Tech Note | Revision B

Technote – HYPERION Full Redundancy

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1. Description

With the release of HYPERION firmware version 12.12.1, Micron Optics is providing, on an OEM basis, the "Full Redundancy" feature.

Full redundancy refers to the ability to interrogate both ends of a fiber optic sensor link. For certain applications, it is useful and/or necessary to measure sensors from both ends of a sensor array. Consider the situation in which a sensor array is disrupted (cut or damaged) such that sensors following the damage are no longer accessible. With the full redundancy feature, a user can connect both ends of a sensor array and maintain access to all sensors following a single sensor array disruption or break.

In non-full redundancy 16 channel HYPERION instruments operating at 1 kHz, each channel is, on every scan, transmitting AND receiving the reflected power from a sensor array. The following figure illustrates this.

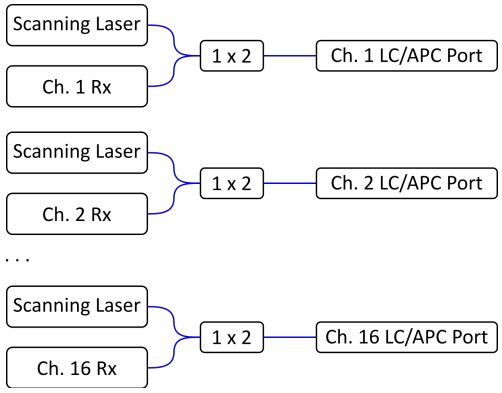

Figure 1. Conceptual Tx/Rx configuration.

With the full redundancy feature, channels 5-8 and 13-16 do NOT transmit when channels 1-4 and 9-12 are transmitting. Similarly, channels 1-4 and 9-12 do not transmit when channels 5-8 and 13-16 are transmitting. In other words, the receivers are always enabled on every scan, however, each channel only transmits on every other scan. Channels 1-4 and 9-12 transmit together, as does channels 5-8 and 13-16. Channels 1-4 and 9-12 are out of phase with channels to 5-8 and 13-16 to facilitate this feature. This is illustrated in the following table.

Channel	Transmitter Status		Receiver Status
	Odd Serial Numbers	Even Serial Numbers	
1	ON	OFF	ON
2	ON	OFF	ON
3	ON	OFF	ON
4	ON	OFF	ON
5	OFF	ON	ON
6	OFF	ON	ON
7	OFF	ON	ON
8	OFF	ON	ON
9	ON	OFF	ON
10	ON	OFF	ON
11	ON	OFF	ON
12	ON	OFF	ON
13	OFF	ON	ON
14	OFF	ON	ON
15	OFF	ON	ON
16	OFF	ON	ON

Table 1. Tx and Rx status of channels as a function of acquisition serial number.

1.1. Peak Data

Peak data is returned for every scan at a 1 kHz rate. In the case of a sensor array connected to channels 1 and 5, on odd serial numbers, channel 1 will process the reflected spectrum of the sensor array while channel 5 will process the transmitted spectrum and vice versa. If using the full redundancy feature to interrogate both ends of a sensor array, the client code must correctly acquire and process the peak data. In the case where 8 sensor arrays are being interrogated at both ends of each array, peak data for one array will be located on one channel on odd serial numbers and another on even serial numbers. While data is being acquired at 1 kHz, each channel can only return useful data at 500 Hz. Half of the 1 kHz data is processed transmitted spectrum and often has no utility.

NOTE: Be sure to connect sensor arrays appropriately to interrogate both ends of a sensor array. For example, for sensor arrays A, B, C, D, E, F, G, and H, with ends A1, A2, B1, B2, etc., a particular sensor array must be connected such that one end is connected to a channel transmitting on even serial numbers, and the other is connected to a channel transmitting on odd serial numbers. For example:

Sensor Array	Array End	Channel
A	A1	1
	A2	5
B	B1	2
	B2	6
C	C1	3
	C2	7
D	D1	4
	D2	8
E	E1	9
	E2	13
F	F1	10
	F2	14
G	G1	11
	G2	15
H	H1	12
	H1	16

Table 2. Typical full redundancy configuration of 8 sensor arrays on a 16-channel unit.

The example configuration in the previous table allows for both ends of a sensor array to be interrogated in reflection.

HYPERION instruments with full redundancy enabled can also be used as a 16-channel unit to interrogate 16 separate sensor arrays. By combing peak data on channels 1-4 and 9-12 on odd serial numbers and peak data on 5-9 and 13-16 on even serial numbers, the unit, while scanning at 1 kHz acquires 16 channels of data at 500 Hz. Again, this is due to half of the transmitters being off on every other scan. In this case, when a channel is off, no data, not even transmitted spectrum is being processed as the sensor arrays are only connected on one end.

ENLIGHT makes easy use of this feature without additional complication. When the OEM feature is detected, ENLIGHT ignores peak data when the channel is NOT transmitting. ENLIGHT automatically concatenates data from sequential odd and even serial numbers and returns 16 channels of peak data from the processed reflected spectrums. The peak data from transmitted spectrums (or when the transmitters are off) are ignored. Thus, while running at 1 kHz, ENLIGHT acquires peak data sets at a 500 Hz rate.

1.2. Full Spectrum

For full spectrum, the firmware only returns the reflected spectrums from each channel. Full spectrum from channels 1-4 and 9-12 are the received spectrum on odd serial number scans, while full spectrums returned from channels 5-8 and 12-16 are from even serial number scans. In this way, consumption of the data is seamless for the client.

The transmitted spectrum (received spectrums when transmitters are off) are not available.

2. ENLIGHT

ENLIGHT makes use of this feature in a seamless manner. When used with ENLIGHT, each channel of data returns peak and spectrum data only when the transmitters and receivers are on. Data acquired when the transmitters are off are ignored. Users are presented with full spectrum and peak data that makes logical sense.

3. 4 Channel and 8 Channel Versions

The full redundancy feature is currently available on the si255 HYPERION platform. This hardware version of HYPERION is available in 4, 8 or 16 DUT channels. On non-full redundancy configurations, data is returned on only the 4, 8, or 16 channels in which the instrument is configured. On full redundancy configurations, there are a few special considerations of which the user must be aware.

3.1. Determining if an instrument has full redundancy available

A user can use the `#GetHardwareInformation` command to determine if full redundancy is available. This command is described as followed (as of firmware version 12.14.0):

`#GetHardwareInformation`

Description:
Get the information that describes the hardware and its capabilities. The information is returned as a string with each field delimited by the '#' character. The fields are 'info_version#model#board_version#board_revision#num_physical_ch#num_active_ch#amp_type#polar_type#redundancy_type'. This command can be used to return more information about the specific configuration of the instrument.

Syntax:
Command: #GetHardwareInformation
Arguments: N/A

Example:
Command: #GetHardwareInformation
Arguments: N/A

Message:
The hardware information key is 2.0#SI255#0.93#5#16#4#Linear#Uncontrolled#Full.

Content:
Length: Variable length ASCII string
Content: 0x 50 46 48 . . .

The 9th entry in this hardware information key will read either "None" or "Full". "Full" indicates that the full redundancy feature is enabled.

3.2. Determining the number of active channels

Using the `#GetHardwareInformation` command described above, the 6th entry in the hardware information key will read either 4, 8, or 16 as the number of active channels.

Note, the terminology of active channel in the context of full redundancy enabled configurations indicate the number of available physical channels on the unit.

3.2.1. 16 Active Channels

If the number of active channels is returned as 16, then the unit is capable of providing full redundancy to 8 sensor arrays as described earlier in this technical note in Table 2.

3.2.2. 8 Active Channels

If the number of active channels is returned as 8, then the unit is capable of providing full redundancy to 4 sensor arrays.

NOTE: Be sure to connect sensor arrays appropriately to interrogate both ends of a sensor array. For example, for 4 sensor arrays A, B, C, and D, with ends A1, A2, B1, B2, etc., a particular sensor array must be connected such that one end is connected to a channel transmitting on even serial numbers, and the other is connected to a channel transmitting on odd serial numbers. For example:

Sensor Array	Array End	Channel
A	A1	1
	A2	5
B	B1	2
	B2	6
C	C1	3
	C2	7
D	D1	4
	D2	8

Table 3. Typical full redundancy configuration of 4 sensor arrays on an 8-channel unit.

The example configuration in the previous table allows for both ends of a sensor array to be interrogated in reflection.

NOTE: In an 8-channel full redundancy configuration, channels 9 through 16 are not available. Blank in plates will replace the optical bulkheads where channels 9 through 16 are located on a 16-channel unit.

3.2.3. 4 Active Channels

If the number of active channels is returned as 4, then the unit is capable of providing full redundancy to 2 sensor arrays.

NOTE: Be sure to connect sensor arrays appropriately to interrogate both ends of a sensor array. For example, for 2 sensor arrays A and B, with ends A1, A2, B1, and B2, a particular sensor array must be connected such that one end is connected to a channel transmitting on even serial numbers, and the other is connected to a channel transmitting on odd serial numbers. For example:

Sensor Array	Array End	Channel
A	A1	1
	A2	5
B	B1	2
	B2	6

Table 4. Typical full redundancy configuration of 2 sensor arrays on a 4-channel unit.

The example configuration in the previous table allows for both ends of a sensor array to be interrogated in reflection.

NOTE: In a 4-channel full redundancy configuration, channels 3-4 and 7-16 are not available. Channels 1-2 and 5-6 will be located in a single quad bulkhead. Blank in plates will replace the optical bulkheads where channels 5 through 16 are located on a 16-channel unit.

3.3. Parsing the peak and full spectrum data on 4 and 8 channels configurations

When using a configuration with 16 active channels, the parsing of data and Enlight functionality has been described in sections 1.1, 1.2, and 2.

When the number of active channels is 4 or 8 on full redundancy enable configurations, the data is returned in the exact same manner. In other words, a 4 or 8 active channel full redundancy enable configuration will still return 16 channels of peak or full spectrum data. However, as per Table 3 and Table 4, only a subset of data will be relevant.

For example, relevant data for an 8-channel full redundancy enable configuration will only be returned on channels 1-8. Similarly, relevant data for a 4-channel full redundancy enable configuration will only be returned on channels 1-2 and 4-5.

NOTE: Non-relevant data can be ignored. Full spectrum received on these channels will exhibit some amount of electronic noise. Peak data will most likely return zero peaks. However, if a user sets custom peak detection parameters on these channels, it is possible to return noise peaks. Again, any data returned on these other channels can be ignored.