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SFF specifications are available at ftp://ftp.seagate.com/sff

SFF Committee

Specification for

Tunable SFP+ Memory Map for ITU Frequencies

Rev 1.4 January 23, 2013

Secretariat: SFF Committee

Abstract: This specification defines extensions to SFF-8472 needed to support tuning to the ITU frequency grid.

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.

Finisar
Hewlett Packard
IBM
JDS Uniphase
LSI
Oclaro
Panduit
TE Connectivity
Volex

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

Amphenol
EMC
Emulex
FCI
Foxconn
HGST
Luxshare-ICT
MGE
Molex
NetApp
Pioneer
Sandisk
Seagate
Sumitomo
Toshiba
Western Digital

Update History:

Rev 1.1 First distributed version.

Rev 1.2 Not distributed.

Rev 1.3 Changes in response to ballot comments:
- Deleted reference to new identifier code 0Dh in sections 1 and 4.1.
- Added green to color code definition for zero chirp.
- Added section on Timing Behavior

Rev 1.4 Corrected table 4-4 and accompanying text. Reference to byte 152 changed to byte 151.

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.

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Tunable SFP+ Memory Map for ITU Frequencies

1 Scope

The SFP+ (10 Gigabit Enhanced Small Form Factor Pluggable Module) is defined in SFF-8472 and SFF-8431, and includes definition of transmitter wavelength compliance with 1 nanometer resolution. Unfortunately this resolution does not align well with the ITU frequency grid (e.g., as specified in ITU-T G.694.1) and is currently read-only.

SFF-8690 defines enhancements to the SFF-8472 management interface to support:

- Tunable transmitter
- Increased frequency resolution for wavelength reporting.

Electrical, mechanical, and thermal interface details remain without change as specified in SFF-8431.

The management interface defined in SFF-8472 remains largely unchanged. Proposed changes are:

- Using A0h byte 65 bit 6 to identify tunable transmitter technology.

This specification details the registers in SFF-8690.

2 References

2.1 Industry Documents

The following interface standards are relevant to this specification:

- SFF-8431	SFP+
- SFF-8472	Diagnostic Monitoring Interface for Optical Transceivers
- ITU-T G.694.1	Spectral grids for WDM applications: DWDM frequency grid
- ITU-T G.698.1	Multichannel DWDM applications with single-channel optical interfaces
- ITU-T G.698.2	Amplified multichannel DWDM applications with single channel optical interfaces
- OIF-ITLA-MSA-01.0	Integratable Tunable Laser Assembly Multi Source Agreement

2.2 SFF Specifications

There are several projects active within the SFF Committee. The complete list of specifications which have been completed or are still being worked on are listed in the specification at ftp://ftp.seagate.com/sff/SFF-8000.TXT

2.3 Sources

Those who join the SFF Committee as an Observer or Member receive electronic copies of the minutes and SFF specifications (http://www.sffcommittee.com/ie/join.html).

Copies of ANSI standards may be purchased from the InterNational Committee for Information Technology Standards (http://www.techstreet.com/incitsgate.tmpl).

2.4 Conventions

The ISO convention of numbering is used i.e., the thousands and higher multiples are separated by a space and a period is used as the decimal point. This is equivalent to the English/American convention of a comma and a period.

American	French	ISO
0.6	0,6	0.6
1,000	1 000	1 000
1,323,462.9	1 323 462,9	1 323 462.9

3 General Description

SFF-8431 defines the 10 Gigabit Small Formfactor Pluggable SFP+ Module including electrical, mechanical, and thermal requirements. 2-wire management interface details are defined in SFF-8472.

In the SFF-8472 specification, transmitter wavelength is defined in 1 nanometer resolution, A0h byte 60 and 61. Many potential applications for a tunable SFP+ must conform to an ITU frequency grid of 50 GHz (approximately 400 picometers). DWDM applications also demands spectral excursion limits that can be as tight as ±2.5 GHz under normal operating conditions. Thus 1 nanometer wavelength step size defined in SFF-8472 will not adequately define the laser wavelength of a tunable SFP+.

To avoid possible conflict with legacy tuning systems designed to SFF-8472, the frequency grid tuning commands of SFF-8690 supplement rather than supplant the wavelength definitions of SFF-8472. These frequency grid tuning commands are detailed in Section 4.

4 Tuning Management Interface for ITU Frequency Grid Applications

4.1 Proposed Changes to A0h and A2h

Tunable SFP+ will implement A0h and A2h as in SFF-8472 with the proposed modification herein.

A currently unused bit, A0h byte 65 bit 6, shall indicate transmitter technology. If the value of bit 6 is 0 the transmitter is not tunable. If the value of bit 6 is 1 the transmitter technology is tunable.

The page Tunable SFP+ Control/Status, consisting of addressable locations in A2h bytes 128-255, will be accessible when the Page Select Byte is set to page 02h. Register definitions in A2h bytes 128-255 described in the remainder of this section will be based on the Page Select Byte set to 02h. All undefined registers in A2h bytes 128-255 are reserved and are set to 00h.

A2h bytes 128-255 can revert to the contents described in SFF-8472 by setting the Page Select Byte to 00h or 01h.

TABLE 4-1 PAGE SELECT

A2h Address	Bit	Description
Byte 127	All	Page Select Byte Entry. For Tunable SFP+ Control/Status = 02h

4.2 Byte Definitions

The SFP+ vendor can implement wavelength only tuning, frequency only tuning, or both, as indicated by the transceiver description encoded in A2h, byte 128.

Tx Dither can be important for suppression of Stimulated Brillouin Scattering (SBS). Support for Tx dithering is indicated by A2h byte 128 bit 2.

TABLE 4-2 DITHERING

A2h Address	Bit	Description of Transceiver
Byte 128	3-7	Reserved
Byte 128	2	Tx Dither Supported
Byte 128	1	Tunable DWDM (selection by channel number; bytes 144-145)
Byte 128	0	Tunable DWDM (selection in 50pm steps; bytes 146-147)

Module capabilities are defined in A2h, bytes 132-141.

TABLE 4-3 MODULE CAPABILITIES

A2h Address	Size	Name	Description
Bytes 132 (MSB) & 133 (LSB)	2 bytes	LFL1	Lasers First Frequency (THz)
Bytes 134 (MSB) & 135 (LSB)	2 bytes	LFL2	Lasers First Frequency (GHz*10), in units of 0.1 GHz
Bytes 136 (MSB) & 137 (LSB)	2 bytes	LFH1	Lasers Last Frequency (THz)
Bytes 138 (MSB) & 139 (LSB)	2 bytes	LFH2	Lasers Last Frequency (GHz*10), in units of 0.1 GHz
Bytes 140 (MSB) & 141 (LSB)	2 bytes	LGrid	Laser’s minimum supported grid spacing (GHz*10), i.e., in units of 0.1 GHz NOTE: LGrid can be a positive or negative number.

A desired frequency channel can be commanded by the user by writing into A2h bytes 144 (MSB) and 145 (LSB).

The channel number is derived from the following equation using parameters found in Module capabilities as listed in A2h bytes 132-141:

Channel number = 1 + (Desired Frequency - First Frequency) / Grid Spacing

Alternatively, a desired wavelength on the ITU grid can be commanded by the user by writing into A2h bytes 146 (MSB) and 147 (LSB). Thus for instance a target wavelength of 1556.55 nm would correspond to 79h (MSB) written to A2h byte 146 and 9Bh (LSB) written to A2h byte 147.

A2h byte 151 bit 0 is used to command Tx Dither (Bit 0 low) or to disable Dither (Bit 0 high).

Frequency and wavelength control commands are detailed in the table below.

TABLE 4-4 FREQUENCY AND WAVELENGTH CONTROL COMMANDS

A2h Address	Bit	Name	Description
Bytes 144 (MSB) & 145 (LSB)	All	Channel Number Set	User input of wavelength channel # integer 1 to N (N=Number of channels)
Bytes 146 (MSB) & 147 (LSB)	All	Wavelength Set	User input of Wavelength setpoint. (Units of 0.05 nm)
Bytes 148-150	All	Reserved	Reserved
Byte 151	7-1	Reserved	Reserved
Byte 151	0	Tx Dither	Logic 1 disables Dither, 0 enables Dither.

Digital Diagnostics and Alarms

A2 bytes 152-155, 168, and 172 contain digital diagnostic monitoring and alarms. The frequency error in bytes 152-153 and wavelength error in bytes 154-155 are 16 bit signed 2's complement value in units of 0.1 GHz and 0.005 nm respectively.

TABLE 4-5 FREQUENCY AND WAVELENGTH ERRORS

A2h Address	Bit	Name	Description
Bytes 152 (MSB)& 153 (LSB)	All	Frequency Error	Frequency error reported in 16 bit signed integer with LSB=0.1 GHz
Bytes 154 (MSB) & 155 (LSB)	All	Wavelength Error	Wavelength error reported in 16 bit signed integer with LSB=0.005 nm

A2h byte 168 is the current status register containing unlatched status bits for TEC Fault, Wavelength Unlock, and TxTune (i.e., tuning operation is in process and is not yet completed).

TABLE 4-6 CURRENT STATUS

A2h Address	Bit	Name	Description
Byte 168	7	Reserved	Reserved
Byte 168	6	TEC Fault	TEC Fault
Byte 168	5	Wavelength Unlocked	Wavelength Unlocked Condition
Byte 168	4	TxTune	Identifies Tx is not ready due to tuning
Byte 168	3-0	Reserved	Reserved

A2h byte 172 is the latched status register. The latched indicators for TEC Fault and Wavelength Unlock are located here. Bit 4, Bad Channel, indicates a bad channel number request (i.e., a channel number outside of the supported range). Bit 3, New Channel, indicates that a channel change operation has completed. Bit 2 indicates that Tx Dither has been requested in a module that does not support dithering.

TABLE 4-7 LATCHED STATUS

A2h Address	Bit	Name	Description
Byte 172	7	Reserved	Reserved
Byte 172	6	L-TEC Fault	Latched TEC Fault
Byte 172	5	L-Wavelength Unlocked	Latched Wavelength Unlocked Condition
Byte 172	4	L-Bad Channel	Latched Bad Channel Requested
Byte 172	3	L-New Channel	Latched New Channel Acquired
Byte 172	2	L-Unsupported TX Dither	Latched Unsupported TX Dither Request
Byte 172	1-0	Reserved	Reserved

SFF-8472 defines a nominal wavelength in A0h byte 60-61. This is not supported for tunable applications and will return a value of 0000h.

5 Color Coding and Labeling of Tunable SFP+ Transceivers

An exposed feature of the tunable SFP+ transceiver (a feature or surface extending outside of the bezel) shall be color coded as follows:

- Green for negative chirp tunable SFP+.
- Yellow or green for zero chirp tunable SFP+.

6 Timing Behavior

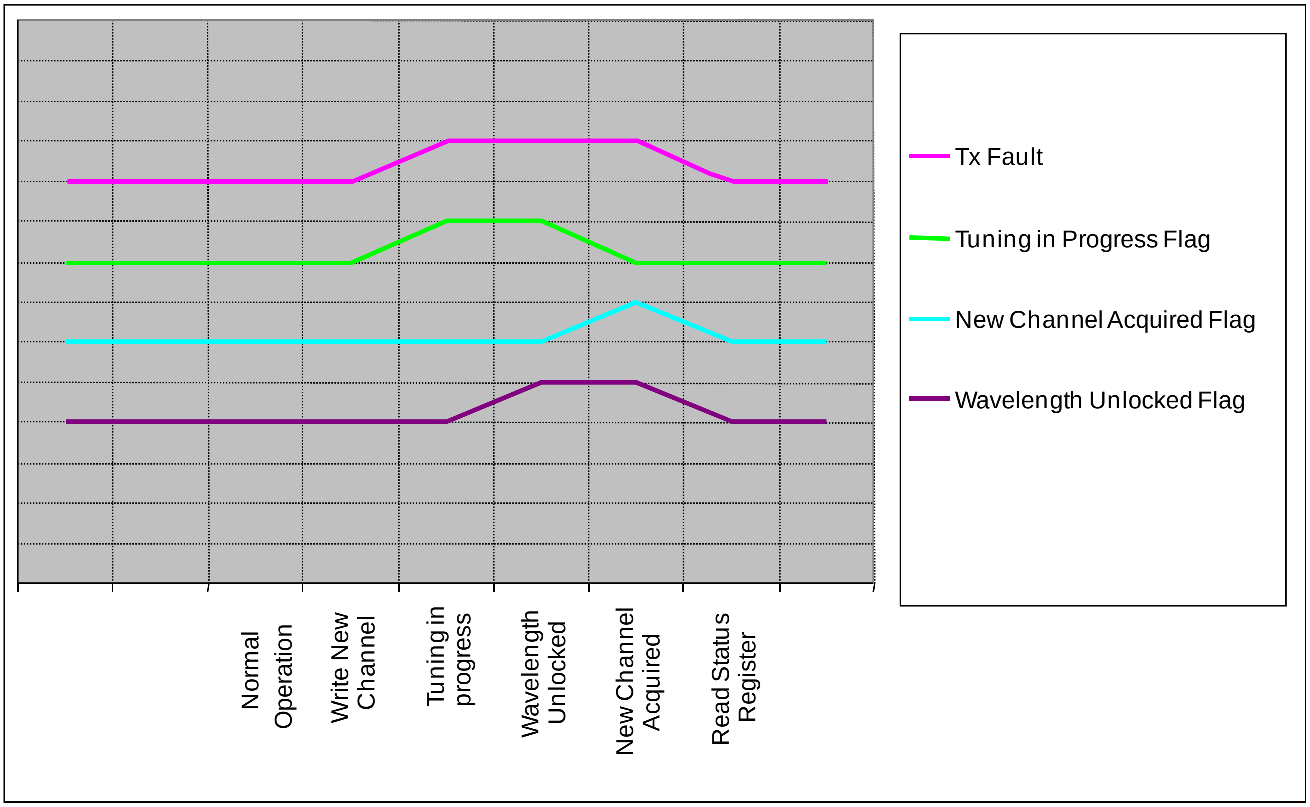

FIGURE 6-1 CHANNEL TO CHANNEL SWITCHING

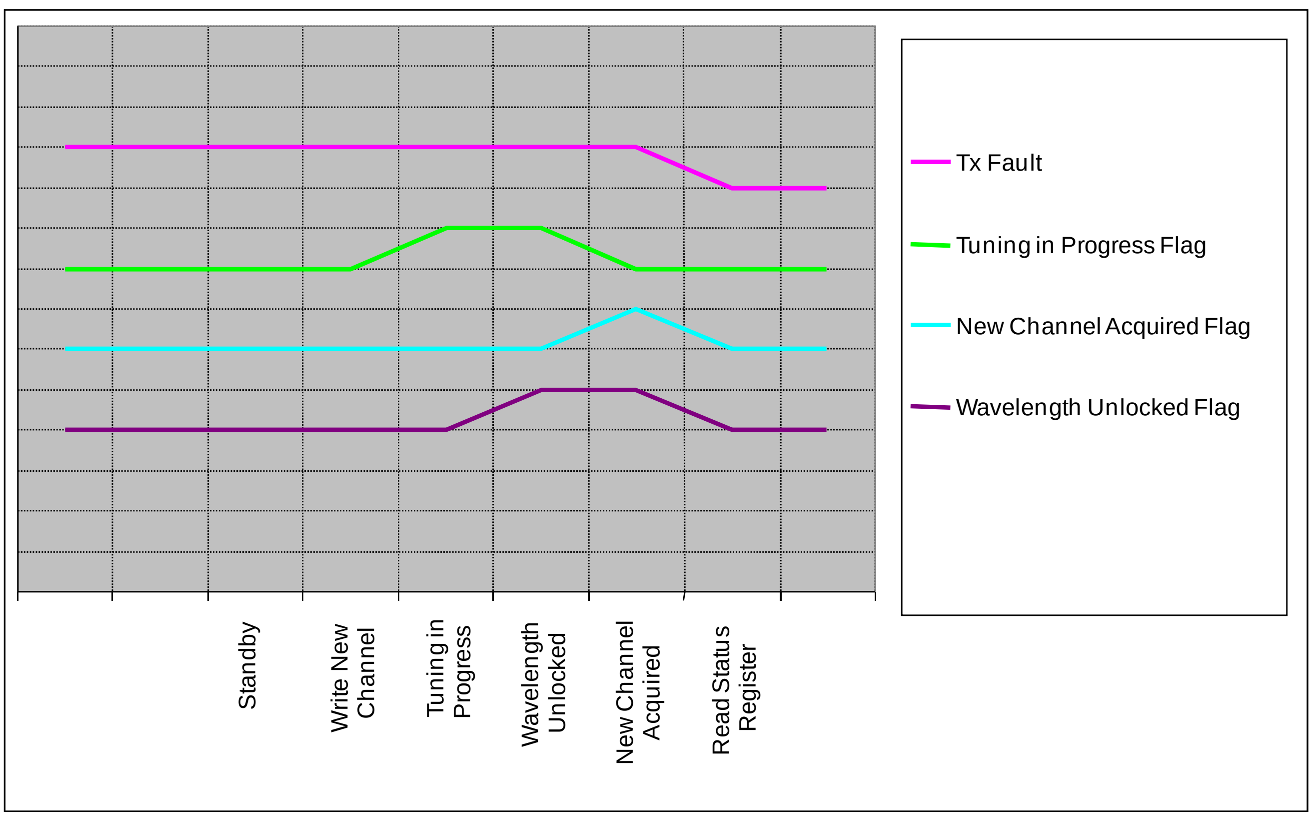

FIGURE 6-2 STANDBY TO CHANNEL SWITCHING