

SURFACE VEHICLE RECOMMENDED PRACTICE

Issued **DRAFT**
Draft
May 2001

Submitted for recognition as an American National Standard

NETWORK MANAGEMENT

Forward

This series of SAE Recommended Practices has been developed by the Truck and Bus Control and Communications Network Subcommittee of the Truck and Bus Electrical and Electronics Committee. The objectives of the subcommittee are to develop information reports, recommended practices, and standards concerned with the requirements, design, and usage of ECUs, that transmit electronic signals and control information among vehicle components. The usage of these recommended practices is not limited to truck and bus applications. Other applications may be accommodated with immediate support being provided for construction and agricultural equipment, and stationary power systems.

These documents are intended as a guide toward standard practice and are subject to change to keep pace with experience and technical advances.

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1. Scope

These SAE Recommended Practices are intended for light and heavy duty vehicles used on or off road as well as appropriate stationary applications which use vehicle derived components (e. g. generator sets). Vehicles of interest include, but are not limited to: on and off highway trucks and their trailers; construction equipment; and agricultural equipment and implements.

The purpose of these documents is to provide an open interconnect system for electronic systems. It is the intention of these documents to allow Electronic Control Units to communicate with each other by providing a standard architecture.

Network management in the SAE J1939 network is concerned with the management of source addresses and the association of those addresses with an actual function and with the detection and reporting of network related errors. Due to the nature of management of source addresses, network management processes, requirements for reaction to brief power outages, and minimum the network.

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2. References

General information regarding this series of recommended practices is found in SAE J1939.

2.1 Applicable Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1 SAE Publications

SAE J1587 - Joint SAE/TMC Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications

SAE J1939 - Recommended Practice for Serial Control and Communications Vehicle Network

SAE J1939-21 - Data Link Layer

SAE J1939-31 - Recommended Practice for Serial Control and Communications Vehicle Network - Part 31-Network Layer

3 Definitions

[Definitions re-written from J1939 and/or to be added to J1939 -

NAME - An 8 byte value which uniquely identifies the primary function of an ~~ECU~~ CA and its instance on the network. A device's CA's NAME must be unique, no two devices may share the same NAME value on a given vehicle network.

Function — A particular specialization of a Controller Application (CA). Function is an 8 bit identifier with an associated label which describes the role of a particular Controller Application on the network. Examples of the label include "Engine", "Transmission", and "Cab Climate Control".
~~A capability of a vehicle system having one or more ECUs that are connected to a J1939 bus segment of a Vehicle System.~~ The function value is used in the 8 bit Function field in the 64 bit NAME entity (See J1939/81, Section 4.1)

Controller — The hardware and software component of an ECU that is dedicated to a particular control function within the vehicle.

Controller Application (CA) — The software component within an ECU that comprises a particular controller.

1

3.1 Terminology used in network management

Terms are defined in SAE J1939 for use in the context of this document.

3.2 Controller Application (CA)

For the purposes of this document, a controller is made up of two components, the software within an electronic control unit (ECU) associated with the controller and the hardware of the ECU associated with the controller. The software within an ECU associated with a particular controller is the "Controller Application" or CA. An ECU may serve as one or more controllers and hence may contain one or more CAs. Each CA within an ECU may will have an address and an associated identifier, a NAME, in order to communicate on the J1939 network.

3.2.3 Address Configuration and Capability

Address configuration defines how the method by which a particular ECU-CA obtains and retains its source address. Separate CA functions implemented within a single ECU, even though the CA function has only one node, may or may not have differing address capabilities for the different functions CAs. Address configuration is distinct from the address claim procedure, which is a process whereby ECUs CAs broadcast their intent to use a particular address. There are four distinct address configurations

3 terms and definitions follow:

Is-CA.

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Fixed Address ~~ECUs-CAs~~ are those ~~ECUs-CAs~~ which are programmed at manufacture or through some process after manufacture to use a particular address. These ~~ECUs-CAs~~ have no means to alter the address they claim and use without intervention through some external process. These ~~ECUs-CAs~~ include non-configurable address, service configurable address, and command configurable address ~~ECUsCAs~~.

3.23.1.1 Non-Configurable Address ~~ECUCA~~.

A Non-Configurable Address ~~ECU-CA~~ is an ~~ECU-CA~~, which has a source address(es) provided by its manufacturer. This address is not alterable by any means in the field. This includes service.

3.23.1.2 Service Configurable Address ~~ECUCA~~.

A Service Configurable Address ~~ECU-CA~~ is an ~~ECU-CA~~ whose source address(es) may be changed in the field by a service technician. The address may be altered by any one of a number of proprietary techniques or by using the Commanded Address message, while in a "service" mode of operation. It is very likely that a service tool would be involved.

3.23.1.3 Command Configurable Address ~~ECUCA~~.

A Command Configurable Address ~~ECU-CA~~ is an ~~ECU-CA~~ whose source address(es) can be altered using the Commanded Address message during normal operation (as opposed to during service).

3.23.4 Self-Configurable Address ~~ECUCA~~.

A Self-Configurable Address ~~ECU-CA~~ is an ~~ECU-CA~~ which determines its source address(es) based on internal calculations and then claims that address. If a Self-Configurable Address ~~ECU-CA~~ is not successful in claiming the first calculated address, then the ~~ECU-CA~~ may re-calculate and claim another address. This latter type of ~~ECU-CA~~ is Arbitrary Address Capable and will indicate so in the ~~ECU's-CA's~~ NAME.

3.23.4.1 Arbitrary Address Capable ~~ECUCA~~.

An Arbitrary Address Capable ~~ECU-CA~~ is a Self-Configurable Address ~~ECU-CA~~ which can select its source address(es) from ~~any addresses~~ those in the range ~~between and including~~ 128 to ~~and including~~ 247 ~~inclusive~~ based on internal calculations and then claim that address. The ~~value in the~~ Arbitrary Address Capable field in the NAME (See Section 4.1.1.2) indicates whether or not an ~~ECU-CA~~ has this capability.

3.34 Types of ~~ECUCAs~~

For the purposes of network management, there are three types of ~~ECUCAs~~: Standard, Diagnostic/Development ~~Tools~~, and Network Interconnection ~~ECUCAs~~.

3.34.1 Standard ~~ECUCAs~~

Standard ~~ECUCAs~~ are those ~~ECUCAs~~ whose primary function is not that of network interconnection or of programming, diagnosing, or otherwise functioning as tools or network interconnection ~~ECUCAs~~.

Standard ~~ECUCAs~~ include those used for engines, transmissions, ~~ABS systems~~brakes, virtual terminals, ~~dashboards~~instrument clusters, and ~~traction control systems~~vehicle navigation. Data loggers and recorders are also examples of standard ~~ECUCAs~~ but if these ~~ECUCAs~~ assume diagnostic tool functions then they should meet requirements of diagnostic tool ~~ECUCAs~~. Standard ~~ECUCAs~~ do not have the ability to modify the source addresses of any other ~~ECUCA~~s except as a result of the address claiming process.

Standard ~~ECUCAs~~ then may or may not be capable of self-configurable addressing. It is not the intent of this document to require a particular address configuration capability ~~for any Standard CA~~.

3.34.2 Diagnostic/Development Tool ~~ECUCAs~~

nt Tool ~~ECUCAs~~ are those which are connected to a particular SAE J1939 of analyzing, debugging, developing or monitoring any ~~ECUCA~~ on the

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subnetwork or the operation of the subnetwork itself. Although these tools are not expected to be permanently attached to a subnetwork, such a tool may well be a permanent part of a particular vehicle or craft. In either case, the capabilities of these tools are more extensive than those of Standard [ECUCAs](#) because they are primarily designed to interact with other [ECUCAs](#) on the network and have no other external functionality (a diagnostic tool, for example, is not expected to provide torque, plant beans, or brake a vehicle).

These tools may be intended as proprietary tools to operate [on-on or in](#) a given manufacturer's ECUs; they may be intended as a general purpose tool to operate on ECUs provided by several manufacturers, or they may be intended to work primarily on the network itself, providing network integration services for system integrators and OEM vehicle manufacturers.

3.34.3 Network Interconnection [ECUCAs](#)

Network Interconnection [ECUCAs](#) are those that exist primarily for the purpose of interconnecting networks or subnetworks. They primarily consist of repeaters, bridges, routers and gateways. In one manner or another, all network interconnection [ECUCAs](#) forward messages from one subnetwork to another.

Subnetworks interconnected by Network Interconnection [ECUCAs](#) may have the same protocol, as in two SAE J1939 subnetworks in the same vehicle; they may have different protocols, such as from SAE J1708/J1587 to SAE J1939, or may be interconnected off-vehicle subnetworks, such as satellite link, token ring or cellular modem.

Network Interconnection [ECUCAs](#) serving as gateways translate from SAE J1939 subnetworks to various other networks. This document will deal only with the SAE J1939 portions of those [ECUCAs](#).



4. Technical Requirements

4.1 NAME and Address Requirements

A NAME is a 64-bit identifier for a CA and identity composed of fields that are assigned by the committee. A NAME shall indicate the ECU-CA Function (e.g. Engine Number 1, Engine Number 2, Transmission Number 1, Anti-Lock Brake System 1). A NAME must be unique within a vehicle. A NAME is required for ECUs-CAs that transmit messages on a SAE J1939 network. The NAME serves two purposes, first, to provide a functional description of the module-CA and second, to provide a numerical value which may be used in arbitration for addresses. Addresses are used within SAE J1939 networks to provide uniqueness to message identifiers and to allow the source of a message to be determined. (Addresses are sometimes referred to as "Source Addresses" indicating the latter use). Address claim messages which contain both a source address and a NAME may be used to associate a NAME with a particular address on the network. The association of an address with a unique NAME (4.1.1) also provides means to associate an addresses with a CAFunction. Manufacturers of ECUs and integrators of networks must assure that the NAMES of all ECUs-CAs intended to transmit on a particular network are unique.

4.1.1 NAME

Source addresses in the SAE J1939 network serve to identify a particular ECU-CA that is communicating on a given network. The NAME (s) associated with a CA, as opposed to the address, provides the primary identifications of the Function(s)CA and the Function that the an ECUCA has on the network serves. Address management procedures in the network management protocol primarily allow the association of individual source addresses with the NAMEFunctions of the ECUCA, and the annunciation of that association onto the network. Appendix C provides examples of the construction of Names-NAMES for SAE J1939 ECUs.

Each ECU-CA on a network should have at least one NAME so the ECU-CA may be uniquely identified by its primary function. An ECU CA's NAME is also used in arbitration when multiple ECUs-CAs attempt to claim the same address, reinforcing the need for unique identification. In turn, each ECU-CA on the network will have at least one a single address, which is unique, so that it can properly arbitrate CAN Data Frames with other ECUs.

Although the entire NAME need not be field programmable, the instance fields should be alterable to allow for the correct configuration when, for example, a spare is installed in the field, or multiple instances may exist on a vehicle. Field programmability of the entire NAME field as well as the preferred address is recommended. NAMES may be programmed through use of the memory access protocol with Directed Spatial Addressing. The pointer Extension should be set to 00000000₂ indicating SPN Space with SPN of the NAME of Address claimed used as the address of the desired object as described in J1939-73.-

Listings of numerical values for Industry Groups, Vehicle Systems, Functions, and Manufacturer Codes are found in the Appendix B of SAE J1939.

NAMES are composed of fields as shown in Table 1 and 2, and are defined in the following paragraphs.

Table 1: NAME Fields

Arbitrary Address Capable	Industry Group	Vehicle System Instance	Vehicle System	Reserved	Function	Function Instance	ECU Instance	Manufacturer Code	Identity Number
1 bit 4.1.1.2	3 bit 4.1.1.3	4 bit 4.1.1.4	7 bit 4.1.1.5	1 bit 4.1.1.6	8 bit 4.1.1.7	5 bit 4.1.1.8	3 bit 4.1.1.9	11 bit 4.1.1.10	21 bit 4.1.1.11
Byte 7				Byte 6		Byte 5		Byte 4	Byte 3
								Byte 2	Byte 1

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The byte ordering of the NAME fields in a CAN message is shown in table 2, and is arranged to allow the NAME to be treated as a number in a manner consistent with SAE J1939-71. The entire 8 byte NAME is used as a single numeric value in arbitration processes when multiple ~~ECUs~~CAs attempt to claim the same address (see 4.4.3.3).

Table 2: Field positions within NAME

Byte	Bits	Position of Most Significant bit	Description	Note:
1	8-1	8	Least significant byte of Identity Number	Bit 8 is the bit sent closest to the DLC bits of the message.
2	8-1	8	Second byte of Identity Number	
3	8-6	8	Least significant 3 bits of Manufacturer Code	
	5-1	5	Most significant 5 bits of Identity Number	
4	8-1	8	Most significant 8 bits of Manufacturer Code	Bit 1 is the last of the data bits sent and is closest to the CRC in the message.
5	8-4	8	Function Instance	
	3-1	3	ECU Instance	
6	8-1	8	Function	
7	8-2	8	Vehicle System	
	1	-	Reserved	
8	8	-	Arbitrary Address Capable	
	7-5	7	Industry Group	
	4-1	4	Vehicle System Instance	

4.1.1.1 NAME Fields

These fields are prioritized from left to right as shown in Table 1. The meaning of the contents of the Vehicle System field is dependent on the Industry Group field contents. Further, the contents of the Function field is dependent on the Vehicle System field contents when the value for Function is greater than 127 and less than 254. Figure 1: ~~illustrates~~illustrates the relationship between the field definitions. The Vehicle System and Function fields may be set to indicate Not Available (binary ones) if values for these fields are not known or not defined in J1939. All other fields in the NAME must be set to their proper value. Table 3 summarizes this requirement.

Table 3: Summarized requirements for setting values in NAME fields

Field	Ability to be set to "Not Available"
Arbitrary Address Capable	No
Industry Group	No
Vehicle System Instance	No
Vehicle System	Yes
Reserved	No
Function	Yes
Function Instance	No
ECU Instance	No
Manufacturer Code	No
Identity Number	No

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This 1-bit field indicates whether an ~~an ECU CA~~ is both self-configurable and can use an arbitrary source address to resolve an address claim conflict. If this bit is set to "1", the ~~ECU CA~~ will resolve an address conflict with an ~~an ECU CA~~ whose NAME has a higher priority (lower numeric value) by selecting an arbitrary source address from the range ~~between and including~~ 128 to ~~and including~~ 247 ~~inclusive~~ and claiming that source address. An ~~an ECU CA~~ which computes ~~it's~~ its address but can claim only from a particular set of addresses is not considered arbitrary address capable (i.e. On-Highway Trailers.) See section 4.2 of this document for details of the address claim process.

4.1.1.3 Industry Group Field

Industry Group is a 3-bit field defined and assigned by the committee. Industry Group definitions may be found in Appendix B.7 of the SAE J1939 base document. The Industry Group field identifies NAMES associated with a particular industry that uses SAE J1939, for example: On-Highway Equipment, or Agricultural Equipment.

4.1.1.4 Vehicle System Instance Field

Vehicle System Instance is a 4-bit field, that is used to identify a particular occurrence of a particular Vehicle System within a connected network.

Note that in the case of single or first Vehicle System of a particular type, the instance field should be set to zero indicating the first instance.

4.1.1.5 Vehicle System Field

Vehicle System is a 7-bit field defined and assigned by the committee, which when combined with the Industry Group can be correlated to a common name. Vehicle System provides a common name for a group of functions within a connected network. Examples of Vehicle Systems for currently defined Industry Groups are "tractor" in the "Common" Industry Group, "Trailer" in the On-Highway Industry Group, and planter in the "Agricultural Equipment" Industry Group.

4.1.1.6 Reserved Field

Reserved for future definition by SAE. The reserved bit should be set to zero.

4.1.1.7 Function Field

Function is an 8-bit field defined and assigned by the committee. When Function has a value of 0 to 127, its definition is not dependent on any other field. When Function has a value greater than 127, its definition depends on Vehicle System. Function, when combined with the Industry Group and the Vehicle System fields identifies a common name for a specific hardware controller. The common name formed from the combination does not imply any specific capabilities.

4.1.1.8 Function Instance Field

The Function Instance is a 5-bit field that identifies the particular occurrence of a Function on the same Vehicle System on a given network.

Note that in the case of single or first Function of a particular type, the instance field should be set to zero indicating the first instance.

Individual manufacturers and integrators are advised that some agreement in the interpretation and use of Function Instances may be necessary. As an example, consider an implementation consisting of two engines and two transmissions. It may be important that engine instance 0 be physically connected to transmission instance 0 and that engine instance 1 be physically connected to transmission instance 1.

[Need to add comment on default configurations]

4.1.1.9 ECU Instance Field

The ECU Instance is a 2-bit field that indicates which one of a group of electronic control modules is being referenced. For example, in the case where a single engine is

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managed by two separate control units, each of which is attached to the same SAE J1939 network, the ECU Instance Field will be set to 0 for the first ECU and 1 for the second ECU.

Note that in the case of a single or first ECUs of a type for a particular CA, the instance fields should be set to zero indicating the first instance.

4.1.1.10 Manufacturer Code Field

The Manufacturer Code is an 11-bit field that indicates which company was responsible for the production of electronic control module for which this NAME is being referenced. Manufacturer codes are assigned by committee and may be found in the SAE J1939 base document. The Manufacturer Code field is not dependent on any other field in the NAME.

4.1.1.11 Identity Number Field

The Identity Number is a 21-bit field in the name assigned by the ECU manufacturer. The Identity Number is necessary in circumstances where it is possible that the NAME would not otherwise be unique (i.e. could be identical). This field should be unique and non-varying with removal of power. This field is necessary to resolve any address contention. The manufacturer must provide this uniqueness among products. It is the manufacturers choice to encode any other information into the identity number, for example, time/date of manufacture, serial number of the module, the vehicle the module is placed into, etc.

4.1.1.12 Dependencies in the NAME Fields

Figure 1 illustrates the dependencies of the upper 128 Functions on Vehicle System and Industry Group. In addition, the dependency of Identity Number on Manufacturer Code is shown. The Reserved field is independent of other fields. Functions 0 through 127 are independent of Industry Group or Vehicle System. Functions 128-254 are dependent on both vehicle system and industry group.

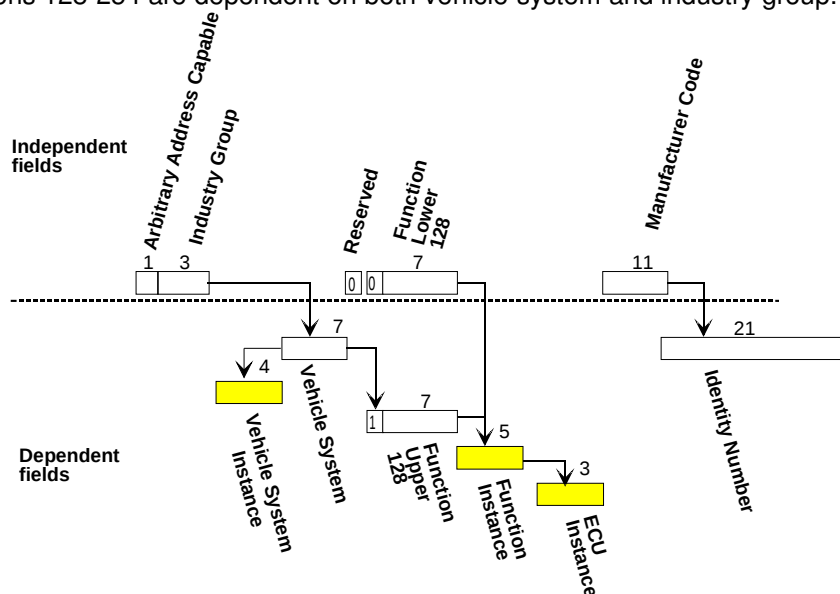


Figure 1. Dependencies in the NAME fields.

4.1.2 Addresses

An address is a one-byte value identifying a particular ECU-CA in a network. The address of an ECU-CA is incorporated into the identifier of every message sent by that ECU-CA and is used to provide uniqueness to messages that are sent by the ECU-CA.

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Most ~~ECUs-CAs~~ that operate on a SAE J1939 network will have an assigned preferred address (see SAE J1939, Tables B2-B9) that the ~~ECU-CA~~ should attempt to use first. If the ~~ECU's-CA's~~ preferred address has been successfully claimed (in use) by another ~~ECU-CA~~ on the network, the ~~ECU-CA~~ will have the option of attempting to secure another source address or it may send a Cannot Claim Address message depending of the ECU's addressing capability and the availability of an unused address.

An ~~ECU-CA~~ claiming a preferred address in the range 0 to 127 and 248 to 253 must ~~be perform~~ the function defined for that preferred address. Other ~~ECUs-CAs~~ may assume ~~the a~~ ~~ECU-CA~~ using ~~one of~~ these addresses ~~are will perform~~ the function defined for that preferred address.

An ~~ECU-CA~~'s initial address, the address ~~an-ECUthe CA~~ attempts to claim on first power-up, should be set by the manufacturer to match the list of application-defined preferred addresses wherever possible (SAE J1939 Tables B2-B9). However, ~~an-ECU-CA~~'s initial address should be reprogrammable to permit an OEM to properly configure a vehicle. Although this may not be necessary on "standard" vehicles, it provides flexibility for applications where multiple instances of a given ~~ECU-CA~~ (i.e., when there are two engines, etc.) may exist. This reprogrammability feature is especially important for temporarily connected or aftermarket ECUs.

Source addresses must be unique within a particular vehicle. Source addresses may be associated with different ~~ECUs-CAs~~ after each powerup of the vehicle and may also vary from vehicle to vehicle. The NAME associated with each ~~ECU-CA~~ is normally configured during initial vehicle or machine configuration (final vehicle assembly), or when the ECU is added to the vehicle. The NAME, which is associated with ~~a~~ source addresses, includes identification of ~~the~~ Functions ~~a~~ ~~ECUs-CAs~~ serves and retains a consistent definition regardless of the address used.

Self-configurable addressing is supported in this Recommended Practice. Self-configurable addressing is intended primarily for use by ~~ECUs-CAs~~ that may be attached to an already operating network, such as data loggers, calibration ECUs, bridges, or implements.

Support for self-configurable addressing in this standard is not intended to imply that a given ~~ECU-CA~~ should support self-configurable addressing. SAE J1939 ~~ECUs-CAs~~ are not required to posses self-configurable addressing capability, however they are required to perform the minimum Network Management functions described in Section 6 of this document and may for particular applications be required by the manufacturer to have such capabilities.

4.2 Network Management Procedure

Network management procedures are the messages passed and the actions taken by individual ~~ECUs-CAs~~ to collectively manage the network. The primary functions of the Network Management protocol are those of Address Management and Network Error Management.

Network Management messages have the same characteristics and requirements as other SAE J1939 messages with the exceptions of the use of the null address. The request for Address Claimed message is a conventional Request message as described in SAE J1939-21. The null address (254) is acceptable in the source address field of a network management message only if the message is a request for Address Claimed or a Cannot Claim Address message. A request directed to the null address (254) yields no responses.

The set of network management messages may be used to request addresses and NAMEs in use by other ~~ECUs-CAs~~ on the network, claim an address for an ECU, announce the inability to claim an address, or command another ~~ECU-CA~~ to assume a new address. Table 4 summarizes the messages.

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Table 4: Address Management Messages

Message name	PGN	PF	PS	SA	Data Length (Bytes)	Data
Request PG (request for Address Claimed)	59904 (See SAE J1939-21)	234	DA	SA ¹	3	PGN 60928
Address Claimed						
Address Claimed	60928	238	255	SA	8	NAME
Cannot Claim Source Address	60928	238	255	254	8	NAME
Commanded Address	65240	254	216	SA	9 ²	NAME, new SA

1. Source address could be set to 254 if no address has yet been claimed.

2. Commanded Address message is sent with the Transport Protocol BAM (See SAE J1939-21)

4.2.1 Request Message for Address Claimed

The request message for Address Claimed is used by any [ECU-CA](#) to request the NAMEs and addresses of [CaAs in](#) ECUs attached to the network. Upon receipt of the request message for Address Claimed, each [ECU-CA](#) shall transmit an Address Claimed message containing its address and its NAME. Any [ECU-CA](#) which cannot claim an address will respond with a Cannot Claim Address message (4.2.2.2) unless the [ECU-CA](#) has not yet attempted to claim an address. [ECUs-CAs](#) which have not yet attempted to claim an address should ~~not participate in network communications until the ECU-CA has attempted to now~~ claim an address. These [ECUs-CAs](#) should ~~not~~ send a Cannot Claim Address message or any other message until an Address Claim has been attempted.

The request for Address Claimed message may be sent to any particular address (0-253) or to a global destination address (255). An [ECU-CA](#) preparing to use a particular address may interrogate that address by sending a request for address claim to that particular address to determine if it has been claimed by another [ECU-CA](#). An [ECU-CA](#) may determine the existence of a functioning [ECU-CA](#) with a particular NAME on the network by sending a request for Address Claim to the global address (255) and examining the responses.

The source address for a request for Address Claimed message must be the null address (254) if the request is from an [ECU-CA](#) that has not yet claimed an address.

An [ECU-CA](#) should respond to its own request for Address Claimed message if the request was directed to the global address.

4.2.2 Address Claimed / Cannot Claim

The Address Claimed PGN may be used in two ways, to claim an address, and to announce that an address cannot be claimed. The former case is referred to in 4.2.2.1 as the Address Claimed message, and the latter in 4.2.2.2 as the Cannot Claim Address message. The Address Claimed message is used by any [ECU-CA](#) to either respond to a received request for Address Claimed message or to simply claim a single address on the network. It must be issued by [ECU-CA](#)s during initialization of a network or by [ECU-CA](#)s when ~~attached-attaching~~ to a running network. If an [ECU-CA](#) receives an Address Claimed message claiming its own source address, it should compare the NAME that was received in the Address Claimed message with its own NAME and determine which [ECU-CA](#) has a higher priority NAME (lower numeric value as described in 4.4.3.3). If the [ECU-CA](#) receiving the Address Claim determines that it has the higher priority NAME it may then transmit an Address Claimed message containing its NAME and address. However if it has the lower priority NAME it should either attempt to claim a different address or send a Cannot Claim Address message. An [ECU-CA](#) which loses address arbitration in this manner and is in the process of sending a transport protocol message should immediately ~~abort the transport~~ ling the transport protocol message and should not send a Transport Protocol isport protocol message must detect the interruption through the normal

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transport protocol timeout process as specified in J1939-21 (1.25 sec.) Queued transport protocol frames should cease within the timeout and constraints given in J1939-21, 5.10.3.4 (50 ms).

Successful claiming of an address by an ECU CA consists of sending an Address Claim message for the address to be claimed and not receiving contending claims for ~~the that~~ address ~~that the ECU CA has claimed from other ECUCAs for 250 ms with one exception. The exception is for~~ Fixed Address ECUCAs with addresses in the 0-127 and 248-253 ranges ~~which have successfully claimed an address may begin regular network communications~~ immediately after sending the address claim message. ~~Other An ECU CAs~~ should not begin or resume origination of normal network traffic until ~~successfully 250 ms after~~ claiming an address (See Figure A1) ~~to allow contending claims to be made before the address is used.~~ An ECU CA may send the Cannot Claim Address message (See 4.2.2.2) or a Request for Address Claim using the null address as a source address (See 4.2.1) without having successfully claimed an address. A network interconnection ECUCA may not use its own address in communications on the network until it has successfully claimed an address. Handling messages of other ECUCAs is a special case for network interconnection devices. Network interconnection devices acting entirely as repeaters may pass messages bearing the originator's Source Address before claiming their own addresses (For further requirements for network interconnection devices see SAE J1939-31).

Configuration of networks with multiple bridges may create significant delay between transmission and reception of address claims which traverse the bridges. The 250 ms delay may not be adequate in these systems to prevent further arbitration after an ECUCA has successfully claimed an address.

Once an ECU CA has successfully claimed an address, it may respond to a Request for Address Claim and immediately resume transmitting other messages on the network.

~~No valid claim may be made for~~ Address 254, the null address, ~~should not be claimed for use by an ECU CA and if an An Address Claimed message is sent with address 254 as the source address, the message will be interpreted as is~~ a Cannot Claim Address message (see 4.2.2.2).

The Address Claimed message should always be sent to the global address (255) to provide all ECUs on the network the information to maintain a current address to NAME correspondence. The address claim message is an exception to the requirements on request messages specified in SAE J1939-21. (SAE J1939-21 defines that a request message which is directed to a specific address be responded to with the destination set to the requester.)

4.2.2.1 Address Claimed Message

Transmission rate:	As required
Data length:	8 bytes
Data page	0
PDU format:	238
PDU specific:	255 (global address)
Default priority:	6
Parameter group number:	60928 (00EE00 ₁₆)
Source Address	0 to 253 (<u>Address claimed for the Controller Application</u>)

NAME of Controller Application

Byte: 1	Bits 8-1	Least significant byte of Identity Number	See 4.1.1.11
Byte: 2	Bits 8-1	Second byte of Identity Number	See 4.1.1.11
Byte: 3	Bits 8-6	Least significant 3 bits of Manufacturer Code	See 4.1.1.10
	Bits 5-1	Most significant 5 bits of Identity Number	See 4.1.1.11
Byte: 4	Bits 8-1	Most significant 8 bits of Manufacturer Code	See 4.1.1.10
Byte: 5	Bits 8-1	Function Instance	See 4.1.1.8
		ECU Instance	See 4.1.1.9
		Function	See 4.1.1.7

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Byte: 7	Bits 8-2	Vehicle System	See 4.1.1.5
	Bit 1	Reserved	See 4.1.1.6
Byte: 8	Bit 8	Arbitrary Address Capable	See 4.1.1.2
	Bits 7-5	Industry Group	See 4.1.1.3
	Bits 4-1	Vehicle System Instance	See 4.1.1.4

4.2.2.3-2 NAME of Controller Application

Identifies a particular communications function within the ECU.

Data Length:	8 Bytes
Resolution:	See 4.1.1.1
Data Range:	0 to 18446744073709551616
Type:	Status
Suspect Parameter Number:	TBD
Reference:	4.2.2.1 and 4.2.2.3

4.2.2.2-3 Cannot Claim Address

The Cannot Claim Address message is the same PGN as the Address Claimed message but has a source address of 254, the null address. A Cannot Claim Address message is transmitted by any ~~ECU~~ CA which cannot claim its preferred address and does not have self-configurable addressing capability, or has self-configurable addressing capability but cannot claim an address because none are available for use.

The Cannot Claim Address message may be sent as a response to a Request for Address Claim message ~~or to an Address Claim message~~. A pseudo-random delay of between 0 and 153 ms should be inserted between the reception of a message triggering the response and the Cannot Claim Address response. The delay is intended to minimize the potential that two Cannot Claim Address messages will cause bus errors. The method for generating the pseudo-random delay is described in 4.4.3.3.

An ECU which cannot claim an address shall not send any message other than the Cannot Claim Address message or a Request for Address Claim.

4.2.3 Commanded Address

A network interconnection ~~ECU~~ CA, a bridge for example, or a diagnostic or scan tool may command another ~~ECU~~ CA (Commanded ~~ECU~~ CA) to use a given source address with the Commanded Address Message. The Commanded Address message may be used to instruct an ~~ECU~~ CA with a specific NAME to use a specific source address (Figures A9 and A10 in appendix A). Upon receipt of a Commanded Address message containing its own NAME, an ~~ECU~~ CA should respond in either of two ways: ~~it~~ it may accept by initiating an address claim procedure using the new address provided in the Commanded Address message or ignore the command by sending no response. If the commanded address is successfully claimed, future transmissions from the ~~ECU~~ CA should use the commanded address until another Commanded Address message is received or, through power-up or address contention, another address claim process is completed. If the Commanded ~~ECU~~ CA elects to receive the Commanded Address message and cannot change to the commanded address, it should ignore the commanded address ~~and issue an address claim for its current address~~. A state transition diagram describing the process for handling a commanded address is presented in Appendix D, Figure D3. Note that if the Commanded ~~ECU~~ CA does not accept the commanded address, an operator or technician may have to modify the ~~ECU's~~ CA's source address or NAME through alternate means for the network to operate. If the source address or NAME is modified, the ~~ECU~~ CA must re-issue an Address Claim before originating transmissions on the network. An ECU manufacturer may elect not to accept Commanded Address other than service tools or bridges. Further, ECU manufacturers may require cation process before accepting a Commanded Address message.

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The Commanded Address message contains 9 bytes of data and should be sent using the Broadcast Announce Mode (BAM) of the transport protocol (SAE J1939-21) and should be sent to the global address (255). ~~ECUs~~ CAs designed to support the Commanded Address message must also support the BAM form of the Transport Protocol.

4.2.3.1 Commanded Address Message

Transmission rate:	As required
Acknowledgement:	See Figures A9 and A10 in Appendix A
Data length:	9 bytes
Data page:	0
PDU format:	254
PDU specific:	216
Default priority:	6
Parameter group number:	65240 (00FED8 ₁₆)

NAME of Commanded Address Target

Byte: 1	Bits 8-1	Least significant byte of Identity Number	See 4.1.1.11
Byte: 2	Bits 8-1	Second byte of Identity Number	See 4.1.1.11
Byte: 3	Bits 8-6	Least significant 3 bits of Manufacturer Code	See 4.1.1.10
	Bits 5-1	Most significant 5 bits of Identity Number	See 4.1.1.11
Byte: 4	Bits 8-1	Most significant 8 bits of Manufacturer Code	See 4.1.1.10
Byte: 5	Bits 8-4	Function Instance	See 4.1.1.8
	Bits 3-1	ECU Instance	See 4.1.1.9
Byte: 6	Bits 8-1	Function	See 4.1.1.7
Byte: 7	Bits 8-2	Vehicle System	See 4.1.1.5
	Bit 1	Reserved	See 4.1.1.6
Byte: 8	Bit 8	Arbitrary Address Capable	See 4.1.1.2
	Bits 7-5	Industry Group	See 4.1.1.3
	Bits 4-1	Vehicle System Instance	See 4.1.1.4
Address Assignment			
Byte: 9	Bits 8-1	New source address	See 4.2.3.2

4.2.3.2 NAME NAME of Commanded Address Target

Identifies a particular communications function within the ECU.

Data Length:	8 Bytes
Resolution:	See 4.1.1.1
Data Range:	0 to 18446744073709551616
Type:	Status
Suspect Parameter Number:	TBD
Reference:	4.2.3.1

4.2.3.3 Address Assignment (new source address)

This 8 bit field is the 9th byte of the data field of the Commanded Address message. It contains the source address that is to be assigned to the ~~ECU~~ CA that has the NAME corresponding to the one conveyed in the first eight bytes of this Commanded Address message. All messages originating from this ~~ECU~~ CA after reception of the Commanded Address message and successful claim of that address shall use that source address.

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Data Length:	1 Byte
Resolution:	See 4.1.2
Data Range:	0 to 253
Type:	Status
Suspect Parameter Number:	TBD
Reference:	4.2.3.1

4.2.4 Working Sets

A Working Set is a concept intended to streamline communications among devices on a network where several applications each with a distinct NAME possibly within different ECU's on different network nodes are acting as distributed processes to create a single function as far as communication is concerned.

This is particularly important on an Ag Implement Bus where several dissimilar NAME's-CA's (probably within different ECU's) are intended to co-operate as a single Implement or terminal. The Working Set can, for network purposes, allow the use of a single Address as a subset of the "global" destination for one-to-many communications, and to permit the receiver of many-to-one communications to associate each of the many entities with the others that form the particular set. The format for the communications becomes one-to-one in each case, with the user device sending all data for the Working Set to the address of the network NAME-CA that has taken the role of Working Set Master. All members of the Working Set listen to messages addressed to the Master as though those messages were sent to each member individually. Messages sent by members of the Working Set are associated with the Set (see the example of the Virtual Terminal below) as far as data entry is concerned. The response to a Request by a member of a Working Set will, in general, be sent to the Working Set Master and thus be heard by all of the members of the Working Set. Working Set Masters and Members need to have additional programming that allows for local determination of when messages may be specific to the Master so that programming operations or Fault Table erasure commands are not taken as applying to the entire Working Set.

Initial use of Working Sets will be in the construction and agriculture areas, where the need is for several NAME's-CA's each within different ECU's to function as the Virtual Terminal. And additionally for several NAME's-CA's not necessarily within different ECU's upon an implement system (planter for instance) to communicate with the Virtual Terminal in a way that the VT understands that all of those NAME's are supplying data as a single VT entity. Similarly, a Task Controller may need to command several CANAME's to take an action - if they are all members of a Working Set, the command sent to the Working Set Master will accomplish the same thing as a series of commands sent to each of the individual NAME's-CA's in the Set. This will relieve the data link message loading in cases where there is a distribution of functionality and reduce the work required of a controller that needs to send commands or other "destination specific" messages to all of the members of the Working Set. Further expansion of the need for Working Sets might be a multiple engine electric power generation system where speed change commands might apply to all of the power units, or tractor-trailer combinations where a single command should apply to all of the NAME's-CA's (regardless of the number of ECU's they reside within) on a given trailer (the trailer Bridge device might be the Master.)

Two message types are needed to define a Working Set. The first is a definition of the set's size, the second identifies the members of the set. All of these messages (the "Working Set Master" defining the Set size, and the series of "Working Set Member" messages giving the NAMES of all Members except the Master) are transmitted by the Master.

4.2.4.1 Application Notes

4.2.4.1.1 Message sequence

A "Working Set Master" message must always be followed by the appropriate (one less than Working Set size) number of "Working Set Member" messages. A user of the Working Set that does not receive member definitions must request the "Working Set Master" PGN from the Master [the first sentence in this note means that the Master must completely this request.]

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4.2.4.1.2 Working Set Member Message Spacing

Working Sets will be defined by the NAMES of the Working Set Members. "Working Set Member" messages should be sent with a spacing of about 100msec. between them. If more than 350msec. elapses after a "Working Set Member" message, the receiver may assume that the Working Set Master believes the list to be complete.

4.2.4.1.3 Compatibility with conventional network processes

Working Set Members are still individual functions on the network, and as such will still communicate as individuals. Fault messages will be sent from the [ECUCA's SA](#)source address (SA), and any commands to clear fault tables, program parameters, etc, will still be addressed to the individual SA of the intended [ECUCA](#) in most cases. Working Set Members must be programmed to allow for such individual communications to the Working Set Master without having all of the Member [ECUCAs](#) accept programming not intended for them. While it is possible that programming of common data into all Members of the Working Set will be intended, that is not the most likely occurrence and will require that the Member NAME's have application software to allow this to take place. Applications that do not work with Working Sets may ignore the Working Set messages and communicate directly with all other network devices.

4.2.4.1.4 Constraints on Working Set Membership

Each [NAME-CA](#) on the network may be a member of at most one Working Set. If an existing Working Set Master issues a new "Working Set Master" message, users of Working Sets on the network must replace the old Working Set definition with the new one. Working Set Masters should accept the responsibility of re-defining their Working Set if they know of needed changes, and may send a "Working Set Master" message with data of zero if the Working Set's purpose is finished. Users of the Working Set should not count on receiving such a message.

4.2.4.1.5 Configuration changes

A change of the NAME of the Working Set Master will require that it create a new Working Set. The old Working Set will cease to exist but its definition will remain in the memory of the user devices until some clean-up method is exercised. Although it would be convenient if all Working Set Masters cleared their Sets before changing their NAMES, that is not likely to happen at all times. The burden of detecting and correcting problems like duplication of Members is on the user of the Working Set. Users of Working Sets will have to periodically check for duplications and for unused Working Sets in order to recover the internal memory used for those Sets that are no longer active. Note that a change in the Source Address of the Working Set Master will NOT change the definition of the Set; users should update the association of SA to NAME when the new Address Claim is received, and Members must change the address they expect to receive Working Set communications through.

4.2.4.1.6 Source Address changes

A change in the Source Address of a Working Set Member will result in the need for the users of Working Sets to associate the new SA with the appropriate Working Set. Since the Working Set Members are defined by NAME, the SA change (assuming that the NAME is unchanged) can be handled by the Working Set users as they receive new Address Claim messages.

4.2.4.1.7 Missing Working Set members

A Working Set may be created with Members included that are not currently on the network. Users should create the Working Set with the total number of Members as specified, and add the SA of members as they claim addresses. This process differs little from the above process of changing the SA of a Member that is active but which changes SA due to a later address claim by another device. In such a case it is the responsibility of the Working Set Master to know the NAMES of all of the potential members. Alternatively, the Master can revise the Working Set definition when the members are added or removed.

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The term "user" in these notes is intended to mean a ~~network-controller~~ application ~~(CA) (whether an ECU or merely a function within an ECU)~~ that understands Working Sets and knows how to communicate with the Set as a separate entity. It is not a member of the set being described, but is not prohibited from being a Member (or Master) of another Working Set.

4.2.4.2 Working Set Master Message

This message is sent by the Master of a Working Set to identify how many members there are in said set. The Master counts as a member in the total. The source address of this message should be used associated with the Master's NAME. Also particular Working Sets may be identified by their Master's NAME.

Transmission rate:	As required
Data length:	8 bytes
Data page:	0
PDU format:	TBD PDU2 Global
PDU specific:	TBD
Default priority:	7
Parameter group number:	TBD (00?16)

Number of Members			
Byte: 1	Bits 8-1	Number of Members in Working Set	See 4.2.4.4
Bytes 2-8:		reserved	

4.2.4.3 Working Set Member Message

This message is sent by the Master of a Working Set to identify an individual member of a specific Working Set (Master's Source Address identifies the particular Working Set). There will be a number of these messages sent by any particular Master. The number of messages will be one less than the number of members in the Working Set. No message is required to identify the Master's NAME. This may be obtained from the Master's Address Claim. This message structure requires that units communicating with a Working Set must verify that they have received the appropriate number of Working Set Member messages so that they can identify all of the members of the particular Working Set.

Transmission repetition rate:	As required
Data length:	8 bytes
Data page:	0
PDU format:	TBD PDU2 Global
PDU specific:	TBD
Default priority:	7
Parameter group number:	TBD (00?16)

NAME of Working Set Member	NAME of this specific member of the Working Set identified by the source address of this message.	
Byte: 1	Bits 8-1	Least significant byte of Identity Number
Byte: 2	Bits 8-1	Second byte of Identity Number
Byte: 3	Bits 8-6	Least significant 3 bits of Manufacturer Code
		Most significant 5 bits of Identity Number
		Most significant 8 bits of Manufacturer Code
		Function Instance

See 4.1.1.11
See 4.1.1.11
See 4.1.1.10
See 4.1.1.11
See 4.1.1.10
See 4.1.1.8

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	Bits 3-1	ECU Instance	See 4.1.1.9
Byte: 6	Bits 8-1	Function	See 4.1.1.7
Byte: 7	Bits 8-2	Vehicle System	See 4.1.1.5
	Bit 1	Reserved	See 4.1.1.6
Byte: 8	Bit 8	Arbitrary Address Capable	See 4.1.1.2
	Bits 7-5	Industry Group	See 4.1.1.3
	Bits 4-1	Vehicle System Instance	See 4.1.1.4

4.2.4.4 Number of Members

Provides the count of the number of members in a particular Working Set. The particular Working Set is identified by the NAME of the Working Set Master, which is associated with the Source Address of the message containing this parameter. No member (as identified by a specific NAME, ~~not by ECU~~) may belong to more than one Working Set at a time.

4.2.4.5 NAME of Working Set Member

The identifier of the particular ~~communications function within the ECU~~ that is a member of the Working Set identified by the source address of this message. This parameter is a NAME with the format described in 4.1.1.

Data Length:	8 Bytes
Resolution:	See 4.1.1.1
Data Range:	0 to 18446744073709551616
Type:	Status
Suspect Parameter Number:	TBD
Reference:	4.2.3.1

4.3 Network Error Management

Network Error Management exists to provide a means of detecting addressing related errors, for example, failure of an ~~ECU~~ to successfully claim an address. Other addressing related errors, for example duplicate address claims or duplicate NAMES may be detected by a diagnostic tool through the use of the request for address claim capability.

4.3.1 Cannot Claim Address

If an ~~ECU~~ has attempted and cannot successfully claim a source address because the address(s) it attempted to claim are already claimed on the network by an ~~ECU~~ with a higher priority NAME, a Cannot Claim Address error exists.

4.4 Address Claim and CA Initialization procedure

The Address Claimed message is used by each ~~ECU~~ to acquire a unique address on the vehicle network after completing its own Power On Self Test (POST) and before originating other communications messages. The procedure below assures that any duplicate addresses are detected during initialization processes and resolved at that time.

4.4.1 Address claim requirements

Every ~~ECU~~ is required to claim its source address upon initialization and upon any change of the ~~ECU's~~ NAME or source address. An ~~ECU~~ may support and act on a Commanded Address message, in which case, the later requirement provides confirmation that the Commanded Address message was accepted. The requirement also assures that each ~~ECU~~ take responsibility for and that other ~~ECUs~~ properly arbitrate for the address if their address is claimed by the ~~ECU~~.

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The destination address for an address claim should be global (255) to "announce" the claim message to all ECUs/CAs on the network.

~~In ECUs/CAs where messages sent by the ECU/CA are also received by the same ECU/CA, the ECU/CA A CA that is configured to receive messages that it transmits~~ should be able to differentiate between Address Claimed messages received from itself and those received from other ECUs/CAs. This capability is necessary to allow duplicate addresses to be detected.

4.4.1.1 Requirements for requests for Address Claimed

The source address for a request for Address Claimed message must be the null address (254) if the request is from an ECU/CA that has not yet successfully claimed an address.

4.4.2 Initialization rules

The following rules apply to all ECUs/CAs (minimum requirements):

4.4.2.1 Response to a Request for Address Claimed sent to the global address

An ECU/CA should always respond to a Request for Address Claimed directed to the global address with either an Address Claimed message or if the ECU/CA has not been successful in claiming an address, a Cannot Claim Address message. ~~The ECU/CA should not respond at all if the ECU/CA has not yet attempted to claim an address (See 4.2.1).~~

4.4.2.2 Response to a Request for Address Claimed sent to a specific address

An ECU/CA should always respond to a Request for Address Claimed where the destination address of the request is the ECU/CA's address. The response to the request, the Address Claimed message, should be sent to the global address (255).

4.4.2.3 Response to address claims of own address

An ECU/CA should transmit an address claim if it receives an address claim with a source address that matches its own, and if its own NAME is of a lower value (higher priority, see 4.4.3.3) than the NAME in the claim it received. If the ECU/CA's NAME is of a higher value (lower priority, see 4.4.3.3) than the NAME in the claim it received, the ECU/CA should not continue to use that address. (It may send a Cannot Claim Address message or it may attempt to claim a different address.)

4.4.2.4 Contention for an address

An ECU/CA that discovers it cannot use an address due to a higher priority competing claim, should either send a Cannot Claim Address message (Non-configurable, Service configurable, or Command configurable) or select another address and attempt to claim that address (Self-configurable). An ECU/CA previously communicating to this ECU/CA should detect that the ECU/CA has become disabled or changed its address by monitoring the Address Claim by the more dominant ECU/CA (lower name value) as well as by monitoring the Cannot Claim Address message. Service tools, and bridges in some systems, may be expected to detect and resolve failures to claim an address. Service tools may monitor the Cannot Claim Address message and report the problem to the operator of the tool.

4.4.3 Message sequences for initialization

Graphical schematics of the initialization sequences for the different ECUs/CAs under the various potential conditions are provided in Figures A1 to A7 in Appendix A. The conditions under which each figure applies is specified in the paragraphs below. The address and NAME prioritization process used in the figures is presented in 4.4.3.3. State transition diagrams describing address claiming processes are presented in Appendix D, Figures D1, D2, and D3.

4.4.3.1 Message sequences for initialization for all ECUs/CAs on the network

Message sequences for initialization of all ECUs/CAs using the network are shown in Appendix A, Figures A1, A2, A3 and A4. The conditions under which the sequence applies is summarized in the table below.

Figure	Condition under which sequence is applicable
	Initial address claim where no contention occurs.
	Claiming the same address, but not synchronized.
	Where NAME A is less than NAME B and <u>ECU/CA</u> B is Self Configurable

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A4 ECUCAs claiming the same address, synchronized.

4.4.3.2 Potential Identical Identifiers in Network Management Messages

The possibility exists for messages with the same identifiers to be generated by different ECUCAs with three of the network management messages. These messages are: 1) request for Address Claimed, 2) Address Claimed, and 3) Cannot Claim Address messages.

1) The sending of a Request for Address Claimed message simultaneously by two different ECUCAs which are both sending from the null address (254) is not a problem because the data field is the same for both messages.

2) The sending of an Address Claimed message simultaneously by two different ECUCAs, which are contending for the same address, will cause bus collisions because the NAMES in the data field of the message will be different. See 4.4.3.3 for the resolution method.

3) The sending of a Cannot Claim Address message simultaneously by two different ECUCAs from address 254 will cause bus collisions because the NAMES in the data field will be different. See section 4.4.3.3 for the resolution method.

4.4.3.3 Address Claim Prioritization

In the event that an address is contended for by two ECUCAs, priority shall be allotted to the ECUCA with the lowest numerical value of the NAME. The NAME should be treated as a single 8 byte numerical value. For determination of value, the Arbitrary Address Capable bit should be considered the most significant bit. For example, should Engine 0 and Engine 1 both desire the same address, Engine Instance 0 will have a lower absolute value NAME and therefore will win address arbitration. This process is shown in Figures A2 and A3 in Appendix A.

Although this requires comparison of the 8-byte NAMES in the Address Claimed Message data fields, it eliminates ambiguity in the address claiming process.

If multiple ECUCAs have the same address and different NAME, simultaneous Address Claimed messages will result in bus errors. To minimize the probability of modules generating bus errors until going bus off, the following special processing should be used when transmitting claim messages.

After transmitting any claim message, the transmitting ECUCA should monitor error code information. If the error code indicates that a bus error has occurred, any automatic retransmission attempts by the CAN peripheral should be canceled if possible.

The re-transmission of the claim message should be re-scheduled after end of frame plus a transmit delay.

The transmit delay will be calculated to produce a pseudo-random value between 0 and 255. The NAME, serial number or other unique information within the ECUCA should be selected by the manufacturer to seed the pseudo-random number generator. The transmit delay will be added to the normal idle period before the next claim message is transmitted. The module should be able to schedule the next claim message within ± 0.6 ms of the calculated delay.

The delay will be calculated by multiplying the 0 to 255 output of the pseudo-random number generator by 0.6 ms (The maximum time one message requires on the bus) producing a delay range of 0-153 ms. If a second claim message transmission results in a bus error, the process should be repeated with a new pseudo-random number.

illustrates the process of simultaneous claims by two ECUCAs of the same

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4.4.3.4 ~~An~~ EGUCA CA Which Cannot Obtain An Address.

The message sequence for answering a request for Address Claimed ~~for by an~~ EGUCa CA which cannot obtain an address is shown in Figure 8. The EGUCA should respond to a request for Address Claimed with a Cannot Claim Address message after a transmit delay (See Section 4.4.3.3.) In the case where there is a collision of the Cannot Claim Address messages, the process in 4.4.3.3 should be used. ~~An~~ EGUCA CA which cannot claim an address may send no messages except 1) A Cannot Claim Address message in response to requests for Address Claimed or to respond to a Commanded Address message, or 2) A request for Address Claimed message.

4.4.4 Requests for Address Claimed for Self-Configurable Addressing EGUCAs

A Self-Configurable Addressing EGUCA may elect to obtain a list of the addresses already claimed on the network before itself claiming an unused address. Note that the EGUCA may, upon discovery that its preferred address has been claimed, request the addresses of all EGUCAs on the network using the source address of 254 and then claim an address that was not previously claimed. Preferably, a Self-Configurable Addressing EGUCA will transmit a request for Address Claimed with a destination address set to the preferred address it would like to claim for the purpose of finding an unclaimed address. The Address Request sent to the global address should be used with care since it generates a response from every EGUCA on the network (Appendix A, Figure A6). The specific request can be directed at an address which is not likely to be occupied and will minimize message traffic (Appendix A, Figure A5).

4.4.4.1 Technical Note Regarding Multiple Self-Configurable Addressing EGUCAs

Special care should be taken in the design of self-configurable addressing EGUCAs if more than one of a manufacturer's ECUs may be connected in a system. These EGUCAs may have the same initialization algorithm and may issue simultaneous initial Address Claimed messages. If these EGUCAs attempt to claim the same address, a bus-OFF condition is likely to occur. Manufacturers should design EGUCAs of this type to minimize the probability that they issue initial address claims at the same time. Alternatively manufacturers may design EGUCAs of this type to minimize the probability that the EGUCAs initially claim the same addresses. The use of both of these techniques would significantly improve (shorten) initialization time.

4.4.4.2 EGUCAs not permanently connected to the network.

A request for Address Claimed message may be used to determine if an address is being used before attempting to claim that address. This process allows a self-configurable device to create less address contention when it initializes on the network. This procedure is appropriate for EGUCAs that are not permanently connected to the network, such as tools. Message sequences for initialization of EGUCAs not permanently connected to the network are shown in Appendix A, Figures A5, A6 and A7. The request for Address Claimed message preceeding the claim can be used in identifying an unused address for EGUCAs that are self-configurable.

4.4.5 Construction of Address to NAME Association Tables

Request for Address Claimed sent to a specific addresses or to the global address may be used to construct an address to NAME association table. This table may be used in some EGUCAs to confirm the associations for critical functions, for example, to confirm that the powertrain engine is located at address 0 to insure that torque/speed control messages from the transmission are sent to the proper destination. In EGUCAs where a small number of address to NAME associations are required, Requests for Address Claimed sent to a specific address should be used. In a diagnostic tool where all of the EGUCAs on a network need to be inventoried, a Request for Address Claimed sent to the global address is appropriate.

4.5 Minimum Network Management Functionality

ie Network Management protocol include more than the minimum required for ig on a SAE J1939 network. The minimum network procedures are those

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without which [an ECUa CA](#) cannot operate on a SAE J1939 network. They are described in the following clauses.

4.5.1 Reaction to Power Supply and Other Related ECU Disturbances

Due to the questionable integrity of power supplied to ECUs on towed vehicles and the time required for address re-arbitration, the following criteria are established. For all ECUs which are powered through a tractor interface connector on a towed subnetwork (corresponding to a breakaway connector for the agricultural industry group), any disturbance, such as momentary power loss, that lasts less than 2 ms (with 10 ms recommended) should not result in network re-initialization (a new round of address claim). This does not preclude [an ECUa CA](#) from performing any degree of reset or re-initialization within the [ECUCA](#). The [ECUCA](#) must retain its NAME, address, and any NAME/address tables used by that [ECUCA](#) through such a disturbance. For disturbances of longer duration or higher frequency, network re-initialization may be performed and is required if the disturbance is longer than 1 second. The required re-initialization after 1 second is needed to force towed vehicle systems to reinitialize after disconnection from the towing vehicle.

There is no requirement for towing vehicles.

4.5.2 Minimum Network Management Capability

The following section describes minimum network management capability for [ECUCAs](#) to operate on a SAE J1939 network. A summary of the requirements and capabilities for SAE J1939 [ECUCAs](#) is provided in Appendix B.

4.5.2.1 Request for Address Claimed Message

Upon receipt of a Request for Address Claimed message, [an ECUa CA](#) must transmit an Address Claimed message. ~~This message will contain containing its current address if it has already successfully claimed, its proposed address if it has not yet attempted a claim, or the NULL address if it has tried to claim an address and failed. if it cannot claim an address for whatever reason, it should transmit a Cannot Claim Address message using the null address in the source address field unless the ECUCA has not yet attempted to claim an address.~~ [ECUCAs](#) which have not yet attempted to claim an address should not participate in network communications until the [ECUCA](#) has attempted to claim an address. These [ECUCAs](#) should not send a Cannot Claim Address message or any other message until an Address Claim has been attempted.

Note that [an ECUa CA](#) should also respond to its own request for Address Claimed message.

4.5.2.2 Address Claimed Message Before Using a Source Address

No [ECUCA](#) may originate a message on the network until ~~250 milliseconds after it has transmitted an Address Claimed message without address contention~~ it has successfully claimed an address (see section 4.2.2) with ~~four~~ these exceptions:

- ~~1. If a Cannot Claim Address message has been issued by the ECUCA, it should respond to a request for Address Claimed message directed to the global address (255) by retransmitting the Cannot Claim Address message. The ECUCA may also transmit a Request for Address Claimed but should not transmit other messages.~~
- ~~2. The ECUCA may transmit a Request for Address Claimed using the null address as a source address.~~
- ~~3. The CA must respond to a request for Address Claimed message directed to the global address (255) by transmitting its claim: see Section 4.5.2.1 for details.~~
- ~~4. Fixed Address ECUcAs with addresses in the 0-127 and 248-253 ranges may originate a message on the network immediately after sending an address claim message.~~
4. A network interconnection device acting entirely as a repeater may pass messages bearing s of the originator before claiming its own address (For further requirements on connection devices see SAE J1939-31).

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Once an ~~ECU~~_a CA has successfully claimed an address, it may respond to a Request for Address Claimed and immediately resume transmitting other messages on the network.

If the source address or NAME of an ~~ECU~~_a CA is modified, (for example, through the Commanded Address message or through proprietary techniques) the ~~ECU~~_a CA must re-issue an Address Claim before originating transmissions on the network.

4.5.2.3 Disruption of the network during connection or disconnection of an ECU

Connection, disconnection, or powerup of the ECU should not disrupt network communications.

Disruption of the network would consist of uncontrolled transmission of a bit stream to the network during the power-up of an ECU.

4.5.2.4 Continuity of addresses across power-down and power-up cycles

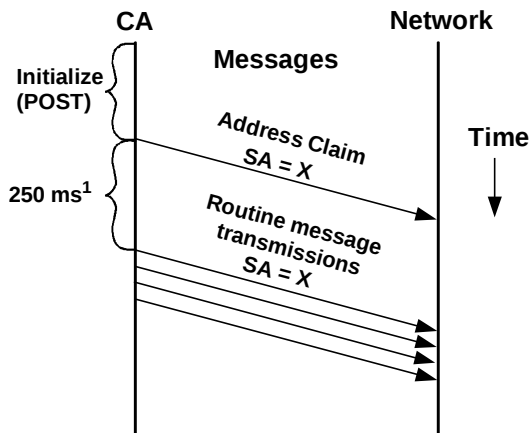
~~ECU~~_as should be able to maintain their source address and any addresses for ~~ECU~~_as that are communicated with so that the ~~ECU~~_a can attempt to use the same addresses at the next power-up.

This should be done except in cases where special requirements override this recommendation, for example in towed subnetworks of On-Highway trailers where the instance and associated addresses of the trailer may change at each power-up.

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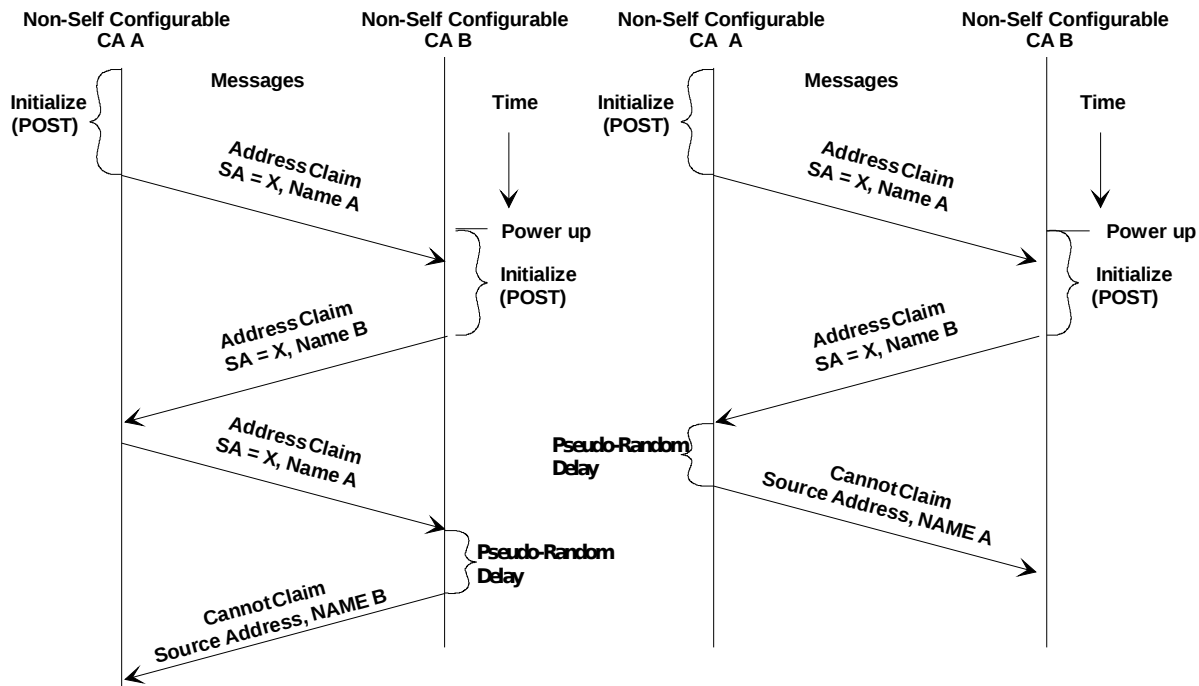
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Appendix A: INITIALIZATION SEQUENCE TIMING DIAGRAMS



1. Fixed Address ECUs-CAs with addresses in the 0-127 and 248-253 ranges may omit the 250 ms delay.

FIGURE A1 - INITIALIZATION OF AN ECU-CA WITH ADDRESS CLAIM AND NO CONTENTION



Where NAME A is less than NAME B

Where NAME B is less than NAME A

FIGURE A2 - INITIALIZATION OF AN ECU WHERE TWO Fixed Address ECUs-CAs ATTEMPT TO CLAIM THE SAME ADDRESS BUT ARE NOT SYNCHRONIZED



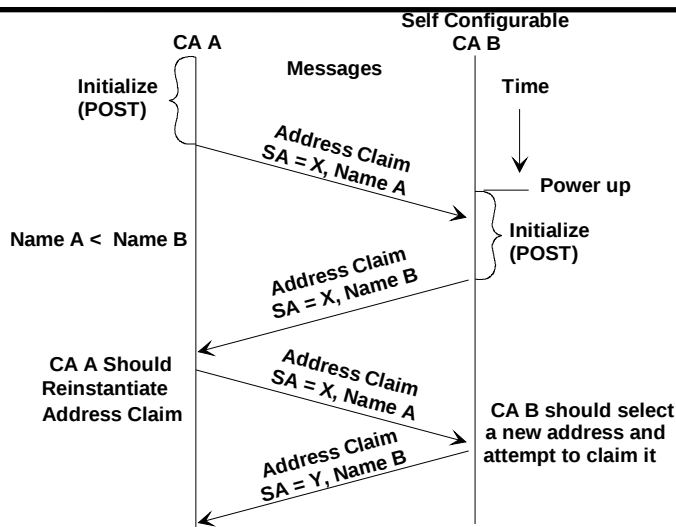


FIGURE A3 - INITIALIZATION OF AN ECU CA WHERE NAME A IS LESS THAN NAME B AND ECU CA B IS SELF-CONFIGURABLE

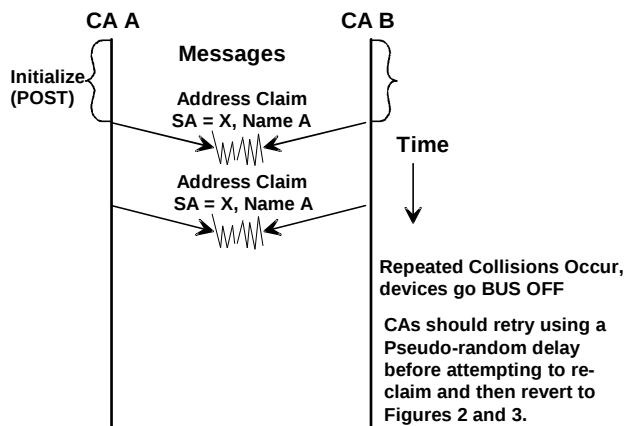
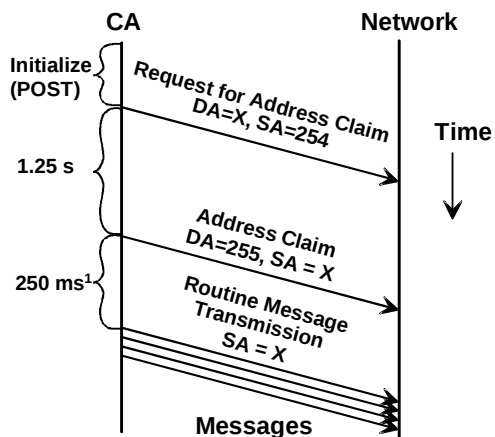


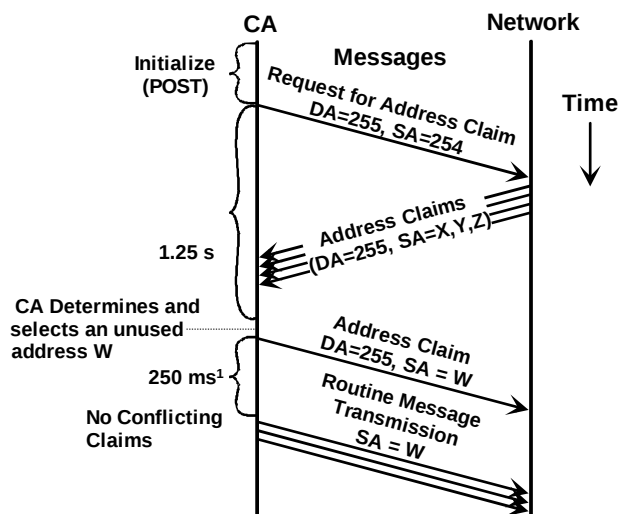
FIGURE A4 - INITIALIZATION OF AN ECU CA WITH TWO ECUs ATTEMPTING TO CLAIM THE SAME ADDRESS BUT WITH SYNCHRONIZED CLAIMS



CAs with addresses in the 0-127 and 248-253 ranges may omit the 250 ms delay.

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FIGURE A5 - INITIALIZATION OF A SELF-CONFIGURABLE ECU-CA WITH NO CONTENTION



1. Fixed Address ECUs-CAs with addresses in the 0-127 and 248-253 ranges may omit the 250 ms delay.

FIGURE A6 - INITIALIZATION OF A SELF-CONFIGURABLE ECU-CA WITH A REQUEST FOR ADDRESS CLAIMED SENT TO THE GLOBAL ADDRESS

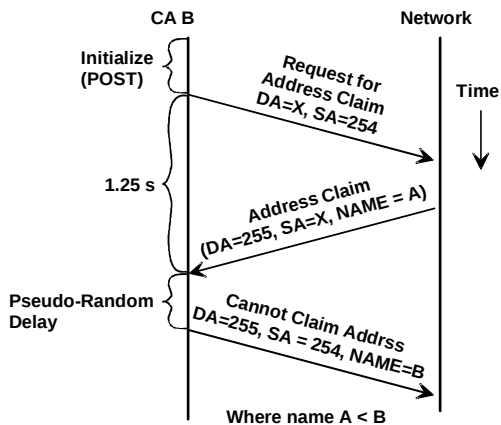


FIGURE A7 - INITIALIZATION OF A Fixed Address ECU-CA WITH A REQUEST FOR ADDRESS CLAIMED WHERE ADDRESS IS IN USE

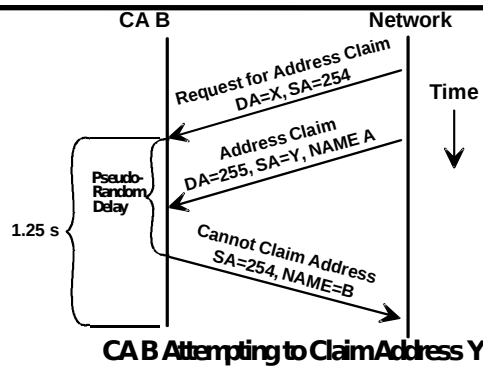


FIGURE A8 - RESPONSE TO A REQUEST FOR ADDRESS CLAIMED BY AN ECU CA WHICH HAS BEEN EARLIER UNSUCCESSFUL IN CLAIMING AN ADDRESS.

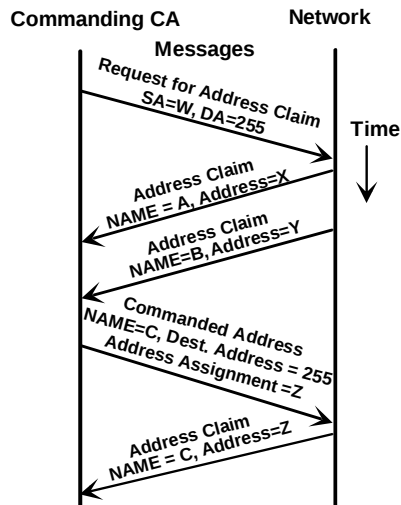


FIGURE A9 - COMMANDING AN ADDRESS OF AN ECU CA WHICH DOES NOT HAVE AN ADDRESS AND SUPPORTS THE COMMANDED ADDRESS MESSAGE

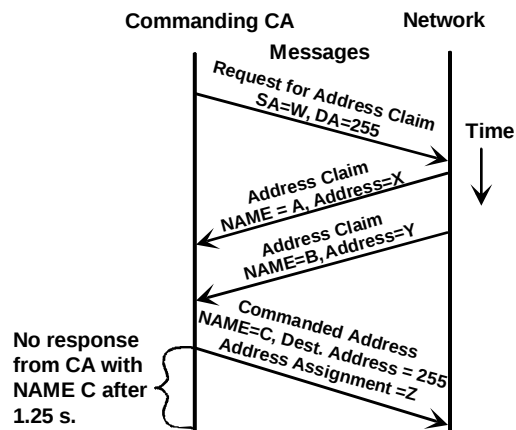


FIGURE A10 - COMMANDING AN ADDRESS OF AN ECU CA WHICH DOES NOT HAVE AN THE COMMANDED ECU CA DOES NOT SUPPORT A COMMANDED MESSAGE

(Note: the commanded ECU may elect not to support the Commanded Address message in which case, the Commanded address message will be ignored.)

Appendix B - SUMMARY OF REQUIREMENTS AND CAPABILITIES OF ECUs¹ **Appendix B - SUMMARY OF REQUIREMENTS AND CAPABILITIES OF CAs¹**

Capability	Standard				Diagnostic / Development Tools				Network Interconnection			
Key: R - Required P - Permissible D - Desirable N - Not recommended or required NA - Not Applicable	Non-Configurable	Service-Configurable	Command Configurable	Self-Configurable	Non-Configurable	Service-Configurable	Command Configurable	Self-Configurable	Non-Configurable	Service-Configurable	Command Configurable	Self-Configurable
Upon receipt of a request for Address Claimed message, an CA should transmit an Address Claimed or a Cannot Claim SA Message (4.5.2.1)	R	R	R	R	R	R	R	R	R	R	R	R
Support Commanded Address Message Containing Own NAME (4.2.3)	NA	P	R	P	NA	D	R	D	NA	D	R	D
Issue a Valid Address Claimed Message before using a Source Address (4.5.2.2)	R	R	R	R	R	R	R	R	R	R	R	R
Support transmission of Commanded Address Message (4.2.3)	P	P	P	P	D	D	D	D	P	P	P	P
Send Request for Address Claim before attempting to claim (4.4.5)	P	P	P	P	D	D	D	D	P	P	P	P
Monitor and correct situations where CAs cannot claim addresses (4.2.3)	N	N	N	N	D	D	D	D	P	P	P	P
Address configuration capability (3.2)	P	P	P	P	N	P	D	D	P	P	P	P
Name field programmability (4.1.1)	NA	D	D	D	NA	D	D	D	NA	D	D	D
Address retained across power up cycle (4.5.2.4)	R	R	R	D	R	R	R	D	R	R	R	D
Name retained across power up cycle (4.1)	R	R	R	D	R	R	R	D	R	R	R	D
Address table retained across powerup (4.5.2.4)	P	P	P	D	P	P	P	D	P	P	P	D

1. Other than the required categories (R), the classifications are provided for general guidance only.

FIGURE B1 - SUMMARY OF REQUIREMENTS AND CAPABILITIES OF ECUsCAs

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Appendix C NAME Examples

C.1 NAME Examples

Three examples of the NAMES are shown below, ranging from a very simple case to a very complex case. Due to the nature of the naming convention, NAMES in these examples are expressed in binary. Appendix B of SAE J1939 should be used as a source when constructing a NAME.

C.1.1 A Single ECU with a CA serving an engine on an On-Highway heavy-duty truck.

From Appendix B, Table B1 of SAE J1939, the Industry Group for this application is On-Highway which has an Industry Group value of 1. (Had the specific application not been identified it would have been correct to place an engine controller within the Global, applies to all, Industry Group.) For a tractor in Industry Group 1, the Vehicle System value is 1 from Appendix B, Table B12 of SAE J1939. The Vehicle System Instance is 0 since there is only one and therefore it must be the first instance. From the pointer to table B11, we find engines are to have a Function value of 0. As this is a single-engine vehicle, the Function Instance value is also set to 0. Since there is only one ECU, the ECU Instance value is 0. The Manufacturer Code, and the Identity Number bits are shown in a generic form. This yields the ECU name as shown in Figure C1:

Self-Configurable Address	Industry Group	Vehicle System Instance	Vehicle System	Reserved	Function	Function Instance	ECU Instance	Mfg. Code	Identity Number
1 bit 0	3 bit 001	4 bit 0000	7 bit 0000001	1 bit 0	8 bit 00000000	5 bit 00000	3 bit 000	11 bit mm...m	21 bit ii...i

FIGURE C1 - SINGLE ECU with a CA SERVING AN ENGINE ON AN ON-HIGHWAY HEAVY-DUTY TRUCK

C.1.2 Brakes on the second trailer of heavy-duty truck.

This example illustrates NAME assignment for a single ECU with a Fixed Address ECU-CA serving a brake controller on the second trailer of heavy-duty truck. From Appendix B, Table B1 of SAE J1939, the Industry Group for this application is On-Highway and has an Industry Group value of 1. The Vehicle System Name value for a trailer is 2 which is found in Appendix B, Table B12 of SAE J1939 under the On-Highway Industry Group. The Vehicle System Instance is 1 for the second Instance of trailer. Brake Controller ECUs-CAs on a trailer are identified as a "Brakes - System Controller" and have a Function value of 11. Assuming this is the only Brake controller on the trailer, the Function Instance value is set to 0. Since there is only one ECU for this ABS functionCA, the ECU Instance value is 0. The Manufacturer Code, and the Identity Number bits are again shown in a generic form. See Figure C2.

Self-Configurable Address	Industry Group	Vehicle System Instance	Vehicle System	Reserved	Function	Function Instance	ECU Instance	Mfg. Code	Identity Number
1 bit 0	3 bit 001	4 bit 0001	7 bit 0000010	1 bit 0	8 bit 00001011	5 bit 00000	3 bit 000	11 bit mm...m	21 bit ii...i

FIGURE C2 - ABS ON THE FIRST TRAILER OF HEAVY-DUTY TRUCK

C.1.3 Agricultural planters with separate row guidance.

This example illustrates NAME assignment for two agricultural planters connected together in a system with separate row guidance on eight individual rows, each row with two ECUs. From Appendix B, Table B1 of SAE J1939, the Industry Group for this application is Agricultural Equipment and has an Industry Group value of 2. For a planter in this Industry Group, the Vehicle System Name value is 4 from Appendix B, Table B12 of SAE J1939. Since this is an agricultural implement 'self configurable addressing' should be the norm and is assumed, thus the Arbitrary Address Capable bit is set to 1. Since there are two planters, the Vehicle System Instances would be 0 for ECUs-CAs on planter 1 and 1 for ECUs-CAs on planter 2. Since the CAs Function is Row Guidance, the Function Name value is not yet defined and represented generically in the name here. The Function Instance field would run from 0 to 7 on each of the planters to identify row 1 through 8. Since there are two ECUs per row, the ECU instances of 0 and 1 would occur for each of the eight Function values. The Manufacturer Code, and the Identity Number bits are again shown in a generic form. The resulting NAMES are shown in Figure C.3:

	Self-Config. Address	Ind. Group	Vehicle System Instance	Vehicle System	Reserved	Function	Function Instance	ECU Instance	Mfg. Code	Identity Number
	1 bit	3 bit	4 bit	7 bit	1 bit	8 bit	5 bit	3 bit	11 bit	21 bit
	1	010	No.	Planter	0	Row Guidance	No.	No.	mm...m	Mfg. Assigned
Planter '1', Row '1', ECU '1'	1	010	0000	0000101	0	ff...f	00000	000	mm...m	ii...i
Planter '1', Row '1', ECU '2'	1	010	0000	0000101	0	ff...f	00000	001	mm...m	ii...i+n
Planter '1', Row '2', ECU '1'	1	010	0000	0000101	0	ff...f	00001	000	mm...m	ii...i+p
Planter '1', Row '2', ECU '2'	1	010	0000	0000101	0	ff...f	00001	001	mm...m	ii...i+q
	...	...	...	...	...	...	...	...	...	...
Planter '2', Row '8', ECU '1'	1	010	0001	0000101	0	ff...f	00111	000	mm...m	ii...i+r
Planter '2', Row '8', ECU '2'	1	010	0001	0000101	0	ff...f	00111	001	mm...m	ii...i+s

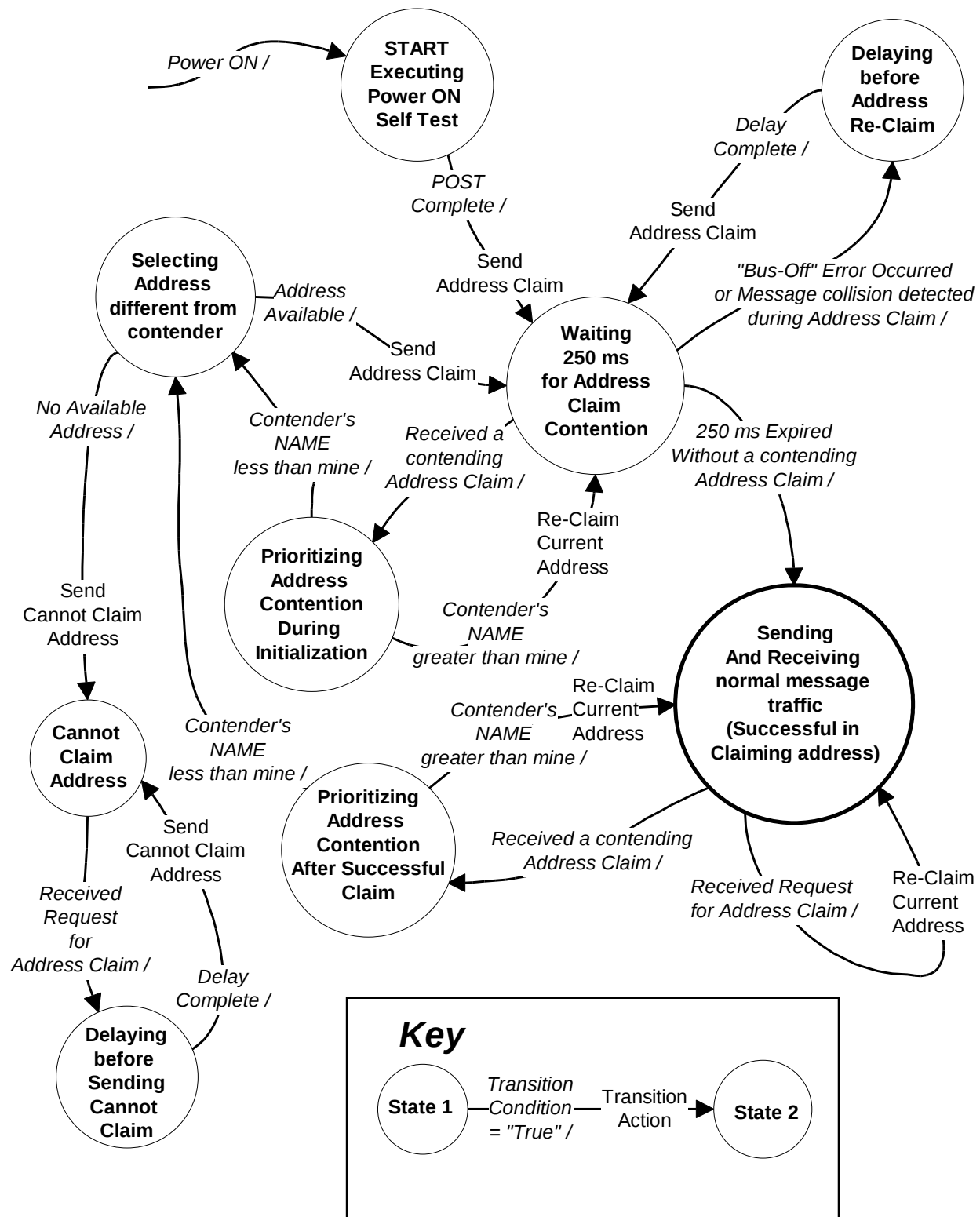
FIGURE C3 - AGRICULTURAL PLANTERS WITH SEPARATE ROW GUIDANCE

Appendix D: STATE TRANSITION DIAGRAMS FOR ADDRESS CLAIMING PROCESSES

State transition diagrams are presented in Figures D1, D2, and D3 for address claiming processes. Processes are presented for initialization of both self-configuring and Fixed Address ECUs and for response to the Commanded Address message. These diagrams are intended to clarify processes outlined throughout this specification. The specifications in the paragraphs of this document have precedence in the event of any discrepancy between the text and figures.

States are shown in the diagrams as circles with the title of the state enclosed in the circle. arrows leaving the states have associated text describing the event that triggers transition from the state. The triggering event text is followed by a slash (/). In most cases, there is an action that takes place after the trigger on entering the next state. The transition action is associated with the arrows leaving a state and is text that is not followed by a slash (/).

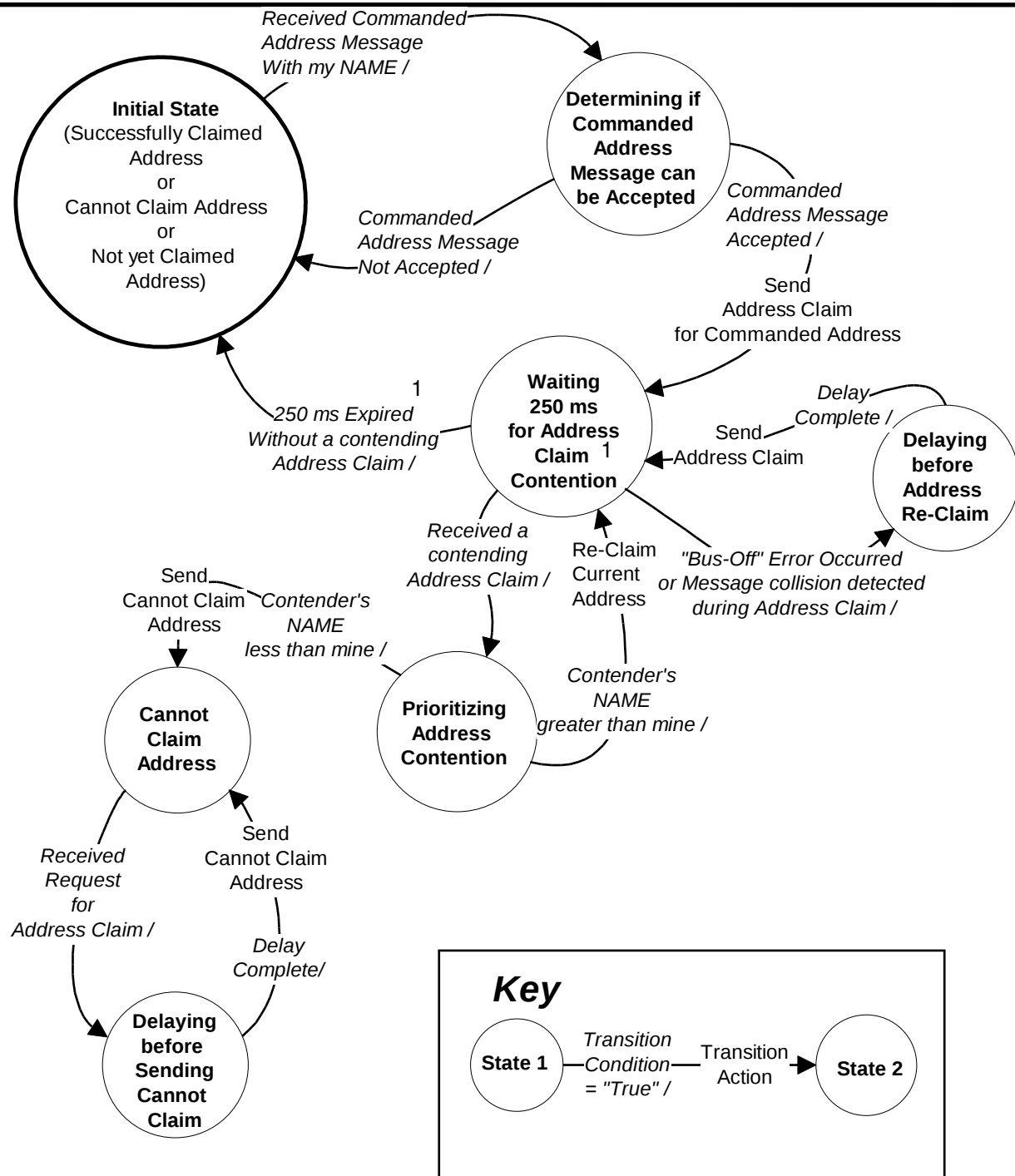




POSITION DIAGRAM FOR INITIALIZATION OF SELF-CONFIGURING

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1. Fixed Address ECUs-CAs with addresses in the 0-127 range may omit the 250 ms delay.

FIGURE D.3 - STATE TRANSITION DIAGRAM FOR RESPONSE OF AN ECU-CA TO THE COMMANDED ADDRESS MESSAGE

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Rationale - Not Applicable.

Relationship of SAE to ISO Standard - Not Applicable.

Application - These Recommended Practices are intended for light and heavy duty vehicles used on or off road as well as appropriate stationary applications which use vehicle derived components (e. g. generator sets). Vehicles of interest include, but are not limited to: on and off highway trucks and their trailers; construction equipment; and agricultural equipment and implements.

The purpose of these Recommended Practices is to provide an open interconnect system for electronic systems. It is the intention of these recommended practices to allow Electronic Control Units to communicate with each other by providing a standard architecture.

Network management in the SAE J1939 network is concerned with the management of source addresses and the association of those addresses with an actual functional and with the detection and reporting of network related errors. Due to the nature of management of source addresses, network management also specifies initialization processes, requirements for reaction to brief power outages, and minimum requirements for ECUs on the network.

Reference Section

SAE J1587 - Joint SAE/TMC Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications

SAE J1939 - Recommended Practice for Serial Control and Communications Vehicle Network

SAE J1939-21 - Data Link Layer

SAE J1939-31 - Recommended Practice for Serial Control and Communications Vehicle Network - Part 31-Network Layer

Developed by the SAE Truck and Bus Control and Communications Subcommittee

Sponsored by the SAE Truck and Bus Electrical and Electronics Committee

