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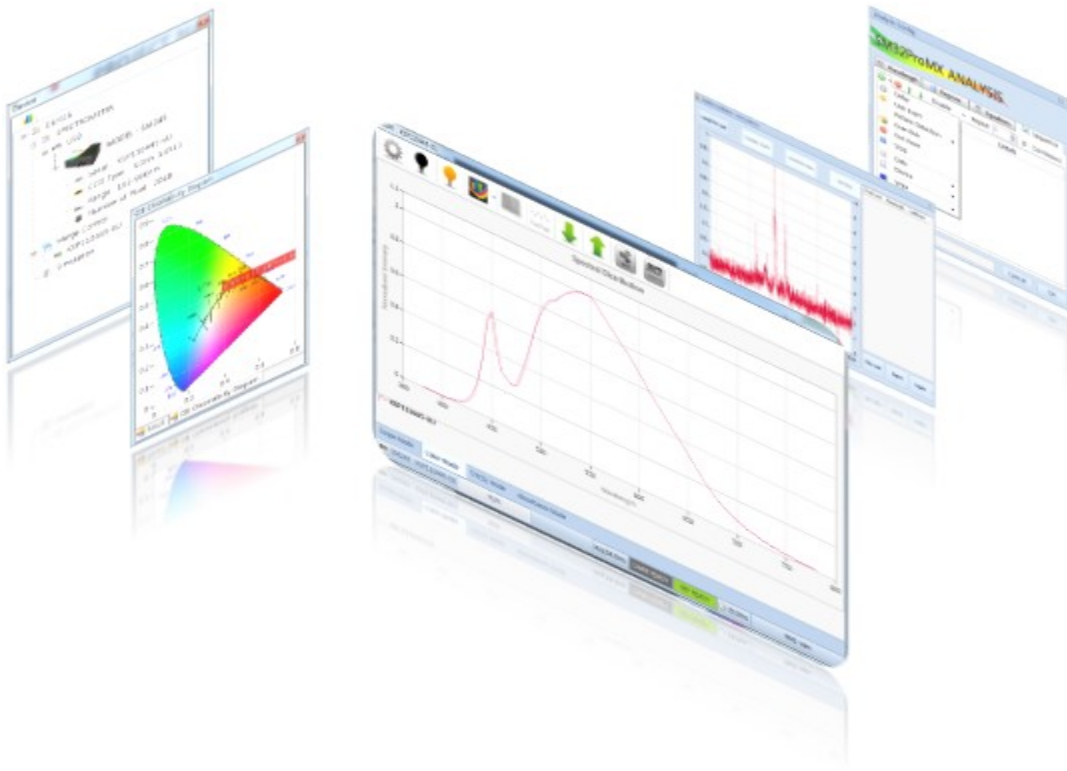
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SDK For N Series

Spectrometer Operating SOFTWARE Development kit USER MANUAL

For USB3.0, Ethernet Multi-channel User Only



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Getting Started

This document documents a library of functions for the operation of USB and Ethernet data acquisition boards in CCD measurement devices. The two basic CCD imaging concepts are the collection of data detected by the CCD and operating and calibrating this data to have meaningful values.

Collection of Data

In the array CCD spectrometer, light is scattered and incident on the pixel array. The number of pixels is different for each CCD type and consists of a pixel that does not respond to light (Dummy Pixel) + a pixel that responds (Effective Pixel). Data is collected by each pixel and converted into relative light intensity by a 16-bit (0-65535) analog-to-digital (A/D) converter and output. This library of functions allows you to control the light exposure time on the CCD, allowing you to measure signals of different intensities. When adjusting the exposure time, it is recommended to adjust it so that the peak value of the pixel array data does not exceed 65535. In this way, each pixel of the CCD can obtain an optimized measurement condition without saturation.

	Dummy pixel	Effective Pixel	Start Effective Pixel Index	Total Pixel
SM245N Sony ILX511	32	2048	33	2080
SM445N Toshiba TCD1304	32	3648	33	3680
SM642N Hamamatsu S10420	32	2048	11	2080
SM303N Hamamatsu S7031-1006S	32	1024	11	1056
SM303NP Hamamatsu S10141-1007S	32	2048	11	2080

[Table 1]. Pixel Information by CCD Type

Generating Meaningful Values

The only information the system collects is the relative signal magnitude of each CCD pixel before it is calibrated to an absolute value (a certified reference). That is, in this initial data, the position of each pixel of the CCD indicates a spatial distribution, and the corresponding intensity is expressed as a digital value (Intensity). And since the intensity of the light source and the exposure time can be adjusted, the

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output digital value (Intensity) represents the relative value of the intensity of the light. When these two problems are solved, the data measured by the spectrometer will have a meaningful value.

First, wavelength calibration should be performed by matching with a table indicating the wavelength of each pixel and nanometer unit based on the information of the light source dispersed and incident on the CCD. Using a known emission light source (Ex: Correction light source such as Ar, Hg, narrow band filter), the wavelength information of the peak measured and the pixel are matched to make a calibration point, and then these points are polynomial fitting to calculate the wavelength information of all pixels. After performing this wavelength calibration, the measured light can be checked as wavelength information within the pixel range.

And to use the digital value (Intensity) representing the relative light intensity, normalization is required. Several calculation methods may exist for normalization according to a method of selecting reference data. Transmittance and reflectance are only briefly discussed in this document. Transmittance is obtained by measuring the data of the light source used for measurement without any obstacles other than air in the optical path, using it as 100% reference data, and calculating the ratio with the measured data by putting a sample in the optical path. A more accurate measured value is calculated by subtracting the baseline intensity value of the spectrometer from the data during calculation. The baseline intensity is used by measuring the dark state data after turning off or blocking only the light source in the measurement environment. It is recommended to do this prior to sample measurement. In this way, the DC offset level of the background is subtracted, and the baseline becomes 0 for all subsequent measurements.

$$\frac{Sample - Dark}{Ref - Dark} * 100 = Trans(\%)$$

The reflectance can also be applied in a similar way to the above.

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Using the SP Libraries

The function library provided by SP is based on C and is provided in the form of a DLL file. Basically, it can be used in C++ MFC, VB, and C#, and it is compatible with other development environments as well. If you have any questions related to this or SDK, you can get detailed guidance by contacting the website or contact information below.

Website: www.spectralproducts.com

Phone: 860-928-5834

Procedure for using the .dll with VC++

1. Copy the "SPdbEthm.dll" and "SPdbEthm.lib" files to the working project folder or release folder. these files are

"[Software installed directory]/SDK Examples/DLL".

The folder is divided for use by call type and application build environment.

2. The prototype declaration of a function is

"[Software installed directory]/SDK Examples/VC++/SPdbEthm.h"

It is included in the file, so you can copy and use it in your work project.

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General Overview

Some Basic Fundamentals of Utilizing the SP SDK Functions

SP provides two types of interfaces (USB, Ethernet), and when using the function library, select the interface type from the function to be initially connected, and use the functions to be used afterward. First, the currently connected spectrometers are searched using `spNScanDevice()`. The number of spectrometers connected via USB and Ethernet is returned. Next, if you use the `spNGetDeviceList()` function, you can check the connection information of the spectrometers retrieved above. The model, serial, interface type, and connection address (USB → COM Port, Ethernet → IP address) are returned. If you call the `spNConnect()` function by passing the interface type and connection information of the spectrometer to be connected from the spectrometer list, it will connect to the spectrometer. If the connection is successful, the channel of the spectrometer is assigned, and it is passed as a return value. Normal use is possible by calling the spectrometer driving function with the returned channel value.

Using Curve Fitting to Calibrate

Curve fitting is used for polynomial fitting of the calibration point matched with the wavelength information of the known emission light source matched with the CCD pixel during the wavelength calibration. Basically, when manufacturing a spectrometer in SP, it performs its own wavelength calibration using a calibration light source. At this time, the generated calibration points are stored in the EEPROM inside the spectrometer and used as factory default values. When the wavelength information of each pixel is received by calling the `spNGetWLTable()` function, the calculated result is output using the calibration point stored in the EEPROM.

Occasionally, if a user wants to perform wavelength calibration by creating a calibration point using a calibration light source, polynomial fitting can be performed directly with `spPolyCalc()` and `spPolyFit()` functions. In the calculation, the third-order polynomial calculation must be performed with the order of 3 to generate a function representing all points well. However, if the known wavelength of the calibration light source is limited, the number of calibration points is small, so it may be necessary to set the order to 3 or less.

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SDK Functions

spNScanDevice

short spNScanDevice

```
(  
    short sScanMode = SP_SCAN_CONNECTABLE  
)
```

This function searches the spectrometer connected by USB and Ethernet. When the function is called, the number of found spectrometers is returned.

sScanMode: Search mode option input variable. Do not enter anything when calling the function. Case is set to the default value. When called with default settings, the current. Only accessible devices are searched. Other options are not available. If devices are also found, they are printed.

```
SP_SCAN_ALLDEVICE = 0  
SP_SCAN_CONNECTABLE = 1
```

RETURN

If there is no error, an error occurs when the number of found spectrometers is less than 0

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spNScanDevice_IP

```
short spNScanDevice_IP  
(  
    char *pcNetworkID  
    short sStartHostID  
    short sEndHostID  
)
```

This function sets the IP range and searches for spectrometers connected via Ethernet. IP consists of Network ID and Host ID, and you can search by setting the Host ID range of the Network ID you want to search.

EX) IP = 192.168.1.100
 Network ID Host ID

pcNetworkID : Network ID to search
sStartHostID : Search range start Host ID
sEntHostID : Last Host ID in the search range

RETURN

If there is no error, the number of found spectrometers is returned.
Error when less than 0

spNGetDeviceList

```
short spNGetDeviceList  
(  
    DeviceList *pDevList // Output variable. (struct)  
)
```

This function outputs the connection information of the spectrometers found in the spNScanDevice function. With DevList, spectrometer information is output as an array of structures.

*p**DevList**: The retrieved spectrometer List structure includes interface type, model, serial, and connection address.

short sInterfaceType	`interface type
char cCOM[100]	`In case of USB, COM Port information
char cSerial[100]	`Spectrometer serial number
char cIPAddr[100]	`In case of Ethernet, IP address information

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

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spNConnect

short spNConnect

```
(  
    short slInterface,  
    char * cConnectAddr  
)
```

This function is a function that connects to the spectrometer. If the connection is successful, a channel is allocated internally, and this value is returned. The returned channel value is then used as a spectrometer access handle to the drive function. The information used for connection is the interface type and connection address, and connection information of the spectrometers found with the spNGetDeviceList function can be checked.

slInterface : Connection request interface type

cConnectAddr : IP address in case of Ethernet, COM Port in case of USB

⌘ **Notice**: When requesting a connection to the Ethernet interface, it is possible to try to connect to an IP address that is not found in the spNScanDevice function. Even if the connection fails, a channel is allocated, and the connection continues until the connection is successful. To stop subsequent connection attempts, the channel must be closed with the spNDevClose function even if the connection is not successful.

RETURN

If the connection is successful, the channel value is returned,
Error when less than 0

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spNGetDevParam

short spNGetDevParam

```
(  
    DevInfrmation *pDevInfo  
    short sChannel  
)
```

This function is a function that outputs the spectrometer setup and detailed information as an output structure.

***pDevInfo:** Device information output structure variable

char strCOM[100]: COM Port when connected via USB

char strModel[100]: the model name of the spectrometer

char strSerial[100]: the spectrometer's serialchar

strIPAddr[100]: IP address assigned to the spectrometer when connected via Ethernet

char strStaticIPAddr[100]: static IP address recorded in spectrometer internal ROM

char strMACAddr[100]: MAC address of the spectrometer

double dWLTable[3648]: As factory default recorded in spectrometer EEPROM

wavelength table corresponding to each calculated pixel

int iDummyPixelNum: The number of pixels that do not respond to the frontmost light in the CCD pixel.

int iIntTime: Integration Time set in the spectrometer

int iTimeAvg: H/W Time Average set in the spectrometer

int iTotPixelNum: the number of all pixels in the used CCD of the spectrometer

int iRealPixelNum: excluding the number of Optical Black Pixels in front of CCD pixels
number of pixels used

short sTrgMode: Spectrometer internal driving mode

SP_TRIGGER_FREERUN_NEXT = 1

SP_TRIGGER_FREERUN_PREV = 2

SP_TRIGGER_SOFTWARE = 3

SP_TRIGGER_EXTERNAL = 4

short sInterfaceType: Spectrometer connection interface type

SP_INTERFACE_USB = 0

SP_INTERFACE_ETHERNET = 1

short sNetMode: IP address allocation mode when connected to the spectrometer's Ethernet

SP_NETMODE_DHCP = 0

SP_NETMODE_STATIC = 1

short sChannel: Channel assigned to the spectrometer

short sCCDType: CCD type used in the spectrometer

SP_CCD_SONY = 0 (SM245N)

SP_CCD_TOSHIBA = 1 (SM445N)

SP_CCD_PDA = 2 (SM303N)

SP_CCD_G92XX_512 = 3 (SM304N_512)

SP_CCD_S10420 = 4 (SM642N)

SP_CCD_G92XX_256 = 5 (SM304N_256)

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✂ **Notice:** `IntTime` output value is in us units for SM445N and SM642N, and ms units for SM245N.

RETURN

If there is no error, `SP_NO_ERROR(1)` is returned.

Error when less than 0

spNGetDevInfo

short spNGetDevInfo

```
(  
    char *pstrModel  
    char *pstrSerial  
    short *psInterfaceType  
    short sChannel  
)
```

This function outputs the spectrometer model, serial, and interface type information.

***pstrModel:** the model output variable of the spectrometer. Array memory size: 30

***pstrSerial:** Spectrometer's serial output variable. Array memory size: 30

***psInterfaceType:** Spectrometer's connection interface type output variable

`SP_INTERFACE_USB = 0`

`SP_INTERFACE_ETHERNET = 1`

sChannel: The channel assigned to the spectrometer. Return value of `spNConnect` function

RETURN

If there is no error, `SP_NO_ERROR(1)` is returned.

Error when less than 0

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spNGetCCDType

```
short spNGetCCDType  
(  
  short *psCCDType  
  short channel  
)
```

This function outputs the CCD type information of the spectrometer.

***psCCDType:** CCD type output variable of the spectrometer

SP_CCD_SONY = 0 (SM245N)
SP_CCD_TOSHIBA = 1 (SM445N)
SP_CCD_PDA = 2 (SM303N)
SP_CCD_G92XX_512 = 3 (SM304N_512)
SP_CCD_S10420 = 4 (SM642N)
SP_CCD_G92XX_256 = 5 (SM304N_256)

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

spNGetEEPROM

```
short spNGetEEPROM  
(  
  char *pcEEPData  
  short channel  
)
```

This function outputs the data recorded in the EEPROM of the spectrometer.

***pcEEPData:** EEPROM information output variable to the spectrometer. Array memory size: 1024

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

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spNGetWLTable

```
short spNGetWLTable  
(  
    double *dWLTable  
    short sChannel  
)
```

This function retrieves the spectrometer's wavelength table. Used to simply import wavelength tables. Calibration data stored in EEPROM is read and polynomial calculation is performed internally to perform wavelength calibration.

***dWLTable:** Outputs the calculated wavelength value for each pixel.

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)
Error if less than 0

spNSetIntTime

```
short spNSetIntTime  
(  
    long lIntTime  
    short sChannel  
)
```

This function sets the exposure time of the spectrometer.

lIntTime : The exposure time input variable to set. $0 < \text{lIntTime} < 65535$. (ms units)

sChannel : The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

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spNSetDBIntTime

short spNSetIntTime

```
(  
    double dIntTime  
    short channel  
)
```

This function sets the exposure time of the spectrometer.

dIntTime : The exposure time input variable to set. $0 < \text{dIntTime} < 65535$. Decimal in ms
Up to 3 digits can be entered.

sChannel : The channel assigned to the spectrometer. Return value of spNConnect function

✂ **Notice:** Models that can be set in us units: SM445N and SM642N only

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

spNSetTimeAvg

short spNSetTimeAvg

```
(  
    short sAvgTime  
    short channel  
)
```

This function sets the H/W Time Average of the spectrometer. When data is acquired by calling the spNReadDataEx function, the average value of repeated measurements is output as many times as sAvgTime.

sAvgTime : H/W Time Average input variable to set

sChannel : The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

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spNSetTrgMode

short spNSetTrgMode

```
(  
    short sTrgMode  
    short sChannel  
)
```

This function is to set the data acquisition trigger mode of the spectrometer.

sTrgMode: Trigger Mode input variable to set

SP_TRIGGER_FREERUN_NEXT = 1
SP_TRIGGER_FREERUN_PREV = 2
SP_TRIGGER_SOFTWARE = 3
SP_TRIGGER_EXTERNAL = 4

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function.

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

spNSetDevice

short spNSetDevice

```
(  
    long lIntTime  
    short sAverage  
    short sTrgMode  
    short sChannel  
)
```

This function is to set the spectrometer. Exposure time, H/W Time Average, and Trigger Mode can be set at once.

lIntTime: The exposure time input variable to set. $0 < \text{lIntTime} < 65535$

sAverage: H/W Time Average input variable to set

sTrgMode: Trigger Mode input variable to set

SP_TRIGGER_FREERUN_NEXT = 1
SP_TRIGGER_FREERUN_PREV = 2
SP_TRIGGER_SOFTWARE = 3
SP_TRIGGER_EXTERNAL = 4

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

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spNGetNetInfo

short spNGetNetInfo

```
(  
    char *pcIPAddr  
    char *pcMACAddr  
    char *sNetMode  
    short sChannel  
)
```

This function is to output the Ethernet related information of the spectrometer.

***pcIPAddr:** IP address information assigned to the spectrometer. Array memory size: 100

***pcMACAddr:** Spectrometer MAC Address. Array memory size: 100

***sNetMode:** Ethernet operating mode of the spectrometer. There are DHCP mode and Static mode. In DHCP mode, IP of the spectrometer is automatically assigned, and in Static mode, a static IP recorded inside is assigned and used.

SP_NETMODE_DHCP = 0

SP_NETMODE_STATIC = 1

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

spNCheckConnect

bool spNCheckConnect

```
(  
    short sChannel  
)
```

This function gets the current connection state of the spectrometer. Outputs the current connection status as a return value.

✂ **Notice:** In case of Ethernet interface, even if the output value of this function is false, internal connection is continuously being attempted with the corresponding IP. If the device of the corresponding IP is reconnected, the return value of this function is returned as true.

RETURN

If the return value is true, connection is in progress; if false, connection is disconnected.

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spNReadDataEx

short spNReadDataEx

```
(  
    long *pIArray  
    short sChannel  
)
```

This function gets the CCD signal of the spectrometer. When calling the function, the measurement time is determined by the exposure time set with the 'spNSetIntTime' function and the repeated measurement value set with the 'spNSetTimeAvg' function.

***pIArray:** CCD signal output array variable. The size of the array must be greater than or at least equal to the total number of pixels of iTotPixelNum received from the 'spNGetDevParam' function. The number of pixels in the CCD varies by model and is as follows:

SM245N = 2080,
SM445N = 3680,
SM642N = 2080,
SM303N = 1056,
SM304N_512 = 512,
SM304N_256 = 256

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

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spNGetGainOffsetValue

short spNGetGainOffsetValue

```
(  
    int* piGainValue,  
    int* piOffsetValue  
    short sChannel  
)
```

This function outputs the digital gain and offset setting values of the spectrometer control board. Each spectrometer has a slightly different initial base line on a computer depending on the impedance matching, so the base line needs to be adjusted by the user.

piGainValue: Set gain value output variable. Range: 0-1023

Actual gain (signal magnification) = (piGainValue X 0.0487683) + 0.11

piOffsetValue: Set Offset value output variable. Range: 0-1023

Actual offset (count) = piOffsetValue X 50

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

spNGetMemState

short spNGetMemState

```
(  
    short sMempage,  
    MEMORYSTATE *stMemArray  
    short sChannel  
)
```

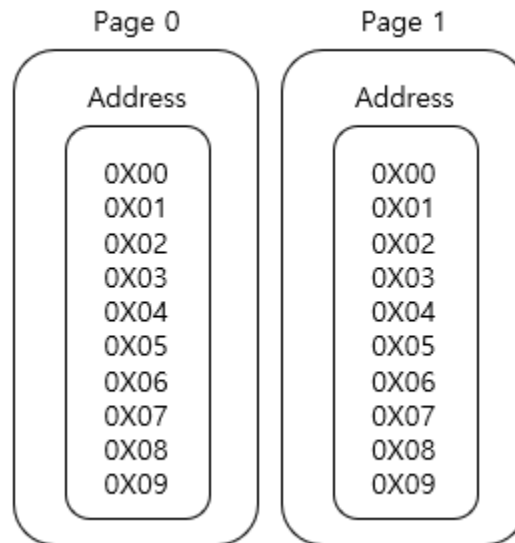
This function is to get information of data stored in memory through 'spNSaveDataToMem' function. Whether the corresponding *Memory area is allocated and the storage name can be received.

✖ **Notice:** Memory area is divided into 0-1 pages, and each page consists of 10 addresses of 0X00 0X09. Each address can store the spectrometer's full wavelength spectrum data.

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sMempage: page input variable to check information

stMemArray: Structural array that outputs the information of each address in the page area

short sMemState: Whether to store data in Address

1: stored, 255: EMPTY

char MemName[100]: Name information when saving data in Address

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

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spNGetMemData

short spNGetMemData

```
(  
    short sMemPage,  
    byte btAddress,  
    long *pIDataArray,  
    short channel  
)
```

This function gets the spectral data stored in the spectrometer memory area.

sMemPage: page input variable to check information

btAddress: Address input variable to get data from
range: 0X01 - 0X09

pIDataArray: Spectrum data output variable stored in the address

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

spNSaveDataToMem

short spNSaveDataToMem

```
(  
    short sMemPage,  
    byte btAddress,  
    char *pcName,  
    long *pIDataArray,  
    short channel  
)
```

This function is to save the spectral data in the spectrometer memory area.

sMemPage: page input variable to store data

btAddress: Address input variable to store data
range : 0X01 - 0X09

pcName: A descriptive input variable of the spectral data to be stored. If saving is successful, you can check the information output structure by calling the 'spNGetMemState' function.

pIDataArray: Spectral data input variable to save

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

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spNDeleteMemData

```
short spNGetMemData  
(  
    short sMemPage,  
    byte btAddress,  
    short channel  
)
```

This function deletes the spectral data stored in the spectrometer memory area.

sMemPage: the page input variable to delete data from

btAddress: Address input variable to delete data
range : 0X01 - 0X09

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

spNStartBurstData

```
short spNStartBurstData  
(  
    short sCount,  
    short sChannel  
)
```

When this function is called, the inside of the spectrometer starts measuring as many as sCount, and the function returns immediately. The data that has been measured is stored in memory, and the saved data can be called with the spNGetBurstData or spNGetBurstSingleData function. Up to 30000 data can be stored in memory.

sCount: Total number of data measurements. Input range 1 to 30000

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)
Error if less than 0

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spNStartSyncTrgData

```
short spNStartSyncTrgData  
(  
    short sCount,  
    short sChannel  
)
```

When this function is called, measurement starts in Synchronous Trigger Mode as much as sCount inside the spectrometer, and the function returns immediately. Synchronous Trigger Mode is a mode that measures by exposing light to the CCD as much as the period of the TTL signal input to the External Trigger Input terminal of the spectrometer. When sCount is 0, it operates in real-time measurement mode, and measurement continues until measurement is terminated with spNStopSyncTrgData function. Measured data can bring data at the time of call with spNReadDataEx function. If sCount > 0, it is measured as many times as sCount and the data is stored in memory. Data that has been measured can be called the saved data with the spNGetBurstData or spNGetBurstSingleData function. Up to 30000 data can be stored in memory. For detailed driving timing chart, refer to the Triggering Option Manual.

sCount: Total number of data measurements. Input range 1 to 30000

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)
Error if less than 0

spNGetBurstSingleData

```
short spNGetBurstSingleData  
(  
    long *pData,  
    short sChannel  
)
```

This function is a function that sequentially calls data stored in the memory measured in Burst Mode or Synchronous Mode one by one. Whenever the function is called, the data loaded into pData is output. If there is no data to load in the memory, SP_ERROR_MEMORY_EMPTY (-123) is returned.

pData: Data retrieved from memory.

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)
Error if less than 0

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spNGetBurstData

```
short spNGetBurstData  
(  
    long **dpDataList,  
    short sMode,  
    short iCount,  
    short channel  
)
```

This function deletes the spectral data stored in the spectrometer memory area.

sMemPage: page input variable to delete data from

btAddress: Address input variable to delete data from
range : 0X01 - 0X09

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

spNAutoDark

```
short spNAutoDark  
(  
    short sAutoDark,  
    short channel  
)
```

This function enables/disables the AutoDark function. The AutoDark function is a function that averages the signals of the optical black area pixels of the spectrometer CCD and subtracts them from all pixels to sink the base line. If this function is activated, it is calculated every time the spNReadDataEx function is called.

sAutoDark: 0 → Disable

1 → Activate

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

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spNWriteUserMemData

```
short spNWriteUserMemData  
(  
    short address,  
    char *pcWriteData,  
    short channel  
)
```

This function saves arbitrary text data in memory. There are addresses from 0x01 to 0x09, and **4096 bytes** of text can be stored for each address.

sAddress: Input value of memory address to save text data.

$0 \leq \text{sAddress} \leq 9$

***pcWriteData:** Text Data input value.

Maximum Array Size → **4096**

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

spNReadUserMemData

```
short spNReadUserMemData  
(  
    short address,  
    char *pcReadData,  
    short channel  
)
```

This function reads the text data stored in the user memory area of the spectrometer.

sAddress: Input value of memory Address to read.

$0 \leq \text{sAddress} \leq 9$

***pcReadData:** Text Data output value stored in the address.

Array Size → **4096**

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

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spNDeleteUserMemData

short spNDeleteUserMemData

```
(  
    short address,  
    short channel  
)
```

This function deletes the text data stored in the user memory area of the spectrometer.

sAddress: Input value of memory Address to delete.

$0 \leq \text{sAddress} \leq 9$

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.

Error when less than 0

spNSetoutTrgEnable

short spNSetOutTrgEnable

```
(  
    short sEnable,  
    short sChannel  
)
```

This function activates or deactivates the External Trigger Output function. Operates only when SP_TRIGGER_SOFTWARE(3) or SP_TRIGGER_EXTERNAL(4) is set in 'spNSetTrgMode' function. When this function is activated, a trigger signal is output to the output pin of the spectrometer back panel during the exposure time. Trigger signal output delay and pin can be set with 'spNSetOutTrgPin' function.

sEnable : Trigger signal output function enable/disable input variable

0 = SP_OUTTRG_DISABLE: Disable

1 = SP_OUTTRG_ENABLE : Enable

sChannel : The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)

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spNReadDataExOutTrg

```
short spNReadDataExOutTrg
(
    long *pIArray,
    short channel
)
```

This function has the same function as the 'spNReadDataEx' function, which is a CCD signal acquisition function, and a function that outputs a trigger signal during exposure time is added. It operates only when SP_TRIGGER_SOFTWARE mode is set in the 'spNSetTrgMode' function, and the trigger signal is output with a certain delay time from the start of the integration time after the 'spNReadDataExOutTrg' function is called. The trigger signal output pin can be set with the 'spNSetOutTrgPin' function.

***pIArray:** CCD signal output array variable. The size of the array is 'spNGetDevParam' greater than or at least the total number of pixels in iTotPixelNum received from the function should be the same number of pixels in the CCD varies by model and is as follows.

```
SM245N = 2080,
SM445N = 3680;
SM642N = 2080,
SM303N = 1056;
SM304N_512 = 512,
SM304N_256 = 256
```

sChannel: The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, SP_NO_ERROR(1) is returned.
Error when less than 0

spNSetOutTrgPin

```
short spNSetOutTrgPin
(
    short sOutPin,
    short sDelay
    short sChannel
)
```

This function is a function that sets the output pin location and initial delay of the trigger signal when the External Trigger Output function is activated with 'spNSetOutTrgEnable' function. The trigger signal output is output after a delay as much as the sDelay set value after the exposure time starts.

sOutPin : Pin setting value to output trigger signal. Value range: $0 \leq sOutPin \leq 1$, set in order of connector 3 ~ 4 pins on the back of the spectrometer.

sDelay : Set value of delay time until trigger signal output after exposure time. Actual delay calculation and maximum settable value are different for each model. SM245N can input from 0 to 65535, but the

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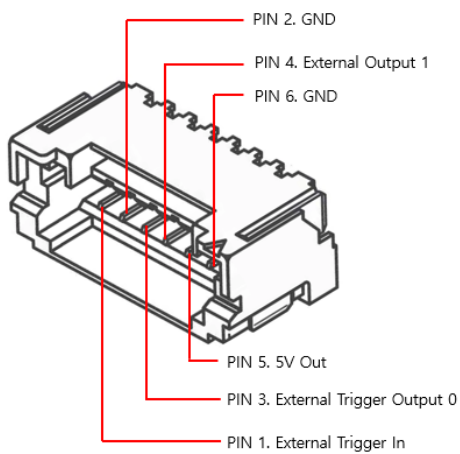
<http://www.spectralproducts.com>

actual delay cannot be set higher than the currently set Integration Time. SM642N can set from 0 to 996.

	Actual delay(us)	Max sDelay Input
SM245N	$5.4\mu s + (sDelay * 1.45\mu s)$	65535
SM642N	$20\mu s + (sDelay * 6\mu s)$	996

[Table 2]. Actual delay and maximum set value for each model

Pinout Diagrams for spectrometers



sChannel : The channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)

Error if less than 0

spNPolyFit

short spNPolyFit

(

double *x

double *y

short sNumPts

double *pdCoefs

short sOrder

)

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This function is used to find the coefficient of a polynomial that calculates the wavelength of each pixel. This function is for wavelength calibration and is calculated using calibration data. Calibration data is data obtained by matching pixels that react by measuring a light source of known wavelength with a spectrometer using a calibration light source or a light source that transmits certain narrow band filters. Calibration data is entered in x and y, and the array size is 1 ~ sNumPts. The calculated polynomial coefficient is output to the pdCoefs array, and then it can be used with spNPPolyCalc to calculate the wavelength of each pixel.

x: pixel input array variable of calibration data. Array size: 1 to sNumPts

y: wavelength array input variable of calibration data. Array size: 1 to sNumPts

sNumPts: number of points of calibration data

coefs : polynomial coefficient output array. Array size: 1 to (order + 1)

order : order of the polynomial. In most cases, a third-order polynomial calculation that is optimal for wavelength correction is used.

use

RETURN

If there is no error, return SP_NO_ERROR(1)

Error if less than 0

spNPPolyCalc

short spNPPolyCalc

```
(  
    double *pdCoefs  
    short sOrder  
    double x  
    double *y  
)
```

This function calculates the following formula:

$$y = a0 + a1 * x + a2 * x^2 + \dots + aN * x^n$$

pdCoefs: polynomial coefficient input array. Coefficient values calculated using the spNPPolyFit function

sOrder : The order of the polynomial to be used in the calculation. It must be smaller than the input pdCoefs array size.

x : pixel number to calculate

y: calculated wavelength value

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RETURN

If there is no error, return SP_NO_ERROR(1)

Error if less than 0

spNReadWLCalCoeff User

short spNReadWLCalCoeff_User

```
(  
    double *pdCoefs  
    short *psOrder  
    short sChannel  
)
```

This function is used when recalling the coefficients stored in the user area EEPROM of the spectrometer.

pdCoefs : coefficient output array. The maximum array size that can be output is 30, and the size of psOrder + 1 is output.

psOrder: Outputs the order of the saved coefficients.

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)

If there is no data stored in memory, SP_EEPROM_EMPTY (-113) is returned, and if it is less than 0, an error occurs.

spNWriteWLCalCoeff User

short spNWriteWLCalCoeff_User

```
(  
    double *pdCoefs  
    short sOrder  
    short sChannel  
)
```

This function is used to store coefficient information in the user area EEPROM of the spectrometer. Input coefficient information can be read using the spNReadWLCalCoeff_User function.

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pdCoefs: coefficient input array. The maximum input array size is 30, and only the size of sOrder +1 is stored in EEPROM.

sOrder : Order of polynomial coefficient.

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)

Error if less than 0

spNReadWLCalPoint_User

short spNReadWLCalPoint_User

```
(  
    double *pdPixel  
    double *pdWavelength  
    short *psPointNum  
    short sChannel  
)
```

This function is used to retrieve calibration data stored in the user area EEPROM of the spectrometer.

pdPixel: Pixel output array of calibration data. The maximum array size that can be output is 30, and the size of psPointNum is output.

pdWavelength: wavelength output array of calibration data. The maximum array size that can be output is 30, and the size of psPointNum is output.

psPointNum: The number of points in the saved calibration data

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)

If there is no data stored in memory, SP_EEPROM_EMPTY (-113) is returned, and if it is less than 0, an error occurs.

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spNWriteWLCalPoint User

```
short spNWriteWLCalPoint_User  
(  
    double *pdPixel  
    double *pdWavelength  
    short sPointNum  
    short sChannel  
)
```

This function is used to save calibration data to the user area EEPROM of the spectrometer. Input calibration data can be read with spNReadWLCalPoint_User function.

pdPixel: Pixel input array of calibration data. The maximum input array size is 30, and only the size of psPointNum is stored in EEPROM.

pdWavelength: wavelength input array of calibration data. The maximum array size that can be input is 30, and only the size of psPointNum is saved.

psPointNum: The number of points in the input calibration data

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)
Error if less than 0

spNGetWLTable User

```
short spNGetWLTable_User  
(  
    double *pdWLTable  
    short sSelMemory  
    short sChannel  
)
```

This function reads calibration information from the user area EEPROM, calculates the wavelength, and outputs it. You can select and import coefficients or calibration data points to calculate wavelengths.

pdWLTable: Output array of calculated wavelength values for each pixel. The size of the array is different for each model and is as follows.

SM245N = 2048,

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SM445N = 3648,
SM642N = 2048,
SM303N = 1024,
SM304N_512 = 512,
SM304N_256 = 256,
SM303NP = 2048

sSelMemory: Selection variable for calibration information to be recalled.

SP_WLCAL_COEFFICIENT(0) : coefficient

SP_WLCAL_CALPOINT(1) : calibration data point

sChannel: channel assigned to the spectrometer. Return value of spNConnect function

RETURN

If there is no error, return SP_NO_ERROR(1)

Error if less than 0

[spNGetErrorString](#)

```
char *spNGetErrorString  
(  
    short sErrorCode  
)
```

This function returns the description of the entered error code as a string.

sErrorCode : Error Code input variable

RETURN

Return Error Code String as char array

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spNCloseDevice

```
short spNCloseDevice  
(  
    short sChannel  
)
```

This function disconnects the collimator and

sChannel: channel assigned to the spectrometer. The return value of the spNConnect function.

RETURN

If there is no error, return SP_NO_ERROR(1)
Error if less than 0

Error Code

Error Code	Value	Description
SP_NO_ERROR	1	Normal operation
SP_ERROR_DEVICE_IO_CTRL	-101	Communication error with device
SP_ERROR_OPEN_DRIVER	-102	Handle open error
SP_ERROR_OPEN_FILE	-103	Handle creation error
SP_ERROR_MEMORY_ALLOC	-105	Memory allocation error
SP_ERROR_AUTODARK	-106	Auto Dark setting error
SP_ERROR_NOTSUPORT_DEV	-107	Unsupported equipment
SP_ERROR_INVALIDHANDLE	-108	Handle access error
SP_ERROR_INPUT_PARAM	-109	Invalid input parameter
SP_ERROR_SHUTTER_VALUE	-110	Shutter movement error
SP_ERROR_READ_ERROR	-112	EEPROM access error
SP_ERROR_EEPROM_EMPTY	-113	Unwritten EEPROM
SP_ERROR_DATA_LACK	-114	string parsing error

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SP_ERROR_NOTFINDDEVICE	-115	The device cannot be found
SP_ERROR_ALREADYOPEN	-116	Device already connected
SP_ERROR_WAIT_TIMEOUT	-117	response timeout
SP_ERROR_INVALIDVALUE	-120	Invalid response data
SP_ERROR_INVALID_INPUTCHANNEL	-121	input channel error
SP_ERROR_CHECKINTERFACE	-122	Connection interface error
SP_ERROR_COM_SETTING	-201	COM Port setting error
SP_ERROR_COM_READ	-202	USB data reception error
SP_ERROR_COM_WRITE	-203	USB data transfer error
SP_ERROR_COM_OPERATING	-204	USB connection status error
SP_ERROR_COM_NOTMATCHDEV	-205	Device check error during initial USB connection
SP_ERROR_COM_NOTCONNECTION	-206	not connected
SP_ERROR_ETH_NOTMATCHDEV	-302	Device verification error during initial ETH connection
SP_ERROR_ETH_SOCKETCREATE	-303	ETH Socket creation error
SP_ERROR_ETH_SOCKETCONNECT	-304	ETH Socket connection error
SP_ERROR_ETH_TIME	-305	ETH response timeout
SP_ERROR_ETH_RECVBUFFER	-307	ETH response data error
SP_ERROR_ETH_DISCONNECT	-308	ETH device disconnection
SP_ERROR_ETHSENDPACKET	-309	ETH data transmission error
SP_EXT_TRG_WATING	-99	external trigger input timeout