INTERNATIONAL STANDARD

ISO 11783-9

Second edition
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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

Reference number
ISO 11783-9:2012(E)

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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 2.

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*.

This second edition cancels and replaces the first edition (ISO 11783-9:2002), which has been technically revised.

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: Mobile data element dictionary*

— *Part 12: Diagnostics services*

— *Part 13: File server*

— *Part 14: Sequence control*

Introduction

Parts 1 to 14 of ISO 11783 specify a communications system for agricultural equipment based on the ISO 11898-1[1] protocol. SAE J1939[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 J1939 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:

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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 that 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

ISO 11783 as a whole 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 (TECU), the control function (CF) that provides the gateway between the network's tractor and implement buses, as well as performing other functions.

New requirements in this second edition are specified as version 2 TECUs and Working Sets.

NOTE The Tractor ECU is also the control function (CF) 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11783-1, *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, *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 11783-6, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 6: Virtual terminal*

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

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

ISO 11783-10, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 10: Task controller and management information system data interchange*

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

ISO 16154, *Tractors and machinery for agriculture and forestry — Installation of lighting, light signalling and marking devices for travel on public roadways*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11783-1 apply.

4 Description and specifications

4.1 Ports

4.1.1 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 port for connection to the implement bus. However, when the tractor has both an implement and a tractor bus, the Tractor ECU shall have two ports — the Tractor ECU implement bus port and the Tractor ECU tractor bus port.

4.1.2 Port referencing

For communication network references to either of a Tractor ECU's ports,

— port 1 shall be used as the implement bus port;

— port 2 shall be used as the tractor bus port, where a tractor bus is installed.

See ISO 11783-4:2011, Figure 1.

4.1.3 Port physical layer

The implement bus port of the Tractor ECU shall be designed so that it can connect to the physical layer specified in ISO 11783-2. The tractor bus port 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 ports have been designed for the ISO 11783 physical layer.

4.2 Functions and parameter repackaging

4.2.1 General

As the CF representing the tractor and its messages on the implement bus, the Tractor ECU is responsible for the communications between the tractor and the other CFs on that bus; to this end, it shall appear to the system to be the same as any other CF on the implement bus. Particularly important is that the tractor's access to the virtual terminal (VT) (see ISO 11783-6) be identical to that of any other implement. The Tractor ECU is also responsible, as part of its network interconnect functions, for converting to and from any implement bus, processing 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. The Tractor ECU exhibits the behaviour of a gateway and/or router, depending on the type(s) of networks to which it is connected.

4.2.2 Messages from the tractor bus to the 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 messages identified by a particular classification. It shall then redirect this data in the messages specified for its class 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 to reduce filter database requirements in the Tractor ECU).

To minimize bandwidth usage on the implement bus, data which is sent in PGs by a Tractor ECU that is of interest to a task controller are not to be duplicated in a Process Data message. ISO 11783-10 allows data to be received by a Task Controller via PGs and this method is to be utilized for any data that is already sent in a standard PG by the Tractor ECU.

4.2.3 Messages from the implement bus to the 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.

4.2.4 Messages from the Tractor ECU to the implement bus

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

EXAMPLE Placing a tractor performance screen on the VT.

4.3 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 implement CFs. To avoid these services requiring two different network drivers, one for the implement bus and another for the tractor bus, the grouping as members of the tractor set of the CFs on the tractor bus shall be structured by the Tractor ECU analogous to the grouping of the CFs by an implement CF or a working set master.

4.4 Classification and minimum supported message sets

4.4.1 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.

4.4.2 Tractor–implement interface classifications

4.4.2.1 General

A tractor class defines a minimum set of messages a Tractor ECU provides on the implement bus to connected implement CFs. There are three main tractor–implement interface classes for a tractor with an ISO 11783 bus system which are defined in subsequent clauses as classes 1, 2 and 3. 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 4.4.2.2 to 4.4.2.4. A tractor can maintain a classification when a required feature is physically missing from the tractor (i.e. if a rear hitch or PTO is not installed). In this case, 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 for producing 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 can be used in conjunction with any of the numbered classifications. These shall be appended as follows:

— class xN tractor – navigational messages;

— class xF tractor – front mounted implement messages;

— class xG tractor – guidance messages (TECU version 2 and later);

— class xP tractor – powertrain messages (TECU version 2 and later);

— class xM tractor – motion initiation messages (TECU version 2 and later);

where x is the class number, and N, F, G, P, and M represent the message sets listed above (see 4.4.2.5 to 4.4.2.9). In addition, multiple addenda can be associated with a tractor. For example, class 3GP would indicate a class 3 tractor that supports both guidance and powertrain control messages.

The tractor manufacturer may provide additional messages without providing the complete set of messages of the next highest class of Tractor ECU.

The following paragraphs of this subclause are applicable to Version 2 and later TECUs.

All classes of Tractor ECU shall support the ISOBUS compliance certification message, in particular, the compliance certification type TECU class parameters.

As specified in ISO 11783-7 the Tractor ECU shall transmit the tractor facility response message at power up and when requested. Connected implement CFs can also use the required tractor facilities message to query the Tractor ECU for determining its classification and the provided facilities.

The information in the tractor facility response message shall be related to the installed facilities and not to the required facilities requested by an implement CF.

If an implement CF requires a tractor facility which is not supported by the Tractor ECU the implement CF can inform the operator of the missing facility.

An implement CF can send the required tractor facilities message to the Tractor ECU to enable the transmission of the messages that provide the required facilities. A facility is not required if its corresponding bits are set to 0 in the implement CF required tractor facilities message. The Tractor ECU can then stop the transmission of this implement message to reduce bandwidth. If the Tractor ECU receives required tractor facilities messages from more than one implement CF, the Tractor ECU shall transmit only one Tractor facility response message with the required facilities bits set for all required facilities.

The Tractor ECU function can be integrated into a display which provides the VT function, for the transmission of the ISO 11786 basic tractor internal measurements on the implement bus as specified in 4.4.2.2. When there are multiple Tractor ECUs connected to the implement bus the following rules apply.

a) The Tractor ECU with function instance 0 is the primary Tractor ECU while the Tractor ECU with function instance 1 is the secondary Tractor ECU.

b) The Tractor ECU with function instance 0 shall be responsible for the power management, lighting control and response to the language command.

c) A Tractor ECU with a higher function instance shall not provide any messages which are provided by a Tractor ECU with a lower function instance.

d) A Tractor ECU with function instance not equal to zero shall also request the tractor facility response message from the Tractor ECUs with a lower function instance. This Tractor ECU shall only set those facilities bit(s) that are not available in the other Tractor ECUs. This allows the possibility, for example, when the ground-based speed and distance message are not available in the TECU with instance zero that the message can be transmitted by a display with an integrated Tractor ECU that is connected to a GPS receiver.

An implement CF shall be able to receive and process multiple tractor facility response messages when there are multiple Tractor ECUs connected to the implement bus.

4.4.2.2 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, supported default language and tractor facilities response message. This is a new requirement for version 2 TECUs.

The tractor with this tractor–implement interface supports the following parameters, which are specified in ISO 11783-7, except for engine speed, which is specified in ISO 11783-8:

a) power management:

   1) key switch state;

   2) maximum time of tractor power;

   3) maintain power requests;

b) speed information:

   1) wheel-based machine speed;

   2) ground-based machine speed;

   3) engine speed (the message transmission rate shall be 100 ms);

c) hitch information:

   1) rear hitch position;

   2) rear hitch in-work indication;

d) PTO (power take-off) information:

   1) rear PTO output shaft speed;

   2) rear PTO engagement;

e) language information: A default language shall be stored in the Tractor ECU for the purpose of initializing a VT. See ISO 11783-7 for details of updating the language stored in the tractor ECU;

f) tractor facilities response (TECU version 2 and later).

4.4.2.3 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 machine distance and direction;

— rear draft information;

— lighting messages; and

— auxiliary valve estimated or measured flow.

This allows a more sophisticated implement control and security strategy.

The tractor with this tractor–implement interface supports class 1 messages and the following parameters, specified in ISO 11783-7:

a) time/date;

b) speed and distance:

   1) ground-based machine distance;

   2) ground-based machine direction;

3) wheel-based machine distance;

4) wheel-based machine direction;

c) additional hitch parameter: rear draft;

d) implement and tractor lighting message set as required by ISO 16154 for an applicable region (TECU version 2 and later);

e) auxiliary valve estimated or measured flow.

4.4.2.4 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 shall 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 tractor–implement interface supports class 2 messages and the following commands, specified in ISO 11783-7:

a) hitch information:

1) rear hitch position limit status (TECU version 2 and later);

2) rear hitch exit/reason code (TECU version 2 and later);

b) hitch command: rear hitch position command;

c) PTO (power take-off) information;

1) rear PTO engagement request status (TECU version 2 and later);

2) rear PTO shaft speed limit status (TECU version 2 and later);

3) rear PTO exit/reason code (TECU version 2 and later);

d) PTO commands:

1) rear PTO output shaft speed set point command;

2) rear PTO engagement command;

e) auxiliary valve estimated or measured information:

1) auxiliary valve exit flow limit status (TECU version 2 and later);

2) auxiliary valve exit/reason code (TECU version 2 and later);

f) auxiliary valve command.

4.4.2.5 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 provides navigational information on the implement bus.

For example, a class 3 tractor–implement interface (see 4.4.2.4) which is also able to support navigational messages shall be classified class 3N, and support “Navigation location system messages” (see ISO 11783-7).

4.4.2.6 Secondary or front-mounted implement support

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

For example, a class 2 tractor–implement interface (see 4.4.2.3) which is also able to support front-mounted implement messages shall be classified class 2F. Front command messages can only be supported by class 3 tractor–implement interface. The following parameters shall be used for the corresponding classification of the front-mounted implement (see ISO 11783-7):

a) hitch information (Class 1 TECU):

   1) front hitch position;

   2) front hitch in-work indication;

b) PTO information (Class 1 TECU):

   1) front PTO output shaft speed;

   2) front PTO engagement;

c) additional hitch information (Class 2 TECU): front draft;

d) hitch information (Class 3 TECU):

   1) front hitch position limit status (TECU version 2 and later);

   2) front hitch exit/reason code (TECU version 2 and later);

e) hitch command (Class 3 TECU): front hitch position command;

f) PTO (power take-off) information (Class 3 TECU)

   1) front PTO engagement request status (TECU version 2 and later);

   2) front PTO shaft speed limit status (TECU version 2 and later);

   3) front PTO exit/reason code (TECU version 2 and later);

g) PTO commands (Class 3 TECU):

   1) front PTO output shaft speed set point command;

   2) front PTO engagement command.

4.4.2.7 Guidance support – TECU version 2 and later

This set of messages, defined in ISO 11783-7, is provided by the installation of a guidance (steering) system on the tractor. A special classification, “G”, shall be appended to the class number when the tractor is able to provide the guidance function. Unlike addendum “F”, the “G” classification is independent of the base classification (“1”, “2”, or “3”) of the tractor. A tractor appending a “G” to its tractor classification shall provide all of the parameters encompassing both status and control of guidance.

For example, a class 2 tractor–implement interface (see 4.4.2.3) which is also able to support guidance shall be classified class 2G and shall support the external control of the guidance system. The following parameters shall be used for the classification of guidance (see ISO 11783-7):

— curvature command;

— estimate curvature;

— curvature command status;

— request reset command status;

— steering input position status;

— steering system readiness;

— mechanical system lockout.

4.4.2.8 Powertrain – TECU version 2 and later

This set of messages, defined in ISO 11783-7, is provided by the tractor if it is capable of accepting speed and/or drive strategy commands from an implement controller. A special classification, “P”, shall be appended to the class number when the tractor is able to provide this functionality. The “P” classification indicates that the tractor is capable of accepting the commands regardless of the base classification (“1”, “2”, or “3”) of the tractor. A tractor appending a “P” to it’s tractor classification shall provide all of the parameters encompassing both status and control of speed. The ability to control the drive strategy or bring the tractor to a stop (i.e. speed of “0.0”) are optional and can be determined by an implement via the tractor facilities response message (see ISO 11783-7).

For example, a class 2 tractor–implement interface (see 4.4.2.3) which is also able to support speed control shall be classified class 2P. The following parameters shall be used for the classification of powertrain (see ISO 11783-7):

— machine selected speed;

— machine selected direction;

— machine selected speed limit status (TECU version 2 and later);

— machine selected speed exit/reason code (TECU version 2 and later);

— machine selected speed source;

— machine selected speed set point command;

— machine selected speed direction command.

When used for control, the machine selected speed shall be the speed source that the tractor uses to control the speed of the vehicle. This is typically wheel-based speed, but may be one of the others. It is the responsibility of the tractor to ensure a smooth transition if the speed source changes while being controlled.

4.4.2.9 Motion initiation – TECU version 2 and later

A set of messages, to be defined in ISO 11783-7, is provided by the tractor if it is capable of accepting commands to initiate motion of the vehicle (forward or reverse). A special classification, “M”, shall be appended to the class number when the tractor is able to provide this functionality.

For example, a class 3 tractor–implement interface (see 4.4.2.3) which is also able to support motion initiation commands shall be classified class 3M.

4.4.3 Implement commanded tractor — Control option

The tractor can provide additional control modes, for 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 can be determined via the tractor facilities message (see ISO 11783-7).

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

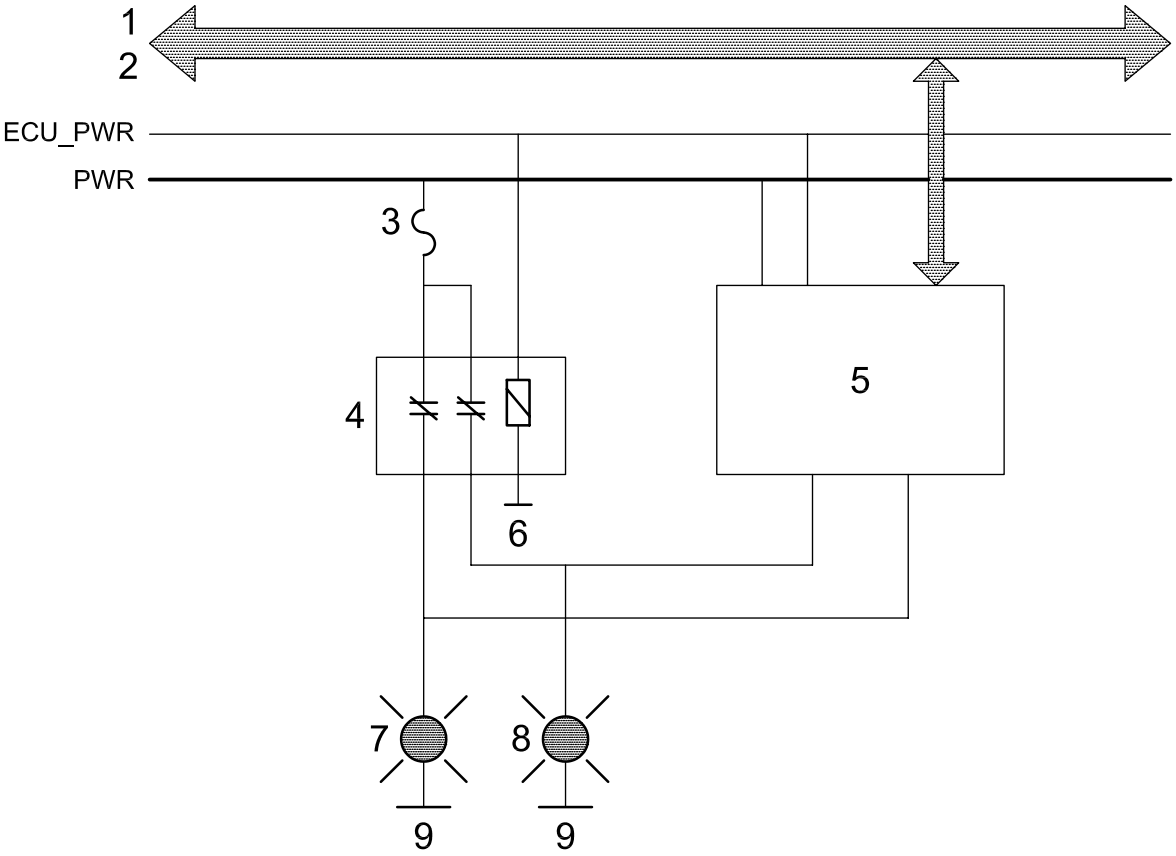
4.5 Control of lighting

For version 2 and later, the Tractor ECU with function instance 0 is responsible for the control of lighting on an implement. This control involves using the lighting command and lighting data messages specified in ISO 11783-7 and control of ECU_PWR and PWR (see 4.6).

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 can 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 a message for the 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

4.6 Control of ECU_PWR and PWR

4.6.1 ECU_PWR

For version 2 and later, the function instance 0 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. The Tractor ECU shall transmit its address claim message after turning on the ECU_PWR.

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 bus extension connector are to be powered via ECU_PWR.

The terminating bias circuits TBC_PWR for the implement bus shall be sourced 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. For version 2 TECUs and later, overload protection shall be included in the TBC_PWR connection to ECU_PWR to provide protection from TBC_PWR shorts to TBC_RTN or ECU_GND.

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 can control ECU_PWR.

4.6.2 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 50 A. This is a changed requirement for TECU version 2 and later.

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

4.6.3 ECU_PWR and PWR minimum combined current capacity

The minimum combined current capacity from the implement bus ECU_PWR and PWR shall be a continuous 55 A. TECU version 2 and later changed requirement.

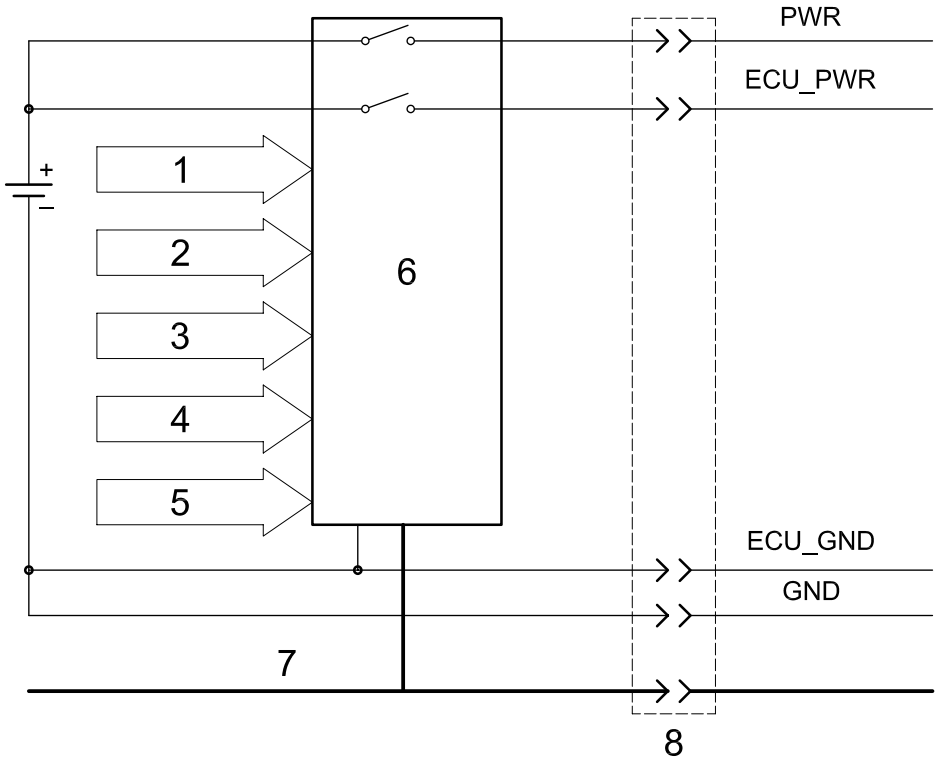
4.6.4 System shutdown – TECU version 2 and later

4.6.4.1 General

System shutdown is the period of time when the key switch state indicates the key is off and the ECU_PWR remains on for at least 2 s. PWR can or cannot remain on concurrent with ECU_PWR (see ISO 11783-7 for the message and parameter definitions). See Figure 3 for messages sent without any request to maintain power.

To control its shutdown, a control function shall monitor the key switch state and as a result of the transition from “Key switch not off” to “Key switch off”, depending on its operational requirements, complete the power down actions specified in 4.6.1 and 4.6.2. If a control function has to save settings and/or log files before shutting down, it can request to only maintain ECU_PWR. If a control function has to set valves or actuators to a shutdown state, it can request to maintain both PWR and ECU_PWR to operate the valves or actuator and to continue to communicate control messages on the network.

NOTE Starting the engine can cause an unforeseen power interruption (see ISO 11783-7 and ISO 11783-5). During such a power interruption, the transmission of the key switch state parameter and the power maintain functionality for ECU_PWR and PWR can be inhibited.



Key

1 key Sw
2 light Sw
3 work light Sw
4 hazard Sw
5 marker Sw
6 tractor ECU
7 implement bus
8 implement bus breakaway connector

Figure 2 — Control of ECU_PWR and PWR

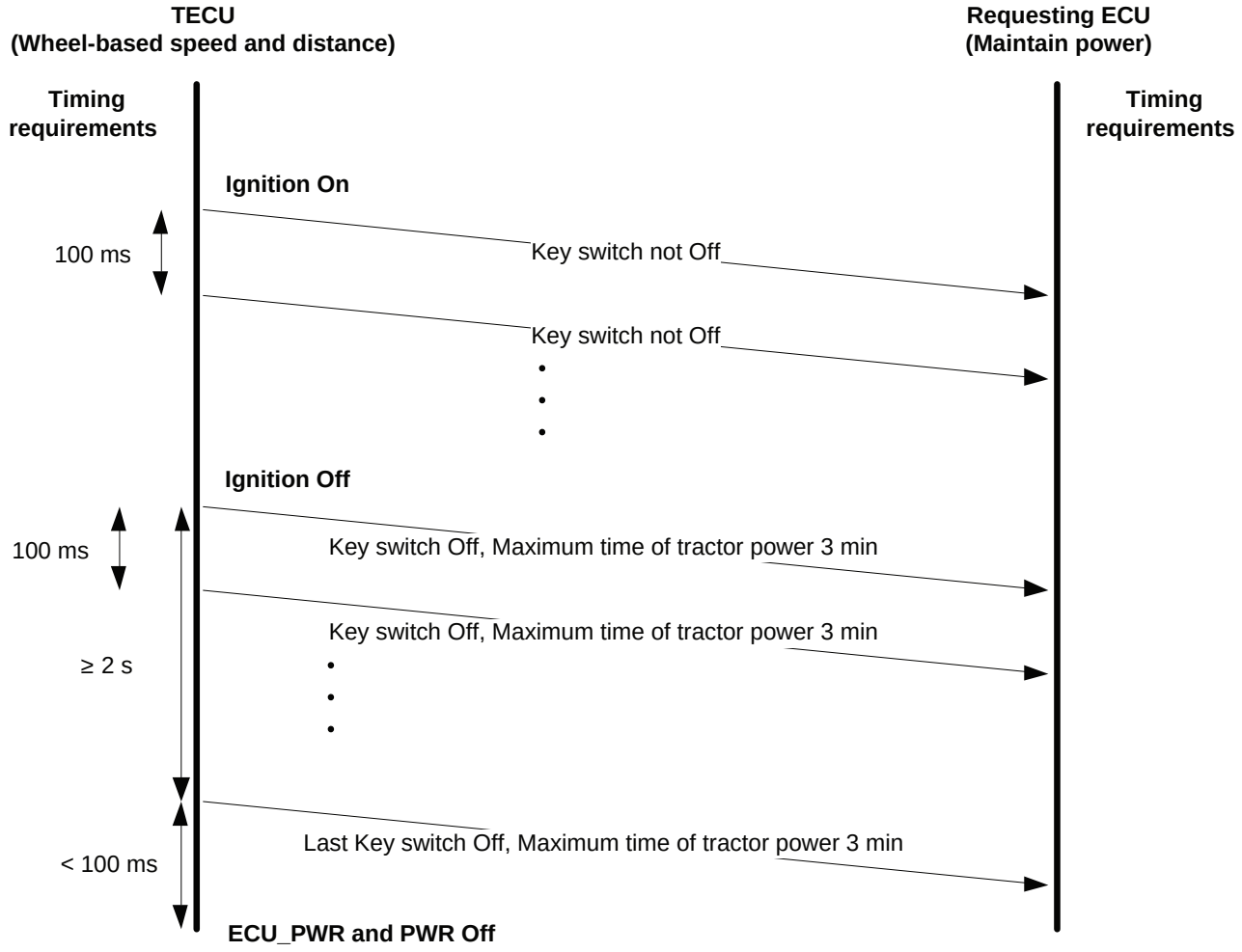


Figure 3 — Message sequence with no requests to maintain power

4.6.4.2 Control function saving data

When a control function detects the key switch state change from “Key switch not off” to “Key switch off” and has to take more than 2 s to save settings or data, it shall take the following action:

a) The CF shall send a “Maintain power” message (see ISO11783-7) with the requirement for 2 s more of ECU_PWR to inform the system Tractor ECU that it needs to maintain the ECU_PWR.

b) The CF shall continue to send a “Maintain power” message with the requirement for 2 s more of ECU power at least once per second while the saving process is not completed.

c) Once the CF has completed saving the data, it either stops sending this message, or sends the “Maintain power” message with no further requirement for ECU_PWR.

4.6.4.3 Control function shutting down valves and/or actuators

When a control function detects the key switch state change from “Key switch not off” to “Key switch off” and has to take more than 2 s to set valves or actuators to a shutdown state, it shall take the following action:

a) The CF shall send a “Maintain power” message (see ISO 11783-7) with the requirement for 2 s more of ECU_PWR and requirement for 2 s more of PWR parameters set to inform the system Tractor ECU that it has to maintain both ECU_PWR and PWR.

b) The CF shall continue to send a “Maintain power” message with the requirement for 2 s more of ECU_PWR and requirement for 2 s more of PWR at least once a second while it is still completing the shutdown process.

c) Once the CF has completed shutting down, it shall send the “Maintain power” message with no further requirement for actuator power parameter set.

d) If the CF has data that it requires to be saved, then see 4.6.4.2 “Control function saving data”. Otherwise the control function shall either stop sending this message, or send the “Maintain power” message with no further requirement for ECU_PWR and PWR parameter set.

The CF shall also monitor the “Maximum time of tractor power” to determine if it has enough time to complete the shutdown. If a system shutdown cannot be completed in the allowed time of tractor power available, it is recommended to notify the operator at the next power up to allow the appropriate action(s) to be taken (for example: review settings, check valve and/or actuator state or replace battery). See Figures 4, 5 and 6 for messages sent with requests to maintain power.

4.7 Safe-mode operation

4.7.1 Upon loss of power or communication with the tractor, the implement shall assume a condition of fail-safe operation. The interruption, re-establishment after interruption or fluctuation in any manner whatsoever of the power supply to the implement shall not result in a dangerous situation. Neither shall a fault in the control logic, nor failure or damage to the control circuit, be allowed to lead to danger. The following are particular requirements for ensuring such safe-mode operation.

4.7.2 The implement shall not start unexpectedly.

4.7.3 The implement shall not be prevented from stopping once the command has been given.

4.7.4 No part of the implement, or a piece held by the implement, shall fall or be ejected.

4.7.5 Automatic or manual stopping of any moving part shall be unimpeded.

4.7.6 The protection devices shall remain fully effective.

4.7.7 Implements remotely controlled by an operator shall be designed and constructed to stop automatically in the event a detectable failure prevents the operator from remotely controlling the implement.

4.7.8 The operator shall have the ability to override implement-controlled systems.

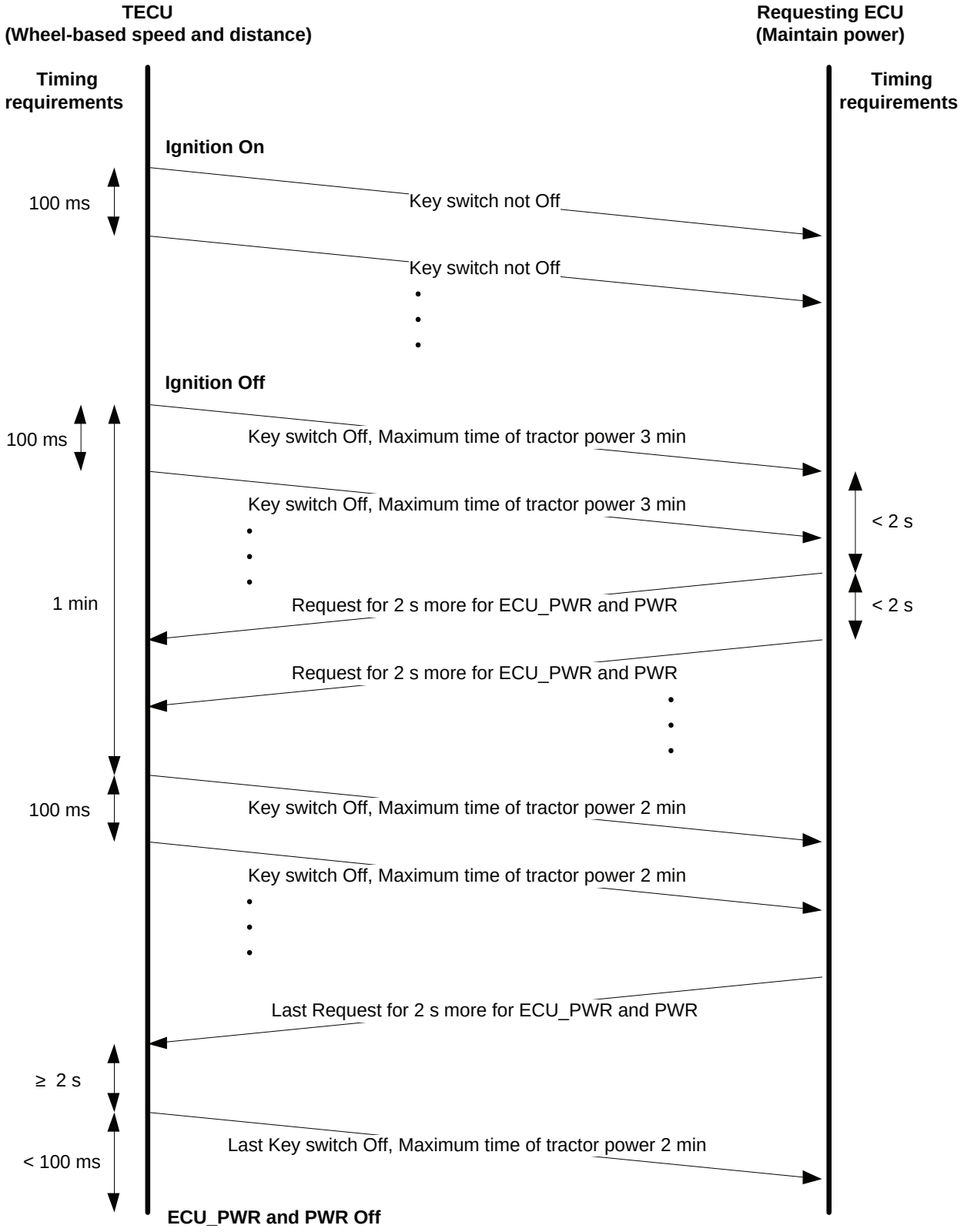


Figure 4 — Requesting CF is done before maximum time

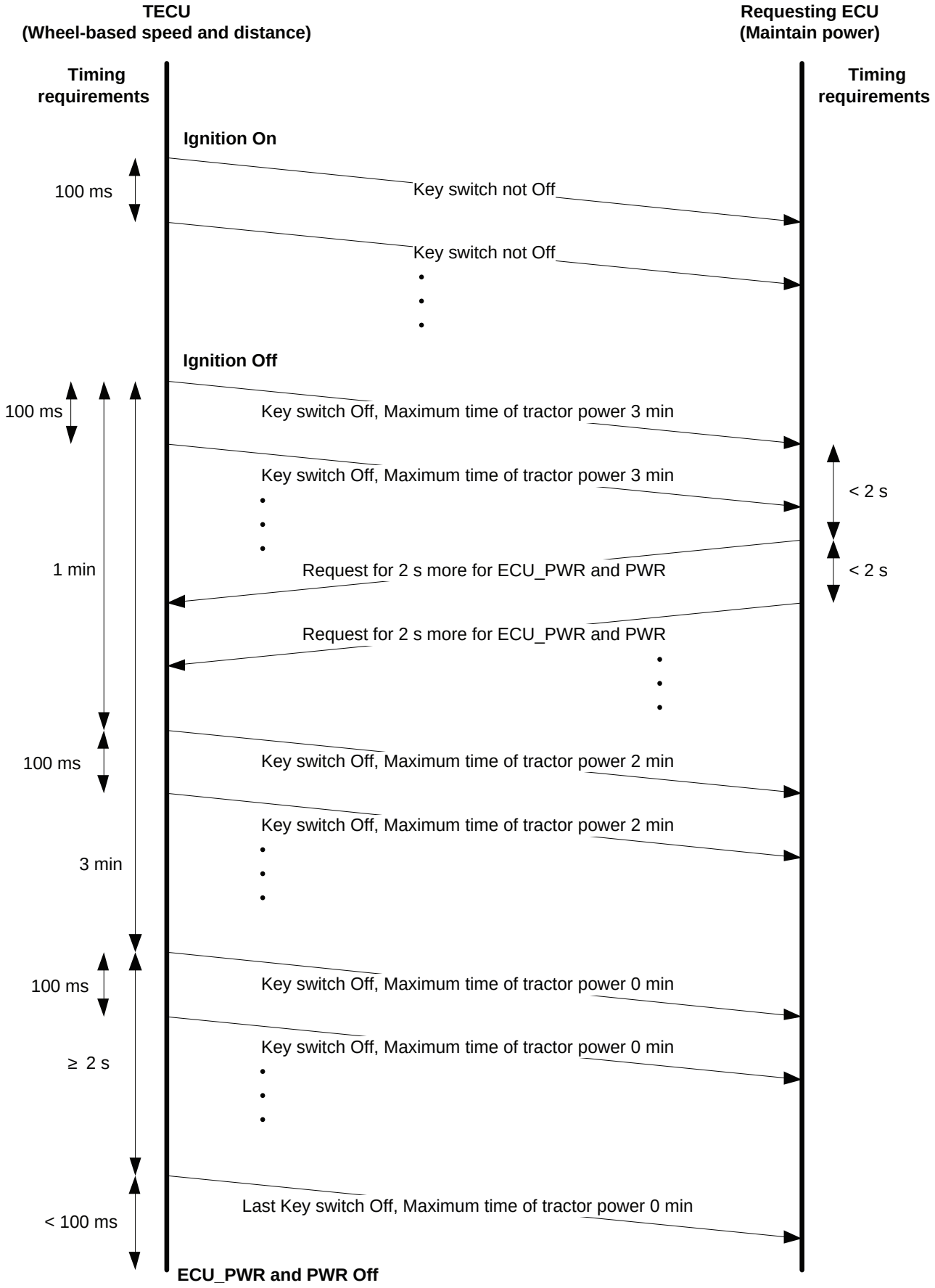


Figure 5 — Requesting CF does not finish before maximum time

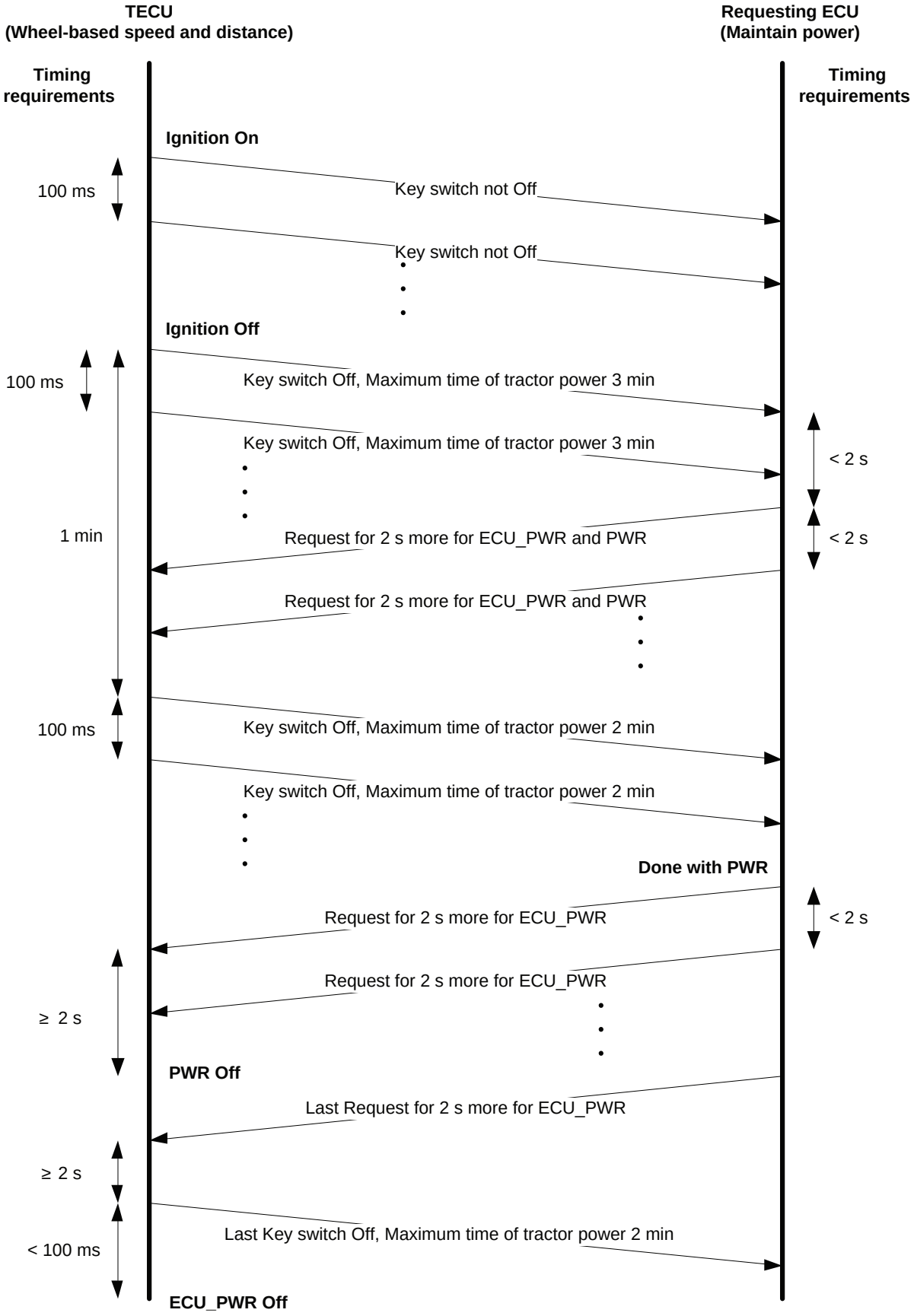


Figure 6 — Requesting CF done with PWR first

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