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This specification was developed by the SFF Committee prior to it becoming the SFF TA (Technology Affiliate) TWG (Technical Working Group) of SNIA (Storage Networking Industry Association).

The information below should be used instead of the equivalent herein.

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If you are interested in participating in the activities of the SFF TWG, the membership application can be found at:
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The complete list of SFF Specifications which have been completed or are currently being worked on can be found at:
http://www.snia.org/sff/specifications/SFF-8000.TXT

The operations which complement the SNIA's TWG Policies & Procedures to guide the SFF TWG can be found at:
http://www.snia.org/sff/specifications/SFF-8032.PDF

Suggestions for improvement of this specification will be welcome, they should be submitted to:
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SFF Committee

SFF-8472

Specification for

Diagnostic Monitoring Interface for Optical Transceivers

Rev 12.2 November 21, 2014

摘要：本规范为光收发器定义了增强型数字诊断监控接口，可实时访问设备工作参数。本规范为系统制造商，系统集成商和供应商提供了通用参考。这是SFF委员会的内部工作规范，这是一个业界专案小组。本规范可供公众查阅，书面征求意见。会员将收到的意见将纳入本规范的未来版本。

Secretariat: SFF Committee

Abstract: This specification defines an enhanced digital diagnostic monitoring interface for optical transceivers which allows real time access to device operating parameters.

This specification provides a common reference for systems manufacturers, system integrators, and suppliers. This is an internal working specification of the SFF Committee, an industry ad hoc group.

This specification is made available for public review, and written comments are solicited from readers. Comments received by the members will be considered for inclusion in future revisions of this specification.

Support: This specification is supported by the identified member companies of the SFF Committee.

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EXPRESSION OF SUPPORT BY MANUFACTURERS

The following member companies of the SFF Committee voted in favor of this industry specification.

AMI
Applied Micro
Arista Networks
Broadcom
Clariphy
ENDL
ETRI
Finisar
Hewlett Packard
Honda Connector
IBM
Infineon
Intel
JDS Uniphase
LSI
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Oclaro
Panduit
Picolight
Samsung
Stratos
Sumitomo
Sun Microsystems
Unisys
Vitesse Semiconductor
W L Gore

The following member companies of the SFF Committee voted against this industry specification.

QLogic

The following member companies of the SFF Committee voted to abstain on this industry specification.

Adaptec
Amphenol
Avago
Brocade
Comax
Cortina Systems
Dell Computer
EMC
Emulex
FCI
Foxconn
Fujikura/DDK
Fujitsu Components
Fujitsu CPA
Hitachi Cable
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Foreword

The development work on this specification was done by the SFF Committee, an industry group. The membership of the committee since its formation in August 1990 has included a mix of companies which are leaders across the industry.

When 2 1/2" diameter disk drives were introduced, there was no commonality on external dimensions e.g. physical size, mounting locations, connector type, connector location, between vendors.

The first use of these disk drives was in specific applications such as laptop portable computers and system integrators worked individually with vendors to develop the packaging. The result was wide diversity, and incompatibility.

The problems faced by integrators, device suppliers, and component suppliers led to the formation of the SFF Committee as an industry ad hoc group to address the marketing and engineering considerations of the emerging new technology.

During the development of the form factor definitions, other activities were suggested because participants in the SFF Committee faced more problems than the physical form factors of disk drives. In November 1992, the charter was expanded to address any issues of general interest and concern to the storage industry. The SFF Committee became a forum for resolving industry issues that are either not addressed by the standards process or need an immediate solution.

Those companies which have agreed to support a specification are identified in the first pages of each SFF Specification. Industry consensus is not an essential requirement to publish an SFF Specification because it is recognized that in an emerging product area, there is room for more than one approach. By making the documentation on competing proposals available, an integrator can examine the alternatives available and select the product that is felt to be most suitable.

SFF Committee meetings are held during T10 weeks (see www.t10.org), and Specific Subject Working Groups are held at the convenience of the participants. Material presented at SFF Committee meetings becomes public domain, and there are no restrictions on the open mailing of material presented at committee meetings.

Most of the specifications developed by the SFF Committee have either been incorporated into standards or adopted as standards by EIA (Electronic Industries Association), ANSI (American National Standards Institute) and IEC (International Electrotechnical Commission).

If you are interested in participating or wish to follow the activities of the SFF Committee, the signup for membership and/or documentation can be found at:

www.sffcommittee.com/ie/join.html

The complete list of SFF Specifications which have been completed or are currently being worked on by the SFF Committee can be found at:

ftp://ftp.seagate.com/sff/SFF-8000.TXT

If you wish to know more about the SFF Committee, the principles which guide the activities can be found at:

ftp://ftp.seagate.com/sff/SFF-8032.TXT

Suggestions for improvement of this specification will be welcome. They should be sent to the SFF Committee, 14426 Black Walnut Ct, Saratoga, CA 95070.

SFF委员会会议在T10周期间举行（见www.t10.org），特定主题工作组在参加者方便的时候举行。在SFF委员会会议上提交的材料成为公有领域，对委员会会议上提交的材料的公开邮寄没有限制。SFF委员会制定的大多数规范已经被EIA（电子工业协会），ANSI（美国国家标准协会）和IEC（国际电工委员会）纳入标准或采用标准。如果您有兴趣参加或希望遵循SFF委员会的活动，可以在以下网址找到会员资格和/或文档的注册信息：www.sffcommittee.com/ie/join.html

成。自1990年8月成立以来，委员会的成员包括作为行业领导者的公司。当引入2 1/2“直径的磁盘驱动器时，在外部尺寸（例如物理尺寸，安装位置，连接器类型，连接器位置，供应商之间）之间没有共同点。这些磁盘驱动器的首次使用是在笔记本。系统集成商等在具体应用中与供应商分开开发包装。结果是广泛的多样性，不兼容。集成商，设备供应商和组件供应商面临的问题导致SFF委员会成立为一个行业特设小组，以解决新兴技术的营销和工程考虑。在形式因素定义的发展过程中，提出了其他活动，因为SFF委员会的参与者面临比磁盘驱动器的物理形式因素更多的问题。 1992年11月，扩大了章程，以解决存储行业普遍关心的任何问题。 SFF委员会成为解决不符合标准过程或需要立即解决的行业问题的论坛。已经同意支持规范的那些公司在每个SFF规范的第一页中被标识。行业共识并不是发布SFF规范的基本要求，因为认识到在新兴产品领域，存在多种方法的空间。通过提供有关竞争性提案的文档，集成商可以检查可用的替代方案，并选择被认为最合适的产品。

Publication History

Revision Number	Description	Date
1.0	Initial Submission of Document, Preliminary	4/5/01
2.0	Draft Second Revision, Preliminary	5/18/01
3.0	Draft Third Revision, Preliminary	6/27/01
4.0	Draft Fourth Revision, Preliminary	10/8/01
5.0	Draft Fifth Revision	11/5/01
6.0	Draft Sixth Revision	11/19/01
7.0	Draft Revision 7.0	01/09/02
8.0	Draft Revision 8.0	02/01/02
9.0	Draft Revision 9.0	03/28/02
9.0	Revision 9.0 Approved for Technical Content	5/02
9.2	Revision 9.2 Submitted for Publication	5/30/02
9.3	Editorial Modifications to rev. 9.2. 9.3 Submitted for Publication	8/01/02
9.4	Add extensions to include additional technologies. Results of Dec. 5 03 discussions. Includes: Support for Multiple Application Selection Reserved values for SFF-8079 in Table 3.1, Table 3.10, Table 3.12, and Table 3.17. Additional transceiver type values in Table 3.5 Additional values in Table 3.1a, 3.5a and 3.5b Additional values in Table 3.12 General editorial modifications.	5/26/04
9.5	Editorial Modifications to rev. 9.4. 9.5 Submitted for Publication.	6/01/04
10.0	Add extensions to the following tables: Table 3.1b, 3.2, 3.4, 3.5, 3.5b, 3.7, 3.11, 3.12, 3.21 Editorial changes to the following tables: Table 3.2, 3.3, 3.4, 3.6, 3.7, 3.9, 3.10, 3.17 Add table 3.1a, 3.6a, 3.18a and references to 8079/8431.	2/06/07
10.2	Editorial updates per ballot feedback. Technical update to Tables 3.1.	6/01/07
10.3	Edits per SFF-8431	12/07/07
10.4	Edits per SFF-8431, add bits in Table 3.5 and add Tables 3.6b and 3.6c for SFF-8431 and SFF-8461. Add Table 3.1c.	1/30/09
11.0	Edits per FC-PI-5 (16GFC) to tables 3.6a,3.12,	5/21/10
11.1	Table 3-2 Identifier Values and modified to point to SFF-8024 as the reference for later values and codes.	10/26/12
11.2	Added FC-PI-6 to Table 3.6a Rate Identifier	6/6/13
11.3	Added OM4 to Table 3.1 and Address A0h, Byte 18. Added 3200 MBytes to Table 3.5 Byte 10 Bit 3.	6/11/13
11.4	Added optional support for: CDR/Retimer in transceiver; Variable Receiver Decision Threshold; Rate Select logic for 10G/8G with bypassable CDRs; Table addressing in upper half of address A2h; Laser temperature and TEC current alarms and warnings; Compliance codes for OTN 2km, 40km and 80km profiles in G.959.1.	7/24/14
11.8	Introduced a major style change. The addition of Section, Figure, and Table numbering makes correlation of previous Change History difficult for readers, so a Cross Reference of Figures and Tables was prepared.	7/31/14
11.9	Re-defined byte 36 of Table 5-4 Transceiver Compliance Codes to be 'Extended Compliance Codes' Added definitions of the coding formats for optional laser temperature and TEC current to Section 9.2. Added Table 9-3 and Table 9-4 to illustrate the TEC current 2's complement format.	8/14/14

	Corrected Table 10-2 Retimer/CDR Rate Select Logic Table 'Bit 64.1 of A2h' to be 'Bit 64.3 of A0h' Added Byte 64 Bit 5 in Table 8-3 to identify transceivers with Power Level 3 plus: o Renamed t_power_level2 to t_hpower_level inTable 8-7 and modified the contents of the parameter and conditions cells. o Changed the description for bits 1 and 0 in Table 10-1.	
11.9b	Moved CDR unlocked flags from byte A2h 115 to 119. Added Tx input EQ and RX output EMPH to bytes A2h 114-115 Added Tables 9-13 and 9-14 Tx input EQ and Rx output EMPH values.	8/27/14
12.0	The mix of references to tables and pages was reduced to use only pages Consolidated the two figures in Section 4 into one. Corrected Table 4-4. Byte 12 G959 value from 0Ah, to 6Bh Removed P1I1-2D1, P1S1-2D2, and P1L1-2D2 from Table 5-6	8/28/14
12.1	During the review of Rev 12.0 it was recommended that: - the contents of Table 5-3 Connector Values be moved to SFF-8024. - the contents of Table 5-7 Encoding Values be returned to SFF-8024.	9/12/14
12.2	Further updates to clarify operation of rate select with byte content 0Eh	11/21/14

Cross Reference of Figures and Tables	Pre-12	Rev 12+
Digital Diagnostic Memory Map	3. 1	Deleted
Digital Diagnostic Memory Map	3. 1b	Figure 4-1
Two-wire interface ID: Data Fields - Address A0h	3. 1	Table 4-1
Diagnostics: Data Fields - Address A2h	3. 1a	Table 4-2
(continued) Address A2h, Table 00h or 01h	3. 1a	Table 4-3
(continued) Address A2h, Table 02h	3. 1a	Table 4-3
Transceiver Identification/Performance Examples (A0h Bytes 12-18)	3. 1b	Table 4-4
Copper Cable Identification/Performance Examples (A0h Bytes 7, 8, 60, 61)	3. 1c	Table 4-5
Identifier values	3.2	Table 5-1
Extended Identifier values	3.3	Table 5-2
Connector Values	3.4	SFF-8024
Transceiver codes(Address A0h)	3. 5	Table 5-3
SONET Compliance Specifiers (A0h)	3. 5a	Table 5-4
Transceiver Identification Examples (A0h Bytes 3.10)	3. 5b	Table 5-5
Encoding codes	3. 6	SFF-8024
Rate Identifier	3. 6a	Table 5-6
Passive Cable Specification Compliance (A0h Byte 8 Bit 2 set)	3. 6b	Table 8-1
Active Cable Specification Compliance (A0h Byte 8 Bit 3 set)	3. 6c	Table 8-2
Option values	3. 7	Table 8-3
Date Code	3.8	Table 8-4
Diagnostic Monitoring Type	3.9	Table 8-5
Enhanced Options	3.10	Table 8-6
I/O Timing for Soft (via 2-wire interface) Control & Status Functions	3.11	Table 8-7
SFF-8472 Compliance	3.12	Table 8-8
Bit weights (degrees C) for temperature reporting registers	3.13	Table 9-1
Digital temperature format	3.14	Table 9-2
Alarm and Warning Thresholds (2-Wire Address A2h)	3.15	Table 9-5
Calibration constants for External Calibration Option (2 Wire Address A2h)	3.16	Table 9-6
Unsigned fixed-point binary format for slopes	3.16a	Table 9-7
Format for offsets	3.16b	Table 9-8
IEEE-754 Single-Precision Floating Point Number Format	3.16c	Table 9-9
Example of Floating Point Representation	3.16d	Table 9-10
A/D Values and Status Bits (2 Wire Address A2h)	3.17	Table 9-11
Alarm and Warning Flag Bits (2-Wire Address A2h)	3.18	Table 9-12
Extended Control/Status Memory Addresses (2-Wire Address A2h)	3.18a	Table 10-1
Retimer/CDR Rate Select Logic Table - if bit 64.1 of A2h is set to 1 and byte 13d of A0h is set to E0h	3.18b	Table 10-2
Vendor Specific Memory Addresses (2-Wire Address A2h)	3.19	Table 10-3
User EEPROM (2-Wire Address A2h)	3.20	Table 10-4
Vendor Control Function Addresses (2-Wire Address A2h)	3.21	Table 10-5
Variable Receiver Decision Threshold Control (Address A2h, Table 02h, Bytes	3.22	Table 10-6

Reference	Revision 9.3	Revision 9.4/9.5
Section 2 Applicable Documents	GBIC and SFP MSA	Add: SFF 8079 and 8089
Table 3.1 Address A0h	Base definition	Byte 13 = Reserved for SFF-8079 Bytes 128-255 Reserved for SFF-8079
Table 3.1a	n/a	Add Transceiver ID Examples
Table 3.1b	n/a	n/a
Table 3.1c	n/a	n/a
Table 3.2 Identifiers	Same as SFP MSA 8074	Same as SFP MSA 8074
Table 3.4 Connectors	Same as SFP MSA 8074	Same as SFP MSA 8074
Table 3.5 Transceiver Compliance	Add Sonet and IB to SFP MSA 8074	Add ESCON, EFM, Copper and 8G
Table 3.5a Sonet Compliance	Base definition	Add short reach SR-1
Table 3.5b Transceiver ID Examples	n/a	Add Base definition
Table 3.6 Encoding	Same as SFP MSA 8074	Same as SFP MSA 8074
Table 3.6a Rate Identifier	n/a	n/a
Table 3.6b Cable Identifier	n/a	n/a
Table 3.6c Cable Identifier	n/a	n/a
Table 3.7 Option Values	Same as SFP MSA 8074	Same as SFP MSA 8074
Table 3.10 Enhanced Options	Base definition	Add Byte 93, Bit 2 for SFF 8079
Table 3.11 Soft Timing	Base definition	<same>
Table 3.12 Compliance	01h = revision 9.3	Add 02h = revision 9.5
Table 3.17 Status/Control	Base definition	Reserve 110h/5 and all of 111h for SFF 8079
Table 3.18 Alarm/Warning Flags	Base definition	<same>
Table 3.18a Extended Status/Control	n/a	n/a

Reference	Revision 10.2/10.4	Revision 10.4	Revision 11.0
Section 2 Applicable Documents	Add SFF 8431	Add SFF 8431	<no change>
Table 3.1 Address A0h	Byte 13 = Rate Identifier Byte 19 = OM3 Link Length Bytes 128-255 Reserved for SFF-8079	Byte 13 = Rate Identifier Byte 19 = OM3 Link Length Bytes 128-255 Reserved for SFF-8079	<no change>
Table 3.1a	Change to A2h Diagnostic Fields	Change to A2h Diagnostic Fields	<no change>
Table 3.1b	Add Transceiver ID Examples	Add Transceiver ID Examples	<no change>
Table 3.1c	Add Transceiver ID Examples	Add Transceiver ID Examples	<no change>
Table 3.2 Identifiers	Add 04h to 0Ch for alternate MSAs	Add 04h to 0Ch for alternate MSAs	<no change>
Table 3.4 Connectors	Add 0Ch and 22h for new connectors	Add 0Ch and 22h for new connectors	<no change>
Table 3.5 Transceiver Compliance	Add 10GE, 10GFC, OC-192, FC Base-T and medium FC length	Add 10GE, 10GFC, OC-192, FC Base-T and medium FC length	<no change>
Table 3.5a Sonet Compliance	<same>	<same>	<no change>
Table 3.5b Transceiver ID Examples	Add more examples	Add more examples	<no change>
Table 3.6 Encoding	Add 06h = 64B/66B	Add 06h = 64B/66B	<no change>
Table 3.6a Rate Identifier	Add Base definition	Add Base definition	Expand to add 08h and 0Ah for FC-PI-5
Table 3.6b Cable Identifier	Add Base definition	Add Base definition	<no change>
Table 3.6c Cable Identifier	Add Base definition	Add Base definition	<no change>
Table 3.7 Option Values	Add Byte 64h for SFF 8431	Add Byte 64h for SFF 8431	<no change>
Table 3.10 Enhanced Options	Add Byte 93, Bit 1 for SFF-8431	Add Byte 93, Bit 1 for SFF-8431	<no change>
Table 3.11 Soft Timing	Add t_power_level2 for SFF-8431	Add t_power_level2 for SFF-8431	<no change>
Table 3.12 Compliance	Add 03h = revision 10	Add 03h = revision 10	Add 05h = revision 11.0
Table 3.15 Alarm and Warning Thresholds		<no change>	<no change>
Table 3.17 A/D Values & Status/Control Bits	Editorial changes only	Editorial changes only	<no change>
Table 3.18 Alarm/Warning Flags	Remove bytes 118 and 119 for Table 3.18a	Remove bytes 118 and 119 for Table 3.18a	<no change>
Table 3.18a Extended Status/Control	Add Byte 118 for SFF 8431	Add Byte 118 for SFF 8431	<no change>
Table 3.18b Retimer/CDR Rate Select Logic		N/A	N/A
Table 3.19 Vendor Specific Memory Addresses		<no change>	<no change>
Table 3.22 Variable Receiver Decision Threshold		N/A	N/A

Reference	Revision 11.3	Revision 11.4
Section 2 Applicable Documents	<no change>	Updated SFF-8431 reference to rev 4.1+Addendum
Table 3.1 Address A0h	Byte 12 for > 25 Gb Byte 18 = OM4 and Copper Link Length Bytes 66, 67 for >25 Gb	<no change>
Table 3.1a	<no change>	Split table to show table 00/01h and table 02h separately. New values at addresses: 40-55, 106-109, 115, 127 and all of Table 02h.
Table 3.1b	<no change>	Added values for 3 new G959.1 profiles.
Table 3.1c	<no change>	<no change>
Table 3.2 Identifiers	Points to SFF-8024 for future expansion	Added DWDM SFP+ to value 0Bh
Table 3.4 Connectors	<no change>	<no change>
Table 3.5 Transceiver Compliance	Add 3200 MBytes (32GFC)	Added 3 G959.1 profiles to byte 36 bits 2,1,0.
Table 3.5a Sonet Compliance	<no change>	<no change>
Table 3.5b Transceiver ID Examples	Fix error on 10G SR/LR	Added 3 G959.1 profiles to end of table.
Table 3.6 Encoding	<no change>	<no change>
Table 3.6a Rate Identifier	Expand to add 0Ch for FC-PI-6	Added 0Eh for 10G/8G independent Tx & Rx Rate Select.
Table 3.6b Cable Identifier	<no change>	<no change>
Table 3.6c Cable Identifier	<no change>	<no change>
Table 3.7 Option Values	<no change>	Add bits for: paging (64.4); Retimer/CDR (64.3); RDT (65.7); and Tunable Tx (65.6).
Table 3.10 Enhanced Options	<no change>	<no change>
Table 3.11 Soft Timing	<no change>	<no change>
Table 3.12 Compliance	Add 06h = revision 11.3	Add 07h = revision 11.4
Table 3.15 Alarm and Warning Thresholds	<no change>	Added thresholds for laser temp & TEC current at bytes 40-55.
Table 3.17 A/D Values & Status/Control Bits	<no change>	Added A/D values for optional laser temp & TEC current. Updated Soft Rate Select description bit 110.3.
Table 3.18 Alarm/Warning Flags	<no change>	Added alarm bits for laser temp & TEC current. Bits 113.5 to 113.2. Added CDR unlocked bits 115.1 to 115.0.
Table 3.18a Extended Status/Control	<no change>	Updates Soft RS(1) Select description, bit 118.3.
Table 3.18b Retimer/CDR Rate Select Logic	N/A	Add base definition.
Table 3.19 Vendor Specific Memory Addresses	<no change>	Defined byte 127 as optional table select byte.
Table 3.22 Variable Receiver Decision Threshold	N/A	Add base definition.

TABLE OF CONTENTS

FIGURES

TABLES

该文件定义了一个增强的存储器映射，其中包含用于光学收发器的数字诊断监视接口，允许伪实时访问设备操作参数。它还为先前定义的两线接口ID存储器映射添加了新选项，以适应SFP MSA或GBIC文档中未考虑的新收发器类型。该接口是GBIC规范以及SFP MSA中定义的两线接口ID接口的扩展。这两个规范都定义了EEPROM中的256字节存储器映射，可通过8位地址1010000X（A0h）的2线串行接口访问。数字诊断监视接口使用8位地址1010001X（A2h），因此原来定义的两线接口ID存储器映射保持不变。该接口向下兼容GBIC规范和SFP MSA。为了为将来的扩展提供存储空间，为A2h存储器空间的高128个字节定义了多个可选页面。

Published

SFF Committee --

Diagnostic Monitoring Interface for Optical Transceivers

1. Scope

This document defines an enhanced memory map with a digital diagnostic monitoring interface for optical transceivers that allows pseudo real time access to device operating parameters. It also adds new options to the previously defined two-wire interface ID memory map that accommodate new transceiver types that were not considered in the SFP MSA or GBIC documents.

The interface is an extension of the two-wire interface ID interface defined in the GBIC specification as well as the SFP MSA. Both specifications define a 256 byte memory map in EEPROM which is accessible over a 2 wire serial interface at the 8 bit address 1010000X (A0h). The digital diagnostic monitoring interface makes use of the 8 bit address 1010001X (A2h), so the originally defined two-wire interface ID memory map remains unchanged. The interface is backward compatible with both the GBIC specification and the SFP MSA.

In order to provide memory space for future extensions, multiple optional pages are defined for the upper 128 bytes of the A2h memory space.

增强的数字诊断接口是2000年9月14日SFP MSA文件中定义的MOD_DEF接口的超集，后来作为INF-8074提交给SFF委员会。 2线接口引脚定义，硬件和时序在那里被明确定义。本文档描述了SFP MSA中定义的存储器映射的扩展（见图4-1）。增强型接口使用两线串行总线地址1010001X（A2h）提供有关模块当前工作条件的诊断信息。收发器通过内部模拟信号的数字化产生此诊断数据。在设备制造期间写入校准和报警/警告阈值数据。未分配或为SFF-8472保留的所有位都应设置为零和/或忽略。对于其他用途，例如SFF-8079标记为保留或可选的位应按照其他文档执行，如果未实现，则将其设置为零和/或忽略。如果执行SFF-8472的可选功能，则应按照SFF-8472中的规定进行实施。如果未实现，则写入位将被忽略，状态位应设置为零。
修订版9.5中提供了额外的A0h和A2h内存分配，以支持SFF-8079和SFF-8089规范中定义的多速率和应用程序选择。
自修订版本10.4以来，已对修订进行了各种扩展。这些包括添加新的连接器，工业外形，收发器代码和收发器功能的控制。

2. References

The following standards are relevant to many SFF Specifications.

INF-8074	SFP (Small Formfactor Pluggable) 1 Gb/s Transceiver
SFF-8024	SFF Committee Cross Reference to Industry Products
SFF-8053	GBIC (Gigabit Interface Converter)
SFF-8079	SFP Rate and Application Selection
SFF-8089	SFP Rate and Application Codes
SFF-8431	SFP+ 10 Gb/s and Low Speed Electrical Interface
SFF-8690	Tunable SFP+ Memory Map for ITU Frequencies

3. Enhanced Digital Diagnostic Interface Definition

3.1 Overview

The enhanced digital diagnostic interface is a superset of the MOD_DEF interface defined in the SFP MSA document dated September 14, 2000, later submitted to the SFF Committee as INF-8074. The 2 wire interface pin definitions, hardware, and timing are clearly defined there.

This document describes an extension to the memory map defined in the SFP MSA (see Figure 4-1). The enhanced interface uses the two wire serial bus address 1010001X (A2h) to provide diagnostic information about the module's present operating conditions. The transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture.

All bits that are unallocated or reserved for SFF-8472 shall be set to zero and/or ignored.

Bits labeled as reserved or optional for other usage, such as for SFF-8079, shall be implemented per such other documents, or set to zero and/or ignored if not implemented.

If optional features for SFF-8472 are implemented, they shall be implemented as defined in SFF-8472. If they are not implemented, then write bits will be ignored, and state bits shall be set to zero.

Additional A0h and A2h memory allocations were provided in revision 9.5 to support multi-rate and application selection as defined in the SFF-8079 and SFF-8089 specifications.

Various extensions have been made in revisions since revision 10.4 . These include adding new connectors, industry form factors, transceiver codes and controls for transceiver features.

4. Memory Organization

4.1 Two-wire Interface Fields

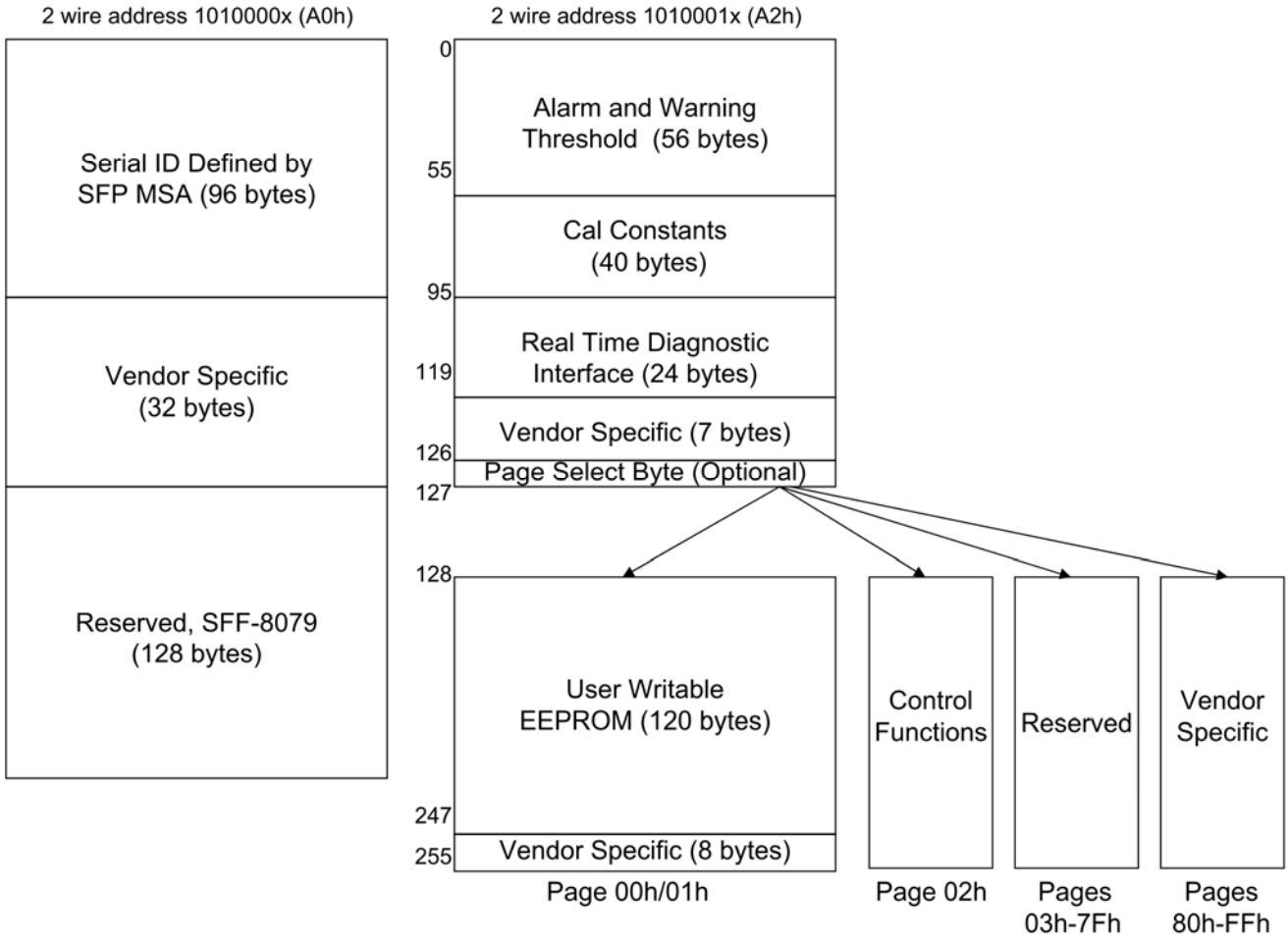

FIGURE 4-1 TWO-WIRE INTERFACE FIELDS

4.2 Pages

The optional Page Select byte expands the range of information that can be provided by the manufacturer. Where used in this specification the Page ID is defined in hexadecimal. Note: Vendor Specific IDs may be password-protected.

可选的页面选择字节可扩展制造商可提供的信息范围。在本规范中使用的页面ID以十六进制定义。注意：供应商特定ID可能受密码保护。

4.3 Data Fields

TABLE 4-1 DATA FIELDS - ADDRESS A0H

A0h	# Bytes	Name	Description
BASE ID FIELDS			
0	1	Identifier	Type of transceiver (see Table 5-1)
1	1	Ext. Identifier	Extended identifier of type of transceiver (see Table 5-2)
2	1	Connector	Code for connector type (see SFF-8024 Transceiver Management)
3-10	8	Transceiver	Code for electronic or optical compatibility (see Table 5-3)
11	1	Encoding	Code for high speed serial encoding algorithm (see SFF-8024 Transceiver Management)
12	1	BR, Nominal	Nominal signalling rate, units of 100MBd. (see details for rates > 25.0Gb/s)
13	1	Rate Identifier	Type of rate select functionality (see Table 5-6)
14	1	Length(SMF,km)	Link length supported for single mode fiber, units of km
15	1	Length (SMF)	Link length supported for single mode fiber, units of 100 m
16	1	Length (50um)	Link length supported for 50 um OM2 fiber, units of 10 m
17	1	Length (62.5um)	Link length supported for 62.5 um OM1 fiber, units of 10 m
18	1	Length (OM4 or copper cable)	Link length supported for 50um OM4 fiber, units of 10m. Alternatively copper or direct attach cable, units of m
19	1	Length (OM3)	Link length supported for 50 um OM3 fiber, units of 10 m
20-35	16	Vendor name	SFP vendor name (ASCII)
36	1	Transceiver	Code for electronic or optical compatibility (see Table 5-3)
37-39	3	Vendor OUI	SFP vendor IEEE company ID
40-55	16	Vendor PN	Part number provided by SFP vendor (ASCII)
56-59	4	Vendor rev	Revision level for part number provided by vendor (ASCII)
60-61	2	Wavelength	Laser wavelength (Passive/Active Cable Specification Compliance)
62	1	Unallocated	
63	1	CC_BASE	Check code for Base ID Fields (addresses 0 to 62)
EXTENDED ID FIELDS			
64-65	2	Options	Indicates which optional transceiver signals are implemented (see Table 8-3)
66	1	BR, max	Upper bit rate margin, units of % (see details for rates > 25.0Gb/s)
67	1	BR, min	Lower bit rate margin, units of % (see details for rates > 25.0Gb/s)
68-83	16	Vendor SN	Serial number provided by vendor (ASCII)
84-91	8	Date code	Vendor's manufacturing date code (see Table 8-4)
92	1	Diagnostic Monitoring Type	Indicates which type of diagnostic monitoring is implemented (if any) in the transceiver (see Table 8-5)
93	1	Enhanced Options	Indicates which optional enhanced features are implemented (if any) in the transceiver (see Table 8-6)
94	1	SFF-8472 Compliance	Indicates which revision of SFF-8472 the transceiver complies with. (see Table 8-8).
95	1	CC_EXT	Check code for the Extended ID Fields (addresses 64 to 94)
VENDOR SPECIFIC ID FIELDS			
96-127	32	Vendor Specific	Vendor Specific EEPROM
128-255	128	Reserved	Reserved for SFF-8079

TABLE 4-2 DATA FIELDS - ADDRESS A2H

A2h	# Bytes	Name	Description
DIAGNOSTIC AND CONTROL/STATUS FIELDS			
0-39	40	A/W Thresholds	Diagnostic Flag Alarm and Warning Thresholds (see Table 9-5)
40-55	16	Optional A/W Thresholds	Thresholds for optional Laser Temperature and TEC Current alarms and warnings (see Table 9-5)
56-91	36	Ext Cal Constants	Diagnostic calibration constants for optional External Calibration (see Table 9-6)
92-94	3	Unallocated	
95	1	CC_DMI	Check code for Base Diagnostic Fields (addresses 0 to 94)
96-105	10	Diagnostics	Diagnostic Monitor Data (internally or externally calibrated) (see Table 9-11)
106-109	4	Optional Diagnostics	Monitor Data for Optional Laser temperature and TEC current (see Table 9-11)
110	1	Status/Control	Optional Status and Control Bits (see Table 9-11)
111	1	Reserved	Reserved for SFF-8079
112-113	2	Alarm Flags	Diagnostic Alarm Flag Status Bits (see Table 9-12)
114	1	Unallocated	
115	1	CDR Unlocked	Optional flags indicating that Tx or Rx CDR is unlocked
116-117	2	Warning Flags	Diagnostic Warning Flag Status Bits (see Table 9-12)
118-119	2	Ext Status/Control	Extended module control and status bytes (see Table 10-1)
GENERAL USE FIELDS			
120-126	7	Vendor Specific	Vendor specific memory addresses (see Table 10-3)
127	1	Table Select	Optional Page Select (see Table 10-3)

TABLE 4-3 DATA FIELDS - ADDRESS A2H PAGE TABLES

A2h	# Bytes	Name	Description
Page 00-01h			
128-247	120	User EEPROM	User writable non-volatile memory (see Table 10-4)
248-255	8	Vendor Control	Vendor specific control addresses (see Table 10-5)
Page 02h			
128-129	2	Reserved	Reserved for SFF-8690 (Tunable Transmitter)
130	1	Reserved	Reserved for future receiver controls
131	1	Rx Decision Threshold	RDT value setting
132-172	41	Reserved	Reserved for SFF-8690
173-255	83	Unallocated	

The examples of transceiver and copper cable performance codes below are provided for illustration. Compliance to additional standards and technologies is possible so bits other than those indicated in each row may also be set to indicate compliance to these additional standards and technologies.

以下的收发器和铜缆电缆性能代码的例子是为了说明而提供的。遵守额外的标准和技术是可能的，因此除了每行中指出的位之外的位也可以被设置为指示符合这些额外的标准和技术。

TABLE 4-4 TRANSCEIVER IDENTIFICATION/PERFORMANCE EXAMPLES

		Address A0h						
		Rate and Distance Fields						Wave-length Fields
Transceiver Type	**Transceiver Description**	**Byte 12**	**Byte 14**	**Byte 15**	**Byte 16**	**Byte 17**	**Byte 18**	**Bytes 60 & 61**
100-M5-SN-I and 100-M6-SN-I	1062.5 MBd MM 850nm 500m/50um, 300m/62.5um	0Bh	00h	00h	32h	1Eh	00h	0352h
200-SM-LC-L and 100-SM-LC-L	2125 MBd and 1062.5 MBd 10km SM 1310nm	15h *3	0Ah *3	64h *3	00h	00h	00h	051Eh
400-M5-SN-I and 400-M6-SN-I [4]	4250 MBd MM 850nm 150m/50um, 70m/62.5um	2Bh *3	00h	00h	0Fh *3	07h *3	00h	0352h
400-SM-LC-M	4250 MBd SM 1310nm 4km "medium" length	2Bh *3	04h	28h	00h	00h	00h	051Eh
400-SM-LC-L	4250 MBd SM 1310nm 10km "long" length	2Bh *3	0Ah	64h	00h	00h	00h	051Eh
200-SM-LL-V and 100-SM-LL-V	2125 MBd and 1062.5 MBd 50km SM 1550nm	15h *3	32h	FFh	00h	00h	00h	060Eh
ESCON SM	200 MBd 20km SM 1310nm	02h	14h	C8h	00h	00h	00h	051Eh
100BASE-LX10	125 MBd 10km SM 1310nm	01h	0Ah	64h	00h	00h	00h	051Eh
1000BASE-T	1250 MBd 100m Cat 5 Cable	0Dh *1	00h	00h	00h	00h	64h	0000h
1000BASE-SX	1250 MBd 550m MM 850nm	0Dh *1	00h	00h	37h *2	1Bh *2	00h	0352h
1000BASE-LX	1250 MBd 5km SM 1310nm	0Dh *1	05h	32h	37h	37h	00h	051Eh
1000BASE-LX10	1250 MBd 10km SM 1310nm	0Dh *1	0Ah	64h	00h	00h	00h	051Eh
1000BASE-BX10-D	1250 MBd 10km SM 1490nm downstream TX	0Dh *1	0Ah	64h	00h	00h	00h	05D2h
1000BASE-BX10-U	1250 MBd 10km SM 1310nm upstream TX	0Dh *1	0Ah	64h	00h	00h	00h	051Eh
OC3/STM1 SR-1	155 MBd 2km SM 1310nm	02h	02h	14h	00h	00h	00h	051Eh
OC12/STM4 LR-1	622 MBd 40km SM 1310nm	06h *3	28h	FFh	00h	00h	00h	051Eh
OC48/STM16 LR-2	2488 MBd 80km SM 1550nm	19h *3	50h	FFh	00h	00h	00h	060Eh
G959.1 P1I1-2D1	10709 MBd 2 km SM 1310 nm	6Bh	02h *5	14h	00h	00h	00h	051Eh
G959.1 P1S1-2D2	10709 MBd 40 km SM 1550 nm	6Bh	28h *5	FFh	00h	00h	00h	060Eh
G959.1 P1L1-2D2	10709 MBd 80 km SM 1550 nm	6Bh	50h *5	FFh	00h	00h	00h	060Eh

*1) By convention 1.25 Gb/s should be rounded up to 0Dh (13 in units of 100 MBd) for Ethernet 1000BASE-X.

*2) Link distances for 1000BASE-SX variants vary between high and low bandwidth cable types per 802.3 Clause 38. The values shown are 270m [275m per 802.3] for 62.5um/200 MHz*km cable and 550m for 50um/500 MHz*km cable.

*3) For transceivers supporting multiple data rates (and hence multiple distances with a single fiber type) the highest data rate and the distances achievable at that data rate are to be identified in these fields.

*4) In this example, the transceiver supports 400-M5-SN-I, 200-M5-SN-I, 100-M5-SN-I, 400-M6-SN-I, 200-M6-SN-I and 100-M6-SN-I.

*5) These target distances are for classification and not for specification.

* 1）按照惯例，对于以太网1000BASE-X，1.25 Gb / s应舍入为0Dh（以100 MBd为单位为13）。
* 2）根据802.3条款38，1000BASE-SX型号的链路距离各不相同。在62.5um / 200 MHz * km电缆上，所显示的值为270m [802.3]，对于50um / 500 MHz的电缆为550m *公里电缆。
* 3）对于支持多种数据速率的收发器（以及单个光纤类型的多个距离），可以在这些领域中确定最高的数据速率和在该数据速率下可达到的距离。
* 4）本例中，收发器支持400-M5-SN-I，200-M5-SN-I，100-M5-SN-I，400-M6-SN-I，200-M6-SN-I和100-M6-SN-I。
* 5）这些目标距离用于分类，而不是规格。

TABLE 4-5 COPPER CABLE IDENTIFICATION/PERFORMANCE EXAMPLES

	Address A0h		
	Link Length and Transmitter Technology		Laser wavelength and Cable Specification Compliance
Cable Type	**Byte 7**	**Byte 8**	**Bytes 60 and 61**
Passive Cable compliant to SFF-8431 Appendix E.	00h	04h	0100h
Active cable compliant to SFF-8431 Appendix E	00h	08h	0100h
Active cable compliant to SFF-8431 limiting	00h	08h	0400h
Active cable compliant to both SFF-8431 limiting and FC-PI-4 limiting	00h	08h	0C00h

5. Identifiers and Codes

标识符值指定通过两线接口信息描述的物理设备。该值应包含在两线接口数据中。

5.1 Physical Device Identifier Values [Address A0h, Byte 0]

The identifier value specifies the physical device described by two-wire interface information. This value shall be included in the two-wire interface data.

TABLE 5-1 PHYSICAL DEVICE IDENTIFIER VALUES

A0h	Value	Description
0	00h	Unknown or unspecified
	01h	GBIC
	02h	Module soldered to motherboard (ex: SFF)
	03h	SFP or SFP+
	04-7Fh	Not used by this specification. These values are maintained in the Transceiver Management section of SFF-8024.
	80-FFh	Vendor specific

扩展标识符值提供有关收发器的附加信息。对于表示两线接口ID模块定义的所有SFP模块，该字段应设置为04h。在许多情况下，GBIC选择使用MOD_DEF 4提供有关GBIC可用的附加信息，即使GBIC实际上符合为GBIC定义的其他六个MOD_DEF值之一。扩展标识符允许GBIC明确指定此类合规性，而不需要从提供的其他信息中推断MOD_DEF值。

5.2 Physical Device Extended Identifier Values [Address A0h, Byte 1]

The extended identifier value provides additional information about the transceiver. The field should be set to 04h for all SFP modules indicating two-wire interface ID module definition. In many cases, a GBIC elects to use MOD_DEF 4 to make additional information about the GBIC available, even though the GBIC is actually compliant with one of the six other MOD_DEF values defined for GBICs. The extended identifier allows the GBIC to explicitly specify such compliance without requiring the MOD_DEF value to be inferred from the other information provided.

TABLE 5-2 PHYSICAL DEVICE EXTENDED IDENTIFIER VALUES

A0h	Value	Description of connector
1	00h	GBIC definition is not specified or the GBIC definition is not compliant with a defined MOD_DEF. See product specification for details.
	01h	GBIC is compliant with MOD_DEF 1
	02h	GBIC is compliant with MOD_DEF 2
	03h	GBIC is compliant with MOD_DEF 3
	04h	GBIC/SFP function is defined by two-wire interface ID only
	05h	GBIC is compliant with MOD_DEF 5
	06h	GBIC is compliant with MOD_DEF 6
	07h	GBIC is compliant with MOD_DEF 7
	08-FFh	Unallocated

5.3 Connector Values [Address A0h, Byte 2]

The connector value indicates the external optical or electrical cable connector provided as the media interface. This value shall be included in the two-wire interface data. These values are maintained in the Transceiver Management section of SFF-8024.

连接器值表示作为介质接口提供的外部光缆或电缆连接器。该值应包含在两线接口数据中。这些值在SFF-8024的收发器管理部分维护。

Published

字节3-10中的以下位指示符和字节36中的代码定义了收发器支持的电子或光学接口。在此字段中至少设置一位。对于光纤通道收发器，光纤通道速度，传输介质，发射机技术和距离能力均应予以说明。SONET符合性代码通过包含表5-4的内容完成。以太网，ESCON和InfiniBand代码已被包括在内，以扩大SFP收发器的可用应用。

5.4 Transceiver Compliance Codes [Address A0h, Bytes 3-10 and 36]

The following bit significant indicators in bytes 3-10 and code in byte 36 define the electronic or optical interfaces that are supported by the transceiver. At least one bit shall be set in this field. For Fibre Channel transceivers, the Fibre Channel speed, transmission media, transmitter technology, and distance capability shall all be indicated. SONET compliance codes are completed by including the contents of Table 5-4. Ethernet, ESCON and InfiniBand codes have been included to broaden the available applications of SFP transceivers.

TABLE 5-3 TRANSCEIVER COMPLIANCE CODES

A0h	Bit *1	Description
Extended Compliance Codes		
36	7-0	See SFF-8024 Transceiver Management
10G Ethernet Compliance Codes		
3	7	10G Base-ER
3	6	10G Base-LRM
3	5	10G Base-LR
3	4	10G Base-SR
Infiniband Compliance Codes		
3	3	1X SX
3	2	1X LX
3	1	1X Copper Active
3	0	1X Copper Passive
ESCON Compliance Codes		
4	7	ESCON MMF, 1310nm LED
4	6	ESCON SMF, 1310nm Laser
SONET Compliance Codes		
4	5	OC-192, short reach *2
4	4	SONET reach specifier bit 1
4	3	SONET reach specifier bit 2
4	2	OC-48, long reach*2
4	1	OC-48, intermediate reach *2
4	0	OC-48, short reach *2
5	7	Unallocated
5	6	OC-12, single mode, long reach *2
5	5	OC-12, single mode, inter. reach *2
5	4	OC-12, short reach *2
5	3	Unallocated
5	2	OC-3, single mode, long reach *2
5	1	OC-3, single mode, inter. reach *2
5	0	OC-3, short reach *2

A0h	Bit *1	Description
Fibre Channel Link Length		
7	7	very long distance (V)
7	6	short distance (S)
7	5	intermediate distance (I)
7	4	long distance (L)
7	3	medium distance (M)
Fibre Channel Technology		
7	2	Shortwave laser, linear Rx (SA) *7
7	1	Longwave laser (LC) *6
7	0	Electrical inter-enclosure (EL)
8	7	Electrical intra-enclosure (EL)
8	6	Shortwave laser w/o OFC (SN) *7
8	5	Shortwave laser with OFC (SL) *4
8	4	Longwave laser (LL) *5
SFP+ Cable Technology		
8	3	Active Cable *8
8	2	Passive Cable *8
Unallocated		
8	1	Unallocated
8	0	Unallocated
Fibre Channel Transmission Media		
9	7	Twin Axial Pair (TW)
9	6	Twisted Pair (TP)
9	5	Miniature Coax (MI)
9	4	Video Coax (TV)
9	3	Multimode, 62.5um (M6)
9	2	Multimode, 50um (M5, M5E)
9	1	Unallocated
9	0	Single Mode (SM)

* 1 位7是高位，并在每个字节中首先发送。* 2 SONET符合性代码要求达到表5-4中的说明符位3和4，以完全指定收发器功能。* 3以太网LX，PX和BX兼容性代码需要使用比特率，标称值（字节12），单模和两种类型的多模光纤（字节14-17）的链路长度值和激光器的波长值字节60和61），以完全指定收发器功能。有关设置这些参数值的示例，请参见表4-3和表5-6。* 4注意：开放光纤控制（OFC）是在千兆位链路模块（GLM）型收发器设备上实现的传统眼睛安全电气联锁系统，并不被认为与SFP收发器相关。* 5激光类型“ LL ”（长长度）通常与1550nm相关联，窄光谱宽度的激光器能够实现非常长的链路长度。* 6激光类型“ LC ”（低成本）通常与能够长到中等长度的1310nm激光器相关联。* 7类SN和SA是互斥的。两者都没有OFC。 SN具有限制Rx输出，SA具有每个FC-PI-4的线性Rx输出。* 8有关应用铜缆标准规范的定义，请参见字节60和61。

Ethernet Compliance Codes			Fibre Channel Speed		
6	7	BASE-PX *3	10	7	1200 MBytes/sec
6	6	BASE-BX10 *3	10	6	800 MBytes/sec
6	5	100BASE-FX	10	5	1600 MBytes/sec
6	4	100BASE-LX/LX10	10	4	400 MBytes/sec
6	3	1000BASE-T	10	3	3200 MBytes/sec
6	2	1000BASE-CX	10	2	200 MBytes/sec
6	1	1000BASE-LX *3	10	1	Unallocated
6	0	1000BASE-SX	10	0	100 MBytes/sec

*1 Bit 7 is the high order bit and is transmitted first in each byte.
*2 SONET compliance codes require reach specifier bits 3 and 4 in Table 5-4 to completely specify transceiver capabilities.
*3 Ethernet LX, PX and BX compliance codes require the use of the Bit Rate, Nominal value (byte 12), link length values for single mode and two types of multimode fiber (Bytes 14-17) and wavelength value for the laser (Bytes 60 & 61) as specified in Table 4-1 to completely specify transceiver capabilities. See Table 4-3 and Table 5-6 for examples of setting values for these parameters.
*4 Note: Open Fiber Control (OFC) is a legacy eye safety electrical interlock system implemented on Gigabit Link Module (GLM) type transceiver devices and is not considered relevant to SFP transceivers.
*5 Laser type "LL" (long length) is usually associated with 1550nm, narrow spectral width lasers capable of very long link lengths.
*6 Laser type "LC" (low cost) is usually associated with 1310nm lasers capable of medium to long link lengths.
*7 Classes SN and SA are mutually exclusive. Both are without OFC. SN has a limiting Rx output, SA has a linear Rx output, per FC-PI-4.
*8 Refer to bytes 60 and 61 for definitions of the application copper cable standard specification.

5.5 SONET Compliance Code Specifiers [Address A0h, Bytes 3-10]

The SONET compliance code bits allow the host to determine with which specifications a SONET transceiver complies. For each bit rate defined in Table 5-3 (OC-3, OC-12, OC-48), SONET specifies short reach (SR), intermediate reach (IR), and long reach (LR) requirements. For each of the three bit rates, a single short reach (SR) specification is defined. Two variations of intermediate reach (IR-1, IR-2) and three variations of long reach (LR-1, LR-2, and LR-3) are also defined for each bit rate. Byte 4, bits 0-2, and byte 5, bits 0-7 allow the user to determine which of the three reaches has been implemented - short, intermediate, or long. Two additional 'specifier' bits (byte 4, bits 3-4) are necessary to discriminate between different intermediate or long reach variations.

TABLE 5-4 SONET COMPLIANCE CODE SPECIFIERS

Speed	Reach	Specifier bit 1 (Byte 4 bit 4)	Specifier bit 2 (Byte 4 bit 3)	Description
OC 3/OC 12/OC 48/OC 192	Short	0	0	SONET SR compliant *1
OC 3/OC 12/OC 48/OC 192	Short	1	0	SONET SR-1 compliant *2
OC 3/OC 12/OC 48	Intermediate	1	0	SONET IR-1 compliant
OC 3/OC 12/OC 48	Intermediate	0	1	SONET IR-2 compliant
OC 3/OC 12/OC 48	Long	1	0	SONET LR-1 compliant
OC 3/OC 12/OC 48	Long	0	1	SONET LR-2 compliant
OC 3/OC 12/OC 48	Long	1	1	SONET LR-3 compliant
*1 OC 3/OC 12 SR is multimode based short reach *2 OC 3/OC 12 SR-1 is single-mode based short reach				

SONET符合代码规范[地址A0h，字节3-10]
SONET符合性码位允许主机确定SONET收发器符合哪些规范。对于表5-3（OC-3，OC-12，OC-48）中定义的每个比特率，SONET指定短距离（SR），中距离（IR）和长距离（LR）要求。对于三个比特率中的每一个，定义单个短距离（SR）规范。对于每个比特率，也定义了中间到达（IR-1，IR-2）和长距离的三种变化（LR-1，LR-2和LR-3）的两种变化。字节4，位0-2和字节5，位0-7允许用户确定三个到达中的哪一个已经被实现 - 短，中间或长。需要两个额外的“说明符”位（字节4，位3-4）来区分不同的中间或长距离变化。

TABLE 5-5 TRANSCEIVER IDENTIFICATION EXAMPLES

		Address A0h Transceiver Code Fields							
Transceiver Type	**Transceiver Description**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**	**Byte 9**	**Byte 10**
100-M5-SN-I and 100-M6-SN-I	1062.5 MBd MM 850nm 500m/50um, 300m/62.5um	00h	00h	00h	00h	20h	40h	0Ch	01h
200-SM-LC-L and 100-SM-LC-L	2125 MBd 10km SM 1310nm	00h	00h	00h	00h	12h	00h	01h	05h
400-M5-SN-I and 400-M6-SN-I *1	4/2/1 GBd MM 850nm 150m/50um, 70m/62.5um	00h	00h	00h	00h	20h	40h	0Ch	15h
800-M5-SN-I and 800-M6-SN-I *1	8/4/2 GBd MM 850nm 50um & 62.5um	00h	00h	00h	00h	20h	40h	0Ch	54h
400-SM-LC-M *1	4250 MBd SM 1310nm 4km "medium" length	00h	00h	00h	00h	0Ah	00h	01h	15h
400-SM-LC-L *1	4250 MBd SM 1310nm 10km "long" length	00h	00h	00h	00h	12h	00h	01h	15h
200-SM-LL-V and 100-SM-LL-V	2125 MBd 50km SM 1550nm	00h	00h	00h	00h	80h	10h	01h	05h
1000BASE-T	1250 MBd 100m Cat 5 Cable	00h	00h	00h	08h	00h	00h	00h	00h
1000BASE-SX	1250 MBd 550m MM 850nm	00h	00h	00h	01h	00h	00h	00h	00h
1000BASE-LX	1250 MBd 5km SM 1310nm	00h	00h	00h	02h *2	00h	00h	00h	00h
1000BASE-LX10	1250 MBd 10km SM 1310nm	00h	00h	00h	02h *2	00h	00h	00h	00h
10GBASE-SR	10.3125 GBd 300m OM3 MM 850nm	10h	00h	00h	00h	00h	00h	00h	00h
10GBASE-LR	10.3125 GBd 10km SM 1310nm	20h	00h	00h	00h	00h	00h	00h	00h
OC3/STM1 SR-1	155 MBd 2km SM 1310nm	00h	00h	01h	00h	00h	00h	00h	00h
OC12/STM4 LR-1	622 MBd 40km SM 1310nm	00h	10h	40h	00h	00h	00h	00h	00h
OC48/STM16 LR-2	2488 MBd 80km SM 1550nm	00h	0Ch	00h	00h	00h	00h	00h	00h
	10GE Passive copper cable with embedded SFP ends *3 *4	00h	00h	00h	00h	00h	04h	00h	00h
	10GE Active cable with embedded SFP ends *3 *4	00h	00h	00h	00h	00h	08h	00h	00h
	8/4/2G Passive copper cable with embedded SFP ends[3]	00h	00h	00h	00h	00h	04h	00h	54h
	8/4/2G Active cable with embedded SFP ends[3]	00h	00h	00h	00h	00h	08h	00h	54h

*1 The assumption for this example is the transceiver is "4-2-1" compatible, meaning operational at 4.25 Gb/s, 2.125 Gb/s & 1.0625 Gb/s.

*2 To distinguish between 1000BASE-LX and 1000BASE-LX10, A0h Bytes 12 to18 must be used … see Table 4-1 and Table 4-2 for more information.

*3 See A0h Bytes 60 and 61 for compliance of these media to industry electrical specifications.

*4 For Ethernet and Sonet applications, data rate capability of these links will be identified in A0h Byte 12 [nominal bit rate identifier]. This is due to no formal IEEE designation for passive and active cable interconnects, and lack of corresponding identifiers in Table 5-3.

5.6 Encoding [Address A0h, Byte 11]

The encoding value indicates the serial encoding mechanism that is the nominal design target of the particular transceiver. The value shall be contained in the two-wire interface data. These values are maintained in the Transceiver Management section of SFF-8024.

* 1这个例子的假设是收发器是“4-2-1”兼容的，意思是在4.25Gb / s，2.125Gb / s和1.0625Gb / s的情况下工作。
* 2要区分1000BASE-LX和1000BASE-LX10，必须使用A0h字节12至18 ...有关详细信息，请参见表4-1和表4-2。
* 3请参阅A0h字节60和61，以符合这些介质与工业电气规格。
* 4对于以太网和Sonet应用，这些链路的数据速率能力将在A0h字节12 [标称比特率标识符]中标识。这是由于没有正式的IEEE指定被动和有源电缆互连，并且表5-3中没有相应的标识符。

编码值表示作为特定收发器的标称设计目标的串行编码机制。该值应包含在两线接口数据中。这些值在SFF-8024的收发器管理部分维护。

BR，标称[地址A0h，字节12]
标称位（信号）速率（BR，标称值）以100 MBd为单位指定，舍入到最接近的100 MBd。比特率包括编码和限定信号所需的那些位以及携带数据信息的那些位。 FFh值表示比特率大于25.0Gb / s，地址66和67用于确定比特率。值为0表示比特率未指定，必须从收发器技术确定。实际的信息传输速率将取决于由编码值定义的数据的编码。

速率标识符[地址A0h，字节13]
速率标识符字节是指Rate_Select或Application_Select控制行为的几个（可选）行业标准定义，旨在管理多个工作速率的收发器优化。

5.7 BR, nominal [Address A0h, Byte 12]

The nominal bit (signaling) rate (BR, nominal) is specified in units of 100 MBd, rounded off to the nearest 100 MBd. The bit rate includes those bits necessary to encode and delimit the signal as well as those bits carrying data information. A value of FFh indicates the bit rate is greater than 25.0Gb/s and addresses 66 and 67 are used to determine bit rate. A value of 0 indicates that the bit rate is not specified and must be determined from the transceiver technology. The actual information transfer rate will depend on the encoding of the data, as defined by the encoding value.

5.8 Rate Identifier [Address A0h, Byte 13]

The rate identifier byte refers to several (optional) industry standard definitions of Rate_Select or Application_Select control behaviors, intended to manage transceiver optimization for multiple operating rates.

TABLE 5-6 RATE IDENTIFIER

A0h	Value	Description
13	00h	Unspecified
	01h	SFF-8079 (4/2/1G Rate_Select & AS0/AS1)
	02h	SFF-8431 (8/4/2G Rx Rate_Select only)
	03h	Unspecified *
	04h	SFF-8431 (8/4/2G Tx Rate_Select only)
	05h	Unspecified *
	06h	SFF-8431 (8/4/2G Independent Rx & Tx Rate_select)
	07h	Unspecified *
	08h	FC-PI-5 (16/8/4G Rx Rate_select only) High=16G only, Low=8G/4G
	09h	Unspecified *
	0Ah	FC-PI-5 (16/8/4G Independent Rx, Tx Rate_select) High=16G only, Low=8G/4G
	0Bh	Unspecified *
	0Ch	FC-PI-6 (32/16/8G Independent Rx, Tx Rate_Select) High=32G only, Low = 16G/8G
	0Dh	Unspecified *
	0Eh	10/8G Rx and Tx Rate_Select controlling the operation or locking modes of the internal signal conditioner, retimer or CDR, according to the logic table defined in Table 10-2, High Bit Rate (10G) =9.95-11.3 Gb/s; Low Bit Rate (8G) = 8.5 Gb/s. In this mode, the default value of bit 110.3 (Soft Rate Select RS(0), Table 9-11) and of bit 118.3 (Soft Rate Select RS(1), Table 10-1) is 1.
	0Fh	Unspecified *
	10h -FFh	Unallocated

* To support legacy, the LSB is reserved for Unspecified or INF-8074 (value = 0) or 4/2/1G selection per SFF-8079 (value = 1). Other rate selection functionalities are not allowed to depend on the LSB.

10 / 8G Rx和Tx Rate_Select根据表10-2中定义的逻辑表，控制内部信号调节器，重定时器或CDR的操作或锁定模式;高比特率（10G）= 9.95-11.3 Gb / s,低比特率（8G）= 8.5Gb / s。在此模式下，位110.3（软速率选择RS（0），表9-11）和位118.3（软比率选择RS（1），表10-1）的默认值为1。

从原始GBIC定义添加EEPROM数据。该值指定在符合适用标准的情况下，使用单模光纤收发器支持的链路长度。价值以公里为单位。值255表示收发器支持长度大于254km的链路长度。值为零表示收发器不支持单模光纤，或者必须从收发器技术确定长度信息。

6. Link Length

6.1 Length (single mode)-km [Address A0h, Byte 14]

Addition to EEPROM data from original GBIC definition. This value specifies the link length that is supported by the transceiver while operating in compliance with the applicable standards using single mode fiber. The value is in units of kilometers. A value of 255 means that the transceiver supports a link length greater than 254 km. A value of zero means that the transceiver does not support single mode fiber or that the length information must be determined from the transceiver technology.

6.2 Length (single mode)-(100's)m [Address A0h, Byte 15]

This value specifies the link length that is supported by the transceiver while operating in compliance with the applicable standards using single mode fiber. The value is in units of 100 meters. A value of 255 means that the transceiver supports a link length greater than 25.4 km. A value of zero means that the transceiver does not support single mode fiber or that the length information must be determined from the transceiver technology.

该值指定在符合适用标准的情况下使用单模光纤，收发器支持的链路长度。价值以100米为单位。值为255表示收发器支持的链路长度大于25.4公里。值为零表示收发器不支持单模光纤，或者必须从收发器技术确定长度信息。

该值指定使用50微米多模OM2 [850nm的500MHz * km]光纤标准的收发器支持的链路长度。值以10米为单位。值255表示收发器支持的链路长度大于2.54 km。值为零表示收发器不支持50微米多模光纤，或者必须从收发器技术确定长度信息。

该值指定使用62.5微米多模OM1 [850 MHz时为200 MHz * km，1310nm为500 MHz * km]符合适用的标准的光纤收发器支持的链路长度。值以10米为单位。值255表示收发器支持的链路长度大于2.54 km。一个值为零意味着收发器不支持62.5微米多模光纤，或者长度信息必须从收发器技术确定。多模收发器通常支持OM1，OM2和OM3光纤。

长度（50um，OM3）[地址A0h，字节19]
该值指定在使用50微米多模OM3 [2000 MHz * km]光纤的符合适用标准的情况下，收发器支持的链路长度。价值以10米为单位。值255表示收发器支持的链路长度大于2.54 km。值为零表示收发器不支持50微米多模光纤，或者必须从收发器技术确定长度信息。

6.3 Length (50um, OM2) [Address A0h, Byte 16]

This value specifies link length that is supported by the transceiver while operating in compliance with applicable standards using 50 micron multimode OM2 [500MHz*km at 850nm,] fiber. The value is in units of 10 meters. A value of 255 means that the transceiver supports a link length greater than 2.54 km. A value of zero means that the transceiver does not support 50 micron multimode fiber or that the length information must be determined from the transceiver technology.

6.4 Length (62.5um, OM1) [Address A0h, Byte 17]

This value specifies link length that is supported by the transceiver while operating in compliance with applicable standards using 62.5 micron multimode OM1 [200 MHz*km at 850nm, 500 MHz*km at 1310nm] fiber. The value is in units of 10 meters. A value of 255 means that the transceiver supports a link length greater than 2.54 km. A value of zero means that the transceiver does not support 62.5 micron multimode fiber or that the length information must determined from the transceiver technology. It is common for a multimode transceiver to suppor OM1, OM2 and OM3 fiber.

6.5 Length (50um, OM4) and Length (Active Cable or Copper) [Address A0h, Byte 18]

For optical links, this value specifies link length that is supported by the transceiver while operating in compliance with applicable standards using 50 micron multimode OM4 [4700 MHz*km] fiber. The value is in units of 10 meters. A value of 255 means that the transceiver supports a link length greater than 2.54 km. A value of zero means that the transceiver does not support 50 micron multimode fiber or that the length information must be determined from the transceiver codes specified in Table 5-3.

For copper links, this value specifies minimum link length supported by the transceiver while operating in compliance with applicable standards using copper cable. For active cable, this value represents actual length. The value is in units of 1 meter. A value of 255 means the transceiver supports a link length greater than 254 meters. A value of zero means the transceiver does not support copper or active cables or the length information must be determined from transceiver technology. Further information about cable design, equalization, and connectors is usually required to guarantee meeting a particular length requirement.

6.6 Length (50um, OM3) [Address A0h, Byte 19]

This value specifies link length that is supported by the transceiver while operating in compliance with applicable standards using 50 micron multimode OM3 [2000 MHz*km] fiber. The value is in units of 10 meters. A value of 255 means that the transceiver supports a link length greater than 2.54 km. A value of zero means that the transceiver does not support 50 micron multimode fiber or that the length information must be determined from the transceiver technology.

长度（50um，OM4）和长度（有源电缆或铜缆）[地址A0h，字节18]
对于光链路，该值指定使用50微米多模OM4 [4700 MHz * km]光纤符合适用标准的收发器支持的链路长度。值以10米为单位。值255表示收发器支持的链路长度大于2.54 km。值为零意味着收发器不支持50微米多模光纤，或者长度信息必须从表5-3中指定的收发器代码确定。
对于铜链路，该值指定使用铜缆连接符合适用的标准的收发器支持的最小链路长度。对于有源电缆，该值表示实际长度。值以1米为单位。值为255表示收发器支持大于254米的链路长度。值为零表示收发器不支持铜缆或有源电缆，或者长度信息必须由收发器技术确定。通常需要有关电缆设计，均衡和连接器的更多信息来保证满足特定的长度要求。

7. Vendor Fields

7.供应商字段
7.1供应商名称[地址A0h，字节20-35]
供应商名称是一个包含ASCII字符的16个字符的字段，左对齐并在右侧填充ASCII空格（20h）。供应商名称应为公司的全称，公司名称的公认缩写，公司的SCSI公司代码或公司的证券交换代码。供应商名称或供应商OUI字段中的至少一个应包含有效数据。

7.1 Vendor name [Address A0h, Bytes 20-35]

The vendor name is a 16 character field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h). The vendor name shall be the full name of the corporation, a commonly accepted abbreviation of the name of the corporation, the SCSI company code for the corporation, or the stock exchange code for the corporation. At least one of the vendor name or the vendor OUI fields shall contain valid data.

7.2供应商OUI [地址A0h，字节37-39]
供应商组织唯一标识符字段（供应商OUI）是包含供应商的IEEE公司标识符的3字节字段。3字节字段中全为零的值表示未指定供应商OUI。

7.2 Vendor OUI [Address A0h, Bytes 37-39]

The vendor organizationally unique identifier field (vendor OUI) is a 3-byte field that contains the IEEE Company Identifier for the vendor. A value of all zero in the 3-byte field indicates that the Vendor OUI is unspecified.

7.3供应商PN [地址A0h，字节40-55]
供应商部件号（供应商PN）是一个包含ASCII字符的16字节的字段，左对齐并在右侧填充ASCII空格（20h），定义供应商部件号或产品名称。16字节字段中全零的值表示供应商PN未指定。

7.3 Vendor PN [Address A0h, Bytes 40-55]

The vendor part number (vendor PN) is a 16-byte field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the vendor part number or product name. A value of all zero in the 16-byte field indicates that the vendor PN is unspecified.

7.4供应商版本[地址A0h，字节56-59]
供应商修订号（供应商rev）是一个包含ASCII字符的4字节字段，左对齐并在右侧填充ASCII空格（20h），定义供应商的产品版本号。4字节字段中全为零的值表示未指定供应商版本。

7.4 Vendor Rev [Address A0h, Bytes 56-59]

The vendor revision number (vendor rev) is a 4-byte field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the Vendor's product revision number. A value of all zero in the 4-byte field indicates that the vendor revision is unspecified.

8.1光纤和电缆变体规格符合性[地址A0h，字节60-61]
对于光学变型，如在A0h字节8位2和3中具有零定义的，字节60和61表示室温下的标称发射机输出波长。 16位值，字节60为高位字节，字节61为低位字节。激光波长等于16位整数值，单位为nm。该字段允许用户直接读取激光波长，因此不需要从收发器代码A0h字节3到10推断出（参见表5-3）。这也允许规定收发器码中未涵盖的波长，例如在粗WDM系统中使用的波长。
对于无源和有源电缆变体，A0h字节60和字节61的值为00h表示未指定激光波长或电缆规格符合性。

8. Link Characteristics

8.1 Optical and Cable Variants Specification Compliance [Address A0h, Bytes 60-61]

For optical variants, as defined by having zero's in A0h Byte 8 bits 2 and 3, Bytes 60 and 61 denote nominal transmitter output wavelength at room temperature. 16 bit value with byte 60 as high order byte and byte 61 as low order byte. The laser wavelength is equal to the 16 bit integer value in nm. This field allows the user to read the laser wavelength directly, so it is not necessary to infer it from the Transceiver Codes A0h Bytes 3 to 10 (see Table 5-3). This also allows specification of wavelengths not covered in the Transceiver Codes, such as those used in coarse WDM systems.

For passive and active cable variants, a value of 00h for both A0h Byte 60 and Byte 61 denotes laser wavelength or cable specification compliance is unspecified.

TABLE 8-1 PASSIVE CABLE SPECIFICATION COMPLIANCE (A0H BYTE 8 BIT 2 SET)

A0h	Bit	Description	A0h	Bit	Description
60	7	Unallocated	61	7	Unallocated
60	6	Unallocated	61	6	Unallocated
60	5	Reserved for SFF-8461	61	5	Unallocated
60	4	Reserved for SFF-8461	61	4	Unallocated
60	3	Reserved for SFF-8461	61	3	Unallocated
60	2	Reserved for SFF-8461	61	2	Unallocated
60	1	Compliant to FC-PI-4 Appendix H	61	1	Unallocated
60	0	Compliant to SFF-8431 Appendix E	61	0	Unallocated

TABLE 8-2 ACTIVE CABLE SPECIFICATION COMPLIANCE (A0H BYTE 8 BIT 3 SET)

A0h	Bit	Description	A0h	Bit	Description
60	7	Unallocated	61	7	Unallocated
60	6	Unallocated	61	6	Unallocated
60	5	Unallocated	61	5	Unallocated
60	4	Unallocated	61	4	Unallocated
60	3	Compliant to FC-PI-4 Limiting	61	3	Unallocated
60	2	Compliant to SFF-8431 Limiting	61	2	Unallocated
60	1	Compliant to FC-PI-4 Appendix H	61	1	Unallocated
60	0	Compliant to SFF-8431 Appendix E	61	0	Unallocated

8.2 CC_BASE [Address A0h, Byte 63]

The check code is a one byte code that can be used to verify that the first 64 bytes of two-wire interface information in the SFP is valid. The check code shall be the low order 8 bits of the sum of the contents of all the bytes from byte 0 to byte 62, inclusive.

CC_BASE [地址A0h，字节63]
检查码是一个单字节代码，可用于验证SFP中前64个字节的两线接口信息是否有效。校验码应为从字节0到字节62（包括端值）的所有字节的内容之和的低位8位。

8.3选项值[地址A0h，字节64-65]选项字段中的位应指定在收发器中实现的选项。

分页实现指标。值1表示实现了寻呼，设备地址A2h的字节127d用于页面选择。

8.3 Option Values [Address A0h, Bytes 64-65]

The bits in the option field shall specify the options implemented in the transceiver.

TABLE 8-3 OPTION VALUES

A0h	Bit	Description
64	7-6	Unallocated
	5	High Power Level Declaration (see SFF-8431 Addendum) Value of zero identifies standard Power Levels 1 and 2 as indicated by bit 1. Value of one identifies Power Level 3 requirement.
	4	Paging implemented indicator. A value of 1 indicates that paging is implemented and byte 127d of device address A2h is used for page selection.
	3	Retimer or CDR indicator. A value of 1 indicates that the transceiver has an internal retimer or Clock and Data Recovery (CDR) circuit.
	2	Cooled Transceiver Declaration (see SFF-8431). Value of zero identifies a conventional uncooled (or unspecified) laser implementation. Value of one identifies a cooled laser transmitter implementation.
	1	Power Level Declaration (see SFF-8431). Value of zero identifies Power Level 1 (or unspecified) requirements. Value of one identifies Power Level 2 requirement. See Table 8-7 and Table 10-1 for control, status, timing. See Bit 5 for Power Level 3 declaration.
	0	Linear Receiver Output Implemented (see SFF-8431). Value of zero identifies a conventional limiting (or unspecified) receiver output. Value of one identifies a linear receiver output.
65	7	Receiver decision threshold implemented. A value of 1 indicates that RDT is implemented.
	6	Tunable transmitter technology. A value of 1 indicates that the transmitter wavelength/frequency is tunable in accordance with SFF-8690.
	5	RATE_SELECT functionality is implemented NOTE: Lack of implementation does not indicate lack of simultaneous compliance with multiple standard rates. Compliance with particular standards should be determined from Transceiver Code Section (Table 5-3). Refer to Table 5-6 for Rate_Select functionality type identifiers.
	4	TX_DISABLE is implemented and disables the high speed serial output.
	3	TX_FAULT signal implemented. (See SFP MSA)
	2	Loss of Signal implemented, signal inverted from standard definition in SFP MSA (often called "Signal Detect"). NOTE: This is not standard SFP/GBIC behavior and should be avoided, since non-interoperable behavior results.
	1	Loss of Signal implemented, signal as defined in SFP MSA (often called "Rx_LOS").
	0	Unallocated

高功率级别声明（见SFF-8431附录）零值表示由位1指示的标准功率级别1和2。0值标识功率等级3要求。

Retimer或CDR指示剂。值为1表示收发器具有内部重定时器或时钟和数据恢复（CDR）电路。

实现线性接收器输出（见SFF-8431）。零值表示传统的限制（或未指定）接收器输出。1识别线性接收器输出。

收发器制冷声明（见SFF-8431）。零值表示传统的未冷却（或未指定）激光器。1值识别冷却的激光发射机。

RATE_SELECT功能被实现
注意：缺乏实施并不表示缺乏同时遵守多种标准费率。应从收货代码部分（表5-3）确定符合特定标准。有关Rate_Select功能类型标识符，请参见表5-6。

功率级别声明（见SFF-8431）。零值表示功率级别1（或未指定）要求。1标识功率级别2要求。控制，状态，时序见表8-7和表10-1。有关功率级别3的声明，请参见第5位。

接收机决策阈值实现。值1表示实现了RDT。

可调谐变送器技术。值1表示发射机波长/频率可根据SFF-8690进行调节。

如果地址12未设置为FFh，则收发器仍将满足其规格中（BR，最大）的高比特率限制，并以比标称比特率高1%的单位进行指定。如果地址12设置为FFh，则标称位（信令）速率（BR，额定值）以250 MBd为单位指定，舍入到最接近的250 MBd。值00h表示未指定该字段。

实现TX_DISABLE，禁用高速串行输出。

TX_FAULT信号实现。（见SFP MSA）

信号丢失实现，信号在SFP MSA中的标准定义中反转。（通常称为“信号检测”）注意：这不是标准的SFP / GBIC行为，应该避免，因为不可互操作。

信号丢失实现，SFP MSA中定义的信号（通常称为“Rx_LOS”）。

8.4 BR, max [Address A0h, Byte 66]

If address 12 is not set to FFh, the upper bit rate limit at which the transceiver will still meet its specifications (BR, max) is specified in units of 1% above the nominal bit rate. If address 12 is set to FFh, the nominal bit (signaling) rate (BR, nominal) is specified in units of 250 MBd, rounded off to the nearest 250 MBd. A value of 00h indicates that this field is not specified.

8.5 BR, min [Address A0h, Byte 67]

If address 12 is not set to FFh, the lower bit rate limit at which the transceiver will still meet its specifications (BR, min) is specified in units of 1% below the nominal bit rate. If address 12 is set to FFh, the limit range of bit rates specified in units of +/- 1% around the nominal signaling rate. A value of zero indicates that this field is not specified.

如果地址12未设置为FFh，则收发器仍将满足其规格中（BR，min）的较低比特率限制，以低于标称比特率1%的单位指定。如果地址12设置为FFh，则以标称信令速率的+/- 1%为单位指定的比特率的限制范围。值为零表示未指定此字段

供应商序列号（供应商SN）是一个包含ASCII字符的16个字符的字段，左对齐，右侧填充ASCII空格（20h），定义了收发器的供应商序列号。 16字节字段中的全部零值表示供应商SN未指定。

8.6 Vendor SN [Address A0h, Bytes 68-83]

The vendor serial number (vendor SN) is a 16 character field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the Vendor's serial number for the transceiver. A value of all zero in the 16-byte field indicates that the vendor SN is unspecified.

日期代码是一个8字节的字段，其中包含供应商日期代码的ASCII字符。日期代码是强制性的。

8.7 Date Code [Address A0h, Bytes 84-91]

The date code is an 8-byte field that contains the Vendor's date code in ASCII characters. The date code is mandatory.

TABLE 8-4 DATE CODE

A0h	Description
84-85	ASCII code, two low order digits of year. (00 = 2000).
86-87	ASCII code, digits of month (01 = Jan through 12 = Dec)
88-89	ASCII code, day of month (01-31)
90-91	ASCII code, vendor specific lot code, may be blank

8.8 Diagnostic Monitoring Type [Address A0h, Byte 92]

"Diagnostic Monitoring Type" is a 1 byte field with 8 single bit indicators describing how diagnostic monitoring is implemented in the particular transceiver.

Note that if bit 6, address 92 is set indicating that digital diagnostic monitoring has been implemented, received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring must all be implemented. Additionally, alarm and warning thresholds must be written as specified in this document at locations 00 to 55 on 2 wire serial address 1010001X (A2h) (see Table 8-5).

Two calibration options are possible if bit 6 has been set indicating that digital diagnostic monitoring has been implemented. If bit 5, "Internally calibrated", is set, the transceiver directly reports calibrated values in units of current, power etc. If bit 4, "Externally calibrated", is set, the reported values are A/D counts which must be converted to real world units using calibration values read using 2 wire serial address 1010001X (A2h) from bytes 56 to 95. See "Diagnostics" section for details.

Bit 3 indicates whether the received power measurement represents average input optical power or OMA. If the bit is set, average power is monitored. If it is not, OMA is monitored.

8.9 Addressing Modes

Bit 2 indicates whether or not it is necessary for the host to perform an address change sequence before accessing information at 2-wire serial address A2h. If this bit is not set, the host may simply read from either address, A0h or A2h, by using that value in the address byte during the 2-wire communication sequence. If the bit is set, the following sequence must be executed prior to accessing information at address A2h. Once A2h has been accessed, it will be necessary to execute the address change sequence again prior to reading from A0h. The address change sequence is defined as the following steps on the 2 wire serial interface:

1) Host controller performs a Start condition, followed by a slave address of 0b00000000. Note that the R/W bit of this address indicates transfer from host to device (‘0'b).
2) Device responds with Ack
3) Host controller transfers 0b00000100 (04h) as the next 8 bits of data
   This value indicates that the device is to change its address
4) Device responds with Ack
5) Host controller transfers one of the following values as the next 8 bits of data:
   0bXXXXXX00 - specifies Two-wire interface ID memory page
   0bXXXXXX10 - specifies Digital Diagnostic memory page
6) Device responds with Ack
7) Host controller performs a Stop condition
8) Device changes address that it responds to, based on the Step 5 byte value above:
   0bXXXXXX00 - address becomes 0b1010000X (A0h)
   0bXXXXXX10 - address becomes 0b1010001X (A2h)

位2指示在访问2线串行地址A2h之前的信息时，主机是否需要执行地址改变序列。如果该位未设置，则在2线通信序列期间，主机可以通过在地址字节中使用该值来简单地从任一地址A0h或A2h读取。如果该位被置位，则在访问地址A2h之前的信息时必须执行以下序列。一旦访问了A2h，就需要在从A0h读取之前再次执行地址更改序列。
2线串行接口的地址变更顺序如下：
1）主机控制器执行启动条件，后跟从地址为0b00000000。请注意，该地址的R / W位表示从主机传输到设备（'0'b）。
2）设备用Ack响应
3）主机控制器将0b00000100（04h）作为接下来的8位数据传输
该值表示设备要更改其地址
4）设备用Ack响应
5）主机控制器将以下值之一作为下一个8位数据传输：
0bXXXXXX00 - 指定两线接口ID内存页
0bXXXXXX10 - 指定数字诊断内存页面
6）设备用Ack响应
7）主机控制器执行停止条件
8）设备根据上述步骤5字节值更改其响应的地址：
0bXXXXXX00 - 地址变为0b1010000X（A0h）
0bXXXXXX10 - 地址变为0b1010001X（A2h）

"Diagnostic Monitoring Type" 是一个1字节的字段，其中8个单个位描述了在特定收发器中如何实现。注意，如果位6，地址92被设置为指示已经实现数字化，则必须实现接收功率监视，发射功率监视，偏置电流监视，电源电压监视和温度监视。另外，报警和警告阈值必须按照本文档的规定，在2线串行地址1010001X（A2h）（见表8-5）的位置00至55上写入。如果已经设置了第6位表示数字化已被实现，则两个校准选项是可能的。如果位5设置为“内部校准”，则收发器直接以电流，功率等为单位报告校准值。如果设置了第4位“外部校准”，则报告的值为必须转换的A / D计数，使用从字节56到95的2线串行地址1010001X（A2h）读取的现实世界单位的校准值。有关详细信息，请参见“诊断”部分。
位3指示接收功率测量是表示平均输入光功率还是OMA。如果该位被置位，则监视平均功率。如果不是，则监视OMA。

TABLE 8-5 DIAGNOSTIC MONITORING TYPE

A0h	Bit	Description
92	7	Reserved for legacy diagnostic implementations. Must be '0' for compliance with this document.
	6	Digital diagnostic monitoring implemented (described in this document). Must be '1' for compliance with this document.
	5	Internally calibrated
	4	Externally calibrated
	3	Received power measurement type 0 = OMA, 1 = average power
	2	Address change required see section above, "addressing modes"
	1-0	Unallocated

8.10 Enhanced Options [Address A0h, Byte 93]

The Enhanced Options are a one byte field with 8 single bit indicators which describe the optional digital diagnostic features implemented in the transceiver. Since transceivers will not necessarily implement all optional features described in this document, this field allows the host system to determine which functions are available over the 2 wire serial bus. A '1' indicates that the particular function is implemented in the transceiver. Bits 3 and 6 of byte 110 (see Table 9-11) allow the user to control the Rate_Select and TX_Disable functions. If these functions are not implemented, the bits remain readable and writable, but the transceiver ignores them.

Note that "soft" functions of TX_DISABLE, TX_FAULT, RX_LOS, and RATE_SELECT do not meet timing requirements as specified in the SFP MSA section B3 "Timing Requirements of Control and Status I/O" and the GBIC Specification, revision 5.5, (SFF-8053), section 5.3.1, for their corresponding pins. The soft functions allow a host to poll or set these values over the two-wire interface bus as an alternative to monitoring/setting pin values. Timing is vendor specific, but must meet the requirements specified in the table below. Asserting either the "hard pin" or "soft bit" (or both) for TX_DISABLE or RATE_SELECT will result in that function being asserted.

TABLE 8-6 ENHANCED OPTIONS

A0h	Bit	Description
93	7	Optional Alarm/warning flags implemented for all monitored quantities (see Table 9-12)
	6	Optional soft TX_DISABLE control and monitoring implemented
	5	Optional soft TX_FAULT monitoring implemented
	4	Optional soft RX_LOS monitoring implemented
	3	Optional soft RATE_SELECT control and monitoring implemented
	2	Optional Application Select control implemented per SFF-8079
	1	Optional soft Rate Select control implemented per SFF-8431
	0	Unallocated

增强型选项是一个单字节字段，具有8个单位指示器，用于描述收发器中实现的可选数字诊断功能。由于收发器不一定实现本文档中描述的所有可选功能，因此该字段允许主机系统通过2线串行总线确定哪些功能可用。 '1'表示特定功能在收发器中实现。字节110的位3和6（见表9-11）允许用户控制Rate_Select和TX_Disable函数。如果这些功能未被实现，则这些位保持可读写，但收发器忽略它们。
请注意，TX_DISABLE，TX_FAULT，RX_LOS和RATE_SELECT的“软”功能不符合SFP MSA部分B3“控制和状态I / O的时序要求”和GBIC规范版本5.5（SFF- 8053），第5.3.1节，针对相应的引脚。软功能允许主机通过双线接口总线轮询或设置这些值作为监视/设置引脚值的替代方法。
时间是供应商特定的，但必须满足下表中规定的要求。断言TX_DISABLE或RATE_SELECT的“硬引脚”或“软位”（或两者）将导致该功能被断言。

TABLE 8-7 I/O TIMING FOR SOFT (VIA 2-WIRE INTERFACE) CONTROL & STATUS FUNCTIONS

Parameter	Symbol	Min	Max	Units	Conditions
TX_DISABLE assert time	t_off		100	ms	Time from TX_DISABLE bit set *1 until optical output falls below 10% of nominal
TX_DISABLE deassert time	t_on		100	ms	Time from TX_DISABLE bit cleared *1 until optical output rises above 90% of nominal
Time to initialize, including reset of TX_FAULT	t_init		300	ms	Time from power on or negation of TX_FAULT using TX_DISABLE until transmitter output is stable *2
TX_FAULT assert time	t_fault		100	ms	Time from fault to TX_FAULT bit set.
RX_LOS assert time	t_loss_on		100	ms	Time from LOS state to RX_LOS bit set
RX_LOS deassert time	t_loss_off		100	ms	Time from non-LOS state to RX_LOS bit cleared
Rate select change time	t_rate_select		100 *3	ms	Time from change of state of Rate Select bit[1] until receiver bandwidth is in conformance with appropriate specification
Two-wire serial interface Clock rate	f_serial_clock		100	kHz	n/a
Two-wire serial interface Diagnostic data ready time	t_data		1000	ms	From power on to data ready, bit 0 of byte 110 set
Two-wire serial interface Bus hardware ready time	t_serial		300	ms	Time from power on until module is ready for data transmission over the two wire serial bus.
Optional. High Power Level assert time (per SFF-8431)	t_hpower_level		300	ms	Time from High Power Level enable bit set until module operation is stable. See Table 10-1 for control bit.

*1 Measured from falling clock edge after stop bit of write transaction.
*2 See SFF-8053 GBIC (Gigabit Interface Converter)
*3 The T11.2 committee, as part of its FC-PI-2 standardization effort, has advised that a 1ms maximum is required to be compatible with auto-negotiation algorithms documented in the FC-FS specification.

8.11 SFF-8472 Compliance [Address A0h, Byte 94]

Byte 94 contains an unsigned integer that indicates which feature set(s) are implemented in the transceiver.

TABLE 8-8 SFF-8472 COMPLIANCE

A0h	Value	Interpretation
94	00h	Digital diagnostic functionality not included or undefined.
	01h	Includes functionality described in Rev 9.3 of SFF-8472.
	02h	Includes functionality described in Rev 9.5 of SFF-8472.
	03h	Includes functionality described in Rev 10.2 of SFF-8472.
	04h	Includes functionality described in Rev 10.4 of SFF-8472.
	05h	Includes functionality described in Rev 11.0 of SFF-8472.
	06h	Includes functionality described in Rev 11.3 of SFF-8472.
	07h	Includes functionality described in Rev 11.4 of SFF-8472.
	08h	Includes functionality described in Rev 12.0 of SFF-8472.
	- FFh	Unallocated

检查码是一个单字节代码，可用于验证SFP中前32个字节的扩展两线接口信息是否有效。 校验码应为从字节64到字节94（包括端值）的所有字节的内容之和的低位8位。

8.12 CC_EXT [Address A0h, Byte 95]

The check code is a one byte code that can be used to verify that the first 32 bytes of extended two-wire interface information in the SFP is valid. The check code shall be the low order 8 bits of the sum of the contents of all the bytes from byte 64 to byte 94, inclusive.

2线串行总线地址1010001X（A2h）用于访问收发器温度，内部测量电源电压，TX偏置电流，TX输出功率，接收光功率和两个可选DWDM数据的测量值：激光器温度和TEC电流。取决于地址92处设置的选项位，这些值被不同地解释。如果设置了位5“内部校准”，则这些值是校准绝对测量值，应根据下面的“内部校准”部分进行解释。如果设置了位4“外部校准”，则这些值是A / D计数，它们将在后续章节“外部校准”中转换成实际单位。仅内部校准定义了可选的DWDM数据。测量参数在16位数据字段中报告，即两个级联字节。 16位数据字段允许宽动态范围。这并不意味着建议或要求使用16位A / D系统，以达到下述准确性目标。数据字段的宽度不应该被视为暗示给定的精度级别。可以想到，这里的精确度目标可以通过具有小于16位分辨率的系统来实现。建议将超出系统指定精度的任何低位数据位固定为零。整体系统的准确性和精度将取决于供应商。为了保证数据的一致性，主机需要从数据结构（IE：Rx功率MSB - A2h中的字节104，A2h中的Rx功率LSB - 字节105）中检索任何多字节字段，方法是使用在双线接口接口上的单个双字节读取序列。

收发器需要确保使用数据更新的任何多字节字段（例如，Rx功率MSB - A2h中的字节104，A2h中的Rx功率LSB - 字节105）必须以保证一致性的方式完成此更新，数据的一致性换句话说，收发器的多字节字段的更新不能发生，使得可以将部分更新的多字节字段传送到主机。

9.1 Overview [Address A2h]

2 wire serial bus address 1010001X (A2h) is used to access measurements of transceiver temperature, internally measured supply voltage, TX bias current, TX output power, received optical power, and two optional DWDM quantities: laser temperature, and TEC current.

此外，在将该多字节字段传送到主机期间，收发器不应更新结构内的多字节字段，使得部分更新的数据将被传送到主机。以下规定的精度要求应适用于相关标准规定的运行信号范围。应详细了解制造商的规格，以了解满足精度要求的条件。

内部校准测量根据供应商指定的工作温度和电压进行校准，应解释如下。应以与实时16位数据相同的方式解释报警和警告阈值。

The values are interpreted differently depending upon the option bits set at address 92. If bit 5 "internally calibrated" is set, the values are calibrated absolute measurements, which should be interpreted according to the section "Internal Calibration" below. If bit 4 "externally calibrated" is set, the values are A/D counts, which are converted into real units per the subsequent section titled "External Calibration". The optional DWDM quantities are defined for internal calibration only.

Measured parameters are reported in 16 bit data fields, i.e., two concatenated bytes. The 16 bit data fields allow for wide dynamic range. This is not intended to imply that a 16 bit A/D system is recommended or required in order to achieve the accuracy goals stated below. The width of the data field should not be taken to imply a given level of precision. It is conceivable that the accuracy goals herein can be achieved by a system having less than 16 bits of resolution. It is recommended that any low-order data bits beyond the system's specified accuracy be fixed at zero. Overall system accuracy and precision will be vendor dependent.

To guarantee coherency of the diagnostic monitoring data, the host is required to retrieve any multi-byte fields from the diagnostic monitoring data structure (IE: Rx Power MSB - byte 104 in A2h, Rx Power LSB - byte 105 in A2h) by the use of a single two-byte read sequence across the two-wire interface interface.

The transceiver is required to ensure that any multi-byte fields which are updated with diagnostic monitoring data (e.g. Rx Power MSB - byte 104 in A2h, Rx Power LSB - byte 105 in A2h) must have this update done in a fashion which guarantees coherency and consistency of the data. In other words, the update of a multi-byte field by the transceiver must not occur such that a partially updated multi-byte field can be transferred to the host. Also, the transceiver shall not update a multi-byte field within the structure during the transfer of that multi-byte field to the host, such that partially updated data would be transferred to the host.

Accuracy requirements specified below shall apply to the operating signal range specified in the relevant standard. The manufacturer's specification should be consulted for more detail on the conditions under which the accuracy requirements are met.

9.2 Internal Calibration

Measurements are calibrated over vendor specified operating temperature and voltage and should be interpreted as defined below. Alarm and warning threshold values should be interpreted in the same manner as real time 16 bit data.

1) Internally measured transceiver temperature. Represented as a 16 bit signed twos complement value in increments of 1/256 degrees Celsius, yielding a total range of -128C to +128C. Temperature accuracy is vendor specific but must be better than ±3 degrees Celsius over specified operating temperature and voltage. Please see vendor specification for details on location of temperature sensor. See Table 9-1 and Table 9-2 below for examples of temperature format.
2) Internally measured transceiver supply voltage. Represented as a 16 bit unsigned integer with the voltage defined as the full 16 bit value (0-65535) with LSB equal to 100 uVolt, yielding a total range of 0 to +6.55 Volts. Practical considerations to be defined by transceiver manufacturer will tend to limit the actual bounds of the supply voltage measurement. Accuracy is vendor specific but must be better than ±3% of the manufacturer's nominal value over specified operating temperature and voltage. Note that in some transceivers, transmitter supply voltage and receiver supply voltage are isolated. In that case, only one supply is monitored. Refer to the device specification for more detail.
3) Measured TX bias current in uA. Represented as a 16 bit unsigned integer with the current defined as the full 16 bit value (0-65535) with LSB equal to 2 uA, yielding a total range of 0 to 131 mA. Accuracy is vendor specific but must be better than ±10% of the manufacturer's nominal value over specified operating temperature and voltage.
4) Measured TX output power in mW. Represented as a 16 bit unsigned integer with the power defined as the full 16 bit value (0-65535) with LSB equal to 0.1 uW, yielding a total range of 0 to 6.5535 mW (~ -40

1）内部测量的收发器温度。以1/256摄氏度的增量表示为16位带符号二进制补码，产生-128C至+128C的总范围。温度精度是供应商特定的，但在指定的工作温度和电压下必须比±3摄氏度更好。有关温度传感器位置的详细信息，请参见供应商规范。有关温度格式的示例，请参见下表9-1和表9-2。

2）内部测量的收发器电源电压。表示为16位无符号整数，其电压定义为满16位值（0-65535），LSB等于100 uVolt，产生0到+6.55伏的总范围。收发器制造商定义的实际考虑将倾向于限制电源电压测量的实际范围。精度是供应商特定的，但必须比制造商的额定值超过指定工作温度和电压的±3%。请注意，在某些收发器中，发射机电源电压和接收器电源电压是隔离的。在这种情况下，只监控一个电源。有关详细信息，请参阅设备规范。

3）测量的uA为单位的TX偏置电流。表示为16位无符号整数，其电流定义为LSB等于2 uA的完整16位值（0-65535），产生0到131 mA的总范围。准确度是供应商特定的，但必须比制造商的额定值超过指定工作温度和电压的±10%。

4）测量的TX输出功率（mW）。表示为16位无符号整数，功率定义为全16位值（0-65535），LSB等于0.1 uW，总范围为0至6.5535 mW（～-40至+8.2 dBm）。假设数据是基于激光监测光电二极管电流的测量。使用最具代表性的光纤输出类型将其出厂校准为绝对单位。精度是供应商特定的，但在指定的温度和电压下必须比±3dB更好。当发射机被禁用时，数据无效。

to +8.2 dBm). Data is assumed to be based on measurement of laser monitor photodiode current. It is factory calibrated to absolute units using the most representative fiber output type. Accuracy is vendor specific but must be better than ±3dB over specified temperature and voltage. Data is not valid when the transmitter is disabled.

5) Measured RX received optical power in mW. Value can represent either average received power or OMA depending upon how bit 3 of byte 92 (A0h) is set. Represented as a 16 bit unsigned integer with the power defined as the full 16 bit value (0-65535) with LSB equal to 0.1 uW, yielding a total range of 0 to 6.5535 mW (~ -40 to +8.2 dBm). Absolute accuracy is dependent upon the exact optical wavelength. For the vendor specified wavelength, accuracy shall be better than ±3dB over specified temperature and voltage. This accuracy shall be maintained for input power levels up to the lesser of maximum transmitted or maximum received optical power per the appropriate standard. It shall be maintained down to the minimum transmitted power minus cable plant loss (insertion loss or passive loss) per the appropriate standard. Absolute accuracy beyond this minimum required received input optical power range is vendor specific.

6) Measured optional laser temperature. For DWDM applications bytes 106-107 report laser temperature, The encoding is the same as for transceiver internal temperature defined in row 1) above. The relative and absolute accuracy are vendor specific but relative laser temperature accuracy must be better than +/- 0.2 degrees Celsius. [Relative temperature accuracy refers to the accuracy of the reported temperature changes relative to the actual laser temperature changes].

7) Measured TEC current. For DWDM applications, bytes 108-109 report the measured TEC current. The format is signed two's complement with the LSB equal to 0.1 mA. Thus a range from -3276.8 to +3276.7 mA may be reported with a resolution of 0.1 mA. See T and T for further details. Reported TEC current is a positive number for cooling and a negative number for heating. The accuracy of the TEC current monitor is vendor specific but must be better than +/- 15% of the maximum TEC current as stored in the TEC current high alarm threshold (bytes 48-49).

The tables below illustrate the 16 bit signed twos complement format used for temperature reporting. The most significant bit (D7) represents the sign, which is zero for positive temperatures and one for negative temperatures.

TABLE 9-1 BIT WEIGHTS (DEGREES C) FOR TEMPERATURE REPORTING REGISTERS

Most Significant Byte (byte 96)								Least Significant Byte (byte 97)							
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
Sign	64	32	16	8	4	2	1	1/2	1/4	1/8	1/16	1/32	1/64	1/128	1/256

TABLE 9-2 DIGITAL TEMPERATURE FORMAT

Temperature		Binary		Hexadecimal	
Decimal	Fraction	High Byte	Low Byte	High Byte	Low Byte
+127.996	+127 255/256	01111111	11111111	7F	FF
+125.000	+125	01111101	00000000	7D	00
+25.000	+25	00011001	00000000	19	00
+1.004	+1 1/256	00000001	00000001	01	01
+1.000	+1	00000001	00000000	01	00
+0.996	+255/256	00000000	11111111	00	FF
+0.004	+1/256	00000000	00000001	00	01
0.000	0	00000000	00000000	00	00
-0.004	-1/256	11111111	11111111	FF	FF
-1.000	-1	11111111	00000000	FF	00
-25.000	-25	11100111	00000000	E7	00
-40.000	-40	11011000	00000000	D8	00
-127.996	-127 255/256	10000000	00000001	80	01

The tables below illustrate the 16-bit twos complement format used for TEC current reporting. The most significant bit (D7) represents the sign, which is zero for positive currents (cooling) and one for negative currents (heating).

5) 测量的RX接收到的光功率（mW）。值可以表示平均接收功率或OMA，取决于字节92（A0h）的位3设置。表示为16位无符号整数，功率定义为全16位值（0-65535），LSB等于0.1 uW，总范围为0至6.5535 mW（～-40至+8.2 dBm）。绝对精度取决于精确的光波长。对于供应商指定的波长，在指定温度下的精度应优于±3dB。对于符合相应标准的最大传输或最大接收光功率较小的输入功率，应保持此精度。应按照适当的标准将其维持最小传输功率减去电缆厂的损耗（插入损耗或被动损耗）。超过此最小值所需的接收输入光功率范围的绝对精度是供应商特定的。

6) 测量可选的激光温度。对于DWDM应用程序，字节106-107报告激光器温度，编码与上面第1行中定义的收发器内部温度相同。相对和绝对精度是供应商特定的，但相对激光温度精度必须优于+/- 0.2摄氏度。[相对温度精度是指相对于实际激光温度变化而报告的温度变化的精度]。

7) 测量TEC电流。对于DWDM应用，字节108-109报告测量的TEC电流。格式是带有二进制补码，LSB等于0.1 mA。因此，可以报告从-3276.8到+3276.7mA的范围，分辨率为0.1mA。详见T和T。报告的TEC电流，冷却是正数，加热是负数。 TEC电流监视器的精度是供应商特定的，但必须优于存储在TEC当前高警报阈值（字节48-49）中的最大TEC电流的+/- 15%。
下表说明了用于温度报告的16位带符号二进制补码格式。最高有效位（D7）表示符号，正温度为零，负温度为零。

TABLE 9-3 BIT WEIGHTS (mA) FOR TEC CURRENT REPORTING REGISTERS

Most Significant Byte (byte 108)								Least Significant Byte (byte 109)							
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
Sign	1638.4	819.2	409.6	204.8	102.4	51.2	25.6	12.8	6.4	3.2	1.6	0.8	0.4	0.2	0.1

外部校准
测量是原始A / D值，必须使用存储在EEPROM位置56-95的2线串行总线地址A2h的校准常数转换为真实世界单位。校准在供应商指定的工作温度和电压范围内有效。应以与实时16位数据相同的方式解释报警和警告阈值。
根据每个变量给出的方程式进行校准后，结果与内部校准器件的精度和分辨率目标一致。
1）内部测量的收发器温度。模块温度T由下式给出：
T（C）= T_slope * T_AD（16位有符号二进制补码）+ T_offset
结果为1 / 256C的单位，产生-128℃至+ 128℃的总范围。T_slope和T_offset的位置见表9-6。温度精度是供应商特定的，但必须比指定的工作温度和电压要高于+/- 3摄氏度。有关温度传感器位置的详细信息，请参见供应商规格表。表9-1和表9-2给出了16位有符号二进制补码温度格式的示例。

TABLE 9-4 TEC CURRENT FORMAT

Current	Binary		Hexadecimal	
Decimal	High Byte	Low Byte	High Byte	Low Byte
+3276.7	01111111	11111111	7F	FF
+3200.0	01111101	00000000	7D	00
+640.0	00011001	00000000	19	00
+25.7	00000001	00000001	01	01
+25.6	00000001	00000000	01	00
+25.5	00000000	11111111	00	FF
+0.1	00000000	00000001	00	01
0.0	00000000	00000000	00	00
-0.1	11111111	11111111	FF	FF
-25.6	11111111	00000000	FF	00
-640.0	11100111	00000000	E7	00
-1024.0	11011000	00000000	D8	00
-3276.7	10000000	00000001	80	01
-3276.8	10000000	00000000	80	00

2）内部测量电源电压。模块内部电源电压V以微伏给出如下：
V（uV）= V_slope * V_AD（16位无符号整数）+ V_offset
结果为100uV，总范围为0-6.55V。V_slope和V_offset的位置见表9-6。指定的工作温度和电压下，精度是供应商特定的，但必须超过制造商的额定值的+/- 3%。请注意，在某些收发器中，发射机电源电压和接收器电源电压是隔离的。在这种情况下，只监控一个电源。有关详细信息，请参阅制造商的规格。
3）测量发射机激光偏置电流。模块激光偏置电流I以微安为单位，通过以下公式给出：
I（uA）= I_slope * I_AD（16位无符号整数）+ I_offset

9.3 External Calibration

Measurements are raw A/D values and must be converted to real world units using calibration constants stored in EEPROM locations 56-95 at 2 wire serial bus address A2h. Calibration is valid over vendor specified operating temperature and voltage. Alarm and warning threshold values should be interpreted in the same manner as real time 16 bit data.

After calibration per the equations given below for each variable, the results are consistent with the accuracy and resolution goals for internally calibrated devices.

1) Internally measured transceiver temperature. Module temperature, T, is given by the following equation:

   T(C) = T_slope * T_AD (16 bit signed twos complement value) + T_offset

   The result is in units of 1/256C, yielding a total range of -128C to +128C. See Table 9-6 for locations of T_slope and T_offset. Temperature accuracy is vendor specific but must be better than +/-3 degrees Celsius over specified operating temperature and voltage. Please see vendor specification sheet for details on location of temperature sensor. Table 9-1 and Table 9-2 give examples of the 16 bit signed twos complement temperature format.

2) Internally measured supply voltage. Module internal supply voltage, V, is given in microvolts by the following equation:

   V(uV) = V_slope * V_AD (16 bit unsigned integer) + V_offset

   The result is in units of 100uV, yielding a total range of 0-6.55V. See Table 9-6 for locations of V_slope and V_offset. Accuracy is vendor specific but must be better than +/-3% of the manufacturer's nominal value over specified operating temperature and voltage. Note that in some transceivers, transmitter supply voltage and receiver supply voltage are isolated. In that case, only one supply is monitored. Refer to the manufacturer's specification for more detail.

3) Measured transmitter laser bias current. Module laser bias current, I, is given in microamps by the following equation:

   I (uA) = I_slope * I_AD (16 bit unsigned integer) + I_offset

该结果为2 uA的单位，产生0到131 mA的总范围。 I_slope和I_offset的位置见表9-6。精度是供应商特定的，但必须超过制造商的额定值的+/- 10%指定的工作温度和电压。4）测量的耦合TX输出功率。模块发射机耦合输出功率TX_PWR以uW表示，由下式表示：TX_PWR（uW）= TX_PWR_slope * TX_PWR_AD（16位无符号整数）+ TX_PWR_offset。该结果为0.1uW，总范围为0-6.5mW。 TX_PWR_slope和TX_PWR_offset的位置见表9-6。精度是供应商特定的，但必须比指定工作温度和电压的+/- 3dB更好。假设数据是基于激光监测器光电二极管电流的测量。使用最具代表性的光纤输出类型将其出厂校准为绝对单位。当发射机被禁用时，数据无效。

This result is in units of 2 uA, yielding a total range of 0 to 131 mA. See Table 9-6 for locations of I_slope and I_offset. Accuracy is vendor specific but must be better than +/-10% of the manufacturer's nominal value over specified operating temperature and voltage.

4) Measured coupled TX output power. Module transmitter coupled output power, TX_PWR, is given in uW by the following equation:

TX_PWR (uW) = TX_PWR_slope * TX_PWR_AD (16 bit unsigned integer) + TX_PWR_offset.

This result is in units of 0.1uW yielding a total range of 0-6.5mW. See Table 9-6 for locations of TX_PWR_slope and TX_PWR_offset. Accuracy is vendor specific but must be better than +/-3dB over specified operating temperature and voltage. Data is assumed to be based on measurement of a laser monitor photodiode current. It is factory calibrated to absolute units using the most representative fiber output type. Data is not valid when the transmitter is disabled.

5) Measured received optical power. Received power, RX_PWR, is given in uW by the following equation:

Rx_PWR (uW) = Rx_PWR(4) * Rx_PWR_ADe4 (16 bit unsigned integer) +
Rx_PWR(3) * Rx_PWR_ADe3 (16 bit unsigned integer) +
Rx_PWR(2) * Rx_PWR_ADe2 (16 bit unsigned integer) +
Rx_PWR(1) * Rx_PWR_AD (16 bit unsigned integer) +
Rx_PWR(0)

The result is in units of 0.1uW yielding a total range of 0-6.5mW. See Table 9-6 for locations of Rx_PWR(4-0). Absolute accuracy is dependent upon the exact optical wavelength. For the vendor specified wavelength, accuracy shall be better than +/-3dB over specified temperature and voltage. This accuracy shall be maintained for input power levels up to the lesser of maximum transmitted or maximum received optical power per the appropriate standard. It shall be maintained down to the minimum transmitted power minus cable plant loss (insertion loss or passive loss) per the appropriate standard. Absolute accuracy beyond this minimum required received input optical power range is vendor specific.

5）测得接收光功率。接收功率RX_PWR通过以下公式以uW给出：Rx_PWR（uW）= Rx_PWR（4）* Rx_PWR_ADe4（16位无符号整数）+ Rx_PWR（3）* Rx_PWR_ADe3（16位无符号整数）+ Rx_PWR（2）* Rx_PWR_ADe2（16位无符号整数）+ Rx_PWR（1）* Rx_PWR_AD（16位无符号整数）+ Rx_PWR（0）结果为0.1uW，总范围为0-6.5mW。Rx_PWR（4-0）的位置见表9-6。绝对精度取决于精确的光波长。对于供应商指定的波长，在指定的温度和电压下，精度应优于+/- 3dB。对于符合相应标准的最大传输或最大接收光功率较小的输入功率电平，应保持此精度。应按照适当的标准维持最小传输功率减去电缆厂的损耗（插入损耗或被动损耗）。绝对精度超过此最小值所需的接收输入光功率范围是供应商特定的。

9.4 Alarm and Warning Thresholds [Address A2h, Bytes 0-39]

Each A/D quantity has a corresponding high alarm, low alarm, high warning and low warning threshold. These factory preset values allow the user to determine when a particular value is outside of "normal" limits as determined by the transceiver manufacturer. It is assumed that these values will vary with different technologies and different implementations. When external calibration is used, data may be compared to alarm and warning threshold values before or after calibration by the host. Comparison can be done directly before calibration. If comparison is to be done after calibration, calibration must first be applied to both data and threshold values.

The values reported in the alarm and warning thresholds area (see below) may be temperature compensated or otherwise adjusted when setting warning and/or alarm flags. Any threshold compensation or adjustment is vendor specific and optional. See Vendor's data sheet for use of alarm and warning thresholds.

报警和警告阈值[地址A2h，字节0-39]
每个A / D量具有相应的高报警，低报警，高警告和低警告阈值。这些出厂预设值允许用户确定某个特定值何时超出收发器制造商确定的“正常”限制。假设这些值将随着不同的技术和不同的实现而变化。当使用外部校准时，可以将数据与主机校准之前或之后的报警和警告阈值进行比较。比较可以在校准前直接进行。如果在校准后进行比较，必须首先对数据和阈值进行校准。
在报警和警告阈值区域（见下文）中报告的值可以在设置警告和/或报警标志时进行温度补偿或其他调整。任何阈值补偿或调整是供应商特定的和可选的。请参阅供应商的数据表以使用报警和警告阈值。

TABLE 9-5 ALARM AND WARNING THRESHOLDS

A2h	# Bytes	Name	Description
00-01	2	Temp High Alarm	MSB at low address
02-03	2	Temp Low Alarm	MSB at low address
04-05	2	Temp High Warning	MSB at low address
06-07	2	Temp Low Warning	MSB at low address
08-09	2	Voltage High Alarm	MSB at low address
10-11	2	Voltage Low Alarm	MSB at low address
12-13	2	Voltage High Warning	MSB at low address
14-15	2	Voltage Low Warning	MSB at low address
16-17	2	Bias High Alarm	MSB at low address
18-19	2	Bias Low Alarm	MSB at low address
20-21	2	Bias High Warning	MSB at low address
22-23	2	Bias Low Warning	MSB at low address
24-25	2	TX Power High Alarm	MSB at low address
26-27	2	TX Power Low Alarm	MSB at low address
28-29	2	TX Power High Warning	MSB at low address
30-31	2	TX Power Low Warning	MSB at low address
32-33	2	RX Power High Alarm	MSB at low address
34-35	2	RX Power Low Alarm	MSB at low address
36-37	2	RX Power High Warning	MSB at low address
38-39	2	RX Power Low Warning	MSB at low address
40-41	2	Optional Laser Temp High Alarm	MSB at low address
42-43	2	Optional Laser Temp Low Alarm	MSB at low address
44-45	2	Optional Laser Temp High Warning	MSB at low address
46-47	2	Optional Laser Temp Low Warning	MSB at low address
48-49	2	Optional TEC Current High Alarm	MSB at low address
50-51	2	Optional TEC Current Low Alarm	MSB at low address
52-53	2	Optional TEC Current High Warning	MSB at low address
54-55	2	Optional TEC Current Low Warning	MSB at low address

单精度浮点校准数据 - Rx光功率。 字节56的位7是MSB。 字节59的位0是LSB。 对于“内部校准”设备，Rx_PWR（4）应设置为零。

9.5 Calibration Constants for External Calibration Option [Address A2h, Bytes 56-91]

TABLE 9-6 CALIBRATION CONSTANTS FOR EXTERNAL CALIBRATION OPTION

A2h	# Bytes	Name	Description
56-59	4	Rx_PWR(4)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 56 is MSB. Bit 0 of byte 59 is LSB. Rx_PWR(4) should be set to zero for "internally calibrated" devices.
60-63	4	Rx_PWR(3)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 60 is MSB. Bit 0 of byte 63 is LSB. Rx_PWR(3) should be set to zero for "internally calibrated" devices.
64-67	4	Rx_PWR(2)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 64 is MSB, bit 0 of byte 67 is LSB. Rx_PWR(2) should be set to zero for "internally calibrated" devices.
68-71	4	Rx_PWR(1)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 68 is MSB, bit 0 of byte 71 is LSB. Rx_PWR(1) should be set to 1 for "internally calibrated" devices.
72-75	4	Rx_PWR(0)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 72 is MSB, bit 0 of byte 75 is LSB. Rx_PWR(0) should be set to zero for "internally calibrated" devices.
76-77	2	Tx_I(Slope)	Fixed decimal (unsigned) calibration data, laser bias current. Bit 7 of byte 76 is MSB, bit 0 of byte 77 is LSB. Tx_I(Slope) should be set to 1 for "internally calibrated" devices.
78-79	2	Tx_I(Offset)	Fixed decimal (signed two's complement) calibration data, laser bias current. Bit 7 of byte 78 is MSB, bit 0 of byte 79 is LSB. Tx_I(Offset) should be set to zero for "internally calibrated" devices.
80-81	2	Tx_PWR(Slope)	Fixed decimal (unsigned) calibration data, transmitter coupled output power. Bit 7 of byte 80 is MSB, bit 0 of byte 81 is LSB. Tx_PWR(Slope) should be set to 1 for "internally calibrated" devices.
82-83	2	Tx_PWR(Offset)	Fixed decimal (signed two's complement) calibration data, transmitter coupled output power. Bit 7 of byte 82 is MSB, bit 0 of byte 83 is LSB. Tx_PWR(Offset) should be set to zero for "internally calibrated" devices.
84-85	2	T (Slope)	Fixed decimal (unsigned) calibration data, internal module temperature. Bit 7 of byte 84 is MSB, bit 0 of byte 85 is LSB. T(Slope) should be set to 1 for "internally calibrated" devices.
86-87	2	T (Offset)	Fixed decimal (signed two's complement) calibration data, internal module temperature. Bit 7 of byte 86 is MSB, bit 0 of byte 87 is LSB. T(Offset) should be set to zero for "internally calibrated" devices.
88-89	2	V (Slope)	Fixed decimal (unsigned) calibration data, internal module supply voltage. Bit 7 of byte 88 is MSB, bit 0 of byte 89 is LSB. V(Slope) should be set to 1 for "internally calibrated" devices.
90-91	2	V (Offset)	Fixed decimal (signed two's complement) calibration data, internal module supply voltage. Bit 7 of byte 90 is MSB. Bit 0 of byte 91 is LSB. V(Offset) should be set to zero for "internally calibrated" devices.
92-94	3	Unallocated	
95	1	Checksum	Byte 95 contains the low order 8 bits of the sum of bytes 0-94.

The slope constants at addresses 76, 80,84, and 88, are unsigned fixed-point binary numbers. The slope will therefore always be positive. The binary point is in between the upper and lower bytes, i.e., between the eight and ninth most significant bits. The most significant byte is the integer portion in the range 0 to +255. The least significant byte represents the fractional portion in the range of 0.00391 (1/256) to 0.9961 (255/256). The smallest real number that can be represented by this format is 0.00391 (1/256); the largest real number that can be represented using this format is 255.9961 (255 + 255/256). Slopes are defined, and conversion formulas found, in the "External Calibration" section. Examples of this format are illustrated below:

地址76,80,84和88处的斜率常数是无符号定点二进制数。 因此，斜坡将始终为正。 二进制点位于上和下字节之间，即在八位和九位最高有效位之间。 最高有效字节是0到+255范围内的整数部分。 最低有效字节表示0.00391（1/256）至0.9961（255/256）范围内的小数部分。 可以用此格式表示的最小实数为0.00391（1/256）；可以使用此格式表示的最大实数为255.9961（255 + 255/256）。 定义斜率，并在“外部校准”部分找到转换公式。 此格式的示例如下所示：

TABLE 9-7 UNSIGNED FIXED-POINT BINARY FORMAT FOR SLOPES

Decimal Value	Binary Value		Hexadecimal Value	
	MSB	LSB	High Byte	Low Byte
0.0000	00000000	00000000	00	00
0.0039	00000000	00000001	00	01
1.0000	00000001	00000000	01	00
1.0313	00000001	00001000	01	08
1.9961	00000001	11111111	01	FF
2.0000	00000010	00000000	02	00
255.9921	11111111	11111110	FF	FE
255.9961	11111111	11111111	FF	FF

校准偏移是16位有符号的二进制补码二进制数。 偏移量由“外部校准”部分中的公式定义。 最低有效位表示与相应模拟参数的“内部校准”相同的单位，例如偏置电流为2μA，光功率为0.1μW等。可能的整数值范围为+32767至-32768。 此格式的示例如下所示。

The calibration offsets are 16-bit signed twos complement binary numbers. The offsets are defined by the formulas in the "External Calibration" section. The least significant bit represents the same units as described above under "Internal Calibration" for the corresponding analog parameter, e.g., 2μA for bias current, 0.1μW for optical power, etc. The range of possible integer values is from +32767 to -32768. Examples of this format are shown below.

TABLE 9-8 FORMAT FOR OFFSETS

Decimal Value	Binary Value		Hexadecimal Value	
	MSB	LSB	High Byte	Low Byte
+32767	01111111	1111111	7F	FF
+3	00000000	00000011	00	03
+2	00000000	00000010	00	02
+1	00000000	00000001	00	01
0	00000000	00000000	00	00
-1	11111111	11111111	FF	FF
-2	11111111	11111110	FF	FE
-3	11111111	11111101	FF	FD
-32768	10000000	00000000	80	00

接收光功率的外部校准使用IEEE标准二进制浮点数算法IEEE Std 754-1985定义的单精度浮点数。 简而言之，该格式利用四个字节（32位）来表示实数。 第一个也是最重要的位是符号位；接下来的八位表示在+126到-127的范围内的指数；其余23位表示尾数。 因此，32位如下表所示排列。

External calibration of received optical power makes use of single-precision floating-point numbers as defined by *IEEE Standard for Binary Floating-Point Arithmetic*, IEEE Std 754-1985. Briefly, this format utilizes four bytes (32 bits) to represent real numbers. The first and most significant bit is the sign bit; the next eight bits indicate an exponent in the range of +126 to -127; the remaining 23 bits represent the mantissa. The 32 bits are therefore arranged as in the following table.

TABLE 9-9 IEEE-754 SINGLE-PRECISION FLOATING POINT NUMBER FORMAT

Function	Sign	Exponent	Mantissa		
Bit	31	30.....23	22 0		
Byte	3		2	1	0
← Most Significant					Least Significant →

Rx_PWR(4), as an example, is stored as:

TABLE 9-10 EXAMPLE OF FLOATING POINT REPRESENTATION

Byte Address	Contents	Significance
56	SEEEEEEE	Most
57	EMMMMMMM	Second Most
58	MMMMMMMM	Second Least
59	MMMMMMMM	Least
where S = sign bit; E = exponent bit; M = mantissa bit.		

Special cases of the various bit values are reserved to represent indeterminate values such as positive and negative infinity; zero; and "NaN" or not a number. NaN indicates an invalid result. As of this writing, explanations

of the IEEE single precision floating point format were posted on the worldwide web at

http://www.psc.edu/general/software/packages/ieee/ieee.html

and

http://research.microsoft.com/~hollasch/cgindex/coding/ieeefloat.html.

The actual IEEE standard is available at www.IEEE.org

9.6 CC_DMI [Address A2h, Byte 95]

This check sum is a one byte code that can be used to verify that the first 94 bytes of factory programmed "diagnostic management interface" information in the SFP is valid. The check code shall be the low order 8 bits of the sum of the contents of all the bytes from byte 0 to byte 94, inclusive.

9.7 Real Time Diagnostic and Control Registers [Address A2h, Bytes 96-111]

TABLE 9-11 A/D VALUES AND STATUS BITS

A2h	Bit	Name	Description
Converted analog values. Calibrated 16 bit data.			
96	All	Temperature MSB	Internally measured module temperature.
97	All	Temperature LSB	
98	All	Vcc MSB	Internally measured supply voltage in transceiver.
99	All	Vcc LSB	
100	All	TX Bias MSB	Internally measured TX Bias Current.
101	All	TX Bias LSB	
102	All	TX Power MSB	Measured TX output power.
103	All	TX Power LSB	
104	All	RX Power MSB	Measured RX input power.
105	All	RX Power LSB	
106	All	Optional Laser Temp/Wavelength MSB	Measured laser temperature or wavelength
107	All	Optional Laser Temp/Wavelength LSB	
108	All	Optional TEC current MSB	Measured TEC current (positive is cooling)
109	All	Optional TEC current LSB	

Optional Status/Control Bits			
110	7	TX Disable State	Digital state of the TX Disable Input Pin. Updated within 100ms of change on pin.
	6	Soft TX Disable Select	Read/write bit that allows software disable of laser. Writing '1' disables laser. See Table 8-7 for enable/disable timing requirements. This bit is "OR"d with the hard TX_DISABLE pin value. Note, per SFP MSA TX_DISABLE pin is default enabled unless pulled low by hardware. If Soft TX Disable is not implemented, the transceiver ignores the value of this bit. Default power up value is zero/low.
	5	RS(1) State	Digital state of SFP input pin AS(1) per SFF-8079 or RS(1) per SFF-8431. Updated within 100ms of change on pin. See A2h Byte 118, Bit 3 for Soft RS(1) Select control information.
	4	Rate_Select State [aka. "RS(0)"]	Digital state of the SFP Rate_Select Input Pin. Updated within 100ms of change on pin. Note: This pin is also known as AS(0) in SFF-8079 and RS(0) in SFF-8431.
	3	Soft Rate_Select Select [aka. "RS(0)"]	Read/write bit that allows software rate select control. Writing '1' selects full bandwidth operation. This bit is "OR'd with the hard Rate_Select, AS(0) or RS(0) pin value. See Table 8-7 for timing requirements. Default at power up is logic zero/low, unless specifically redefined by value selected in Table 5-6. If Soft Rate Select is not implemented, the transceiver ignores the value of this bit. Note: Specific transceiver behaviors of this bit are identified in Table 5-6 and referenced documents. See Table 10-1, byte 118, bit 3 for Soft RS(1) Select.
	2	TX Fault State	Digital state of the TX Fault Output Pin. Updated within 100ms of change on pin.
	1	Rx_LOS State	Digital state of the RX_LOS Output Pin. Updated within 100ms of change on pin.
	0	Data_Ready_Bar State	Indicates transceiver has achieved power up and data is ready. Bit remains high until data is ready to be read at which time the device sets the bit low.
111	7-0	Reserved	Reserved for SFF-8079.

The data_ready_bar bit is high during module power up and prior to the first valid A/D reading. Once the first valid A/D reading occurs, the bit is set low until the device is powered down. The bit must be set low within 1 second of power up.

9.8 Alarm and Warning Flag Bits [Address A2h, Bytes 112-117]

Bytes 112-117 contain an optional set of alarm and warning flags. The flags may be latched or non-latched. Implementation is vendor specific, and the Vendor's specification sheet should be consulted for details. It is recommended that in either case, detection of an asserted flag bit should be verified by a second read of the flag at least 100ms later. For users who do not wish to set their own threshold values or read the values in locations 0-55, the flags alone can be monitored. Two flag types are defined.

1) Alarm flags associated with transceiver temperature, supply voltage, TX bias current, TX output power and received optical power as well as reserved locations for future flags. Alarm flags indicate conditions likely to be associated with an in-operational link and cause for immediate action.

2) Warning flags associated with transceiver temperature, supply voltage, TX bias current, TX output power and received optical power as well as reserved locations for future flags. Warning flags indicate conditions outside the normally guaranteed bounds but not necessarily causes of immediate link failures. Certain warning flags may also be defined by the manufacturer as end-of-life indicators (such as for higher than expected bias currents in a constant power control loop).

指示收发器已上电，数据准备就绪。 位数据保持为高电平，直到数据准备好读取为止，器件将其置位为低电平。

SFP Rate_Select输入引脚的数字状态。 在100ms内更新。 注意：该引脚在SFF-8079中也称为AS（0），SFF-8431中也称为RS（0）

根据SFF-8079的AS1或SFF-8431的RS1引脚状态。在100ms内更新。参见A2h字节118位3，软RS1选择控制信息

读/写位，允许软件禁用激光。 写1禁用激光。 有关启用/禁用时序要求，请参见表8-7。 该位与硬TX_DISABLE引脚值进行或操作。 注意，每个SFP MSA TX_DISABLE引脚默认使能，除非被硬件拉低。 如果没有实现Soft TX Disable，收发器将忽略该位的值。 默认上电值为零/低。

TX禁用输入引脚的数字状态。 在引脚变动100ms内更新。

读/写位，允许软件速率选择控制。 写入'1'选择全带宽操作。 该位与硬Rate_Select，AS（0）或RS（0）引脚值进行或操作，见表8-7的时序要求。 上电时的默认值为逻辑0/低，除非由表5-6表明软速率选择未实现，收发器忽略该位的值注意：该位的特定收发器行为在表5-6和参考文档中标识，请参见表10-1，字节118，软RS的位3（1）选择。

112-117字节包含一组可选的报警和警告标志。 标志可以被锁存或非锁存。 实施是供应商特定的，并且应详细了解供应商的规格表。 建议在任一种情况下，至少100ms之后，通过第二次读取该标志来检测被断言的标志位。 对于不想设置自己的阈值或读取位置0-55中的值的用户，可以监视单独的标志。 定义了两种标志类型。

在模块上电期间和第一次有效的A / D读取之前，data_ready_bar位为高电平。 一旦发生第一个有效的A / D读取，该位置低，直到器件掉电。 该位必须在加电1秒内设置为低电平。

1）与收发器温度，电源电压，TX偏置电流，TX输出功率和接收光功率相关的报警标志以及未来标志的保留位置。 报警标志表示可能与操作中链接相关联的情况，并导致立即采取行动。
2）与收发器温度，电源电压，TX偏置电流，TX输出功率和接收光功率相关的警告标志以及未来标志的保留位置。 警告标志表示正常保证范围之外的条件，但不一定是立即链路故障的原因。 某些警告标志也可以由制造商定义为寿命终止指示器（例如在恒定功率控制回路中高于预期的偏置电流）

TABLE 9-12 ALARM AND WARNING FLAG BITS

A2h	Bit	Name	Description
Reserved Optional Alarm and Warning Flag Bits (See Notes 3-6)			
112	7	Temp High Alarm	Set when internal temperature exceeds high alarm level.
	6	Temp Low Alarm	Set when internal temperature is below low alarm level.
	5	Vcc High Alarm	Set when internal supply voltage exceeds high alarm level.
	4	Vcc Low Alarm	Set when internal supply voltage is below low alarm level.
	3	TX Bias High Alarm	Set when TX Bias current exceeds high alarm level.
	2	TX Bias Low Alarm	Set when TX Bias current is below low alarm level.
	1	TX Power High Alarm	Set when TX output power exceeds high alarm level.
	0	TX Power Low Alarm	Set when TX output power is below low alarm level.
113	7	RX Power High Alarm	Set when Received Power exceeds high alarm level.
	6	RX Power Low Alarm	Set when Received Power is below low alarm level.
	5	Optional Laser Temp High Alarm	Set when laser temperature or wavelength exceeds the high alarm level.
	4	Optional Laser Temp Low Alarm	Set when laser temperature or wavelength is below the low alarm level.
	3	Optional TEC current High Alarm	Set when TEC current exceeds the high alarm level.
	2	Optional TEC current Low Alarm	Set when TEC current is below the low alarm level.
	1	Reserved Alarm	
	0	Reserved Alarm	
114	7-4	Tx input equalization control RATE=HIGH	Input equalization level control
	3-0	Tx input equalization control RATE=LOW	Input equalization level control
115	7-4	RX output emphasis control RATE=HIGH	Output emphasis level control
	3-0	RX output emphasis control RATE=LOW	Output emphasis level control
116	7	Temp High Warning	Set when internal temperature exceeds high warning level.
	6	Temp Low Warning	Set when internal temperature is below low warning level.
	5	Vcc High Warning	Set when internal supply voltage exceeds high warning level.
	4	Vcc Low Warning	Set when internal supply voltage is below low warning level.
	3	TX Bias High Warning	Set when TX Bias current exceeds high warning level.
	2	TX Bias Low Warning	Set when TX Bias current is below low warning level.
	1	TX Power High Warning	Set when TX output power exceeds high warning level.
	0	TX Power Low Warning	Set when TX output power is below low warning level.
117	7	RX Power High Warning	Set when Received Power exceeds high warning level.
	6	RX Power Low Warning	Set when Received Power is below low warning level.
	5	Optional Laser Temp High Warning	Set when laser temperature or wavelength exceeds the high warning level.
	4	Optional Laser Temp Low Warning	Set when laser temperature or wavelength is below the low warning level.
	3	Optional TEC current High Warning	Set when TEC current exceeds the high warning level.
	2	Optional TEC current Low Warning	Set when TEC current is below the low warning level.
	1	Reserved Warning	
	0	Reserved Warning	

TABLE 9-13 INPUT EQUALIZATION (ADDRESS A2H BYTE 114)

Code	Transmitter Input Equalization	
	Nominal	Units
11xx	Reserved	
1011	Reserved	
1010	10	dB
1001	9	dB
1000	8	dB
0111	7	dB
0110	6	dB
0101	5	dB
0100	4	dB
0011	3	dB
0010	2	dB
0001	1	dB
0000	0	No EQ

TABLE 9-14 OUTPUT EMPHASIS CONTROL (ADDRESS A2H BYTE 115)

Code	Receiver Output Emphasis At nominal Output Amplitude	
	Nominal	Units
1xxx	Vendor Specific	
0111	7	dB
0110	6	dB
0101	5	dB
0100	4	dB
0011	3	dB
0010	2	dB
0001	1	dB
0000	0	No Emphasis

10. Extended Information

10.1 Extended Module Control/Status Bytes [Address A2h, Bytes 118-119]

Addresses 118-119 are defined for extended module control and status functions. Depending on usage, the contents may be writable by the host. See Table 8-3 for power level declaration requirement in Address 64, byte 1.

定义了扩展模块控制和状态功能的地址118-119。 根据使用情况，内容可能由主机写入。 地址64，字节1中的功率电平声明要求见表8-3。

TABLE 10-1 EXTENDED MODULE CONTROL/STATUS BYTES

A2h	Bit	Name	Description
118	4-7	Reserved	
	3	Soft RS(1) Select	Read/write bit that allows software Tx rate control. Writing '1' selects full speed Tx operation. This bit is "OR'd with the hard RS(1) pin value. See Table 8-7 for timing requirements. Default at power up is logic zero/low, unless specifically redefined by value selected in Table 5-6. If Soft RS(1) is not implemented, the transceiver ignores the value of this bit. Note: Specific transceiver behaviors of this bit are identified in Table 5-6 and referenced documents. See Table 9-11, byte 110, bit 3 for Soft RS(0) Select.
	2	Reserved	
	1	Power Level Operation State	Optional. SFF-8431 Power Level (maximum power dissipation) status. Value of zero indicates Power Level 1 operation (1.0 Watt max). Value of one indicates Power Level 2 or 3 operation (1.5 or 2.0 Watt max), depending on the values in byte 64 of A0h. Refer to Table 8-3 for Power Level requirement declaration. Refer to Table 8-7 for timing.
	0	Power Level Select	Optional. SFF-8431 Power Level (maximum power dissipation) control bit. Value of zero enables Power Level 1 only (1.0 Watt max). Value of one enables Power Level 2 or 3 (1.5 or 2.0 Watt max), depending on the values in byte 64 of A0h. Refer to Table 8-3 for Power Level requirement declaration. Refer to Table 8-7 for timing. If Power Levels 2 or 3 are not implemented, the SFP ignores the value of this bit.
119	7-2	Unallocated	
	1	Optional Tx CDR unlocked	Used when bit 64.3 (A0h) is set to 1. If the Tx side CDR is enabled, a value of 0 indicates that the CDR is locked, whereas a value of 1 indicates loss of lock of the CDR. If the CDR is in bypass mode this bit is set to 0.
	0	Optional Rx CDR unlocked	Used when bit 64.3 (A0h) is set to 1. If the Rx side CDR is enabled, a value of 0 indicates that the CDR is locked, whereas a value of 1 indicates loss of lock of the CDR. If the CDR is in bypass mode this bit is set to 0.

SFF-8431功率级（最大功耗）状态。 值为零表示功率级别1操作（最大1.0瓦特）。 值为1表示功率级别2或3操作（最大为1.5或2.0瓦特），具体取决于A0h的字节64中的值。有关功率等级要求声明，请参见表8-3。 时序参见表8-7。

SFF-8431功率级（最大功耗）控制位。 零值仅允许功率级别1（最大1.0瓦特）。 值为1，根据A0h的字节64中的值，启用功率级别2或3（最大为1.5或2.0瓦特）。有关功率等级要求声明，请参见表8-3。 时序参见表8-7。 如果未实现功率级别2或3，则SFP忽略该位的值。

当位64.3（A0h）设置为1时使用。如果Tx侧CDR启用，值0表示CDR被锁定，而值1表示CDR的锁定丢失。 如果CDR处于旁路模式，则该位设置为0。

如果A0h的字节13d的内容设置为0Eh，并且页面A0h的位64.3被设置为1，则位110.3和位118.3控制内部重定时器或CDR的锁定模式。 重新定时器/ CDR锁定模式根据表10-2中定义的逻辑表进行设置。 位110.3和118.3的默认值为1。

If the content of byte 13d of A0h is set 0Eh and bit 64.3 of page A0h is set to 1, bits 110.3 and bits 118.3 control the locking modes of the internal retimer or CDR. The retimer/CDR locking modes are set according to the logic table defined in Table 10-2. The default value of bits 110.3 and 118.3 is 1.

TABLE 10-2 RETIMER/CDR RATE SELECT LOGIC TABLE

When byte 13d of A0h is set to 0Eh and bit 64.3 of A0h is set to 1			
Logic OR of RS0 pin and RS0 bit	**Logic OR of RS1 pin and RS1 bit**	**Receiver retimer/CDR**	**Transmitter retimer/CDR**
Low/0	Low/0	Lock at low bit rate	Lock at low bit rate
Low/0	High/1	Lock at high bit rate	Bypass
High/1	Low/0	Bypass	Bypass
High/1	High/1	Lock at high bit rate	Lock at high bit rate

Note: Low and high bit rates are defined in byte 13d of A0h.

10.2 Vendor Specific Locations [Address A2h, Bytes 120-126]

Addresses 120-126 are defined for vendor specific memory functions. Potential usage includes vendor password field for protected functions, scratch space for calculations or other proprietary content.

地址120-126被定义用于供应商特定的存储器功能。 潜在用途包括受保护功能的供应商密码字段，用于计算的临时空间或其他专有内容。

10.3 Optional Page Select Byte [Address A2h, Byte 127]

为了提供DWDM和CDR控制功能的存储空间以及其他潜在的扩展，可以为A2h地址空间的上半部分定义多个页面。 在启动时，字节127的值默认为00h，它指向用户EEPROM。 这确保了不实现可选页面结构的收发器的向后兼容性。 当页面值写入字节127时，对相关页面进行对字节128-255的后续读取和写入。

In order to provide memory space for DWDM and CDR control functions and for other potential extensions, multiple Pages can be defined for the upper half of the A2h address space. At startup the value of byte 127 defaults to 00h, which points to the User EEPROM. This ensures backward compatibility for transceivers that do not implement the optional Page structure. When a Page value is written to byte 127, subsequent reads and writes to bytes 128-255 are made to the relevant Page.

This specification defines functions in Pages 00h-02h. Pages 03-7Fh are reserved for future use. Writing the value of a non-supported Page shall not be accepted by the transceiver. The Page Select byte shall revert to 0 and read / write operations shall be to the unpaged A2h memory map.

本规范定义了第00h-02h页的功能。 第03-7Fh页保留供将来使用。 写入不支持页面的值不被收发器所接受。 页面选择字节应恢复为0，读/写操作应为未分页的A2h存储器映射。 页面80h-FFh保留用于特定于供应商的功能。

Pages 80h-FFh are reserved for vendor specific functions.

对于不支持页面的收发器，或者如果页面选择字节写入00h或01h，则地址128-247表示120字节的用户/主机可写非易失性存储器 - 用于任何合理的使用。 有关写入这些位置的任何限制，请咨询供应商数据表，包括时序和最大写入数。 潜在用途包括客户特定的识别信息，使用历史统计信息，计算的临时空间等。通常不建议将此内存用于延迟关键或重复使用。

TABLE 10-3 OPTIONAL PAGE SELECT BYTE

A2h	# Bytes	Name	Description
120-126	7	Vendor Specific	Vendor specific memory addresses
127	1	Optional Page Select	Defines the page number for subsequent reads and writes to locations A2h<128-255>

10.4 User Accessible EEPROM Locations [Address A2h, Page 00h / 01h, Bytes 128-247]

For transceivers that do not support pages, or if the Page Select byte is written to 00h or 01h, addresses 128-247 represent 120 bytes of user/host writable non-volatile memory - for any reasonable use. Consult vendor datasheets for any limits on writing to these locations, including timing and maximum number of writes. Potential usage includes customer specific identification information, usage history statistics, scratch space for calculations, etc. It is generally not recommended this memory be used for latency critical or repetitive uses.

TABLE 10-4 USER ACCESSIBLE EEPROM LOCATIONS

A2h	# Bytes	Name	Description
128-247	120	User EEPROM	User writable EEPROM

10.5 Vendor Specific Control Function Locations [Address A2h, Page 00h / 01h, Bytes 248-255]

For transceivers that do not support pages, or if the Page Select byte is written to 00h or 01h, addresses 248-255 are defined for vendor specific control functions. Potential usage includes proprietary functions enabled by specific vendors, often managed in combination with addresses 120-127.

对于不支持页面的收发器，或者如果将页面选择字节写入00h或01h，则为特定于供应商的控制功能定义地址248-255。 潜在用途包括由特定供应商启用的专有功能，通常与地址120-127组合进行管理。

TABLE 10-5 VENDOR SPECIFIC CONTROL FUNCTION LOCATIONS

A2h	# Bytes	Name	Description
248-255	8	Vendor Specific	Vendor specific control functions

10.6 Variable Receiver Decision Threshold Control [Address A2h, Page 02h, Bytes 130-131]

Byte 131 of Page 02h is used to control the variable receiver decision threshold function. The availability of this function is indicated in address A0h, byte 65, bit 7 in the serial ID section. Byte 131 is a 2's complement 7-bit value (-128 to +127). The decision threshold is given by:

*Decision Threshold = 50% + [Byte(131) / 256] * 100%*

The value of byte 131 defaults to 0 on power-up. This corresponds to a threshold of 50%.

第02h字节131用于控制可变接收机决策阈值功能。 此功能的可用性在序列号部分的地址A0h，字节65，位7中指示。 字节131是2的补码7位值（-128至+127）。 决策阈值由以下公式给出：

TABLE 10-6 VARIABLE RECEIVER DECISION THRESHOLD CONTROL

Address	# Bytes	Name	Description
130	1	Reserved	Reserved for additional receiver controls
131	1	Optional RDT Control	Value sets the receiver decision threshold: 10000000b = -128d; threshold = 0% 00000000b = 0d; threshold = 50% 01111111b = +127d: threshold = 99.61%