1394 PRINTER WORKING GROUP

CSR and CONFIGURATION ROM
for
IMAGING DEVICE PROFILE

*** DRAFT PROPOSAL ***

Revision 0.3a - January 22, 1999

Author – Gregory A. LeClair
EMAIL: greg@erc.epson.com
TEL: 1.408.474.0500 x3610
FAX: 1.408.474.0511

1 Scope and Purpose

1.1 Scope

This document specifies the Configuration and Status Registers (CSR) and the Configuration ROM of an SBP-2 target node that implements the minimal requirements to support the 1394 PWG Imaging Device Profile. This profile includes elements from released standards and work in progress by other groups referenced in Section 3.

This document does not address:

- Isochronous communication.
- Use with 1394.1 bridges.
- Security.
- Power Management Issues.

1.2 Purpose

The 1394 PWG has focused on defining a general purpose solution which uses the ANSI SBP-2 protocol for peripheral devices. This document contains examples that can be used to provide consistent implementations of the CSR and Configuration ROM requirements for printers, scanners, copiers, digital still cameras and other imaging devices which support the 1394 PWG Imaging Profile.

The basic model can be scaled from simple single function devices to more complex compound devices.

Requirements are specified in conformance to applicable standards. In all areas that are mandatory, the applicable standards will apply. Where applicable standards allow more than one choice of implementation, this document defines either a choice or preference for the 1394 PWG Imaging Profile.

The term “image device” is used throughout the remainder of this document to refer to image devices in general including any of the devices listed above.

2 References

This document makes reference to and contains excerpts from several standards or draft documents of proposed standards.

More recent revisions may or may not support the information contained in this document:

1. ISO/IEC 13213:1994 Control and Status Register Architecture for Microcomputer Buses.
2. IEEE Std 1394-1995, Standard for High Performance Serial Bus.
3. ANSI T10/1155x (SBP-2) Serial Bus Protocol 2
4. IEEE-p1394a Draft Standard for a High Performance Serial Bus (Supplement).
5. IEEE-1212r Draft – Revision to ISO/IEC 13213:1994

3 Definitions and Notation

3.1 Definitions

See SBP-2 Section 3.1.x

3.2 Notation

See SBP-2 Section 3.2.x

4 CSR Definitions

4.1 Requirements

Compliant devices shall implement the minimal Configuration and Status registers as defined below. Optional registers may be implemented depending on the device requirements,

4.1.1 Minimal

The minimal implementation of Configuration and Status registers shall be as defined by ANSI SBP-2.

4.1.2 Optional

The following registers can be implemented to provide for a basic form of Target Initiated Operations as defined in the 1394 PWG Imaging Profile.

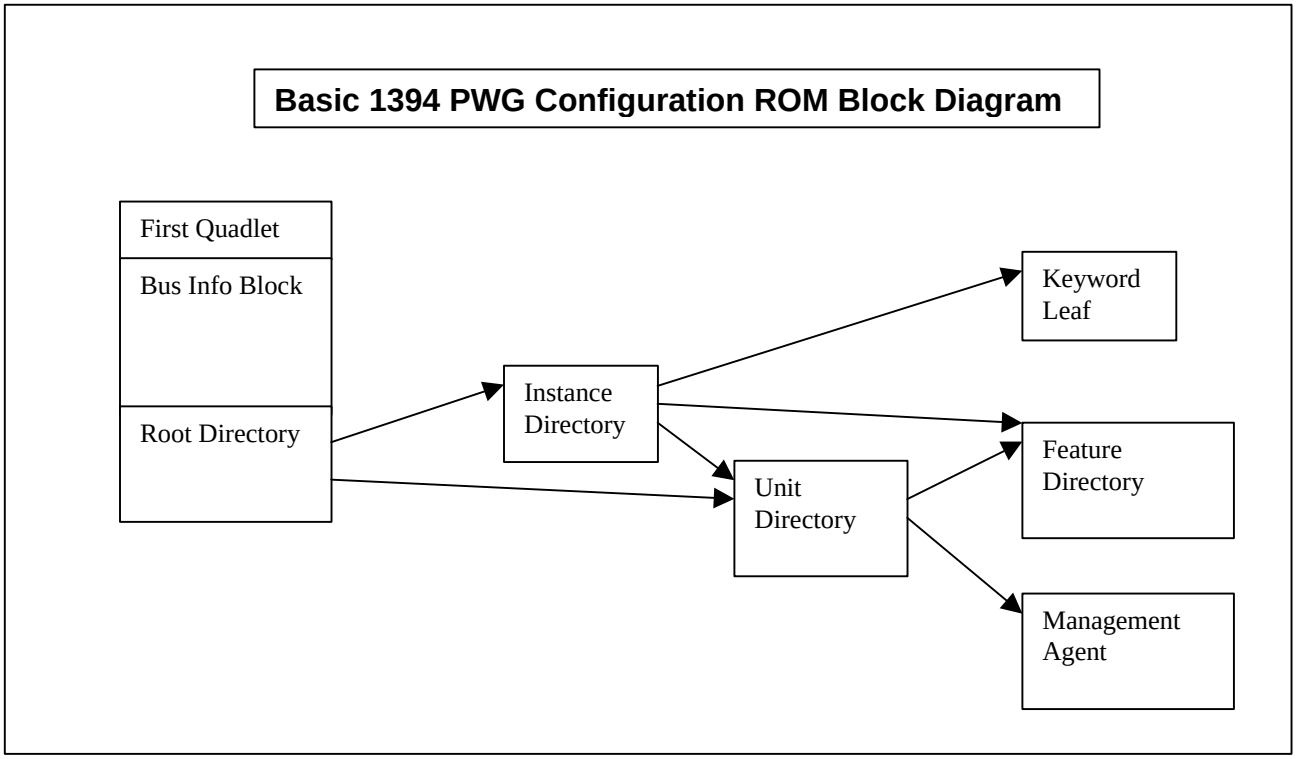
OFFSET	REGISTER NAME	USAGE
128-188	MESSAGE_REQUEST	Target Address for Messages
192-252	MESSAGE_RESPONSE	Target Address for Message Responses

Table 1 – Optional Configuration and Status Registers

5 Configuration ROM

5.1 Requirements

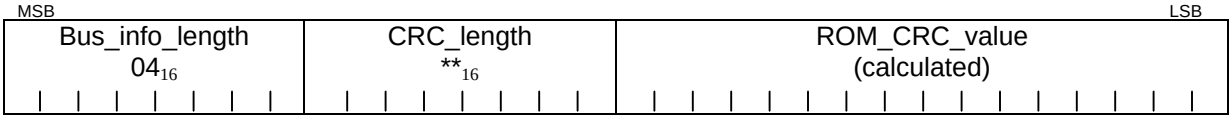
Compliant devices shall implement general format configuration ROM in accordance with ANSI SBP-2, IEEE-p1212r and this profile. The block diagram below illustrates a minimum set of Configuration ROM objects required by this profile.



The locations of the initial blocks, *Bus_Info_Block* and *Root_Directory*, are fixed. The locations of the other entries are specified in the *Root_Directory* or associated directories.

Note:
Reserved fields shall be set to zero.
Length values in the Configuration ROM specify the number of Quadlets.
Refer to ISO 13213/IEEEE 1212 section 8.2.4 table 21 for all key_type definitions.

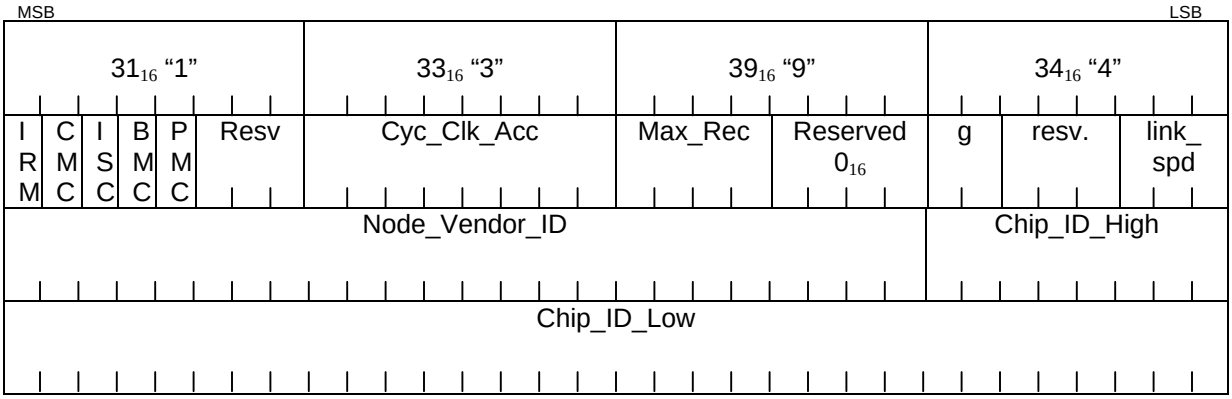
5.1.1 First Quadlet



Compliant devices shall implement the first quadlet located at a base address offset of FFFF F000 0400_{16}.

The CRC_length value is set to the number of quadlets to be used in calculating the ROM_CRC_value. The minimum value used for the CRC_length shall provide coverage for the Bus_Info_Block. The ROM_CRC_value is calculated according to the formula in ISO/IEC 13213:1994 Section 8.1.5.

5.1.2 Bus Information Block

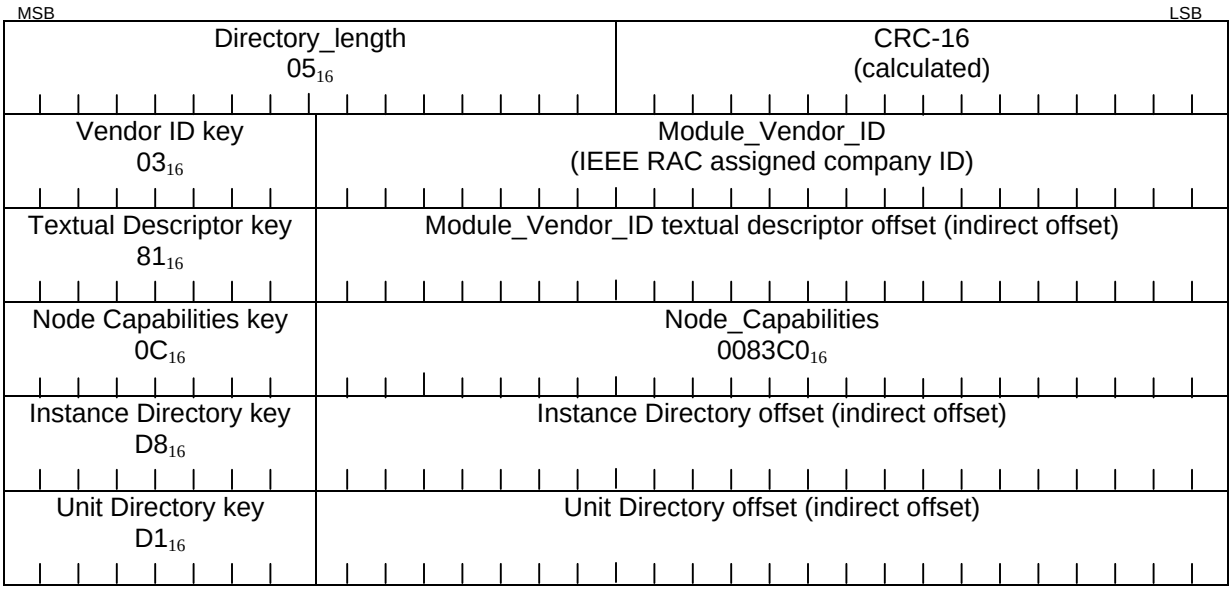


Compliant devices shall implement the bus information block located at a base address offset of FFFF F000 0404_{16} in the format defined by the SBP-2 specification.

The second quadlet of the bus information block at offset 408h contains capability bits. These bits are defined in IEEE-1394-1995. The 'g' field bits affect the CRC value in the first quadlet when the CRC_Length in the first quadlet of configuration ROM covers the Bus_Info_Block. These bits shall be changed when the device updates information in the configuration ROM that alters the device configuration. After the bits are changed, the device must recalculate the CRC stored in the first quadlet of configuration ROM. The changes to the generate bits and the ROM_CRC_Value shall be effected during a bus reset.

The third and fourth quadlets of the bus information block contain the Node_Vendor_ID, Chip_ID_High and Chip_ID_Low values. Chip_ID_High and Chip_ID_Low values should be unique between different units supplied by the same vendor. Together, these values provide the globally unique identifier which is referred to as the EUI-64 (Extended Unique Identifier, 64 bits).

5.1.3 Root Directory



Compliant devices shall implement the root directory as defined in this specification located at a fixed address following the bus information block. This specification extends the SBP-2 root directory by including a Textual Descriptor, which provides a human readable form of the Module_Vendor_ID, and an Instance_Directory entry in addition to the Module_Vendor_ID, Node_Capabilities, and SBP-2 Unit_Directory entries.

The Node_Capabilities entry contains subfields specified by subclause 8.4.11 of ISO/IEC 13213:1994 for more details on this entry.

This profile defines an implementation which should operate with legacy and future bus enumerations strategies by including both Instance_Directory_offset and Unit_Directory_offset entries in the root directory.

5.1.4 Module_Vendor_ID_Textual_Descriptor

Compliant devices shall implement a textual descriptor leaf that is referenced from the Root Directory encoded using the minimal ASCII subset defined in ISO/IEC 13213:1994. The textual descriptor shall contain the name of the company referenced by the Module_Vendor_ID entry in the Root Directory.

5.1.5 Instance Directory

Compliant devices shall implement at least one Instance Directory off of the root directory. The Instance Directory has been defined as part of the IEEE p1212r effort. It contains a Keyword leaf, one or more Feature Directory entries, zero or more Unit Directory entries, and zero or more Instance Directory entries.

Vendors may implement various configurations of Instance directories, Feature directories, and Unit directories based on their design.

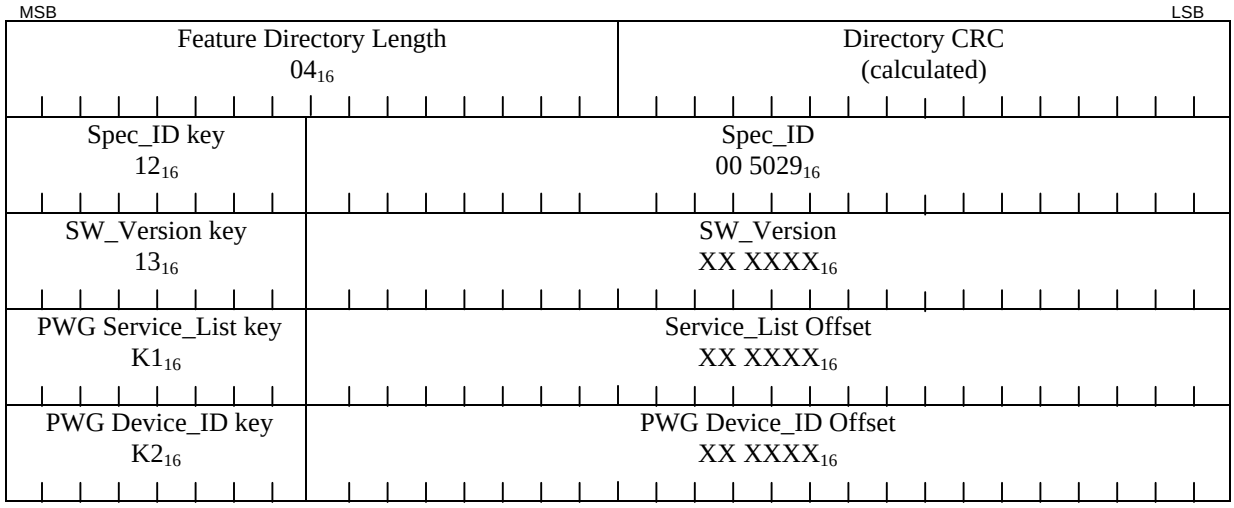
5.1.6 Keyword Leaf

Compliant devices shall implement at least one Keyword Leaf located off of the Instance Directory. The Keyword Leaf has been defined as part of the IEEE p1212r effort. A keyword leaf is a collection of one or more ASCII keywords that pertain to the parent directory which referenced the leaf. Refer to section x.x.x of this document for the preferred spelling of typical keywords.

Individual keywords within a keyword leaf shall be zero-terminated ASCII strings. The character set for keywords is an ASCII subset consisting of the characters 'A' through 'Z' (lowercase is not allowed), '0' through '9' and the hyphen '-'; neither spaces nor any other characters, printing or nonprinting, shall appear in keywords.

If the length, in bytes, of the keywords and separators are not a multiple of four, the last quadlet shall be padded with bytes whose value is 00_{16}.

5.1.7 Feature Directory



Compliant devices shall implement a PWG defined Feature directory. The Feature directory is a new structure defined in the IEEE-p1212r Draft.

Compliant devices shall implement at least one Feature Directory located at an offset that is pointed to from an Instance Directory and the associated Unit Directory. A Feature Directory contains a collection of feature entries. The feature entries are to be interpreted based on the Spec_ID and SW_Version fields in the directory.

The example shown above, for a simple device, provides for a list of features to be defined by the PWG. Implementations may provide for one or more feature directories. For example, devices may implement both a PWG and a vendor specific feature directory.

5.1.8 Service List

Compliant devices shall implement at least one Service List. The Service List is implemented as a Keyword Leaf located off of the PWG Feature Directory. The keyword leaf has been defined as part of the IEEE p1212r effort. The 1394 PWG profile reuses the format of the keyword leaf to provide a mechanism which can be used to enumerate the supported services. Keywords used within the Service Keyword Leaf must follow the guidelines established by IANA for service names.

Individual keywords within a keyword leaf shall be zero-terminated ASCII strings. The character set for keywords is an ASCII subset consisting of the characters 'A' through 'Z' (lowercase is not allowed), '0' through '9' and the hyphen '-'; neither spaces nor any other characters, printing or nonprinting, shall appear in keywords.

If the length, in bytes, of the keywords and separators are not a multiple of four, the last quadlet shall be padded with bytes whose value is 00_{16}.

5.1.9 Device_ID Leaf

Compliant devices shall implement at least one Device_ID Leaf. The Device_ID Leaf contains a string encoded using the minimal ASCII subset defined in ISO/IEC 13213:1994. The string uses the format defined in IEEE-1284-1994 Section 6.6

If the length, in bytes, of the string in the Device_ID Leaf is not a multiple of four, the last quadlet shall be padded with bytes whose value is 00_{16}.

5.1.10 Unit Directory

Compliant devices shall implement at least one unit directory as defined in this specification. Unit directories should be referenced from the root directory and the instance directory which describes the functional unit supported by the unit directory. This specification constrains the SBP-2 Unit directory definition by limiting the logical unit implementation. This specification extends the SBP-2 Unit directory by including a reference to one or more Feature Directory entries. The required entries are listed in the following table.

KEY	DOCUMENTED BY	REQUIRED BY	DEFINED BY
Unit_Spec_ID	IEEE-1212	IEEE-1212	SBP-2
Unit_SW_Version	IEEE-1212	IEEE-1212	SBP-2
Management_Agent	ANSI SBP-2	SBP-2	SBP-2
Command_Set_Spec_ID	ANSI SBP-2	SBP-2	1394 PWG Profile
Command_Set	ANSI SBP-2	SBP-2	1394 PWG Profile
Command_Set_Revision	ANSI SBP-2	SBP-2	1394 PWG Profile
Unit_Characteristics	ANSI SBP-2	SBP-2	1394 PWG Profile
Logical_Unit_Number	ANSI SBP-2	SBP-2	1394 PWG Profile
Reconnect_Timeout	ANSI SBP-2	1394 PWG Profile	1394 PWG Profile
Feature_Directory	IEEE p1212r	IEEE p1212r	1394 PWG Profile
Unit_Unique_ID	ANSI SBP-2	(Optional)	(Optional)

The second column lists the specification that documents the key and usage. The third column lists the specification that requires the keys implementation. The fourth column lists the specification that defines the key value and usage.

Compliant devices shall implement one logical unit, logical unit zero, defined in the unit directory. Logical Unit Directory structures are beyond the scope of this specification.

The Unit_Characteristics entry is $00A008_{16}$ which defines the following characteristics.

- The queuing model is defined by this profile and associated command set.
- The unordered execution model is supported.
- Asynchronous mode is used.
- Management ORB timeouts (refer to SBP-2 specification)
- The ORB size field is set to eight bytes.

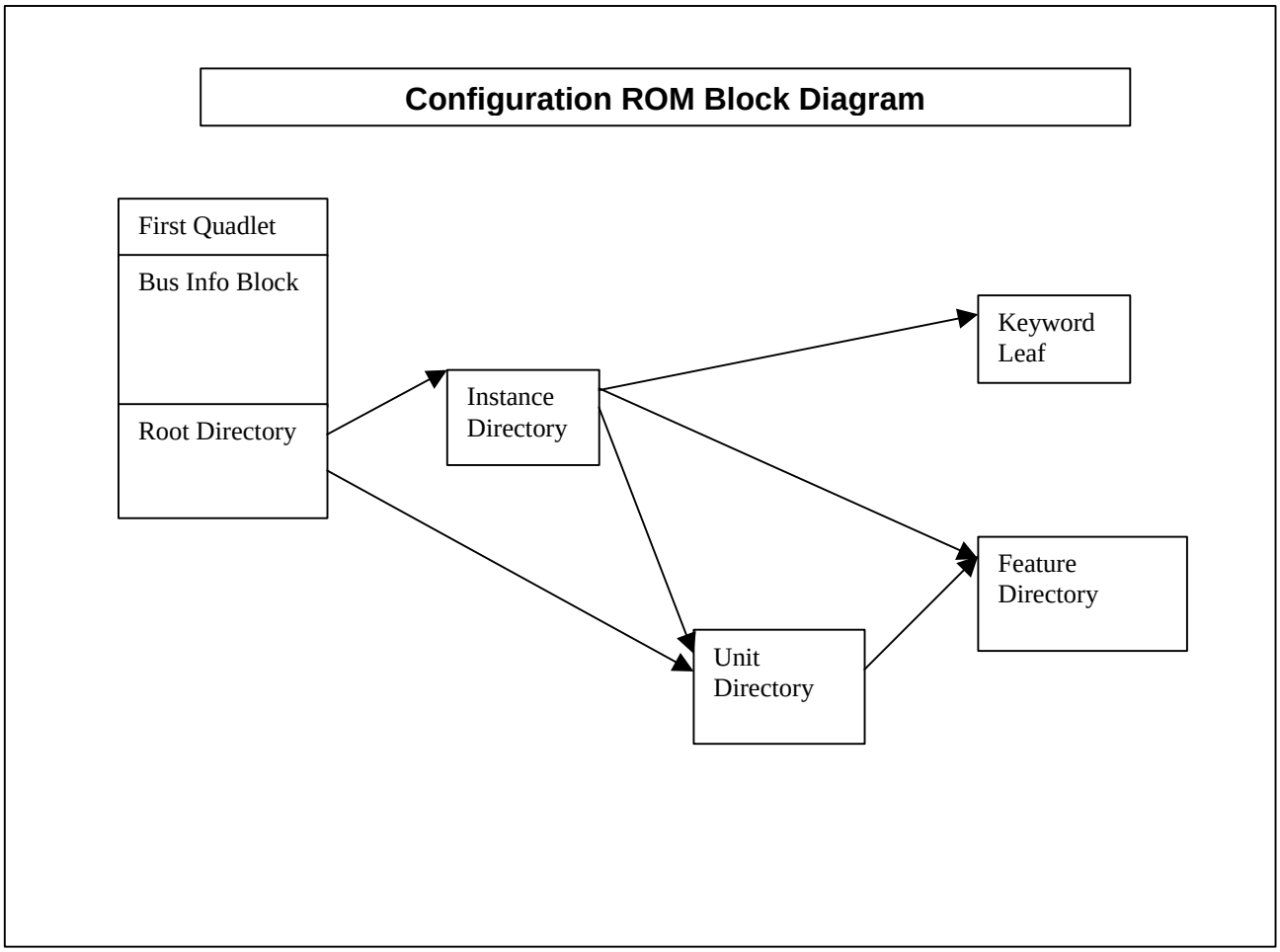
The Logical_Unit_Number entry is divided into three fields: a group of reserved bits, a five bit device_type field, and a 16 bit Logical_Unit_Number field. Valid device_type values range from 00_{16} to $1F_{16}$. Defined values are:

02_{16} - Printer
03_{16} - Processor
06_{16} - Scanner
09_{16} - Comm Device
$1F_{16}$ - Unknown – Needs Command_Set specific detection

5.2 Printer Device Example (Informative)

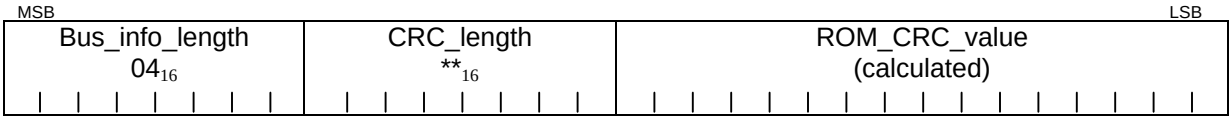
The sections contain information on a minimal implementation of Configuration ROM for a simple imaging device.

5.2.1 Block Diagram



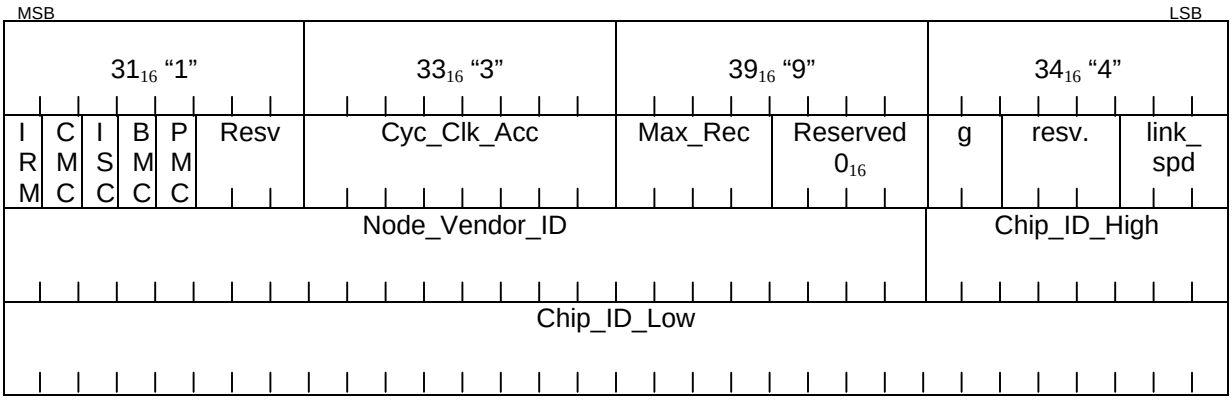
5.2.2 First Quadlet

Offset: 0400_{16}



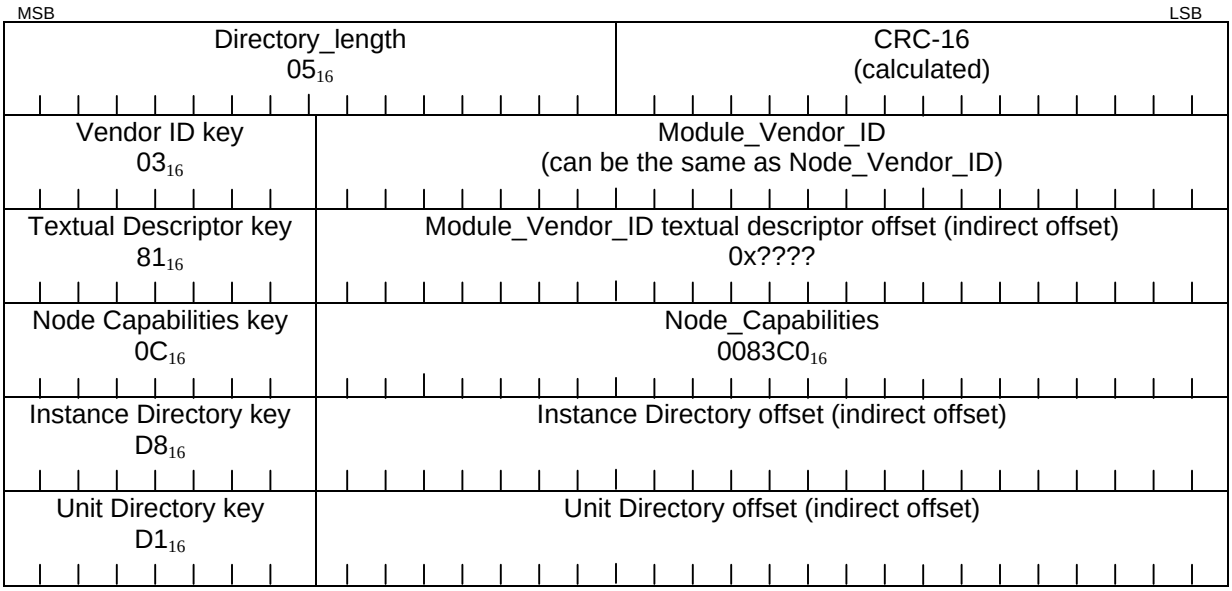
5.2.3 Bus_Info_Block

Offset: 0404_{16}



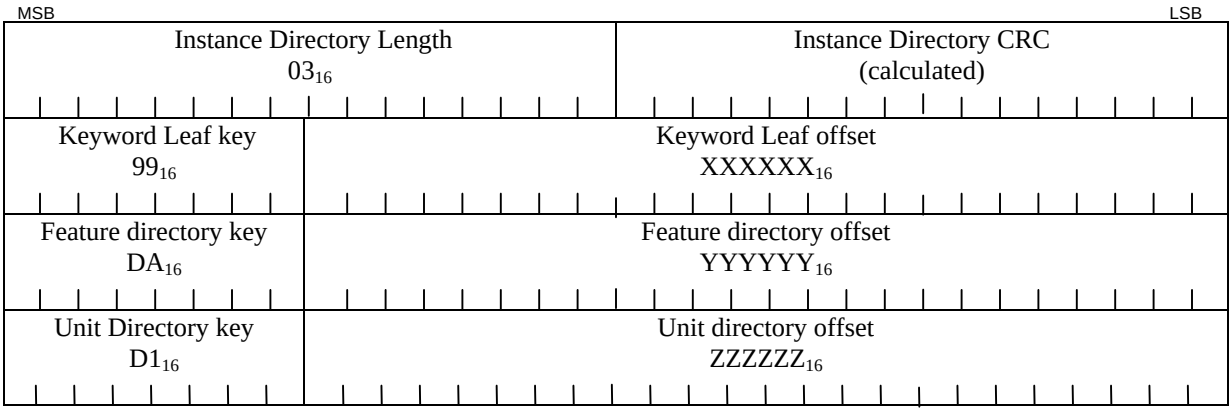
5.2.4 Root Directory

Offset: 0414_{16}



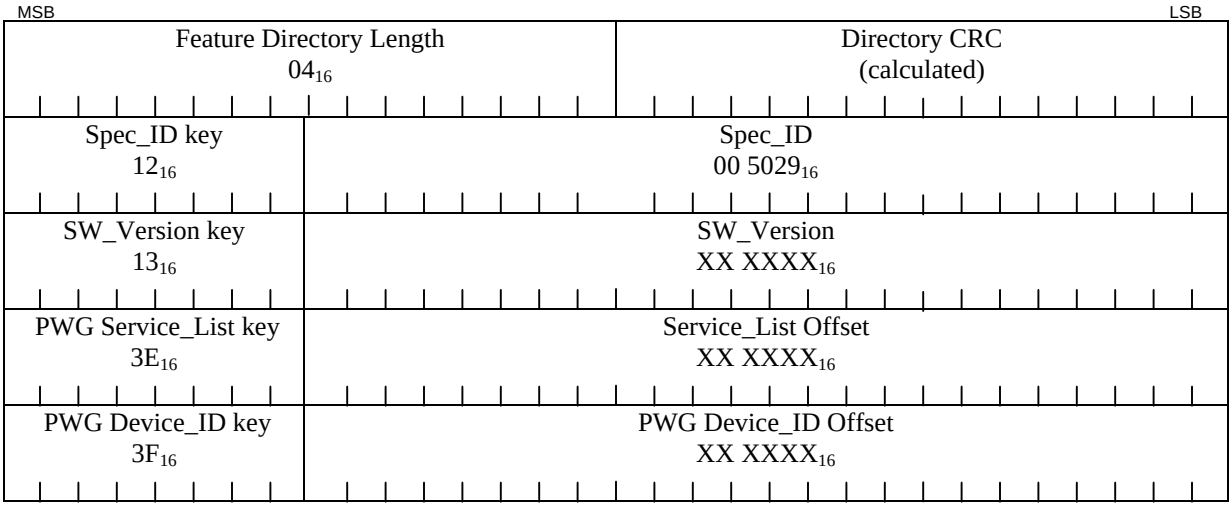
5.2.5 Instance Directory

Offset: $042C_{16}$



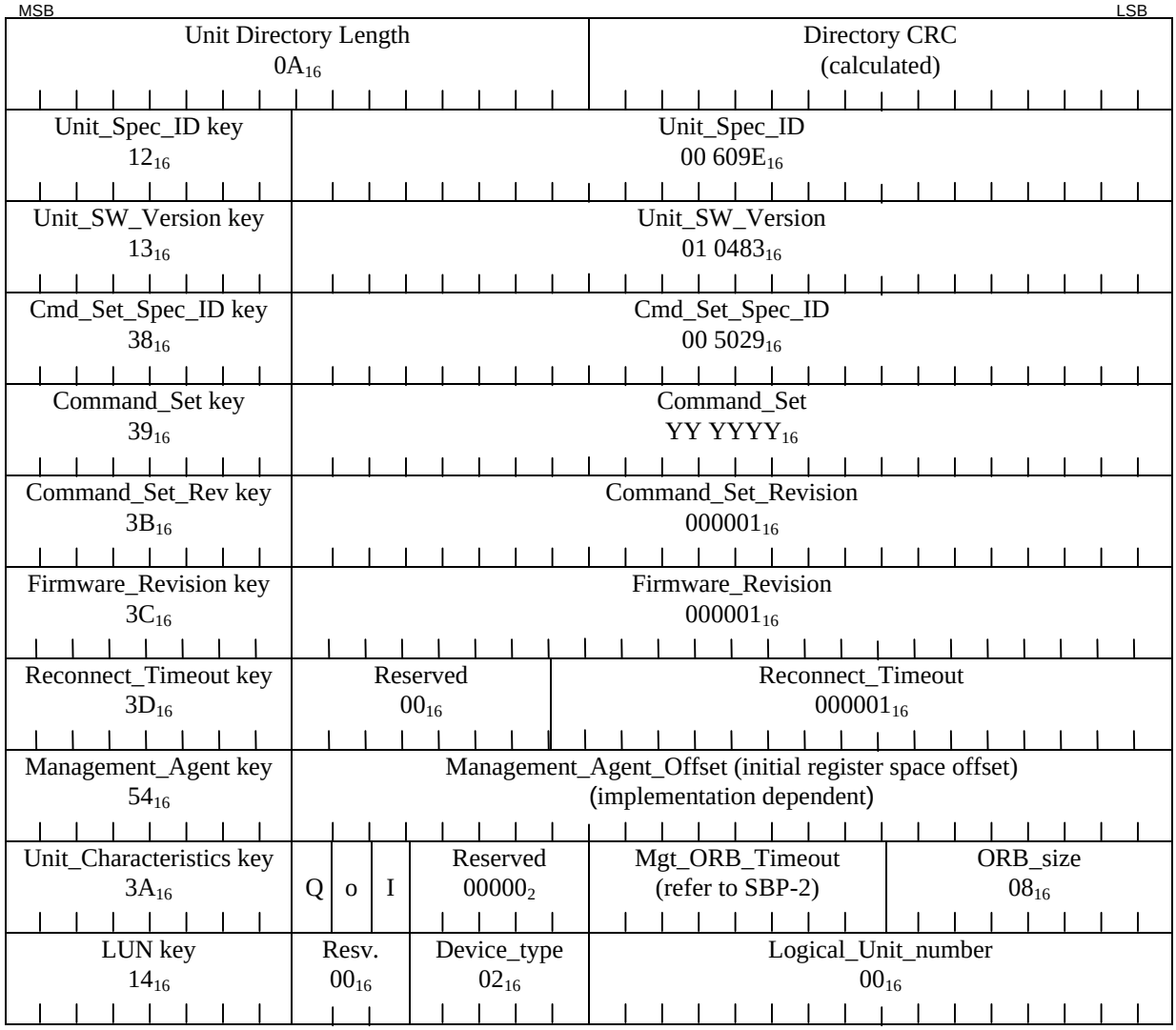
5.2.6 Feature Directory

Offset: $043C_{16}$



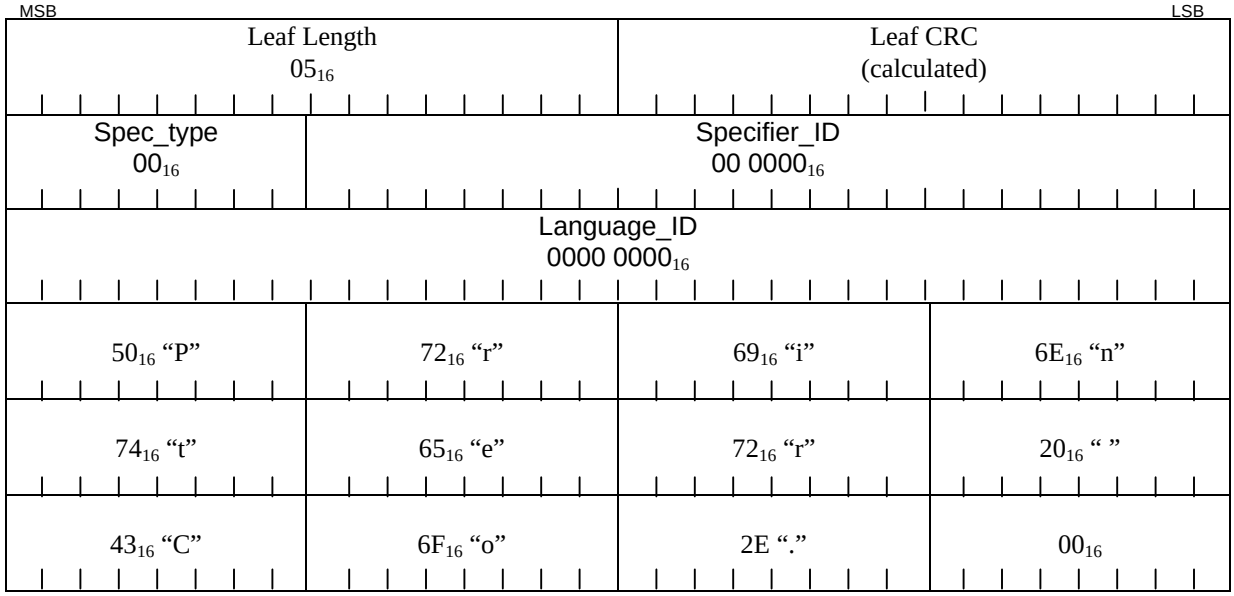
5.2.7 Unit Directory

Offset: 0450_{16}



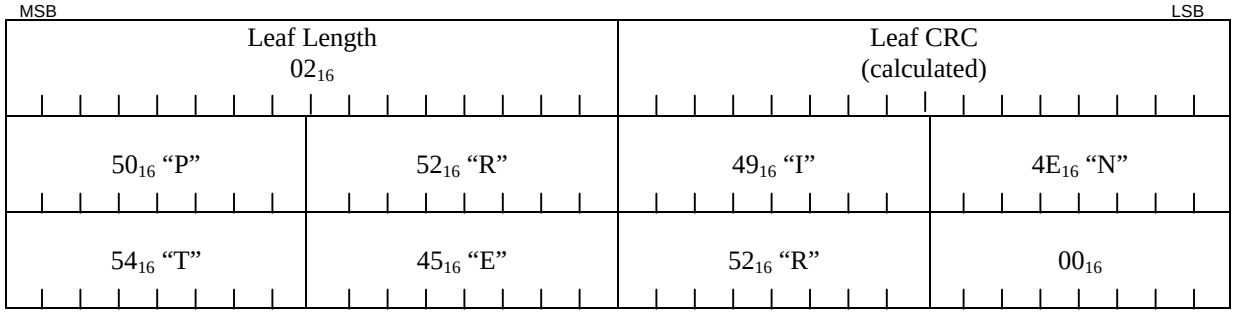
5.2.8 Vendor Textual Descriptor

Offset: $047C_{16}$



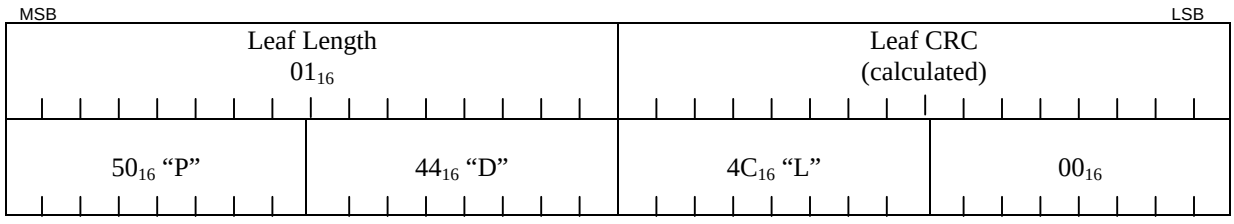
5.2.9 Keyword Leaf

Offset: 0494_{16}



5.2.10 Service List

Offset: $04A0_{16}$



5.2.11 Device_ID Key

Offset: $04A8_{16}$

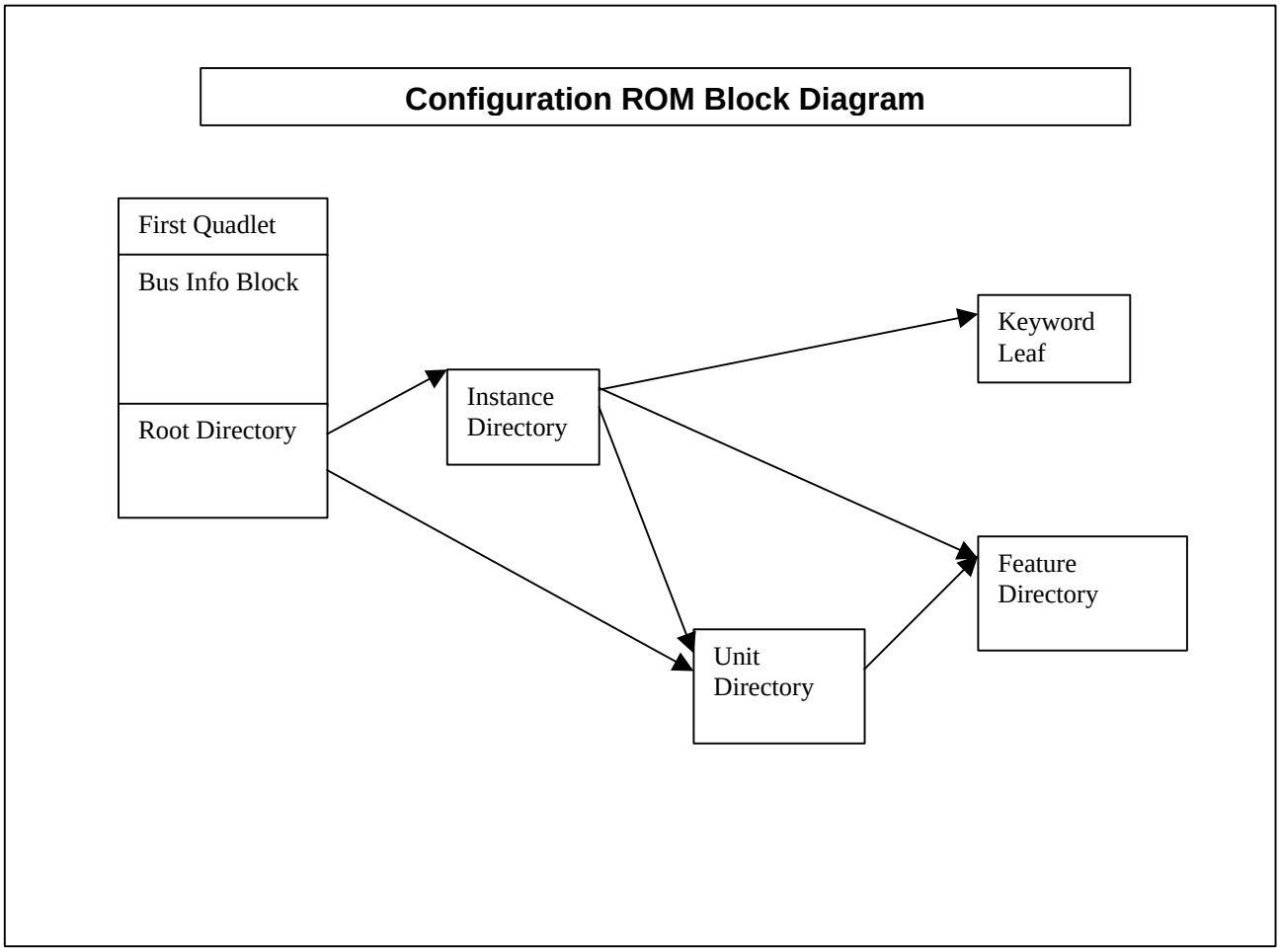
MSB LSB

Leaf Length 01_{16}		Leaf CRC (calculated)	
$4D_{16}$ “M”	46_{16} “F”	47_{16} “G”	$3A_{16}$ “:”
50_{16} “P”	72_{16} “r”	69_{16} “i”	$6E_{16}$ “n”
74_{16} “t”	65_{16} “e”	72_{16} “r”	20_{16} “ ”
43_{16} “C”	$6F_{16}$ “o”	$2E_{16}$ “.”	$0D_{16}$ (CR)
$0A_{16}$ (LF)	$4D_{16}$ “M”	44_{16} “D”	$4C_{16}$ “L”
$3A_{16}$ “:”	$4E_{16}$ “N”	61_{16} “a”	$6D_{16}$ “m”
65_{16} “e”	$0D_{16}$ (CR)	$0A_{16}$ (LF)	00_{16}

5.3 Scanner Device Example (Informative)

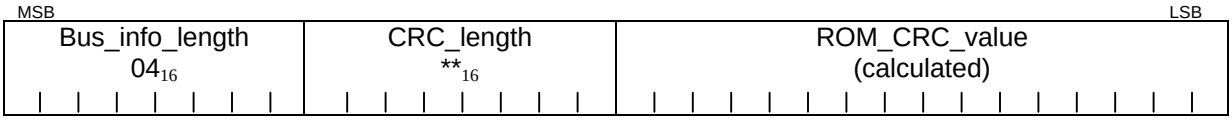
The sections contain information on a minimal implementation of Configuration ROM for a simple imaging device.

5.3.1 Block Diagram



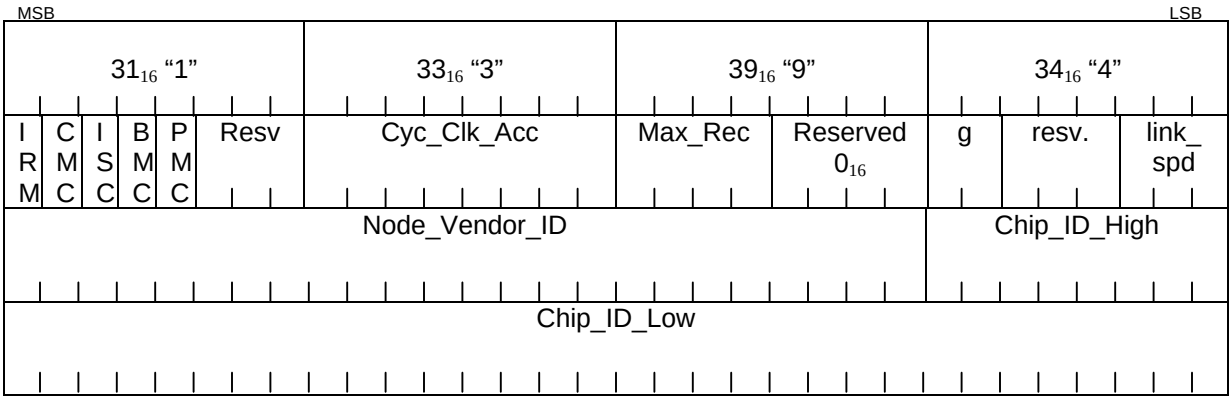
5.3.2 First Quadlet

Offset: 0400_{16}



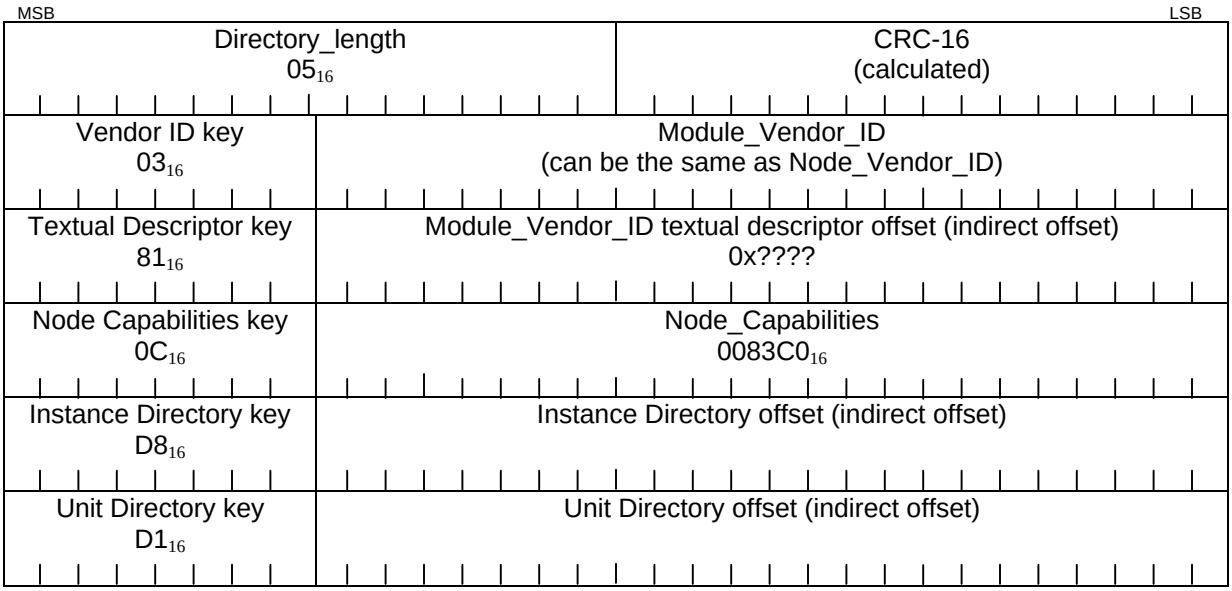
5.3.3 Bus_Info_Block

Offset: 0404_{16}



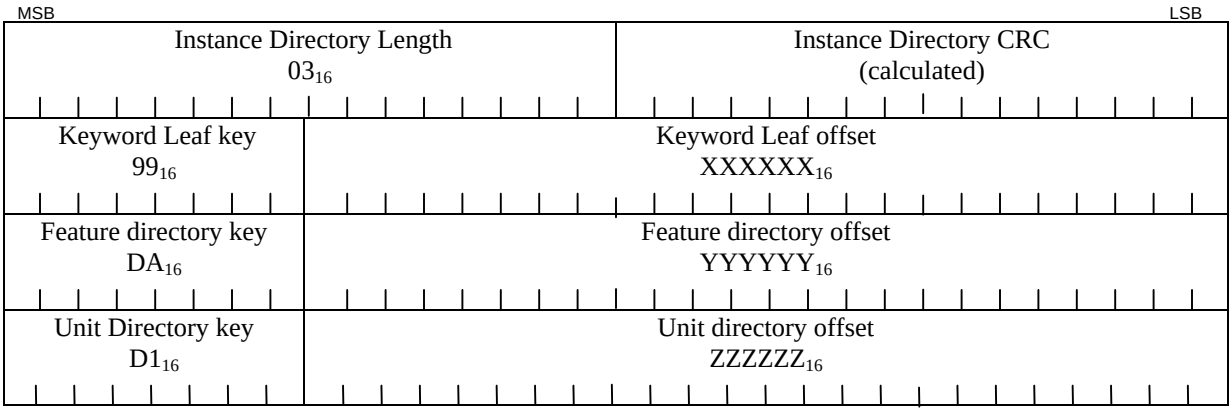
5.3.4 Root Directory

Offset: 0414_{16}



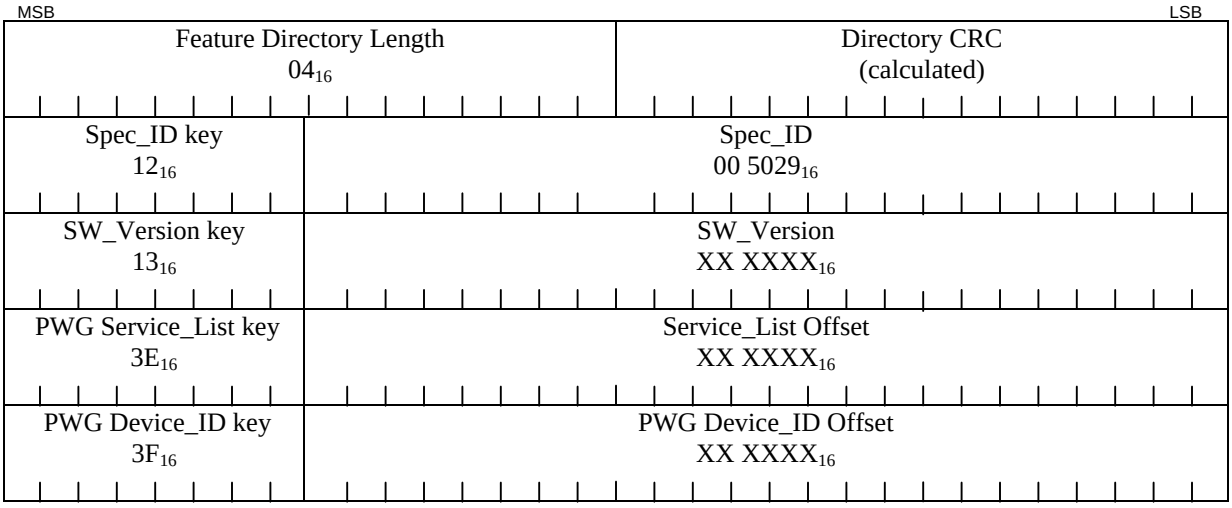
5.3.5 Instance Directory

Offset: $042C_{16}$



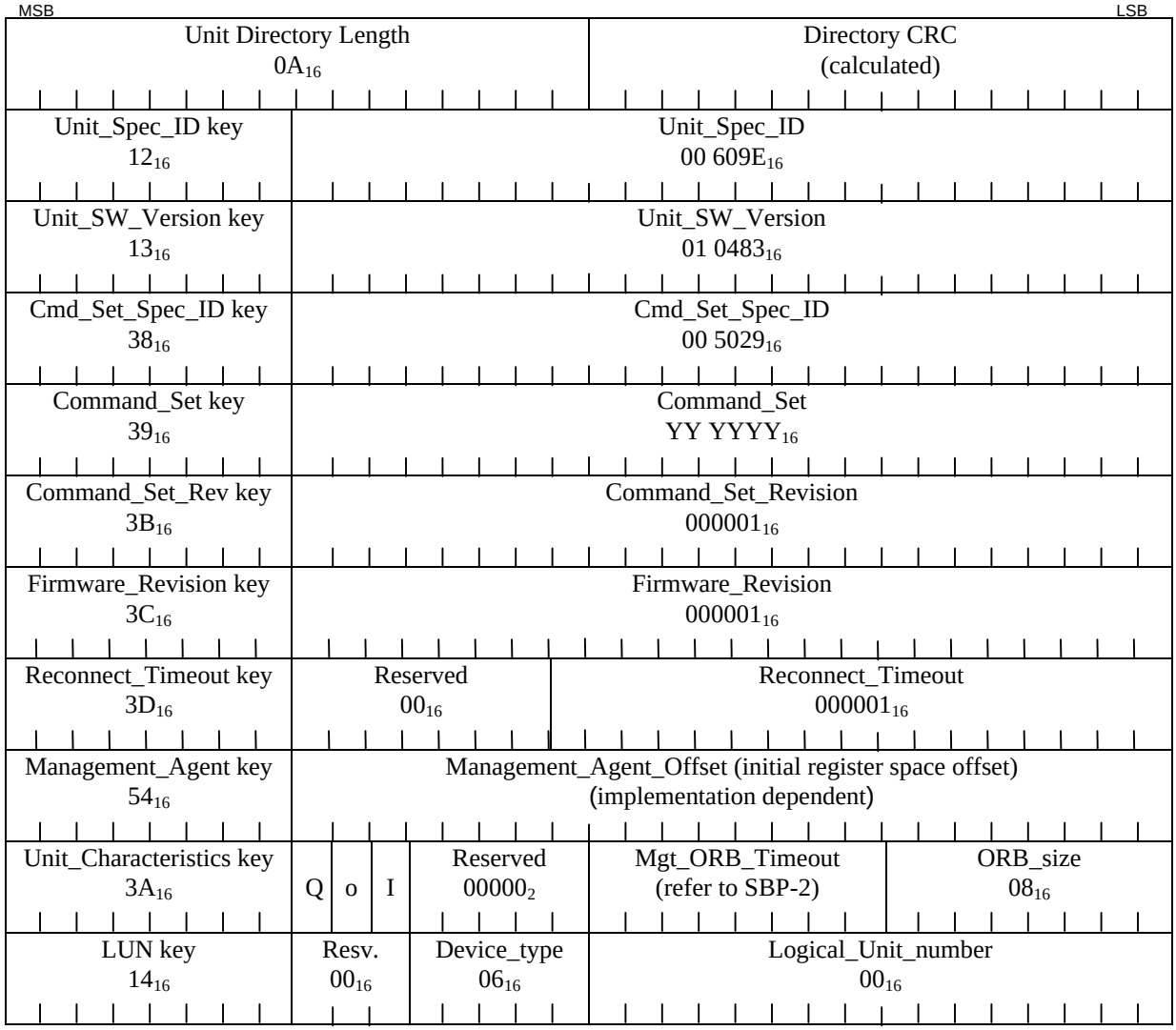
5.3.6 Feature Directory

Offset: $043C_{16}$



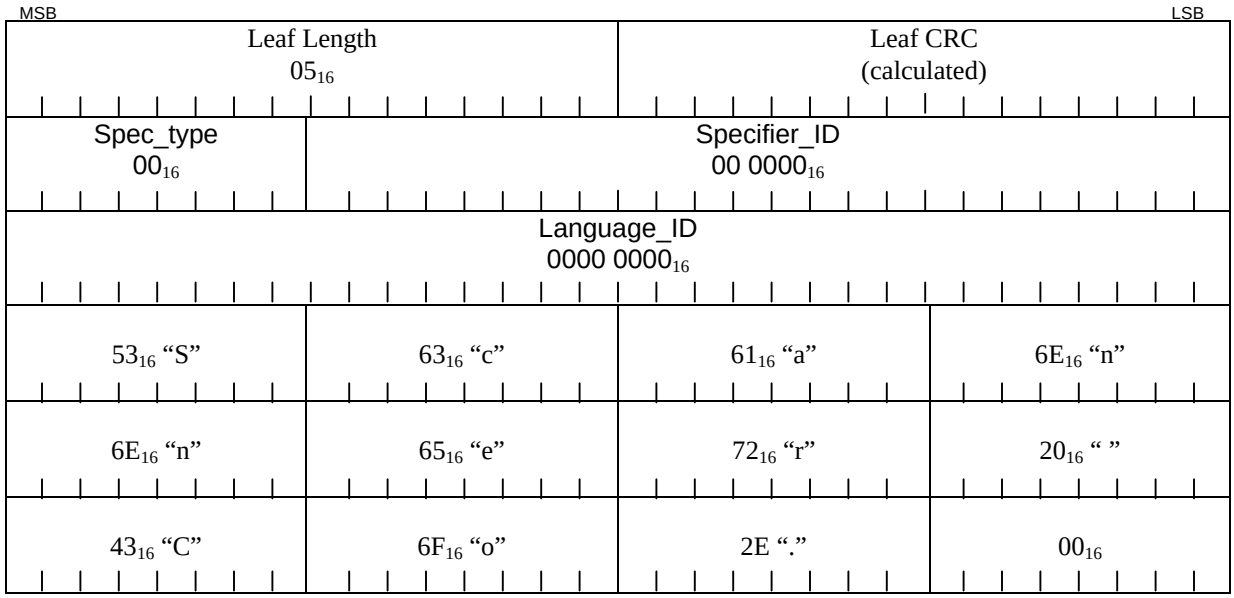
5.3.7 Unit Directory

Offset: 0450_{16}



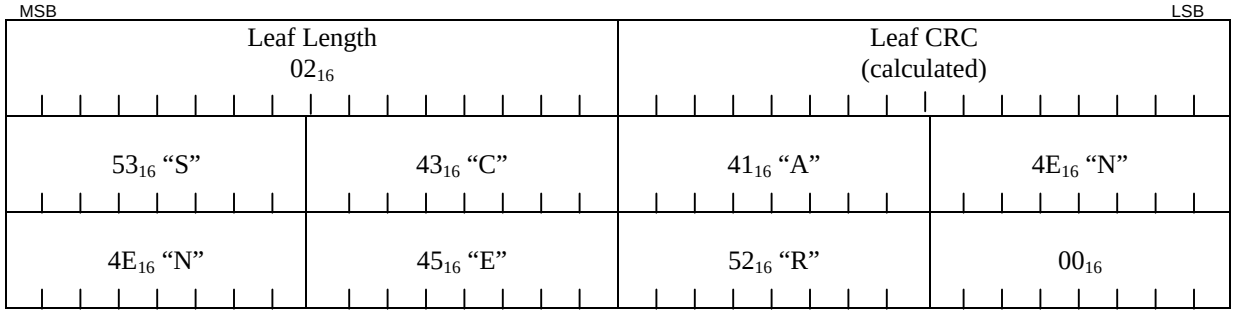
5.3.8 Vendor Textual Descriptor

Offset: $047C_{16}$



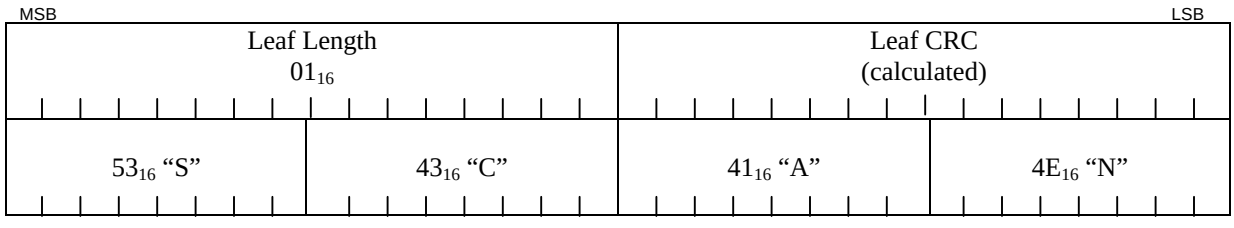
5.3.9 Keyword Leaf

Offset: 0494_{16}



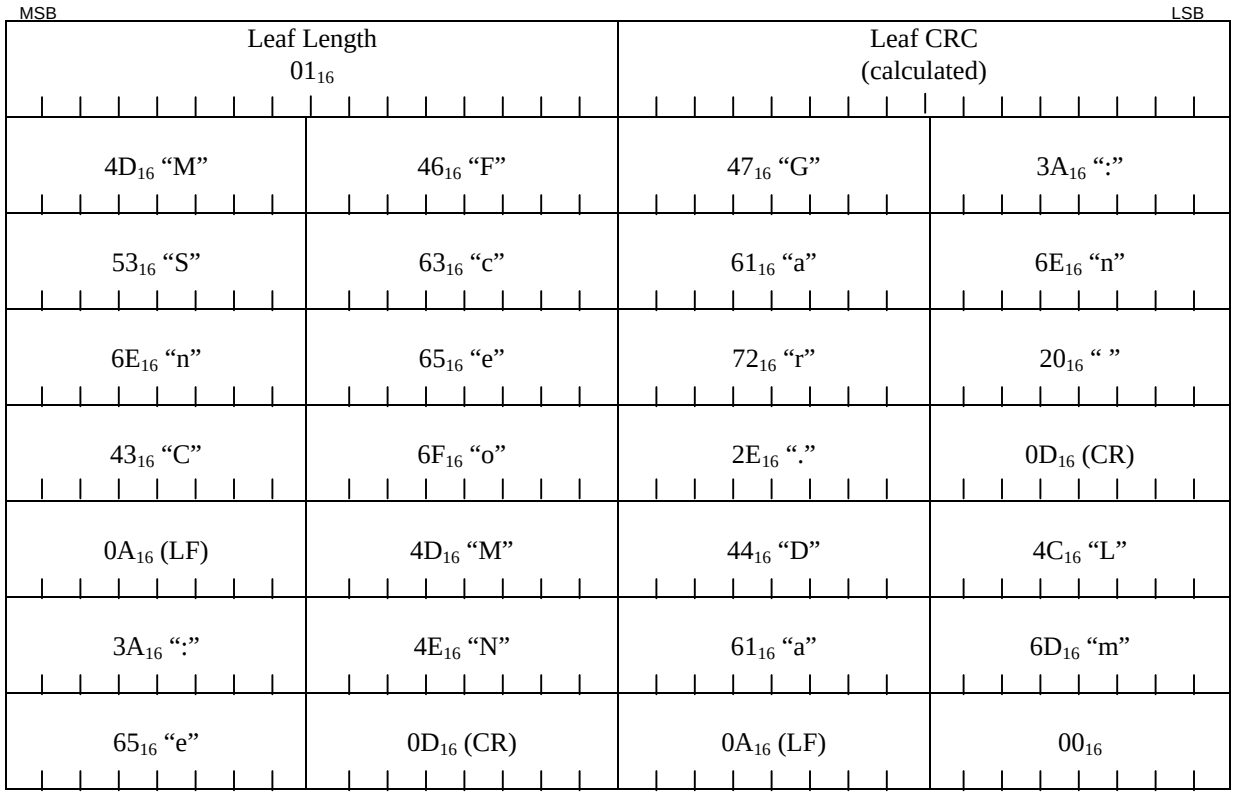
5.3.10 Service List

Offset: $04A0_{16}$



5.3.11 Device_ID Key

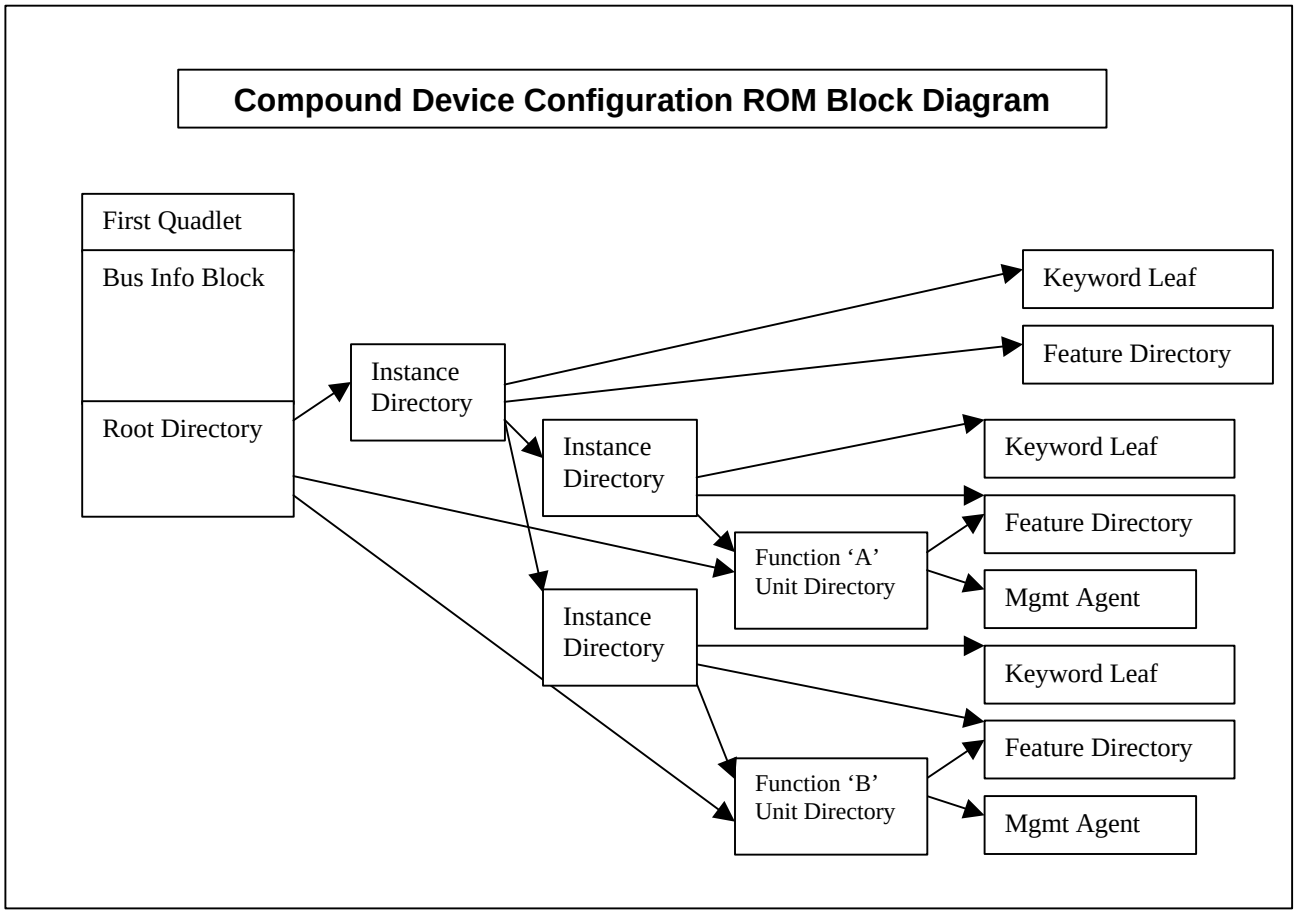
Offset: $04A8_{16}$



5.4 Compound Imaging Device (Informative)

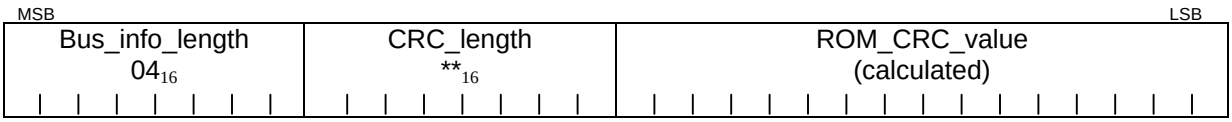
The sections contain information on a minimal implementation of Configuration ROM for a compound imaging device with two distinct functions. In this example, one function is a printer and the other is a scanner.

5.4.1 Block Diagram



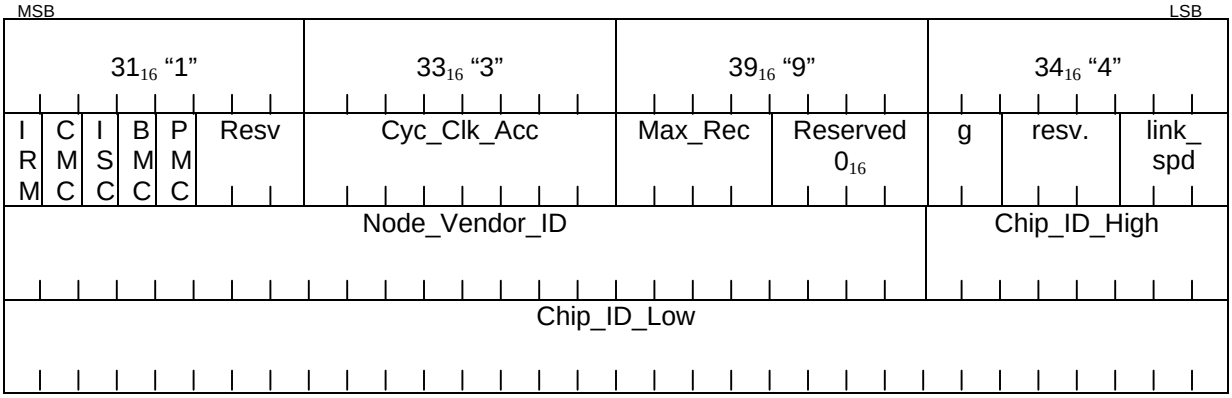
5.4.2 First Quadlet

Offset: 0400_{16}



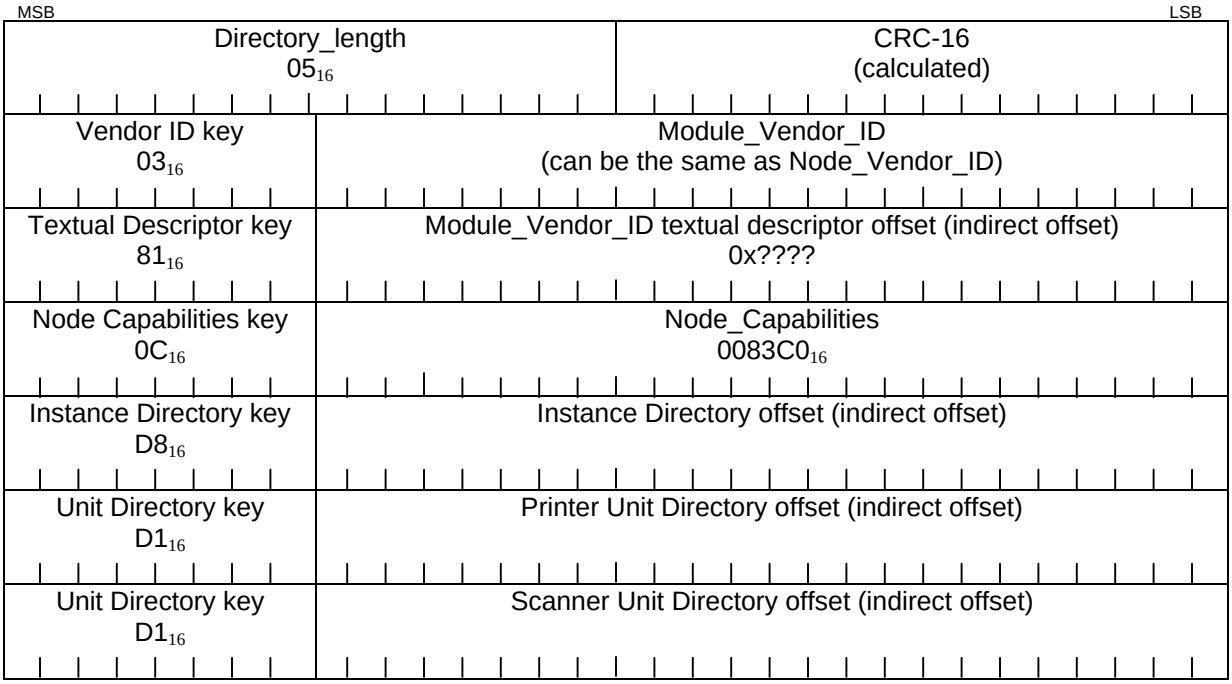
5.4.3 Bus_Info_Block

Offset: 0404_{16}



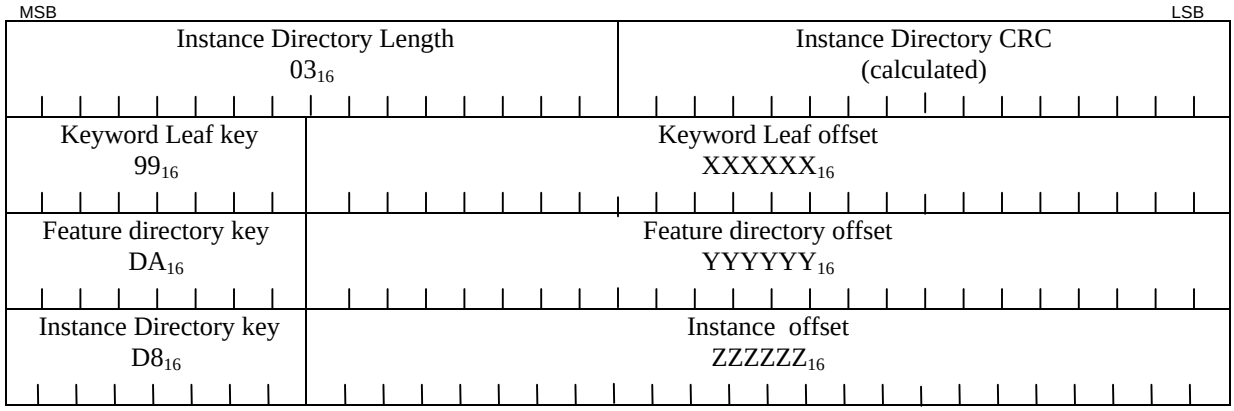
5.4.4 Root Directory

Offset: 0414_{16}



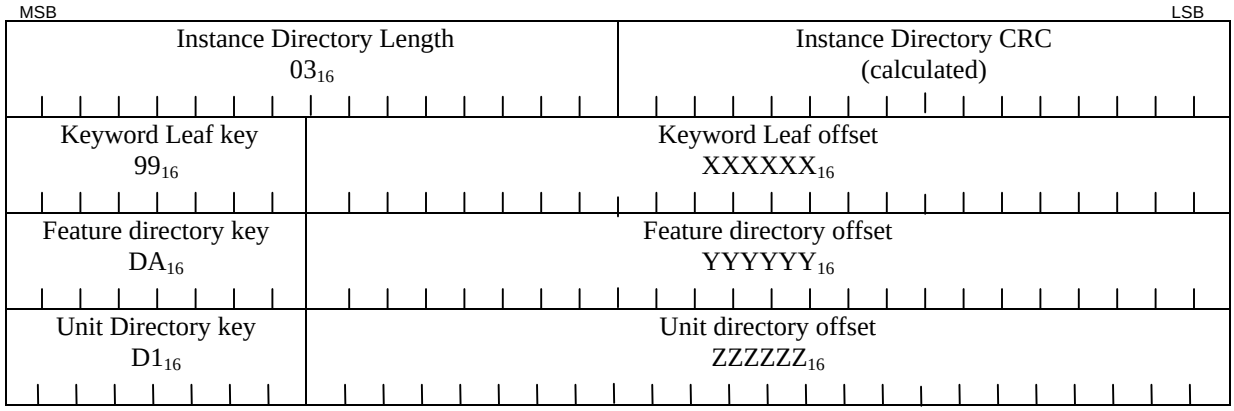
5.4.5 Instance Directory (Root)

Offset: 0430_{16}



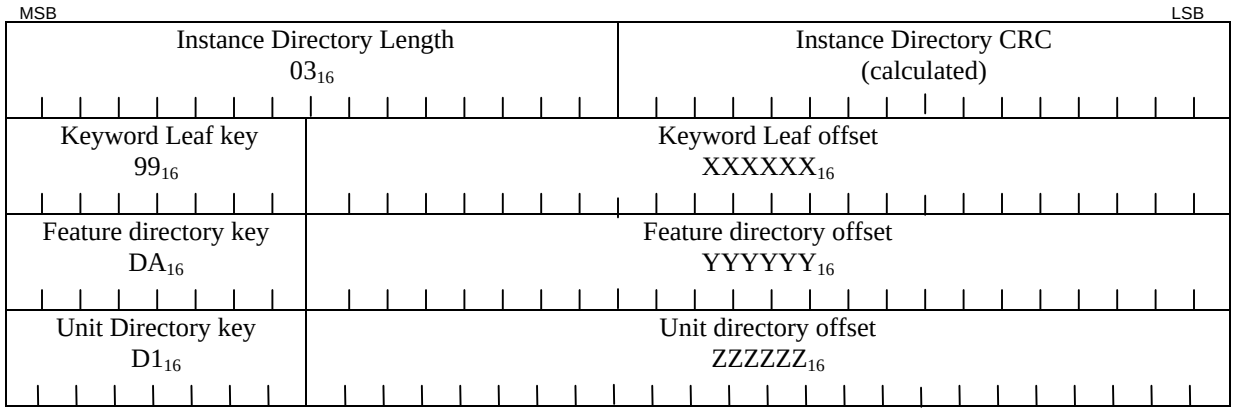
5.4.6 Instance Directory (Printer)

Offset: 0440_{16}



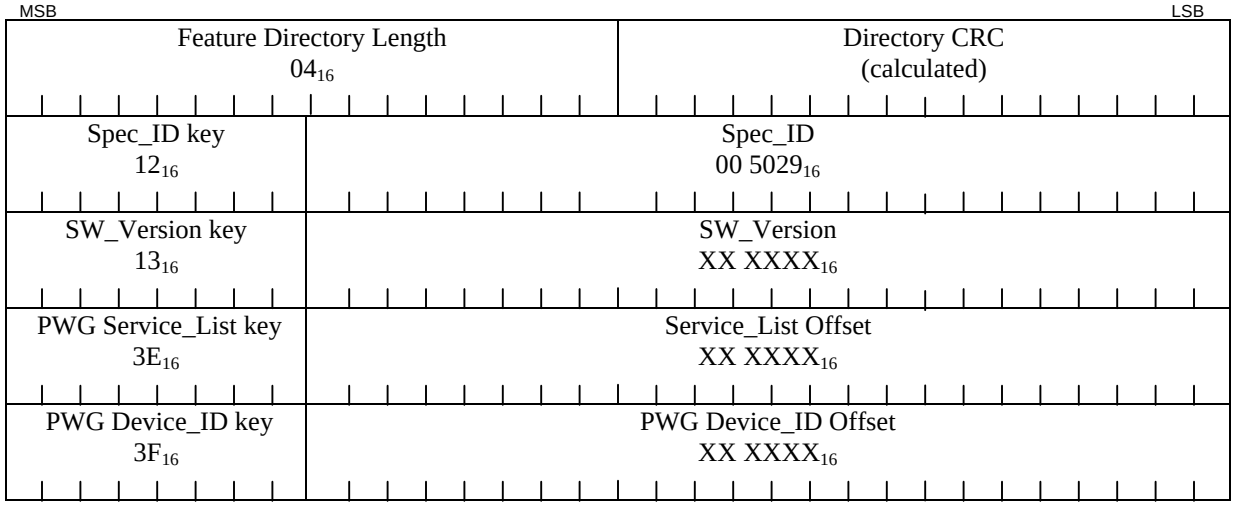
5.4.7 Instance Directory (Scanner)

Offset: 0450_{16}



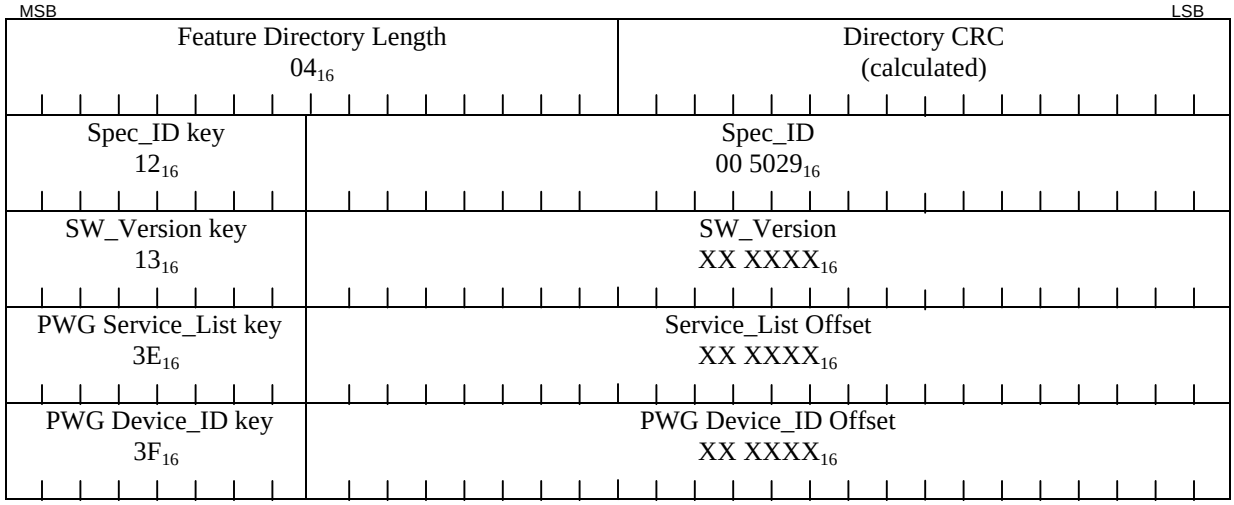
5.4.8 Feature Directory (Root)

Offset: 0460_{16}



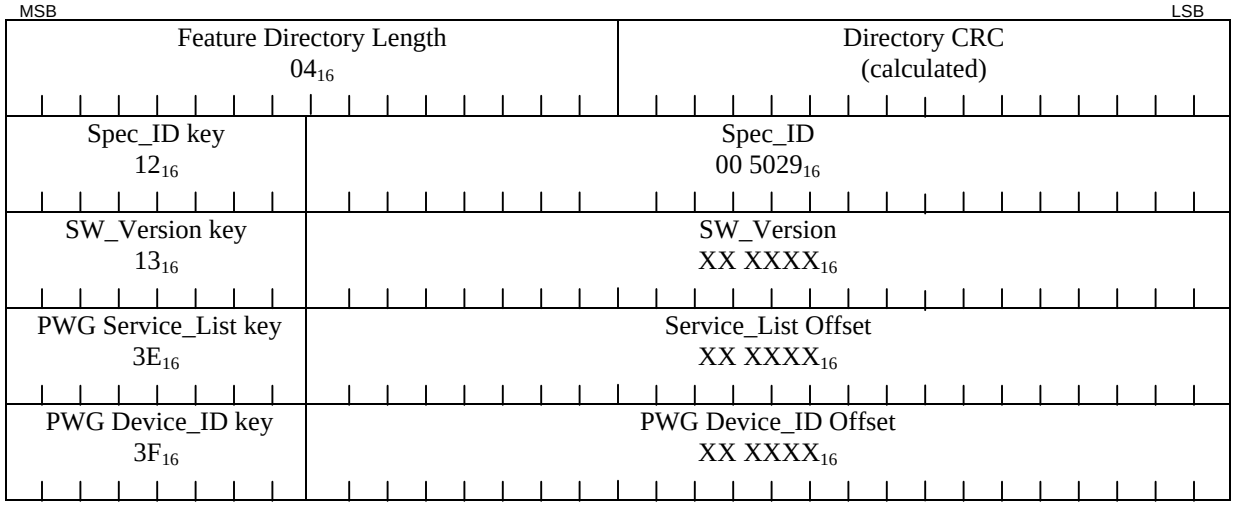
5.4.9 Feature Directory (Printer)

Offset: 0474_{16}



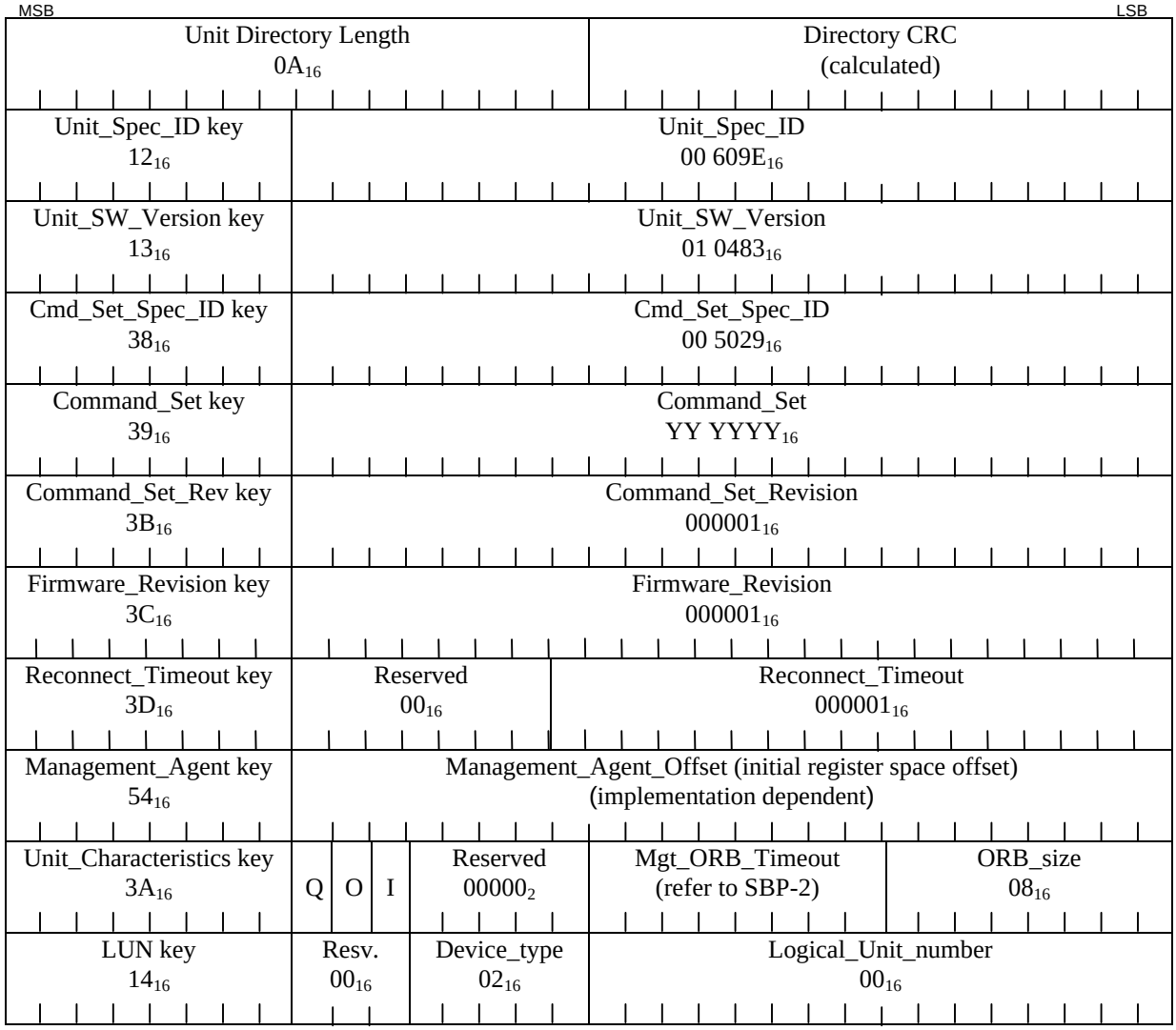
5.4.10 Feature Directory (Scanner)

Offset: 0488_{16}



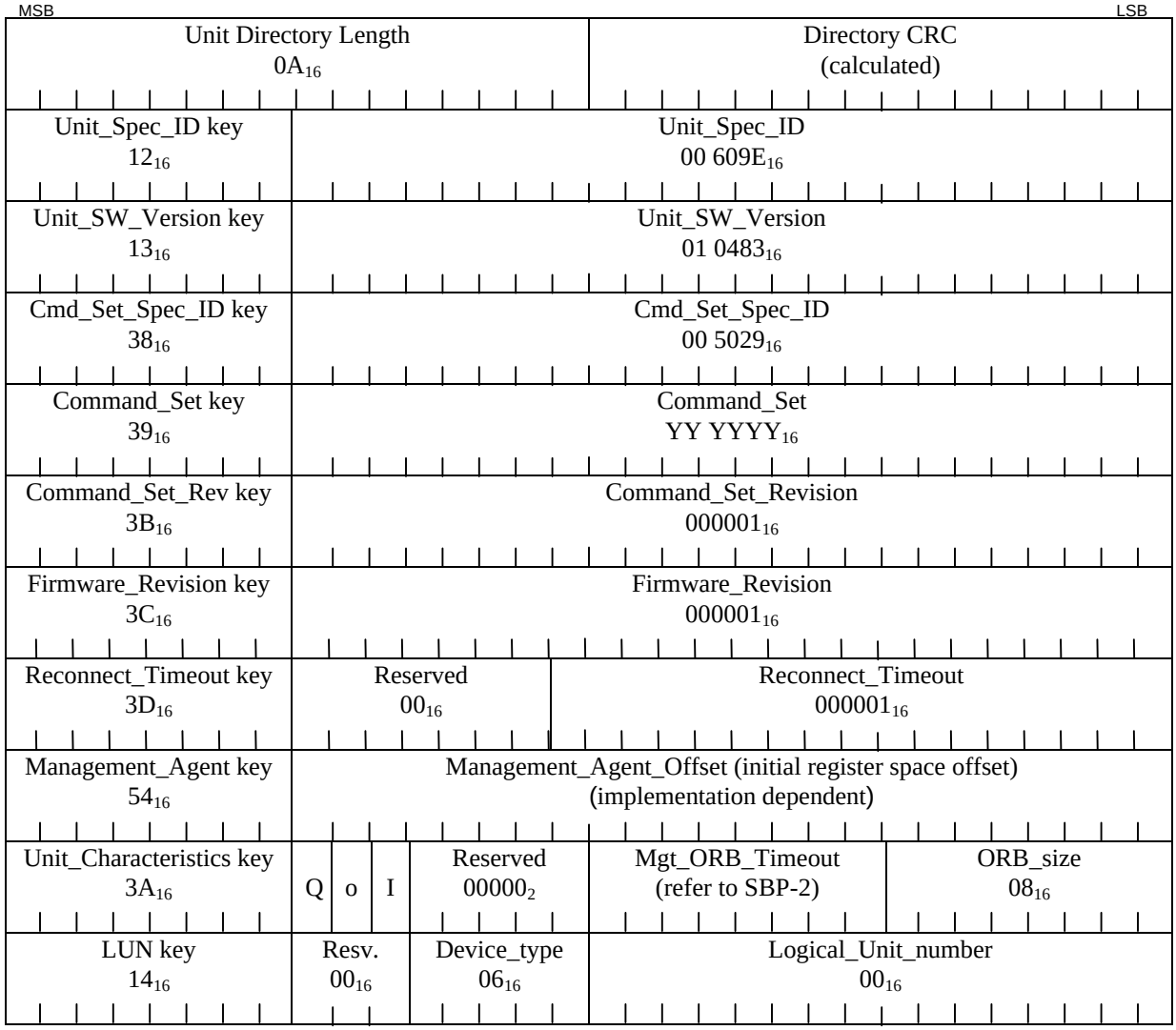
5.4.11 Unit Directory (Printer)

Offset: $049C_{16}$



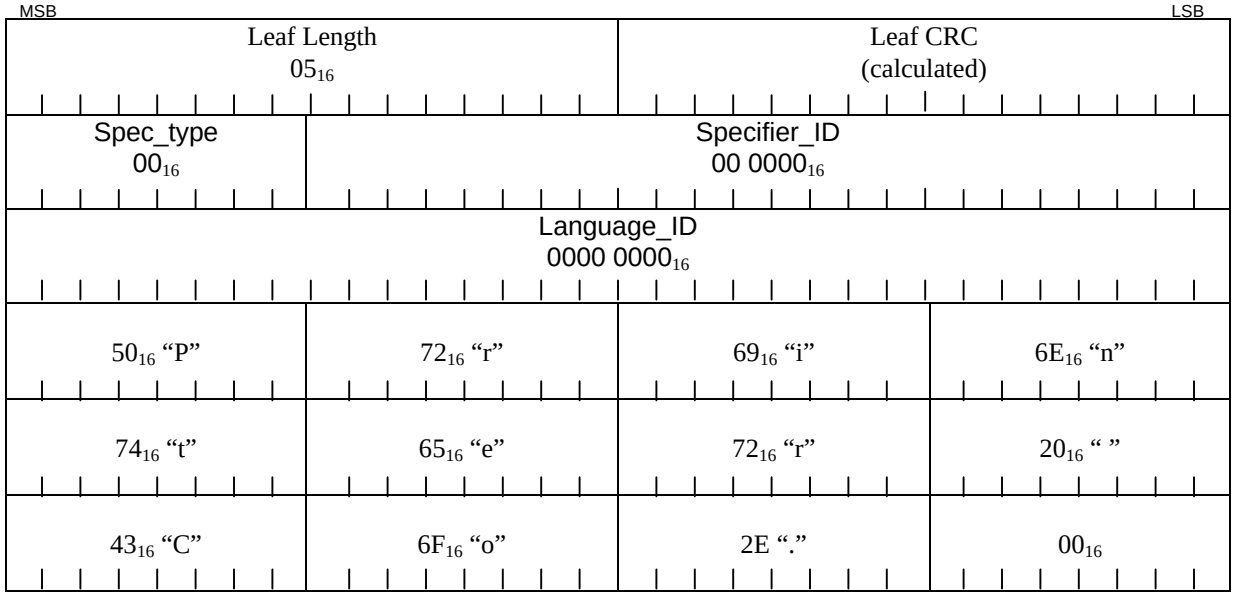
5.4.12 Unit Directory (Scanner)

Offset: $04C8_{16}$



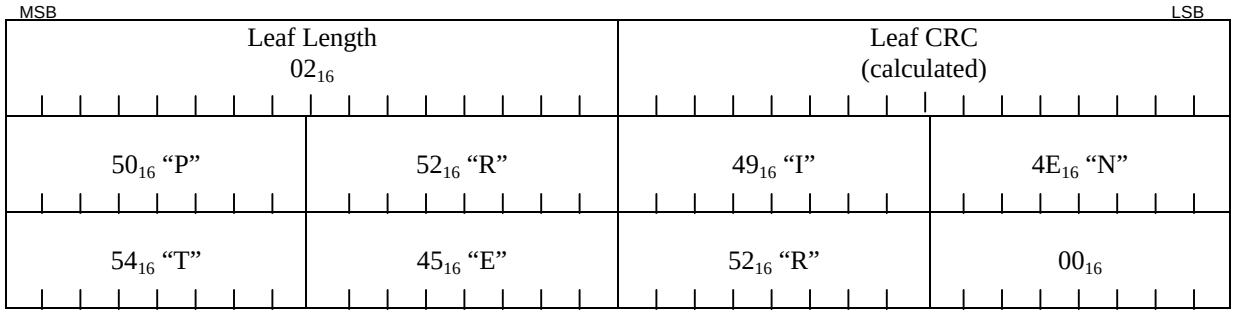
5.4.13 Vendor Textual Descriptor

Offset: $04F4_{16}$



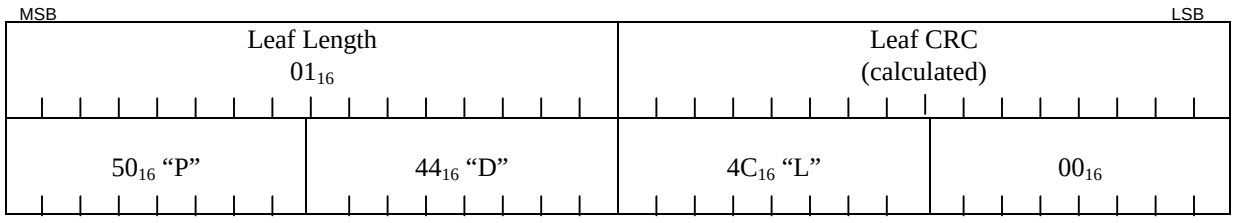
5.4.14 Keyword Leaf (Printer)

Offset: $050C_{16}$



5.4.15 Service List (Printer)

Offset: 0518_{16}



5.4.16 Device_ID Key (Printer)

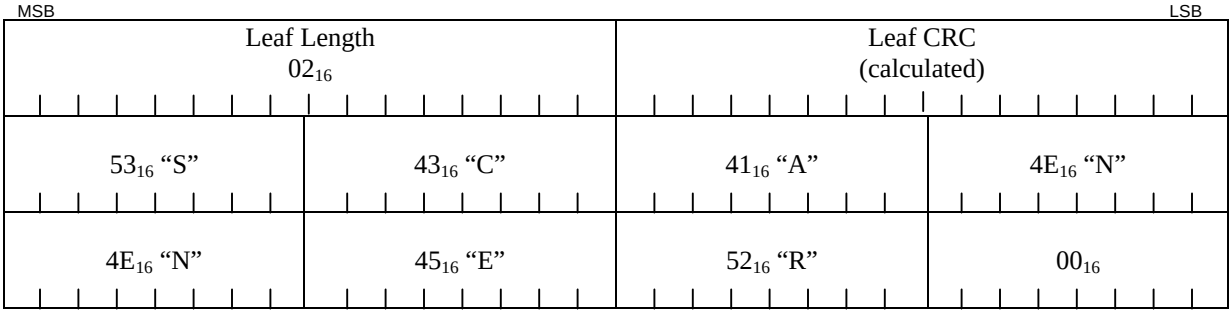
Offset: 0520_{16}

MSB LSB

Leaf Length 01_{16}		Leaf CRC (calculated)	
$4D_{16}$ “M”	46_{16} “F”	47_{16} “G”	$3A_{16}$ “:”
50_{16} “P”	72_{16} “r”	69_{16} “i”	$6E_{16}$ “n”
74_{16} “t”	65_{16} “e”	72_{16} “r”	20_{16} “ ”
43_{16} “C”	$6F_{16}$ “o”	$2E_{16}$ “.”	$0D_{16}$ (CR)
$0A_{16}$ (LF)	$4D_{16}$ “M”	44_{16} “D”	$4C_{16}$ “L”
$3A_{16}$ “:”	$4E_{16}$ “N”	61_{16} “a”	$6D_{16}$ “m”
65_{16} “e”	$0D_{16}$ (CR)	$0A_{16}$ (LF)	00_{16}

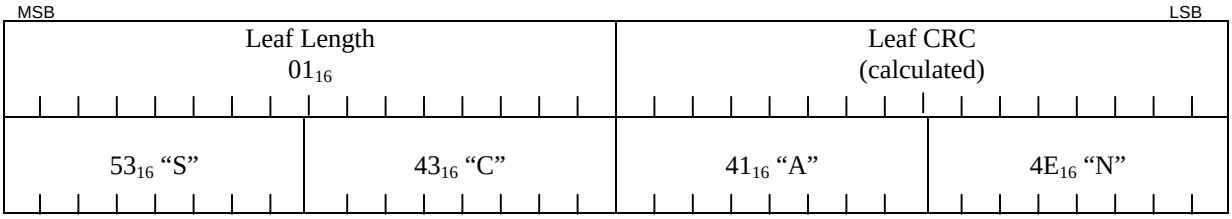
5.4.17 Keyword Leaf (Scanner)

Offset: 0540_{16}



5.4.18 Service List (Scanner)

Offset: $054C_{16}$



5.4.19 Device_ID Key (Scanner)

Offset: 0554_{16}

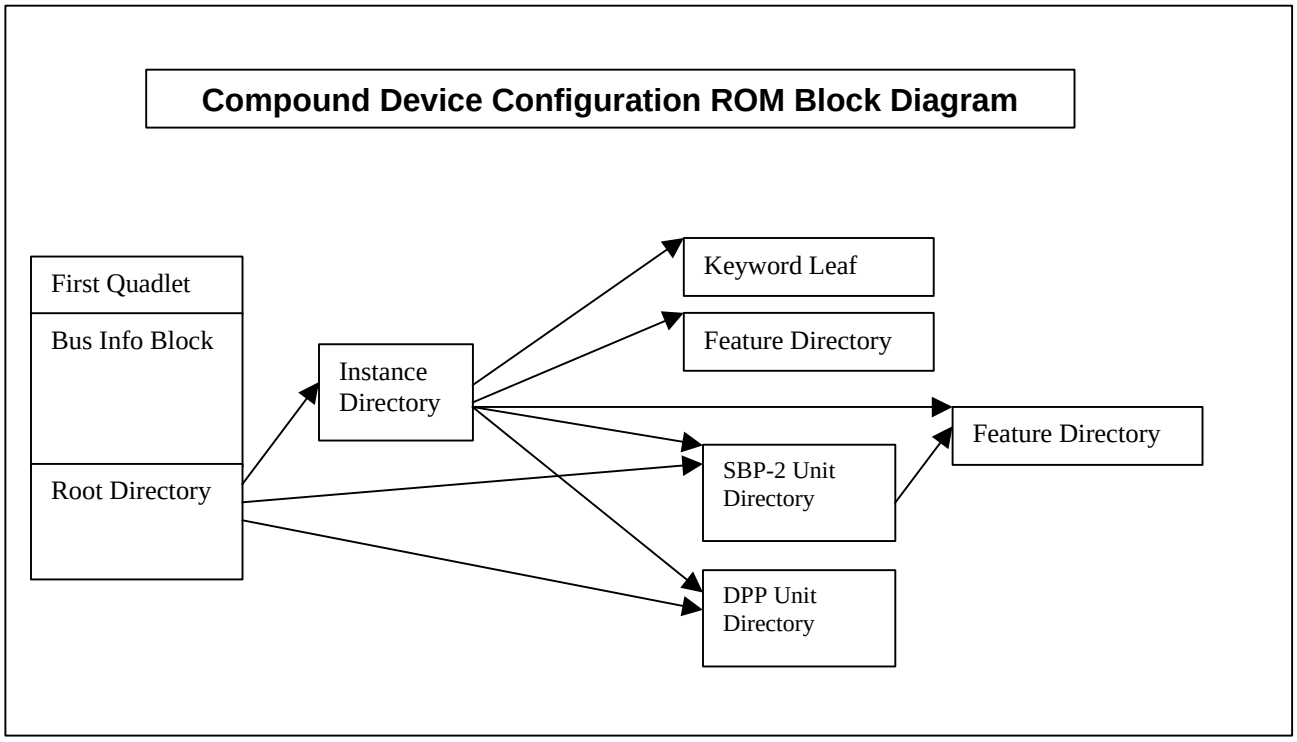
MSB LSB

Leaf Length 01_{16}		Leaf CRC (calculated)	
$4D_{16}$ “M”	46_{16} “F”	47_{16} “G”	$3A_{16}$ “:”
53_{16} “S”	63_{16} “c”	61_{16} “a”	$6E_{16}$ “n”
$6E_{16}$ “n”	65_{16} “e”	72_{16} “r”	20_{16} “ ”
43_{16} “C”	$6F_{16}$ “o”	$2E_{16}$ “.”	$0D_{16}$ (CR)
$0A_{16}$ (LF)	$4D_{16}$ “M”	44_{16} “D”	$4C_{16}$ “L”
$3A_{16}$ “:”	$4E_{16}$ “N”	61_{16} “a”	$6D_{16}$ “m”
65_{16} “e”	$0D_{16}$ (CR)	$0A_{16}$ (LF)	00_{16}

5.5 Multi-Protocol Imaging Device (Informative)

The sections contain information on a minimal implementation of Configuration ROM for a Multi-Protocol imaging device. In this example, the printer function is accessed either via the PWG Imaging Profile or the PWG-C DPP command set.

5.5.1 Block Diagram



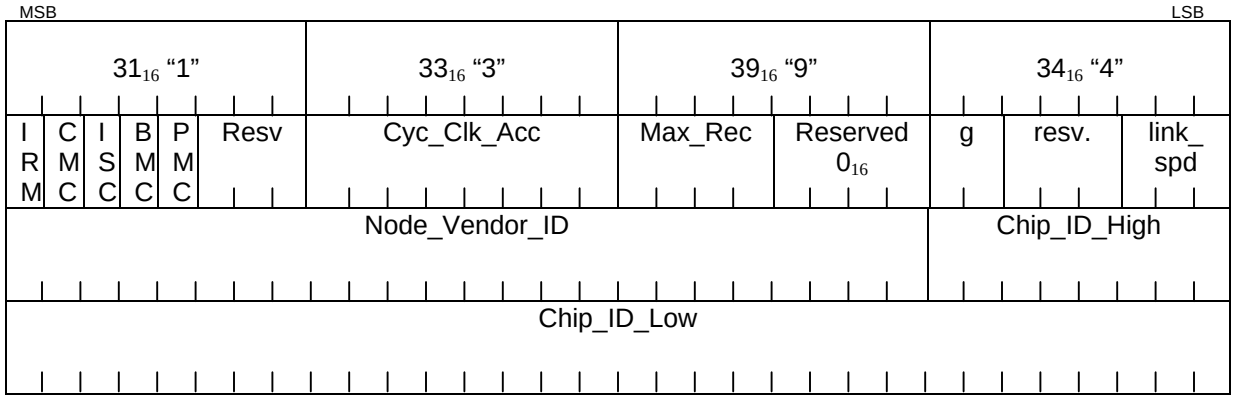
5.5.2 First Quadlet

Offset: 0400_{16}

MSB		LSB
Bus_info_length 04_{16}	CRC_length $**_{16}$	ROM_CRC_value (calculated)

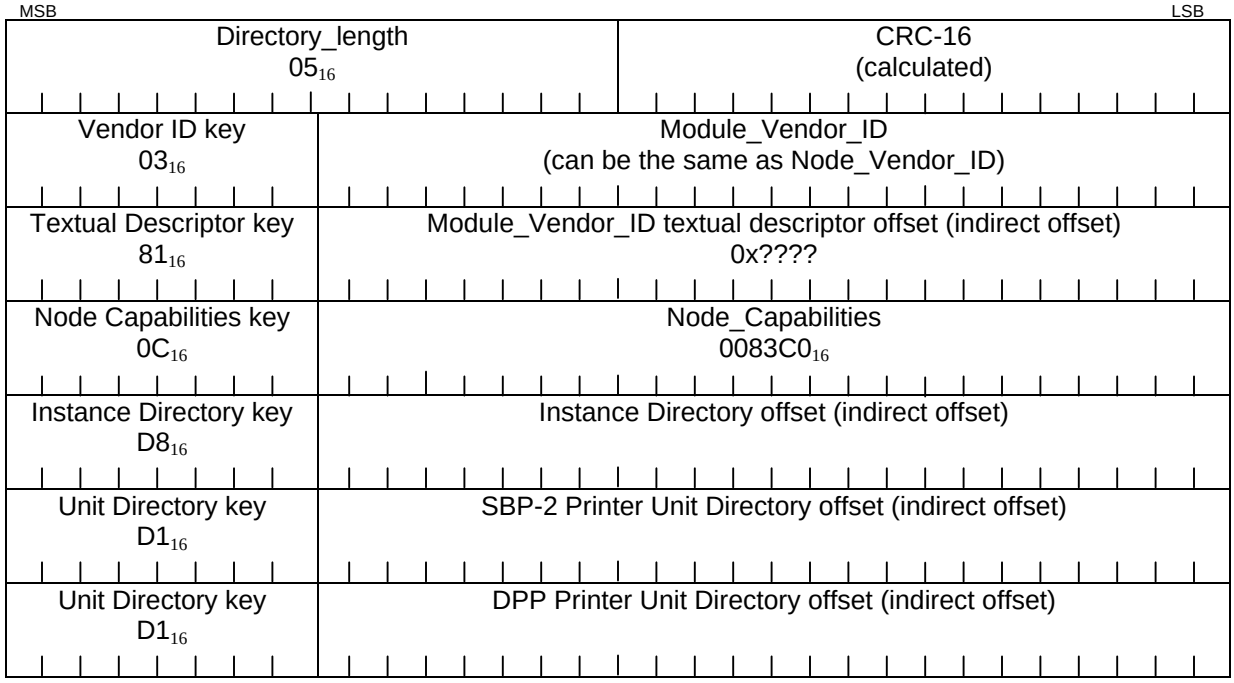
5.5.3 Bus_Info_Block

Offset: 0404_{16}



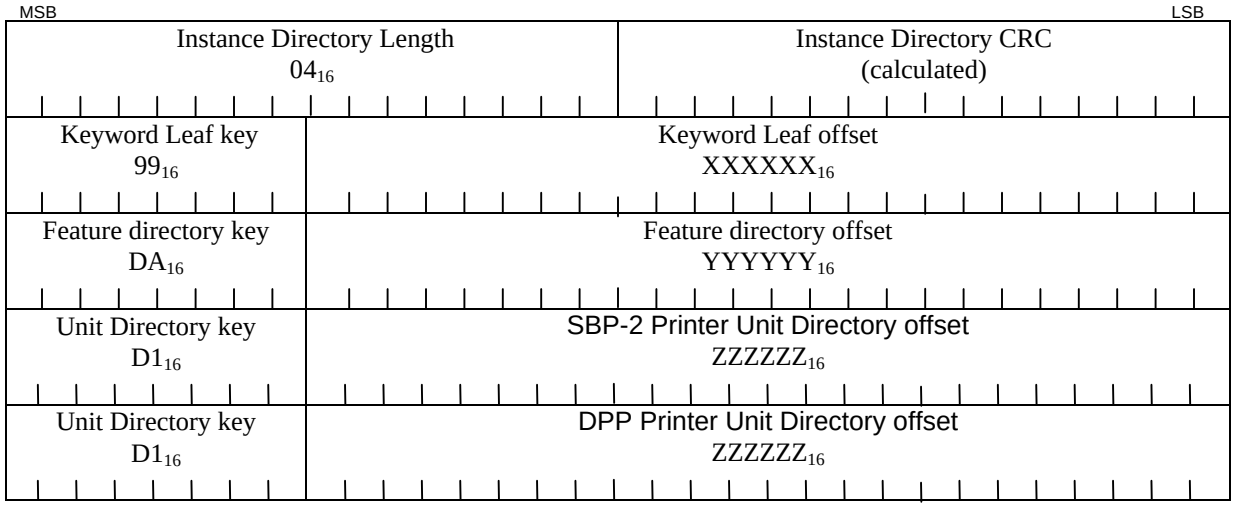
5.5.4 Root Directory

Offset: 0414_{16}



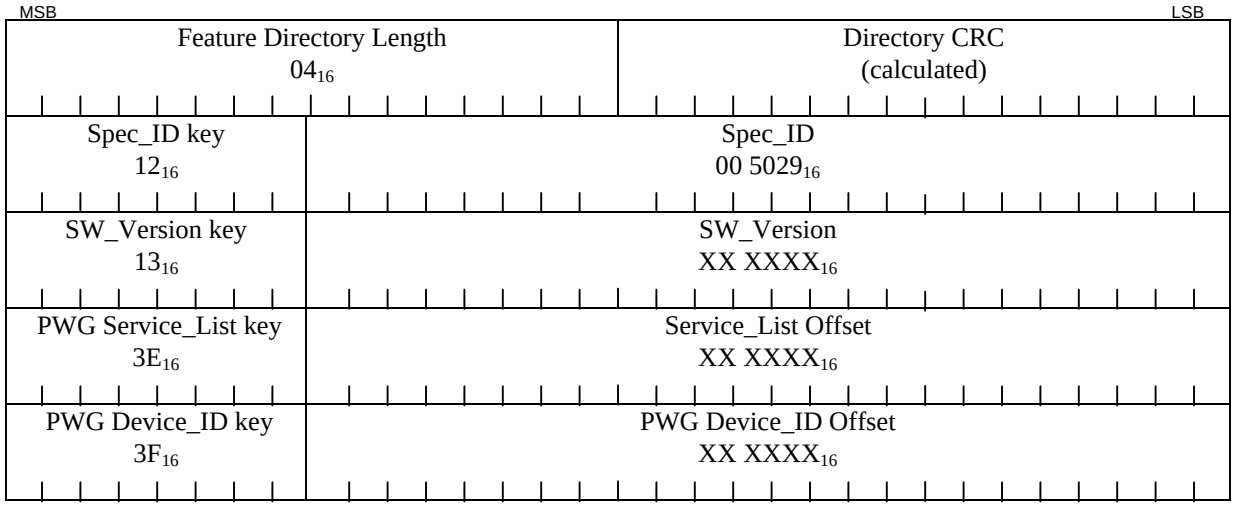
5.5.5 Instance Directory (Root)

Offset: 0430_{16}



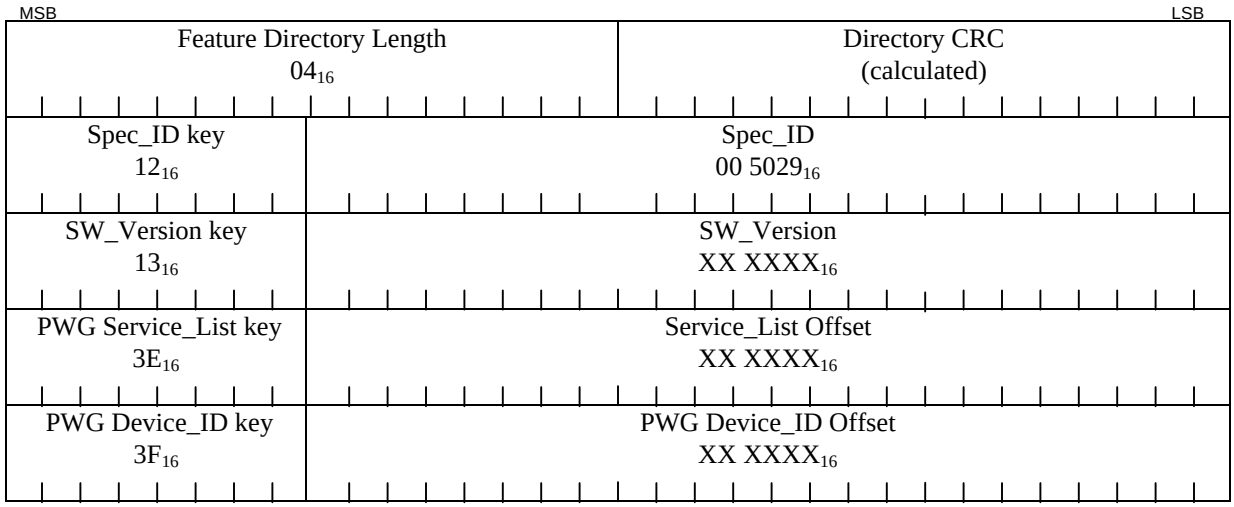
5.5.6 Feature Directory (Root)

Offset: 0444_{16}



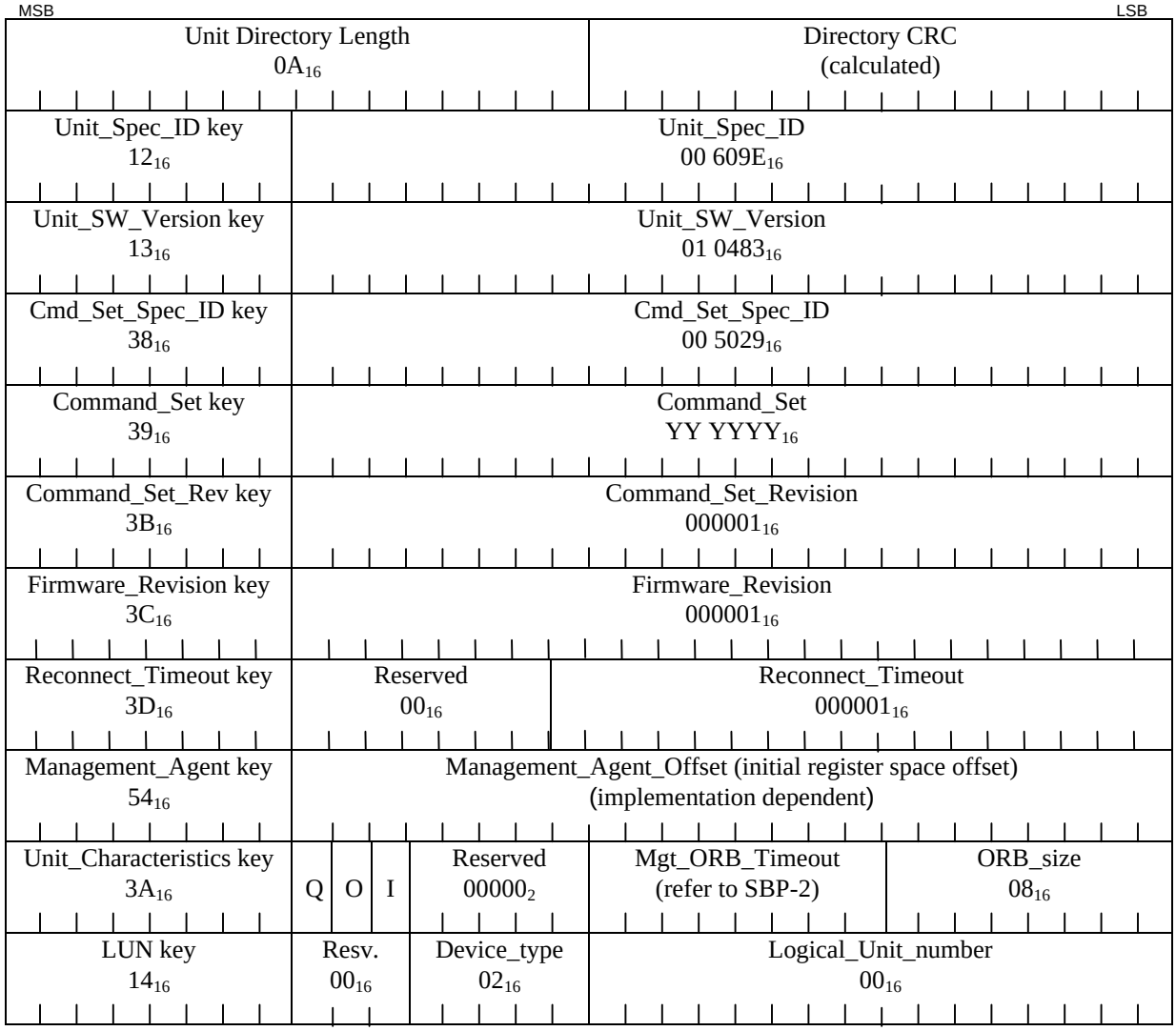
5.5.7 Feature Directory (SBP-2 Printer)

Offset: 0458_{16}



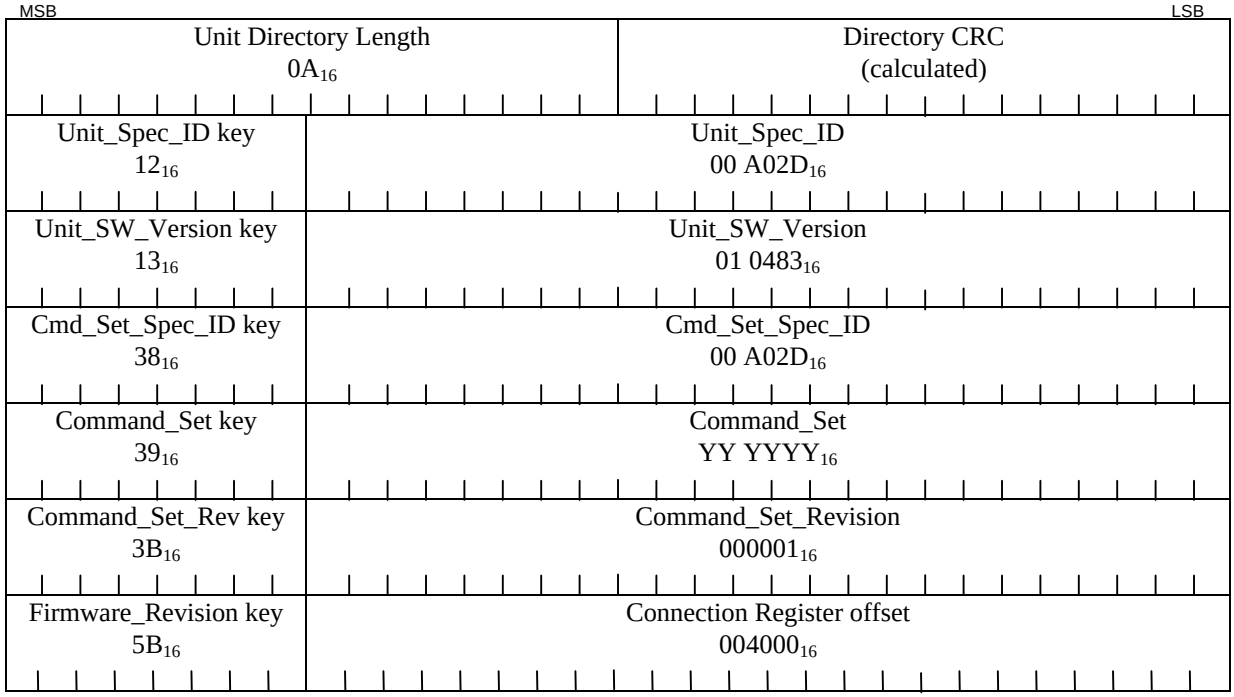
5.5.8 Unit Directory (SBP-2 Printer)

Offset: $046C_{16}$



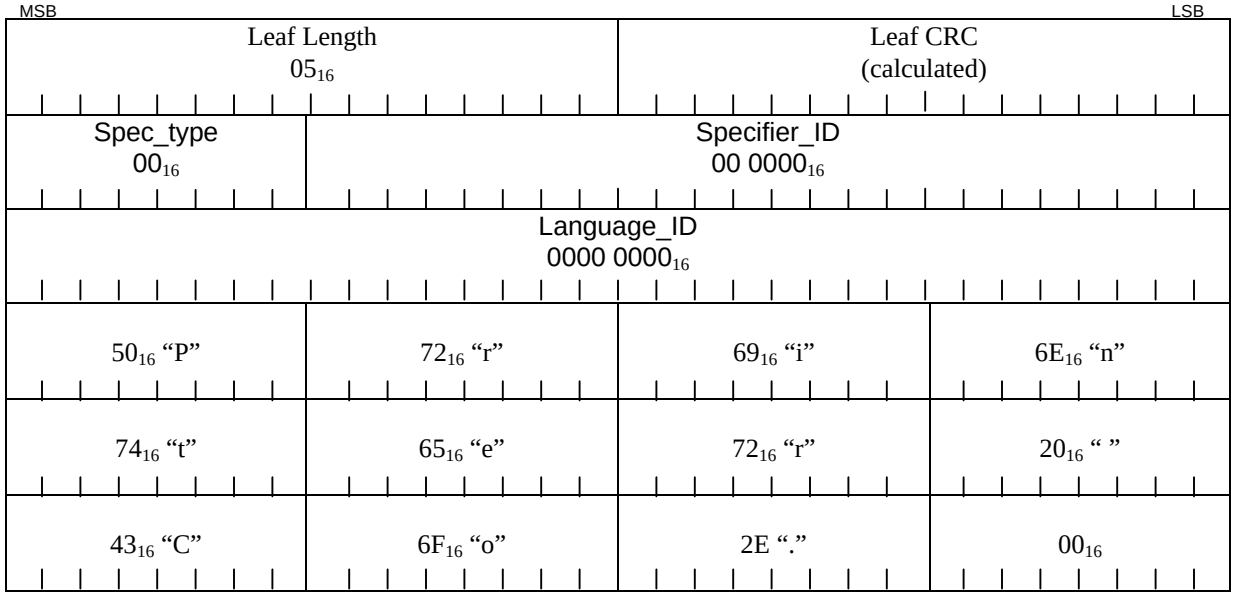
5.5.9 Unit Directory (DPP Printer)

Offset: 0498_{16}



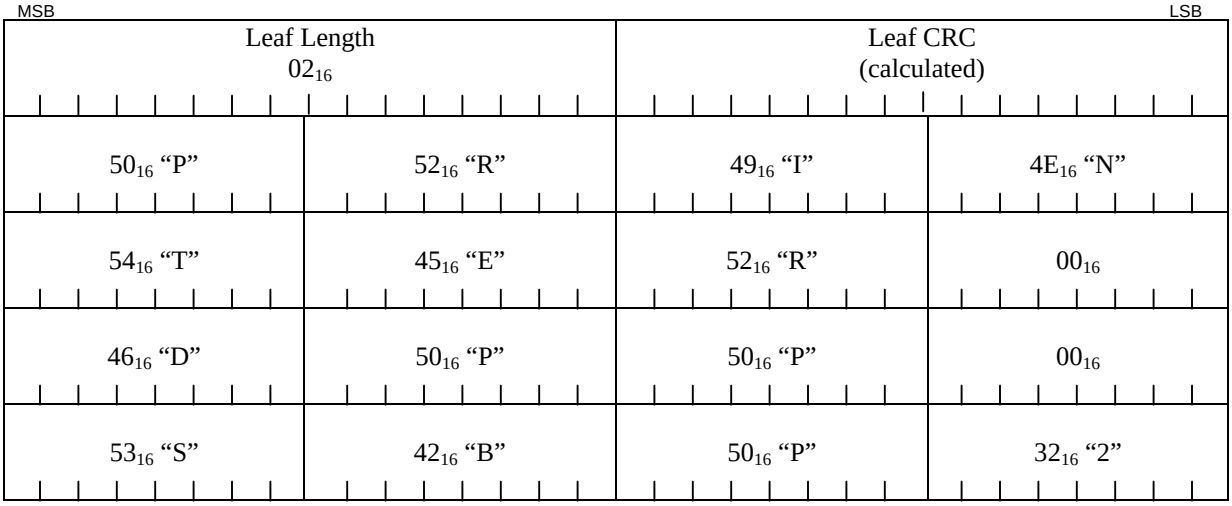
5.5.10 Vendor Textual Descriptor

Offset: $04B4_{16}$



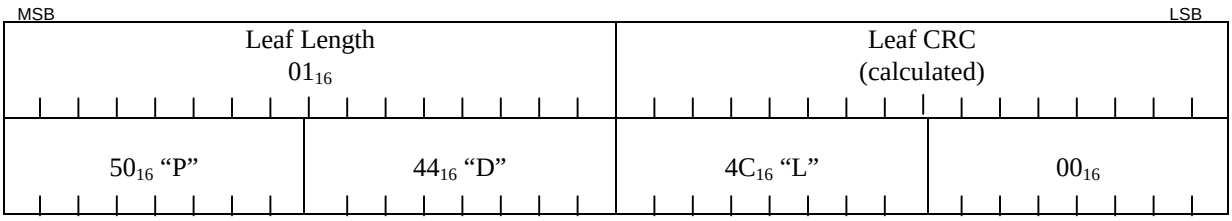
5.5.11 Keyword Leaf (Printer)

Offset: $04CD_{16}$



5.5.12 Service List (Printer)

Offset: $04E0_{16}$



5.5.13 Device_ID Key (Printer)

Offset: $4E8_{16}$

MSB LSB

Leaf Length 01_{16}		Leaf CRC (calculated)	
$4D_{16}$ “M”	46_{16} “F”	47_{16} “G”	$3A_{16}$ “:”
50_{16} “P”	72_{16} “r”	69_{16} “i”	$6E_{16}$ “n”
74_{16} “t”	65_{16} “e”	72_{16} “r”	20_{16} “ ”
43_{16} “C”	$6F_{16}$ “o”	$2E_{16}$ “.”	$0D_{16}$ (CR)
$0A_{16}$ (LF)	$4D_{16}$ “M”	44_{16} “D”	$4C_{16}$ “L”
$3A_{16}$ “:”	$4E_{16}$ “N”	61_{16} “a”	$6D_{16}$ “m”
65_{16} “e”	$0D_{16}$ (CR)	$0A_{16}$ (LF)	00_{16}

6 Discovery (Informative)

The primary method for discovering devices on the Serial Bus is through information read from the Configuration ROM. This profile defines information in addition to that defined in the referenced specifications.

6.1 Device Information Model

6.1.1 Device Availability

Availability of the configuration ROM data is determined by the first quadlet at location FFFF F000 $0400_{16.}$

6.1.2 Configuration ROM Changes

Devices that change values in their configuration ROM shall only change those values during a bus reset.

6.1.3 Change Indicator

Devices shall implement the generate bits defined in IEEE-p1394a. The value of this field is incremented if any portion of the configuration ROM has changed during a bus reset. The coverage of the Bus_Info_Block in the first quadlet via the CRC_Length field causes the the CRC value in the first quadlet to be recalculated each time the generate bits are modified.

6.1.4 Device Class Detection

This section is provided to understand the detection mechanism for the device class.

1394 PWG Profile compliant nodes are required to implement an instance directory which contains a Keyword Leaf, Feature Directory and Unit_Directory_offset entries.

A bus enumerator can perform a top level search of the bus by inspecting the keyword leaf. The Feature Directory provides more specific information related to the device class listed in the Keyword Leaf.

In addition to these new extensions to Configuration ROM, legacy SBP-2 enumerators can inspect the five-bit device_type field contained within the Logical_Unit_Number entry in the Unit Directory.

6.1.5 Protocol Detection

This section is provided to understand the detection mechanism for the protocol driver stack.

SBP-2 compliant nodes are required to implement a unit directory that contains a Unit_Spec_ID and Unit_SW_Version entries. The concatenated values of key type and key value for the Unit_Spec_ID is 12_{16} and Unit_SW_Version is 13_{16}. The SBP-2 Unit_Spec_ID value is 00 $609E_{16}$ and the Unit_SW_Version value is 01 0483_{16}.

1394 PWG Profile compliant nodes are required to implement a unit directory which contains a Cmd_Set_Spec_ID and Command_Set entries. The concatenated values of key type and key value for the Cmd_Set_Spec_ID is 12_{16} and Unit_SW_Version is 13_{16}. The 1394 PWG Profile Cmd_Set_Spec_ID value is 005029_{16} and the Command_Set value is XX $XXXX_{16}$. In addition, the Logical_Unit_Number entry in the Unit Directory contains a five-bit device_type field.

6.1.6 Plug & Play Support

Devices may provide additional configuration ROM entries in addition to those defined in this profile. The specification for these additional entries is vendor dependent.

7 Identifiers

1394 nodes require 24 bit identifiers to correctly identify the software interface for a node.

7.1 SBP-2 Defined Identifiers

Unit_Spec_ID == 00 $609E_{16}$
Unit_SW_Version == 01 0483_{16}.

7.2 1394 PWG Organization Unique Identifier (OUI)

The 1394 PWG Profile implements the following references to 24 bit identifiers.

7.2.1 Cmd_Set_Spec_ID.

The 24 bit value for Cmd_Set_Spec_ID == 005029_{16}

7.2.2 Command_Set.

The 1394 PWG Transport Command Set 24 bit value for Command_Set == XX $XXXX_{16}$.

7.2.3 Feature Directory Spec_ID

Spec_ID == XX $XXXX_{16}$

7.3 1394 PWG Keyword Definitions

The 1394 PWG has defined the following keywords as the standard format for use within the Keyword Leaf.

PRINTER
SCANNER
MFP
CAMERA
DISK
MODEM
FAX
SEND
RECEIVE
IMAGE
PHOTO
COLOR

7.4 1394 PWG Key Feature Directory Definitions

The 1394 PWG Profile defines the following values and keys for use within the PWG Feature Directory.

7.4.1 Unit_SW_Version Value

Unit_SW_Version == XX $XXXX_{16}$

7.4.2 PWG Service_List Key Value

Service_List == $3E_{16}$

7.4.3 PWG Device_ID Key Value

Device_ID == $3F_{16}$

7.5 OUI Source

OUI values are available from the IEEE Registration Authority Committee (RAC). Their address is:

Registration Authority Committee
The Institute of Electrical and Electronic Engineers, Inc.
445 Hoes Lane
Piscataway, NJ 08855-1331
USA
(908) 562 3813