



Green indication

in the Speed Info Area of the ETCS-DMI

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Abstract

Managing train traffic in congested areas of the network is a major challenge nowadays. However, only a very few Driver Advisory System (DAS) in connection with the trackside Train Management System (TSM) are in the market today.

As the European Train Control System (ETCS) spreads rapidly, a huge opportunity is offered to develop a standard and comprehensive DAS using the main driver display ETCS-DMI.

This paper focuses on the “Speed Info” area which is the key part of the ETCS Driver Machine Interface (DMI). After presenting the ETCS standard colours and their meaning, the paper proposes to use the green colour for DAS information even if this colour is nowadays considered by ETCS as a National Train Control (NTC) Colour. Then the paper describes some alternative ways of displaying the green colour or shades of green on the Circular Speed Gauge (CSG).

Some options are also presented to complete the Speed Advice by a Speed Guidance, which is considered to be the best way to minimise both delays and energy consumption.

Keywords

DAS, CGTO, Speed Guidance, TSR, ETCS-DMI

1. Introduction

Managing train traffic in congested areas of the network is a major challenge nowadays. Onboard Driver Advisory System (DAS) helps drivers to optimise their behaviour. A lot of DAS are in the market, but only a few of them are in connection with the trackside Train Management System (TMS). Such Centrally Guided Train Operation Systems (CGTO) can help to optimally smooth train dynamic speed profiles. The expected advantages are: reduction of delay knock-ons, as well as significant reduction of both the energy consumption and the wear and tear and, also, positive impacts on the comfort for passengers. As the European Train Control System (ETCS) spreads rapidly, a huge opportunity is offered to develop a standard and comprehensive CGTO.

This paper focuses on the “Speed Info” area which is the key part of the ETCS Driver Machine Interface (DMI).

The chapter 2 presents the ETCS standard colours and sounds, their meaning, as well as the reasons for the choice of the green colour for DAS information, even if this colour is nowadays considered by ETCS as a National Train Control Colour (NTC).

The chapter 3 describes some alternative ways of displaying the green colour or shades of green on the Circular Speed Gauge (CSG).

Finally, the chapter 4 brings some conclusions and future perspectives.

2. ETCS-DMI Colours and sounds philosophy

No less than 12 colours are defined and compulsory related to the ETCS Driver Machine Interface [ERA (2015)].

Focusing only on the “Speed Info” rectangle area¹, which is the central part of the DMI, information concerning the actual speed of the train and the speed limits to be respected uses a colour strategy based mainly on the current status of the speed of the train (table 1)

Table 1 Conditions for display and colour of the speed pointer and CSG in FS mode when V_{release} does not exist

Supervision status	$0 \leq \text{pointer} < V_{\text{perm}}$	$0 \leq \text{pointer} < V_{\text{target}}$	$V_{\text{target}} \leq \text{pointer} \leq V_{\text{perm}}$	$\text{pointer} > V_{\text{perm}}$
CSM - NoS	Grey	---	---	---
CSM - OvS/WaS	---	---	---	Orange
CSM - IntS	Grey	---	---	Red
TSM - IndS	---	Grey	Yellow	---
TSM – OvS/WaS	---	---	---	Orange
TSM - IntS	---	Grey	Yellow	Red

Supervision status	$0 \leq \text{CSG} < V_{\text{perm}}$	$0 \leq \text{CSG} < V_{\text{target}}$	$V_{\text{target}} \leq \text{CSG} \leq V_{\text{perm}}$	$\text{pointer} > V_{\text{perm}}$
CSM - NoS	Dark Grey	---	---	---
CSM - OvS/WaS	Dark Grey	---	---	Orange
CSM - IntS	Dark Grey	---	---	Red
TSM - IndS	---	Grey	Yellow	---
TSM – OvS/WaS	---	Grey	Yellow	Orange
TSM - IntS	---	Grey	Yellow	Red

Source: [1] (ERA, ETCS Driver. Machine Interface, ERA_ERTMS_015560, V.3.5.0, December 2015)

¹ B-Area of ETCS-DMI Onboard Command and Control Display

The four supervision statuses are:

The normal status (NoS). The significant colour is grey. It is in use when the driver has no need to reduce the speed of the train for safety reasons. It is the ideal case for the intervention of the CGTO. In fact, speed advice or speed guidance² for energy savings or more fluid traffic doesn't interact with a supervision status asking the driver to focus its attention on speed reduction for safety reasons.

The indication status (IndS). The significant colour is yellow. Today, it is in use when the driver should reduce the speed of the train for safety reasons. The standardized S_info sound is played as soon as the train enters IndS. Human aspects must be particularly considered as additional speed advice or guidance that can confuse the driver must be avoided.

The warning status (WaS). The significant colour is orange. It is in use when the speed of the train is above the permitted speed. The standardized S1_overspeed sound is played as soon as the train enters WaS. If the overspeeding exceeds a given threshold, the standardized S2_toofast sound is played. More than ever, human aspects must be particularly considered as additional speed advice or guidance must absolutely not distract the driver from being awarded of the need to reduce the speed of the train.

The intervention status (IntS). The significant colour is red. It is in use when the system brakes the train by itself. Either the system service braking is sufficient to keep the train in safe condition and the ETCS mode doesn't change and the status returns to WaS, or the system finally applies an emergency braking and the ETCS mode turns into TRIP. In the last case, any speed advice, guidance or order must immediately disappear from the ETCS-DMI.

² See the glossary, abbreviations, acronyms and references section below

3. Displaying some green in the Speed Info Area

The green colour is used to symbolize a lot of topics. A lot of expressions have entered the common language like “Green economy”, “Green Energy” or “Green Building”.

In the railway domain, **green driving techniques** are taught to drivers for some decades. Taking benefit from the time allowance. i.e. the difference between the minimum running time and the one used to build the timetable, the driver is invited to drive the train economically, namely by coasting at appropriate places.

Whenever the DAS are connected with the TMS, a **green wave policy** can be adopted to better manage the congestion. In fact, the TMS has a global knowledge of actual timetables of all trains that can potentially conflict. It therefore can provide speed instructions to each of them, to minimise for instance the total sum of individual delays.

Table 2 Definition of ETCS-DMI colours [1]

















Colour name		RGB	Colour name		RGB
Yellow		223/223/0	PASP light		41/74/107
Orange		234/145/0	White		255/255/255
Red		191/0/2	Grey		195/195/195
Dark Blue		3/17/34	Medium Grey		150/150/150
Shadow		8/24/57	Dark Grey		85/85/85
PASP dark		33/49/74	Black		0/0/0





Table 3 Definition of the ETCS NTC additional colours [1]

Colour name		RGB	Colour name		RGB
Blue		0/0/234	Light Red		255/96/96
Green		0/234/0	Light Green		96/255/96

As seen above, there is no reason to choose a colour another than green. By chance, the green isn't used on the by ETCS-DMI (cf. table 2). At this time “green” and “light green” are “national train control” (NTC) colours (cf. table 3). Reserving green shades for ETCS-DMI DAS purposes are acceptable as “blue” (cf. table 3) and/or “NExTEO blue” (cf. table 4) are very suitable for NTC on the ETCS-DMI.

For Swiss railways, Magenta is the standard colour to indicate system failure.

Table 4 Definition of the ETCS-DMI national non-standard colours for research purposes

Colour name	RGB	Reference
Very Light Grey	 215/215/215	SBB (2006)
Dark Yellow	 105/105/0	SBB (2006)
Magenta	 255/0/255	SBB (2006)
NExTEO Blue	 63/173/255	SNCF (2015)

3.1 A1: Advice without guidance

This option is the simplest one. The result of the calculation by the DAS of the optimal speed V_{opt} is shown on the CSG and accompanied by the S_info sound. The driver receives no guidance on how to reach economically V_{opt} (by coasting only?, by use of regenerative brakes?, by use of energy dissipating brakes?). If the DAS considers that V_{opt} will be not reached in time, it calculates and displays a new V_{opt} , which is lower than the previous one, and the S_info is repeated.

This option uses only the green colour. The display is fixed in the CSG. As soon as NoS is quitted, the advice disappears.

3.2 A2: Advice repeated without guidance

The result of the calculation by the DAS of the optimal speed V_{opt} is drawn on the CSG and accompanied by the S_info sound. The driver receives no guidance how to reach V_{opt} but coasting/and use of regenerative brakes should be sufficient to reach V_{opt} . If the deceleration is not sufficient, then the green colour turns to light green, indicating to the driver that the braking should be increased to reach rapidly V_{opt} . If the DAS considers that V_{opt} will be not reached in time, it calculates and displays a new V_{opt} , which is lower than the previous one, and the S_info is repeated.

This option uses the green and the light green colour. The display is fixed in the CSG. As soon as NoS is quitted, the advice disappears.

3.3 G3: Guidance

The result of the calculation by the DAS of the optimal speed V_{opt} is drawn on the CSG and accompanied by the S_info sound. At the same time, the DAS also calculates and displays a guidance speed curve on the CSG. This curve is to be followed by the driver to optimally reach V_{opt} . The guidance curve is based on coasting and regenerative braking opportunities. If the deceleration is not sufficient, new calculations and displays are made for a lower V_{opt} .

This option uses the green and the light green colour. The display is variable in the CSG. As soon as NoS is quitted, guidance and advice disappear.

3.4 O4: Order without green guidance

The result of the calculation by the DAS of the optimal speed V_{opt} is shown on the CSG and accompanied by the S_info sound. This V_{opt} is assimilated to an Operational Temporary Speed Restriction (OTSR) that must be obeyed. At the same time, the DAS also calculates a guidance curve to optimally reach V_{opt} . This curve is not shown to the driver. The guidance curve is based on coasting and regenerative braking opportunities. If the deceleration is not sufficient, the Indication status (IndS) is entered, accompanied of course by the S_info sound.

This option uses the green colour. The display is fixed in the CSG.

3.5 O5: Order with green guidance

The result of the calculation by the DAS of the optimal speed V_{opt} is shown on the CSG and accompanied by the S_info sound. This V_{opt} is assimilated to an Operational Temporary Speed Restriction (OTSR) that must be obeyed. At the same time, the DAS also calculates and displays on the CSG a guidance speed curve that has to be followed by the driver to optimally reach V_{opt} . The guidance curve is based on coasting and regenerative braking opportunities. If the deceleration is not sufficient, the Indication status (IndS) is entered, accompanied of course by the S_info sound.

This option uses the green and the light green colour. The display is fixed in the CSG.

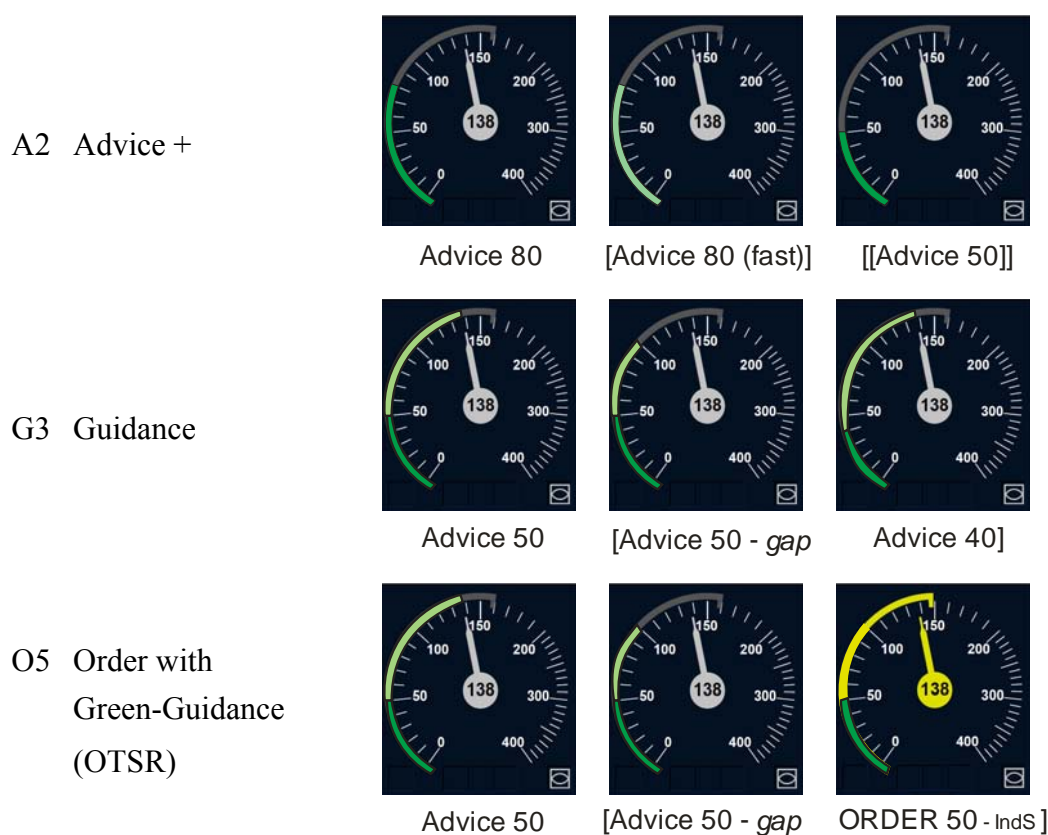
3.6 Synoptic view of the options

Table 5 Main characteristics of the options

Code and name	Com-pulsory	Green shade(s)	Remark
A1 Advice without guidance	No	1	
A2 Advice +	No	2	Only one green shade at the same time
G3 Guidance	No	2	
O4 Order without green guidance	Yes	1	
O5 Order with green guidance	Yes	2	

The sound S_info is played for each new advice/order or change of it, whatever the option is. A proposal is not to play the sound S_info when the advice should be followed urgently (cf. options A2 or G3+). According to the standard ERTMS rules, the sound S_info is played when the train enters the IndS.

Figure 1 Typical Speed Info Display according to promising options
 [...]: change of the advice if the driver does not react correctly



4. Conclusions

The Circular Speed Gauge of the ETCS-DMI is the appropriate place for giving DAS information as well as speed orders.

Using the green colour seems particularly appropriate for two reasons at least: Green is the world well-known ecological colour and one of the main purposes of DAS is to reduce energy consumption; moreover, green is not used in the ETCS-DMI for other purposes for now. Two shades of green when the train runs with the normal status and only one with another status seem to be the right level for speed information for the driver.

The display of a “green guidance” curve to reach the optimal speed seems to be very valuable to drive the train economically and comfortably for the passengers, even in congested areas.

If the driver is allowed to ignore the DAS, then the Option G3 is adequate. If the driver must obey the DAS, then the Option O5 is relevant.

The Planning Area Speed Profile, directly to the right of the Speed Area, has to be coloured in harmony with the colouring of the Circular Speed Gauge proposed.

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Glossary, abbreviations, acronyms and references

Centrally Guided Train Operation Systems: Driver Advice Systems (DAS) receiving Speed Advice continuously or semi-continuously from the track-side Traffic Management System (TMS).

Operational Temporary Speed Restrictions: Speed Restrictions varying rapidly in space and time. They are not given for safety reasons but mainly for more fluid traffic.

Speed Advice: Discrete speed indication given in advance to the driver. The driver can decide freely how to comply with the advice. No system intervention is foreseen if the driver ignores the advice.

Speed Guidance: Speed indications given in advance to the driver. The guidance can be continuous or semi-continuous (target speed and tactic to reach it). No system intervention is foreseen if the driver ignores the guidance.

Speed Order: Speed indications given in advance to the driver. The order shall be obeyed by the driver. If not, a system intervention brakes the train.

CGTO: Centrally Guided Train Operation System	IndS: Indication Status (ETCS status)
CSG: Circular Speed Gauge	IntS: Intervention Status (ETCS status)
CSM: Ceiling Speed Monitoring	OvS : Overspeed Status (ETCS status)
DAS: Driver Advisory System	NoS: Normal Status (ETCS status)
DMI: Driver Machine Interface	NTC: National Train Control
ERA: European Railway Agency	TMS: Train Management System
ETCS: European Train Control System	TRIP: ETCS mode (as soon as an emergency braking occurs)
FS: Full Supervision (ETCS mode)	WaS: Warning Status (ETCS status)

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