate this specific flag in multiple ways:

- Create a warning message (like LEDs or graphic message) for the Blue Flag, that could be triggered by either ID 6, 16, 36, 55, 56, 72, 73.
- Create a warning message (like LEDs or graphic message) for both Sector Blue Flag or Personal Blue Flag that are triggered by the respective IDs 6, 36, 56, 72 (normal) or 16, 55, 73 (personal).

Please note, in any case the display will still need to mirror *the original requested flag ID* in the response CAN message 0x201. It does not suffice to respond with ID 6 when ID 72 has been requested, this will cause the X2Link system to generate error messages to Race Control.

Flag ID 160-250 subset: custom user flags
Hex 0xA0-0xFA
Flag ID 160-250 are custom flags that any track, organization or series can use however they see fit. Any use of these IDs is out of MYLAPS' control, displaying of these flags needs to be discussed on an individual basis between series organizer and display supplier (or race team able to configure this).

Flag ID 251-255 subset: not used
Hex 0xFB-0xFF
Flag ID 251-255 cannot be used.

FLAG ID LIST

0	Unknown	-		**32**	Double yellow + slippery (FIM)		
1	Clear (no flag / turn off flag)		-	33*	Static yellow		-
2	Yellow			34*	Static yellow + attention border		
3	Double yellow			35*	Static green		-
4	White			36*	Static blue		-
5	Green			37*	Static white		-
6	Blue			38*	Flashing Oil / Slippery		
7	Red			39*	Oil / Slippery + attention border		
8	Oil / Slippery		-	40*	Static red		-
9	Safety car	SC	SC	41*	Static BLACK/BF without nr	BF	-
10	Virtual safety car	VSC	VSC	42*	Flashing BLACK/BF without nr	BF	
11	Full course yellow	FCY	FCY	43*	Static Behavior without nr		-
12	Code 60	60	60	44*	Flashing Behavior without nr		
13	Pit entry right			45*	Static Mechanical without nr		-
14	Pit entry left			46*	Flashing Mechanical without nr		
15	Pit entry closed			47*	Static Pit entry right		-
16	Blue (for blue with number)		999	48*	Static Pit entry left		-
17	Standing start	SS	SS	49*	Static Pit entry closed		-
18	Rolling start	RS	RS	50*	Alerts detection system active		
19	Mechanical		999	51*	Alerts detection system off	OFF	-
20	Behavior		999	52*	Flashing MX Medical		
21	Black	BF	999	53*	Static MX Medical		-
22	Checkered			54*	MX Medical (USA style)		
23	Next slow	NS	NS	55*	Flashing Blue with red X + nr		999
24	Slow zone	SZ	SZ	56*	Flashing Blue with red X		
25	Rain (FIM)			57*	Karting chevron up		-
26	Rain + slippery (FIM)			58*	Karting chevron down		-
27	Logo (example customer logo)	-	-	59*	Static FCY	FCY	-
28	MYLAPS logo		-	60*	Flashing FCY (Asia style)	FCY	
29	Error			61*	Flashing SC (Asia style)	SC	
30	MYLAPS Speedhive logo		-	62*	Slow zone orange + 60	SZ 60	SZ
31	Yellow + slippery (FIM)			63*	Slow zone orange + 80	SZ 80	SZ

64*	FCY start prepare		96*	Exit right	
65*	FCY start countdown	onboard only	97*	Exit left	
66*	FCY ending		98*	Red + Go to pit	
67*	SC in this lap		99*	Red + Go to grid	
68*	VSC ending		100*	Use run-off right	
69*	Code60 start prepare		101*	Use run-off left	
70*	Code60 ending		102*	Blue + red umbrella	
71*	Yellow/white combo		103*	No speed limit	-
72*	Flashing Blue with yellow \		104*	40km/h standard road sign	-
73*	Flashing Blue with yellow \ + nr	999	105*	60km/h standard road sign	-
74*	Flashing DQ (black/white X)		106*	80km/h standard road sign	-
75*	Flashing DQ (black/white X) + nr	999	107*	110km/h standard road sign	-
76*	Flashing Medical karting (white/green +)		108*	110km/h road sign + raindrops	
77*	FIA weigh bridge >>>	-	109*	Animal on track	
78*	FIA weigh bridge <<<	-	110*	Flashing yellow/white	
79*	FIA weigh bridge continue ^		111*	Static drive through	-
80*	Flashing Start Delayed		112*	Static stop and go	-
81*	Extra formation lap		113*	Static long lap	-
82*	Chequered red-white		114*	Go to pit (black)	-
83*	Chequered green-white		115	-	
84*	Raindrops animation (Formula 1)		116	-	
85*	Black + static white border	-	117	-	
86*	Black + flashing white border		118	-	
87*	Drive through + nr	999	119	-	
88*	Stop and go + nr	999	120	-	
89*	Long lap + nr	999	121	-	
90*	Noise / dB + nr	999	122	-	
91*	Noise / dB without nr		123	-	
92*	Yellow with black X (last lap)		124	-	
93*	Red with white X (safety vehicle)		125	-	
94*	Flashing move right		126	-	
95*	Flashing move left		127	-	

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