Driverless Specification 2026

Contents

Changelog

Rule	Version	Change
DS	1.0	Initial revision
DS 3.4	1.1	Added option for using more than one type of Race E-Key
DS 3.6	1.1	Require rotary switch if more than one type of Race E-Key is used

Abbreviations

AMI Autonomous Mission Indicator
AS Autonomous System
ASF Autonomous System Form
DL Data Logger
DV Driverless
EBS Emergency Brake System
FSD Formula Student Driverless
NMT Network Management Protocol (CANopen)
PDO Process Data Object (CANopen)
RES Remote Emergency System
SDO Service Data Object (CANopen)

About this document

This document is based on the “Formula Student Rules 2026” and is intended to specify additional rules, see chapter DS Applicable Rules, and to provide additional information regarding the Formula Student Driverless (FSD) disciplines that are held as part of a Formula Student event. If applicable this document or parts of it will be referenced in the respective Event Handbook.

DS Applicable Rules

DS 1 Autonomous Mode Disciplines Track Marking

DS 1.1 The markings of all dynamic disciplines will have the following characteristics:

- The track is marked with cones.
- The left borders of the track are marked with small blue cones.
- The right borders of the track are marked with small yellow cones.
- Exit and entry lanes are marked with small orange cones.
- Big orange cones will be placed before and after start, finish and timekeeping lines.
- If not defined otherwise in chapter D of the rules, the maximum distance between two cones in driving direction is 5 m. In corners, the distance between the cones is smaller for a better indication.
- The start, finish and timekeeping lines as well as keep out zones around the timekeeping equipment are marked with red, orange or pink paint.
- Additionally for Skidpad and Trackdrive, track limit lines on either side of the track and entry/exit lanes may be marked with yellow, green or white paint.
- There are no track limit lines for Acceleration and EBS-Test.
- Timekeeping equipment may be surrounded by additional cones outside of the track boundary.

DS 1.2 All lines are spray painted with the chalk-based marking paint “Technima - Tempo T.P.”[1] or similar.

DS 1.3 The cones used at the event are equal to the cones listed in Table 1.

[1] https://fsg.one/spraypaint

			
big orange cone	small orange cone	small yellow cone	small blue cone
two white stripes	single white stripe	single black stripe	single white stripe
WEMAS 307.610500.00.00	WEMAS 400.000013.00.00	WEMAS 400.000013.01.10	WEMAS 400.000043.00.00
285 mm × 285 mm × 505 mm	228 mm × 228 mm × 325 mm		
1.05 kg	0.45 kg		

Table 1: Cone specs

DS 1.4 There are the following limitations mainly resulting from track conditions and organizational/authorizational issues:

- The lines may not be perfectly and continuously drawn.
- There may be further markings, to those mentioned above, that are not part of the track
  (e.g. markings, including cone position markings, lines from other disciplines or different colored surface, etc.) on or close to the track which will not be removed by the officials.
- There may be (stacked) spare cones standing at the track side at distinguishable distance.
- There is time keeping equipment next to the track that could be recognized as cone.
- No special artificial landmarks are provided by officials. The team must not place additional landmarks on the track or inside the dynamic area.
- No map data is provided by the officials.

DS 1.5 Figure 2, Figure 3 and Figure 4 visualize the track layout descriptions given in D 5.1, D 4.2.5 and D 8.1.

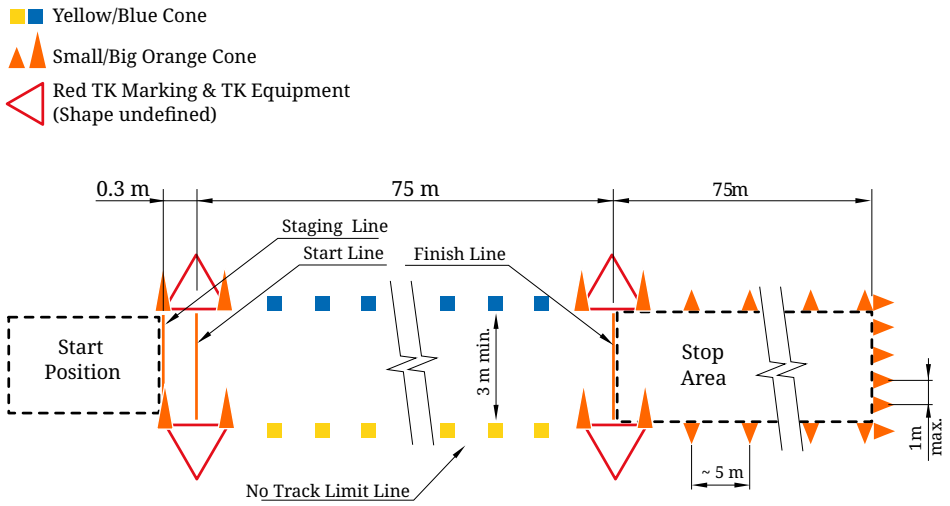

Figure 2: Acceleration according to D 5.1

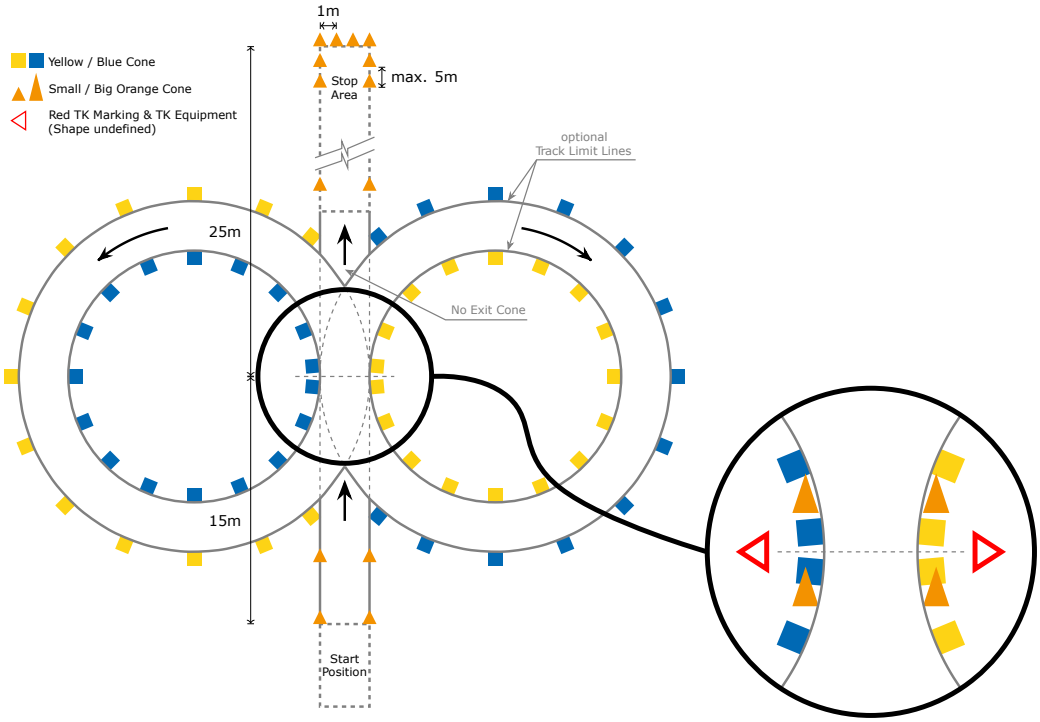

Figure 3: Skidpad according to D 4.2.5

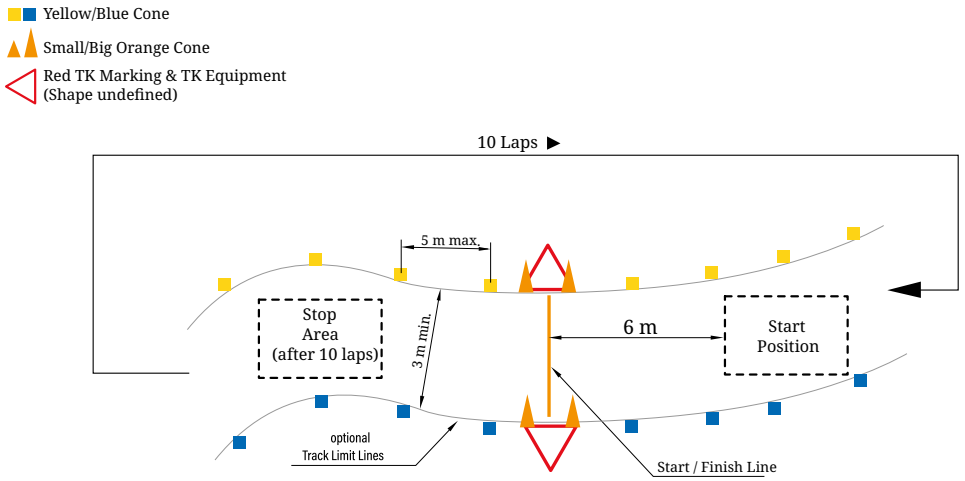

Figure 4: Trackdrive according to D 8.1

DS 2 Data Logger

DS 2.1 The communication described in Table 4 must be traceable in the logs.

DS 2.2 Beside RES messages, see Table 4, the messages defined in Table 2 must be provided to the Data Logger (DL) with a cycle time of 100 ms each. Steering angle δ and vehicle coordinate system is defined in Figure 5.

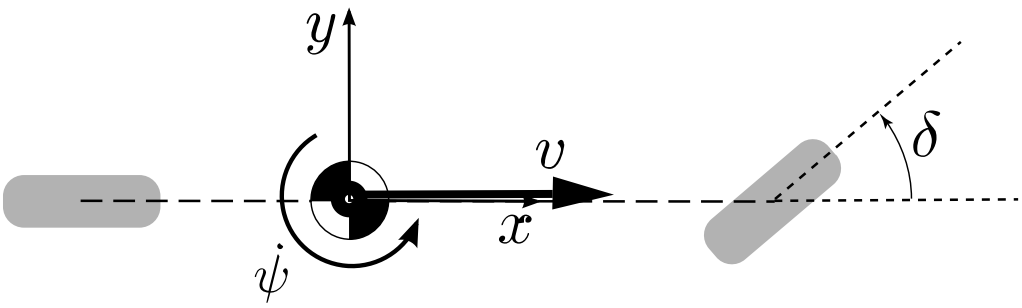

Figure 5: Bicycle model defining steering angle δ (drawn in positive direction after “ISO 8855” coordinate system $\rightarrow$ z up) and speed v.

CAN-ID	Name	Length	Format	Unit	Scale
0x500	DV driving dynamics 1	8B			
	Speed_actual	bit 0-7	unsigned	km/h	
	Speed_target	bit 8-15	unsigned	km/h	
	Steering_angle_actual	bit 16-23	signed	°	0.5
	Steering_angle_target	bit 24-31	signed	°	0.5
	Brake_hydr_actual	bit 32-39	unsigned	%	
	Brake_hydr_target	bit 40-47	unsigned	%	
	Motor_moment_actual	bit 48-55	signed	%	
	Motor_moment_target	bit 56-63	signed	%	
0x501	DV driving dynamics 2	6B			
	Acceleration longitudinal	bit 0-15	signed	m/s^2	$\frac{1}{512}$
	Acceleration lateral	bit 16-31	signed	m/s^2	$\frac{1}{512}$
	Yaw rate	bit 32-47	signed	°/s	$\frac{1}{128}$
0x502	DV system status	5B			
	AS_status_off	bit 0-2	1		
	AS_status_ready		2		
	AS_status_driving		3		
	AS_status_emergency		4		
	AS_status_finished		5		
	ASB_EBS_state_deactivated	bit 3-4	1		
	ASB_EBS_state_initial_checkup_passed		2		
	ASB_EBS_state_activated		3		
	AMI_state_acceleration	bit 5-7	1		
	AMI_state_skidpad		2		
	AMI_state_trackdrive		3		
	AMI_state_braketest		4		
	AMI_state_inspection		5		
	AMI_state_autocross		6		
	Steering_state	bit 8	bool		
	ASB_redundancy_state_deactivated	bit 9-10	1		
	ASB_redundancy_state_engaged		2		
	ASB_redundancy_state_initial_checkup_passed		3		
	Lap_counter	bit 11-14	unsigned		
	Cones_count_actual	bit 15-22	unsigned		
	Cones_count_all	bit 23-39	unsigned		

Table 2: Message definition of logged general DV data

The following definitions apply concerning actuator related status signals:

- **ASB_EBS_state_deactivated**: After vehicle startup and once brakes are released according to T 14.8.2.
- **ASB_EBS_state_initial_checkup_passed**: The initial checkup according to T 15.3 is passed after being in deactivated state. This state is active until deactivated or activated state is entered.
- **ASB_EBS_state_activated**: See T 14.8.1.
- **ASB_redundancy_state_deactivated**: See definition of ASB_EBS_state_deactivated.

- **ASB_redundancy_state_engaged**: The brake actuator is engaged, i.e. brake pressure is built up, after entering the state ASB_redundancy_state_initial_checkup_passed.
- **ASB_redundancy_state_initial_checkup_passed**: The initial checkup according to T 15.3 is passed after being in deactivated state. This state is active until deactivated or engaged state is entered.
- **Steering_state**:
  - 0 = Steering actuator is unavailable and will not actuate the steering system in any manner.
  - 1 = Steering actuator is available and responds to the commands from the AS.

DS 2.3 All signals are little-endian (Intel). Scale, if not defined, is 1.

DS 2.4 Messages 0x500 and 0x502 must be filled in any case. If some values are not directly available, they should be interpolated or calculated (i.e. target values). 0x501 depends on available sensor data.

DS 2.5 All signals mentioned in the team's ASF have to be provided within the up to five messages with CAN-IDs 0x511 to 0x515. Each message can be up to 8 B of data length. Cycle time is 100 ms.

DS 3 Remote Emergency System

DS 3.1 The RES according to T 14.3 that has to be used for the event is a GF2000i-codec/T53R98 combination from Gross-Funk GmbH[2].

DS 3.2 All RES must be of the latest 2022 hardware revision (with E-Key).

- SIL3 (EN61508) certified
- EMV certified
- communication in 430 MHz to 440 MHz band
- increased signal strength of 88 mW
- 12 V to 24 V supply voltage (0.26 A @ 12 V)
- 450 g, 173 × 113 × 35 mm
- IP20 (receiver) / IP65 (sender)

Figure 6: RES sender & receiver

DS 3.3 The Node-ID has to be set to 0x011 during the event. Only in severe cases, there will be an exception. Please give a detailed problem description with the request.

DS 3.4 For dynamic disciplines, the officials may hand-out one or more Race E-Keys that replace the team's Training E-Key for the time of the run (switching the RES to a different set of frequencies within the range listed in DS 3.2). They must be returned to the officials immediately after the run has been finished.

DS 3.5 If only the Race 1 E-Key is used the input "Race 1" has to be set to high (by bridging the input with supply "+Ub") in order to enable the Race 1 E-Key frequencies at the receiver. That needs to be done upon receival of the E-Key with a flip switch in proximity to the AMI, see T 14.10. Race mode position has to be marked with an "R".

DS 3.6 If all 3 Race E-Keys are used, one of the inputs "Race 1", "Race 2" or "Race 3" has to be set to high (by bridging the input with supply "+Ub") in order to enable the

[2] https://fsg.one/res

respective Race E-Key frequencies at the receiver. That needs to be done upon receival of the E-Key with a single, multi-position switch (i.e. rotary) in proximity to the AMI, see T 14.10. The switch has to be marked with an “R” and race mode positions have to be marked the numbers 0 (Training E-Key mode, no input set to high), 1, 2, 3 which may be part of the switch itself.

DS 3.7 Correct mode selection can be traced via the input’s LED as well as in PDO 2007, bit 7.

Additional Information

Cone Purchasing

The manufacturer WEMAS[3] does not sell the cones to end customers, but they may be purchased from baustellenabsicherung24.de[4].

RES Purchasing

Please contact Mr. Keller (christian.keller@grossfunk.de) at Gross-Funk for purchasing.

RES Technical Information

Main Technical Characteristics

Main technical characteristics of the latest 2022 hardware revision:

- SIL3 (EN61508) certified
- EMV certified
- communication in 430 MHz to 440 MHz band
- increased signal strength of 88 mW
- 12 V to 24 V supply voltage (0.26 A @ 12 V)
- 450 g, 173 mm × 113 mm × 35 mm
- IP20 (receiver) / IP65 (sender)

Relay Outputs

The receiver includes a normally-open (NO) relay which must be part of shutdown circuit. It opens on switching shutdown, on signal loss, and on power loss. Maximum current rating is 4 A.

[3] https://www.wemas.de
[4] https://fsg.one/cones

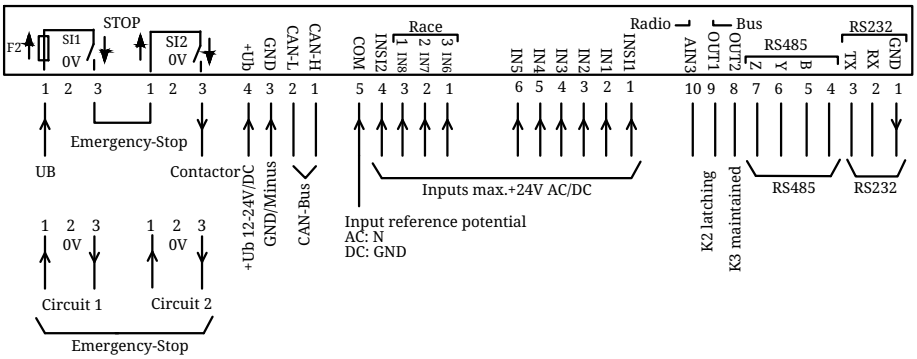

Figure 7: Connections at the RES receiver

Either K2 or K3 are allowed to be used to signalize the Go-signal for switching from “Ready” to “Driving” state, see T 14.8, Figure 15. Both the CAN message or the digital outs can be used.

CANopen Interface

The CANopen interface of the receiver has the following properties:

- 1 000 $\frac{kb}{s}$, 125 $\frac{kb}{s}$, 250 $\frac{kb}{s}$, 500 $\frac{kb}{s}$ in standard configuration.
- Cyclic PDOs containing states of switches (Go-signal) and radio
- Warns if signal loss detected (200 ms in advance to shutdown, contained in cyclic PDO)

The Node-ID and baud rate settings of the vehicle-side installed receiver can be configured with the external DIP switch:

DIP SW	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Baud Rate**
Note-ID	+1	+2	+4	+8	+16	+32	0	0	1 $\frac{Mb}{s}$
Bit	0	1	2	3	4	5	1	0	125 $\frac{Mb}{s}$
							0	1	250 $\frac{Mb}{s}$
							1	1	500 $\frac{Mb}{s}$
	Node-ID						Baud Rate		

Table 3: DIP switch configuration RES.

The receiver is booted up and sends a message to signalize its initialization (NMT message with CAN-ID 0x700 + Node-ID and a single data byte 0x00). A CAN/CANopen master device must set the receiver to operational mode (NMT message CAN-ID = 0x000, byte 0 = 0x01 (requested state), byte 1 = addressed Node-ID or 0x00 for all). After setting to operational mode, the receiver starts sending a status message of 8 bytes containing PDOs 2000 - 2007 (one byte each, CAN-ID = 0x180 + Node-ID) every 30 ms.

Manually resetting the RES before sending the operational mode message may be used to check if the device is online (NMT message CAN-ID = 0x000, byte 1 = 0x80 (requested state), byte 2 = addressed Node-ID). This will be answered with the boot-up message.

Beside the CAN-IDs mentioned above, be aware not to use the CANopen-related IDs listed in Table 4 on the bus[5].

[5] https://fsg.one/canopen-poster

Communication object	CAN-ID	Slave nodes
NMT node control	0x000	Receive only
Sync	0x080 + Node-ID	Transmit
TimeStamp	0x100	Receive only
PDO	0x180 + Node-ID	1. Transmit PDO
	0x200 + Node-ID	1. Receive PDO
SDO	0x580 + Node-ID	Transmit
	0x600 + Node-ID	Receive
NMT node monitoring	0x700 + Node-ID	Transmit
LSS	0x7E4	Transmit
	0x7E5	Receive

Table 4: Reserved message IDs for RES.

The status of the switch (K2) and the button (K3) at the sender is contained in the PDO 2000 (bit 1 and 2) as well as on the digital outputs, see Figure 7. The E-Stop is signalized by PDO 2000 bit 0 and PDO 2003 bit 7. PDO 2006 contains the radio quality (0 % to 100 %) whereas PDO 2007 summarizes several radio states, i.e. the pre-alarm radio communication interruption (bit 6, 200 ms in advance to shutdown).