VERSION AMENDMENTS		
NO.	VERSION	APPROVED
1	V 1.4	2006-07-10

Software Description

MTCS-C2-DLL
MTCS-ME1-DLL

Library Description (MTCSApi.dll)
API programming interface DLL

Revision 2.43

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1 Introduction

The document describes the MTCSApi.dll as a gateway between the firmware on the Evaluation Kit MTCS-ME1 (Mod EVA) or the firmware on the board MTCS-C2 (Colorimeter2) and the user interface (host).
A USB 2.0 port is required for the software to be executable. The software was written for and tested with WindowsXP. Please pay attention to the firmware version for Mod EVA (>V2.22) and / or for Colorimeter2 (V0.13) and the version numbers of the DLL (> V2.43).
The commands for Colorimeter2 only function with DLL Version 2.40 or later.
You can find the latest information and upgrade software in the download area at www.mazet.de. Please refer to data sheet MTCS-ME1 and / or MTCS-C2 for a better understanding of the hardware functionality.
The basic principle is that the host sends a request as a command to the Mod EVA. After processing the command, the Mod EVA sends its response to the host. The initiative always comes from the host and a response, which is forwarded after the command is sent, is always anticipated.
The MTSCApi.dll uses the USB port or the serial RS232 port (provided that this is available). In the delivery status, the value 0xfff appears on address 0x3fe in the EEPROM and the board is activated via USB. If this address is allocated a 0, then the serial port is used in mode 57600,8,n,1 (provided that this is available).
The dll is located in the directory of the executable program. The lib necessary for program development is in the directory of the corresponding project.

#define USB_DLL_API __declspec(dllexport) __stdcall

2 MTCS – FUNCTIONS

2.1 MTCS – Functions which are applicable to all MTCS-ME1 versions

2.1.1 MTCSInitSystem

int USB_DLL_API MTCSInitSystem(char cTyp, int iVendorID, int iProductID);

Initialising the system

char cTyp	Type of connection between the board and the user interface	
	cTyp = 0	USB Oxff must appear in address 0x3fe in the EEPROM
	cTyp = 1	Serial port 0 must appear in address 0x3fe in the EEPROM
int iVendorID	= 0x400	for Mod EVA
int iProductID	= 0xc35d	
int iVendorID	= 0x152a	for Colorimeter2
int iProductID	= 0x8220	
Return value	= 0	No errors exist
	= -1	Internal initialisation error, reset Mod EVA
	= -2	Faulty device notification
	= -4	This Mod EVA has already been configured
	= -5	Device not found

2.1.2 MTCSDllGetVersion

void USB_DLL_API MTCSDllGetVersion(char cBuf);*
The DLL version is read.

char* cBuf	Pointer on the buffer, which contains the DLL version, Buffer size for the response from Mod EVA : 5 bytes

2.1.3 MTCSReadVersion

int USB_DLL_API MTCSReadVersion(char cBuf);*
The current version number of the firmware is retrieved.
With the error code, the status of the firmware initialisation is restored after connection via USB.

This command can be used by the application on the host site to test the communication via USB.

char* cBuf	Pointer on the buffer, which contains the firmware version, e.g. 0x32, 0x2e, 0x34, 0x30 for version number 2.40 Buffer size for the response from Mod EVA : 5 bytes, the last byte is 0.	
Return value	= 0	No errors exist
	= 1	Parameter error 1
	= 2	Firmware detected an illegal command
	= 7	Transmission error

2.1.4 MTCSReadMemory

int USB_DLL_API MTCSReadMemory(unsigned char cBuf, int iAnz);*
iAnz integrity values for the contents of the EEPROM are read in bytes successively from address 0.
The EEProm contains, for example, all the correction value data for the sensor calibration. More detailed information can be found under 4. EEProm.

unsigned char* cBuf	Pointer on the buffer, which contains the contents of the EEPROM, Buffer size for the response from Mod EVA : iAnz*2 bytes	
int iAnz	The number of integrity values which are to be read. (Param1 in the example)	
Return value	= 0	No errors exist
	= 1	Parameter error
	= 2	Firmware detected an illegal command
	= 6	The number of integrity values exceeds the total number for EEProm
	= 7	Transmission error

2.1.5 MTCSWriteMemory

int USB_DLL_API MTCSWriteMemory(unsigned char cBuf, int iAnz);*

iAnz integrity values for the contents of the EEPROM are always written in bytes successively from address 0.

unsigned char* cBuf	Pointer on the buffer, which contains the contents for the EEPROM, (Param2 in the example)	
int iAnz	The number of integrity values which are to be written. (Param1 in the example)	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 6	The number of integrity values exceeds the total number for EEProm.
	= 7	Transmission error

2.1.6 MTCSSetUpdateMode

int USB_DLL_API MTCSSetUpdateMode(void);

Shifts the firmware into update mode. After PowerUp Reset, the firmware can be updated using the "flip software" via the USB port. PowerUp Reset resets the Setup mode.

Return value	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	Other values are not possible as the USB port is no longer in use.	

2.2 MTCS – Functions which are applicable to the TOP, FRONT, DARK TIA versions

2.2.1 MTCSGetADCxx

These commands are used for measuring reflective samples or sources with a constant brightness.
The brightness of the LED lighting (only with MTCS-ME1 FRONT and TOP) must be adjusted using MTCSSetEPoti.
“iCounts“ determines the number of measurement values, which are used to take an average.

2.2.2 MTCSGetADCBL

*int USB_DLL_API MTCSGetADCBL(unsigned short * usBuf, int iCounts);*

The ADC mean values UTD taking into account stray light compensation (AD value of the voltage of the isolating diode), URT (AD value Red), UGR (AD value Green), UBL (AD value Blue) are directly read out using iCounts measurements.

Stray light compensation is the process whereby measurements are taken in the illuminated and unilluminated condition and the difference is calculated.

int iCounts	The number of measurement values for averaging (Param1 in the example)	
unsigned *short * usBuf*	Pointer on the buffer, which contains the ADC values Buffer size for the response from Mod EVA : 8 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter1, or .. Parameter x
	= 7	Transmission error

2.2.3 MTCSGetADCAVR

*int USB_DLL_API MTCSGetADCAVR(unsigned short * usBuf, int iCounts);*

The ADC mean values UTD (AD value of the voltage of the isolating diode), URT (AD value Red), UGR (AD value Green), UBL (AD value Blue) are directly read out using iCounts measurements.

int iCounts	The number of measurement values for averaging (Param1 in the example)	
unsigned *short * usBuf*	Pointer on the buffer, which contains the ADC values Buffer size for the response from Mod EVA : 8 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.2.4 MTCSGetADCBuf

*int USB_DLL_API MTCSGetADCBuf(unsigned short * usBuf);*

The ADC values UTD, URT, UGR, UBL are read from the buffer and the red LED is reset. This occurs by means of a keystroke after the measurement.

unsigned *short * usBuf*	Pointer on the buffer, which contains the ADC values Buffer size for the response from Mod EVA : 8 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.2.5 MTCSGetADC

int USB_DLL_API MTCSGetADC(unsigned short ** usBuf);*

The ADC values UTD (AD value of the voltage of the isolating diode), URT (AD value Red), UGR (AD value Green), UBL (AD value Blue) are directly read out.

unsigned *short * usBuf*	Pointer on the buffer, which contains the ADC values Buffer size for the response from Mod EVA : 8 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.2.6 MTCSSetSwitch

int USB_DLL_API MTCSSetSwitch(int iCounts);

The switch for transimpedance amplification of the isolating diode is set.

int iCounts	Value, at which the switch is to be set (Param1 in the example)	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.2.7 MTCSSetEPoti

int USB_DLL_API MTCSSetEPoti(int iCounts);

The brightness of the LED lighting (only with MTCS-ME1 FRONT and TOP) is adjusted. The E-Poti is adjusted to the assigned value (0x00...0xFF).

int iCounts	Value, at which the Epoti is to be set (Param1 in the example)	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.3 MTCS – Functions which are applicable to DARK CCC versions

2.3.1 MTCSStartRGB, MTCSStopRGB, MTCSGetRGB

These commands are used for measuring light sources e.g. with illumination LEDs and monitors.
The iTime parameter is entered into the integration time. It is variable between 5000µs and 25000µs.
It corresponds to the synchronisation of source frequencies (e.g. CRT monitors) 200Hz to 40Hz.

A measurement is carried out within a multiple of the given integration time. The measurement value (“ADC / number of iterations“) represents the integral deviation of the signal lever divided by the number of integration intervals (“number of iterations“).
With the “iZyklen“ parameter, the stop criterion, the maximum number of recorded integration intervals, is defined for a measurement cycle.

2.3.2 MTCSStartRGB

int USB_DLL_API MTCSStartRGB(unsigned short usBuf, int iTime, int iZyklen);*

The interval time and the maximum number of integration cycles is defined.
RGB integration is started.

unsigned short* usBuf	Pointer on the buffer, which contains the outcome message Buffer size for the response from Mod EVA : 2 bytes	
int iTime	Interval time (Param1 in the example)	
int iZyklen	max. integration cycles (Param2 in the example)	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.3.3 MTCSStopRGB

int USB_DLL_API MTCSStopRGB(unsigned short usBuf);*

The command stops a measurement and reads out the current RGB values and the number of intervals, which have occurred. The MTCSStopRGB command is not required during normal operation because the measurement is terminated after the number of iterations.

unsigned short* usBuf	Pointer on the buffer, which contains the outcome message (red, green, blue and number of cycles for red, number of cycles for green, number of cycles for blue. Buffer size for the response from Mod EVA : 12 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.3.4 MTCSGetRGB

int USB_DLL_API MTCSGetRGB(unsigned short usBuf);*

The command reads out the current RGB values and the number of iterations, which have occurred.

unsigned short* usBuf	Pointer on the buffer, which contains the outcome message (red, green, blue and number of iterations for red, number of iterations for green, number of iterations for blue. Buffer size for the response from Mod EVA : 12 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.4 MTCS – Functions which are applicable to the MTCS-C2

2.4.1 MTCSGetADCAVR2

int USB_DLL_API MTCSGetADCAVR2(int iIndex, unsigned short usBuf, int iCounts);*

The amplification and ADC mean values URT (AD value Red), UGR (AD value Green), UBL (AD value Blue) are directly read out using iCounts measurements.

The amplification can be set using MTCSSetParameter or determined automatically using MTCSSearchAmplification.

If the amplification factor is 0, the optimum amplification factor for the series of measurements is sought first. In addition, AD conversions on the red, green and blue channels are carried out until all channels provide values within a defined ADC operating range.

If the amplification factor is in the range (1, 8), the “automatic search of the optimum amplification factors” stage does not occur.

N series of measurements are carried out and the average value is generated.

If the subsequent measurement values differ from the first measurement value by more than 10%, then these are logged as error code 0xE003. (This serves as a reference to major sources of interference or pulsed light sources for which the measurement procedure is not suitable.)

These 3 mean values and the adjusted amplification factor are sent in the response to the host.

int iIndex	= 0	reserved for device number
int iCounts	The number of measurement values for averaging (Param1 in the example)	
unsigned short* usBuf	Pointer on the buffer, which contains the amplification factor and the ADC values	
	Buffer size for the response from Col2 : 8 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 3	Difference in measurement values is too large
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.4.2 MTCSGetADCSummen

int USB_DLL_API MTCSGetADCSummen(int iIndex, unsigned long ulBuf, int iCounts);*
The amplification and ADC mean values URT (AD value Red), UGR (AD value Green), UBL (AD value Blue) are added together and read out using iCounts milliseconds.
The amplification can be set using MTCSSetParameter or defined automatically using MTCSSearchAmplification.
If the amplification factor is 0, the optimum amplification factor for the series of measurements is sought first. In addition, AD conversions on the red, green and blue channels are carried out until all channels provide values within a defined ADC operating range.
If the amplification factor is in the range (1, 8), the “automatic search of the optimum amplification factors” stage does not occur.
N series of measurements are carried out using iCounts milliseconds and the values are added together.
The adjusted amplification factor, the sum of the 3 AD values and the total number of measurements are sent in the response to the host.
All values are unsigned long values.

int iIndex	= 0	reserved for device number
int iCount		The number of milliseconds which are to be measured for the totals formation.
	(Param1 in the example)	
unsigned long * ulBuf	Pointer on the buffer, which contains the amplification factor and the ADC values and the total number of measurements	
	Buffer size for the response from Col2 : 20 bytes	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 3	Difference in measurement values is too large
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 7	Transmission error

2.4.3 MTCSSetParameter

int USB_DLL_API MTCSSetParameter(int iIndex, int iCounts);
The amplification factor and tolerance parameters are set.
The default values are: Amplification factor = 8 Tolerance = 90(percent)
Both parameters are included in the “automatic search of the optimum amplification factors“ stage.

int iIndex	= 0	reserved for device number
int iCounts	Amplification factor, 1 byte (low byte)	
	Tolerance, 1 byte (high byte)	
	(Param1 in the example)	
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 7	Transmission error

2.4.4 MTCSSearchAmplification

int USB_DLL_API MTCSSearchAmplification(int iIndex, unsigned short usBuf, int iLimit);*

Search for the optimum amplification factor

The optimum amplification factor for the series of measurements is sought. In addition, AD conversions on the red, green and blue channels are carried out with a decreasing amplification factor until the strongest channel provides a signal which is below the limit value (value range 1..100%).
The measurement values are expanded according to the bit shifting parameter.
The located amplification factor and the last 3 measurement values from the algorithm are sent in the response to the host.
The located amplification factor is set for the following measurements.

Note

This algorithm can also be used to bring the AD conversions into an optimum operating range. This is essential if, due to very bright light sources, the colour sensor is overloaded when the amplification factor is at its highest. Therefore, the AD conversion would always provide the maximum AD values.

int iIndex	= 0	reserved for device number
int iLimit		Limit values (in %), 1 byte
unsigned *short * usBuf*		Pointer on the buffer, which contains the amplification factor and the ADC values Buffer size for the response: 8 bytes
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 7	Transmission error

2.4.5 MTCSWriteMemToAdr

int USB_DLL_API MTCSWriteMemToAdr(int iIndex, unsigned char cBuf, int iAdr, int iAnz)*

iAnz integrity values for the contents of the EEPROM are always written in bytes successively from address iAdr.

iAnz items are written as a data stream in the external EEPROM from a defined address iAdr.
iAnz = (1, 57)

The size of the EEPROM is 128 bytes. It can also be addressed in the range (0x00, 0x6F). If address + 2*number data items to be written is larger than the above address, error code 6 is restored.

int iIndex	= 0	reserved for device number
unsigned char* cBuf		Pointer on the buffer, which contains the contents for the EEPROM, (Param1 in the example)
int iAdr		Address, from which the EEProm is to be rewritten. (Param2 in the example)
int iAnz		The number of integrity values which are to be written. (=1 in the example)
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 4..x	Parameter error Parameter 1, or .. Parameter x
	= 6	The number of integrity values exceeds the total number for EEProm
	= 7	Transmission error

2.4.6 MTCSReadMemFromAdr

int USB_DLL_API MTCSReadMemFromAdr(int iIndex, unsigned char cBuf, int iAdr, int iAnz);*

iAnz integrity values for the contents of the EEPROM are always read in bytes successively from address iAdr.

iAnz values are read as a data stream by the external EEPROM from a defined address iAdr.

The size of the EEPROM is 128 bytes. It can also be addressed in the range (0x00, 0x6F). If address + 2* iAnz of data items to be read is larger than the above address, error code 6 is restored.

int iIndex	= 0	reserved for device number
unsigned char* cBuf		Pointer on the buffer, which contains the contents of the EEPROM, Buffer size for the response from Colorimeter2 : iAnz*2 bytes
int iAdr		Address, from which the EEProm is to be rewritten. (Param1 in the example)
int iAnz		The number of integrity values which are to be read. (Param2 in the example)
Return value	= 0	No errors exist
	= 1	Parameter error
	= 2	Firmware detected an illegal command
	= 6	The number of integrity values exceeds the total number for EEProm
	= 7	Transmission error

2.4.7 MTCSGetSerienNummer

void USB_DLL_API MTCSGetSerienNummer (int iIndex, char cBuf);*
Read the serial numbers from the board's EEPROM

int iIndex	= 0	reserved for device number
char* cBuf		Pointer on the buffer, which contains the serial numbers which are in the USB descriptor. Buffer size for the response from Colorimeter2 : 16 bytes
Return value	= 0	No errors exist
	= 2	Firmware detected an illegal command
	= 7	Transmission error

3 BASIC FUNCTIONS FN…

3.1 fnSendZeroPacket

void USB_DLL_API fnSendZeroPacket(void);
Sends synchronisation string

4 EEPROM

The contents of the EEPROM is structured.
System parameters are data which are saved permanently.
Access to the data is gained using the ReadMemory, WriteMemory, WriteMemToAdr and ReadMemFromAdr commands. These commands treat the memory as a data stream.

The maximum size of the EEPROM of the Mod EVA is 1024 bytes. The last 10 bytes are reserved for internal characteristics. Only essential data should be written to the EEProm because writing to the EEProm is a slow process.

No.	Contents	Length in WORD
1.	Application code	1
2.	E-Poti	1
3.	Dark value	3
4.	White value	3
5.	BL (stray light compensation 0=off, 1=on)	1
6.	Number of average value	1
7.	Integration time	1
8.	Correction matrix sensor	9
9.	Correction matrix display	9
10.	Free memory	

Table 1: Overview relating to the system parameters in the EEProm of the Mod EVA

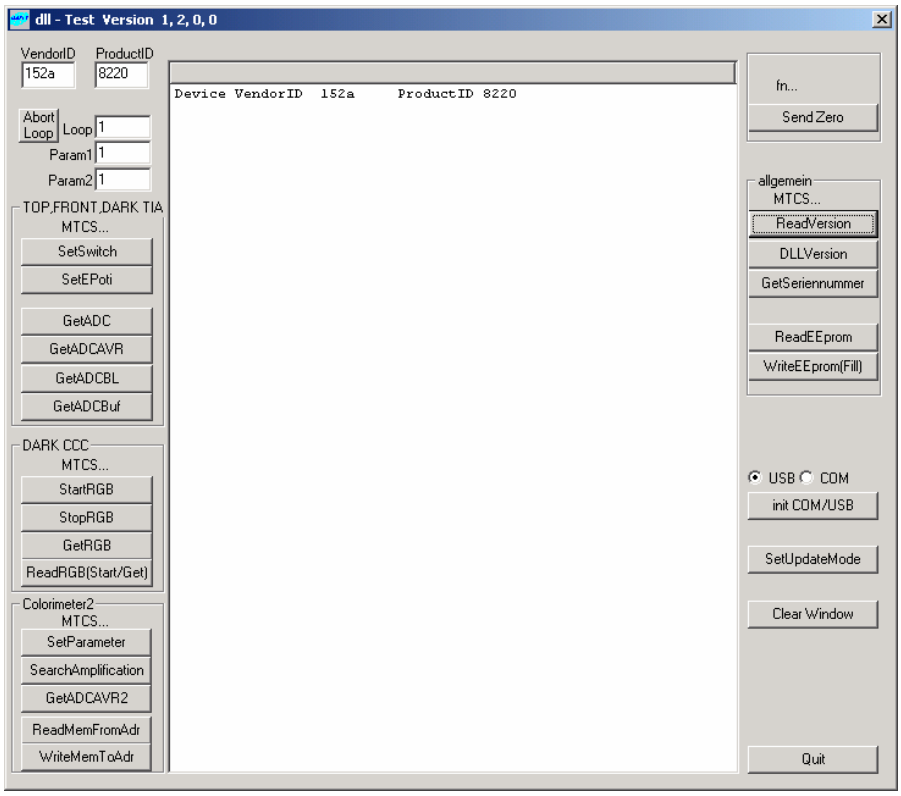
The maximum size of the EEPROM of the Colorimeter 2 is 128 bytes.
The top 16 bytes are reserved for the serial numbers.

No	Contents	Length in WORD	Comments
1	Application code	1	The application code for the Colorimeter 2 is 0x0011
2	E-Poti	1	No relevance
3	Dark value	3	Is the parameter for the PC application
4	White value	3	Is the parameter for the PC application
5	Stray light compensation BL	1	No relevance
6	Number of average values	1	For GetADCAvr2
7	Amplification factor	1	For GetADC2, GetADCAvr2
8	Correction matrix sensor	9	is the parameter for the PC application
9	Correction matrix display	9	is the parameter for the PC application
10			

Table 2: Overview relating to the system parameters in the EEProm of the Colorimeter2

5 TEST INTERFACE

The project “ddl_test.dsw“ is a c++ project for Microsoft Visual Studio 6.0 and indicates the use of the individual functions used in the dll.



The system is initialised during startup using MTCSInitSystem().

It is possible to access MTCS… with a maximum of 2 entry parameters. The meaning of the parameters is to be inferred from the command description. Loop contains the number of cycles for the command which has been accessed. This loop can be cancelled using “Abort Loop“.
“Clear Window“ clears the current display window. All entered parameters are interpreted as decimal numbers, VendorID and ProductID are interpreted as hexadecimal numbers.

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