

**Development kit for DATAMAN 770
Programmer's Guide
Visual C++ 6.0
Version 2.01**



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Thank you for choosing the Dataman 770 Series Oscilloscope with Development Kit. We are confident, that it will meet your expectations.

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1. Basic information

1.1. Development kit contents

All development kit (DK) parts are located in the installation directory.

Directory	Contents
Examples\C#.NET	C#.NET example
Examples\VB.NET	Visual Basic .NET example
Examples\VB	Visual Basic 6.0 example
Examples\Delphi	Delphi example
Examples\CBuilder	C++ Builder example
Examples\VC	Visual C++ example
Include\C#.NET	C#.NET header files
Include\VB.NET	Visual Basic .NET header files
Include\VB	Visual Basic 6.0 header files
Include\Delphi	Delphi header files
Include\CBuilder	C++ Builder header files
Include\VC	Visual C++ 6.0 header files
Bin	M770drvdk.dll and m770drv.dll libraries

Table 1.1. –Development kit (DK) contents

1.2. DK usage

In order to make the DK work properly, it is necessary to have the DATAMAN 770 oscilloscope drivers installed. The m770drv.h header file contains all DK functions and m770drv.lib contains association of these functions with external DLL. Add both files to project to gain access to DK functions. The m770drvdk.dll and m770drv.dll must be present in the project directory.

1.3. Application deployment

The m770drvdk.dll and m770drv.dll libraries must be distributed together with your application. The drivers for the DATAMAN 770 oscilloscope must be installed in the system in order to communicate with the device. The application will work with every device with an activated DK.

2. Controlling the device

2.1. Device initialization

First of all, it is necessary to load the driver using the function `LoadDriver`.

```
LoadDriver();
```

After the driver is loaded it is possible to initialize the device using the function `InitHardware`. This function also returns the information for the calibration data.

```
unsigned char calibok;  
InitHardware(&calibok);
```

2.2. Error handling

In case an error occurs all subsequent calls of functions will fail. Therefore it is necessary to check if the operations were successful (for example check if the initialization was successful). Use `GetDKError` to obtain the error code.

```
int res;
```

```
int res = GetDKError();
```

In case of an error it is necessary to reset the error flag (to indicate to the DK, that the error has been handled). Use `ResetDKError` function to do so (otherwise no other function will be successful).

```
ResetDKError();
```

2.3. Data acquisition loop

The data acquisition process can be started by calling `StartMeasurement` function.

```
StartMeasurement();
```

After the data acquisition starts the software must wait until the data is ready in the device. Use `IsDataReady` function to check the acquisition status.

```
if (IsDataReady() == DATA_READY)  
{  
}
```

When the data is ready for transfer to the computer (return value `DATA_READY`), it is possible to transfer them to the computer using `GetData` function.

```
TSample data[1024*1024];  
int lng;  
GetData(&data[0],&lng);
```

2.4. Acquired data allocation

The array that is passed as the first parameter of the GetData function must be at least 1048576 items long. Acquired data will be written in the array like this:

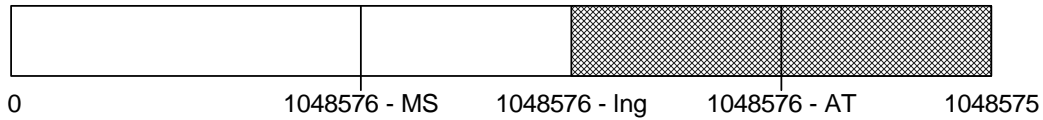


Fig. 2.4.1. – Data allocation in the array

MS is the memory size, AT is the amount of samples acquired after trigger, lng is the amount of received data (second parameter of the GetData function). If the $AT + HoldOff \geq MS$, MS equals to lng.

2.5. Measurement in the sampling mode

The DATAMAN 774 oscilloscope samples at 100MS/s in real time. To achieve a higher sampling speed a random sampling method is used.

2.5.1. Random sampling method

The sampling technology is applicable to periodical waveforms only. It is also known as “random sampling” or “equivalent sampling”. It uses the fact, that the sampled waveform is repeated periodically and the sampling clock is asynchronous in relation to the waveform. The principle is shown on the figure 2.5.1.1. The sampled waveform with triangular shape is sampled with the rising edge of the sampling clock.

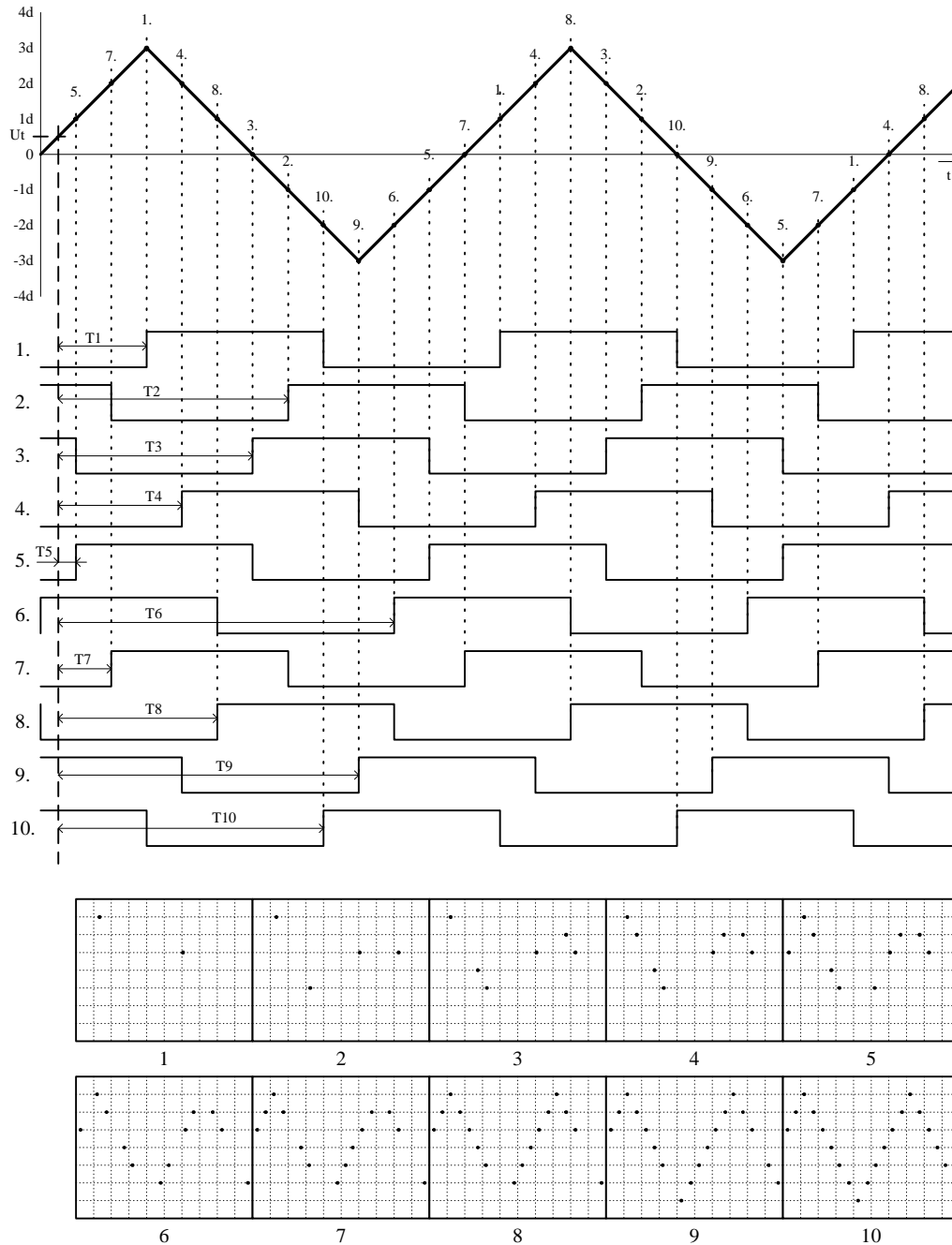


Fig. 2.5.1.1. – Random sampling principle

The trigger's threshold is set to U_t with the rising edge of the trigger input selected. Below the sampled waveform there is shown ten sampling clocks after valid trigger events. Because the phase of the sampling clock and the trigger event are independent (asynchronous) in time, the time period between the trigger event and the rising edge of the first sampling clock after the trigger event is a random value (T_1 thru T_{10}). Using these time periods it is possible to reconstruct the measured waveform. Every step of the reconstruction is shown at the bottom of the picture. This is the way in which you can multiply the sampling rate of the oscilloscope.

For sampling rate multiplication by N it is necessary to perform a minimum N subsequent measurements. In the majority of cases it is necessary to perform more

measurements because the random nature of this process causes measurements with the same clock phase.

When the random sampling method is used it is necessary to trigger with a well defined and stable waveform.

2.5.2. Measurement in sampling mode

Synthesis and interpolation of the samples is done automatically by the DK. Application received synthesized data. The only difference between real mode and sampling mode is that it is necessary to perform more acquisition loops to get a real image of the signal. Use `GetReconstructionPercentage` function to get the quality of the signal image (ratio of the measured and calculated samples).

2.6. Using more 770 devices

In case your application needs to use more than one device from the 770 family, please use following initialization process:

First of all it is necessary to load the driver using `LoadDriver` function.

```
LoadDriver();
```

Before initialization of the device the device list must be obtained by calling the `GetDeviceList` function.

```
unsigned int devs[16];  
GetDeviceList(&devs[0]);
```

The function fills the array with serial numbers of the present devices. Item index identifies the device in further calls of initialization functions.

The device can be initialized by calling the `InitHardwareFromList` function.

```
InitHardwareFromList(1, &CalibOK);
```

First parameter (device index in the array) indicates which device will be initialized.

After the device is initialized the `UseDevice` function can be used to select the device. All following calls of other functions (such as `SetTimeBase`, `SetRange` ...) will affect the selected device.

```
UseDevice(1);
```

3. Reference

Functions available in the DK can be divided into five groups:

Functions, that returns information about device

- GetDKError
- ResetDKError
- GetDeviceID
- GetDeviceSerialNumber
- GetDKVersion
- GetTimeBaseList
- GetRangeList

Initialization functions

- LoadDriver
- InitHardware
- GetDeviceList
- InitHardwareFromList
- UseDevice

Functions, that set the data acquisition parameters

- SetTimeBase
- SetRange
- SetCoupling
- SetVert
- SetTriggerLevel
- SetTriggerCount
- SetTriggerLength
- SetTriggerMode
- SetAfterTriggerLength
- SetHoldOff
- SetTriggerSource
- SetTriggerEdge
- SetProbe
- SetMemorySize
- SetCompensationGenerator
- SetGround
- SetDigitalShielding

Data acquisition functions

- StartMeasurement
- IsDataReady
- GetReconstructionPercentage
- GetData

Other functions

GroundPositionToShift

3.1. Functions, that returns information about device

3.1.1. GetDKError

In the case where the error occurs during the call of any DK function the error code is stored in the DK internal variable. All subsequent calls of DK functions will fail. GetDKError returns error code.

Declaration:

```
int __declspec(dllimport) __stdcall GetDKError();
```

Parameters: -

Return value:

ERROR_OK – no error occurred
ERROR_DRIVER_NOT_LOADED – unable to load driver/driver wasn't loaded before call
ERROR_DRIVER_INCOMPATIBLE - driver is not compatible with DK
ERROR_UNABLE_TO_LOAD_EM77X – unable to load em77x driver
ERROR_INIT_FAILED – device initialization failed
ERROR_FPGA_CONFIG_FAILED – FPGA configuration failed
ERROR_COMMUNICATION_FAILED – the communication with device is broken
ERROR_OPERATION_FAILED – unable to finish last operation
ERROR_DK_NOT_ENABLED – the device doesn't have DK enabled
ERROR_INCORRECT_PARAMETER – the function was called with incorrect parameter value

3.1.2. ResetDKError

In the case where the error occurs during the call of any DK function the error code is stored in the DK internal variable. All subsequent calls of any DK functions will fail. ResetDKError function resets this variable thus allowing you to call the DK functions again.

Declaration:

```
void __declspec(dllimport) __stdcall ResetDKError();
```

Parameters: -

Return value: -

3.1.3. GetDeviceID

Returns ID of the connected device.

```
int __declspec(dllimport) __stdcall GetDeviceID();
```

Parameters: -

Return value:

Device code is calculated as 771+*return value*.

3.1.4. GetDeviceSerialNumber

Returns device serial number.

```
unsigned int __declspec(dllimport) __stdcall GetDeviceSerialNumber();
```

Parameters: -

Return value:

Device serial number.

3.1.5. GetDKVersion

Returns the version of the selected DK part.

```
void __declspec(dllimport) __stdcall GetDKVersion(int module, TDKVersion *ver);
```

Parameters:

module – identifies DK part, which version is to be obtained

VERSION_EM770 – em770 driver

VERSION_DK – DK (m770drvdk.dll)

version – structure, which will be filled with the version

Return value: -

3.1.6. GetTimeBaseList

Returns the list of available timebases.

```
void __declspec(dllimport) __stdcall GetTimeBaseList(TTimeBaseItem *TimeBaseList, int *TimeBaseListLength);
```

Parameters:

timebaselist – the first item of the array which will be filled with the available timebases. Array must be at least 31 items long.

timebaselistlength – the number of array items which was filled (number of available timebases)

Return value: -

Remark:

Each array item is of *TTimeBaseItem* type. This structure comprises of the following items:

nsPerDiv – amount of nanoseconds per screen division (50 samples); this value is passed to the *SetTimeBase* function

RealSamplingRate – real sampling rate (in case, that the timebase doesn't run in sampling mode, this value equals to *SamplingRate*)

SamplingRate – equivalent sampling rate; this frequency determines distance between two samples

SamplingMulti – indicates ratio of *SamplingRate* and *RealSamplingRate*; the value of 1 indicates sampling in real time, value greater than 1 indicates sampling mode

3.1.7. GetRangeList

Returns the list of available ranges.

```
void __declspec(dllimport) __stdcall GetRangeList(TRangeItem *RangeList,
int *RangeListLength);
```

Parameters:

rangelist – the first item of the array which will be filled with the available ranges. Array must be at least 13 items long.

rangelistlength – the number of array items which was filled (number of available ranges)

Return value: -

Remark:

Each array item is of *TRangeItem* type. This structure comprise of following items:

mVPerDiv – amount of mV per one screen division (32 quantization levels); this value is passed to the *SetRange* function

3.2. Initialization functions

3.2.1. LoadDriver

Loads *m770drv.dll* driver.

```
int __declspec(dllimport) __stdcall LoadDriver();
```

Parameters: -

Return value:

ERROR_OK – driver loaded successfully

ERROR_DRIVER_NOT_LOADED – unable to load *m770drv.dll* library

ERROR_DRIVER_INCOMPATIBLE – *m770drv.dll* isn't compatible with DK

Remark:

The return value is stored in the internal DK variable as well. Use *GetDKError* function to access this internal variable.

3.2.2. InitHardware

Initializes device. After successful call of this function, the device can be used.

```
int __declspec(dllimport) __stdcall InitHardware(unsigned char *CalibOK);
```

Parameters:

CalibOK – this variable will be filled with information whether the calibration data in the device is ok

1 – calibration data are ok

0 – calibration data in the device are broken

Return value:

ERROR_OK – device was initialized successfully

ERROR_UNABLE_TO_LOAD_EM77X – unable to load em77x driver

ERROR_INIT_FAILED – device initialization failed (one of the reason can be, that the device isn't connected)

ERROR_FPGA_CONFIG_FAILED – FPGA initialization failed

ERROR_DK_NOT_ENABLED – the DK isn't enabled in the connected device

ERROR_DRIVER_NOT_LOADED – the driver m770drv.dll wasn't loaded before this call (use LoadDriver function to load it)

3.2.3. GetDeviceList

Obtains the list of the connected devices. This function is used when several 770 oscilloscopes are connected.

```
void __declspec(dllimport) __stdcall GetDeviceList(unsigned int *DevList);
```

Parameters:

DevList – array with length of 16, which is filled with the serial numbers of the found devices

Return value: -

3.2.4. InitHardwareFromList

Initializes selected device. This function is used when several 770 oscilloscopes are connected. After successful call, the active device can be selected by *UseDevice* function.

```
int __declspec(dllimport) __stdcall InitHardwareFromList(int index, unsigned char *CalibOK);
```

Parameters:

index – indicates device index from the list (obtained by *GetDeviceList* function)

CalibOK – this variable will be filled with information whether the calibration data in the device are ok

1 – calibration data are ok

0 – calibration data in the device are broken

Return value:

ERROR_OK – device was initialized successfully
ERROR_UNABLE_TO_LOAD_EM77X – unable to load em77x driver
ERROR_INIT_FAILED – device initialization failed (one of the reason can be, that the device isn't connected)
ERROR_FPGA_CONFIG_FAILED – FPGA initialization failed
ERROR_DK_NOT_ENABLED – the DK isn't enabled in the connected device
ERROR_DRIVER_NOT_LOADED – the driver m770drv.dll wasn't loaded before this call (use LoadDriver function to load it)

3.2.5. UseDevice

Selects the device, which will be affected by calls of other functions (such as *SetTimeBase*, *SetRange* ...). This function is used when several 770 oscilloscopes are connected.

```
void __declspec(dllimport) __stdcall UseDevice(int index);
```

Parameters:

index – indicates device index from the list (obtained by *GetDeviceList* function)

Return value: -

3.3. Functions, that set the data acquisition parameters**3.3.1. SetTimeBase**

Sets selected timebase.

```
void __declspec(dllimport) __stdcall SetTimeBase(unsigned int ns);
```

Parameters:

ns – amount of nanoseconds per one division (50 samples)

Return value: -

Remark:

The list of available timebases can be obtained by *GetTimeBaseList* function.

3.3.2. SetRange

Sets selected range to the selected channel.

```
int __declspec(dllimport) __stdcall SetRange(int channel, int mV);
```

Parameters:

channel – determines channel

- CHANNEL_A* – channel A
- CHANNEL_B* – channel B

mV – determines range, which is to be set (amount of mV per division)

Return value:

The vertical shift which must be set to keep the position of 0V at the same place.

Remark:

If it is necessary to keep the 0V position on the screen intact, it is necessary to set the vertical shift using function SetVert to the return value.

3.3.3. SetCoupling

Sets selected coupling on the channel.

```
void __declspec(dllimport) __stdcall SetCoupling(int channel, int coupling);
```

Parameters:

channel – determines channel

CHANNEL_A – channel A

CHANNEL_B – channel B

coupling – determines coupling

COUPLING_AC – AC coupling

COUPLING_DC – DC coupling

Return value: -

3.3.4. SetVert

Sets specified shift to the selected channel.

```
int __declspec(dllimport) __stdcall SetVert(int channel, int shift);
```

Parameters:

channel – determines channel

CHANNEL_A – channel A

CHANNEL_B – channel B

shift – shift value from 0 to 4095, where 0 moves the waveform maximally downwards and 4095 moves the waveform maximally upwards

Return value:

Position on the screen (quantization level), which corresponds with 0V.

3.3.5. SetTriggerLevel

Sets threshold on the selected source.

```
void __declspec(dllimport) __stdcall SetTriggerLevel(int channel, int level);
```

Parameters:

channel – determines channel

CHANNEL_A – channel A

CHANNEL_B – channel B

level – determines quantization level (0 to 255), which will be considered as threshold

Return value: -

3.3.6. SetTriggerCount

Sets amount of trigger events necessary to start acquisition on the selected trigger level.

```
void __declspec(dllimport) __stdcall SetTriggerCount(int level, int amount);
```

Parameters:

level – determines level of the trigger system

TRIGGER_LEVEL_PRIMARY – primary level

TRIGGER_LEVEL_SECONDARY – secondary level

amount – amount of trigger events necessary to start acquisition

Return value: -

3.3.7. SetTriggerLength

Sets minimal length of valid trigger event.

```
void __declspec(dllimport) __stdcall SetTriggerLength(int level, int samples);
```

Parameters:

level – determines level of the trigger system

TRIGGER_LEVEL_PRIMARY – primary level

TRIGGER_LEVEL_SECONDARY – secondary level

samples – minimal length of the valid trigger event from 8 to 131068 with step of 4. Value 0 turns the digital filter off.

Return value: -

3.3.8. SetTriggerMode

Sets trigger mode.

```
void __declspec(dllimport) __stdcall SetTriggerMode(int mode);
```

Parameters:

mode – trigger mode

TRIGGER_MODE_AUTO – in case, that the trigger event doesn't occur for longer time, the acquisition starts anyway

TRIGGER_MODE_NORMAL – the acquisition starts only on valid trigger event

TRIGGER_MODE_MANUAL – the acquisition starts immediately after call of StartMeasurement function

Return value: -

3.3.9. SetAfterTriggerLength

Sets amount of samples acquired after trigger event.

```
void __declspec(dllimport) __stdcall SetAfterTriggerLength(int samples);
```

Parameters:

samples – amount of samples acquired after trigger event (from 1 to 1048576 samples)

Return value: -

3.3.10. SetHoldOff

Sets length of hold-off.

```
void __declspec(dllimport) __stdcall SetHoldOff(int samples);
```

Parameters:

samples – length of hold-off in samples from 4 to 1048576 with step of 4

Return value: -

3.3.11. SetTriggerSource

Sets selected trigger sources on the selected level of the trigger system.

```
void __declspec(dllimport) __stdcall SetTriggerSource(int level, int sources);
```

Parameters:

level – determines level of the affected trigger system

TRIGGER_LEVEL_PRIMARY – primary level

TRIGGER_LEVEL_SECONDARY – secondary level

sources – sum of following constants determines selected sources:

TRIGGER_SOURCE_A – channel A

TRIGGER_SOURCE_B – channel B

TRIGGER_SOURCE_E – external trigger input

Return value: -

3.3.12. SetTriggerEdge

Sets triggering on the selected edge (leading or trailing) on the selected source.

```
void __declspec(dllimport) __stdcall SetTriggerEdge(int level, int source, int edge);
```

Parameters:

level – determines level of the affected trigger system

TRIGGER_LEVEL_PRIMARY – primary level

TRIGGER_LEVEL_SECONDARY – secondary level

source – determines the source, whose sensitivity is affected

TRIGGER_SOURCE_A – channel A

TRIGGER_SOURCE_B – channel B

TRIGGER_SOURCE_E – external trigger input

edge – determines sensitivity

TRIGGER_EDGE_LEADING – sensitivity on the leading edge

TRIGGER_EDGE_TRAILING – sensitivity on the trailing edge

Return value: -

3.3.13. SetProbe

Sets device to measure with selected probe accurately.

```
void __declspec(dllimport) __stdcall SetProbe(int channel, int probe);
```

Parameters:

channel – determines channel

CHANNEL_A – channel A

CHANNEL_B – channel B

probe – determines connected probe

PROBE_1_1 – probe 1:1

PROBE_1_10 – probe with attenuation 1:10 or higher

Return value: -

Remark:

This function sets correction of the input impedance inaccuracy. This correction is turned on with probes with attenuation of 1:10 or higher.

3.3.14. SetMemorySize

Sets length of memory used for data acquisition.

```
void __declspec(dllimport) __stdcall SetMemorySize(int size);
```

Parameters:

size – length of memory used for data acquisition (valid values are: 1024, 2048, 4096, 8192, 16384, 32768, 65536, 131072, 262144, 524288 and 1048576)

Return value: -

3.3.15. SetCompensationGenerator

Turns compensation generator (square wave with frequency of 1.465kHz on the E connector) on/off.

```
void __declspec(dllimport) __stdcall SetCompensationGenerator(int OnOff);
```

Parameters:

onoff – determines whether the compensation generator should be turned on/off

ONOFF_OFF – turns generator off

ONOFF_ON – turns generator on

Return value: -

3.3.16. SetGround

Grounds inputs on the selected channel.

```
void __declspec(dllimport) __stdcall SetGround(int channel, int OnOff);
```

Parameters:

channel – determines channel

CHANNEL_A – channel A

CHANNEL_B – channel B

onoff – determines, whether the channel should be grounded

ONOFF_OFF – grounds channel

ONOFF_ON – disconnects channel from ground

Return value: -

3.3.17. SetDigitalShielding

Turns digital shielding on the selected channel on/off.

```
void __declspec(dllimport) __stdcall SetDigitalShielding(int channel, int OnOff, int level);
```

Parametre:

channel – determines channel

CHANNEL_A – channel A

CHANNEL_B – channel B

onoff – determines whether the digital shielding will be turned on or off

ONOFF_OFF – turns the digital shielding off

ONOFF_ON – turns the digital shielding on

level – determines the digital shielding factor (valid values are: 2, 4, 8, 16, 32 and 64)

Return value: -

Remark:

In order to make the digital shielding work correctly, it is necessary to have a stable and well triggered signal on the input. Digital shielding prolongs the oscilloscope response to the signal change (the higher the factor the longer the response).

3.4. Data acquisition functions

3.4.1. StartMeasurement

Starts/restarts data acquisition.

```
void __declspec(dllimport) __stdcall StartMeasurement();
```

Parameters: -

Return value: -

3.4.2. IsDataReady

Returns the data acquisition status.

```
int __declspec(dllimport) __stdcall IsDataReady();
```

Parameters: -

Return value:

Indicates data acquisition status. It is one of following constants:

DATA_NOT_TRIGGERED – valid trigger event hasn't occurred

DATA_TRIGGERED – the acquisition is triggered and is in progress

DATA_READY – the acquisition is finished, data are prepared to be transferred to computer. This transfer can be done by GetData function.

DATA_ERROR – the communication with device is broken, it is not possible to determine acquisition status

3.4.3. GetReconstructionPercentage

Returns ratio of the measured data to measured data + interpolated data.

```
void __declspec(dllimport) __stdcall GetReconstructionPercentage(int *channelA, int *channelB);
```

Parameters:

channelA – amount of channel A, that was measured (percentage)

channelB – amount of channel B, that was measured (percentage)

Return value: -

Remark:

This function works only in case, that the selected timebase uses sampling mode (*SamplingMulti* > 1).

3.4.4. GetData

Transfers data from device to computer.

```
void __declspec(dllimport) __stdcall GetData(TSample *data, int
*returnedlength);
```

Parameters:

data – array, which contains 1048576 items of TSample type. This array is filled with the data transferred from the device. Last transferred sample from device is written to the end of array (item index 1048575), first sample is written to the item index 1048576 - *length*

length – amount of samples, that were transferred from device

Return value: -

3.5. Other functions**3.5.1. GroundPositionToShift**

Returns vertical shift, which is necessary to set, to have the 0V at the selected position of the screen (quantization level).

```
int __declspec(dllimport) __stdcall GroundPositionToShift(int channel, int
position);
```

Parameters:

channel – determines channel

CHANNEL_A – channel A

CHANNEL_B – channel B

position – screen position (quantization level), where the 0V should be placed

Return value:

The vertical shift value, which places 0V to the selected screen position (quantization level). Set this value using SetVert to place 0V to the selected position.