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SFF Committee

SFF-8477 Specification for

Tunable XFP for ITU Frequency Grid Applications

Rev 1.4 December 4, 2009

Secretariat: SFF Committee

Abstract: This specification defines additions to the INF-8077 XFP MSA 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.

EMC
Finisar
Hewlett Packard
JDS Uniphase
Luxtera
OpNext
Panduit
Sun Microsystems
Tyco
Vitesse Semiconductor

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

AMCC
Amphenol
Arastra
Cortina Systems
Emulex
FCI
Foxconn
Fujitsu CPA
Hitachi GST
ICT Solutions
Meritec
Molex
Seagate
Toshiba

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 Committee --

Tunable XFP for ITU Grid Applications

1. Scope

The XFP (10 Gigabit Small Form Factor Pluggable Module) is defined in INF-8077i, including transmitter tuning on a wavelength grid with 50 picometer resolution. Unfortunately this wavelength grid does not align well with the ITU frequency grid (e.g., as specified in ITU-T G.694.1).

SFF-8477 defines enhancements to the INF-8077i management interface to support frequency tuning, including timing diagrams, for better support of the ITU frequency grid.

Electrical, mechanical, and thermal interface details remain without change as specified in INF-8077i. The management interface defined in INF-8077i remains unchanged, other than using reserved bytes as detailed in SFF-8477.

1.1 Description of Clauses

Clause 1 contains the Scope and Purpose.
Clause 2 contains Referenced and Related Standards and SFF Specifications.
Clause 3 contains the General Description.
Clause 4 contains the tuning management interface for ITU frequency grid compliance.
Clause 5 contains timing diagrams and expected response during tuning operation.

2. References

The SFF Committee activities support the requirements of the storage industry, and it is involved with several standards.

2.1 Industry Documents

The following interface standards are relevant to this SFF-8477 Specification:

INF-8077i	10 Gigabit Small Form Factor Pluggable Module
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://tinyurl.com/c4psg).

Copies of SFF, T10 (SCSI), T11 (Fibre Channel) and T13 (ATA) standards and standards still in development are available on the HPE version of CD_Access (http://tinyurl.com/85fts).

2.4 Conventions

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

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

3. General Description

INF-8077i defines the 10 Gigabit Small Form Factor Pluggable “XFP” Module, including electrical, mechanical, thermal, and 2-wire management interface details. Included in the INF-8077i specification is definition of transmitter tuning on a wavelength grid with 50 picometer resolution.

Many potential applications for a tunable XFP must conform to an ITU frequency grid (for example, G.698.1). A channel spacing of 100 GHz corresponds approximately to 800 picometers (for C band), so 50 picometer of resolution as specified in INF-8077i would seem to be sufficient for this application. However, ITU defines maximum spectral excursion limits that can be as tight as ±12.5 GHz, approximately 100 picometers. Thus the 50 picometer resolution defined in INF-8077i can be a significant fraction of the ITU maximum spectral excursion limit. This is the motivation for defining tuning based upon a frequency grid rather than a wavelength grid.

To avoid possible conflict with legacy tuning systems designed to INF-8077i, the frequency grid tuning commands of SFF-8477 supplement rather than supplant the wavelength grid tuning commands of INF-8077i. These frequency grid tuning commands are detailed in Section 4. Timing diagrams which clarify the sequence of commands and status signals are presented in Section 5. Diagrams for channel-to-channel frequency shift and for standby-to-channel switch are shown.

The design intent of this document is to define “set and forget” behavior. Upon power-up, the module returns to the last commanded channel prior to power-down. If it desired to reset to a default channel, other than the last commanded channel, then use Tx_DIS, which places the module in a standby condition. In standby, the module is on but the laser power is off and will stay off until a command to tune to a channel is received.

4. Tuning Management Interface for ITU Frequency Grid Applications

Implementation of wavelength or frequency tunability is indicated in Serial ID Byte 221 (Table 01h) bit 1.

Data Address	Bit	Description
221 (Table 01h)	1	Wavelength or frequency tunability implemented

The XFP vendor can implement wavelength only tuning (as specified in INF-8077i), frequency only tuning, or both, as indicated by the transceiver description encoded in Serial ID Byte 138 bits 1 and 2.

Address	Bit	Description of transceiver
138	3	Tunable DWDM (selection by channel number, bytes 112-113)
138	2	Tunable DWDM (selection in 50 pm steps, bytes 72-73)
138	0-1	Reserved

A desired wavelength can be commanded by the user by writing into Bytes 72 (MSB) and 73 (LSB).

Wavelength control command:

Address	Bit	Name	Description
72 (MSB) & 73 (LSB)	All	Wavelength Set	User input of Wavelength setpoint (in units of 50 picometers).
74 (MSB) & 75 (LSB)	All	Wavelength Error	Monitor of Current Wavelength Error (in units of 5 picometers).

Thus for instance a target wavelength of 1556.55 nm would correspond to 79h (MSB) written to Byte address 72 and 9Bh (LSB) written to Byte address 73.

Alternatively a desired frequency channel can be commanded by the user by writing into Bytes 112 (MSB) and 113 (LSB).

Frequency channel control command:

Address	Bit	Name	Description
112 (MSB) & 113 (LSB)	All	Channel Number Set	User input of channel number, which is an integer 1 to N (N=Number of Channels)
114 (MSB) & 115 (LSB)	All	Frequency Error	Frequency error reported in 16 bit signed integer with LSB=0.1 GHz
116-117	All	Reserved	Reserved

The channel number is derived from the following equation using parameters found in Module capabilities as listed in Byte Addresses 60-69:

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

Tx Dither can be important for suppression of Stimulated Brillouin Scattering (SBS). Support for Tx dithering is indicated by Serial ID Byte 139 bit 2.

Address	Bit	Description of transceiver
139	2	Tx Dither Supported
139	0-1	Reserved

Tx Dither can be enabled or disabled by means of the General Control / Status Bits Table at Serial ID Byte 111, described at the top of the next page.

Module capabilities:

Address	Size	Name	Description
60 (MSB) & 61 (LSB)	2 bytes	LFL1	Lasers First Frequency (THz)
62 (MSB) & 63 (LSB)	2 bytes	LFL2	Lasers First Frequency (GHz*10), i.e., in units of 0.1 GHz
64 (MSB) & 65 (LSB)	2 bytes	LFH1	Lasers Last Frequency (THz)
66 (MSB) & 67 (LSB)	2 bytes	LFH2	Lasers Last Frequency (GHz*10), i.e., in units of 0.1 GHz
68 (MSB) & 69 (LSB)	2 bytes	LGrid	Lasers maximum supported grid spacing (GHz*10), i.e., In units of 0.1 GHz

Tunable capability is indicated in the Transmitter technology (Byte Address 147; see Table 52 of INF-8077i):

Value	Description of physical device
…	…
1001b	1550 nm tunable – negative chirp
1010b	1550 nm tunable – zero chirp
1011b-1111b	Reserved

Three Latched interrupt flags are defined at Byte Address 85. One flag at Bit 4 indicates a bad channel number request (i.e., a channel number outside of the supported range). A second flag at Bit 3 indicates that a channel change operation has completed. A third flag at Bit 2 indicates that Tx Dither has been requested in a module that does not support dithering.

Address	Bit	Name	Description
85	4	L-Bad Channel	Latched Bad Channel Requested
85	3	L-New Channel	Latched New Channel Acquired
85	2	L-Unsupported Tx Dither	Latched Unsupported Tx Dither Request
85	0-1	Reserved	Reserved

Associated with these three interrupt flags are three masking bits at Byte Address 93.

Address	Bit	Name	Description
93	4	M-Bad Channel	Masking bit Bad channel requested
93	3	M-New Channel	Masking bit New channel acquired
93	2	M-Unsupported Tx Dither	Masking bit Unsupported Tx Dither Request
93	0-1	Reserved	Reserved

An unlatched status Bit 2 at Byte Address 111 is defined to indicate that a tuning operation is in process and not yet completed. Bit 1 is used to command Tx Dither (Bit 1 low) or to disable Dither (Bit 1 high).

Address	Bit	Name	Description
111	3-7	…	…
111	2	Tx_Tune	Identifies Tx Not Ready due to tuning
111	1	Tx Dither	Logic “1” disables Dither, “0” enables Dither
111	0	Reserved	Reserved

Receiver type is indicated with the Extended Identifier at Byte Address 129.

Address	Bit	Description
129	7-6	00: Power level 1 module (1.5W max power) 01: Power level 2 module (2.5W max power) 10: Power level 3 module (3.5W max power) 11: Power level 4 module (>3.5W max power)
129	5	0: Module with CDR function 1: Non-CDR version of XFP
129	4	0: Tx Ref Clock input required 1: Tx Ref Clock input not required
129	3	0: No CLEI code present in Table 02h 1: CLEI code present in Table 02h
129	2	0: Module with limiting receiver 1: Module with linear receiver and Rx CDR bypassed
129	1-0	Reserved

INF-8077i defines Auxiliary Monitoring in Table 59, including Laser Wavelength Monitoring. This option is not supported for tunable applications. Any attempt to access this will return a value of 0000h in bytes 106-107 (AUX1) or 108-109 (AUX2) if 0101b (Laser Wavelength) is set in bits 7-4 or 3-0 respectively in Serial Byte Address 222.

INF-8077i defines the options of Laser Wavelength Alarms in Table 35 through AUX1 and AUX2 definitions in Serial Byte Address 222. This is not supported for tunable applications.

INF-8077i defines a Nominal Wavelength in the Serial ID Data Field at Address 186 and 187 of Page 01h. This is not supported for tunable applications and will return a value of 0000h.

INF-8077i defines a Wavelength Tolerance in the Serial ID Data Field at Address 188 and 189 of Page 01h. This reports the approximate wavelength accuracy on all channels in units of (nm / 200). This is supported for tunable applications. Thus for example ±2.5 GHz corresponds to ±20 pm, for a value of 0004h.

This concludes the list of registers defined for tuning operation.

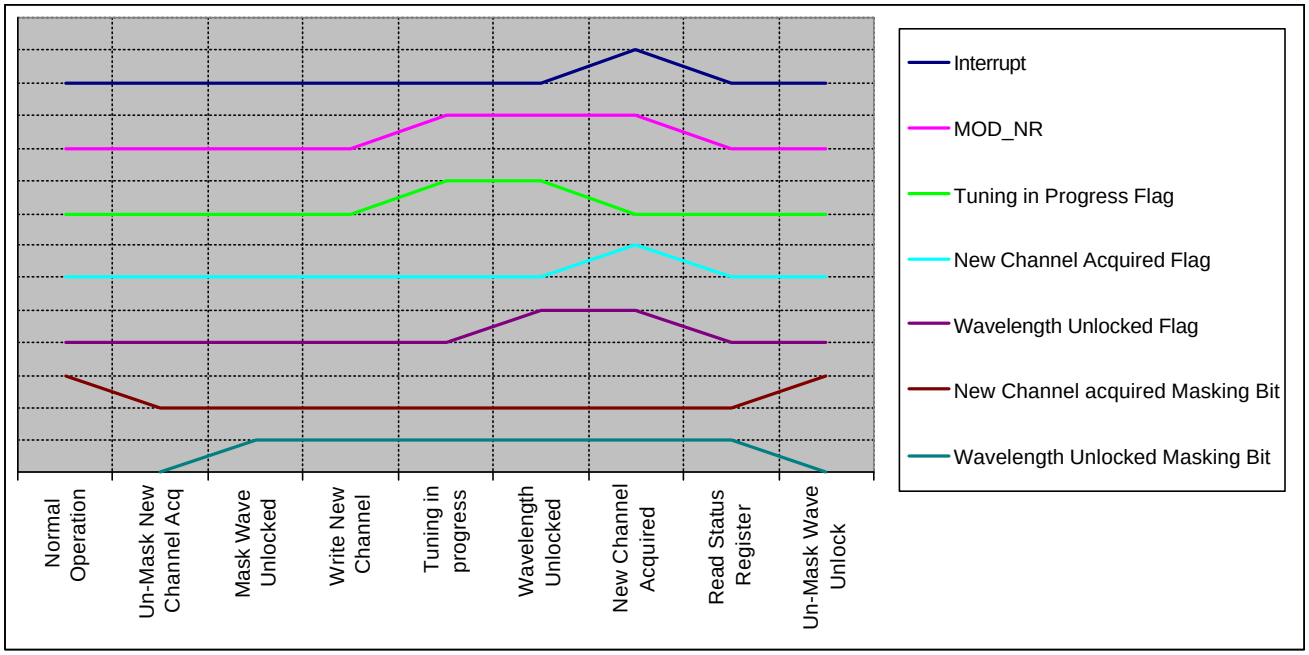
5. Timing Diagrams and Tuning Response Sequence

When a tunable module is plugged in for the first time it will go to a default channel, or if Tx_DIS is asserted it will go to a standby condition.

When the module is power cycled it will automatically go to the last channel selected, or if Tx_DIS is asserted it will go to a standby condition. If Tx_DIS is asserted, the last channel selected will be cleared, and a valid new channel command will be required to set a channel.

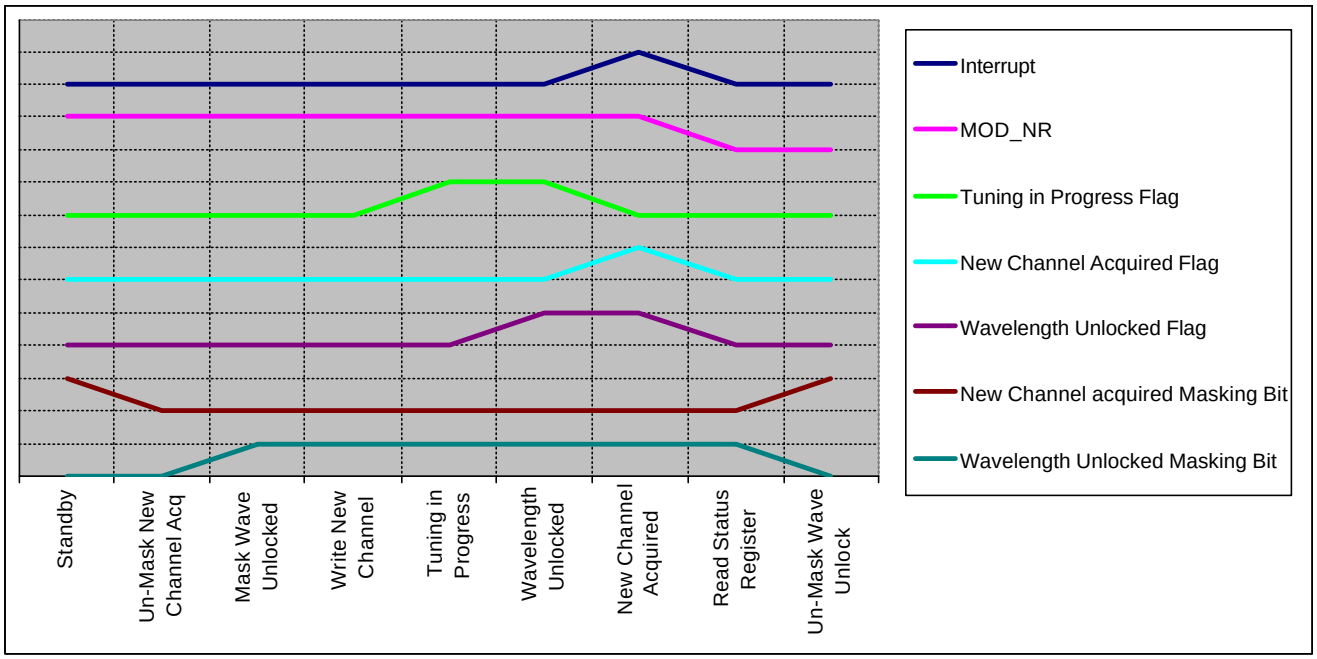
If the Tx is disabled and then re-enabled, the module returns to the last channel selected.

The following timing diagram shows the sequence of events and signals which switching from a valid channel to another valid channel. Interrupt refers to the hardware signal (pin 4 of the 30 pin connector). MOD_NR is the Module Not Ready status Bit 1 at Byte Address 84. The Tuning in Progress flag is Bit 2 of Byte Address 111. The New Channel Acquired flag is Bit 3 of Byte Address 85. The Wavelength Unlocked flag is Bit 5 of Byte Address 85. The New Channel Acquired masking (Bit 3 of Byte Address 93) and the Wavelength Unlocked masking (Bit 5 of Byte Address 93) should not be changed while a tuning operation is in process.



Timing diagram for channel-to-channel switching.

Next consider the timing diagram for a transition from standby state to valid channel acquired.



Timing diagram for standby-to-channel switching.

6. Color Coding and Labeling of T-XFP Transceivers

An exposed feature of the T-XFP transceiver (a feature or surface extending outside of the bezel) shall be color coded as follows:

- Green for tunable XFP.

7. Change Log

Version 1.4:

- Add paragraph at end of Section 3 defining expected default behavior.
- Added clarifying notes for “Module Capability” at Addresses 62, 66, and 68.
- Added negative chirp and zero chirp options for Transmitter technology at byte address 147.
- Added extended identifier byte 129 table, and added a new line for limiting vs. linear receiver.
- Added Section 6 to define color coding and labeling.
- Added change log.

Version 1.3:

- First published version.