

| NMRA Standard | |
|---|-----------|
| Layout Command Control™ (LCC) Datagram Transport | |
| Apr 25, 2021 | S-9.7.3.2 |

Adopted as a NMRA Standard

The OpenLCB Standard document appended to this cover sheet has been formally adopted as a NMRA Standard by the NMRA Board of Directors on the date shown in the *Adopted* column in the *Version History* table below.

Version History

| Date | Adopted | Summary of Changes |
|--------------|---------------------|---|
| Feb 17, 2015 | | Initial version submitted for public comment |
| Feb 6, 2016 | Feb 20, 2016 | Minor grammatical corrections and readability improvements as well as the following specific changes: <ul style="list-style-type: none"> • 4.3 Datagram Rejected • 4.3.1 Error Codes • 6.1 Normal Transmission • 6.2 Rejected Transmission • 7.1 CAN Message Formats • 7.2 CAN States • 7.3.1 Normal Transmission • 7.3.2 Rejected Transmission |
| Apr 25, 2021 | July 2, 2021 | Changed LCC logo to include the ® symbol Changed “Layout Command Control” to have the ™ symbol Added the NMRA Legal Disclaimer fine-print Changed the OpenLCB license to “Creative Commons Attribution-ShareAlike 4.0 International” |
| | | |

Important Notices and Disclaimers Concerning NMRA Standards Documents

The Standards (S), Recommended Practices (RP), Technical Note (TN) and Technical Information (TI) documents of the National Model Railroad Association (“NMRA Standards documents”) are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading “Important Notices and Disclaimers Concerning NMRA Standards Documents.”

Notice and Disclaimer of Liability Concerning the Use of NMRA Standards Documents

NMRA Standards documents are developed within the Standards and Conformance Department of the NMRA in association with certain Working Groups, members, and representatives of manufacturers and sellers. NMRA develops its standards through a consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. NMRA Standards documents are developed by volunteers with modeling, railroading, engineering, and industry-based expertise. Volunteers are not necessarily members of NMRA, and participate without compensation from NMRA.

NMRA does not warrant or represent the accuracy or completeness of the material contained in NMRA Standards documents, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard or recommended practice, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, NMRA disclaims any and all conditions relating to results and workmanlike effort. In addition, NMRA does not warrant or represent that the use of the material contained in NMRA Standards documents is free from patent infringement. NMRA Standards documents are supplied “AS IS” and “WITH ALL FAULTS.”

Use of NMRA Standards documents is wholly voluntary. The existence of an NMRA Standard or Recommended Practice does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the NMRA Standards documents. Furthermore, the viewpoint expressed at the time that NMRA approves or issues a Standard or Recommended Practice is subject to change brought about through developments in the state of the art and comments received from users of NMRA Standards documents.

In publishing and making its standards available, NMRA is not suggesting or rendering professional or other services for, or on behalf of, any person or entity, nor is NMRA undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any NMRA Standards document, should rely upon their own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given NMRA Standards documents.

IN NO EVENT SHALL NMRA BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: THE NEED TO PROCURE SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD OR RECOMMENDED PRACTICE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

NMRA’s development of NMRA Standards documents involves the review of documents in English only. In the event that an NMRA Standards document is translated, only the English version published by NMRA is the approved NMRA Standards document.

Official Statements

A statement, written or oral, that is not processed in accordance with NMRA policies for distribution of NMRA communications, or approved by the Board of Directors, an officer or committee chairperson, shall not be considered or inferred to be the official position of NMRA or any of its committees and shall not be considered to be, nor be relied upon as, a formal position of NMRA.

Comments on Standards

Comments for revision of NMRA Standards documents are welcome from any interested party, regardless of membership. However, **NMRA does not provide interpretations, consulting information, or advice pertaining to NMRA Standards documents.**

Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since NMRA standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, NMRA, its departments, Working Groups or committees cannot provide an instant response to comments, or questions except in those cases where the matter has previously been addressed. For the same reason, NMRA does not respond to interpretation requests. Any person who would like to participate in evaluating comments or in revisions to NMRA Standards documents may request participation in the relevant NMRA working group.

Laws & Regulations

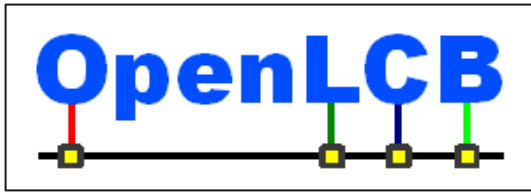
Users of NMRA Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any NMRA Standards document does not constitute compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. NMRA does not, by the publication of NMRA Standards documents, intend to urge action that is not in compliance with applicable laws, and NMRA Standards documents may not be construed as doing so.

Copyrights

NMRA Standards documents are copyrighted by NMRA under US and international copyright laws. They are made available by NMRA and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of modeling, structural and engineering practices and methods. By making NMRA Standards documents available for use and adoption by public authorities and private users, NMRA does not waive any rights in copyright to the NMRA Standards documents.

IMPORTANT NOTICE

NMRA Standards documents do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other systems, devices or networks. NMRA Standards documents development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. Implementers and users of NMRA Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.



OpenLCB Standard

Datagram Transport

Apr 25, 2021

Adopted

1 Introduction (Informative)

This standard defines the protocol for transporting OpenLCB datagrams.

2 Intended Use (Informative)

The datagram transport protocol is intended to efficiently transfer small amounts (0-72 bytes) of data reliably between two OpenLCB nodes. It allows for management of overlapping independent transmissions.

The datagram transport protocol relies on the underlying OpenLCB message transport protocol for reliable sequenced communications.

This document describes the required message formats for datagram transport. Section 4 gives an overview of the message types with an abstract numeric description intended as a normative guide to the construction of concrete message types over specific physical transport media. Section 7 describes, in concrete detail, the implementation of the datagram transport message formats for the specific physical transport media that have been adopted as normative standards.

3 References and Context (Normative)

This is in the context of the following OpenLCB Standards:

- The OpenLCB Message Network Standard, which defines the basic messages and how they interact. Higher-level protocols are based on this message network, but are defined elsewhere. The Message Network Standard defines the global error codes which are referenced here.
- The OpenLCB CAN Frame Transfer Standard, which specifies the use and format of CAN frames for OpenLCB communications.

4 Message Formats (Normative)

In the following, the “Common MTI” column specifies the the MTI value to be used when communicating in OpenLCB common format. The Common MTI is an abstract numeric description intended as a normative guide to the construction of concrete message formats over specific physical transport media.

4.1 Datagram Content

| Name | Simple Node | Dest ID | Event ID | Common MTI | Data Content |
|------------------|-------------|---------|----------|------------|--------------|
| Datagram Content | N | Y | N | 0x1C48 | 0-72 bytes |

The first byte of the data content defines the datagram type and is designated the Datagram Content ID. The values for that byte are documented in the Standard for the protocol that defines the type.

4.2 Datagram Received OK

| Name | Simple Node | Dest ID | Event ID | Common MTI | Data Content |
|----------------------|-------------|---------|----------|------------|----------------|
| Datagram Received OK | N | Y | N | 0x0A28 | Flags (1 byte) |

The flag bits are defined as:

- MSB 0x80 – Reply Pending – Use is defined by higher-level protocols.
 - Low four bits 0x0F – Timeout Value – Zero indicates no timeout value. A value N of 0x01 through 0x0F indicates that the pending reply will be transmitted before 2^N seconds have elapsed; if not, an error has occurred.
 - All others are reserved, shall be sent as zero and ignored upon receipt.
- Datagram Received OK messages without a Flags byte shall be treated as if they contained a byte with a zero value.

4.3 Datagram Rejected

| Name | Simple Node | Dest ID | Event ID | Common MTI | Data Content |
|-------------------|-------------|---------|----------|------------|---------------------------|
| Datagram Rejected | N | Y | N | 0x0A48 | Error Code, optional info |

The data contents are, in order:

- Two bytes of error code.
- Any extra bytes that the node wishes to include. There can be zero or more of these, to a maximum of 64 bytes. These shall be described in the node documentation.

Nodes shall accept and process Datagram Rejected messages that do not contain the full error code. Missing error code bits are to be interpreted as zero.

4.3.1 Error Code

- The Error Code field shall be in accordance with the Message Network Standard.

5 States (Normative)

The common OpenLCB datagram protocol has no formal states.

6 Interactions (Normative)

- 55 A node that receives a valid Datagram Content message shall send either a Datagram Received OK or Datagram Rejected message in reply. A node that receives a Datagram Content message that does not comply with this Standard may, but is not required to, reply with a Datagram Rejected message.

6.1 Normal Transmission

- 60 Normal transmission consists of the transmitting node sending a Datagram Content message to the receiving node, followed by the receiving node sending a Datagram Received OK message to the transmitting node. A node shall not send a second Datagram to the same receiving node before receiving a reply from the receiving node or a timeout occurs.

6.2 Rejected Transmission

- 65 After the transmitting node sends a Datagram Content message to the receiving node, the receiving node may send a Datagram Rejected message to the transmitting node.

Upon receipt of a Datagram Rejected message with a Temporary Error, the original transmitting node may resend the same Datagram Content message, or may abandon the transmission attempt.

- 70 Upon receipt of a Datagram Rejected message with a Permanent Error, the original transmitting node shall abandon the transmission attempt and not resend the original Datagram Content message.

7 Adaptation to CAN Transport (Normative)

This section describes the CAN implementation of the datagram transport message formats.

7.1 CAN Message Formats

- 75 The OpenLCB CAN Frame Transport Standard and OpenLCB Message Network Standard define how OpenLCB messages are carried across CAN networks. Following those standards, the Datagram Transport messages used on CAN are as defined in the following table.

| Name | CAN-MTI | Can Header | Data Content |
|----------------------|-------------------|---|--|
| Datagram Content | 0xdd ¹ | 0x1Add,dsss ² – Single ³ 0x1Bdd,dsss – First 0x1Cdd,dsss – Middle 0x1Ddd,dsss – Last | 0–8 bytes 0–8 bytes 1–8 bytes 0–8 bytes |
| Datagram Received OK | 0xA28 | 0x19A2,8sss | 0xfddd ⁴ , Flags |
| Datagram Rejected | 0xA48 | 0x19A4,8sss | 0xfddd, Error Code |

7.2 CAN States

80 A node implementing the OpenLCB-CAN datagram protocol shall maintain a Datagram-started state for each datagram that it is receiving as a sequence of frames. If the node receives multiple overlapping datagrams from different source nodes, the states shall be independent.

7.3 CAN Interactions

7.3.1 Normal Transmission

85 Normal transmission of a datagram over CAN consists of the transmitting node sending the Datagram Content message using one of two sequences of Datagram frames:

- One Datagram Content Single Frame
- One Datagram Content First Frame, followed by zero or more Datagram Content Middle Frame, followed by one Datagram Content Last Frame

90 A node shall not transmit frames with lower CAN priority between the frames making up a datagram. A node may, but is not required to, transmit frames with higher CAN priority between the frames making up a datagram.

A receiving node receiving either of the above sequences shall send either a Datagram Received OK or Datagram Rejected message in reply.

7.3.2 Rejected Transmission

95 If a receiving node receives a sequence of Datagram frames other than one of

- One Datagram Content Single Frame
- One Datagram Content First Frame, followed by zero or more Datagram Content Middle Frame, followed by one Datagram Content Last Frame⁵

¹ddd – The 12-bit destination alias field

²sss – The 12-bit source alias field

³Because CAN frames are limited to 8 bytes, datagrams larger than 8 bytes must be broken up among multiple messages. Thus, four distinct message types are defined to aid in flow control.

⁴fddd — First two bytes of the data-part, representing the 4-bit flag field and 12-bit destination Alias. See the OpenLCB-CAN Frame Transport Standard.

⁵The total payload bytes sent, including any First, Middle, and Last Frames, cannot exceed 72 bytes.

100 the receiving node shall send a Datagram Rejected message with a Temporary Error, indicating a resend is allowed.

Table of Contents

| | |
|--|---|
| 1 Introduction (Informative)..... | 1 |
| 2 Intended Use (Informative)..... | 1 |
| 3 References and Context (Normative)..... | 1 |
| 4 Message Formats (Normative)..... | 1 |
| 4.1 Datagram Content..... | 2 |
| 4.2 Datagram Received OK..... | 2 |
| 4.3 Datagram Rejected..... | 2 |
| 4.3.1 Error Code..... | 2 |
| 5 States (Normative)..... | 3 |
| 6 Interactions (Normative)..... | 3 |
| 6.1 Normal Transmission..... | 3 |
| 6.2 Rejected Transmission..... | 3 |
| 7 Adaptation to CAN Transport (Normative)..... | 3 |
| 7.1 CAN Message Formats..... | 3 |
| 7.2 CAN States..... | 4 |
| 7.3 CAN Interactions..... | 4 |
| 7.3.1 Normal Transmission..... | 4 |
| 7.3.2 Rejected Transmission..... | 4 |