VLCB Versatile Layout Control Bus

# Opcode Specification

Version 1.1, March 2024

Compatible with CBUS ® 4.0 Rev 8j

# 0.1 Table of Contents

## 0.2 Document History

| Date | Changed by | Summary of changes |
|---|---|---|
| 18th October 2022 | Ian Hogg M.5144 | Initial document |
| 5th December 2022 | Ian Hogg M.5144 | Removed GSTOP |
| 14th November 2022 | Ian Hogg M.5144 | Added placeholder ENACK |
| 29th December 2022 | Ian Hogg M.5144 | Changed the RQSD/SD and RDGN/DGN for ServiceIndex |
| 14 April 2023 | Ian Hogg M.5144 | Changed name to VLCB |
| 15 May 2023 | Ian Hogg M.5144 | Allocated bit 6 of module parameter flags to support for service discovery. PNN also updated. |
| 26 August 2023 | Ian Hogg M.5144 | AREQ updated to exclude short message check and NN check.<br>EVULN, REQEV, EVLRN updated to also return GRSP. |
| 29 August 2023 | Ian Hogg M.5144 | Updated Appendix C to include GRSP error codes. Updated RQSD and REQEV to align with Appendix C. |
| 30 August 2023 | Ian Hogg M.5144 | Changed event being present condition for REQEV from event index to NN:EN |
| 6 October 2023 | Ian Hogg M.5144 | Allow RQMN to be used in LEARN mode in addition to SETUP mode. |
| 5 November 2023 | Ian Hogg M.5144 | Added a DGN response to RDGN when DiagnosticCode=0 indicating the number of following diagnostics. |
| 23 November 2023 | Ian Hogg M.5144 | Added further clarification ro RDGN. |
| 29 January 2024 | Ian Hogg M.5144 | Updated MODE opcode to change parameter from a mode to a command.<br>EVLRN now returns a GRSP(ok) in addition to a WRACK.<br>Update NNULN conditions so that NN does not need to match that of the module.<br>Corrected REQEV errors. |

| | | |
|---|---|---|
| 12 February 2024 | Ian Hogg M.5144 | Added additional condition to RQSD to check for serviceIndex being valid. |
| 26 February 2024 | Ian Hogg M.5144 | Changed NENRD error response for an invalid index.<br>Updated both REVAL and REQEV for EV#0 to both return the number of EVs followed by a response for each EV. |

# 1 Introduction

This document provides a detailed description of the VLCB opcodes.

# 2 Opcodes

## 2.1 Opcode bit checks

### 2.1.1 Message length

CBUS uses the top 3 bits of the opcode to define the number of data bytes following the opcode. Whilst on CAN this is not necessary as the CAN DLC field also contains the data length, having the length could be beneficial for other protocols if messages are not wrapped using a format which is able to indicate the message length.
VLCB opcodes have maintained the top 3 bits length format for CBUS compatible opcodes but may not comply with this for new opcodes. It is recommended that the developer makes no assumptions about the length of the message based upon the top 3 bits of the opcode.
If a module is targeted with a command message i.e. the NN matches its own node number and there are insufficient data bytes in the message then it should respond with a GRSP(Invalid Command). Otherwise if a message is received which has insufficient data bytes then it shall be ignored.

### 2.1.2 Event checks

If the bits of the opcode equal 1xx10000 then the message is an ON long event.
If the bits of the opcode equal 1xx10001 then the message is an OFF long event.
If the bits of the opcode equal 1xx11000 then the message is an ON short event.
If the bits of the opcode equal 1xx11001 then the message is an OFF short event.

### 2.1.3 Extension Checks

If the bits of the opcode equal xxx11111 with the exception of  00011111 (0x1F) then the opcode is an Extension Opcode.

## 2.2 Opcodes ordered by Name

| Name | Value | |
|---|---|---|
| | Decimal | Hex |
| ACDAT | 246 | F6 |
| ACK | 0 | 00 |
| ACOF | 145 | 91 |
| ACOF1 | 177 | B1 |
| ACOF2 | 209 | D1 |
| ACOF3 | 241 | F1 |

| | | |
|---|---|---|
| ACON | 144 | 90 |
| ACON1 | 176 | B0 |
| ACON2 | 208 | D0 |
| ACON3 | 240 | F0 |
| ALOC | 67 | 43 |
| ARDAT | 247 | F7 |
| AREQ | 146 | 92 |
| AROF | 148 | 94 |
| AROF1 | 180 | B4 |
| AROF2 | 213 | D5 |
| AROF3 | 244 | F4 |
| ARON | 147 | 93 |
| ARON1 | 179 | B3 |
| ARON2 | 212 | D4 |
| ARON3 | 243 | F3 |
| ARSOF | 158 | 9E |
| ARSOF1 | 190 | BE |
| ARSOF2 | 222 | DE |
| ARSOF3 | 254 | FE |
| ARSON | 157 | 9D |
| ARSON1 | 189 | BD |
| ARSON2 | 221 | DD |
| ARSON3 | 253 | FD |
| ARST | 7 | 07 |
| ASOF | 153 | 99 |
| ASOF1 | 185 | B9 |
| ASOF2 | 217 | D9 |

| | | |
|---|---|---|
| ASOF3 | 249 | F9 |
| ASON | 152 | 98 |
| ASON1 | 184 | B8 |
| ASON2 | 216 | D8 |
| ASON3 | 248 | F8 |
| ASRQ | 154 | 9A |
| BON | 3 | 03 |
| BOOTM | 92 | 5C |
| CABDAT | 194 | C2 |
| CANID | 117 | 75 |
| CMDERR | 111 | 6F |
| DBG1 | 48 | 30 |
| DDES | 250 | FA |
| DDRS | 251 | FB |
| DFLG | 72 | 48 |
| DFNOF | 74 | 4A |
| DFNON | 73 | 49 |
| DFUN | 96 | 60 |
| DGN | 199 | C7 |
| DKEEP | 35 | 23 |
| DSPD | 71 | 47 |
| DTXC | 233 | E9 |
| ENACK | 230 | E6 |
| ENRSP | 242 | F2 |
| ENUM | 93 | 5D |
| ERR | 99 | 63 |
| ESD | 231 | E7 |

| | | |
|---|---|---|
| ESTOP | 6 | 06 |
| EVANS | 211 | D3 |
| EVLRN | 210 | D2 |
| EVLRNI | 245 | F5 |
| EVNLF | 112 | 70 |
| EVULN | 149 | 95 |
| FCLK | 207 | CF |
| GLOC | 97 | 61 |
| GRSP | 175 | AF |
| HEARTB | 163 | AB |
| HLT | 2 | 02 |
| KCON | 70 | 46 |
| KLOC | 33 | 21 |
| MODE | 118 | 76 |
| NAK | 1 | 01 |
| NAME | 226 | E2 |
| NENRD | 114 | 72 |
| NERD | 87 | 57 |
| NEVAL | 181 | B5 |
| NNACK | 82 | 52 |
| NNCLR | 85 | 55 |
| NNEVN | 86 | 56 |
| NNLRN | 83 | 53 |
| NNREL | 81 | 51 |
| NNRSM | 79 | 4F |
| NNRST | 94 | 5E |
| NNULN | 84 | 54 |

| | | |
|---|---|---|
| NUMEV | 116 | 74 |
| NVANS | 151 | 97 |
| NVRD | 113 | 71 |
| NVSET | 150 | 96 |
| NVSETRD | 142 | 8E |
| PARAMS | 239 | EF |
| PARAN | 155 | 9B |
| PCON | 69 | 45 |
| PCVS | 133 | 85 |
| PLOC | 225 | E1 |
| PNN | 182 | B6 |
| QCON | 65 | 41 |
| QCVS | 132 | 84 |
| QLOC | 34 | 22 |
| QNN | 13 | 0D |
| RDCC3 | 128 | 80 |
| RDCC4 | 160 | A0 |
| RDCC5 | 192 | C0 |
| RDCC6 | 224 | E0 |
| RDGN | 135 | 87 |
| REQEV | 178 | B2 |
| RESTP | 10 | 0A |
| REVAL | 156 | 9C |
| RLOC | 64 | 40 |
| RQDAT | 90 | 5A |
| RQDDS | 91 | 5B |
| RQEVN | 88 | 58 |

| | | |
|---|---|---|
| RQMN | 17 | 11 |
| RQNN | 80 | 50 |
| RQNP | 16 | 10 |
| RQNPN | 115 | 73 |
| RQSD | 120 | 78 |
| RSTAT | 12 | 0C |
| RTOF | 8 | 08 |
| RTON | 9 | 09 |
| SD | 140 | 8C |
| SNN | 66 | 42 |
| SSTAT | 76 | 4C |
| STAT | 227 | E3 |
| STMOD | 68 | 44 |
| TOF | 4 | 04 |
| TON | 5 | 05 |
| WCVB | 131 | 83 |
| WCVO | 130 | 82 |
| WCVOA | 193 | C1 |
| WCVS | 162 | A2 |
| WRACK | 89 | 59 |

## 2.3 Opcodes ordered by Value

| **Name** | **Value** | |
|---|---|---|
| | **Decimal** | **Hex** |
| ACK | 0 | 00 |
| NAK | 1 | 01 |

| | | |
|---|---|---|
| HLT | 2 | 02 |
| BON | 3 | 03 |
| TOF | 4 | 04 |
| TON | 5 | 05 |
| ESTOP | 6 | 06 |
| ARST | 7 | 07 |
| RTOF | 8 | 08 |
| RTON | 9 | 09 |
| RESTP | 10 | 0A |
| RSTAT | 12 | 0C |
| QNN | 13 | 0D |
| RQNP | 16 | 10 |
| RQMN | 17 | 11 |
| KLOC | 33 | 21 |
| QLOC | 34 | 22 |
| DKEEP | 35 | 23 |
| DBG1 | 48 | 30 |
| RLOC | 64 | 40 |
| QCON | 65 | 41 |
| SNN | 66 | 42 |
| ALOC | 67 | 43 |
| STMOD | 68 | 44 |
| PCON | 69 | 45 |
| KCON | 70 | 46 |
| DSPD | 71 | 47 |
| DFLG | 72 | 48 |
| DFNON | 73 | 49 |

| | | |
|---|---|---|
| DFNOF | 74 | 4A |
| SSTAT | 76 | 4C |
| NNRSM | 79 | 4F |
| RQNN | 80 | 50 |
| NNREL | 81 | 51 |
| NNACK | 82 | 52 |
| NNLRN | 83 | 53 |
| NNULN | 84 | 54 |
| NNCLR | 85 | 55 |
| NNEVN | 86 | 56 |
| NERD | 87 | 57 |
| RQEVN | 88 | 58 |
| WRACK | 89 | 59 |
| RQDAT | 90 | 5A |
| RQDDS | 91 | 5B |
| BOOTM | 92 | 5C |
| ENUM | 93 | 5D |
| NNRST | 94 | 5E |
| DFUN | 96 | 60 |
| GLOC | 97 | 61 |
| ERR | 99 | 63 |
| CMDERR | 111 | 6F |
| EVNLF | 112 | 70 |
| NVRD | 113 | 71 |
| NENRD | 114 | 72 |
| RQNPN | 115 | 73 |
| NUMEV | 116 | 74 |

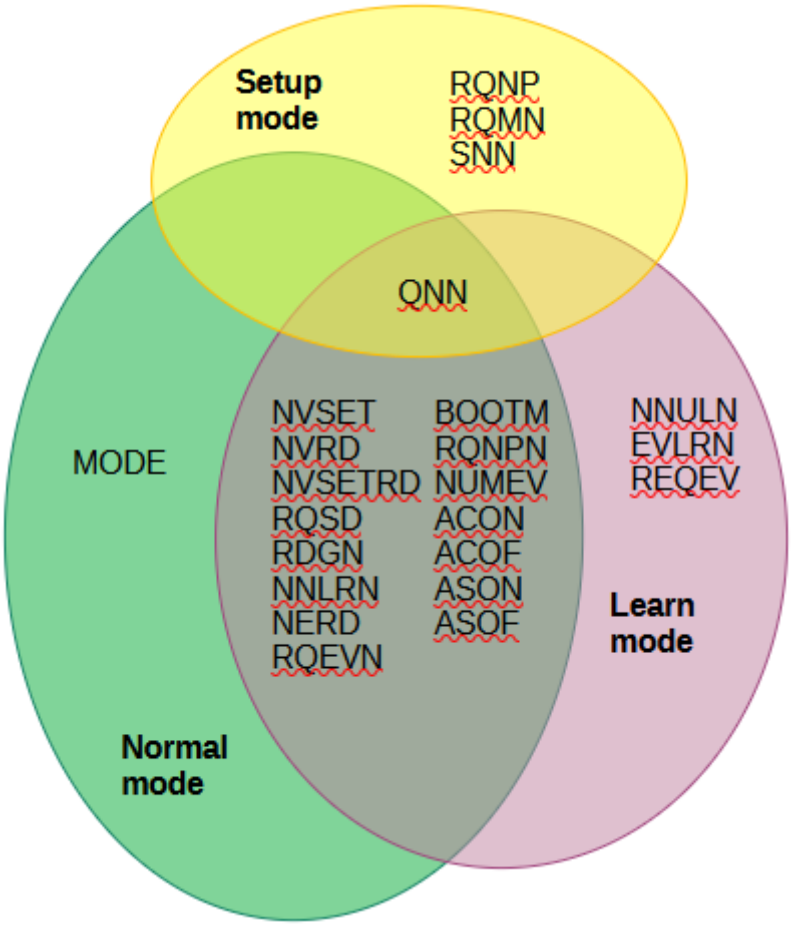
| | | |
|---|---|---|
| CANID | 117 | 75 |
| MODE | 118 | 76 |
| RDGN | 119 | 77 |
| RQSD | 120 | 78 |
| RDCC3 | 128 | 80 |
| WCVO | 130 | 82 |
| WCVB | 131 | 83 |
| QCVS | 132 | 84 |
| PCVS | 133 | 85 |
| SD | 140 | AC |
| NVSETRD | 142 | 8E |
| ACON | 144 | 90 |
| ACOF | 145 | 91 |
| AREQ | 146 | 92 |
| ARON | 147 | 93 |
| AROF | 148 | 94 |
| EVULN | 149 | 95 |
| NVSET | 150 | 96 |
| NVANS | 151 | 97 |
| ASON | 152 | 98 |
| ASOF | 153 | 99 |
| ASRQ | 154 | 9A |
| PARAN | 155 | 9B |
| REVAL | 156 | 9C |
| ARSON | 157 | 9D |
| ARSOF | 158 | 9E |
| RDCC4 | 160 | A0 |

| | | |
|---|---|---|
| WCVS | 162 | A2 |
| HEARTB | 163 | AB |
| GRSP | 175 | AF |
| ACON1 | 176 | B0 |
| ACOF1 | 177 | B1 |
| REQEV | 178 | B2 |
| ARON1 | 179 | B3 |
| AROF1 | 180 | B4 |
| NEVAL | 181 | B5 |
| PNN | 182 | B6 |
| ASON1 | 184 | B8 |
| ASOF1 | 185 | B9 |
| ARSON1 | 189 | BD |
| ARSOF1 | 190 | BE |
| RDCC5 | 192 | C0 |
| WCVOA | 193 | C1 |
| CABDAT | 194 | C2 |
| DGN | 199 | C7 |
| FCLK | 207 | CF |
| ACON2 | 208 | D0 |
| ACOF2 | 209 | D1 |
| EVLRN | 210 | D2 |
| EVANS | 211 | D3 |
| ARON2 | 212 | D4 |
| AROF2 | 213 | D5 |
| ASON2 | 216 | D8 |
| ASOF2 | 217 | D9 |

| | | |
|---|---|---|
| ARSON2 | 221 | DD |
| ARSOF2 | 222 | DE |
| RDCC6 | 224 | E0 |
| PLOC | 225 | E1 |
| NAME | 226 | E2 |
| STAT | 227 | E3 |
| ENACK | 230 | E6 |
| ESD | 231 | E7 |
| DTXC | 233 | E9 |
| PARAMS | 239 | EF |
| ACON3 | 240 | F0 |
| ACOF3 | 241 | F1 |
| ENRSP | 242 | F2 |
| ARON3 | 243 | F3 |
| AROF3 | 244 | F4 |
| EVLRNI | 245 | F5 |
| ACDAT | 246 | F6 |
| ARDAT | 247 | F7 |
| ASON3 | 248 | F8 |
| ASOF3 | 249 | F9 |
| DDES | 250 | FA |
| DDRS | 251 | FB |
| ARSON3 | 253 | FD |
| ARSOF3 | 254 | FE |

## 2.4 Opcodes by Mode

Not all of the opcodes are available in all modes. A limited number of opcodes are available in Setup mode as, generally the module has no node number whilst in Setup mode. Normal mode encompasses the majority of the opcodes, Learn mode adds opcodes specifically for event learning, on top of the Normal opcodes, many of which require additional parameters leaving no room for a node number.
A visual way of representing this is with a Venn diagram. The diagram below doesn't list all of the opcodes available in each mode but gives an indication of the capabilities available in each mode.




| Name | Value | | Modes |
|---|---|---|---|
| | Decimal | Hex | |
| NNULN | 84 | 54 | Learn |
| NNCLR | 85 | 55 | Learn |
| EVULN | 149 | 95 | Learn |
| REQEV | 178 | B2 | Learn |

| Name | Value | | Modes |
|---|---|---|---|
| | Decimal | Hex | |
| EVLRN | 210 | D2 | Learn |
| EVANS | 211 | D3 | Learn |
| EVLRNI | 245 | F5 | Learn |
| ACK | 0 | 00 | Normal, Learn, NOHEARTB, ENACK |
| NAK | 1 | 01 | Normal, Learn, NOHEARTB, ENACK |
| HLT | 2 | 02 | Normal, Learn, NOHEARTB, ENACK |
| BON | 3 | 03 | Normal, Learn, NOHEARTB, ENACK |
| TOF | 4 | 04 | Normal, Learn, NOHEARTB, ENACK |
| TON | 5 | 05 | Normal, Learn, NOHEARTB, ENACK |
| ESTOP | 6 | 06 | Normal, Learn, NOHEARTB, ENACK |
| ARST | 7 | 07 | Normal, Learn, NOHEARTB, ENACK |
| RTOF | 8 | 08 | Normal, Learn, NOHEARTB, ENACK |
| RTON | 9 | 09 | Normal, Learn, NOHEARTB, ENACK |
| RESTP | 10 | 0A | Normal, Learn, NOHEARTB, ENACK |
| RSTAT | 12 | 0C | Normal, Learn, NOHEARTB, ENACK |
| QNN | 13 | 0D | Normal, Learn, NOHEARTB, ENACK, Setup |
| KLOC | 33 | 21 | Normal, Learn, NOHEARTB, ENACK |
| QLOC | 34 | 22 | Normal, Learn, NOHEARTB, ENACK |
| DKEEP | 35 | 23 | Normal, Learn, NOHEARTB, ENACK |
| DBG1 | 48 | 30 | Normal, Learn, NOHEARTB, ENACK |
| RLOC | 64 | 40 | Normal, Learn, NOHEARTB, ENACK |
| QCON | 65 | 41 | Normal, Learn, NOHEARTB, ENACK |
| ALOC | 67 | 43 | Normal, Learn, NOHEARTB, ENACK |
| STMOD | 68 | 44 | Normal, Learn, NOHEARTB, ENACK |
| PCON | 69 | 45 | Normal, Learn, NOHEARTB, ENACK |

| Name | Value | | Modes |
|---|---|---|---|
| | Decimal | Hex | |
| KCON | 70 | 46 | Normal, Learn, NOHEARTB, ENACK |
| DSPD | 71 | 47 | Normal, Learn, NOHEARTB, ENACK |
| DFLG | 72 | 48 | Normal, Learn, NOHEARTB, ENACK |
| DFNON | 73 | 49 | Normal, Learn, NOHEARTB, ENACK |
| DFNOF | 74 | 4A | Normal, Learn, NOHEARTB, ENACK |
| SSTAT | 76 | 4C | Normal, Learn, NOHEARTB, ENACK |
| NNRSM | 79 | 4F | Normal, Learn, NOHEARTB, ENACK |
| NNLRN | 83 | 53 | Normal, Learn, NOHEARTB, ENACK |
| NNEVN | 86 | 56 | Normal, Learn, NOHEARTB, ENACK |
| NERD | 87 | 57 | Normal, Learn, NOHEARTB, ENACK |
| RQEVN | 88 | 58 | Normal, Learn, NOHEARTB, ENACK |
| WRACK | 89 | 59 | Normal, Learn, NOHEARTB, ENACK |
| RQDAT | 90 | 5A | Normal, Learn, NOHEARTB, ENACK |
| RQDDS | 91 | 5B | Normal, Learn, NOHEARTB, ENACK |
| BOOTM | 92 | 5C | Normal, Learn, NOHEARTB, ENACK |
| ENUM | 93 | 5D | Normal, Learn, NOHEARTB, ENACK |
| NNRST | 94 | 5E | Normal, Learn, NOHEARTB, ENACK |
| DFUN | 96 | 60 | Normal, Learn, NOHEARTB, ENACK |
| GLOC | 97 | 61 | Normal, Learn, NOHEARTB, ENACK |
| ERR | 99 | 63 | Normal, Learn, NOHEARTB, ENACK |
| CMDERR | 111 | 6F | Normal, Learn, NOHEARTB, ENACK |
| EVNLF | 112 | 70 | Normal, Learn, NOHEARTB, ENACKCANID |
| NVRD | 113 | 71 | Normal, Learn, NOHEARTB, ENACK |
| NENRD | 114 | 72 | Normal, Learn, NOHEARTB, ENACK |
| RQNPN | 115 | 73 | Normal, Learn, NOHEARTB, ENACK |

| Name | Value | | Modes |
|---|---|---|---|
| | Decimal | Hex | |
| NUMEV | 116 | 74 | Normal, Learn, NOHEARTB, ENACK |
| CANID | 117 | 75 | Normal, Learn, NOHEARTB, ENACK |
| RQSD | 120 | 78 | Normal, Learn, NOHEARTB, ENACK |
| RDCC3 | 128 | 80 | Normal, Learn, NOHEARTB, ENACK |
| WCVO | 130 | 82 | Normal, Learn, NOHEARTB, ENACK |
| WCVB | 131 | 83 | Normal, Learn, NOHEARTB, ENACK |
| QCVS | 132 | 84 | Normal, Learn, NOHEARTB, ENACK |
| PCVS | 133 | 85 | Normal, Learn, NOHEARTB, ENACK |
| RDGN | 135 | 87 | Normal, Learn, NOHEARTB, ENACK |
| SD | 140 | 8C | Normal, Learn, NOHEARTB, ENACK |
| NVSETRD | 142 | 8E | Normal, Learn, NOHEARTB, ENACK |
| ACON | 144 | 90 | Normal, Learn, NOHEARTB, ENACK |
| ACOF | 145 | 91 | Normal, Learn, NOHEARTB, ENACK |
| AREQ | 146 | 92 | Normal, Learn, NOHEARTB, ENACK |
| ARON | 147 | 93 | Normal, Learn, NOHEARTB, ENACK |
| AROF | 148 | 94 | Normal, Learn, NOHEARTB, ENACK |
| NVSET | 150 | 96 | Normal, Learn, NOHEARTB, ENACK |
| NVANS | 151 | 97 | Normal, Learn, NOHEARTB, ENACK |
| ASON | 152 | 98 | Normal, Learn, NOHEARTB, ENACK |
| ASOF | 153 | 99 | Normal, Learn, NOHEARTB, ENACK |
| ASRQ | 154 | 9A | Normal, Learn, NOHEARTB, ENACK |
| PARAN | 155 | 9B | Normal, Learn, NOHEARTB, ENACK |
| REVAL | 156 | 9C | Normal, Learn, NOHEARTB, ENACK |
| ARSON | 157 | 9D | Normal, Learn, NOHEARTB, ENACK |
| ARSOF | 158 | 9E | Normal, Learn, NOHEARTB, ENACK |

| Name | Value | | Modes |
|---|---|---|---|
| | Decimal | Hex | |
| RDCC4 | 160 | A0 | Normal, Learn, NOHEARTB, ENACK |
| WCVS | 162 | A2 | Normal, Learn, NOHEARTB, ENACK |
| HEARTB | 163 | AB | Normal, Learn, NOHEARTB, ENACK |
| GRSP | 175 | AF | Normal, Learn, NOHEARTB, ENACK |
| ACON1 | 176 | B0 | Normal, Learn, NOHEARTB, ENACK |
| ACOF1 | 177 | B1 | Normal, Learn, NOHEARTB, ENACK |
| ARON1 | 179 | B3 | Normal, Learn, NOHEARTB, ENACK |
| AROF1 | 180 | B4 | Normal, Learn, NOHEARTB, ENACK |
| NEVAL | 181 | B5 | Normal, Learn, NOHEARTB, ENACK |
| PNN | 182 | B6 | Normal, Learn, NOHEARTB, ENACK |
| ASON1 | 184 | B8 | Normal, Learn, NOHEARTB, ENACK |
| ASOF1 | 185 | B9 | Normal, Learn, NOHEARTB, ENACK |
| ARSON1 | 189 | BD | Normal, Learn, NOHEARTB, ENACK |
| ARSOF1 | 190 | BE | Normal, Learn, NOHEARTB, ENACK |
| RDCC5 | 192 | C0 | Normal, Learn, NOHEARTB, ENACK |
| WCVOA | 193 | C1 | Normal, Learn, NOHEARTB, ENACK |
| CABDAT | 194 | C2 | Normal, Learn, NOHEARTB, ENACK |
| DGN | 199 | C7 | Normal, Learn, NOHEARTB, ENACK |
| FCLK | 207 | CF | Normal, Learn, NOHEARTB, ENACK |
| ACON2 | 208 | D0 | Normal, Learn, NOHEARTB, ENACK |
| ACOF2 | 209 | D1 | Normal, Learn, NOHEARTB, ENACK |
| ARON2 | 212 | D4 | Normal, Learn, NOHEARTB, ENACK |
| AROF2 | 213 | D5 | Normal, Learn, NOHEARTB, ENACK |
| ASON2 | 216 | D8 | Normal, Learn, NOHEARTB, ENACK |
| ASOF2 | 217 | D9 | Normal, Learn, NOHEARTB, ENACK |

| Name | Value | | Modes |
|---|---|---|---|
| | Decimal | Hex | |
| ARSON2 | 221 | DD | Normal, Learn, NOHEARTB, ENACK |
| ARSOF2 | 222 | DE | Normal, Learn, NOHEARTB, ENACK |
| RDCC6 | 224 | E0 | Normal, Learn, NOHEARTB, ENACK |
| PLOC | 225 | E1 | Normal, Learn, NOHEARTB, ENACK |
| STAT | 227 | E3 | Normal, Learn, NOHEARTB, ENACK |
| ESD | 231 | E7 | Normal, Learn, NOHEARTB, ENACK |
| DTXC | 233 | E9 | Normal, Learn, NOHEARTB, ENACK |
| ACON3 | 240 | F0 | Normal, Learn, NOHEARTB, ENACK |
| ACOF3 | 241 | F1 | Normal, Learn, NOHEARTB, ENACK |
| ENRSP | 242 | F2 | Normal, Learn, NOHEARTB, ENACK |
| ARON3 | 243 | F3 | Normal, Learn, NOHEARTB, ENACK |
| AROF3 | 244 | F4 | Normal, Learn, NOHEARTB, ENACK |
| ACDAT | 246 | F6 | Normal, Learn, NOHEARTB, ENACK |
| ARDAT | 247 | F7 | Normal, Learn, NOHEARTB, ENACK |
| ASON3 | 248 | F8 | Normal, Learn, NOHEARTB, ENACK |
| ASOF3 | 249 | F9 | Normal, Learn, NOHEARTB, ENACK |
| DDES | 250 | FA | Normal, Learn, NOHEARTB, ENACK |
| DDRS | 251 | FB | Normal, Learn, NOHEARTB, ENACK |
| ARSON3 | 253 | FD | Normal, Learn, NOHEARTB, ENACK |
| ARSOF3 | 254 | FE | Normal, Learn, NOHEARTB, ENACK |
| QNN | 13 | 0D | Normal, Learn, NOHEARTB, ENACK, Setup |
| MODE | 118 | 76 | Normal |
| ENACK | 230 | E6 | ENACK |
| NNREL | 81 | 51 | Setup |
| RQNP | 16 | 10 | Setup |

| Name | Value | | Modes |
|---|---|---|---|
| | Decimal | Hex | |
| RQMN | 17 | 11 | Learn, Setup |
| SNN | 66 | 42 | Setup |
| RQNN | 80 | 50 | Setup |
| NNACK | 82 | 52 | Setup |
| NAME | 226 | E2 | Setup |
| PARAMS | 239 | EF | Setup |

## 2.5 Opcodes by Service

| Name | Value | | Implement when service included |
|---|---|---|---|
| | Decimal | Hex | |
| ACK | 0 | 00 | |
| NAK | 1 | 01 | |
| HLT | 2 | 02 | |
| BON | 3 | 03 | |
| ARST | 7 | 07 | |
| DBG1 | 48 | 30 | |
| RQDAT | 90 | 5A | |
| RQDDS | 91 | 5B | |
| NNRST | 94 | 5E | |
| FCLK | 207 | CF | |
| ACDAT | 246 | F6 | |
| ARDAT | 247 | F7 | |
| BOOTM | 92 | 5C | Boot |
| CABDAT | 194 | C2 | CABDAT |
| ENUM | 93 | 5D | CAN |
| CANID | 117 | 75 | CAN |
| TOF | 4 | 04 | DCC_CAB or DCC_CMD |
| TON | 5 | 05 | DCC_CAB or DCC_CMD |
| ESTOP | 6 | 06 | DCC_CAB or DCC_CMD |
| RTOF | 8 | 08 | DCC_CAB or DCC_CMD |
| RTON | 9 | 09 | DCC_CAB or DCC_CMD |
| RESTP | 10 | 0A | DCC_CAB or DCC_CMD |
| RSTAT | 12 | 0C | DCC_CAB or DCC_CMD |

| | | | |
|---|---|---|---|
| KLOC | 33 | 21 | DCC_CAB or DCC_CMD |
| QLOC | 34 | 22 | DCC_CAB or DCC_CMD |
| DKEEP | 35 | 23 | DCC_CAB or DCC_CMD |
| RLOC | 64 | 40 | DCC_CAB or DCC_CMD |
| QCON | 65 | 41 | DCC_CAB or DCC_CMD |
| ALOC | 67 | 43 | DCC_CAB or DCC_CMD |
| STMOD | 68 | 44 | DCC_CAB or DCC_CMD |
| PCON | 69 | 45 | DCC_CAB or DCC_CMD |
| KCON | 70 | 46 | DCC_CAB or DCC_CMD |
| DSPD | 71 | 47 | DCC_CAB or DCC_CMD |
| DFLG | 72 | 48 | DCC_CAB or DCC_CMD |
| DFNON | 73 | 49 | DCC_CAB or DCC_CMD |
| DFNOF | 74 | 4A | DCC_CAB or DCC_CMD |
| SSTAT | 76 | 4C | DCC_CAB or DCC_CMD |
| DFUN | 96 | 60 | DCC_CAB or DCC_CMD |
| GLOC | 97 | 61 | DCC_CAB or DCC_CMD |
| ERR | 99 | 63 | DCC_CAB or DCC_CMD |
| RDCC3 | 128 | 80 | DCC_CAB or DCC_CMD |
| WCVO | 130 | 82 | DCC_CAB or DCC_CMD |
| WCVB | 131 | 83 | DCC_CAB or DCC_CMD |
| QCVS | 132 | 84 | DCC_CAB or DCC_CMD |
| PCVS | 133 | 85 | DCC_CAB or DCC_CMD |
| RDCC4 | 160 | A0 | DCC_CAB or DCC_CMD |
| WCVS | 162 | A2 | DCC_CAB or DCC_CMD |
| RDCC5 | 192 | C0 | DCC_CAB or DCC_CMD |
| WCVOA | 193 | C1 | DCC_CAB or DCC_CMD |
| RDCC6 | 224 | E0 | DCC_CAB or DCC_CMD |

| | | | |
|---|---|---|---|
| PLOC | 225 | E1 | DCC_CAB or DCC_CMD |
| STAT | 227 | E3 | DCC_CAB or DCC_CMD |
| DDES | 250 | FA | DCC_CAB or DCC_CMD |
| DDRS | 251 | FB | DCC_CAB or DCC_CMD |
| ACON | 144 | 90 | Producer or Consumer |
| ACOF | 145 | 91 | Producer or Consumer |
| AREQ | 146 | 92 | Producer |
| ARON | 147 | 93 | Producer |
| AROF | 148 | 94 | Producer |
| ASON | 152 | 98 | Producer or Consumer |
| ASOF | 153 | 99 | Producer or Consumer |
| ASRQ | 154 | 9A | Producer |
| ARSON | 157 | 9D | Producer |
| ARSOF | 158 | 9E | Producer |
| ACON1 | 176 | B0 | Producer or Consumer |
| ACOF1 | 177 | B1 | Producer or Consumer |
| ARON1 | 179 | B3 | Producer |
| AROF1 | 180 | B4 | Producer |
| ASON1 | 184 | B8 | Producer or Consumer |
| ASOF1 | 185 | B9 | Producer or Consumer |
| ARSON1 | 189 | BD | Producer |
| ARSOF1 | 190 | BE | Producer |
| ACON2 | 208 | D0 | Producer or Consumer |
| ACOF2 | 209 | D1 | Producer or Consumer |
| ARON2 | 212 | D4 | Producer |
| AROF2 | 213 | D5 | Producer |
| ASON2 | 216 | D8 | Producer or Consumer |

| | | | |
|---|---|---|---|
| ASOF2 | 217 | D9 | Producer or Consumer |
| ARSON2 | 221 | DD | Producer |
| ARSOF2 | 222 | DE | Producer |
| ACON3 | 240 | F0 | Producer or Consumer |
| ACOF3 | 241 | F1 | Producer or Consumer |
| ARON3 | 243 | F3 | Producer |
| AROF3 | 244 | F4 | Producer |
| ASON3 | 248 | F8 | Producer or Consumer |
| ASOF3 | 249 | F9 | Producer or Consumer |
| ARSON3 | 253 | FD | Producer |
| ARSOF3 | 254 | FE | Producer |
| ENACK | 230 | E6 | Consumer and EventAck |
| QNN | 13 | 0D | MNS |
| NNRSM | 79 | 4F | MNS |
| RQNPN | 115 | 73 | MNS |
| RQSD | 120 | 78 | MNS |
| RDGN | 135 | 87 | MNS |
| SD | 140 | 8C | MNS |
| DGN | 199 | C7 | MNS |
| PARAN | 155 | 9B | MNS |
| HEARTB | 163 | AB | MNS |
| GRSP | 175 | AF | MNS |
| PNN | 182 | B6 | MNS |
| ESD | 231 | E7 | MNS |
| MODE | 118 | 76 | MNS |
| NNREL | 81 | 51 | MNS |
| RQNP | 16 | 10 | MNS |

| | | | |
|---|---|---|---|
| RQMN | 17 | 11 | MNS |
| SNN | 66 | 42 | MNS |
| RQNN | 80 | 50 | MNS |
| NNACK | 82 | 52 | MNS |
| NAME | 226 | E2 | MNS |
| PARAMS | 239 | EF | MNS |
| CMDERR | 111 | 6F | MNS or Teach or NV |
| NVRD | 113 | 71 | NV |
| NVSETRD | 142 | 8E | NV |
| NVSET | 150 | 96 | NV |
| NVANS | 151 | 97 | NV |
| DTXC | 233 | E9 | Stream |
| NNLRN | 83 | 53 | Teach |
| NNULN | 84 | 54 | Teach |
| NNCLR | 85 | 55 | Teach |
| NNEVN | 86 | 56 | Teach |
| NERD | 87 | 57 | Teach |
| RQEVN | 88 | 58 | Teach |
| EVNLF | 112 | 70 | Teach |
| NENRD | 114 | 72 | Teach |
| NUMEV | 116 | 74 | Teach |
| EVULN | 149 | 95 | Teach |
| REVAL | 156 | 9C | Teach |
| REQEV | 178 | B2 | Teach |
| NEVAL | 181 | B5 | Teach |
| EVLRN | 210 | D2 | Teach |
| EVANS | 211 | D3 | Teach |

| | | | |
|---|---|---|---|
| ENRSP | 242 | F2 | Teach |
| EVLRNI | 245 | F5 | Teach |
| WRACK | 89 | 59 | Teach or NV |

## 2.6 Opcodes Extending CBUS

| Name | Value | | Description |
|---|---|---|---|
| | Decimal | Hex | |
| MODE | 118 | 76 | Set Mode |
| RQSD | 120 | 78 | Request Service Discovery |
| RDGN | 135 | 87 | Request Diagnostics |
| SD | 140 | 8C | Service Discovery Response |
| NVSETRD | 142 | 8E | Set and Read NV |
| HEARTB | 163 | AB | Heartbeat |
| GRSP | 175 | AF | General Response |
| DGN | 199 | C7 | Diagnostic Data |
| ESD | 231 | E7 | Extended Service Discovery Response |
| ENACK | 230 | E6 | Event Acknowledge |

# 3 Opcode detail

Each opcode in Section 3 contains a table with the following information.

| | | |
|---|---|---|
| **Name** | | A short name for the opcode's operation |
| **Value** | **Decimal** | The decimal (base 10) number of the opcode |
| | **Hex** | The hexadecimal (base 16) number of the opcode |
| **Priority** | | Priority of the specific opcode (Low, Normal, Above Normal or High). Each transport (e.g. CAN) will detail the mapping to the message encoding |
| **Description** | | A brief explanation of the opcode's operation |
| **Comment** | | An explanation of the opcode's operation including any associated opcodes, parameter usage and points to note. |
| **Direction** | | The normal direction for the opcode:<br>● To module - is usually sent from a configuration tool to a module.<br>● From module - usually sent as a response to a configuration command.<br>● To command station - usually sent by a configuration tool or Cab to a DCC command station.<br>● Blank - communications between modules. |
| **States/Modes** | | The set of states that the module must be in in order for the opcode's message to be recognised. |
| **Services** | | The Service which the module must support in order for the opcode's message to be processed |
| **Parameters** | | The ordered list of parameters for the opcode.<br>16bit (2 byte) values are sent highest byte first. |
| **Conditions** | | An ordered list of conditions for the module to process the opcode's message. Each condition is described as a failure condition with the failure result. If none of the conditions match then the successful processing of the message continues.<br>I.e. Pre-conditions. |
| **Result** | | The result of successfully processing the message.<br>I.e. post-conditions. |
| **History** | | Origin and changes for the opcode definition |

# 3.1 OPCODES with 0 additional bytes

## 3.1.1 [00] ACK - General Acknowledgement

| | | |
|---|---|---|
| **Name** | | ACK |
| **Value** | **Decimal** | 0 |
| | **Hex** | 00 |
| **Priority** | | Normal |
| **Description** | | General Acknowledgement. |
| **Comment** | | Positive response to query/ request performed or report of availability on-line. |
| **Direction** | | |
| **States / Modes** | | Normal, Learn, NOHEARTB |
| **Services** | | |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver  8j |

### 3.1.2 [01] NAK - General No Ack

| | | |
|---|---|---|
| **Name** | | NAK |
| **Value** | **Decimal** | 1 |
| | **Hex** | 01 |
| **Priority** | | Normal |
| **Description** | | General No Ack. |
| **Comment** | | Negative response to query/ request denied. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.3 [02] HLT - Bus Halt

| | | |
|---|---|---|
| **Name** | | HLT |
| **Value** | **Decimal** | 2 |
| | **Hex** | 02 |
| **Priority** | | High |
| **Description** | | Bus Halt. |
| **Comment** | | Commonly broadcasted to all nodes to indicate CBUS is not available and no further packets should be sent until a BON or ARST is received. |
| **Direction** | | Both |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | |
| **Conditions** | | Opcode is supported |
| **Result** | | If conditions are met then disable transmission of all messages on all interfaces otherwise ignore the request. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.4 [03] BON - Bus ON

| | | |
|---|---|---|
| **Name** | | BON |
| **Value** | **Decimal** | 3 |
| | **Hex** | 03 |
| **Priority** | | Above Normal. |
| **Description** | | Bus ON |
| **Comment** | | Commonly broadcasted to all nodes to indicate CBUS is available following a HLT. |
| **Direction** | | Both |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | |
| **Conditions** | | Opcode is supported |
| **Result** | | If conditions are met then enable transmission of all messages on all interfaces otherwise ignore the request. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.5 [04] TOF - Track OFF

| | | |
|---|---|---|
| **Name** | | TOF |
| **Value** | **Decimal** | 4 |
| | **Hex** | 04 |
| **Priority** | | Above Normal |
| **Description** | | Track OFF. |
| **Comment** | | Commonly broadcasted to all nodes by a command station to indicate track power is off and no further command packets should be sent, except inquiries. |
| **Direction** | | From command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.6 [05] TON - Track ON

| | | |
|---|---|---|
| **Name** | | TON |
| **Value** | **Decimal** | 5 |
| | **Hex** | 05 |
| **Priority** | | Above Normal |
| **Description** | | Track ON. |
| **Comment** | | Commonly broadcasted to all nodes by a command station to indicate track power is on. |
| **Direction** | | From command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.7 [06] ESTOP - Emergency Stop

| | | |
|---|---|---|
| **Name** | | ESTOP |
| **Value** | **Decimal** | 6 |
| | **Hex** | 06 |
| **Priority** | | Above Normal |
| **Description** | | Emergency Stop. |
| **Comment** | | Commonly broadcast to all nodes by a command station to indicate all engines have been emergency stopped. |
| **Direction** | | From command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.8 [07] ARST - System Reset

| | | |
|---|---|---|
| **Name** | | ARST |
| **Value** | **Decimal** | 7 |
| | **Hex** | 07 |
| **Priority** | | High |
| **Description** | | System Reset. |
| **Comment** | | Commonly broadcasted to all nodes to indicate a full system reset. Similar to NNRST which directs a single node to be reset. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | |
| **Conditions** | | Opcode is supported |
| **Result** | | If conditions are met then perform a module reset as if power on has just been performed otherwise ignore request. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.9 [08] RTOF - Request Track OFF

| | | |
|---|---|---|
| **Name** | | RTOF |
| **Value** | **Decimal** | 8 |
| | **Hex** | 08 |
| **Priority** | | Above Normal |
| **Description** | | Request Track OFF. |
| **Comment** | | Sent to request change of track power state to “off”. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.10 [09] RTON - Request Track ON

| | | |
|---|---|---|
| **Name** | | RTON |
| **Value** | **Decimal** | 9 |
| | **Hex** | 09 |
| **Priority** | | Above Normal |
| **Description** | | Request Track ON. |
| **Comment** | | Sent to request change of track power state to “on”. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.11 [0A] RESTP - Request Emergency Stop All

| | | |
|---|---|---|
| **Name** | | RESTP |
| **Value** | **Decimal** | 10 |
| | **Hex** | 0A |
| **Priority** | | High |
| **Description** | | Request Emergency Stop ALL. |
| **Comment** | | Sent to request an emergency stop to all trains . Does not affect accessory control. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.12 [0C] RSTAT - Request Command Station Status

| | | |
|---|---|---|
| **Name** | | RSTAT |
| **Value** | **Decimal** | 12 |
| | **Hex** | 0C |
| **Priority** | | Normal |
| **Description** | | Request Command Station Status. |
| **Comment** | | Sent to query the status of the command station.<br>See description of (STAT) for the response from the command station. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.13 [0D] QNN - Query Node Number

| | | |
|---|---|---|
| **Name** | | QNN |
| **Value** | **Decimal** | 13 |
| | **Hex** | 0D |
| **Priority** | | Low |
| **Description** | | Query node number. |
| **Comment** | | Requests a PNN reply from each node on the bus.<br><br>Can be used by management software to obtain a list of nodes on the network. |
| **Direction** | | To module |
| **States/Modes** | | Setup, Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | |
| **Conditions** | | |
| **Result** | | A PNN response is sent. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.14 [10] RQNP - Request Node Parameters

| | | |
|---|---|---|
| **Name** | | RQNP |
| **Value** | **Decimal** | 16 |
| | **Hex** | 10 |
| **Priority** | | Low |
| **Description** | | Request node parameters. |
| **Comment** | | Sent to a node while in Setup mode to read its parameter set. Used when initially configuring a node. |
| **Direction** | | To module |
| **States/Modes** | | Setup |
| **Services** | | MNS |
| **Parameters** | | |
| **Conditions** | | If the module is not in setup mode then ignore the message. |
| **Result** | | If conditions are met then send a PARAMS message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.1.15 [11] RQMN - Request Module Name

| | | |
|---|---|---|
| **Name** | | RQMN |
| **Value** | **Decimal** | 17 |
| | **Hex** | 11 |
| **Priority** | | Normal |
| **Description** | | Request module name. |
| **Comment** | | Sent by a node to request the name of the type of module that is in setup mode or Learn mode. The module in setup mode or learn mode will reply with opcode NAME.<br>Note if there is a module in setup mode and a module in Learn mode then both will respond. |
| **Direction** | | To module |
| **States/Modes** | | Learn, Setup |
| **Services** | | MNS |
| **Parameters** | | |
| **Conditions** | | If the module is not in Setup mode or Learn mode then the message is ignored. |
| **Result** | | If conditions are met then send a NAME message otherwise. |
| **History** | | No change from CBUS revision 4 ver 8j |

# 3.2 OPCODES with 1 additional bytes

## 3.2.1 [21] KLOC - Release Engine

| | | |
|---|---|---|
| **Name** | | KLOC |
| **Value** | **Decimal** | 33 |
| | **Hex** | 21 |
| **Priority** | | Normal |
| **Description** | | Release Engine. |
| **Comment** | | Sent by a CAB to the Command Station. The engine with that Session number is removed from the active engine list. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then the message is ignored.<br>If the module does not have an active session with the specified session identifier then an ERR message is sent. |
| **Result** | | If conditions are met then the loco for that session is removed from the active engine list. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.2.2 [22] QLOC - Query Engine

| | | |
|---|---|---|
| **Name** | | QLOC |
| **Value** | **Decimal** | 34 |
| | **Hex** | 22 |
| **Priority** | | Normal |
| **Description** | | Query engine. |
| **Comment** | | Used to determine if the command station session is valid and to obtain information about the status of the locomotive. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then the message is ignored.<br>If the module does not have an active session with the specified session identifier then an ERR message is sent. |
| **Result** | | If conditions are met then send a PLOC message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.2.3 [23] DKEEP - Session Keep Alive

| | | |
|---|---|---|
| **Name** | | DKEEP |
| **Value** | **Decimal** | 35 |
| | **Hex** | 23 |
| **Priority** | | Normal |
| **Description** | | Session keep alive. |
| **Comment** | | The cab sends a keep alive at regular intervals for the active session. The interval between keep alive messages must be less than the session timeout implemented by the command station. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then the message is ignored. |
| **Result** | | If conditions are met then Reset the session’s keep alive timer. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.2.4 [30] DBG1 - Debug with 1 Data Byte

| | | |
|---|---|---|
| **Name** | | DBG1 |
| **Value** | **Decimal** | 48 |
| | **Hex** | 30 |
| **Priority** | | Normal |
| **Description** | | Debug with one data byte. |
| **Comment** | | Freeform status byte for debugging during CBUS module development. Not used during normal operation. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Status (1 bytes) |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.2.5 [3F] EXTC - Extended Opcode 0 Additional Bytes

| | | |
|---|---|---|
| **Name** | | EXTC |
| **Value** | **Decimal** | 63 |
| | **Hex** | 3F |
| **Priority** | | Low |
| **Description** | | Extended opcode with zero additional bytes. |
| **Comment** | | Reserved to allow the 0 additional bytes range to be extended by a further 256 opcodes. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Ext_OPC (1 bytes) Extended opcode, |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.3 OPCODES with 2 additional bytes

### 3.3.1 [40] RLOC - Request Engine Session

| | | |
|---|---|---|
| **Name** | | RLOC |
| **Value** | **Decimal** | 64 |
| | **Hex** | 40 |
| **Priority** | | Normal |
| **Description** | | Request engine session. |
| **Comment** | | This command is typically sent by a cab to the command station following a change of the controlled decoder address. RLOC is exactly equivalent to GLOC with all flag bits set to zero, but command stations must continue to support RLOC for backwards compatibility. 7 bit addresses have (AddrH=0).14 bit addresses have bits 6,7 of AddrH set to 1. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Dat1 (1 bytes) AddrH of the decoder,<br>Dat2 (1 bytes) AddrL of the decoder |
| **Conditions** | | If the module is not a DCC command station then the message is ignored.<br>If the command station does not have an available session slot an ERR (Loco stack full) message is sent.<br>If the loco is currently assigned to another session then an ERR (Loco address Taken) is sent. |
| **Result** | | If conditions are met then associate loco address to the specified session and send a PLOC message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.2 [41] QCON - Query Consist

| | | |
|---|---|---|
| **Name** | | QCON |
| **Value** | **Decimal** | 65 |
| | **Hex** | 41 |
| **Priority** | | Normal |
| **Description** | | Query Consist. |
| **Comment** | | Allows enumeration of a consist. Command station responds with PLOC if an engine exists at the specified index, otherwise responds with ERR: no more engines. |
| **Direction** | | To command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | ConID (1 byte) Consist ID<br>Index (1 byte) |
| **Conditions** | | If the module is not a DCC command station then the message is ignored.<br>If an engine does not exist at the specified index then send an ERR (No session) message. |
| **Result** | | If conditions are met then send a PLOC message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.3 [42] SNN - Set Node Number

| | | |
|---|---|---|
| **Name** | | SNN |
| **Value** | **Decimal** | 66 |
| | **Hex** | 42 |
| **Priority** | | Low |
| **Description** | | Set Node Number. |
| **Comment** | | Sent by a configuration tool to assign a node number to a requesting node in response to a RQNN message. The target node must be in 'setup' mode. |
| **Direction** | | To module |
| **States/Modes** | | Setup |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) the new node number |
| **Conditions** | | Module must be in setup mode otherwise the SNN message is ignored. |
| **Result** | | If conditions are met then the specified node number is saved in persistent storage for use in future communications. The module shall send a NNACK message in response. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.4 [43] ALOC - Allocate Loco to Activity

| | | |
|---|---|---|
| **Name** | | ALOC |
| **Value** | **Decimal** | 67 |
| | **Hex** | 43 |
| **Priority** | | Normal |
| **Description** | | Allocate loco to activity. |
| **Comment** | | |
| **Direction** | | To command station |
| **States/Modes** | | Normal |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session ID (1 byte) the Session ID.<br>Allocation code (1 byte) application specific allocation code. |
| **Conditions** | | If the module is not a DCC command station then ignore the request.<br>If the module does not have an active session with the specified session identifier then send an ERR (No session) message. |
| **Result** | | If conditions are met then assign the activity code to the session otherwise. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.5 [44] STMOD - Set Cab Session Mode

| | | |
|---|---|---|
| **Name** | | STMOD |
| **Value** | **Decimal** | 68 |
| | **Hex** | 44 |
| **Priority** | | Normal |
| **Description** | | Set CAB session mode. |
| **Comment** | | Bits 0 –1: speed mode<br>00 =128 speed steps,<br>01 =14 speed steps,<br>10 =28 speed steps with interleave steps,<br>11 =28 speed steps<br>Bit 2: service mode<br>Bit 3:sound control mode |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>mode (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the request.<br>If the module does not have an active session with the specified session identifier then send an ERR (No session) message. |
| **Result** | | If conditions are met then update the session information for number of speed steps, service mode and sound control mode. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.6 [45] PCON - Consist Engine

| | | |
|---|---|---|
| **Name** | | PCON |
| **Value** | **Decimal** | 69 |
| | **Hex** | 45 |
| **Priority** | | Normal |
| **Description** | | Consist Engine. |
| **Comment** | | Adds a decoder specified by Session to a consist. Consist# has bit 7 set if consist direction is reversed. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Consist# (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the request.<br>If the module does not have an active session with id Session then send ERR (No session). |
| **Result** | | If the module does not already have a consist with the specified id then the consist is created.<br>The session is added to the specified consist. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.7 [46] KCON - Remove Loco from Consist

| | | |
|---|---|---|
| **Name** | | KCON |
| **Value** | **Decimal** | 70 |
| | **Hex** | 46 |
| **Priority** | | Normal |
| **Description** | | Removes a loco from a consist. |
| **Comment** | | |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Consist# (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the module does not have a session with the specified Session id then send ERR (No session).<br>If the module does not have a consist with the specified Consist# id then ignore the message. |
| **Result** | | If conditions are met then remove the specified session from the specified consist. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.8 [47] DSPD - Set Engine Speed/Dir

| | | |
|---|---|---|
| **Name** | | DSPD |
| **Value** | **Decimal** | 71 |
| | **Hex** | 47 |
| **Priority** | | Normal |
| **Description** | | Set Engine Speed/Dir. |
| **Comment** | | Speed/dir value, where the most significant bit is direction and the 7ls bits are the unsigned speed value. Sent by a CAB or equivalent to request an engine speed/dir change. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Speed/Dir (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the module does not have an active session with the specified session identifier then send ERR (No session). |
| **Result** | | If conditions are met then set the speed and direction of the loco specified by the session. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.9 [48] DFLG - Set Engine Flags

| | | |
|---|---|---|
| **Name** | | DFLG |
| **Value** | **Decimal** | 72 |
| | **Hex** | 48 |
| **Priority** | | Normal |
| **Description** | | Set Engine Flags. |
| **Comment** | | Bits 0-1: Speed Mode (00 =128 speed steps, 01 =14 speed steps,10 =28 speed steps with interleave steps, 11 =28 speed steps)<br>Bit 2:Lights On/OFF<br>Bit 3:Engine relative direction<br>Bits 4-5: Engine state (active =0 , consisted =1, consist master=2, inactive=3)<br>Bits 6-7: Reserved.<br><br>Sent by a cab to notify the command station of a change in engine flags. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>SpeedMode (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the module does not have an active session with the specified session identifier then send an ERR (No session) message. |
| **Result** | | If conditions are met then set the specified session flags. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.10 [49] DFNON - Set Engine Function ON

| | | |
|---|---|---|
| **Name** | | DFNON |
| **Value** | **Decimal** | 73 |
| | **Hex** | 49 |
| **Priority** | | Normal |
| **Description** | | Set Engine function on. |
| **Comment** | | Sent by a cab to turn on a specific loco function. This provides an alternative method to DFUN for controlling loco functions. A command station must implement both methods. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Fnum (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message. If the module does not have an active session with the specified session identifier then send an ERR (No session) message. |
| **Result** | | If conditions are met then turn on the loco function on the specified session. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.11 [4A] DFNOF - Set Engine Function OFF

| | | |
|---|---|---|
| **Name** | | DFNOF |
| **Value** | **Decimal** | 74 |
| | **Hex** | 4A |
| **Priority** | | Normal |
| **Description** | | Set Engine function off. |
| **Comment** | | Sent by a cab to turn off a specific loco function. This provides an alternative method to DFUN for controlling loco functions. A command station must implement both methods. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Fnum (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the module does not have an active session with the specified session identifier then send an ERR (No session) message. |
| **Result** | | If conditions are met then turn off the loco function on the specified session. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.12 [4C] SSTAT - Service Mode Status

| | | |
|---|---|---|
| **Name** | | SSTAT |
| **Value** | **Decimal** | 76 |
| | **Hex** | 4C |
| **Priority** | | Low |
| **Description** | | Service mode status. |
| **Comment** | | Status returned by command station/programmer at the end of a programming operation that does not return data.<br>Response to QCVS to indicate no data. |
| **Direction** | | From command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Status (1 bytes) |
| **Conditions** | | Response to QCVS when no data was available. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.13 [4F] NNRSM - Reset to Manufacturer Settings

| | | |
|---|---|---|
| **Name** | | NNRSM |
| **Value** | **Decimal** | 79 |
| | **Hex** | 4F |
| **Priority** | | Low |
| **Description** | | Reset to manufacturer settings. |
| **Comment** | | Reset a module back to manufacturer settings. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then ignore the message. |
| **Result** | | If conditions are met then the module shall respond with GRSP OK and then clear all configuration and revert to a state at time of initial programming, including *Uninitialised* mode i.e. NN=0, manufacturer's default NVs and default Events.<br>(CANID will be enumerated on the first CAN message send.) |
| **History** | | CBUS specifies preservation of NN and returns to FLiM. VLCB reverts the module to NN=0 and enters Uninitialised mode. |

### 3.3.14 [50] RQNN - Request Node Number

| | | |
|---|---|---|
| **Name** | | RQNN |
| **Value** | **Decimal** | 80 |
| | **Hex** | 50 |
| **Priority** | | low |
| **Description** | | Request node number. |
| **Comment** | | The module is requesting that it is provided with a new node number.<br><br>A configuration tool should respond with SNN to provide the requesting module with an allocated node number.<br><br>The NN within the message is the current node number of the module. |
| **Direction** | | From module |
| **States/Modes** | | Setup |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Existing Node number |
| **Conditions** | | Module has been instructed to request a new node number. This may be done in a variety of ways such as holding down a push button on the module for a number of seconds.<br><br>Module will not send RQNN until instructed to obtain new NN. |
| **Result** | | The module enters setup mode.<br>If the module does not receive a SNN with in 30 seconds, the module will return to its previous mode and reclaim its previous NN by issuing a NNACK. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.15 [51] NNREL - Node Number Release

| | | |
|---|---|---|
| **Name** | | NNREL |
| **Value** | **Decimal** | 81 |
| | **Hex** | 51 |
| **Priority** | | Low |
| **Description** | | Node number release. |
| **Comment** | | A node signals that it no longer requires a node number by sending NNREL. The module will do this upon moving from normal mode to setup mode. |
| **Direction** | | From module |
| **States/Modes** | | Setup |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | Module is in the process of changing to Setup mode. |
| **Result** | | Module no longer has a node number. The node number is replaced with 0 indicating ‘no node number’. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.16 [52] NNACK - Node Number Acknowledge

| | | |
|---|---|---|
| **Name** | | NNACK |
| **Value** | **Decimal** | 82 |
| | **Hex** | 52 |
| **Priority** | | Low |
| **Description** | | Node number acknowledge. |
| **Comment** | | This message is sent in response to SNN. A node signals that it will now use the node number specified in the SNN message. |
| **Direction** | | From module |
| **States/Modes** | | Setup |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) the new node number to be used. |
| **Conditions** | | Module will be transitioning from Setup mode to Normal mode. |
| **Result** | | Module will be in Normal mode with the new node number assigned. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.17 [53] NNLRN - Set Node to Learn Mode

| | | |
|---|---|---|
| **Name** | | NNLRN |
| **Value** | **Decimal** | 83 |
| | **Hex** | 53 |
| **Priority** | | Low |
| **Description** | | Set node into learn mode. |
| **Comment** | | Sent by a configuration tool to put a specific node into learn mode.<br>Deprecated and replaced by MODE. |
| **Direction** | | To module |
| **States/Modes** | | Normal |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | if the NN does NOT match the node number of the module and the module is in Learn mode then it must revert to Normal mode.<br>If the NN does NOT match the node number of the module and the module is not in Learn mode then the message is ignored.<br>If the NN matches the module's node number and the module supports event teaching then the module enters Learn mode.<br>If the NN matches the module's node number and the module does not support event teaching then the message is ignored. |
| **Result** | | If conditions are met then the module enters Learn mode. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.18 [54] NNULN - Node Out of Learn Mode

| | | |
|---|---|---|
| **Name** | | NNULN |
| **Value** | **Decimal** | 84 |
| | **Hex** | 54 |
| **Priority** | | Low |
| **Description** | | Release node from learn mode. |
| **Comment** | | Sent by a configuration tool to take the module out of learn mode and revert to normal operation.<br>Deprecated and replaced by MODE. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the module does not support event teaching then the message is ignored.<br>If the module is in Learn mode then the module exits Learn mode and returns to Normal mode. Note: the NN does not need to match the module's node number. |
| **Result** | | If the conditions are met the module exits Learn mode and enters Normal mode. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.19 [55] NNCLR - Clear All Events

| | | |
|---|---|---|
| **Name** | | NNCLR |
| **Value** | **Decimal** | 85 |
| | **Hex** | 55 |
| **Priority** | | Low |
| **Description** | | Clear all events from a node. |
| **Comment** | | Sent by a configuration tool to clear all events from a specific node. Must be in learn mode first to safeguard against accidental erasure of all events |
| **Direction** | | To module |
| **States/Modes** | | Learn |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then the message is ignored.<br>If the module is not in learn mode then a CMDERR(Not Learn Mode) message and a GRSP(Not in Learn Mode) is returned.<br>If the module does not support event teaching then the message is ignored. |
| **Result** | | If conditions are met then remove all stored events and send a WRACK message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.20 [56] NNEVN - Number of Events Available

| | | |
|---|---|---|
| **Name** | | NNEVN |
| **Value** | **Decimal** | 86 |
| | **Hex** | 56 |
| **Priority** | | Low |
| **Description** | | Read the number of event slots available in a node. |
| **Comment** | | Sent by a configuration tool to read the number of available event slots in a node. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then ignore the message. |
| **Result** | | If conditions are met then send EVNLF message with number of available slots in event table. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.21 [57] NERD - Read All Events

| | | |
|---|---|---|
| **Name** | | NERD |
| **Value** | **Decimal** | 87 |
| | **Hex** | 57 |
| **Priority** | | Low |
| **Description** | | Read back all stored events in a node.<br>There MUST be no hidden events. |
| **Comment** | | Sent by a configuration tool to read all the stored events in a node. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then ignore the message. |
| **Result** | | If conditions are met then send a ENRSP message for each configured event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.22 [58] RQEVN - Read number of Stored Events

| | | |
|---|---|---|
| **Name** | | RQEVN |
| **Value** | **Decimal** | 88 |
| | **Hex** | 58 |
| **Priority** | | Low |
| **Description** | | Request to read number of stored events. |
| **Comment** | | Sent by a configuration tool to read the number of stored events in a node. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then ignore the message. |
| **Result** | | If conditions are met then send a NUMEV message to indicate the number of stored events. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.23 [59] WRACK - Write Acknowledge

| | | |
|---|---|---|
| **Name** | | WRACK |
| **Value** | **Decimal** | 89 |
| | **Hex** | 59 |
| **Priority** | | Low |
| **Description** | | Write acknowledge. |
| **Comment** | | Sent by a node to indicate the completion of a write to memory operation. All nodes must issue WRACK when a write operation to node variables, events or event variables has completed. This allows for teaching nodes where the processing time may be slow.<br>Deprecated and replaced by GRSP. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach, NV |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | The module has completed writing to non-volatile memory and is ready to accept more commands. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.24 [5A] RQDAT - Request Data Event

| | | |
|---|---|---|
| **Name** | | RQDAT |
| **Value** | **Decimal** | 90 |
| | **Hex** | 5A |
| **Priority** | | Low |
| **Description** | | Request node data event. |
| **Comment** | | Sent by one node to read the data event from another node.(eg: RFID data). |
| **Direction** | | Both |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then ignore the message.<br>If the module does not support RQDAT then ignore the message. |
| **Result** | | If conditions are met then send an ARDAT message containing the application specific data. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.25 [5B] RQDDS - Request Device Data - short mode

| | | |
|---|---|---|
| **Name** | | RQDDS |
| **Value** | **Decimal** | 91 |
| | **Hex** | 5B |
| **Priority** | | Low |
| **Description** | | Request device data –short mode. |
| **Comment** | | To request a ‘data set’ from a device using the short event method where DN is the device number. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | DN (2 bytes) Device number |
| **Conditions** | | If DN is not recognised by the module then ignore the message. |
| **Result** | | If conditions are met then send a DDRS message response. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.26 [5C] BOOTM - Enter Bootloader Mode

| | | |
|---|---|---|
| **Name** | | BOOTM |
| **Value** | **Decimal** | 92 |
| | **Hex** | 5C |
| **Priority** | | Low |
| **Description** | | Put node into bootloading mode.<br>Deprecated and replaced by MODE. |
| **Comment** | | For modules with no NN then the NN of the command must be zero.<br>For nodes in Normal mode the command must contain the NN of the target node.<br>Sent by a configuration tool to prepare for loading a new program. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Boot |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If NN does not match the module's node number then ignore the message. |
| **Result** | | If conditions are met then enter BOOT mode.<br>If using the standard PIC bootloader then write a 0x01 to the top EEPROM location and reset the processor. The module's PIC bootloader will be activated before the application code. Once the bootloading is complete it will pass control by to the application at the Load Address in the parameter block. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.3.27 [5D] ENUM - Force Self Enumeration of CANID

| | | |
|---|---|---|
| **Name** | | ENUM |
| **Value** | **Decimal** | 93 |
| | **Hex** | 5D |
| **Priority** | | Low |
| **Description** | | Force a self enumeration cycle for use with CAN.<br>Deprecated. Replaced with automatic self enumeration after duplicate CANID detection. |
| **Comment** | | For nodes in Normal mode using CAN as a transport.. This message will force a self-enumeration cycle for the specified node. A new CAN_ID will be allocated if needed. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | CAN |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then the message will be ignored. |
| **Result** | | If conditions are met then start to perform self enumeration. A RTR CAN frame is sent. The module must wait 100ms for other modules to respond with a zero length data frame containing their CANID. After 100ms the module shall select an unused CANID in the range 1..127.<br>If no CANIDs are available then send CMDERR(7).<br>After the enum process is complete and if a CANID has been assigned then send NNACK. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.3.28 [5E] NNRST - Node Reset

| | | |
|---|---|---|
| **Name** | | NNRST |
| **Value** | **Decimal** | 94 |
| | **Hex** | 5E |
| **Priority** | | Low |
| **Description** | | Reset module's CPU. |
| **Comment** | | Reset a module's microprocessor. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | NN (2 bytes) Node number |
| **Conditions** | | If the NN does not match the module's node number then ignore the request. |
| **Result** | | If conditions are met then perform a reset of the microprocessor. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.3.29 [5F] EXTC1 - Extended Opcode with 1 Additional Bytes

| | | |
|---|---|---|
| **Name** | | EXTC1 |
| **Value** | **Decimal** | 95 |
| | **Hex** | 5F |
| **Priority** | | Low |
| **Description** | | Extended opcode with 1 additional byte. |
| **Comment** | | Reserved to allow the 1 additional bytes range to be extended by a further 256 opcodes. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Ext_OPC (1 bytes) Extended opcode,<br>Data1 (1 bytes) |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

# 3.4 OPCODES with 3 additional bytes

## 3.4.1 [60] DFUN - Set Engine Functions

| | | |
|---|---|---|
| **Name** | | DFUN |
| **Value** | **Decimal** | 96 |
| | **Hex** | 60 |
| **Priority** | | Normal |
| **Description** | | Set Engine functions. |
| **Comment** | | <Fn1>is the function range<br>1 is F0(FL) to F4,<br>2 is F5 to F8,<br>3 is F9 to F12,<br>4 is F13 to F20,<br>5 is F21to F28)<br><Fn2> is the NMRA DCC format function byte for that range in corresponding bits. A bit set to 1 turns function “on” and a cleared bit sets function “off”.<br><br>Sent by a CAB or equivalent to request an engine Fn state change. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Fn1 (1 bytes),<br>Fn2 (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the module does not have an active session with the specified session identifier then send an ERR (No session) message. |
| **Result** | | If conditions are met then set the functions in the range given to the requested state. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.4.2 [61] GLOC - Get Engine Session

| | | |
|---|---|---|
| **Name** | | GLOC |
| **Value** | **Decimal** | 97 |
| | **Hex** | 61 |
| **Priority** | | Normal |
| **Description** | | Get engine session. |
| **Comment** | | <Flags> contains flag bits as follows:<br>Bit 0: Set for "Steal" mode<br>Bit 1: Set for "Share" mode.<br>Both bits set to 0 is exactly equivalent to an RLOC request but command stations must continue to support RLOC for backwards compatibility. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Addr (2 bytes),<br>Flags (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the least significant two bits of Flags are both set then send an ERR (Invalid Request) message.<br>If the loco with the specified address is taken and steal/share is disabled then send an ERR (Loco taken) message.<br>If there is no available session slot for the steal then send an ERR (Stack full) message.<br>If there is no current session for a share then send an ERR(No session) message. |
| **Result** | | Perform the share/steal and send a PLOC message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.4.3 [63] ERR - Command Station Error

| | | |
|---|---|---|
| **Name** | | ERR |
| **Value** | **Decimal** | 99 |
| | **Hex** | 63 |
| **Priority** | | Normal |
| **Description** | | Command Station Error report. |
| **Comment** | | Sent in response to an error situation by a command station. See Appendix A - DCC ERR error codes for a list of error codes. |
| **Direction** | | From command station to cab |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | AddrH (1 bytes),<br>AddrL (1 bytes),<br>ErrorCode (1 bytes) |
| **Conditions** | | Sent by a command station in response to a DCC command to report an error. |
| **Result** | | See table below for the use of the Data fields. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.4.4 [6F] CMDERR - Configuration Error

| | | |
|---|---|---|
| **Name** | | CMDERR |
| **Value** | **Decimal** | 111 |
| | **Hex** | 6F |
| **Priority** | | Low |
| **Description** | | Error messages from nodes during configuration. |
| **Comment** | | Sent by node if there is an error when a configuration command is sent. See Appendix C - CMDERR error codes for the list of supported codes. Deprecated and replaced by GRSP.<br><br>Modules should continue to support CMDERR as possible responses to CBUS compatible requests in order to maintain backwards compatibility to CBUS. In these cases a VLCB GRSP should also be reported. VLCB requests that are not in CBUS should report errors only with GRSP. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS, Teach, NV |
| **Parameters** | | NN (2 bytes) Node number,<br>Error (1 bytes) Error number, see CMDERR list in Appendix C |
| **Conditions** | | Sent by a module to indicate an error response to a command. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.4.5 [70] EVNLF - Number of Event Spaces Remaining

| | | |
|---|---|---|
| **Name** | | EVNLF |
| **Value** | **Decimal** | 112 |
| | **Hex** | 70 |
| **Priority** | | Low |
| **Description** | | Event space left reply from node. |
| **Comment** | | Spaces is a one byte value giving the number of available event spaces left in the node's event table. This is the maximum number of additional events that can be stored by the module. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number,<br>Spaces(1 bytes) |
| **Conditions** | | Sent in response to a NNEVN request. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.4.6 [71] NVRD - Node Variable Read

| | | |
|---|---|---|
| **Name** | | NVRD |
| **Value** | **Decimal** | 113 |
| | **Hex** | 71 |
| **Priority** | | Low |
| **Description** | | Request read of a node variable. |
| **Comment** | | NV# is the index for the node variable value requested. Response is NVANS.<br>Reading NV#0 shall first return a NVANS with the number of NVs followed by a NVANS for each NV. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | NV |
| **Parameters** | | NN (2 bytes) Node number,<br>NV# (1 bytes) Node variable index |
| **Conditions** | | If NN does not match the module's node number then the message is ignored.<br>If message is short so that it does not include the NV# then a GRSP (Invalid Command) message is returned.<br>If NV# is not between 0 and the supported number of NVs then CMDERR (Invalid Node Variable Index) message is returned and a GRSP (Invalid Node Variable Index) message is returned. |
| **Result** | | If conditions are met and NV# is 0 then send a NVANS response for NV#0 and value of the number of NVs followed by a NVANS for each NV.<br>If conditions are met and NV# is greater than 0 then send a single NVANS response containing the value of the requested NV.<br>If NV# is not between 1 and the supported number of NVs then CMDERR(Invalid Node Variable Index) message is returned and a GRSP(Invalid Node Variable Index) message is returned. |
| **History** | | Modified from CBUS revision 4 ver 8j to also return GRSP and support for NV#0. |

### 3.4.7 [72] NENRD - Read Event by Index

| | | |
|---|---|---|
| **Name** | | NENRD |
| **Value** | **Decimal** | 114 |
| | **Hex** | 72 |
| **Priority** | | Low |
| **Description** | | Request read of stored event by event index. |
| **Comment** | | EN# is the index for the stored event requested. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number,<br>EN# (1 bytes) Event index |
| **Conditions** | | NN matches module's node number.<br>EN# is a valid event index |
| **Result** | | If condition 'NN matches module's node number' is not met then ignore request.<br>If condition 'EN# is a valid event index' is met then send ENRSP response message otherwise send CMDERR(Invalid Event Index). |
| **History** | | In CBUS revision 4 ver 8j. |

### 3.4.8 [73] RQNPN - Read Node Parameter By Index

| | | |
|---|---|---|
| **Name** | | RQNPN |
| **Value** | **Decimal** | 115 |
| | **Hex** | 73 |
| **Priority** | | Low |
| **Description** | | Request read of a node parameter by index. |
| **Comment** | | Para# is the index for the parameter requested.<br>Reading Index 0 first returns a PARAN with the number of available parameters followed by a PARAN for each of those parameters.<br>See Appendix B - Module parameters for the list of available parameters and their meaning. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>Para# (1 bytes) |
| **Conditions** | | If NN does not match the module's node number then ignore the message.<br>If message is short so that it does not include the Para# then a GRSP (Invalid Command) message is returned.<br>If Para# is greater than the number of supported parameters the send message CMDERR(Invalid Parameter Index) and message GRSP(Invalid Parameter Index) |
| **Result** | | If conditions are met then<br>If Para# is 0 then send a PARAN message with the number of available parameters as the value for parameter 0 followed by a PARAN message for each of the parameters else send a single PARAN message containing the requested parameter value. |
| **History** | | Modified from CBUS revision 4 ver 8j so that Para# 0 returns a PARAN for each parameter. |

### 3.4.9 [74] NUMEV - Number of Events

| | | |
|---|---|---|
| **Name** | | NUMEV |
| **Value** | **Decimal** | 116 |
| | **Hex** | 74 |
| **Priority** | | Low |
| **Description** | | Number of events stored by node. |
| **Comment** | | Response to request RQEVN |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number,<br>No. of events (1 bytes) Number of events |
| **Conditions** | | Sent in response to a RQEVN request. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.4.10 [75] CANID - Set CANID

| | | |
|---|---|---|
| **Name** | | CANID |
| **Value** | **Decimal** | 117 |
| | **Hex** | 75 |
| **Priority** | | Low |
| **Description** | | Set the CAN_ID in the node.<br>Deprecated. Replaced with Self-enumeration. |
| **Comment** | | Used to force a specified CAN_ID into a node. Value range is from 1 to 0x63 (99 decimal). This OPC must be used with care as duplicate CAN_IDs are not allowed. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | CAN |
| **Parameters** | | NN (2 bytes) Node number,<br>CAN_ID (1 bytes) CAN identifier |
| **Conditions** | | If NN does not match the module's node number then ignore the message.<br>If the message is short so that it does not include the CAN_ID then a GRSP (Invalid Command) message is returned.<br>If CANID is not between 1 (inclusive) and 99 (inclusive) then send message CMDERR(Invalid Event) and message GRSP(Invalid command parameter) |
| **Result** | | If conditions are met then store the CAN_ID to be used in subsequent CAN message transmission. Send message WRACK and GRSP(ok). |
| **History** | | Modified from CBUS revision 4 ver 8j to include GRSP responses. |

### 3.4.11 [76] MODE - Set Operating Mode

| | | |
|---|---|---|
| **Name** | | MODE |
| **Value** | **Decimal** | 118 |
| | **Hex** | 76 |
| **Priority** | | Low |
| **Description** | | Request a change to a module's operating mode. |
| **Comment** | | Request to change the operational mode of the module. |
| **Direction** | | To module |
| **States/Modes** | | Normal and other modes defined by services. |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>Mode (1 bytes) Mode Command.<br>● Mode command = 0 is a request to transition to Setup Mode<br>● Mode command = 1 is a request to transition to Normal Mode.<br>Please refer to service specific documentation for other Mode Command definitions. |
| **Conditions** | | If the module has a non zero node number and NN does not match the module's node number then ignore the message. Note that if the module is in Setup mode or Uninitialised mode then the module's NN should be zero.<br><br>If the message is short so that it does not include the Mode Command then a GRSP (Invalid Command) message is returned.<br><br>If the module is in Setup or Uninitialised modes and the message NN is non zero then ignore the message.<br><br>If the module's services do not recognise the specified Mode Command then send a GRSP(invalid mode) message. |
| **Result** | | If requested Mode Command is supported by the module's services then send GRSP(ok). Any change to the module's current mode is services' dependent. |
| **History** | | New for VLCB |

### 3.4.12 [78] RQSD - Request Service Discovery

| | | |
|---|---|---|
| **Name** | | RQSD |
| **Value** | **Decimal** | 120 |
| | **Hex** | 78 |
| **Priority** | | Low |
| **Description** | | Request service discovery. |
| **Comment** | | Request service data from a module.<br>If the ServiceIndex is zero then the module responds with a SD response for each service supported. If ServiceIndex is non zero then the module will respond with a single ESD message.<br><br>Similar to other requests for data with an index of 0 (e.g. NVRD and REQEV) the first response shall return the number of responses followed by a response for each data item. The first response will have a ServiceIndex=0, ServiceType=0 and Version field to contain the number of services. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>ServiceIndex (1 bytes) Index into the list of services. |
| **Conditions** | | If NN does not match the module's node number then ignore the message.<br>If the message is short so that it does not include the ServiceIndex then a GRSP (Invalid Command) message is returned.<br><br>If ServiceIndex does not reference a valid service then send a GRSP(Invalid service) message.<br><br>If ServiceIndex is greater than the number of supported services then send a GRSP(Invalid service) message. |
| **Result** | | If ServiceIndex is zero a SD(0,0, number of services) message is sent followed by a SD message for each implemented service, otherwise send an ESD message for the specified service. |

| | |
|---|---|
| **History** | New for VLCB |

### 3.4.13 [7F] EXTC2 - Extended Opcode with 2 Additional Bytes

| | | |
|---|---|---|
| **Name** | | EXTC2 |
| **Value** | **Decimal** | 127 |
| | **Hex** | 7F |
| **Priority** | | Low |
| **Description** | | Extended opcode with 2 additional bytes. |
| **Comment** | | Reserved to allow the 2 additional bytes range to be extended by a further 256 opcodes. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Ext_OPC (1 bytes) Extended opcode,<br>Data1 (1 bytes)<br>Data2 (1 bytes) |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

# 3.5 OPCODES with 4 additional bytes

## 3.5.1 [80] RDCC3 - Request 3 bytes DCC Packet

| | | |
|---|---|---|
| **Name** | | RDCC3 |
| **Value** | **Decimal** | 128 |
| | **Hex** | 80 |
| **Priority** | | Normal |
| **Description** | | Request 3-byte DCC Packet. |
| **Comment** | | Allows a CAB or equivalent to request a 3 byte DCC packet to be sent to the track. The packet is sent <REP> times and is not refreshed on a regular basis. Note: a 3 byte DCC packet is the minimum allowed. |
| **Direction** | | Cab to common station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Rep (1 bytes),<br>Byte1 (1 bytes),<br>Byte2 (1 bytes),<br>Byte3 (1 bytes) |
| **Conditions** | | If the module is not a command station then ignore the message. |
| **Result** | | If conditions are met then the DCC command stations shall send the requested DCC packet <REP> times. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.2 [82] WCVO - Write CV byte in OPS mode

| | | |
|---|---|---|
| **Name** | | WCVO |
| **Value** | **Decimal** | 130 |
| | **Hex** | 82 |
| **Priority** | | Normal |
| **Description** | | Write CV (byte) in OPS mode. |
| **Comment** | | Sent to the command station to write a DCC CV byte in OPS mode to a specific loco (on the main). |
| **Direction** | | To command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>CV (2 bytes),<br>Value (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the command station does not have an active session with the specified session identifier then send a message ERR(No session). |
| **Result** | | If conditions are met then the DCC command stations shall write the specified value to the specified CV. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.3 [83] WCVB - Write CV Bit in OPS Mode

| | | |
|---|---|---|
| **Name** | | WCVB |
| **Value** | **Decimal** | 131 |
| | **Hex** | 83 |
| **Priority** | | Normal |
| **Description** | | Write CV (bit) in OPS mode. |
| **Comment** | | Sent to the command station to write a DCC CV in OPS mode to specific loco (on the main).<br>The format for Value is that specified in RP 9.2.1 for OTM bit manipulation in a DCC packet. This is '111CDBBB' where C here is always 1 as only 'writes' are possible OTM (unless some loco ACK scheme like RailCom is used). D is the bit value, either 0 or 1 and BBB is the bit position in the CV byte. 000 to 111 for bits 0 to 7. |
| **Direction** | | To command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>CV (2 bytes),<br>Value (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the command station does not have an active session with the specified session identifier then send a message ERR(No session). |
| **Result** | | If conditions are met then the DCC command stations shall write the specified value to the specified CV in bit mode. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.4 [84] QCVS - Read CV

| | | |
|---|---|---|
| **Name** | | QCVS |
| **Value** | **Decimal** | 132 |
| | **Hex** | 84 |
| **Priority** | | Normal |
| **Description** | | Read CV. |
| **Comment** | | This command is used exclusively with service mode.<br>Sent by the cab to the command station in order to read a CV value. |
| **Direction** | | Cab to command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>CV (2 bytes),<br>Mode (1 bytes) |
| **Conditions** | | If the module is not a DCC command station then ignore the message.<br>If the command station does not have an active session with the specified session identifier then send a message ERR(No session).<br>If the CV value cannot be read then send a SSTAT message with the reason for failure. |
| **Result** | | If conditions are met then send a PVCS message with CV value. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.5 [85] PCVS - Report CV

| | | |
|---|---|---|
| **Name** | | PCVS |
| **Value** | **Decimal** | 133 |
| | **Hex** | 85 |
| **Priority** | | Normal |
| **Description** | | Report CV. |
| **Comment** | | This command is used exclusively with service mode.<br>Sent by the command station to report a read CV in response to QCVS. |
| **Direction** | | From command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>CV (2 bytes),<br>Value (1 bytes) |
| **Conditions** | | |
| **Result** | | Response to QCVS to report the CV value. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.6 [87] RDGN - Request Diagnostic Data

| | | |
|---|---|---|
| **Name** | | RDGN |
| **Value** | **Decimal** | 135 |
| | **Hex** | 87 |
| **Priority** | | Low |
| **Description** | | Request diagnostic data. |
| **Comment** | | Request diagnostic data from a module. If the requested diagnostic data is zero then a response for all diagnostic data is returned. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>ServiceIndex (1 bytes) Index into the list of services,<br>DiagnosticCode (1 bytes) Diagnostic data code |
| **Conditions** | | If NN does not match the module's node number then ignore the message.<br>If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br><br>If ServiceIndex references an unsupported service then send a GRSP(Invalid service) message.<br><br>If ServiceIndex references a valid service and DiagnosticCode is zero but the service does not support diagnostics then GRSP (INVALID_DIAGNOSTIC) should be returned.<br><br>If DiagnosticCode references an invalid or unsupported diagnostic number then send a GRSP(Invalid diagnostic) message. |
| **Result** | | If ServiceIndex is zero then for each service send a DGN message indicating the number of DiagnosticCodes for that service followed by a DGN message for each diagnostic code. Note that DiagnosticCode in the RDGN request is ignored in this scenario. |

| | |
|---|---|
| | If ServiceIndex is non zero and references a valid service and DiagnosticCode is zero then send a DGN message with DiagnosticCode of zero with the DiagnosticVal field containing the number of other DiagnosticCodes.<br><br>Otherwise send a DGN response containing the requested diagnostic data for the service specified. |
| **History** | New for VLCB |

### 3.5.8 [8E] NVSETRD - Set NV with Read

| | | |
|---|---|---|
| **Name** | | NVSETRD |
| **Value** | **Decimal** | 144 |
| | **Hex** | 8E |
| **Priority** | | Low |
| **Description** | | Set a NV value with read back. |
| **Comment** | | Sets a NV value and additionally responds with the new value. The new value may not be the value which was requested to be written. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | NV |
| **Parameters** | | NN (2 bytes) Node number,<br>NV# (1 bytes) Node variable index<br>NVvalue (1 byte) Node variable value |
| **Conditions** | | If the NN does not match the module's node number then ignore the message.<br>If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If the NV# is zero or greater than the number of NVs available then send message GRSP(Invalid node variable index). |
| **Result** | | Update the value of the NV, taking into account any module specific limitations and constraints on NV value. Send a single NVANS message containing the NV value. |
| **History** | | New for VLCB |

### 3.5.9 [90] ACON - Accessory ON Event

| | | |
|---|---|---|
| **Name** | | ACON |
| **Value** | **Decimal** | 144 |
| | **Hex** | 90 |
| **Priority** | | Low |
| **Description** | | Accessory ON long event. |
| **Comment** | | Indicates an ‘ON’ event using the full event number of 4 bytes (long event).<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.5.10 [91] ACOF - Accessory OFF Event

| | | |
|---|---|---|
| **Name** | | ACOF |
| **Value** | **Decimal** | 145 |
| | **Hex** | 91 |
| **Priority** | | Low |
| **Description** | | Accessory OFF long event. |
| **Comment** | | Indicates an ‘OFF’ event using the full event number of 4 bytes (long event).<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.11 [92] AREQ - Accessory Request Event

| | | |
|---|---|---|
| **Name** | | AREQ |
| **Value** | **Decimal** | 146 |
| | **Hex** | 92 |
| **Priority** | | Low |
| **Description** | | Accessory Request Event. |
| **Comment** | | Indicates a ‘request’ event using the full event number of 4 bytes (long event). A request event is used to elicit a status response from a producer when it is required to know the ‘state’ of the producer without producing an ON or OFF event. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If the module does not have the event provisioned then ignore the message. |
| **Result** | | If conditions are met and the 'Current status is ON' then send an ARON message otherwise send an AROF message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.12 [93] ARON - Accessory Response ON Event

| | | |
|---|---|---|
| **Name** | | ARON |
| **Value** | **Decimal** | 147 |
| | **Hex** | 93 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event. |
| **Comment** | | Indicates an ‘ON’ response. A response is a reply to a status request (AREQ) without producing an ON or OFF event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.13 [94] AROF - Accessory Response OFF Event

| | | |
|---|---|---|
| **Name** | | AROF |
| **Value** | **Decimal** | 148 |
| | **Hex** | 94 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event (AROF). |
| **Comment** | | Indicates an ‘OFF’ response. A response is a reply to a status request (AREQ) without producing an ON or OFF event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.14 [95] EVULN - Event Unlearn

| | | |
|---|---|---|
| **Name** | | EVULN |
| **Value** | **Decimal** | 149 |
| | **Hex** | 95 |
| **Priority** | | Low |
| **Description** | | Unlearn an event in learn mode. |
| **Comment** | | Sent by a configuration tool to remove an event from a node. |
| **Direction** | | To module |
| **States/Modes** | | Learn |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If the module does not currently have the event configured then send a CMDERR(Invalid Event) message and a GRSP(Invalid Event) message. |
| **Result** | | If conditions are met then remove the event matching the specified event from the configuration and send WRACK. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.15 [96] NVSET - NV Set

| | | |
|---|---|---|
| **Name** | | NVSET |
| **Value** | **Decimal** | 150 |
| | **Hex** | 96 |
| **Priority** | | Low |
| **Description** | | Set a node variable. |
| **Comment** | | Sent by a configuration tool to set a node variable. NV# is the NV index number.<br>Deprecated and replaced by NVSETRD. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | NV |
| **Parameters** | | NN (2 bytes) Node number,<br>NV# (1 bytes) Node variable index,<br>NV val (1 bytes) Node variable value |
| **Conditions** | | If NN does not match the module's node number then ignore the request.<br>If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If NV# is not between 1 (inclusive) and the number of NVs )inclusive) then send a CMDERR(Invalid Node Variable Index) message.<br>If the NVval is not valid for the type of module then send a CMDERR(Invalid Node Variable Value) message. |
| **Result** | | If conditions are met then store NV value and send WRACK. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.16 [97] NVANS - NV Value Response

| | | |
|---|---|---|
| **Name** | | NVANS |
| **Value** | **Decimal** | 151 |
| | **Hex** | 97 |
| **Priority** | | Low |
| **Description** | | Response to a request for a node variable value. |
| **Comment** | | Sent by node in response to request NVRD or NVSETRD. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | NV |
| **Parameters** | | NN (2 bytes) Node number,<br>NV# (1 bytes) Node variable index,<br>NV val (1 bytes) Node variable value |
| **Conditions** | | If the module Module has accepted a NVRD or NVSETRD request then NVANS is returned in response. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.5.17 [98] ASON - Accessory ON Short Event

| | | |
|---|---|---|
| **Name** | | ASON |
| **Value** | **Decimal** | 152 |
| | **Hex** | 98 |
| **Priority** | | Low |
| **Description** | | Accessory Short ON. |
| **Comment** | | Indicates an ‘ON’ event using the short event number of 2 LS bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.5.18 [99] ASOF - Accessory OFF Short Event

| | | |
|---|---|---|
| **Name** | | ASOF |
| **Value** | **Decimal** | 153 |
| | **Hex** | 99 |
| **Priority** | | Low |
| **Description** | | Accessory Short OFF. |
| **Comment** | | Indicates an ‘OFF’ event using the short event number of 2 LS bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state OFF then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.19 [9A] ASRQ - Accessory Request Short Event

| | | |
|---|---|---|
| **Name** | | ASRQ |
| **Value** | **Decimal** | 154 |
| | **Hex** | 9A |
| **Priority** | | Low |
| **Description** | | Accessory Short Request Event. |
| **Comment** | | Indicates a ‘request’ event using the short event number of 2 LS bytes. A request event is used to elicit a status response from a producer when it is required to know the ‘state’ of the producer without producing an ON or OFF event. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | If NN==0, then every module that produces this short-event should respond.<br>If the NN does not match the module’s node number and is non zero then ignore the message.<br>If the module does not have the event provisioned then ignore the message. |
| **Result** | | If conditions are met and the 'Current status is ON' then send an ARSON message otherwise send an ARSOF message. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.5.20 [9B] PARAN - Node Parameter Response

| | | |
|---|---|---|
| **Name** | | PARAN |
| **Value** | **Decimal** | 155 |
| | **Hex** | 9B |
| **Priority** | | Low |
| **Description** | | Response to request for individual node parameter RQNPN. |
| **Comment** | | NN is the node number of the sending node. Para# is the index of the parameter and Para val is the parameter value.<br><br>Returns a parameter value.<br><br>Parameter index is the parameter number and matches that in the RQNPN request.<br><br>See Appendix B - Module parameters for a list of available parameters. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>Para# (1 bytes) Parameter index,<br>Para val (1 bytes) Parameter value |
| **Conditions** | | Response to RQNPN request |
| **Result** | | The PARAN message contains the requested parameter value. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.5.21 [9C] REVAL - Request EV Read

| | | |
|---|---|---|
| **Name** | | REVAL |
| **Value** | **Decimal** | 156 |
| | **Hex** | 9C |
| **Priority** | | Low |
| **Description** | | Request for read of an event variable. |
| **Comment** | | This request differs from B2 (REQEV) as it doesn't need to be in learn mode but does require the knowledge of the event index to which the EV request is directed.<br>Reading EV#0 shall first return the number of EVs followed by a series of NEVAL with the value for each EV. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number,<br>EN# (1 bytes) Event index,<br>EV# (1 bytes) Event variable index |
| **Conditions** | | If the NN does not match the module's node number then ignore the message.<br>If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If the module does not have an event for the event index then send a message CMDERR(Invalid Event).<br>If the EV# is greater than the number of EVs per event then send a message CMDERR(Invalid Event Variable Index).<br>If the event does not have an EV with the specified EV# then send a message CMDERR(No EV). |
| **Result** | | If conditions are met and EV# is non zero then then send an NEVAL message with the EV value.<br>If conditions are met and EV# is zero then first send NEVAL for index 0 and the value containing the number of EVs followed by a series of NEVAL with the value for each EV. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.5.22 [9D] ARSON - Accessory Response ON Short Event

| | | |
|---|---|---|
| **Name** | | ARSON |
| **Value** | **Decimal** | 157 |
| | **Hex** | 9D |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event. |
| **Comment** | | Indicates an ‘ON’ response. A response is a reply to a status request (ASRQ) without producing an ON or OFF event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver  8j |

## 3.5.23 [9E] ARSOF - Accessory Response OFF Short Event

| | | |
|---|---|---|
| **Name** | | ARSOF |
| **Value** | **Decimal** | 158 |
| | **Hex** | 9E |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event. |
| **Comment** | | Indicates an ‘OFF’ response. A response is a reply to a status request (ASRQ) without producing an ON or OFF event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.5.24 [9F] EXTC3 - Extended Opcode with 3 Additional Bytes

| | | |
|---|---|---|
| **Name** | | EXTC3 |
| **Value** | **Decimal** | 159 |
| | **Hex** | 9F |
| **Priority** | | Low |
| **Description** | | Extended opcode with 3 additional bytes. |
| **Comment** | | Reserved to allow the 3 additional bytes range to be extended by a further 256 opcodes. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Ext_OPC (1 bytes) Extended opcode,<br>Data1 (1 bytes)<br>Data2 (1 bytes)<br>Data3 (1 bytes) |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

# 3.6 OPCODES with 5 additional bytes

## 3.6.1 [A0] RDCC4 - Request 4 Byte DCC Packet

| | | |
|---|---|---|
| **Name** | | RDCC4 |
| **Value** | **Decimal** | 160 |
| | **Hex** | A0 |
| **Priority** | | Normal |
| **Description** | | Request 4-byte DCC Packet. |
| **Comment** | | Allows a CAB or equivalent to request a 4 byte DCC packet to be sent to the track. The packet is sent <REP> times and is not refreshed on a regular basis. |
| **Direction** | | To command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | REP (1 bytes),<br>Byte0 (1 bytes),<br>Byte1 (1 bytes),<br>Byte2 (1 bytes),<br>Byte3 (1 bytes) |
| **Conditions** | | If the NN does not match the node number of the module then ignore the message.<br>If the module is not a DCC command station then ignore the message. |
| **Result** | | If conditions are met then the requested DCC packet is sent <REP> times. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.2 [A2] WCVS - Write CV in Service Mode

| | | |
|---|---|---|
| **Name** | | WCVS |
| **Value** | **Decimal** | 162 |
| | **Hex** | A2 |
| **Priority** | | Normal |
| **Description** | | Write CV in Service mode. |
| **Comment** | | Sent to the command station to write a DCC CV in service mode. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>CV (2 bytes),<br>Mode (1 bytes),<br>Value (1 bytes) |
| **Conditions** | | If the NN does not match the module's node number then ignore the message.<br>If the module is not a DCC command station then ignore the request.<br>If the command station does not have an active session with id <Session> then send a ERR(No session) message. |
| **Result** | | If conditions are met then the DCC command station shall write the specified CV. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.3 [AB] HEARTB - Module Heartbeat

| | | |
|---|---|---|
| **Name** | | HEARTB |
| **Value** | **Decimal** | 171 |
| | **Hex** | AB |
| **Priority** | | Low |
| **Description** | | Heartbeat from module. |
| **Comment** | | Heartbeat message from module indicating that the module is alive and communicating on the bus.<br><br>Sent every 5 seconds by a module to confirm it is alive and connected to the network along with an indication of module status.<br><br>Sequence is a count from 0 incrementing on each message transmitted and wrapping around to zero, It facilitates detection of missing frames.<br><br>Status: This is a binary representation of the module's diagnostic status as outlined in MNS Specification Section 8.3. 0x00 Shall always represent "normal" operation.<br><br>StatusBits: Reserved for future expansion, set to 0x00 |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Source Node number,<br>Sequence (1 bytes) The message sequence number<br>Status (1 bytes) Diagnostic status,<br>StatusBits (1 bytes) Reserved, |
| **Conditions** | | |
| **Result** | | |
| **History** | | New for VLCB |

## 3.5.7 [AC] SD - Service Discovery Response

| | | |
|---|---|---|
| **Name** | | SD |
| **Value** | **Decimal** | 172 |
| | **Hex** | AC |
| **Priority** | | Low |
| **Description** | | Service discovery response. |
| **Comment** | | The version of a service supported by a module.<br><br>Sent in response to RQSD with ServiceIndex = 0. A number of SD messages are sent by a module. The first SD response indicates the number of following SD responses, this message has ServiceIndex=0, and the number in the Version field. Then one SD response for each of the services supported by the module.<br><br>Indicates that the originating module, defined by NN supports the service defined by Service# with the specified version<br><br>Also see ESD. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>ServiceIndex (1 bytes) Index into the list of services. Note that ServiceIndex values may not be contiguous and therefore the ServiceIndex may be greater than the number of services reported within the first response to RQSD.<br>ServiceType (1 bytes) Service Type,<br>Version (1 bytes) Version of the service definition, not the version of its implementation. |
| **Conditions** | | |
| **Result** | | Sent in response to RQSD. Contains the version of a service supported by the module. |
| **History** | | New for VLCB |

### 3.6.4 [AF] GRSP - Generic Response

| | | |
|---|---|---|
| **Name** | | GRSP |
| **Value** | **Decimal** | 175 |
| | **Hex** | AF |
| **Priority** | | Low |
| **Description** | | Generic Response. |
| **Comment** | | Generic response for a configuration change request. Result byte indicates ok for success or an error code in case of failure.<br>Indicates the module is ready for further configuration.<br><br>The CMDERR codes are supported and in addition service specific codes are also to be supported. The CMDERR codes are listed in Appendix C and allocated from 1 upwards, the service specific codes are allocated from 255 downwards.<br>See the service specific documentation for the list of codes. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>opcode (1 bytes) Request opcode,<br>ServiceType (1 bytes) Service Type,<br>Result (1 bytes) Result |
| **Conditions** | | |
| **Result** | | Sent to indicate the result of a configuration change request.<br>Module is ready for further configuration. |
| **History** | | New for VLCB |

### 3.6.5 [B0] ACON1 - Accessory ON Event with 1 Data Byte

| | | |
|---|---|---|
| **Name** | | ACON1 |
| **Value** | **Decimal** | 176 |
| | **Hex** | B0 |
| **Priority** | | Low |
| **Description** | | Accessory ON. |
| **Comment** | | Indicates an ‘ON’ event using the full event number of 4 bytes with one additional data byte.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.6 [B1] ACOF1 - Accessory OFF Event with 1 Data Byte

| | | |
|---|---|---|
| **Name** | | ACOF1 |
| **Value** | **Decimal** | 177 |
| | **Hex** | B1 |
| **Priority** | | Low |
| **Description** | | Accessory OFF. |
| **Comment** | | Indicates an ‘OFF’ event using the full event number of 4 bytes with one additional databyte.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state OFF then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.7 [B2] REQEV - Read Event Variable

| | | |
|---|---|---|
| **Name** | | REQEV |
| **Value** | **Decimal** | 178 |
| | **Hex** | B2 |
| **Priority** | | Low |
| **Description** | | Read event variable in learn mode. |
| **Comment** | | Allows a configuration tool to read stored event variables from a node.<br>EV# is the EV variable index.<br>NN and EN identify the event and not the module.<br>Reading EV#0 shall first return the number of EVs followed by a series of EVANS with the value for each EV. |
| **Direction** | | To module |
| **States/Modes** | | Learn |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number of event,<br>EN (2 bytes) Event number,<br>EV# (1 bytes) Event variable index |
| **Conditions** | | If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If the module does not have an event for the specified NN:EN then send a message CMDERR(Invalid Event) and GRSP(Invalid Event).<br>If the EV# is greater than the number of EVs per event then send a message CMDERR(Invalid event variable index) and GRSP(Invalid event variable index).<br>If the event does not have an EV with the specified EV# then send a message CMDERR(Invalid Event Variable Index) and GRSP(Invalid Event Variable Index). |
| **Result** | | If conditions are met and EV# is non zero then send an EVANS message with the EV value.<br>If conditions are met and EV# is zero then first send EVANS for index 0 and the value containing the number of EVs followed by a series of EVANS with the value for each EV. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.8 [B3] ARON1 - Accessory ON Response Event with 1 Data Byte

| | | |
|---|---|---|
| **Name** | | ARON1 |
| **Value** | **Decimal** | 179 |
| | **Hex** | B3 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event. |
| **Comment** | | Indicates an ‘ON’ response with one additional data byte. A response is a reply to a status request (AREQ) without producing an ON or OFF event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.9 [B4] AROF1 - Accessory OFF Response Event with 1 Data Byte

| | | |
|---|---|---|
| **Name** | | AROF1 |
| **Value** | **Decimal** | 180 |
| | **Hex** | B4 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event. |
| **Comment** | | Indicates an ‘OFF’ response with one additional data byte. A response is a reply to a status request (AREQ) without producing an ON or OFF event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.10 [B5] NEVAL - Response to Read EV

| | | |
|---|---|---|
| **Name** | | NEVAL |
| **Value** | **Decimal** | 181 |
| | **Hex** | B5 |
| **Priority** | | Low |
| **Description** | | Response to request for read of EV value. |
| **Comment** | | This is the response to the request to read an EV - REVAL. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number,<br>EN# (1 bytes) Event index,<br>EV# (1 bytes) Event variable index,<br>EVval (1 bytes) Event variable value |
| **Conditions** | | |
| **Result** | | The EV value is returned in the message. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.11 [B6] PNN - Presence of Node

| | | |
|---|---|---|
| **Name** | | PNN |
| **Value** | **Decimal** | 182 |
| | **Hex** | B6 |
| **Priority** | | Low |
| **Description** | | Response to Query Node - QNN. |
| **Comment** | | Sent in response to a QNN request.<br><br>The Flags byte contains bit flags as follows:<br>● Bit 0:Set to 1 for consumer node,<br>● Bit 1:Set to 1 for producer node,<br>● Bit 2:Set to 1 for FLiM mode (normal mode),<br>● Bit 3:Set to 1 for Bootloader compatible,<br>● Bit 4: Set if able to consume its own produced events<br>● Bit 5: Set to 1 if module is in Learn mode<br>● Bit 6: Set to 1 if module supports service discovery<br><br>If a module is both a producer and a consumer then it is referred to as a “combi” node and both flags will be set.<br><br>The Manufacturer Id and Module Id together make a 16bit module type identification (ManufacturerId in the upper byte).<br><br>VLCB modules shall use a dedicated set of Manufacturer Ids, currently a Manufacturer Id of 250 has been assigned. When developing a new module a new identifier can be obtained with a pull request of the VLCB module Id list in Github.. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>Manufacturer Id (1 bytes) Manufacturer identifier,<br>Module Id (1 bytes) Module identifier,<br>Flags (1 bytes) Module flags |
| **Conditions** | | |
| **Result** | | Returned in response to QNN. The message contains important information about the module. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.6.12 [B8] ASON1 - Accessory ON Event with 1 Data Byte

| | | |
|---|---|---|
| **Name** | | ASON1 |
| **Value** | **Decimal** | 184 |
| | **Hex** | B8 |
| **Priority** | | Low |
| **Description** | | Accessory Short ON. |
| **Comment** | | Indicates an ‘ON’ event using the short event number of 2 LS bytes with one added data byte.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.13 [B9] ASOF1 - Accessory OFF Event with 1 Data Byte

| | | |
|---|---|---|
| **Name** | | ASOF1 |
| **Value** | **Decimal** | 185 |
| | **Hex** | B9 |
| **Priority** | | Low |
| **Description** | | Accessory Short OFF. |
| **Comment** | | Indicates an ‘OFF’ event using the short event number of 2 LS bytes with one added data byte.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state OFF then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.6.14 [BD] ARSON1 - Accessory ON Response Event with 1 Data

| | | |
|---|---|---|
| **Name** | | ARSON1 |
| **Value** | **Decimal** | 189 |
| | **Hex** | BD |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event. |
| **Comment** | | Indicates an ‘ON’ response with one added data byte. A response is a reply to a status request (ASRQ)without producing an ON or OFF event.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.6.15 [BE] ARSOF1 - Accessory OFF Response Event with 1 Data

| | | |
|---|---|---|
| **Name** | | ARSOF1 |
| **Value** | **Decimal** | 190 |
| | **Hex** | BE |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event with one data byte. |
| **Comment** | | Indicates an ‘OFF’ response with one added data byte. A response is a reply to a status request (ASRQ) without producing an ON or OFF event.<br>A response event is a reply to a status request (ASRQ)without producing an ON or OFF event.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data (1 bytes) Event data 1 |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.6.16 [BF] EXTC4 - Extended Opcode with 4 Additional Bytes

| | | |
|---|---|---|
| **Name** | | EXTC4 |
| **Value** | **Decimal** | 191 |
| | **Hex** | BF |
| **Priority** | | Low |
| **Description** | | Extended opcode with 4 additional bytes. |
| **Comment** | | Reserved to allow the 4 additional bytes range to be extended by a further 256 opcodes. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Ext_OPC (1 bytes) Extended opcode,<br>Data1 (1 bytes)<br>Data2 (1 bytes)<br>Data3 (1 bytes)<br>Data4 (1 bytes) |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

# 3.7 OPCODES with 6 additional bytes

## 3.7.1 [C0] RDCC5 - Request 5 Byte DCC Packet

| | | |
|---|---|---|
| **Name** | | RDCC5 |
| **Value** | **Decimal** | 192 |
| | **Hex** | C0 |
| **Priority** | | Normal |
| **Description** | | Request 5-byte DCC Packet. |
| **Comment** | | Allows a CAB or equivalent to request a 5 byte DCC packet to be sent to the track. The packet is sent <REP> times and is not refreshed on a regular basis. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | REP (1 bytes),<br>Byte 0 (1 bytes),<br>Byte1 (1 bytes),<br>Byte2 (1 bytes),<br>Byte3 (1 bytes),<br>Byte4 (1 bytes) |
| **Conditions** | | If the NN does not match the node number of the module then ignore the message.<br>If the module is not a DCC command station then ignore the message. |
| **Result** | | If conditions are met then the requested DCC packet is sent <REP> times. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.2 [C1] WCVOA - Write CV in OPS Mode by Address

| | | |
|---|---|---|
| **Name** | | WCVOA |
| **Value** | **Decimal** | 193 |
| | **Hex** | C1 |
| **Priority** | | Normal |
| **Description** | | Write CV (byte) in OPS mode by address. |
| **Comment** | | Sent to the command station to write a DCC CV byte in OPS mode to specific loco (on the main).<br>Used by computer based ops mode programmer that does not have a valid throttle handle. |
| **Direction** | | To command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Addr (2 bytes),<br>CV (2 bytes),<br>Mode (1 bytes),<br>Value (1 bytes) |
| **Conditions** | | If the NN does not match the module's node number then ignore the message.<br>If the module is not a DCC command station then ignore the request. |
| **Result** | | If conditions are met then the DCC command station shall write the specified CV. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.3 [C2] CABDAT - Send data to CAB

| | | |
|---|---|---|
| **Name** | | CABDAT |
| **Value** | **Decimal** | 194 |
| | **Hex** | C2 |
| **Priority** | | Normal |
| **Description** | | Send data to the DCC CAB which is controlling a particular loco. |
| **Comment** | | addrH and addrL are the loco address in the same format as RLOC and GLOC 7 bit addresses have (addrH=0). 14 bit addresses have bits 6,7 of addrH set to 1.<br><br>dataCode defines the meaning of the remaining 3 bytes. The following values for dataCod have currently been defined:<br><br>● 01 - CABSIG - Transmitted by a layout control system to send signal aspects to be displayed on a cab handset as cab signalling.<br>Parameter data1 is used for aspect1<br>Parameter data2 is used for aspect2<br>Parameter data3 is used for speed<br><br>aspect1 is signalling system independent, and is defined as follows (colours in brackets correspond to UK colour light signalling, the given aspect names may be displayed differently in other signalling systems):<br><br>Bits 0-1 - 2 bit aspect code 00=danger (red), 01=caution (yellow), 10=preliminary caution (double yellow), 11=proceed (green) Bit 2 - set 1 for calling on or shunt aspect (bits 0-1 would be set to 00 for danger when calling on) Bit 3 - Set 0 to indicate upper nibble is feather location, set 1 for upper nibble is theatre type route indicator Bits 4-7 - 0 - no route indicated, 1 to 6 = feather position or 1 to 16 for theatre route indication aspect1 should be set to 0xFF if no signal information is available. This can be used, for example, to indicate leaving a cab signalling area. A cab should extinguish any currently showing aspect on receipt of this code. Note that because bits 0 and 1 should be set to zero when bit 2 is set, the code 0xFF is not otherwise a valid aspect. <aspect2> may be used as required for specific signalling systems. The meaning will vary for each signalling system. For the UK 2003 rulebook, bit 0 set indicates a flashing aspect, applicable to caution, preliminary caution or proceed. For UK semaphore signalling, where there are multiple arms for |

| | |
|---|---|
| | different routes on a mast, these bits indicate which arm has been pulled off, which is equivalent to a feather on colour light signalling.<br><br>speed is a speed limit indication that a cab may optionally display to the driver. If speed is not implemented by a layout control system, or whenever speed limit information is not available, this byte should be set to 0xFF (255).<br><br>How this value is derived from the layout blocks, signals etc, and the range and meaning of the values in this byte, are implementation dependent, except for the requirement that the value of 0xFF must not be a valid speed. |
| **Direction** | To DCC CAB |
| **States/Modes** | Normal, Learn, NOHEARTB, ENACK |
| **Services** | DCC-CAB |
| **Parameters** | addrH (1 bytes)<br>addrL (1 bytes)<br>dataCode (1 bytes)<br>data1 (1 bytes)<br>data2 (1 bytes)<br>data3 (1 bytes) |
| **Conditions** | |
| **Result** | |
| **History** | Defined in RFC0005 |

### 3.7.4 [C7] DGN - Diagnostic Data Response

| | | |
|---|---|---|
| **Name** | | DGN |
| **Value** | **Decimal** | 199 |
| | **Hex** | C7 |
| **Priority** | | Low |
| **Description** | | Diagnostic data response. |
| **Comment** | | Diagnostic data value from a module.<br>Sent in response to RDGN. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>ServiceIndex (1 bytes) Index into the list of services,<br>DiagnosticCode (1 bytes) Diagnostic data code,<br>DiagnosticVal (2 bytes) Diagnostic data value |
| **Conditions** | | |
| **Result** | | A response to RDGN and contains diagnostic information for the requested diagnostic of the specified service. |
| **History** | | New for VLCB |

### 3.7.5 [CF] FCLK - Fast Clock

| | | |
|---|---|---|
| **Name** | | FCLK |
| **Value** | **Decimal** | 207 |
| | **Hex** | CF |
| **Priority** | | Normal |
| **Description** | | Fast Clock. |
| **Comment** | | Used to implement a fast clock for the layout. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | mins (1 bytes) Minutes 0-59,<br>hrs (1 bytes) Hours 0-23,<br>wdmon (1 bytes) Bits 0-3 define day of week (1=Sun ..7=Sat). Bits 4-7 define month (1=Jan .. 12=Dec),<br>div (1 bytes) Divider. 0=freeze,<br>mday (1 bytes) Day of month 1-31,<br>temp (1 bytes) Temperature. Two's complement -127 to +127 |
| **Conditions** | | All the value of any parameter is out of range then send a CMDERR(Invalid Event) message. |
| **Result** | | If conditions are met then update a fast clock with the specified settings. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.6 [D0] ACON2 - Accessory ON Event with 2 Data Bytes

| | | |
|---|---|---|
| **Name** | | ACON2 |
| **Value** | **Decimal** | 208 |
| | **Hex** | D0 |
| **Priority** | | Low |
| **Description** | | Accessory ON. |
| **Comment** | | Indicates an ‘ON’ event using the full event number of 4 bytes with two additional data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.7 [D1] ACOF2 - Accessory OFF Event with 2 Data Bytes

| | | |
|---|---|---|
| **Name** | | ACOF2 |
| **Value** | **Decimal** | 209 |
| | **Hex** | D1 |
| **Priority** | | Low |
| **Description** | | Accessory OFF. |
| **Comment** | | Indicates an ‘OFF’ event using the full event number of 4 bytes with two additional data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | Both |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state OFF then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.8 [D2] EVLRN - Teach an EV

| | | |
|---|---|---|
| **Name** | | EVLRN |
| **Value** | **Decimal** | 210 |
| | **Hex** | D2 |
| **Priority** | | Low |
| **Description** | | Teach an event in learn mode. |
| **Comment** | | Sent by a configuration tool to a node in learn mode to teach it an event variable. Also teaches it the associated event. This command is repeated for each EV required. |
| **Direction** | | To module |
| **States/Modes** | | Learn |
| **Services** | | Event/Teach |
| **Parameters** | | NN (2 bytes) Event Node number,<br>EN (2 bytes) Event number,<br>EV# (1 bytes) Event variable index, (1-n)<br>EV val (1 bytes) Event variable value |
| **Conditions** | | If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If the module does not have space available for the event to be created then send a message a CMDERR(Too many events) message and a GRSP(Too many events) message.<br>If the event variable index is zero or greater than the number of EVs per event parameter then send a CMDERR(Invalid Event Variable Index) message and a GRSP(Invalid Event Variable Index) message. |
| **Result** | | If conditions are met then Save the EV and send a GRSP(ok) and a WRACK message.<br>If the NN is zero then the taught event will be considered to be a Short event. If the NN is non zero then the event will be considered to be a Long event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.9 [D3] EVANS - EV Read Response

| | | |
|---|---|---|
| **Name** | | EVANS |
| **Value** | **Decimal** | 211 |
| | **Hex** | D3 |
| **Priority** | | Low |
| **Description** | | Response to a request for an EV value in a node in learn mode. |
| **Comment** | | A node response to a request from a configuration tool for the EVs associated with an event (REQEV). For multiple EVs, there will be one response per request. |
| **Direction** | | From module |
| **States/Modes** | | Learn |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) event's Node number,<br>EN (2 bytes) Event number,<br>EV# (1 bytes) Event variable index,<br>EV val (1 bytes) Event variable value |
| **Conditions** | | Sent in response to REQEV.<br>If the original request was for EV# of zero then multiple EVANS will be sent, The first for EV#0 with EV val set to the number of EVs and subsequent EVANS one for each EV containing the EV value. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.10 [D4] ARON2 - Accessory Response ON Event with 2 Bytes

| | | |
|---|---|---|
| **Name** | | ARON2 |
| **Value** | **Decimal** | 212 |
| | **Hex** | D4 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event. |
| **Comment** | | Indicates an ‘ON’ response event with two added data bytes. A response is a reply to a status request (AREQ) without producing an ON or OFF event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.7.11 [D5] AROF2 - Accessory Response OFF Event with 2 Bytes

| | | |
|---|---|---|
| **Name** | | AROF2 |
| **Value** | **Decimal** | 213 |
| | **Hex** | D5 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event. |
| **Comment** | | Indicates an ‘OFF’ response event with two added data bytes. A response is a reply to a status request (AREQ) without producing an ON or OFF event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver  8j |

## 3.7.12 [D8] ASON2 - Accessory Short ON Event with 2 Bytes

| | | |
|---|---|---|
| **Name** | | ASON2 |
| **Value** | **Decimal** | 216 |
| | **Hex** | D8 |
| **Priority** | | Low |
| **Description** | | Accessory Short ON. |
| **Comment** | | Indicates an ‘ON’ event using the short event number of 2 LS bytes with two added data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.7.13 [D9] ASOF2 - Accessory Short OFF Event with 2 Bytes

| | | |
|---|---|---|
| **Name** | | ASOF2 |
| **Value** | **Decimal** | 217 |
| | **Hex** | D9 |
| **Priority** | | Low |
| **Description** | | Accessory Short OFF. |
| **Comment** | | Indicates an ‘OFF’ event using the short event number of 2 LS bytes with two added data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state OFF then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.7.14 [DD] ARSON2 - Accessory Response ON Event with 2 Bytes

| | | |
|---|---|---|
| **Name** | | ARSON2 |
| **Value** | **Decimal** | 221 |
| | **Hex** | DD |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event ON with two data bytes. |
| **Comment** | | Indicates an 'ON' response event with two added data bytes. A response is a reply to a status request (ASRQ)without producing an ON or OFF event.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.7.15 [DE] ARSOF2 - Accessory Response OFF Event with 2 Bytes

| | | |
|---|---|---|
| **Name** | | ARSOF2 |
| **Value** | **Decimal** | 222 |
| | **Hex** | DE |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event OFF with two data bytes. |
| **Comment** | | Indicates an ‘OFF’ response event with two added data bytes. A response is a reply to a status request (ASRQ) without producing an ON or OFF event.<br>A response event is a reply to a status request (ASRQ)without producing an ON or OFF event.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2 |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver  8j |

## 3.7.16 [DF] EXTC5 - Extended Opcode with 5 Additional Bytes

| | | |
|---|---|---|
| **Name** | | EXTC5 |
| **Value** | **Decimal** | 223 |
| | **Hex** | DF |
| **Priority** | | Low |
| **Description** | | Extended opcode with 5 additional bytes. |
| **Comment** | | Reserved to allow the 5 additional bytes range to be extended by a further 256 opcodes. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Ext_OPC (1 bytes) Extended opcode,<br>Data1 (1 bytes)<br>Data2 (1 bytes)<br>Data3 (1 bytes)<br>Data4 (1 bytes)<br>Data5 (1 bytes) |
| **Conditions** | | |
| **Result** | | |
| **History** | | |

# 3.8 OPCODES with 7 additional bytes

## 3.8.1 [E0] RDCC6 - Request 6 bytes DCC Packet

| | | |
|---|---|---|
| **Name** | | RDCC6 |
| **Value** | **Decimal** | 224 |
| | **Hex** | E0 |
| **Priority** | | Normal |
| **Description** | | Request 6-byte DCC Packet. |
| **Comment** | | Allows a CAB or equivalent to request a 6 byte DCC packet to be sent to the track. The packet is sent <REP> times and is not refreshed on a regular basis. |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | REP (1 bytes),<br>Byte0 (1 bytes),<br>Byte1 (1 bytes),<br>Byte2 (1 bytes),<br>Byte3 (1 bytes),<br>Byte4 (1 bytes),<br>Byte5 (1 bytes) |
| **Conditions** | | If the NN does not match the node number of the module then ignore the message.<br>If the module is not a DCC command station then ignore the message. |
| **Result** | | If conditions are met then the requested DCC packet is sent <REP> times. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.8.2 [E1] PLOC - Engine Report

| | | |
|---|---|---|
| **Name** | | PLOC |
| **Value** | **Decimal** | 225 |
| | **Hex** | E1 |
| **Priority** | | Normal |
| **Description** | | Engine report. |
| **Comment** | | A report of an engine entry sent by the command station. Sent in response to QLOC or as an acknowledgement of acquiring an engine requested by a cab (RLOC or GLOC). |
| **Direction** | | From command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | Session (1 bytes),<br>Addr (2 bytes),<br>Speed/Dir (1 bytes),<br>Fn1 (1 bytes) Function byte F0-F4,<br>Fn2 (1 bytes) Function byte F5-F8,<br>Fn3 (1 bytes) Function byte F9-F12 |
| **Conditions** | | Sent in response to QLOC, RLOC or GLOC. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## x3.8.3 [E2] NAME - Request for Name Response

| | | |
|---|---|---|
| **Name** | | NAME |
| **Value** | **Decimal** | 226 |
| | **Hex** | E2 |
| **Priority** | | Low |
| **Description** | | Response to request for node name string. |
| **Comment** | | Returns the type name for the module in response to RQMN. Any leading “CAN” or “ETH” is not included in the response. The type is post-padded to 7 characters with spaces (0x20).<br><br>The requester can subsequently add the “CAN” or “ETH” using the protocol indicated in parameter 10. |
| **Direction** | | From module |
| **States/Modes** | | Setup |
| **Services** | | MNS |
| **Parameters** | | NAME (7 bytes) Module type name in ASCII and padded on right with spaces (0x20). |
| **Conditions** | | Sent in response to a RQMN message. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.8.4 [E3] STAT - Command Station Status Report

| | | |
|---|---|---|
| **Name** | | STAT |
| **Value** | **Decimal** | 227 |
| | **Hex** | E3 |
| **Priority** | | Normal |
| **Description** | | Command Station status report. |
| **Comment** | | Sent by the command station in response to RSTAT.<br><flags> is status defined by the bits below:<br>0 -Hardware Error (self test),<br>1 -Track Error<br>2 -Track On/ Off,<br>3 -Bus On/ Halted,<br>4 -EM. Stop all performed,<br>5 -Reset done,<br>6 -Service mode (programming) On/ Off,<br>7 –reserved. |
| **Direction** | | From command station |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | DCC_CAB or DCC_CMD |
| **Parameters** | | NN (2 bytes) Node number,<br>CSnum (1 byte) For future expansion -set to zero at present,<br>Flags (1 byte),<br>Major rev (1 bytes) Major revision number,<br>Minor rev (1 bytes) Minor revision letter,<br>Build no (1 bytes) Build number. |
| **Conditions** | | Sent in response to a RSTAT message. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.8.5 [E6] ENACK - Event Acknowledge

| | | |
|---|---|---|
| **Name** | | ENACK |
| **Value** | **Decimal** | 230 |
| | **Hex** | E6 |
| **Priority** | | Low |
| **Description** | | Event Acknowledge. |
| **Comment** | | Sent by a module to acknowledge the consumption of an event. Used for diagnostic purposes. |
| **Direction** | | From module |
| **States/Modes** | | ENACK |
| **Services** | | ENACK and Consumer |
| **Parameters** | | NN (2 bytes) Module's Node Number,<br>opcode (1 bytes), The opcode of the event being acknowledged,<br>EventNNh (1 bytes), The high byte of the event's NN,<br>EventNNl (1 bytes), The low byte of the event's NN,<br>EventENh (1 bytes), The high byte of the event's EN,<br>EventENl (1 bytes), The low byte of the event's EN |
| **Conditions** | | Module must be in event acknowledge mode.<br>Module must have the specified defined as a consumed event.<br>Sent in response to an event. |
| **Result** | | |
| **History** | | New for VLCB |

### 3.8.6 [E7] ESD - Extended Service Discovery Response

| | | |
|---|---|---|
| **Name** | | ESD |
| **Value** | **Decimal** | 231 |
| | **Hex** | E7 |
| **Priority** | | Low |
| **Description** | | Extended service discovery response. |
| **Comment** | | Detailed information about a service supported by a module. The data supplied is service specific.<br><br>Sent in response to RQSD with ServiceIndex is not zero. A single ESD response message is sent by a module for the specified service.<br><br>The data parameters are service specific and reference should be made to the relevant service specification.<br><br>Also see SD. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | MNS |
| **Parameters** | | NN (2 bytes) Node number,<br>ServiceIndex (1 bytes) Index into the list of services<br>ServiceType (1 bytes) Service Type,<br>Data1 (1 bytes) Service specific data,<br>Data2 (1 bytes) Service specific data,<br>Data3 (1 bytes) Service specific data, |
| **Conditions** | | Sent in response to RQSD when the requested ServiceIndex is not zero. |
| **Result** | | |
| **History** | | New for VLCB |

### 3.8.7 [E9] DTXC- Streaming protocol

| | | |
|---|---|---|
| **Name** | | DTXC |
| **Value** | **Decimal** | 233 |
| | **Hex** | E9 |
| **Priority** | | Low |
| **Description** | | Streaming protocol (RFC0005). |
| **Comment** | | Used to transport a relatively large block of data.<br><br>StreamID is a unique layout wide identifier of a particular message stream. It is the responsibility of the layout installer/module installer to ensure that any StreamIDs are unique across the installation. StreamIDs 0~20 are reserved as CBUS system wide IDs. Users would not allocate these IDs to private streams.<br><br>SequenceNum is a 0x00 to 0xFF identification of the frame sequence . 0x00 is used to denote a header frame , any number != 0x00 indicates a continuation frame.<br><br>MessageLen is a 16 bit size in bytes of the transmitted message , However as only 254 continuation frames are possible the Message Len is limited to a count of 1275. However private protocols may be deployed to send larger messages and the full extent of these fields can be used. A Message length of Zero is supported, albeit rather pointless.<br><br>CRC16 is a standard implementation of CRC, ie $P(x) = x^{16}+x^{15}+x^{2}+1$. CRC fields are optional and set to 0x00 if not implemented.<br><br>Continuation frames merely contain the StreamID and SequenceNum and 5 bytes of message data<br><br>It is recommended that continuation frames are throttled at 1 over 20ms. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |

| | |
|---|---|
| **Parameters** | For sequenceNum != 0<br>StreamID (1 bytes) Stream identifier<br>SequenceNum (1 bytes) Sequence Number<br>Data1 (1 bytes) Stream data<br>Data2 (1 bytes) Stream data<br>Data3 (1 bytes) Stream data<br>Data4 (1 bytes) Stream data<br>Data5 (1 bytes) Stream data<br><br>For sequenceNum = 0<br>StreamID (1 bytes) Stream identifier<br>0x00 (1 bytes) Sequence Number<br>MessageLen (2 bytes) Message Length<br>CRC16 (2 bytes) Checksum<br>Flags (1 bytes) flags - reserved for future use |
| **Conditions** | |
| **Result** | |
| **History** | Defined in RFC0005 |

## 3.8.8 [EF] PARAMS - Response for Node Parameters

| | | |
|---|---|---|
| **Name** | | PARAMS |
| **Value** | **Decimal** | 239 |
| | **Hex** | EF |
| **Priority** | | Low |
| **Description** | | Response to request for node parameters. |
| **Comment** | | Returns the first 7 parameters for the module in response to RQNP.<br><br>See Appendix B - Module parameters for a list of available parameters. |
| **Direction** | | From module |
| **States/Modes** | | Setup |
| **Services** | | MNS |
| **Parameters** | | PARA 1 (1 bytes) Parameter 1,<br>PARA 2 (1 bytes) Parameter 2,<br>PARA 3 (1 bytes) Parameter 3,<br>PARA 4 (1 bytes) Parameter 4,<br>PARA 5 (1 bytes) Parameter 5,<br>PARA 6 (1 bytes) Parameter 6,<br>PARA 7 (1 bytes) Parameter 7 |
| **Conditions** | | Sent in response to RQNP. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.9 [F0] ACON3 - Accessory ON Event with 3 Data Bytes

| | | |
|---|---|---|
| **Name** | | ACON3 |
| **Value** | **Decimal** | 240 |
| | **Hex** | F0 |
| **Priority** | | Low |
| **Description** | | Accessory ON. |
| **Comment** | | Indicates an ‘ON’ event using the full event number of 4 bytes with three additional data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.10 [F1] ACOF3 - Accessory OFF Event with 3 Data Bytes

| | | |
|---|---|---|
| **Name** | | ACOF3 |
| **Value** | **Decimal** | 241 |
| | **Hex** | F1 |
| **Priority** | | Low |
| **Description** | | Accessory OFF. |
| **Comment** | | Indicates an ‘OFF’ event using the full event number of 4 bytes with three additional data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state OFF then send this event.<br>If the module has been configured to consume the event then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.8.11 [F2] ENRSP - Read Event Response

| | | |
|---|---|---|
| **Name** | | ENRSP |
| **Value** | **Decimal** | 242 |
| | **Hex** | F2 |
| **Priority** | | Low |
| **Description** | | Response to request to read node events. |
| **Comment** | | This is a response to either NERD or NENRD. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Node number,<br>EN3 (1 bytes) Event Node number hi,<br>EN2 (1 bytes) Event Node number lo,<br>EN1 (1 bytes) Event number hi,<br>EN0 (1 bytes) Event number lo,<br>EN# (1 bytes) Event index. |
| **Conditions** | | Sent in response to a request to read events. |
| **Result** | | |
| **History** | | Changed from CBUS revision 4 ver 8j |

### 3.8.12 [F3] ARON3 - Accessory Response ON Event with 3 Data

| | | |
|---|---|---|
| **Name** | | ARON3 |
| **Value** | **Decimal** | 243 |
| | **Hex** | F3 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event. |
| **Comment** | | Indicates an ‘ON’ response event with three added data bytes. A response is a reply to a status request (AREQ) without producing an ON or OFF event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.8.13 [F4] AROF3 - Accessory Response OFF Event with 3 Bytes

| | | |
|---|---|---|
| **Name** | | AROF3 |
| **Value** | **Decimal** | 244 |
| | **Hex** | F4 |
| **Priority** | | Low |
| **Description** | | Accessory Response Event. |
| **Comment** | | Indicates an ‘OFF’ response event with three added data bytes. A response is a reply to a status request (AREQ) without producing an ON or OFF event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver  8j |

### 3.8.14 [F5] EVLRNI - Teach an EV using Event Indexing

| | | |
|---|---|---|
| **Name** | | EVLRNI |
| **Value** | **Decimal** | 245 |
| | **Hex** | F5 |
| **Priority** | | Low |
| **Description** | | Teach an event in learn mode using event indexing. |
| **Comment** | | Sent by a configuration tool to a node in learn mode to teach it an event. The event index must be known. Also teaches it the associated event variables (EVs). This command is repeated for each EV required.<br><br>Parameter EN# is ignored and this request is similar to EVLRN. |
| **Direction** | | To module |
| **States/Modes** | | Learn |
| **Services** | | Teach |
| **Parameters** | | NN (2 bytes) Event Node number,<br>EN (2 bytes) Event number,<br>EN# (1 bytes) Event index,<br>EV# (1 bytes) Event variable index,<br>EV val (1 bytes) Event variable value |
| **Conditions** | | If the message is short so that it does not include the specified parameters then a GRSP (Invalid Command) message is returned.<br>If EN# is out of range then send a message a CMDERR(Invalid Event) message.<br>If the event variable index is greater than the number of EVs per event parameter then send a CMDERR(Invalid Event Variable Index) message.<br>If the event variable index is zero and the module requires EVs then send a CMDERR(Invalid Event Variable Index) message. |
| **Result** | | If conditions are met then Save the EV and send a WRACK message. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.15 [F6] ACDAT - Accessory Data Event

| | | |
|---|---|---|
| **Name** | | ACDAT |
| **Value** | **Decimal** | 246 |
| | **Hex** | F6 |
| **Priority** | | Low |
| **Description** | | Accessory node data event. |
| **Comment** | | Indicates an event from this node with 5 bytes of data. For example, this can be used to send the 40 bits of an RFID tag.<br>There is no event number in order to allow space for 5 bytes of data in the packet, so there can only be one data event per node. The meaning of the event is therefore dependent upon the type and use of the module. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | NN (2 bytes) Node number,<br>data 1 (1 bytes),<br>data 2 (1 bytes),<br>data 3 (1 bytes),<br>data 4 (1 bytes),<br>data 5 (1 bytes) |
| **Conditions** | | Sent to indicate an accessory event for this module. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

### 3.8.16 [F7] ARDAT - Accessory Data Response

| | | |
|---|---|---|
| **Name** | | ARDAT |
| **Value** | **Decimal** | 247 |
| | **Hex** | F7 |
| **Priority** | | Low |
| **Description** | | Accessory node data Response. |
| **Comment** | | Indicates a node data response. A response event is a reply to a status request (RQDAT) without producing a new data event.<br>There is no event number in order to allow space for 5 bytes of data in the packet, so there can only be one data event per node. The meaning of the response is therefore dependent upon the type and use of the module. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | NN (2 bytes) Node number,<br>data 1 (1 bytes),<br>data 2 (1 bytes),<br>data 3 (1 bytes),<br>data 4 (1 bytes),<br>data 5 (1 bytes) |
| **Conditions** | | |
| **Result** | | Sent in response to a RQDAT message. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.17 [F8] ASON3 - Accessory Short ON Event with 3 Bytes

| | | |
|---|---|---|
| **Name** | | ASON3 |
| **Value** | **Decimal** | 248 |
| | **Hex** | F8 |
| **Priority** | | Low |
| **Description** | | Accessory Short ON. |
| **Comment** | | Indicates an ‘ON’ event using the short event number of 2 LS bytes with three added data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state ON then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the ON event. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.18 [F9] ASOF3 - Accessory Short OFF Event with 3 Bytes

| | | |
|---|---|---|
| **Name** | | ASOF3 |
| **Value** | **Decimal** | 249 |
| | **Hex** | F9 |
| **Priority** | | Low |
| **Description** | | Accessory Short OFF. |
| **Comment** | | Indicates an ‘OFF’ event using the short event number of 2 LS bytes with three added data bytes.<br>An event is sent by a module when it detects a change of state.<br>Modules may consume the event and perform actions.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer or Consumer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | If the module has not been taught the event nor has the event by default then the event message is ignored. |
| **Result** | | If the module has the event configured to be sent when there is a change of state and that object changes to state OFF then send this event.<br>If the module has been configured to consume the event (ignoring the NN) then perform the actions associated with the OFF event. |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.19 [FA] DDES - Device Data Event (short mode)

| | | |
|---|---|---|
| **Name** | | DDES |
| **Value** | **Decimal** | 250 |
| | **Hex** | FA |
| **Priority** | | Low |
| **Description** | | Device data event (short mode). |
| **Comment** | | Function is the same as ACDAT but uses device addressing so it can relate data to a device attached to a node. e.g. one of several RFID readers attached to a single node.<br>The meaning of the event and the data is dependent upon the type and use of the module. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | DN (2 bytes) Device number,<br>data 1 (1 bytes),<br>data 2 (1 bytes),<br>data 3 (1 bytes),<br>data 4 (1 bytes),<br>data 5 (1 bytes) |
| **Conditions** | | Sent to indicate a device event for this module. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.20 [FB] DDRS - Device Data Response (short mode)

| | | |
|---|---|---|
| **Name** | | DDRS |
| **Value** | **Decimal** | 251 |
| | **Hex** | FB |
| **Priority** | | Low |
| **Description** | | Device data response (short mode). |
| **Comment** | | The response to a RQDDS request for data from a device.<br>The meaning of the event and the data is dependent upon the type and use of the module. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | DN (2 bytes) Device number,<br>data 1 (1 bytes),<br>data 2 (1 bytes),<br>data 3 (1 bytes),<br>data 4 (1 bytes),<br>data 5 (1 bytes) |
| **Conditions** | | Sent in response to a RQDDS request. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.21 [FC] DDWS - Device Data Write

| | | |
|---|---|---|
| **Name** | | DDWS |
| **Value** | **Decimal** | 252 |
| | **Hex** | FC |
| **Priority** | | Low |
| **Description** | | Write data. |
| **Comment** | | Used to write data to a device such as a RFID tag.<br>data1 ~ data5 is data to be written to the device.<br>RC522 devices should have data1 set to 0 |
| **Direction** | | To module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | |
| **Parameters** | | DN (2 bytes) Device number,<br>data 1 (1 bytes) data to be written to device,<br>data 2 (1 bytes) data to be written to device,<br>data 3 (1 bytes) data to be written to device,<br>data 4 (1 bytes) data to be written to device,<br>data 5 (1 bytes) data to be written to device |
| **Conditions** | | |
| **Result** | | |
| **History** | | ? |

## 3.8.22 [FD] ARSON3 - Accessory Response ON Event with 3 Bytes

| | | |
|---|---|---|
| **Name** | | ARSON3 |
| **Value** | **Decimal** | 253 |
| | **Hex** | FD |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event. |
| **Comment** | | Indicates an ‘ON’ response event with three added data bytes.A response is a reply to a status request (ASRQ)without producing an ON or OFF event.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | The module has the event defined and the current state of the event is ON. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

## 3.8.23 [FE] ARSOF3 - Accessory Response OFF Event with 3 Bytes

| | | |
|---|---|---|
| **Name** | | ARSOF3 |
| **Value** | **Decimal** | 254 |
| | **Hex** | FE |
| **Priority** | | Low |
| **Description** | | Accessory Short Response Event. |
| **Comment** | | Indicates an ‘OFF’ response event with three added data bytes.A response is a reply to a status request (ASRQ) without producing an ON or OFF event.<br>A response event is a reply to a status request (ASRQ)without producing an ON or OFF event.<br>The NN is not used to match events, the NN normally indicates the source of the event.<br>The meaning of the additional data is dependent upon the application and must be agreed between the producer and consumer of the event. |
| **Direction** | | From module |
| **States/Modes** | | Normal, Learn, NOHEARTB, ENACK |
| **Services** | | Producer |
| **Parameters** | | NN (2 bytes) Node number,<br>EN (2 bytes) Event number,<br>data1 (1 bytes) Event data 1,<br>data2 (1 bytes) Event data 2,<br>data3 (1 bytes) Event data 3 |
| **Conditions** | | The module has the event defined and the current state of the event is OFF. |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver  8j |

## 3.8.24 [FF] EXTC6 - Extended Opcode with 6 Additional Bytes

| | | |
|---|---|---|
| **Name** | | EXTC6 |
| **Value** | **Decimal** | 255 |
| | **Hex** | FF |
| **Priority** | | Low |
| **Description** | | Extended opcode with 6 additional bytes. |
| **Comment** | | Reserved to allow the 6 additional bytes range to be extended by a further 256 opcodes. |
| **Direction** | | |
| **States/Modes** | | |
| **Services** | | |
| **Parameters** | | Ext_OPC (1 bytes) Extended opcode,<br>Data1 (1 bytes)<br>Data2 (1 bytes)<br>Data3 (1 bytes)<br>Data4 (1 bytes)<br>Data5 (1 bytes)<br>Data6 (1 bytes) |
| **Conditions** | | |
| **Result** | | |
| **History** | | No change from CBUS revision 4 ver 8j |

# 4 Appendix A - DCCERR error codes

| Code | Error | Comment |
|---|---|---|
| 1 | Loco stack full | The first two bytes are the loco address, the third byte is the error number. |
| 2 | Loco address taken | The first two bytes are the loco address, the third byte is the error number. |
| 3 | Session not present | The first byte is the session id, the second byte is zero, the third byte is the error number. |
| 4 | Consist empty | The first byte is the consist id, the second byte is zero, the third byte is the error number. |
| 5 | Loco not found | The first byte is the session id, the second byte is zero, the third byte is the error number. |
| 6 | CAN bus error | The firstTwo data bytes are set to zero (not used), the third is the error number. This would be sent out in the unlikely event that the command station buffers overflow. |
| 7 | Invalid request | The first two bytes are the loco address, the third byte is an error number. Indicates an invalid or inconsistent request. For example, a GLOC request with both steal and share flags set. |
| 8 | Session canceled | The first byte is the session id, the second byte is zero, the third byte is the error number. Sent to a cab to cancel the session when another cab is stealing that session. |

# 5 Appendix B - Module Parameters

<table>
<tr><th>Code</th><th>Use</th><th>VLCB use</th></tr>
<tr><td>0</td><td>Number of parameters</td><td></td></tr>
<tr><td>1</td><td>Manufacturer’s Id.</td><td>Used in combination with ModulerId to create an unique 16bit module identifier. This is the high byte.<br><br>See the Cbusdefs document for existing values</td></tr>
<tr><td>2</td><td>Minor Version (a character) e.g. 0x62 = 'b'</td><td></td></tr>
<tr><td>3</td><td>Module Type Id. See the Cbusdefs document for values</td><td>Used in combination with ManufacturerId to create an unique 16bit module identifier. This is the low byte.<br><br>See the Cbusdefs document for existing values</td></tr>
<tr><td>4</td><td>No. of events supported by module</td><td></td></tr>
<tr><td>5</td><td>No of Event Variables per event</td><td></td></tr>
<tr><td>6</td><td>No of Node Variables</td><td></td></tr>
<tr><td>7</td><td>Major version (integer) e.g. 0x01 = 1</td><td></td></tr>
<tr><td>8</td><td>Flags indicating module support:
<table>
<tr><th>Bit number</th><th>Bit value</th><th colspan="2">Use</th></tr>
<tr><td>0</td><td>1</td><td>Event consumer</td><td rowspan="2">Set to 3 for a Combi module</td></tr>
<tr><td>1</td><td>2</td><td>Event producer</td></tr>
<tr><td>2</td><td>4</td><td colspan="2">Normal mode</td></tr>
</table>
</td><td>Bit 3 used for Normal mode</td></tr>
</table>

| | | |
|---|---|---|
| | <table><tr><td>3</td><td>8</td><td>Bootable using the FCU/JMRI boot loader protocol</td></tr><tr><td>4</td><td>16</td><td>Able to consume own events</td></tr><tr><td>5</td><td>32</td><td>Learn mode</td></tr><tr><td>6</td><td>64</td><td>VLCB compliant</td></tr></table> | |
| 9 | Processor Id -defines the processor, e.g. 2480, 25K80 the firmware was built for. Set to zero for non-PIC processors. See Cbusdefs for values. | Refer to bootloader service. |
| 10 | Interface protocol -the network type that the module uses, currently either CAN or Ethernet. See Cbusdefs for values. | |
| 11-14 | The load address for the new code, this is a 4 byte little endian address, this can vary depending on the module being loaded,the normal address for all PIC processor is 0x800 except for the CANCAB language modules which are loaded above the code area. Currently only used by PIC processors, other processors should set these parameters to zero. | Refer to bootloader service. |
| 15-18 | Manufacturers processor code –this is a four byte field, only the first two bytes are used for the PIC18F processor family, this must be read directly from the hardware when requested. Currently only used by PIC processors, if implemented. If not used, the parameters must be set to zero. | Refer to bootloader service. |
| 19 | Manufacturer code –this parameter identifies the manufacturer. See Cbusdefs for values. | Refer to bootloader service. |
| 20 | Beta release code –a non-zero value specifies the beta release version, zero indicates a normal release | Used for Patch number. |
| 21-24 | Reserved for future use | |

# 6 Appendix C - CMDERR and GRSP error codes

| Code | Error | Used for CMDERR | GRSP service |
|---|---|---|---|
| 0 | OK | | Any |
| 1 | Invalid command, command Not Supported. | ✓ | Any |
| 2 | Not In Learn Mode. | ✓ | Teach |
| 3 | Not in Setup Mode. | ✓ | MNS |
| 4 | Too Many Events. | ✓ | Teach |
| 5 | No Event. | ✓ | Teach |
| 6 | Invalid Event variable index. | ✓ | Teach |
| 7 | Invalid Event. | ✓ | Teach |
| 8 | Reserved. | | |
| 9 | Invalid Parameter Index. | ✓ | MNS |
| 10 | Invalid Node Variable Index. | ✓ | NV |
| 11 | Invalid Event Variable Value. | ✓ | Teach |
| 12 | Invalid Node Variable Value. | ✓ | NV |
| 13 | Other in Learn mode | ✓ | Teach |
| | | | |
| 250 | Invalid mode | | Any |
| 251 | Invalid command parameter | | Any |
| 252 | Invalid service | | Any |
| 253 | Invalid diagnostic | | Any |
| 254 | Unknown NVM type | | Any |
| 255 | Reserved | | |