Development kit for DATAMAN 770
Programmer's Guide
Visual Basic .NET
Version 2.01

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.vb header file contains the cm770drv class, which encapsulates all DK functions and constants. Add this file to project to gain access to the cm770drv class. The m770drvdk.dll and m770drv.dll must be present in the same directory as the .exe file is (bin\debug).

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.

cm770drv.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.

Dim CalibOK As Byte
cm770drv.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.

Dim res As integer
res = cm770drv.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).

cm770drv.ResetDKError()

2.3. Data acquisition loop

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

cm770drv.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.

res = cm770drv.IsDataReady()
If res = cm770drv.DATA_READY Then
End If

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.

Dim Data(1048576) As TSample
Dim lng As Integer
cm770drv.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:

| 0 | 1048576 - MS | 1048576 - lng | 1048576 - AT | 1048575 |
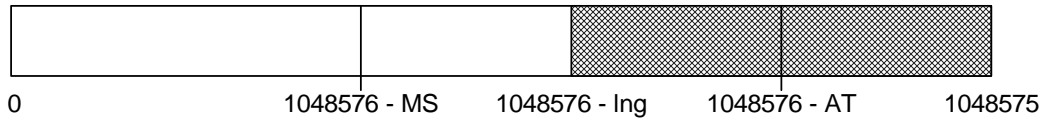
Fig. 2.4.1. – Data allocation in the array

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 >= 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.
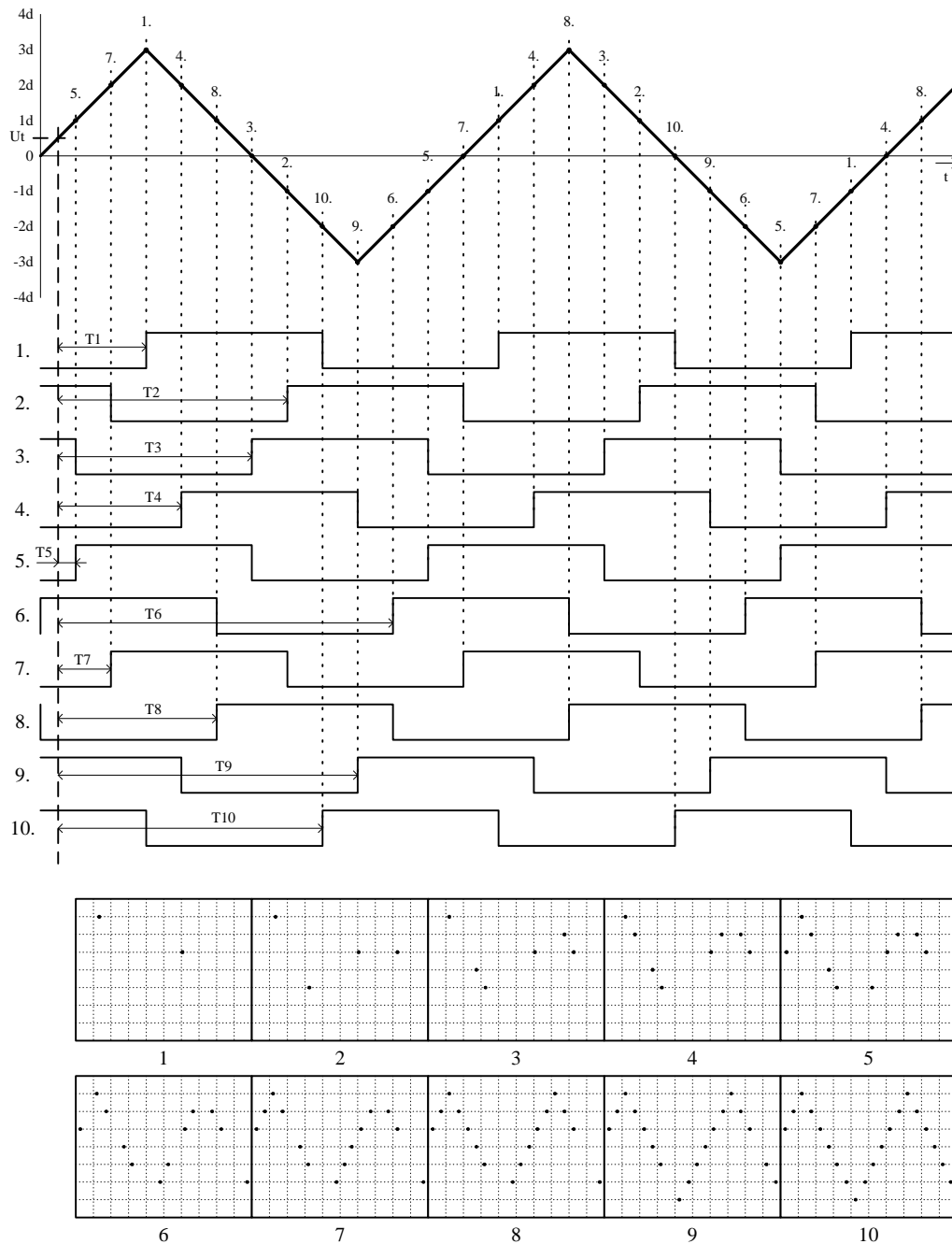
Fig. 2.5.1.1. – Random sampling principle

The trigger's threshold is set to Ut 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 (T1 thru T10). 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 synthetized 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.

cm770drv.LoadDriver()

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

Dim devs(16) As Integer
cm770drv.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.

cm770drv.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.

cm770drv.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
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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:
Public Shared Function GetDKError() As Integer

Parameters: -

Return value:
ERROR_OK – no error occured
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:
Public Shared Sub ResetDKError()

Parameters: -

Return value: -

3.1.3. GetDeviceID

Returns ID of the connected device.

Public Shared Function GetDeviceID() As Integer

Parameters: -

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

3.1.4. GetDeviceSerialNumber

Returns device serial number.

Public Shared Function GetDeviceSerialNumber() As Integer

Parameters: -

Return value:
Device serial number.

3.1.5. GetDKVersion

Returns the version of the selected DK part.

Public Shared Sub GetDKVersion(ByVal moduleindex As Integer, ByRef ver As TDKVersion)

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.

Public Shared Sub GetTimeBaseList(ByRef items As TTimeBaseItem, ByRef itemcount As Integer)

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.

Public Shared Sub GetRangeList(ByRef items As TRangeItem, ByRef itemcount As Integer)

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.

Public Shared Function LoadDriver() As Integer

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.

Public Shared Function InitHardware(ByRef CalibOK As Byte) As Integer

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.

Public Shared Sub GetDeviceList(ByRef DevList As Integer)

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.

Public Shared Function InitHardwareFromList(ByVal index As Integer, ByRef CalibOK As Byte) As Integer

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.

Public Shared Sub UseDevice(ByVal index As Integer)

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.

Public Shared Sub SetTimeBase(ByVal ns As Integer)

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.

Public Shared Function SetRange(ByVal channel As Integer, ByVal mV As Integer) As Integer

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.

> *Public Shared Sub SetCoupling(ByVal channel As Integer, ByVal coupling As Integer)*

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.

> *Public Shared Function SetVert(ByVal channel As Integer, ByVal shift As Integer) As Integer*

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.

> *Public Shared Sub SetTriggerLevel(ByVal channel As Integer, ByVal level As Integer)*

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.

> *Public Shared Sub SetTriggerCount(ByVal level As Integer, ByVal amount As Integer)*

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.

> *Public Shared Sub SetTriggerLength(ByVal level As Integer, ByVal samples As Integer)*

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.

> *Public Shared Sub SetTriggerMode(ByVal mode As Integer)*

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.

Public Shared Sub SetAfterTriggerLength(ByVal samples As Integer)

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.

Public Shared Sub SetHoldOff(ByVal samples As Integer)

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.

Public Shared Sub SetTriggerSource(ByVal level As Integer, ByVal sources As Integer)

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.

Public Shared Sub SetTriggerEdge(ByVal level As Integer, ByVal source As Integer, ByVal edge As Integer)

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.

Public Shared Sub SetProbe(ByVal channel As Integer, ByVal probe As Integer)

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.

Public Shared Sub SetMemorySize(ByVal size As Integer)

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.

> *Public Shared Sub SetCompensationGenerator(ByVal OnOff As Integer)*

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.

> *Public Shared Sub SetGround(ByVal channel As Integer, ByVal OnOff As Integer)*

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.

> *Public Shared Sub SetDigitalShielding(ByVal channel As Integer, ByVal OnOff As Integer, ByVal level As Integer)*

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 acqusition functions

3.4.1. StartMeasurement

Starts/restarts data acquisition.

> *Public Shared Sub StartMeasurement()*

Parameters: -

Return value: -

3.4.2. IsDataReady

Returns the data acquisition status.

> *Public Shared Function IsDataReady() As Integer*

Parameters: -

Return value:
Indicates data acquisition status. It is one of following constants:
> *DATA_NOT_TRIGGERED* – valid trigger event hasn't occured
> *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.

> *Public Shared Sub GetReconstructionPercentage(ByRef channelA As Integer, ByRef channelB As Integer)*

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.

Public Shared Sub GetData(ByRef Data As TSample, ByRef returnedlength As Integer)

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).

Public Shared Function GroundPositionToShift(ByVal channel As Integer, ByVal Position As Integer) As Integer

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.