
**Tractors and machinery for agriculture and
forestry — Serial control and
communications data network —**

**Part 9:
Tractor ECU**

*Tracteurs et matériels agricoles et forestiers — Réseaux de commande et
de communication de données en série —*

Partie 9: Unité de commande électronique du tracteur



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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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Contents

Page

Foreword.....	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Description and specifications	2
3.1 Nodes	2
3.2 Functions and parameter repackaging	2
3.3 Identity association	3
3.4 Classification and minimum supported message sets	3
3.5 Control of lighting.....	6
3.6 Control of ECU_PWR and PWR.....	8
3.7 Safe-mode operation	9
Bibliography	11

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 11783-9 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

ISO 11783 consists of the following parts, under the general title *Tractors and machinery for agriculture and forestry — Serial control and communications data network*:

- *Part 1: General standard for mobile data communication*
- *Part 2: Physical layer*
- *Part 3: Data link layer*
- *Part 4: Network layer*
- *Part 5: Network management*
- *Part 6: Virtual terminal*
- *Part 7: Implement messages application layer*
- *Part 8: Power train messages*
- *Part 9: Tractor ECU*
- *Part 10: Task controller and management information system data interchange*
- *Part 11: Data dictionary*

Introduction

Parts 1 to 11 of ISO 11783 specify a communications system for agricultural equipment based on the CAN 2.0 B [1] protocol. SAE J 1939 [2] documents, on which parts of ISO 11783 are based, were developed jointly for use in truck and bus applications and for construction and agriculture applications. Joint documents were completed to allow electronic units that meet the truck and bus SAE J 1939 specifications to be used by agricultural and forestry equipment with minimal changes. General information on ISO 11783 is to be found in ISO 11783-1.

The purpose of ISO 11783 is to provide an open, interconnected system for on-board electronic systems. It is intended to enable electronic control units (ECUs) to communicate with each other, providing a standardized system.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this part of ISO 11783 may involve the use of a patent concerning the controller area network (CAN) protocol referred to throughout the document.

ISO takes no position concerning the evidence, validity and scope of this patent.

The holder of this patent has assured ISO that he is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO. Information may be obtained from:

Robert Bosch GmbH
Wernerstrasse 51
Postfach 30 02 20
D-70442 Stuttgart-Feuerbach
Germany

Attention is drawn to the possibility that some of the elements of this part of ISO 11783 may be the subject of patent rights other than those identified above. ISO shall not be held responsible for identifying any or all such patent rights.

Tractors and machinery for agriculture and forestry — Serial control and communications data network —

Part 9: Tractor ECU

1 Scope

This part of ISO 11783 specifies a serial data network for control and communications on forestry or agricultural tractors and mounted, semi-mounted, towed or self-propelled implements. Its purpose is to standardize the method and format of transfer of data between sensor, actuators, control elements, and information-storage and -display units, whether mounted on, or part of, the tractor or implement. This part of ISO 11783 describes the tractor ECU, the electronic control unit that provides the gateway between the network's tractor and implement buses, as well as performing other functions.

NOTE The tractor ECU is also the node that represents the tractor, or analogous functions within self-propelled machines, for functions such as the virtual terminal on the implement bus.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 11783. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 11783 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 11783-1:—¹⁾, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 1: General standard for mobile data communication*

ISO 11783-2, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 2: Physical layer*

ISO 11783-4:2001, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 4: Network layer*

ISO 11783-5, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 5: Network management*

ISO 11783-7:—¹⁾, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 7: Implement messages application layer*

ISO 11783-8:—¹⁾, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 8: Power train messages*

ISO 11786, *Agricultural tractors and machinery — Tractor-mounted sensor interface — Specifications*

1) To be published.

3 Description and specifications

3.1 Nodes

3.1.1 General

On a system with an ISO 11783 network, the tractor ECU functions as the gateway (see ISO 11783-4) between the tractor and implement buses.

The tractor ECU shall have at least one node for connection to the implement bus. However, when the tractor has both an implement and a tractor bus, the tractor ECU shall have at least two nodes — the tractor ECU implement bus node and the tractor ECU tractor bus node.

3.1.2 Node referencing

For communication network references to either of a tractor ECU's nodes:

- port/node 1 shall be used as the implement bus node;
- port/node 2 shall be used as the tractor bus node, where a tractor bus is installed.

See ISO 11783-4:2001, Figure 1.

3.1.3 Node physical layer

The implement bus node of the tractor ECU shall be designed so that it can connect to the physical layer specified in ISO 11783-2. The tractor bus node may connect to another physical layer, but the ISO 11783 physical layer is recommended.

NOTE Throughout this part of ISO 11783, it is assumed that both nodes have been designed for the ISO 11783 physical layer.

3.2 Functions and parameter repackaging

3.2.1 General

As the ECU (electronic control unit) representing the tractor and its messages on the implement bus, the tractor ECU is responsible for the communications between the tractor and the other ECUs on that bus; to this end, it must appear to the system to be the same as any other ECU on the implement bus. Particularly important is that the tractor's access to the virtual terminal (VT) be identical to that of any other implement. The tractor ECU is also responsible, as part of its network interconnection functions, for converting, to and from any implement bus, process data and tractor bus messages with appropriate parameters, in order that the tractor can operate on a process data message in a classification-appropriate manner.

3.2.2 Messages from tractor bus to implement bus

The tractor ECU shall collect from the tractor bus, or directly wired sensors such as those specified in ISO 11786, all information contained within the messages identified by a particular classification. It shall then redirect these messages on the implement bus using its own specific source address (SA), while establishing specific destinations for specific messages. When the tractor ECU places requested information on the implement bus, it should use the global destination in order to reduce bandwidth in cases where there are multiple requests for the same information (and also reduce filter database requirements in the tractor ECU).

3.2.3 Messages from implement bus to tractor bus

The tractor ECU shall receive from the implement bus all messages designed to control tractor functions, including process data, as appropriate for the classification.

The tractor ECU shall then parse these messages in a manner appropriate to the tractor design.

It shall then redirect them, globally or to the specific controlling destinations, on the tractor bus and using its own specific SA.

3.2.4 Messages from tractor ECU to implement bus

The tractor ECU may originate destination-specific messages on the implement bus representing the tractor as any other implement ECU.

EXAMPLE Placing a tractor performance screen on the VT.

3.3 Identity association

Tractors shall have the same access to implement bus services (e.g. VT, task controllers, management computer gateway) as that possessed by the implements. To avoid these services requiring two different network drivers, one for implements and another for tractors, the grouping as members of the tractor set of the ECUs on the tractor bus shall be structured by the tractor ECU analogous to the grouping of the ECUs by an implement controller or a working set master.

3.4 Classification and minimum supported message sets

3.4.1 General

For the identification of a tractor on the implement bus by tractor ECU NAME, see ISO 11783-1; for NAME fields, see ISO 11783-5.

3.4.2 Tractor–implement interface classifications

3.4.2.1 General

A tractor class defines a minimum set of messages a tractor ECU is able to provide on the implement bus to connected implements. There are three main tractor–implement interface classes for a tractor with an ISO 11783 bus system. To enable it to use a specific numbered classification, the tractor ECU shall acknowledge all the messages in each of the three classes of interface given in 3.4.2.2 to 3.4.2.4. A tractor may maintain a classification when a required feature is physically missing from the tractor (i.e. if a rear hitch or PTO is not installed); the tractor ECU shall respond with message parameters set to “not available” for those parameters associated with the missing features. If the data or controls required to produce the messages are missing when the feature is installed, the tractor shall be classified at the classification of the provided messages and not that of the installed features.

In addition, lettered addenda addressing groupings of messages related to features may be used in conjunction with any of the numbered classifications. These shall be appended as follows:

- class xN tractor;
- class xF tractor;

where x is the class number, and N and F represent navigational and front-mounted implement messages, respectively (see 3.4.2.5 and 3.4.2.6).

The tractor manufacturer may provide additional messages without providing the complete set of messages of the next highest class of tractor ECU. Connected implement ECUs can query the tractor ECU to determine the classification and the functions provided, using a tractor facilities message (see ISO 11783-7).

3.4.2.2 Tractor–implement interface — Class 1

A tractor with a class 1 tractor–implement interface has a simple network-supporting ECU that provides the basic tractor internal measurements given in ISO 11786. By allowing the connection of existing sensors to a simple network-connected ECU, use of this class of interface enables tractor manufacturers to become quickly ISO-conformant. However, it should not be used for new tractor designs.

The minimum set of information shall include power management and lighting.

The tractor with this ECU supports the following parameters, which are specified in ISO 11783-7, except for engine speed, specified in ISO 11783-8.

- a) Power management:
 - key switch state;
 - maximum time of tractor power;
 - maintain power request.
- b) Speed information:
 - wheel-based implement speed;
 - ground-based implement speed;
 - engine speed: message transmission rate shall be 100 ms.
- c) Hitch Information:
 - rear hitch position;
 - rear implement in-work indication.
- d) PTO (power take-off) information:
 - rear PTO output shaft speed;
 - rear PTO output shaft engagement.
- e) Lighting:
 - left-turn signal lights;
 - right-turn signal lights;
 - marker light;
 - left stop light;
 - right stop light;
 - implement rear work light.
- f) Language-specific parameter storage in tractor ECU, VT or both.

3.4.2.3 Tractor–implement interface — Class 2

The class 2 tractor–implement interface provides the total set of tractor measurement functions. The main enhancements of class 2 are

- ground and wheel based distance and direction,
- rear draft information,
- complete lighting messages, and
- auxiliary valve status.

This allows a more sophisticated implement control and security strategy.

The tractor with this ECU supports class 1 messages and the following parameters, specified in ISO 11783-7.

- a) Time and date.
- b) Speed and distance:
 - ground-based distance;
 - ground-based direction;
 - wheel-based distance;
 - wheel-based direction.
- c) Additional hitch parameter: rear draft.
- d) Full implement (non-tractor) lighting message set.
- e) Estimated or measured auxiliary valve status.

3.4.2.4 Tractor–implement interface — Class 3

Class 3 covers tractor ECUs that accept commands from an implement bus. The basic commands for rear-hitch, PTO and auxiliary valve control must be processed, and this provides the possibility for the implement to control the desired power source as well as the desired hitch position. Tractors may negative-acknowledge these commands.

The tractor with this ECU supports class 2 messages and the following commands, specified in ISO 11783-7.

- a) Hitch command: rear hitch position.
- b) PTO commands:
 - rear PTO output shaft speed set point;
 - rear PTO output engagement.
- c) Auxiliary valves command.

3.4.2.5 Navigational message support

The set of navigational messages defined in ISO 11783-7 is provided by the installation of a GPS (global positioning system) or DGPS (differential global positioning system) receiver on the tractor. A special classification, "N", shall be appended to the class number when the tractor is able to provide navigational information on the implement bus.

For example, a class 3 tractor–implement interface (see 3.4.2.4) also able to support navigational messages shall be classified class 3N, and support the following parameters (see ISO 11783-7):

- navigational system high output position;
- navigational system position data;
- navigational pseudorange noise statistics.

3.4.2.6 Front-mounted implement support

This set of messages, defined in ISO 11783-7, is provided by the installation of a front-mounted hitch and PTO on the tractor. A special classification, "F", shall be appended to the class number when the tractor is able to provide front-mounted information on the implement bus.

For example, a class 2 tractor–implement interface (see 3.4.2.3) also able to support front-mounted implement messages shall be classified class 2F. The following parameters shall be used for the corresponding classifications of the rear hitch (see ISO 11783-7):

- front hitch position;
- front implement in-work indication;
- front PTO output shaft speed;
- front PTO output shaft engagement;
- front draft;
- front hitch position command;
- front PTO output shaft speed command;
- front PTO output engagement command.

3.4.3 Implement commanded tractor — Control option

The tractor may provide additional control modes, aimed at either maximizing or improving the consistency of delivered speed, torque, flow, pressure, force or other controlled variables, using the appropriate commands defined in ISO 11783-7. The availability of any given control mode will vary with tractor design, and may be determined with the tractor using a tractor facilities message (see ISO 11783-7).

The tractor shall determine the constraints of each control mode and acknowledge the commands only as appropriate.

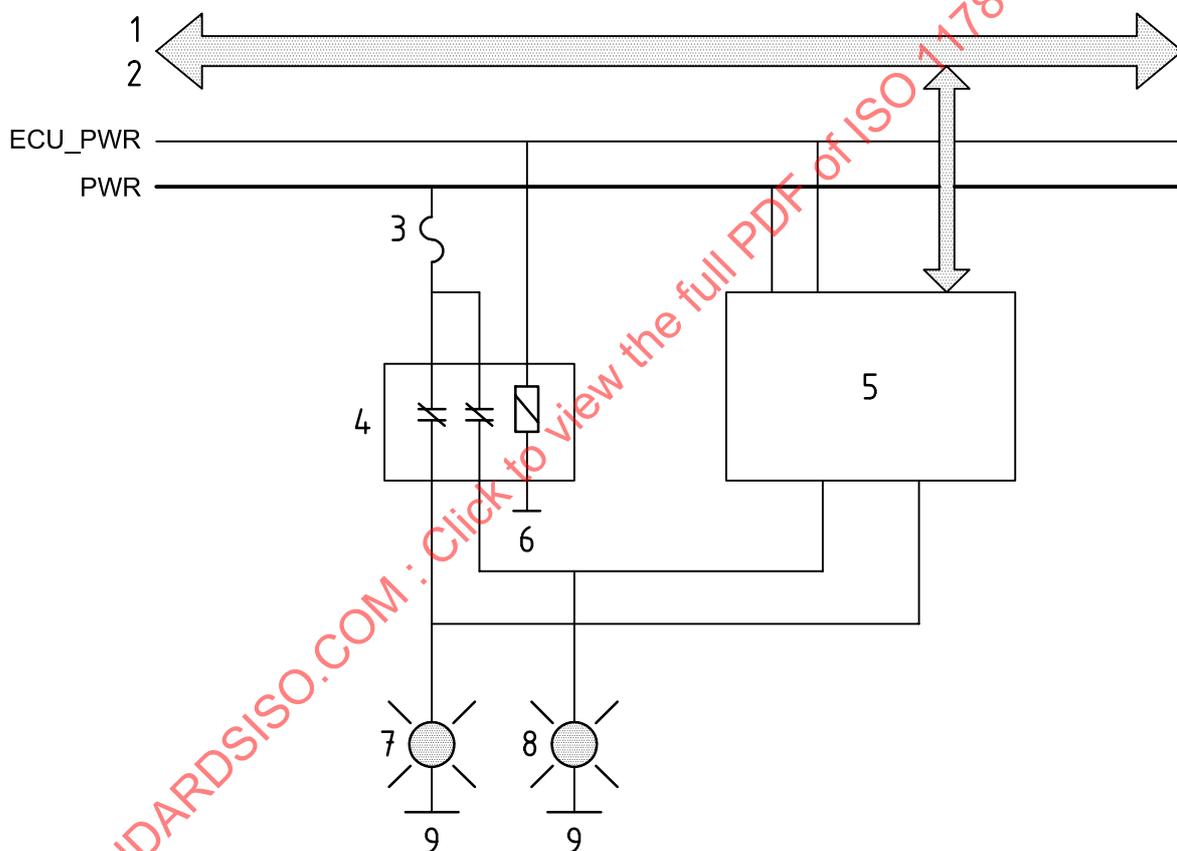
3.5 Control of lighting

The tractor ECU is responsible for the control of lighting on an implement. This control involves using the lighting messages specified in ISO 11783-7, and control of ECU_PWR and PWR (see 3.6).

The tractor ECU shall monitor lighting commands (both those from operator controls and those from within the vehicle system) and the status of the vehicle key switch, and shall use the operational rules governing each of the lights appropriate for the region in which the tractor is designed to operate. The lighting commands may be monitored using either the lighting message on the tractor bus or operator inputs to the tractor ECU. The tractor ECU shall then ensure that the required power to the implement bus is activated and shall send the appropriate lighting messages.

If failures within the implement bus or the tractor compromise the ability to communicate reliably on the implement bus, then the tractor ECU shall control the PWR (power) connection, while disconnecting the ECU_PWR connection. The tractor ECU shall turn the PWR connection on and off at the flash rate for warning lights. The connected equipment with synchronized lighting shall use this arrangement to control hazard lighting.

See Figure 1 for a block diagram showing a means of controlling the implement warning light in the event of a failure occurring within the implement bus or tractor. See ISO 11783-7 for the message for control of tractor and implement lighting.



Key

- 1 CAN bus
- 2 Twisted quad cable
- 3 Overload protection
- 4 Double pole NC relay
- 5 Implement lighting ECU
- 6 ECU_GND
- 7 Left amber warning light
- 8 Right amber warning light
- 9 GND

Figure 1 — Control of implement warning lights

3.6 Control of ECU_PWR and PWR

3.6.1 ECU_PWR

The tractor ECU is responsible for controlling the distribution of ECU_PWR to implements connected to the implement bus via a bus breakaway connector (see ISO 11783-2), for sending the messages indicating the status of the ECU_PWR, and for receiving and acting upon the control messages for ECU_PWR when ECU_PWR originates elsewhere on the tractor.

ECUs such as the VT, mounted on the tractor and permanently connected to the implement bus, should be connected to ECU_PWR. The tractor manufacturer or installer shall determine whether ECUs located on the tractor and connected to the implement bus via the in-cab bus connector are to be powered via ECU_PWR.

The terminating bias circuits for the implement bus shall be powered from ECU_PWR or by the tractor ECU itself in order to ensure that the terminating bias circuits are operational for ECUs using the implement bus to control ECU_PWR.

The minimum current capacity available from the implement bus 12 V ECU_PWR shall be 15 A.

See Figure 2 for a block diagram showing a means by which the tractor ECU may control ECU_PWR.

3.6.2 PWR

The tractor ECU is equally responsible for controlling the distribution of PWR to implements connected to the implement bus via bus breakaway connectors on the tractor (see ISO 11783-2), for sending the messages indicating the status of the PWR, and for receiving and acting upon the control messages for PWR — regardless of where PWR originates on the tractor.

The minimum current capacity available from the implement bus 12 V PWR shall be 30 A.

See Figure 2 for a block diagram showing a means by which the tractor ECU may control PWR.