VLCB Versatile Layout Control Busm

Minimum Node Service Specification

Service# 1 MNS

Version 1.1, March 2024, for Service version 1

Compatible with CBUS ® 4.0 Rev 8j

0.1 Table of Contents

0.2 Document History

Date	Changed by	Summary of changes	Service version
22nd December 2022	Ian Hogg M.5144	Initial document	1
12 April 2023	Ian Hogg M.5144	Changed name to VLCB	1
25 April 2023	Ian Hogg M.5144	Updated version number to use Patch number and added more clarity.	1
15 May 2023	Ian Hogg M.5144	Allocated bit 6 of module parameter flags to support for service discovery.	1
01 Sept 2023	Ian Hogg M.5144	Changed Parameter 0 to return the number of supported parameters instead of fixed value of 24.	1
26 Nov 2023	Martin Da Costa M6223	Updated Section 3 and elsewhere for Mode Commands	1

1 Introduction / Description / Explanation

This document describes the VLCB Minimum Node Service (MNS). This service is mandatory for all VLCB modules.

All VLCB modules shall conform to this specification.

Introduction describing the goals and solutions developed for this service.

1.1 Dependencies on other services

The Minimum Node Service does not depend on any other services.

2 Module Modes

2.1 MNS Modes

MNS supports the following operation *modes*:

- Uninitialised
- Setup
- Normal

MNS permits valid transitions between these modes. In addition MNS permits additional sub-modes to be specified by other services.

MNS must store the major mode value for Uninitialised, Setup Normal. It also needs to persist data so that it can tell that it has been assigned a node number and is in Normal mode.

MNS is also responsible for storing a flag indicating whether the module should be producing Heartbeat messages.

2.1.1 Uninitialised Mode

After preparing the module's hardware for operation a newly installed module will start in the Uninitialised mode.

The module must indicate that it is in the Uninitialised mode by showing a green LED or other means. Please see the VLCB Introduction document for possible user interface options.

Note Uninitialised mode is conceptually the same as the CBUS SLiM mode. Operation in this mode is not currently supported.

Any previously held node number should be released with a NNREL message as the module enters Uninitialised mode from Normal or Setup modes.

Messages acted upon: QNN.
Messages possibly sent: PNN, NNREL.

2.1.2 Setup Mode

The module is in the process of being assigned a node number. Only a single module on the network can be in Setup mode at a time. Therefore, should a module in Setup mode detect a Mode-message instructing another module to enter Setup-Mode, it must immediately exit Setup mode and revert to its previous mode. The module shall reclaim its previous node number and send NNACK with this node number to signify its new status.

The module will respond to Setup opcodes, which do not require a node number.

The module must indicate that it is in Setup mode by flashing the yellow LED at 1Hz or other means. Please see the VLCB Introduction document for possible user interface options.

The module does not have a node number whilst in Setup mode. The module should internally assign a value of zero for its node number.

Mode change messages acted upon: SNN.
Mode change messages possibly sent: RQNN and NNACK.

2.1.3 Normal Mode

As the name suggests this is the normal operating mode of the module. The module has a node number and will respond to configuration commands containing a NN matching its own node number.

The module will also consume and produce events, if these are supported.

The module must indicate that it is in the Normal Mode by showing a yellow LED or other means. Please see the VLCB Introduction document for possible user interface options.

Note: Normal Mode is conceptually the same as the CBUS FLiM Mode.

Messages received: Most.
Messages possibly sent: Most.

2.2 MODE Opcode

The MODE opcode 0x76 is used to request that a module changes its mode. The MODE opcode takes a node number and a mode change request number as parameters.

The first 8 mode request values are reserved for transition between the MNS modes, the values 0x0C and 0x0D are used to turn Heartbeat messages on and off, the remainder of the values are available for other services to use.

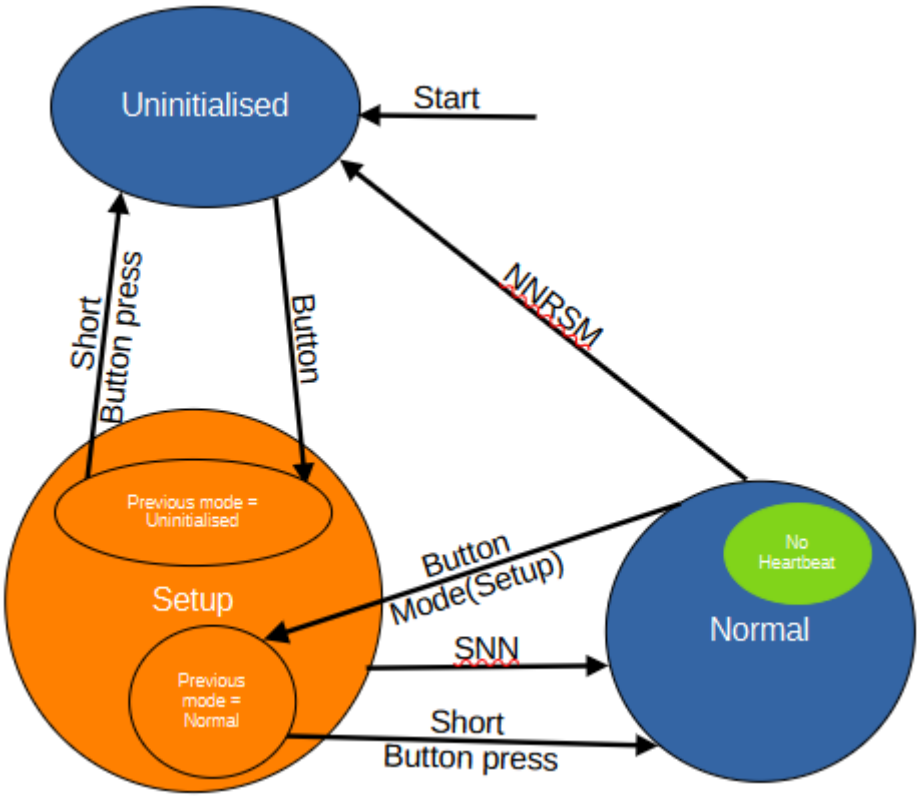
Mode Request Command	Value	Service
change to setup request	0x00	MNS
change to normal requested	0x01	MNS
Reserved	0x02	
Reserved	0x03	
Reserved	0x04	
Reserved	0x05	
Reserved	0x06	
Reserved	0x07	

Available for other service usage	0x08 … 0x0B	Other
Turn on Heartbeat	0x0C	MNS
Turn off Heartbeat	0x0D	MNS
Available for other service usage	0x0E … 0xFE	Other

2.3 Mode transitions

MNS should store a mode variable in RAM which is loaded from non volatile storage upon power up. This variable shall store the possibilities of Uninitialised, Setup, Normal. When the MNS service requires a mode change then this variable is to be updated. If the new mode is either Uninitialised or Normal then the value should also be persisted in the non volatile storage.

The diagram below shows the most commonly used mode transitions.



2.3.1 Factory initial mode

Upon first start of the module the MNS mode should be set to Uninitialised and the NN set to 0. The module should show a green LED or equivalent indication of Uninitialised mode.

Each of the Mode requests are detailed below

2.3.2 Request to move to Uninitialised mode

2.3.2.1 Current mode is Setup mode

If the module was previously in Uninitialised mode then a short button press of at least 1 second and release of the button on the module may be used to move the module back to Uninitialised mode. The module shall send a NNREL to release its current node number.

A MODE command cannot be used for this mode transition, use NNRSM instead.

2.3.3 Request to move to Setup mode

The MODE command cannot be used to request a transition to Setup mode.

2.3.3.1 Current mode is Uninitialised

Note that this mode change is normally initiated by pressing and holding the button for 4 seconds rather than the MODE command. Note that it is NOT necessary to release the button but instead the transition to Setup mode starts whilst the button is down.

- The MNS mode variable should be set to indicate Setup mode.
- Start flashing Yellow LED or equivalent Setup indication.
- Send RQNN with 0 as the existing NN.

2.3.3.2 Current mode is Normal

Note that this mode change is normally initiated by pressing and holding the button for 4 seconds and releasing the button rather than the MODE command.

- The MNS mode variable should be set to indicate Setup mode.
- Start flashing Yellow LED or equivalent Setup indication.
- Send RQNN specifying the current NN.

2.3.4 Request to move to Normal mode

2.3.4.1 Current mode is Setup mode

If the module was previously in Normal mode then a short button press of at least 1 second and then release of the push button on the module may be used to move the module back to Normal mode.

This mode transition request by MODE should be ignored and SNN must be used instead.

- Respond with GRSP(NN, MNS, Invalid Command)
- Continue to show steady Yellow LED or equivalent Normal indication.

For completeness the SNN operation should

- SNN should update mode variable to Normal and persist in non volatile storage.
- NNREL shall be sent if previous NN!=0. SNN should assign and persist the new NN
- The module must then respond by transmitting a NNACK containing its new node number.

2.4 NoHeartbeat Sub-Mode

MNS should also store a heartbeatEnabled flag in RAM which is loaded from non volatile storage upon power up. MNS should send heartbeat messages if it is in Normal mode and the heartbeatEnabled flag is True.

When MNS receives a MODE(Turn on Heartbeat) message the heartbeatEnabled flag should be set and also persisted in non volatile storage.

When MNS receives a MODE(Turn off Heartbeat) message the heartbeatEnabled flag should be cleared and also persisted in non volatile storage.

3 Node Number

A Node Number shall be required for MNS modules, The table below shows the allowed range of numbers that can be freely used

Node Number Ranges	
NN Range	**Use**
0	Reserved for special use by system, E.g. NN==0 is uninitialized.
1-65279 (0x0001-0xFEFF)	Available for user use
65280-65535 (0xFF00-0xFFFF)	Reserved for devices with fixed node numbers

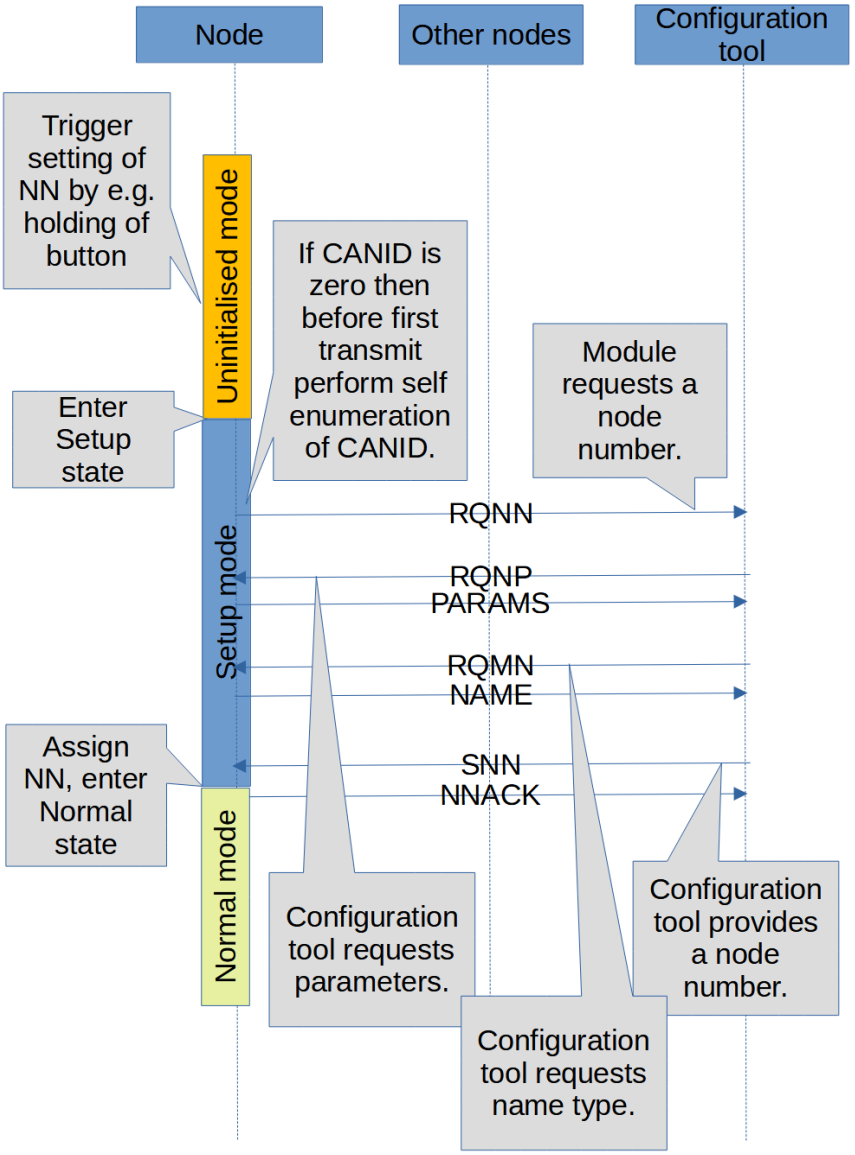
Node number Range

3.1 Duplicate Node Number

The VLCB does not under normal circumstances permit multiple nodes to have the same Node Number. Nodes should avoid this situation, and must implement a detection and reporting (via diagnostics) facility when it sees a response message with its own NodeNumber that it did not send.

3.2 Node Number Assignment

A node must facilitate the assignment of a node number by one or more mandatory methods, namely PushButton, local communication interface or software setup.



Note that, only one node **will** execute a RQNN and SNN, NNREL, NNACK sequence at one time. At the end of this sequence, Parameter 8 Bit 3 shall be set to indicate “Normal” (FLiM) mode.

4 OPCODE support

The list of all MNS mandatory opcodes is recorded here as commands, their parameters, the required action and the required response opcode and action. For the full description, parameter formats and possible errors please see the VLCB MNS opcode specification.

List of Opcodes that MNS must support:

Request to Module	Module's Response	Use/meaning
	RQNN	Request NN (node number). Used to obtain a (new) NN. Enter setup mode.
SNN	NNACK	Set a new NN for the module in setup mode. Exit setup mode
	NNREL	Release previous node number
QNN	PNN	Query NNs
RQNP	PARAMS	Request first 8 parameters
RQMN	NAME	Request module type name
RQNPN	PARAN	Request a single parameter
	CMDERR	Error response
	GRSP	Error response
RDGN	DGN	Request diagnostics
RQSD	SD	Request service discovery
	ESD	Request service discovery
MODE	GRSP	Sets a node's Mode
NNRST		Reset module, just perform a processor restart
NNRSM	NNREL	Restore module to manufacturer's defaults

5 Service Discovery support

The module **will** implement the VLCB Service Discovery protocol.

A service is any feature which a specific module implements **irrespective** of whether that feature is mandatory or not. The Service Discovery lists the current feature list and its feature identification, called the Service#.

5.1 Service Discovery Request

The service Discovery is a command response system, carried out at normal priority.

On receipt of opcode RQSD (request service discovery) directed at a specific node and with a service equal to zero, that node will respond with a SD message indicating the number of services followed by a SD message for each service supported by the module.

The node will respond within 2 seconds with SD for ServiceIndex zero (Minimum Node Specification). All other supported services within 5 seconds.

On receipt of a message with opcode RQSD directed at a specific node and with a non-zero ServiceIndex, that node will respond with a ESD message for that specific service if supported or GRSP(Invalid service) if the node does not support that requested service.

5.2 Service Discovery Response

There will be one SD response for each service supported by the module. The format and data of the command and response is detailed in the VLCB opcode specification.

The version of the service definition implemented by the module is also returned. This is not the version of the software implementation.

5.3 ESD Extended Discovery

In addition the module will implement the Service Discovery extended information option. This uses RQSD with a Service#, the node then responds with ESD which contains additional specific information about that feature.

The service must document the meaning of the data bytes within the ESD message.

6 Diagnostics support

A MNS module **will** implement VLCB diagnostics. Each Service can specify its own set of diagnostics, please consult individual Service specifications for the details.

6.1 Heartbeat

6.1.1 Heartbeat message

The module shall transmit a heartbeat message with the HEARTB opcode. This message shall be broadcast every 5 secs at the lowest priority. This heartbeat message will contain the node number, a sequence counter and a number of global flags indicating module status.

The payload will be

- NodeNumberHi , The high byte of the designated Node.
- NodeNumberLo, The low byte of the designated Node.
- SeqenceCnt, This is a count from 0 incrementing on each message transmitted and wrapping around to zero, It facilitates detection of missing frames.
- StatusByte1: This is a binary representation of the module error states as outlined in Section 8.3 Module Status, 0x00 Shall always represent error free, normal operation.
- StatusByte2: Reserved for future expansion, set to 0x00.

A module will NOT transmit any HEARTB message until it has been assigned a NodeNumber by any specified means, as soon thereafter as practical the HEARTB low priority diagnostic should begin.

The heartbeat message is enabled by manufacturer defaults but may be disabled using the NOHEARTB Mode command. Whether the Heartbeat is enabled or disabled must be saved in non volatile memory and restored upon power up. Whilst in NOHEARTB mode the module otherwise operates as per Normal mode. Heartbeat messages can be re-enabled by the appropriate Mode command.

6.2 MNS Service Specific Diagnostics

A module **must** implement the OPCODE command RDGN and its response DGN opcode. On receipt of the command the module will respond as quickly as practical, with the response packets. The format of the data etc is detailed in the Diagnostics Specification.

Type 2 Command responses should be sent at normal priority, and cannot be disabled.

The following Diagnostics are available:

6.2.1 RDGN Request Diagnostics

This RDGN message may be issued to the module by any node. RDGN takes the following parameters:

- Node NumberHi ; The high byte of the designated node thats is to respond,
- NodeNumberLo : The low byte of the designated node that is to respond,
- Service# : The service identifier,
- DiagnosticCode: see below.

The diagnostic data associated with the specified service and DiagnosticCode is returned in a DGN message. The target node will respond as soon as practical (within 15 secs) with DGN messages.

If DiagnosticCode is specified as zero then a sequence of messages for each DiagnosticCode associated with the service is returned. If the Service# is specified as zero then a sequence of DGM messages is produced for each DiagnosticCode for each Service. This may generate a large number of messages, these must be sent at a rate so that other modules are not stressed. A suggested inter-message time of 10 ms is suggested.

6.2.2 DiagnosticCode for MNS

The DiagnosticCode will indicate the type of information requested. The following DiagnosticCodes are defined by MNS. Other services may define their own diagnostics.

0x00: return a series of DGN messages for each supported DiagnosticCode data.

0x01: return module status code.

0x02: return uptime upper word.

0x03: return uptime lower word.

0x04: return memory error count.

0x05: return number of Node Number changes.

0x06: return number of received messages acted upon.

6.2.3 Diagnostics Data

On receipt the Node will respond with DGN and valid Data or GRSP (see opcodes).

The DGN response message contains two data bytes: DiagnosticVal1 and DiagnosticVal2.

Two bytes of data are always returned, 0x00 being used for no data.

The DiagnosticVal bytes may be combined to form a 16 bit counter value with DiagnosticVal1 being the higher byte and DiagnosticVal2 the lower byte. -

6.2.4 MNS Diagnostics payload data return

The DiagnosticByte1 and DianosticsByte2 are defined for the MNS service and each DiagnosticCode thus:

DiagnosticCode	DiagnosticByte1	DiagnosticByte2	Description
0x01	STATUS	0x00	Facsimile of the global module status byte, see section 6.3 Module Status
0x02	UPTIME Upper Hi	UPTIME Upper Lo	Upper Word of 32bit uptime measured in seconds.
0x03	UPTIME Lower Hi	UPTIME Lower Lo	Lower Word of 32bit uptime measured in seconds.
0x04	MEMFLT	0x00	Memory fault indicator. 0x00: no fault , 0x01: Flash write fault, 0x02: Flash read Fault , 0x04: EEPROM read fault , 0x08: EEPROM Write fault , 0x10: Stack overflow, 0x20: RAM fault , 0x80: general unspecified memory error. Indicator values may be OR'ed together.
0x05	NNCNT Hi	NNCNT Lo	Number of nodeID changes. The node number was assigned or reassigned since power up by any node assignment method.
0x06	MESSACTED Hi	MESSACTED Lo	Count of messages processed by the module. The principle is this count is messages the module "acted on" in some way.

6.3 Module Status

The Heartbeat message and DiagnosticCode 1 contain a module status byte providing an overall view of the health of the module. This is represented by a count of recent errors.

The module status shall be calculated by having an 8-bit counter which is incremented whenever an error diagnostic is incremented by any of the module's services. This increment should max at 255 and not rollover to 0. The counter shall be decremented if it is above 0 every 5 seconds.

7 MNS Service Specific GRSP response codes

Codes 1~12 match those of CMDERR. Additional error codes have been added with error codes beyond those used with CMDERR, starting at 0xFF, and descending.

GRSP Generic Response		
Basic responses, matching CMDER		
Result Code	Description	Comment
0	ok	
1	Command Not Supported.	Used for Invalid Command
2	Not In Learn Mode.	
3	Not in Setup Mode.	
4	Too Many Events.	
5	No Event.	
6	Invalid Event variable index.	
7	Invalid Event.	
8	Reserved.	
9	Invalid Parameter Index.	
10	Invalid Node Variable Index.	
11	Invalid Event Variable Value.	
12	Invalid Node Variable Value.	

Additional MNS specific GRSP codes:

Code	**Service #**	**Error**
0	1	OK
252	1	Invalid Service
253	1	Invalid diagnostic code.
254	1	Unknown non-volatile memory type.

8 Service Specific Automatic Power on Tests

MNS does not support any automatic power on tests.

9 Service Data

9.1 Module Parameters

See https://merg.org.uk/merg_wiki/lib/exe/fetch.php?media=cbus:cbus_-_new_parameter_structure-6.pdf for details for parameter structure.

The module parameters provide information about the module's capability, information for the bootloader and information about the physical hardware. Entries in red are deprecated and replaced by service discovery but included for backwards compatibility. Entries in blue are only required for the CBUS PIC bootloader.

The following table describes the parameters supported by the Minimum Node Service. Other parameters should be set to 0 unless other services included by the module specify other values.

Param#	Name	Usage	VLCB should set these values
0	Number of parameters		The number of supported parameters. E.g. 20 or 24
1	Manufacturer	module manufacturer	See ModuleId
2	Minor version		The minor version ascii character x.Y.z.
3	ModuleId	Module type identifier.	Combined with Manufacturer for a 16 bit code unique to the type of module. The ID can be obtained by the module developer using the VLCB web portal.
7	Major version		The major number X.y.z
8	flags	Module's capabilities and settings	See below for each bit.
8.2	Normal (FLiM)	Indicates if the module is in Normal mode (1) or Uninitialised (0).	Set to 1. VLCB does not support an equivalent of CBUS SLiM.

8.6	VLCB compliant	Indicates if the module supports VLCB capabilities	Set to 1. CBUS modules should have this set to 0.
20	Beta version		The Patch number x.y.Z

9.2 ESD data bytes

The Minimum node service currently does not return any data within the ESD response, all data bytes are set to 0.

10 Service Specific Modes

MNS requires the following MODE Commands:

Mode Command	Request
0x00	Change to Setup mode
0x01	Change to Normal mode
0x0C	Turn on Heartbeat
0x0D	Turn off Heartbeat

11 Service Documentation

None.

12 Glossary

CAN	Controller Area Network. A standard communications bus originally defined by Bosch. Widely used in cars, industry and other electrically noisy environments.
CANID	CAN identifier
CBUS	A set of messages for model railway control. The CBUS system was developed over 4 years by Mike Bolton and Gil Fuchs and introduced with specifications and an initial range of kits in 2007. Since then the system has been further developed by many MERG members into a very comprehensive Layout Control Bus.
EN	Event Number
EN#	Event Number index
EV#	Event Variable index
FLiM	Full Layout implementation Mode
GridConnect	A means of encoding CAN frames for transmission over an ASCII serial link. See https://www.google.com/url?q=https://www.gridconnect.com/products/can-usb-adapter-pcan-usb&sa=D&source=docs&ust=1665387273449617&usg=AOvVaw0fepa9tJq-858M5sbX66fV
MNS	Minimum Node Specification
NN	Node Number
Parameter	Describe the capabilities of a module. Parameters are read-only and set by the module's firmware. Some parameters are dynamic and can change during module operation.

PCB	Printed Circuit Board
SLiM	Simple Layout implementation Mode