

Fieldbus specification —

Part 2: Network management

ICS 35.100:35.200

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This Draft for Development, having been prepared under the direction of the Advanced Manufacturing Technology Assembly, was published under the authority of the Standards Board and comes into effect on 15 June 1996

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The following BSI reference relates to the work on this standard:
Committee reference AMT/7

ISBN 0 580 25847 5

Amendments issued since publication

Amd. No.	Date	Comments

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Foreword

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This publication contains the following parts:

Part 1	System architecture	FF-94-800	Revision 1.0
Part 2	Network management	FF-94-801	Revision 1.0
Part 3	Data link layer services subset	FF-94-821	Revision 1.0
Part 4	Data link protocol specification	FF-94-822	Revision 1.0
Part 5	Fieldbus message specification	FF-94-870	Revision 1.0
Part 6	Fieldbus access sublayer (services and protocol)	FF-94-875	Revision 1.0

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A review of this Draft for Development will be carried out not later than 2 years after its publication. Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development, will be made in an announcement in *BSI News*.

According to the replies received the responsible BSI Committee will judge whether the Draft for Development can be converted into a British Standard or what other action should be taken.

Observations which it is felt should receive attention before the official call for comments will be welcomed.

These should be sent to the Secretary of BSI Technical Committee AMT/7 at BSI, 389 Chiswick High Road, London, W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the FF title page, pages ii to vi, pages 1 to 46 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Fieldbus Foundation Fieldbus Specification Network Management

DOCUMENT: FF-94-801
REVISION : PS 1.0
DATE: August 28, 1995



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Foreword

This document describes the architecture and features for the Management of Networks based on the Fieldbus Foundation specifications.

Open Issue List		
No.	Description of Issue	Affected Documents

Resolution List		
No.	Description of Resolution	Affected Sections

Comments To Be Addressed in the Final Specification

1. **MaxTokenHoldTimeArrayVariable** — Arrays of specified length octetstrings cannot be described in the Object Dictionary. Therefore, this attribute defined as an array of octetstrings, each of length 8, needs to be respecified as a structure of 8 octetstring fields, each of length 8.
2. **5.1.1.1.1** — **AgentFunctionsSupported** — State that the LAS Loadable and VCRL Loadable values mean downloadable and uploadable.
3. **5.1.1.1.1** — **FmsFeaturesSupportedLength** — Because this has to be part of the Variable definition for the **FmsFeaturesSupported**, this should be removed. The length should be fixed at 8.
4. **8.1.1** — **FmsFeaturesSupported** — The data type definition for FMS Features Supported cannot have a variable length value according to FMS. It must be fixed at 8 bytes.
5. **5.2.4.1.1** **FMS State and FAS State** — These attributes should have the same numerical values for corresponding states, as follows:

- 0 = Closed
- 1 = Open
- 2 = Calling/Requesting
- 3 = Called/Responding
- 4 = Replied

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1 Scope

Fieldbus Foundation network management provides for the management of a device's communication system by an external network manager application. This document specifies the network management objects and services necessary to manage the communication system of a Fieldbus Foundation device.

The Network Management objects and services defined in this document support:

Configuration Management	initializes and maintains communication parameter values;
Performance Management	collects and characterizes the performance of device communications;
Fault Management	assists in fault detection, isolation, and recovery.

Definition of the network manager application that accesses these objects and services is beyond the scope of this specification.

The relations between Network Management and the other Fieldbus Foundation Sublayers are described in the Fieldbus Foundation Fieldbus Specification System Architecture.

2 Overview

Network Management permits Fieldbus Foundation Network Manager (NMGr) entities to conduct management operations over the network with their associated Network Management Agents (NMAs). Each NMA is responsible for managing the communication stack within a Fieldbus device. NMAs respond to instructions received from NMGr and are capable of indicating their NMGr when significant events, or change in status occurs by updating accessible objects. The NMA is represented as an FMS VFD, and objects within the NMA are accessed by NMGr using FMS services.

This specification first describes the network management architecture. It then defines:

1. the model of the NMA as a FMS Virtual Field Device (VFD);
2. the structure of the NMA Object Dictionary (OD) and Directory of the NMA VFD;
3. the specification of the network accessible objects contained in the VFD;
4. standard data types specific to Network Management Objects.

Communication between a Network Manager, and a Network Management Agent utilizes the services defined in the Fieldbus Foundation (FF) Fieldbus Messaging Specification (FMS).

2.1 Network Management Capabilities

The following capabilities are provided by network management:

1. Loading a Virtual Communication Relationship (VCR) List or single entries in this list; (A VCR represents a communication channel through the complete communication stack.)
2. Configuring the Communication Stack;
3. Loading the Link Active Schedule;
4. Performance Monitoring;
5. Fault Detection Monitoring (NMA does not generate Information Report or Event Notification, however, it is not restricted from doing so for defined variables);

3 Network Management Architecture

Figure 1 shows the architectural relationship between network management and the other communication and application components in a device. Each device contains a single Network Management Agent and Layer Management Entities (LMEs) for its protocols (FMS LME, FAS LME, DL LME and Phy LME). Each Fieldbus network, segmented or not, has at least one Network Manager (NMGr) which co-ordinates the Network Management of the whole system. All other NMGr get their instructions from a "Higher-Level-NMGr" and act as NMA in relation to this "Higher-Level-NMGr". A NMGr interacts with the NMAs via FMS.

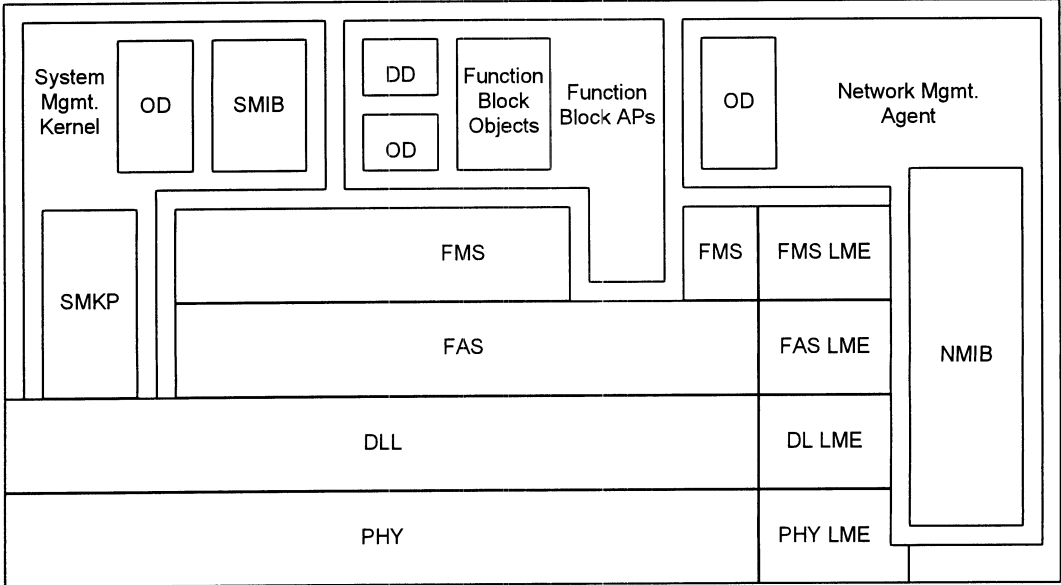


Figure 1 — General FF Architecture

The NMA has access to management information of the different sublayers through local Layer Management Entities (LMEs). It also maintains information about the communication stack as a whole. This information is collectively referred to as the Network Management Information Base (NMIB), and represents communication stack parameters and operations, such as:

- data within the protocol that controls, or reflects protocol operation;
- actions, represented by FMS variables, which may be written to manage protocol operation;

The NMA is modeled as an FMS VFD and its NMIB is modeled as a set of FMS objects. These objects are accessed by NMgrs using FMS services through Virtual Communication Relationships (VCRs) established with the NMA. For interoperability purposes, a standard VCR is defined in Section 6 of this specification. Figure 2 illustrates these concepts.

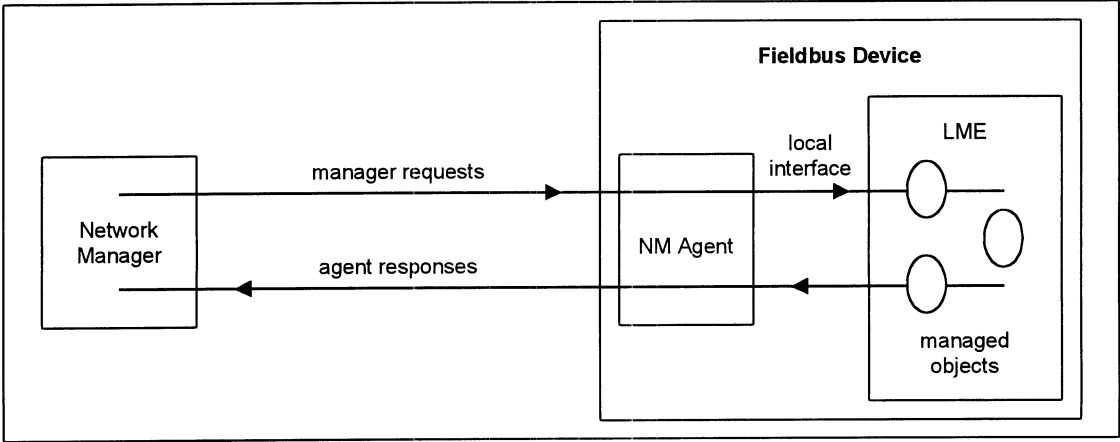


Figure 2 — Interaction between Manager, Agent, Managed Objects

Network Manager (NMgr)

The NMgr is responsible for maintaining the operation of the network according to the policies defined for it by the System Manager (SMgr). The NMgr enforces SM policies by monitoring the status of the communication stack in each device, and by taking action when necessary (or when directed to do so by the SM). The NMgr performs these tasks by processing information reports produced by the NMAs, and by directing the NMAs to perform services requested via FMS.

The specification of the NMgr is beyond the scope of this specification.

The relations between the NMgr and SMgr are described in the Fieldbus Foundation Fieldbus Specification System Architecture. Interactions between NM and SM are local behavior.

Network Management Agent (NMA)

The NMA is responsible for providing the NMgr with an FMS interface to the managed objects of the communication stack. Internal to the device, the NMA maps FMS service requests to objects that it maintains for the communication stack as a whole, and to objects maintained by the Layer Management Entities (LMEs).

Layer Management Entities (LMEs)

Layer Management Entities provide the management capability of a layer protocol, such as FMS, FAS, DLL or the PhyL. They provide NMA a local interface to the managed objects of the protocol. All network access to the LMEs and their objects is provided by the NMA.

Managed Objects

A managed object represents a capability or set of information about a protocol, or set of protocols, that is accessible through the LME. Each is defined by its attributes and behavior. Managed objects are represented remotely by the NMA as FMS objects in the NMIB.

Network Management Information Base (NMIB)

The collection of managed variables is called the Network Management Information Base (NMIB). The NMIB contains configuration, performance, and fault related information for the communication system of the device.

Network Management Communication Relationship

A standard Virtual Communication Relationship (VCR) is defined in Section 6 of this specification for communication between a NMA and its NMgr. This VCR is always the first VCR in the VCR List. It provides Time-Available, queued, user-triggered, bi-directional network access. This Network Management VCR exists at a well-known DLCEP address in all devices that contain an NMA. Additionally, all NMAs are required to support this VCR. An NMA may be accessed simultaneously through other VCRs, but for consistency, only monitoring is permitted via these VCRs.

Network Management VFD

This Virtual Field Device (VFD) is an FMS view of the Network Management Agent. It makes the NMA accessible across the network using FMS services.

4 NMA VFD

4.1 NMA VFD Definition

The Network Management Agent is an application process modeled as a FMS VFD.

VFD:

NMA

VendorName:	Not Defined Here (vendor dependent)
ModelName:	Not Defined Here (vendor dependent)
Revision:	Not Defined Here (vendor dependent)
ProfileNumber:	0x4E4D
LogicalStatus:	Dynamic data
PhysicalStatus:	Dynamic data
List of VFD SpecificObjects:	NMA Directory/Object

VendorName

This attribute, of type VisibleString, identifies the manufacturer of the NMA. This is not represented in the OD, but is accessible from the VFD by using the FMS Identify service.

ModelName

This attribute, of type VisibleString, identifies the manufacturer specific model of the NMA. This is not represented in the OD, but is accessible from the VFD by using the FMS Identify service.

Revision

This attribute, of type VisibleString, is the software revision level of the NMA. This is not represented in the OD, but is accessible from the VFD by using the FMS Identify service.

Profile

This attribute, of type OctetString specifies the Fieldbus Foundation Profile information concerning NMA conformance. This is not represented in the OD, but is used by FMS during the establishment of the a VCR. Its value is the hexadecimal value of “NM”, which is 0x4E4D.

List of VFD SpecificObjects

This attribute is represented by the NMA Directory Object. Figure 3 illustrates the structure of the NMA Directory and its relationship to the Object Dictionary for the NMA VFD.

4.2 NMA VFD OD Object Description

This section defines the contents of the OD Object Description (entry 0) in the Object Dictionary for the NMA VFD.

OD Object Description:	NMIB OD Description
Numeric Identifier:	0
ROM/RAM-Flag:	Not Defined Here
NameLength:	0 to indicate that object names are not supported in the OD.
AccessProtectionSupported:	Not Defined Here (defined per configuration or vendor)
VersionOD:	Not Defined Here (defined per configuration)
LocalAddress-OD-DES:	Not Defined Here (defined per configuration)
ST-OD-Length:	>= 49
LocalAddress-ST-OD:	Not Defined Here (defined per configuration)
FirstIndex-S-OD:	Object index of the First Directory Object.
S-OD-Length:	Not Defined Here (defined per configuration)
LocalAddress-S-OD:	Not Defined Here (defined per configuration)
First-Index-DV-OD:	Not Defined Here (defined per configuration)
DV-OD-Length:	Not Defined Here (defined per configuration)
LocalAddress-DV-OD:	Not Defined Here (defined per configuration)
FirstIndex-DP-OD:	Not Defined Here (defined per configuration)
DP-OD-Length:	Not Defined Here (defined per configuration)
LocalAddress-DP-OD:	Not Defined Here (defined per configuration)

4.3 NMA Directory Object

The NMA directory object is a map to a set of logically grouped objects contained in the NMIB. Each directory object contains the information necessary to access objects managed by the NMA.

NOTE Examples of directories are: the directory describing the objects defined in this specification; the directory describing the objects defined by a communication profile; and the directory describing the objects defined by the manufacturer.

Communication profilers, device profilers, and/or manufacturers may extend the definitions of the network accessible objects contained in the NMA VFD. These additional objects are included in the OD by adding a separate directory to the NMA OD, and referencing the objects via this directory. This ensures that added object definitions do not interfere with a minimum level of management interoperability — that is, standard objects, attributes and data types (i.e. those defined by this specification) may not be changed, altered, or deleted.

The NMA directory object is defined as an FMS Array object. The NMA Standard Directory is always described by the first S-OD entry in the object dictionary. When there are N Directory objects, they will be individually referenced by the first N consecutive S-OD entries in the object dictionary. The number N is contained as the value in directory object array. The specific position within the array is defined below.

The following table summarizes network access to the directory entries.

Table 1 — Network Access to the Directory Entries

OD index	Attribute name	Object Type	Data Type	Number of Elements	Size in octets	Valid Values	Initial Value	Access
S-OD (first entry)	NMA Standard Directory	Array	Unsigned16	max 50	max 100	-----	-----	RaWa
1 entry for each additional directory object	Additional Directory	Array	Unsigned16	max 50	max 100	-----	-----	RaWa

The FMS directory array object is defined as follows:

Array:

NMA Standard Directory Object

Name:	Not Applicable
Numeric Identifier:	FirstIndex-S-OD + (Number of Directory Objects – 1)
Data Type Index:	6 (Unsigned16)
Element Length:	2
Number of Elements:	6 (hdr) + 16 (defined references) + (Number of MME Composites × 2)
Password:	Configuration Defined
Access Groups:	Configuration Defined
Access Rights:	Configuration Defined
Local Address:	Configuration Defined
Extension:	Not Defined Here

The directory object array is logically divided into a header and a set of object references. Three types of objects may be referenced in the directory:

FMS Objects	The object referenced by the directory is an individual FMS Object.
Composite Objects	The object referenced by the directory is composed of a set of two or more individual FMS Objects with consecutive object indices. The objects in the set do not have to be of the same FMS object type. The reference provided by the directory is the object index of the first object (lowest object index) in the set.
Composite List Objects	The object referenced by the directory is a set of related, consecutive directory entries, each of which is a reference to the same type of composite object.

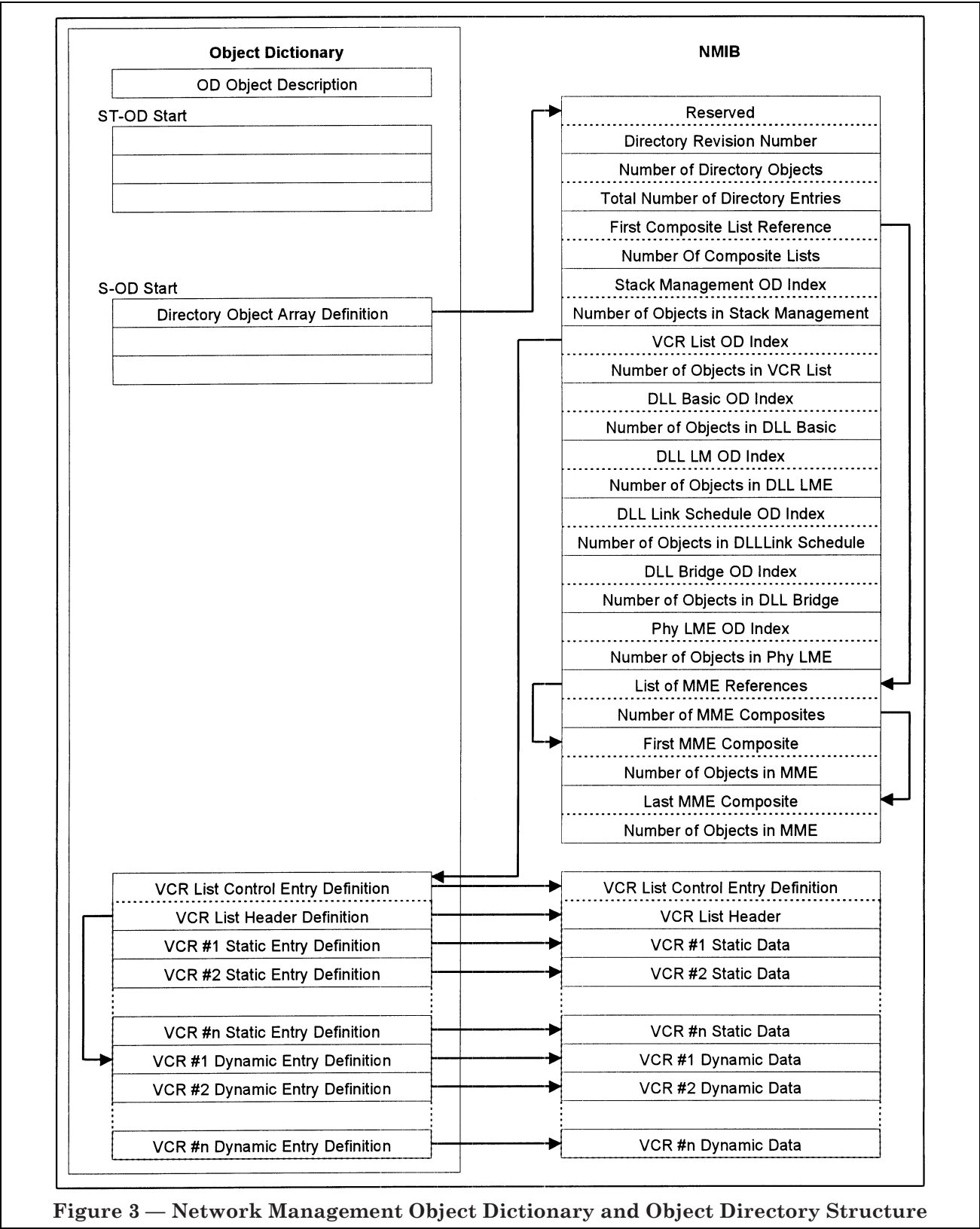


Figure 3 — Network Management Object Dictionary and Object Directory Structure

4.3.1 Directory Header

The directory header consists of six unsigned 16-bit integers and is structured as shown below. It is present only for the first directory object in a directory. The table below specifies the content of the directory header. Each entry in the array is an unsigned 16-bit integer.

Table 2 — Object Directory Header

Array Element	Contents
1	Reserved
2	Directory Revision Number
3	Number of Directory Objects
4	Total Number of Directory Entries
5	First Composite List Reference
6	Number of Composite Lists

Directory Revision Number

This entry identifies the revision level of the NMA Directory Object. It is assigned by the implementor.

Number of Directory Objects

This entry identifies the total number of directory objects in the NMA. The directory objects are consecutively numbered in the Object Dictionary beginning with the first S-OD index.

NOTE The standard directory is always present.

Total Number of Directory Entries

This entry identifies the total number of references in a single directory. Each reference is composed of 2 Unsigned16 array entries. Each directory object may have a maximum length of 100 octets. The value of this entry will be larger than 22 (12 octets for the header plus 22 entries $\times$ 4 octets/entry) when the directory, spans multiple directory objects (The general structure of an Directory is defined in the Fieldbus Foundation Fieldbus Specification System Architecture).

First Composite List Reference

This entry is the directory entry number of the first composite list referenced by the directory. Each composite list reference is composed of a reference to a series of consecutive composite references in the directory. Composite list references are the only type of reference that contain a directory offset and not an OD Index.

Number of Composite Lists

This entry is the number of composite lists referenced by the directory. Composite list references are consecutively entered in the directory.

4.3.2 FMS and Composite Object References

This portion of the directory immediately follows the directory header. Each directory entry consists of a pair of unsigned 16-bit integers. The first in the pair is the Object Dictionary Index for the object being referenced. The second is the number of consecutive Object Dictionary Indices used by the object. If this value is 1, then the object being referenced is a single FMS object.

The table below specifies the content of this portion of the directory.

Table 3 — Composite Object References

Directory Entry	Contents	
1 - StackManagementEntry	StackManagementOdIndex	Number of Objects in Stack Management Composite
2 - VCRLISTEntry	VCRLISTOdIndex	Number of VCR Objects
3 - DllBasicEntry	DllBasicOdIndex	Number of Objects in DllBasic Composite
4 - DllLinkMasterEntry	DllLmOdIndex	Number of Objects in DllLm Composite
5 - LinkScheduleListEntry	LinkScheduleListOdIndex	Number of Objects in LinkScheduleList
6 - DllBridgeEntry	DllBridgeOdIndex	Number of Objects in DllBridge Composite
7 - PhyLmeEntry	PhyLmeOdIndex	Number of Objects in PhyLme Composite

StackManagementOdIndex

This element is the OD Index for the composite for Stack Management Entity for the NMA.

VcrListOdIndex

This element is the OD Index for the composite for the list of Virtual Communication Relationships (VCRs) accessible through the NMA.

DllBasicOdIndex

This element is the OD Index for the composite representing the objects for the BASIC class devices accessible through the NMA.

DllLmOdIndex

This element is the OD Index for the composite representing the additional objects (all BASIC class attributes are implicate) for a LINK MASTER class device accessible through the NMA. If the DLL is a BASIC class device, both entries of this reference are set to zero.

LinkScheduleListOdIndex

This element is the OD Index for the composite representing the objects for a LinkScheduleList class accessible through the NMA. If the DLL is a BASIC class device, both entries of this reference are set to zero.

DllBridgeOdIndex

This element is the OD Index for the composite representing the additional objects (all BASIC and LINK MASTER class attributes are implicate) for the BRIDGE device class accessible through the NMA. If the DLL is not a BRIDGE device, both entries of this reference are set to zero.

PhyLmeOdIndex

This element is the OD Index for the composite representing the PhyLme object(s) accessible through the NMA.

4.3.3 Composite List References

This element is a series of references to composite lists. Each element in the series references a list of composite references of the same type. The only list of composite references for the NMA VFD is the ListOfMmeReferences.

Table 4 — Composite List References

Directory Entry	Composite Lists	
8	ListOfMmeReferences = 9	Number of Mme References
	Composite References	
*	Mme Composite Od Index	Number of Mme Objects
* represents 9 through (9 + Number_Of_MME_References – 1) entries		

ListOfMmeReferences

This entry is a reference to the list of composites (MmeCompositeODIndex, Number of Mme Objects) contained in the object directory which represent the Media Management Entity (MME) objects accessible via the NMA. More than one MME may be defined (e.g. for redundancy). The number of MME composites in the list is implementation and configuration dependent. That is, the implementation may support a certain number of MMEs, and the configuration may restrict that number.

Number of Mme References

This entry indicates the number of consecutive MME Composite References in the List of MME References.

MmeReferenceEntry

This element is composite reference for the MME object(s) accessible through the NMA. Like the other composite references, it is composed of the OD Index for the first object in the composite, and the number of objects in the composite.

This element is repeated in the directory for each MME object defined for VFD, and as specified by the previous element, Number of Mme References.