

NMRA Standard	
Layout Command Control™ (LCC)	
Function Description Information	
July 22, 2024	S-9.7.4.8

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
July 22, 2024	Jan 24, 2025	Initial version submitted for public comment

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

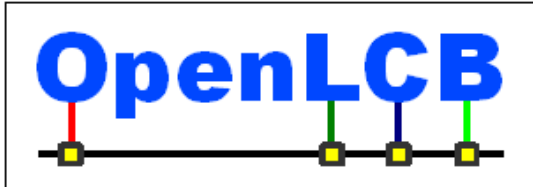
Users of NMRA Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any NMRA Standards document does not constitute compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the 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	
Function Description Information	
July 22, 2024	Adopted

1 Introduction (Informative)

This document defines a standard for the storage of static information that describes the user interface options for controlling available functions on an OpenLCB Train Node, called “Function Description Information (FDI)”.

- 5 The format is XML-based in order to allow reasonable extensibility, while enabling programmatic generation and parsing of the structured information. This XML document is specific to the particular Train, and is exposed at the Memory Space 0xFA. Throttle Nodes retrieve this data from the Train Node using the Memory Configuration Protocol.

2 Intended Use (Informative)

- 10 The Throttle Node downloads the FDI content from the Train Node using the Memory Configuration Protocol after the user selected the given train. The XML is exposed at a fixed Memory Space number (0xFA). The throttle parses the XML and uses the information therein to configure the function buttons’ behavior and/or the display items shown to the user.

- 15 The information presented is the list of available function numbers, the type of the function button (toggle, momentary or analog function), optional name and description strings, and for analog functions the available range of values that are valid.

If the throttle has fixed marked buttons (e.g. a button labeled Horn/Whistle), it will assign a varying function number to these buttons, by finding which function number belongs to the given behavior.

- 20 OpenLCB-connected native Train Nodes built into specific models may ship a fixed constant FDI XML, as it will describe the behavior of the functions as implemented by the hardware and software. Flexible / configurable OpenLCB decoders may provide a mechanism to update the FDI XML if their function numbers can be reconfigured. DCC Command Stations that provide Virtual Train Nodes for OpenLCB throttles may either provide a generic fixed FDI (e.g. listing Headlight, Bell, Horn, F3..F28), or may have a Roster configuration storage, where the user can store a per-DCC-address mapping of functions to behaviors. In this case the Command Station generates the FDI XML on-the-fly based on the DCC address that is being controlled from the throttle. For an MFX/M4 decoder, or a DCC decoder supporting DCC-A, RailComPlus, or the appropriate standardized RailCom data pages, the function mapping can be read out from the locomotive directly using the track protocol, and this information can be used to generate the FDI XML on-the-fly.
- 30

The FDI provides a read-only interaction to retrieve the function metadata. There is no provision in this Standard on how to modify the function metadata. For modification, the regular configuration standards and protocols are recommended.

35 **3 References and Context (Normative)**

For more information on format and presentation, see:

- OpenLCB Common Information Technical Note

For information on how to fetch the FDI information from a node, see:

- OpenLCB Memory Configuration Protocol Standard

40 For information on how to control the functions, see

- OpenLCB Train Control Protocol Standard

For information on XML encoding and XML Schema, see:

- World Wide Web Consortium (W3C) “Extensible Markup Language (XML)”¹
- World Wide Web Consortium (W3C) “XML Schema”²

45 **4 Content (normative)**

The FDI information shall be constant. A node may not change the FDI information after any part of it has been retrieved and before the next transition of the node away from the Initialized state.

5 Format (normative)

50 The FDI is provided as a zero-terminated string of bytes. The bytes encode UTF-8 characters. There is no byte-order mark (BOM) at the start of the string. Lines in the string are delimited with 0x0A Newline (NL) characters.

The content defines the configuration description information in XML 1.0 format using a specific XML vocabulary defined by an XML 1.0 Schema. No extensions to XML 1.0 are permitted.

55 The version number of an OpenLCB FDI schema contains two numbers: The major version first, and the minor version second. This version of this Standard specifies version 1.0 of the schema. That version of the schema is defined at <https://openlcb.org/schema/fdi/1/0/fdi.xsd> and in Appendix A of this document. The FDI content shall pass validation against its referenced schema. Nodes are not required to do the validation.

The first line of the FDI is:

60 `<?xml version="1.0"?>`

to define the XML version of the content.

¹ <http://www.w3.org/XML/>

² <http://www.w3.org/XML/Schema>

The root element of the FDI XML is required to be:

```
<fdi xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:noNamespaceSchemaLocation="https://openlcb.org/schema/fdi/1/0/fdi.xsd">
```

65 to define the OpenLCB FDI version of the content.

The schema contents are normative.

Numerical values in attributes and element text shall be specified as decimal numbers. OpenLCB nodes are not required to parse any other numeric format.

5.1 XML Elements

70 5.1.1 <fdi> Element

A single <fdi> element is the root of the XML information. The <fdi> element must contain exactly one <segment> element.

5.1.2 <segment> Element

75 A <segment> element shall contain an optional user-readable name and optional description, and a sequence of zero or more <group> and/or <function> elements. The user-readable name and description are intended as hints for optional UI display by throttles.

80 A <segment> element may provide a “space” attribute with the fixed value of “249”. Alternative memory spaces beyond the Function Space (249, 0xF9) are not currently defined for use with Functions. A <segment> element may provide an “origin” attribute with the fixed value of “0”. The “space” and “origin” attributes are reserved, and new implementations should omit them.

5.1.3 <group> Element

The <group> element allows logical grouping of functions, providing common documentation for them.

85 A <group> element shall contain an optional user-readable name and optional description tags, and a sequence of zero or more <group> and/or <function> elements. The user-readable name and description are intended as hints for optional UI display by throttles.

5.1.4 <function> Element

The <function> element describes the metadata of one function.

The ‘size’ attribute is currently reserved, and if specified, shall carry a value of 1.

90 The ‘kind’ attribute specifies the behavior of the function button, with the following allowed values:

- ‘binary’ (default) defines an on-off function with a toggle button behavior
 - ‘momentary’ defines an on-off function with a momentary button behavior
 - ‘analog’ defines an analog function with unsigned integer values accepted between the optional <min> and <max> sub-elements (inclusive) If not provided, the default for <min> is 0 and the
- 95 default for <max> is 255.

The <function> element may contain a <name> element. The string contents of that element is meant to be used by a Throttle to convey information about this function to the user.

100 The <function> element shall contain a <number> element with a decimal integer as contents, which specifies the function number defined. The number must be greater than or equal to zero and less than or equal to 16777215.

Appendix A: The 1.0 Version of the XML Schema for FDI

```

105 <?xml version="1.0" encoding="utf-8"?>
    <?xml-stylesheet href="schema2xhtml.xsl" type="text/xsl"?>
    <!-- XML Schema for OpenLCB Function Description Information (FDI) -->
    <xs:schema version="FDI 1.0" xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
110     <xs:simpleType name="NonNegativeInteger">
        <xs:restriction base="xs:int">
            <xs:totalDigits value="5"/>
            <xs:fractionDigits value="2"/>
115     <xs:minInclusive value="0"/>
        </xs:restriction>
    </xs:simpleType>

    <xs:complexType name="groupType">
120     <xs:sequence>
        <xs:element name="name" minOccurs="0" maxOccurs="1" />
        <xs:element name="description" minOccurs="0" maxOccurs="1" />
        <xs:choice minOccurs="0" maxOccurs="unbounded">
            <xs:annotation>
125             <xs:documentation>
                Allows any sequence of the contained element types
            </xs:documentation>
        </xs:annotation>
        <xs:element name="group" type="groupType" minOccurs="0" maxOccurs="1" />
130     <xs:element name="function" type="functionType" minOccurs="0" maxOccurs="1"
    />
        </xs:choice>
    </xs:sequence>
    </xs:complexType>

135     <xs:complexType name="functionType">
        <xs:sequence>
            <xs:element name="name" minOccurs="0" maxOccurs="1" />
            <xs:element name="number" type="NonNegativeInteger" minOccurs="1"
140     maxOccurs="1" />
            <xs:element name="min" type="xs:int" minOccurs="0" maxOccurs="1" >
                <xs:annotation>
                    <xs:documentation>
145                     Smallest valid value for this function.
                        Only used when type is "analog".
                    </xs:documentation>
                </xs:annotation>
            </xs:element>
            <xs:element name="max" type="xs:int" minOccurs="0" maxOccurs="1" >
150     <xs:annotation>
                <xs:documentation>
                    Largest valid value for this function.
                        Only used when type is "analog".
                </xs:documentation>
            </xs:annotation>
155     </xs:element>
    </xs:sequence>
    </xs:complexType>

```

```

</xs:sequence>
<xs:attribute name="kind" default="binary">
  <xs:annotation>
160   <xs:documentation>
        Type of function being described
      </xs:documentation>
    </xs:annotation>
    <xs:simpleType>
165     <xs:restriction base="xs:token">
        <xs:enumeration value="binary"/>
        <xs:enumeration value="momentary"/>
        <xs:enumeration value="analog"/>
      </xs:restriction>
170   </xs:simpleType>
  </xs:attribute>
  <xs:attribute name="size" default="1">
    <xs:annotation>
175     <xs:documentation>
        Storage size of this variable in bytes.
        Reserved, ignore upon receipt.
      </xs:documentation>
    </xs:annotation>
    <xs:simpleType>
180     <xs:restriction base="xs:token">
        <xs:enumeration value="1"/>
      </xs:restriction>
    </xs:simpleType>
  </xs:attribute>
185 </xs:complexType>

<xs:element name="fdi">
  <xs:annotation>
190   <xs:documentation>
        This is the schema for Function
        Description Information (fdi)
      </xs:documentation>
    </xs:annotation>
    <xs:complexType>
195     <xs:sequence>
        <xs:element name="segment" minOccurs="1" maxOccurs="1">
          <xs:annotation>
200           <xs:documentation>
                Define the contents of the function memory space
              </xs:documentation>
            </xs:annotation>
            <xs:complexType>
              <xs:sequence>
205                <xs:element name="name" minOccurs="0" maxOccurs="1" />
                <xs:element name="description" minOccurs="0" maxOccurs="1" />
                <xs:choice minOccurs="0" maxOccurs="unbounded">
                  <xs:annotation>
210                   <xs:documentation>
                        Allows any sequence of the contained element types
                      </xs:documentation>
                  </xs:annotation>
                  <xs:element name="group" type="groupType" minOccurs="0"
maxOccurs="1">

```



```

215         <xs:annotation>
           <xs:documentation>
             Allows grouping and replication of multiple locations.
           </xs:documentation>
         </xs:annotation>
       </xs:element>
220     <xs:element name="function" type="functionType" minOccurs="0"
maxOccurs="1">
       <xs:annotation>
         <xs:documentation>
225           Describes one function.
         </xs:documentation>
       </xs:annotation>
     </xs:element>

230   <!--
     XML Schema 1.1 construct expressing extensibility promise
     <xs:any minOccurs="0" maxOccurs="1" processContents="lax">
     <xs:assert test="every $x in * satisfies
           (exists($x/@size) and $x/@size castable to
235   xs:integer)"/>
     <xs:assert test="every $x in * satisfies
           (exists($x/@offset) and $x/@offset castable to
240   xs:integer)"/>
       <xs:annotation>
         <xs:documentation>
           Extension point for future schema
         </xs:documentation>
       </xs:annotation>
     </xs:any>
   -->
245
     </xs:choice>
   </xs:sequence>
   <xs:attribute name="space" default="249">
     <xs:annotation>
250       <xs:documentation>
         The decimal number of the address space where the information is
found.
         Reserved, ignore upon receipt.
       </xs:documentation>
     </xs:annotation>
     <xs:simpleType>
       <xs:restriction base="xs:token">
         <xs:enumeration value="249"/>
       </xs:restriction>
     </xs:simpleType>
260   </xs:attribute>
   <xs:attribute name="origin" default="0">
     <xs:annotation>
265       <xs:documentation>
         Starting address of the segment's contents
         within the memory space.
         Reserved, ignore upon receipt.
       </xs:documentation>
     </xs:annotation>
270   <xs:simpleType>

```

```
                <xs:restriction base="xs:token">
                    <xs:enumeration value="0"/>
                </xs:restriction>
            </xs:simpleType>
275     </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:sequence>
</xs:complexType>
280 </xs:element>
</xs:schema>
```

Table of Contents

1 Introduction (Informative).....	1
2 Intended Use (Informative).....	1
3 References and Context (Normative).....	2
4 Content (normative).....	2
5 Format (normative).....	2
5.1 XML Elements.....	3
5.1.1 <fdi> Element.....	3
5.1.2 <segment> Element.....	3
5.1.3 <group> Element.....	3
5.1.4 <function> Element.....	3
Appendix A: The 1.0 Version of the XML Schema for FDI.....	5