M8123B2 User's Manual

This document is the User's Manual for M8123B2, an OEM circuit board for the force/torque sensor (loadcell) manufactured by SRI (Sunrise Instruments Co., Ltd). It's strongly recommended that anyone who uses M8123B2 should read this document before any operation. SRI reserves all the rights of this document. Please do not hesitate to contact SRI if there is any question.

Content

1. Introduction

The OEM circuit board M8123B2 provides bridge excitation, signal conditioning, data acquisition and digital communication to the user's controller or PC via EtherCAT, CAN bus or RS232. A 24 bit sigma-delta AD converter (16 bit effective) is used to provide high resolution (1/5000 to 1/10000 of full scale) analog to digital converting. The data rate is up to 2 kHz. A 6 axis loadcell is connected to M8123B2 via a Molex connector.

Specifications:
- Analog
  – # of Channels: 6
  – Low noise instrumentation amplifiers

- Digital
  – EtherCAT, CAN bus and RS232
  – 24 bit sigma-delta ADC (16 bit effective), Sampling rate: 10~2kHz
  – Resolution: 1/5000 to 1/10000 of full scale
  – Programmable system parameters

- Connector
  – Loadcell connector: Molex connector
  – EtherCAT: Molex connector
  – CAN bus: Molex connector
  – RS232: Molex connector
  – Power supply: Molex connector, DC12 – 24V, MAX250mA

- Diemension
  – Outer diameter 54mm, Height 13.3mm, Mounting hole 3*M2.5

- Software
  – iDAS RD: Debugging software to display real-time sampling curve via RS232.
  – The dictionary file(*.xml) is supplied, can be connected into EtherCAT easily.

2. Quick start
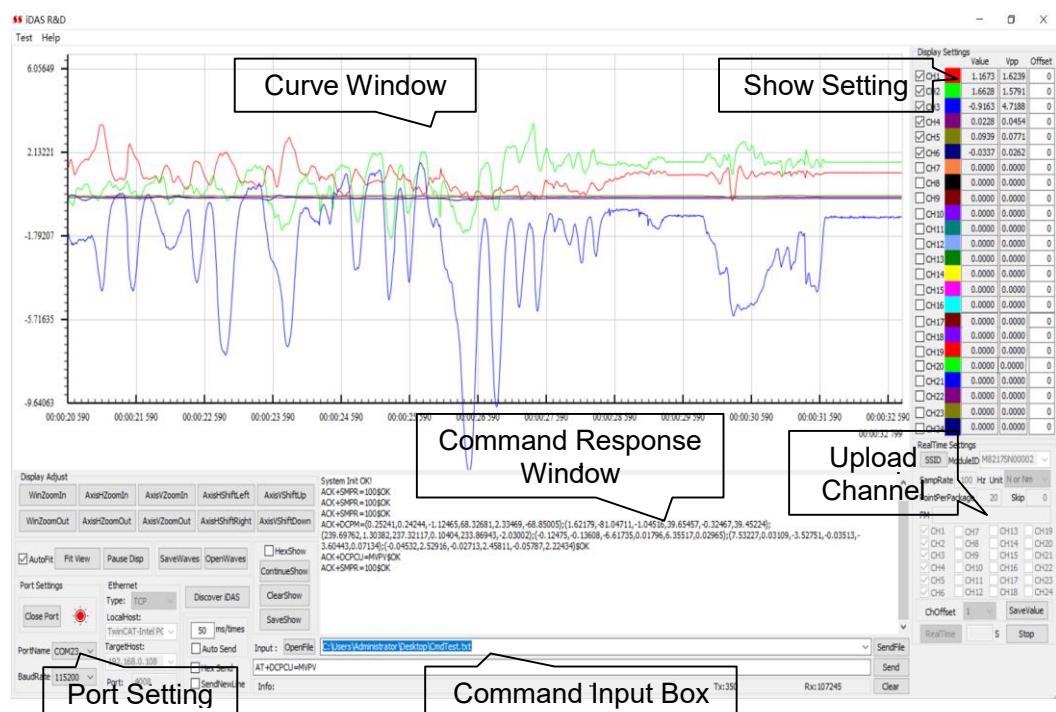
M8123B2 and sensor were configured in SRI factory, and it can be connected to EtherCAT directly by the dictionary file(*.xml).

RS232 is supplied to debug M8123B2 and have a quick start to get sensor real time data by software iDAS RD.

➢ PC Requirement：WIN 7 or above
➢ Installation Procedure：Uncompressed iDAS RD
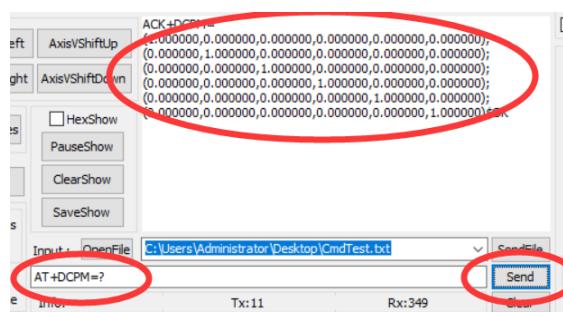
> Note: M8123B2 only can communicate with iDAS RD via RS232. EtherCAT communication is not supported by iDAS RD.

2.1 iDAS RD software
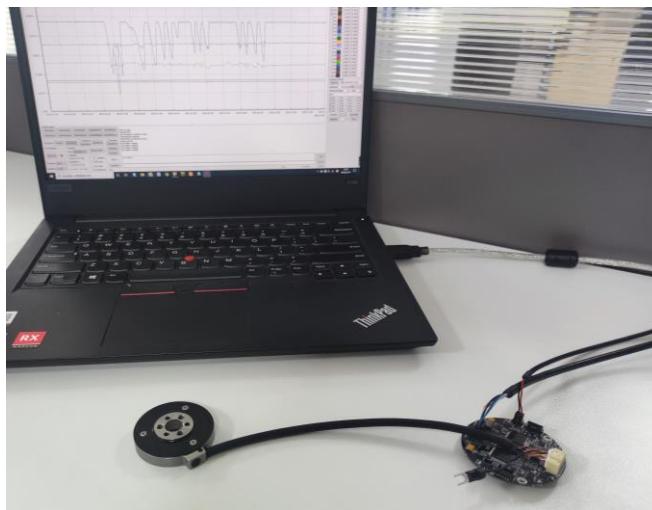
2.2 Send Commands

Type in a command to the Command Box, and click Send. The response information will be shown in the command response window. Error will be prompted or no response will be given if the input command is wrong or is not supported by M8123B2.

2.3 Get real-time data via RS232

Step 1：Power on M8123B2 and open iDAS RD. Connect M8123B2 to PC via RS232.

Step 2：Set PortName, Baudrate and Open Port.
Step 3：Select CH1 through CH6 at the lower right corner on screen.
Step 4：Set SampRate to 100Hz，set Unit to N or Nm.
　　　　Set PointPerPackage to 10，and put in 0 at Skip.
Step 5：Select CH1 through CH6 at the top right corner on screen.
Step 6：Click "Realtime" to get data from M8123B2, the real time data will be shown in the window.
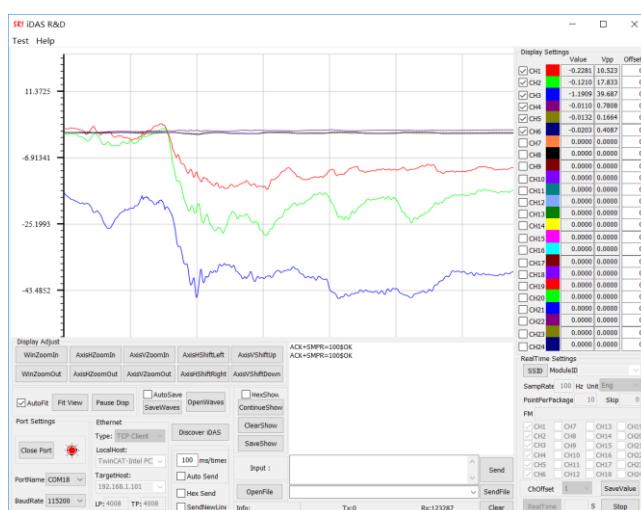
📖 **Note:**

With RS232 communication, SampRate is up to 300 Hz for 6-channel data upload and 1 kHz for 1-channel data upload at BaudRate 115200bps.

⚠️ If the real-time data shown by iDAS R&D is incorrect, please click Stop and send Commands DCPM and DCPCU to make sure that current matrix coefficients and calculation unit match the sensor calibration report.

2.4   Configuration

To configure decoupling matrix:

If the M8123B2 is purchased together with SRI sensor, the decoupled matrix and calculation unit of SRI sensor have been configured in the M8123B2.
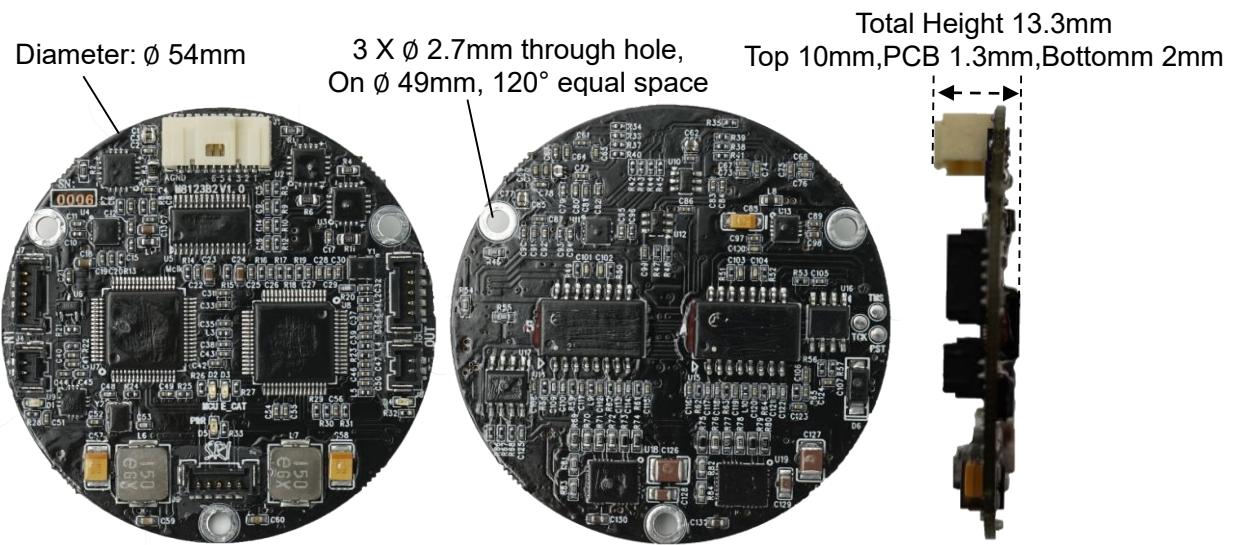
When different sensor connects to M8123B2, M8123B2 must have different configuration. The method is described in chapter 5.

To configure the sampling rate:
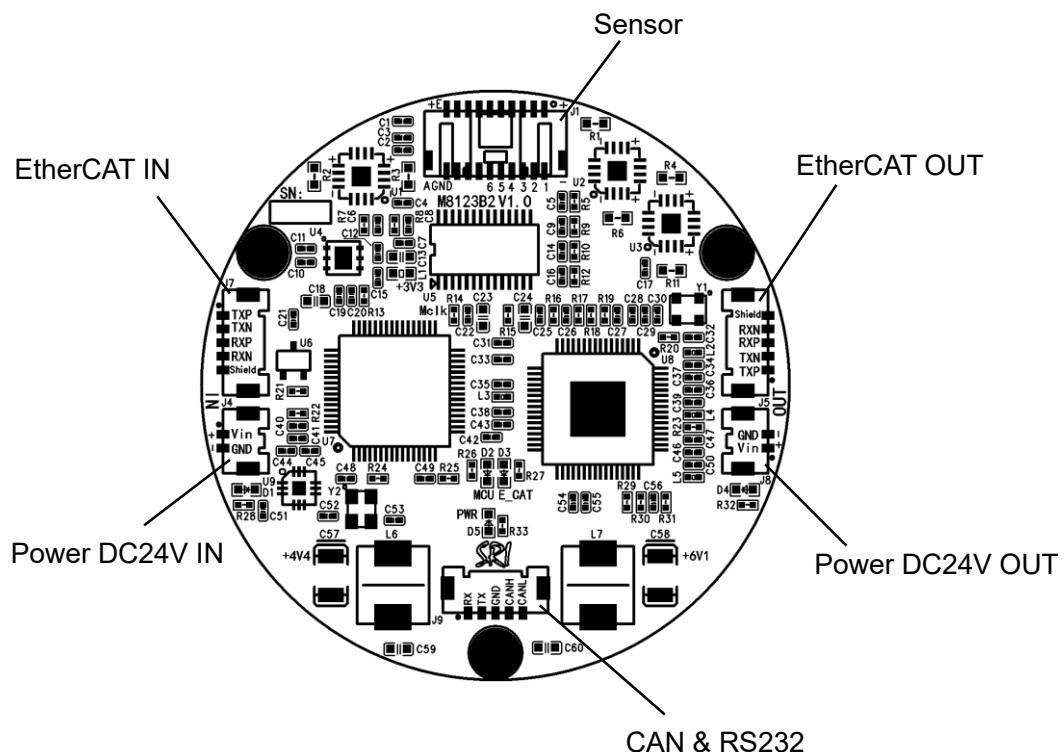
Sampling rate can be configured by command SMPF.

3. Circuit Board

3.1 Dimension

Diameter: Ø 54mm

3 X Ø 2.7mm through hole,
On Ø 49mm, 120° equal space

Total Height 13.3mm
Top 10mm,PCB 1.3mm,Bottomm 2mm

3.2 Connector

Sensor

EtherCAT IN

EtherCAT OUT

Power DC24V IN

Power DC24V OUT

CAN & RS232
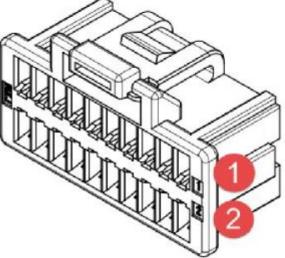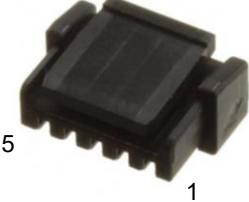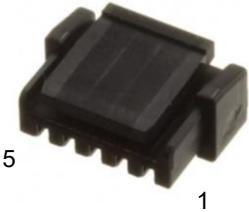
3.3 Connector definition

<table>
<tr><td colspan="4">Sensor connector
(Molex connector Part# 501189-2010)</td></tr>
<tr><td rowspan="17"></td><td>PIN #</td><td>Definition</td><td>Note</td></tr>
<tr><td>1</td><td>CH1+</td><td></td></tr>
<tr><td>2</td><td>CH1-</td><td></td></tr>
<tr><td>3</td><td>CH2+</td><td></td></tr>
<tr><td>4</td><td>CH2-</td><td></td></tr>
<tr><td>5</td><td>CH3+</td><td></td></tr>
<tr><td>6</td><td>CH3-</td><td></td></tr>
<tr><td>7</td><td>CH4+</td><td></td></tr>
<tr><td>8</td><td>CH4-</td><td></td></tr>
<tr><td>9</td><td>CH5+</td><td></td></tr>
<tr><td>10</td><td>CH5-</td><td></td></tr>
<tr><td>11</td><td>CH6+</td><td></td></tr>
<tr><td>12</td><td>CH6-</td><td></td></tr>
<tr><td>13~18</td><td>N/A</td><td>Reserved</td></tr>
<tr><td>19</td><td>+E</td><td></td></tr>
<tr><td>20</td><td>GND</td><td></td></tr>
</table>

<table>
<tr><td colspan="4">EtherCAT connector
(Molex connector Part# 505565-0501)</td></tr>
<tr><td rowspan="6"></td><td>PIN #</td><td>Definition</td><td>Note</td></tr>
<tr><td>1</td><td>TXP</td><td></td></tr>
<tr><td>2</td><td>TXN</td><td></td></tr>
<tr><td>3</td><td>RXP</td><td></td></tr>
<tr><td>4</td><td>RXN</td><td></td></tr>
<tr><td>5</td><td>Shield</td><td></td></tr>
</table>

<table>
<tr><td colspan="4">Power connector
(Molex connector Part# 505565-0201)</td></tr>
<tr><td rowspan="3"></td><td>PIN #</td><td>Definition</td><td>Note</td></tr>
<tr><td>1</td><td>+24V</td><td></td></tr>
<tr><td>2</td><td>GND</td><td></td></tr>
</table>

<table>
<tr><td colspan="4">CAN & RS232 connector
(Molex connector Part# 505565-0501)</td></tr>
<tr><td rowspan="6"></td><td>PIN #</td><td>Definition</td><td>Note</td></tr>
<tr><td>1</td><td>RX</td><td rowspan="3">RS232</td></tr>
<tr><td>2</td><td>TX</td></tr>
<tr><td>3</td><td>GND</td></tr>
<tr><td>4</td><td>CANH</td><td rowspan="2">CAN</td></tr>
<tr><td>5</td><td>CANL</td></tr>
</table>

4. Commands

> **Definition:**
>
> Master: Master equipment, eg.PC, PLC, Robot controller.
> Slave: M8123B2, the DAQ supplied by SRI.

Commands are supplied for master equipment communicate with M8123B2 via RS232 or CAN bus.

Command	Function	Note
SMPF	Read or set sampling rate	
DCPM	Read or set decoupling matrix coefficient	
DCPCU	Read or set matrix calculation unit	mV or mV/V
SFWV	Read firmware version	
CRATE	Read or set baud rate of CAN bus	
CFIDL	Read or set CAN ID of slave for receiving data	
CTXIDL	Read or set CAN ID of slave for sending data	

4.1 SFWV / Read firmware version

Description: To read firmware version.
Command Syntax:AT+SFWV=?

Example:

Send：AT+SFWV=?

Response：ACK+SFWV=V11.00$OK

4.2 DCPM / Read or set decoupled matrix

Description: To read or set decoupled matrix
Command Syntax:AT+DCPM=Matrix

Example:

Send：AT+DCPM=?

Response：ACK+DCPM=(0.000041,-0.020164,-0.000348,0.020287,-0.000145,-0.000047);(-0.000160,-0.011703,-0.000089,-0.011668,-0.000217,0.023526);(-0.031415,-0.000185,-0.032273,0.000010,-0.031708,-0.000481);(-0.000888,-0.000014,0.000951,-0.000006,0.000029,0.000009);(-0.000521,0.000011,-0.000531,-0.000009,0.001061,0.000015);(0.000002,0.000754,-0.000008,0.000753,-0.000007,0.000768)$OK

Send：AT+DCPM=(0.000041,-0.020164,-0.000348,0.020287,-0.000145,-0.000047);(-0.000160,-0.011703,-0.000089,-0.011668,-0.000217,0.023526);(-0.031415,-0.000185,-0.032273,0.000010,-0.031708,-0.000481);(-0.000888,-0.000014,0.000951,-0.000006,0.000029,0.000009);(-0.000521,0.000011,-0.000531,-0.000009,0.001061,0.000015);(0.000002,0.000754,-0.000008,0.000753,-0.000007,0.000768)

Response：ACK+DCPM=(0.000041,-0.020164,-0.000348,0.020287,-0.000145,-0.000047);(-0.000160,-0.011703,-0.000089,-0.011668,-0.000217,0.023526);(-0.031415,-0.000185,-0.032273,0.000010,-0.031708,-0.000481);(-0.000888,-0.000014,0.000951,-0.000006,0.000029,0.000009);(-0.000521,0.000011,-0.000531,-0.000009,0.001061,0.000015);(0.000002,0.000754,-0.000008,0.000753,-0.000007,0.000768)$OK

4.3 DCPCU / Calculation unit for decoupled data

Description: To set or read calculation unit.
Command Syntax:AT+DCPCU=Unit
Example:

Send：AT+DCPCU=?

Response：ACK+DCPCU=MV$OK

Send：AT+DCPCU=MVPV

Response：ACK+DCPCU=MVPV$OK

4.4 SMPF / Read or set sampling rate

Description: To read or set sampling rate.
Command Syntax: AT+**SMPF**=SampleFreq

Example:

Send：AT+SMPF=?

Response：ACK+SMPF=300$OK

Send：AT+SMPF=200

Response：ACK+SMPF=200$OK

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4.5 CRATE / Baud Rate of CAN Bus
Description: To read or set baud rate of CAN Bus.
Command Syntax: AT+**CRATE**=BR:rate

Example:
Send：AT+CRATE=?
Response：ACK+CRATE=BR:1000000$OK

Send：AT+CRATE=BR:125000
Response：ACK+CRATE=BR:125000$OK

> *Note: New configuration of CAN bus is available after re-power on.*

4.6 CFIDL / ID#1 of CAN Bus
Description: To read or set CAN ID of slave for receiving data. Master use this ID to send data to M8123B2.
Command Syntax: AT+**CFIDL**=id

Example:
Send：AT+CFIDL=80
Response：ACK+CFIDL=80$OK
Send：AT+CFIDL=?
Response：ACK+CFIDL=80$OK

> *Note: New configuration of CAN bus is available after re-power on.*

4.7 CTXIDL / ID#2#3#4 of CAN Bus
Description: To read or set CAN ID of slave for sending data. M8123B2 use these IDs send data to master.
Command Syntax: AT+**CTXIDL**=id#2, id#3, id#4

Example:
Send：AT+CTXIDL=291,292,293
Response：ACK+CTXIDL=291,292,293$OK
Send：AT+CTXIDL=?
Response：ACK+CTXIDL=291,292,293$OK

> *Note: New configuration of CAN bus is available after re-power on.*

5. Decoupled Calculation

If the M8123B2 is purchased together with SRI sensor, the decoupled matrix and calculation unit of SRI sensor have been configured in the M8123B2. The decoupled matrix and calculation unit can be updated by Command DCPM and DCPCU when necessary.

Decoupled matrix and calculation unit can be found in the calibration report. Two different reports formats will be provided according to the sensor's structure.

5.1 Matrix decoupled loadcell

The decoupled matrix and calculation unit are provided in the calibration report, as shown below:

[DECOUPLED] =

-0.03220	0.49984	0.00136	-1.01398	-0.01208	0.50908
0.00046	0.84855	0.01531	0.02114	-0.03126	-0.86432
1.19167	0.00028	1.20748	0.00224	1.19808	0.00320
-0.06386	-0.00097	0.13028	-0.00009	-0.06523	0.00012
-0.11090	0.00016	-0.00049	0.00075	0.11138	-0.00019
-0.00046	0.08401	-0.00067	0.08304	-0.00089	0.08433

The six axis loads can be decoupled as follows:

Step 1: Obtain the raw data of Channels 1 through 6 into mV
[DAT] = {rawchn1, rawchn2, rawchn3, rawchn4, rawchn5, rawchn6}
where rawchn1, rawchn2, rawchn3, rawchn4, rawchn5 and raw chn6 are in mV

Step 2: To calculate decoupled loads
$[RESULT]^T = [DECOUPLED]*[DAT]^T$
where [RESULT] = {FX,FY,FZ,MX,MY,MZ}. Force Unit: N. Moment Unit: Nm
[DECOUPLED] is the above decoupled matrix

The Commands to input the matrix coefficients and to set the calculation unit are as follows:

AT+DCPM=(-0.03220,0.49984,0.00136,-1.01398,-0.01208,0.50908);(0.00046,0.84855,0.01531,0.02114,-0.03126,-0.86432);(1.19167,0.00028,1.20748,0.00224,1.198078,0.00320);(-0.06386,-0.00097,0.13028,-0.00009,-0.06523,0.00012);(-0.11090,0.00016,-0.00049,0.00075,0.11138,-0.00019);(-0.00046,0.08401,-0.00067,0.083040,-0.00089,0.08433)
AT+DCPCU=MV

5.2 Structurally decoupled loadcell

The sensitivity provided in the calibration report needs to be converted into a matrix as shown below:

Voltage Calibration

Bridge	Capacity	Zero Offset	Nonlinearity	Hysteresis	Output @ Capacity	Sensitivity	Change
	N/Nm	mV/V	%FS	%FS	mV/V	mV/V/EU	%
FX	-5400	0.0131	-0.08	-0.33	-3.0269	5.6054E-04	0.00
FY	5400	0.0007	0.08	0.27	3.0500	5.6481E-04	0.00
FZ	-10800	0.0001	-0.09	-0.18	-0.7369	6.8230E-05	0.00
MX	-540	-0.0027	-0.09	-0.10	-1.8703	3.4636E-03	0.00
MY	-540	-0.0090	-0.09	-0.09	-1.9014	3.5210E-03	0.00
MZ	432	-0.0099	0.05	0.08	1.9603	4.5378E-03	0.00

Sensitivity unit is mV/V/Eu,. The diagonal elements of the matrix are the inverse of the sensitivities (1/Sensitivity). The calculation unit is mV/V.

1783.9940	0	0	0	0	0
0	1770.5069	0	0	0	0
0	0	14656.3095	0	0	0
0	0	0	288.7169	0	0
0	0	0	0	284.0102	0
0	0	0	0	0	220.3711

The Commands to input the matrix coefficients and to set the calculation unit are as follows:
AT+DCPM=(1783.9940,0,0,0,0,0);(0,1770.5069,0,0,0,0);(0,0,14656.3095,0,0,0)
;(0,0,0,288.7169,0,0); (0,0,0,0,284.0102,0); (0,0,0,0,0,220.3711)
AT+DCPCU=MVPV

Four possible conversion formula:
1) Sensitivity unit is mV/V/Eu. The conversion formula is 1/Sensitivity.
Calculation unit is mv/V: AT+DCPCU=MVPV.
2) Sensitivity unit is mV/Eu. The conversion formula is 1/Sensitivity.
Calculation unit is mv: AT+DCPCU=MV.
3) Sensitivity unit is V/V/Eu. The conversion formula is 1/Sensitivity/1000.
Calculation unit mv/V: AT+DCPCU=MVPV.
4) Sensitivity unit is V/Eu. The conversion formula is 1/Sensitivity/1000.
Calculation unit is mv: AT+DCPCU=MV.

5.3 Other Loadcells

Except 6 axis loadcells, other sensors with voltage out put can also be connected to M8123B2.For calculation in M8123B2, a matrix is also needed.
Please follow the method described below to get the matrix.

3 Axis loadcell

Voltage Calibration

Bridge	Capacity	Zero Offset	Nonlinearity	Hysteresis	Output @ Capacity	Sensitivity	Change
	N/Nm	mV/V	%FS	%FS	mV/V	mV/V/EU	%
FX	-20000	0.0101	-0.13	-0.28	-2.8941	1.4471E-04	0.00
FY	20000	-0.0027	0.11	0.19	2.8894	1.4447E-04	0.00
FZ	-20000	0.0175	-0.07	-0.27	-0.5441	2.7207E-05	0.00

Sensitivity unit is mV/V/Eu. The diagonal elements of the matrix are the inverse of the sensitivities (1/Sensitivity).

6910.3725	0	0	0	0	0
0	6921.8523	0	0	0	0
0	0	36755.2468	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

The Commands to input the matrix coefficients and to set the calculation unit are as follows:
AT+DCPM=(6910.3725,0,0,0,0,0);(0,6921.8523,0,0,0,0);(0,0,36755.2468,0,0,0);(0,0,0,0,0,0);(0,0,0,0,0,0); (0,0,0,0,0,0)
AT+DCPCU=MVPV

Torque Sensor

Voltage Calibration

Bridge	Capacity	Zero Offset	Nonlinearity	Hysteresis	Output @ Capacity	Sensitivity	Change
	Nm	V	%FS	%FS	V	V/EU	%
MZ	100	-0.0049	0.04	0.27	2.0445	2.0445E-02	0.00

Sensitivity unit is V/Eu.
The first row and the first column equal to 1/sensitivity/1000.
Calculation unit is mV.

The Commands to input the matrix coefficients and to set the calculation unit are as follows:
AT+DCPM=(0.048913,0,0,0,0,0);(0,0,0,0,0,0);(0,0,0,0,0,0);(0,0,0,0,0,0);(0,0,0,0,0,0);(0,0,0,0,0,0)
AT+DCPCU=MV

6. EtherCAT Dictionary

Object	Name	Data Type	W/R	Discription
0x1000	Device Type	UINT32	RO	
0x1008	Manufacturer Device Name	STRING	RO	
0x1009	Hardware Version	STRING	RO	
0x100A	Software Version	STRING	RO	
0x1018	Identity Object	RECORD	RO	
0x1018.01	Vendor ID	UINT32	RO	
0x1018.02	Product Code	UINT32	RO	
0x1018.03	Revision Number	UINT32	RO	
0x1018.04	Serial Number	UINT32	RO	
0x1601	RPDO	UINT32	RO	
0x1A03	TPDO	UINT32	RO	
0x1A02	TPDO	UINT32	RO	
0x1C12	SM2 PDO	REC	RW	
0x1C13	SM3 PDO	REC	RW	
0x6030.01	DataNo	UINT16	RO	unsigned int 16bit 0~65535 increment each sample.
0x6030.02	Fx	REAL	RO	float 32bit eng. unit: N
0x6030.03	Fy	REAL	RO	float 32bit eng. unit: N
0x6030.04	Fz	REAL	RO	float 32bit eng. unit: N
0x6030.05	Mx	REAL	RO	float 32bit eng. unit: Nm
0x6030.06	My	REAL	RO	float 32bit eng. unit: Nm
0x6030.07	Mz	REAL	RO	float 32bit eng. unit: Nm
0x6020.01	DataNo	UINT16	RO	unsigned int 16bit 0~65535 increment each sample.
0x6020.02	Fx	INT32	RO	Fx = INT32/10000 eng. unit: N
0x6020.03	Fy	INT32	RO	Fy = INT32/10000 eng. unit: N
0x6020.04	Fz	INT32	RO	Fz = INT32/10000 eng. unit: N
0x6020.05	Mx	INT32	RO	Mx = INT32/10000 eng. unit: Nm
0x6020.06	My	INT32	RO	My = INT32/10000 eng. unit: Nm
0x6020.07	Mz	INT32	RO	Mz = INT32/10000 eng. unit: Nm
0x7010.01	Para1	UINT16	RW	NA, reserved for future use
0x7010.02	Para2	INT16	RW	NA, reserved for future use
0x7010.03	Para3	INT16	RW	NA, reserved for future use

7. CAN Bus

M8123B2 supports CAN 2.0, and the maximum baud rate is 1Mb/s.

7.1 Baud Rate

The default Baud Rate of CAN Bus is 1Mb/s, and the Baud Rate can be changed by Command CRATE.

7.2 ID

M8123B2 uses CAN Bus with standard 11-bits ID. ID can be configured by Command CFIDL and CTXIDL. Please note that the configured ID is unavailable until M8123B2 is restarted. One M8123B2 have 4 IDs.
ID #1:
Master use this ID to send data to M8123B2. Configure by Command CFIDL. Default ID #1 is 0x80.
ID #2:
M8123B2 use this ID send data to master. Configure by Command CTXIDL. Default ID #2 is 0x291.
ID #3:
M8123B2 use this ID send data to master. Configure by Command CTXIDL. Default ID #2 is 0x292.
ID #4:
M8123B2 use this ID send data to master. Configure by Command CTXIDL. Default ID #2 is 0x293.

7.3 How to Get Data via CAN Bus

Step1:
By RS232 communication, configure CAN ID and baud rate by commands CRATE, CFIDL and CTXIDL.
Step2:
By CAN Bus, master send 1(0x01) or 2(0x02) with ID #1 to M8123B2 to notice the start of getting data. 1 means to get one package of data. 2 means to get data continuously.

To stop get data continuously, master should send 0(0x00) with ID #1 to M8123B2.

Step3:
By CAN Bus, M8123B2 send 3 packages of data to Master with ID #2, ID #3, and ID #4 in order. Every package contains 8 bytes data, so there are 24 bytes data. One six axis loadcell has 6 channels FX,FY,FZ,MX,MY and MZ, therefore, each channel has 4 bytes data.

Data Package	Package 1 with ID #2		Package 2 with ID #3		Package 3 with ID #4	
	4Bytes	4Bytes	4Bytes	4Bytes	4Bytes	4Bytes
Definition	FX	FY	FZ	MX	MY	MZ
Variable Type	Float	Float	Float	Float	Float	Float