Implementation of Optical Performance Monitor Module Interfacing in DWDM System

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***Abstract*— Purpose of this paper is to describe the hardware design interfacing of the Optical Performance Monitor Module (OPM) for 80/88 channel DWDM system operating at discrete wavelengths in the C-band (1530nm-1565nm) centered around 193.1 THz frequency as per ITU-T Rec.G.694.1 grid, at 50 GHz channel spacing.The Optical Performance Monitor Module is used to monitor and supervise the Optical signal performance. Optical signal performance includes actual values of OSNR, channel power and optical frequency.**

***Keywords*–** DCM, DWDM, ITU-T, OPM, OBA, ILA, OPA and OSC

I. INTRODUCTION

The OPM module scans the optical spectrum of a multiplexed WDM signal and detects the channel count, power, frequency and OSNR of the individual channels. By calibration of the optical coupling ratio (of the relevant test output) also the absolute power levels can be estimated. Optical Performance Monitor (OPM) is subjected to DWDM system. The module de-multiplexes 50 GHz spaced channel optical signals within the range of C-Band through gratings, tapped from an optical network. The data from the photodiode array is calculated by a processor. The results, which including optical spectrum, channel power, channel wavelength and OSNR, are provided to the customer. An OPM module is placed in each end of the system to get beginning and end performance data for both directions as well as to signal channel count information to the optical amplifiers. This means that minimum two OPM modules are required per system as Shawn in the Fig. 1.

II. GENERIC REQUIREMENTS OF OPM

The objective of optical monitoring is to detect anamalies, defects, degradation and fault affecting the quality of DWDM systems at optical layer. The monitoring of the DWDM system shall provide the facility of locally and remotely monitoring of some parameters as specified in the ITU-T Rec.G.697. The parameters shall facilitate in-service fault analysisi and performance degradation of DWDM system and enhance the reliability of the system.The methodology of "Optical Monitoring" shall be as per ITU-T Rec.G.697. The local and remote monitoring of following optical parameters of the DWDM system shall be supported by the system through its EMS.

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A. Channel Power

The equipment shall support the channel power measurements at the following points:

- Channel Power at the DWDM Transmitter output before the multiplexer.
- Channel Power at the DWDM receiver input after the demultiplexer.
- Channel Power at the output of various stages of optical amplification (optional).

B. Total Power

The equipment shall support the total channel power measurements at the following points:

- Total power at input of various stages of optical amplification.
- Total power at output of various stages of optical amplification.

In addition, the BER before FEC shall also be monitored by analyzing of the number of corrected bits by FEC as specified in ITU-T Rec.G.798.

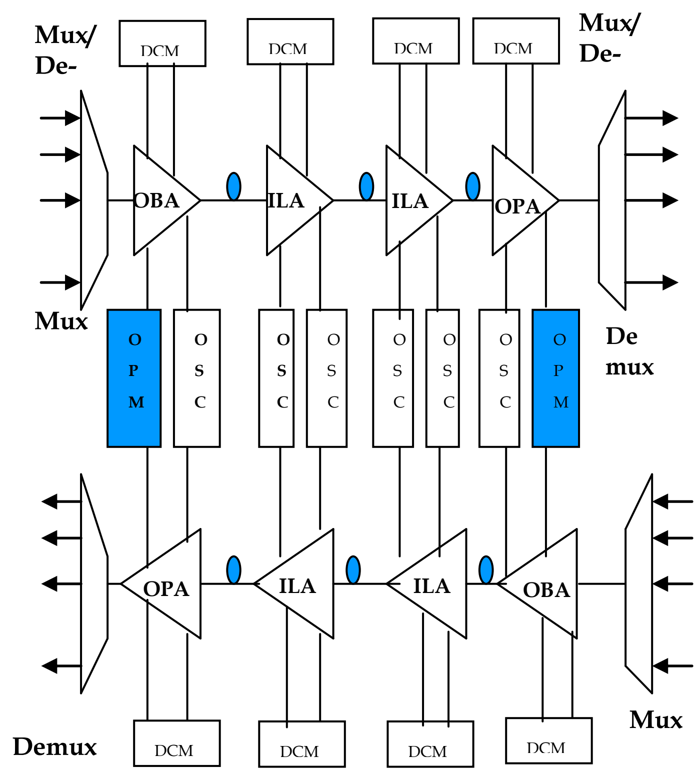

Fig. 1: OPM module in DWDM system

III. OPM MODULE PARAMETER

A. Optic and or Electric Specification

Parameters	Min	Typ	Max	Units	Notes
Minimum channel spacing	50	100	-	GHz	
Spectral range	1528		1568	nm	Extended C-band
Absolute wavelength accuracy			+/-75	pm	
Input power range	-45		-15	dBm	Per Channel
Absolute power accuracy			+/-1.0	dB	
Power resolution		0.1		dB	
OSNR			25	dB	
OSNR accuracy			+/-1.5	dB	
Measurement time			200	ms	
Power consumption		2	4	watt	

Table 1: Optic and electric specification

B. Optic Ports Definition

Port	Definition of port	Connector type	Note
input	Optical input	LC/UPC	Customer define

Table 2: Optic and electric specification

C. Electric Ports Definition

OPM mdule has 50 pin connector for electric interface with host (FPGA or processor). Tolerance of the operating Voltage is ±0.1V, Maximum allowable ripple is 300 µVrms. Tolerance of the operating Voltage is ±0.15V, Maximum allowable ripple is 300 µVrms.Maximum operating current is 0.45A, so fuse value recommended for in put 0.6A.

Pin	Colum-nA	Co-lumnB	I/O	Description
1	D0	D1	I/O	Date Bus Bit 0, 1 (LSB)
2	D2	D3	I/O	Date Bus Bit 2, 3
3	D4	D5	I/O	Date Bus Bit 4, 5
4	D6	D7	I/O	Date Bus Bit 6, 7
5	D8	D9	I/O	Date Bus Bit 8, 9
6	D10	D11	I/O	Date Bus Bit 10, 11
7	D12	D13	I/O	Date Bus Bit 12, 13
8	D14	D15	I/O	Date Bus Bit 14, 15 (MSB)
9	R/W	-	I	High: Read from DPRAM Low: Write into DPRAM
	-	CE	I	DPRAM Chip Enable, Active low
10	A0	A1	I	Address Bus Bit 0, 1 (LSB)
11	A2	A3	I	Address Bus Bit 2, 3
12	A4	A5	I	Address Bus Bit 4, 5
13	A6	A7	I	Address Bus Bit 6, 7
14	A8	A9	I	Address Bus Bit 8, 9
15	A10	A11	I	Address Bus Bit 10,11 (MSB)
16	/DONE	-	O	Mission Done, Strobe≥220ns, Active low
	-	/ERROR	O	Detect Error, Strobe≥220ns, Active low
17	Reserve	Reserve	-	No use, reserve for extending
18	Reserve	/START	I	Start Mission, Strobe≥220ns, Active low
19	Reserve	Reserve	-	No use, reserve for extending
20	/RESET	Reserved	I	Reset OPM Optical Module, Strobe≥220ns, Active low
21	+5V	+5V	I	+5 V Power Supply
22	+3.3 V	-	I	+3.3 V Power Supply
	-	AGND	I	Analog Ground
23	DGND	DGND	I	Digital Ground
24	Reserve	Reserve	-	No use, reserve for extending
25	RXD	TXD	-	Receive & Transmit

Table 3: Electric port definition

D. Dpram Memory Map

OPM module communicates with the host board through a DPRAM or RS232 interface（reserved）.

Address	Content (16 bits)	Direction	Comments
0x0000	Reserved		
0x0001	Reserved		
0x0002	No.of Data Points	From Module Read Only	1024 or 1400 points
0x0003	Scan Start Wavelength	From Module *Read Only*	In nm
0x0004	Scan Stop Wavelength	From Module *Read Only*	In nm
0x0005-0x001F	Reserved		
0x0020	BitMapped Command	From Host	Bit<1>: Start bit 0x0001 = Start
0x0021	Command Code	From Host	4: Scan spectrum and calculate channel performances
0x0022	Command Data	From Host	Number of averages
0x0023	BitMapped Status	From Module Read Only	Bit<0>: Ready bit Bit<1>: Error bit 0x0001 = Ready for read;0x0002 = Detect error
0x0024	Status code	From Module	Used to return number of detected channels
0x0025	Error code	From Module	0x0000 = No er-

			rors; 0x0004 = Invalid command
0x0026-0x007F	Reserved		
0x0080-0x00E3	Signal Type Settings from Host	From Host	4bits/channel, totally use 100Bytes. 0: No channel Present;1: Reserved; 2: 2.5G/10G externally modulated signal;3: 40G ODB; 4: 40G DPSK-NRZ;
0x00E4 - 0x00FF	Reserved		
0x0100-0x067F	Raw Spectrum Data	From Module	1024 or 1400 points containing the "raw" spectral data in scan, from start wavelength to end wavelength; Q8 format
0x0680-0x07FD	Wavelength, power and OSNR data for detected channels	From Module	Up to 96 sets of wavelength, peak power and OSNR of detected channels
0x07FE	Reserved		
0x07FF	Total power		Total power; Q8 format

Table 5: DPRAM memory map

E. Data Format

Representation of W/L, Power, OSNR of Detected Channel.

Address	Content
0x0680	Wavelength of Detected Channel 1
0x0681	Peak Power of Detected Channel 1
0x0682	OSNR of Detected Channel 1
0x0683	Wavelength of Detected Channel 2
0x0684	Peak Power of Detected Channel 2
0x0685	OSNR of Detected Channel 2
⋮	⋮

Table 5: Data format

F. Wavelength, POWER, OSNR Data Representation

Wavelength in DPRAM = 100× (Actual wavelength in nm−1500), for example: 1532.12 nm in DPRAM = 0x0C8C (or 3212 decimal).

Power data (in dBm) is represented in Q8 format, meaning that a conversion factor of 256 is used to convert the integer value stored in DPRAM to the actual power value.Power in DPRAM = 256×(Actual power in dBm). For example: 20.25dBm in DPRAM = 0x1440; −20.25dBm in DPRAM = 0xEBC0;

OSNR data (in dB) is represented in Q8 format, meaning that a conversion factor of 256 is used to convert the value stored in DPRAM to the actual OSNR value.OSNR in DPRAM = 256× (Actual OSNR in dB). For example: 25dB in DPRAM = 0x1900.

G. Timing of Communication with DPRAM

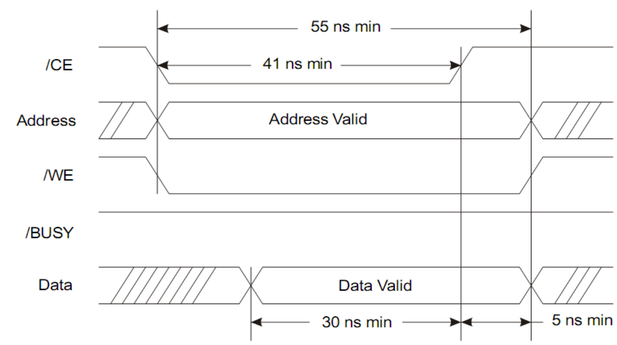

Fig. 2: DPRAM writing diagram

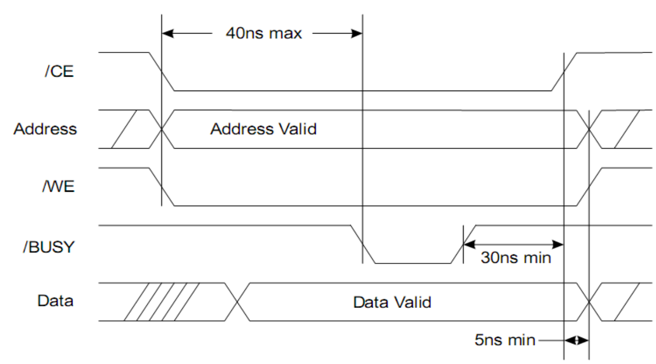

Fig. 3: DPRAM writing diagram with busy

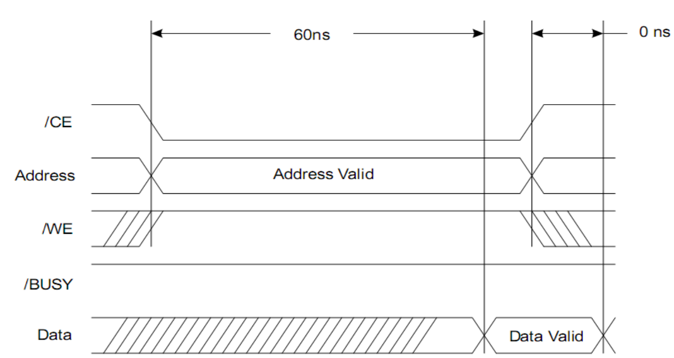

Fig. 4: DPRAM reading diagram

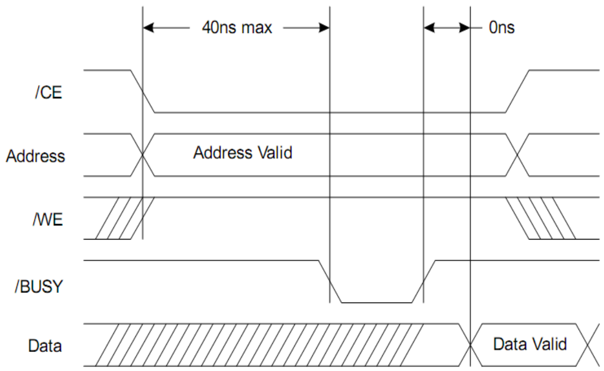

Fig. 5: DPRAM reading diagram with busy

The address, chip select (CS), write enable (WE) signals are generated by interfacing Host-FPGA or Processor.

H. Interrupt Timing, Power up Timing and Reset Timing

The host system must generate a START interrupt (an active low strobe of minimum 220 ns on the START pin) to initiate command processing.

Fig. 6: Interrupt timing

The OPM optical module provides two interrupts to the host system: DONE and ERROR. Under normal operation, the module generates a DONE interrupt to notify the host that command processing is complete or that an alarm status condition has changed. After a power-up or RESET, the module generates a DONE interrupt to notify the host that initialization is complete and it is ready to receive commands. The module generates an ERROR interrupt when an internal failure or error condition is encountered. The timing for the two interrupts is shown.

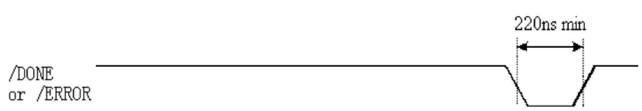

Fig. 7: Host Interrupt timing

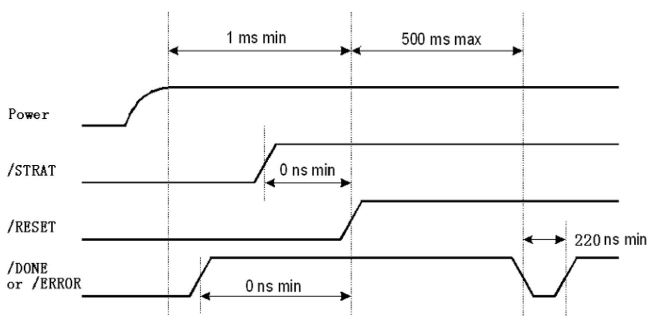

Fig. 8: Power up timing

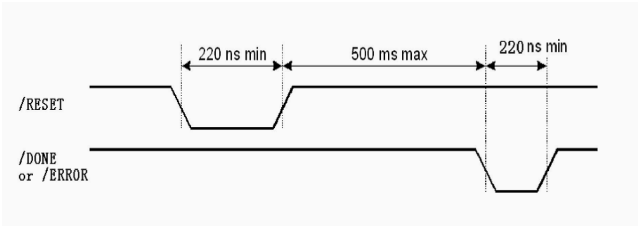

Fig. 9: Reset timing

IV. OPTICAL CONNECTIVITY OF OPM

Mini 1x4 Optical Switch will be used to tap the optical signal to OPM for four different positions as shown in Fig. 10.

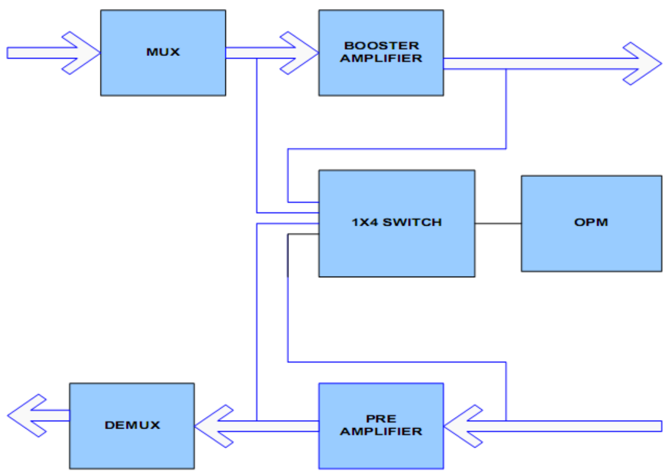

Fig. 10: OPM and 1x4 switch in DWDM system

V. CONCLUSION

The OPM is real time monitoring at DWDM system Fiber sensor or portable spectrometer.This module can be accessed through DPRAM interfacing.The host may be FPGA or Microprocessor.

REFERENCES

[1] Data sheets of "Optical Performance Monitor" by ACCELINK. http://www.accelink.com/uploads/files/20120517_015035.pdf