



M8226CA User's Manual

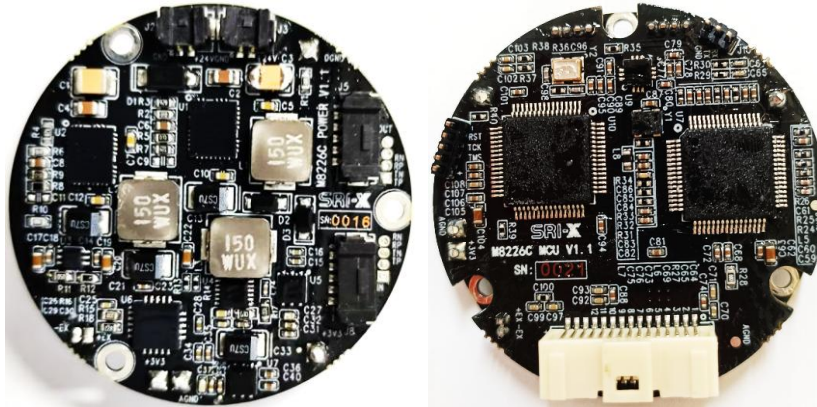
This document is the User's Manual for M8226CA, an OEM circuit board for the force/torque sensor (loadcell) manufactured by SRI (Sunrise Instruments Co., Ltd). It's strongly recommended that anyone who uses M8226CA should read this document before any operation. SRI reserves all the rights of this document. Please do not hesitate to contact SRI if there is any question.

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1. Introduction

The OEM circuit board M8226CA provides bridge excitation, signal conditioning, data acquisition and digital communication to the user's controller or PC via EtherCAT and 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 M8226CA via a Molex connector.



Specifications:

- Analog
 - # of Channels: 12
 - Low noise instrumentation amplifiers
- Digital
 - EtherCAT 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
 - RS232: Molex connector
 - Power supply: Molex connector, DC12 – 48V, MAX250mA
- Dimension
 - Outer diameter 44mm, Height 17mm, Mounting hole 3*M2
- 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

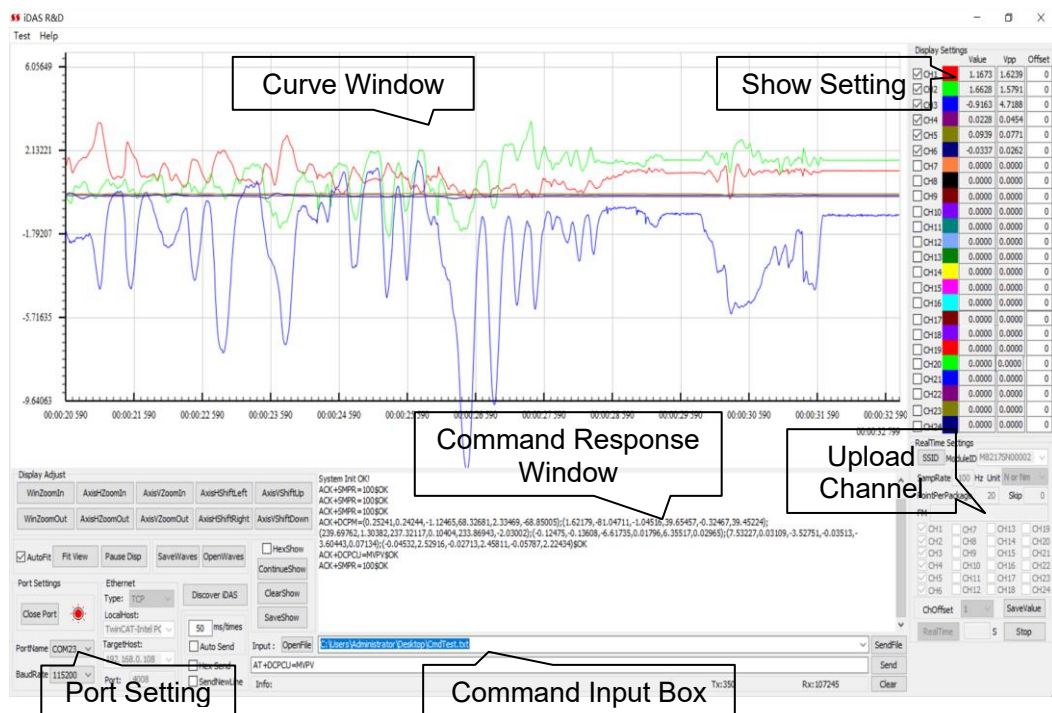
M8226CA and sensor were configured in SRI factory, and it can be connected to EtherCAT directly by the dictionary file(*.xml).

RS232 is supplied to debug M8226CA 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

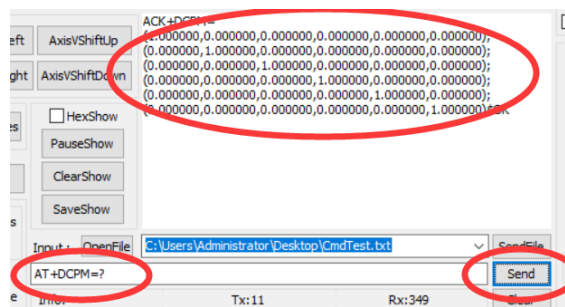
Note: M8123B2 only can communicate with iDAS RD via RS232. EtherCAT communication is not supported by iDAS RD.

2.1 iDAS RD software



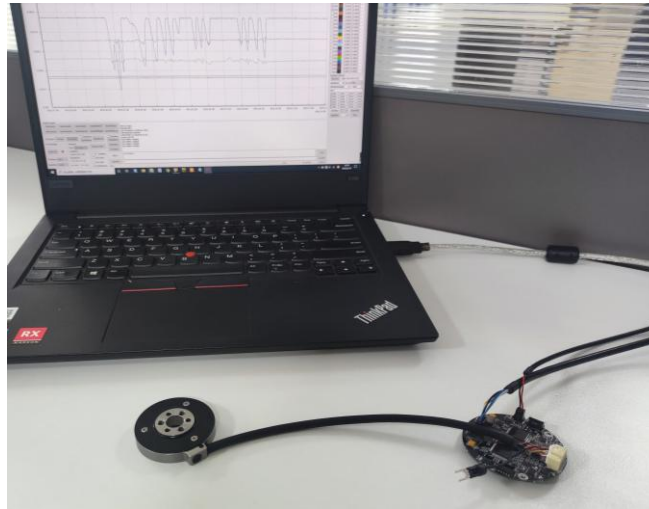
2.2 Send Commands

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 M8226CA.



2.3 Get real-time data via RS232 by software iDAS RD

Step 1: Power on M8226CA and open iDAS RD. Connect M8226CA to PC via RS232.



Step 2: Set PortName, Baudrate and Open Port.

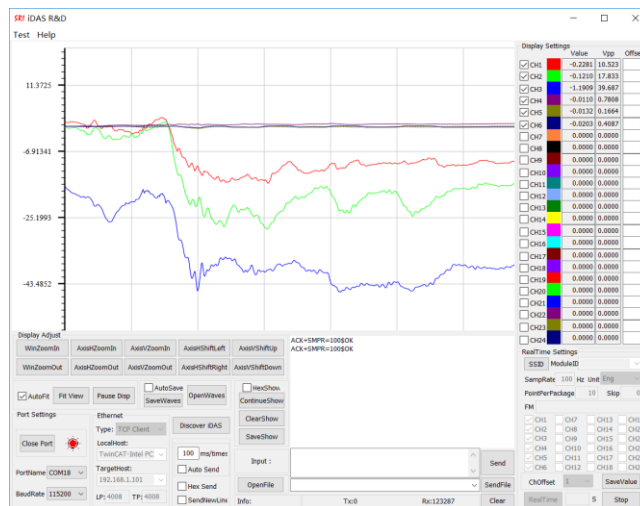
Step 3: Select CH1 through CH6 at the lower right corner on screen.

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 M8226CA, 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 Get real-time data via RS232 by Commands

Step 1: Use command SMPF to set sampling rate. If the sampling rate is 100Hz:

```
AT+SMPF=100\r\n
```

Step 2: Use command GOD to get one package data or command GSD to get data continuously from M8226CA. Refer to Sections 4.8 and 4.9.



Note:

- ✍ The parameters set by Command SMPF are saved to M8226CA, and they are still available after power off.
- ✍ If iDAS R&D software is used, M8226CA is required to restart (Power off and Power on) before debugging your own codes.
- ✍ If the real time data of CH1~CH6 is incorrect, please check the decoupled matrix and the calculation unit, and refer to chapter 5 of this Manual

2.5 Configuration

To configure decoupling matrix:

If the M8226CA is purchased together with SRI sensor, the decoupled matrix and calculation unit of SRI sensor have been configured in the M8226CA.

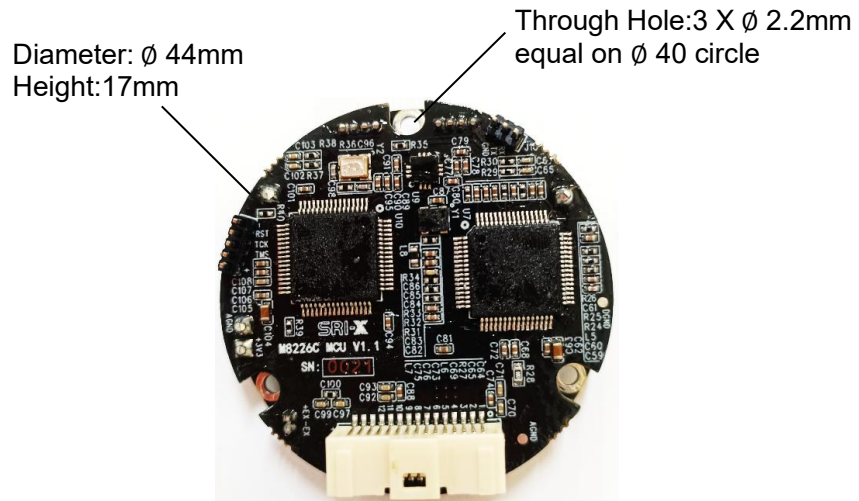
When different sensor connects to M8226CA, M8226CA must have different configuration. The method is described in chapter 5.

To configure the sampling rate:

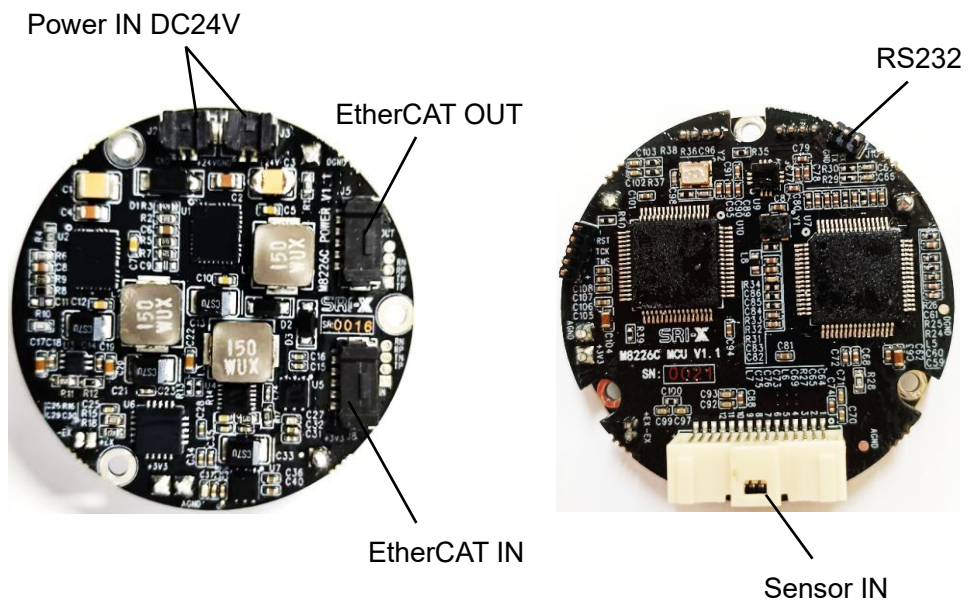
Sampling rate can be configured by command SMPF.

3. Circuit Board

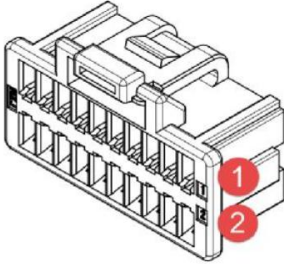
3.1 Dimension

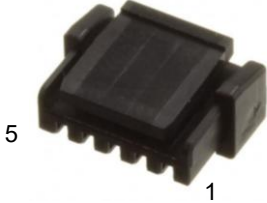



3.2 Connector




3.3 Connector definition

| Sensor connector(on the sensor cable) (Molex connector Part# 501189-3010) | | | | |
|---|---------|------------|---------------------|--|
| <i>Note: To prevent signal interference, it is recommended to short unused sensor signal pins to GND.</i> | | | | |
|  | PIN # | Definition | Note | |
| | 1 | CH1+ | Channel 1 | |
| | 2 | CH1- | | |
| | 3 | CH2+ | Channel 2 | |
| | 4 | CH2- | | |
| | 5 | CH3+ | Channel 3 | |
| | 6 | CH3- | | |
| | 7 | CH4+ | Channel 4 | |
| | 8 | CH4- | | |
| | 9 | CH5+ | Channel 5 | |
| | 10 | CH5- | | |
| | 11 | CH6+ | Channel 6 | |
| | 12 | CH6- | | |
| | 13 | CH7+ | Channel 7 | |
| | 14 | CH7- | | |
| | 15 | CH8+ | Channel 8 | |
| | 16 | CH8- | | |
| | 17 | CH9+ | Channel 9 | |
| | 18 | CH9- | | |
| | 19 | CH10+ | Channel 10 | |
| | 20 | CH10- | | |
| | 21 | CH11+ | Channel 11 | |
| | 22 | CH11- | | |
| | 23 | CH12+ | Channel 12 | |
| | 24 | CH12- | | |
| | 25 - 28 | NC | For future use | |
| | 29 | +EX | +Excitation voltage | |
| | 30 | -EX | -Excitation voltage | |

| EtherCAT connector (Molex connector Part# 505565-0501) | | | |
|---|--------|------------|------|
|  | PIN # | Definition | Note |
| | 1 | TXP | |
| | 2 | TXN | |
| | 3 | RXP | |
| | 4 | RXN | |
| 5 | Shield | | |

| Power connector (Molex connector Part# 505565-0201) | | | |
|---|-------|------------|------|
|  | PIN # | Definition | Note |
| | 1 | +24V | |
| | 2 | GND | |

| RS232 connector | | | |
|---|-------|------------|-------|
|  1.27mm distance | PIN # | Definition | Note |
| | 1 | RX | RS232 |
| | 2 | TX | |
| | 3 | GND | |



3.3 LED lights

| LED -D1 (EtherCAT_IN) | LED -D2 (MCU) | LED -D3 (EtherCAT Module) | LED -D4 (EtherCAT_OUT) | LED -D5 (System Power) | System Status |
|--------------------------|------------------|------------------------------|---------------------------|---------------------------|--|
| Flicker | | | | | EtherCAT_IN normal |
| | Flicker | | | | MCU is working |
| | | ON | | | EtherCAT module is working |
| | | | Flicker | | EtherCAT daisy chain working properly |
| | | | | ON | System power on |
| OFF | Flicker | OFF | OFF | ON | MCU is working, but EtherCAT module is not working. |
| Flicker | Flicker | ON | OFF | ON | EtherCAT communication working, but there is no device on EtherCAT_OUT |
| Flicker | Flicker | ON | Flicker | ON | Everything working |

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 M8226CA via RS232.

| 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 | |
| GSD | Get data from M8123B2 continuously | |
| GOD | Get one package data from M8123B2 | |

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,-0.000047,0,0,0,0,0,0,0);(-0.000160,-0.011703,-0.000089,-0.011668,-0.000217,0.023526,0,0,0,0,0,0,0);(-0.031415,-0.000185,-0.032273,0.000010,-0.031708,-0.000481,0,0,0,0,0,0,0);(-0.000888,-0.000014,0.000951,-0.000006,0.000029,0.000009,0,0,0,0,0,0,0);(-0.000521,0.000011,-0.000531,-0.000009,0.001061,0.000015,0,0,0,0,0,0,0);(0.000002,0.000754,-0.000008,0.000753,-0.000007,0.000768,0,0,0,0,0,0,0)\$OK

Send: AT+DCPM=(0.000041,-0.020164,-0.000348,0.020287,-0.000145,-0.000047,0,0,0,0,0,0,0);(-0.000160,-0.011703,-0.000089,-0.011668,-0.000217,0.023526,0,0,0,0,0,0,0);(-0.031415,-0.000185,-0.032273,0.000010,-0.031708,-0.000481,0,0,0,0,0,0,0);(-0.000888,-0.000014,0.000951,-0.000006,0.000029,0.000009,0,0,0,0,0,0,0);(-0.000521,0.000011,-0.000531,-0.000009,0.001061,0.000015,0,0,0,0,0,0,0);(0.000002,0.000754,-0.000008,0.000753,-0.000007,0.000768,0,0,0,0,0,0,0)

Response: ACK+DCPM=(0.000041,-0.020164,-0.000348,0.020287,-0.000145,-0.000047,0,0,0,0,0,0,0);(-0.000160,-0.011703,-0.000089,-0.011668,-0.000217,0.023526,0,0,0,0,0,0,0);(-0.031415,-0.000185,-0.032273,0.000010,-0.031708,-0.000481,0,0,0,0,0,0,0);(-0.000888,-0.000014,0.000951,-0.000006,0.000029,0.000009,0,0,0,0,0,0,0);(-0.000521,0.000011,-0.000531,-0.000009,0.001061,0.000015,0,0,0,0,0,0,0);(0.000002,0.000754,-0.000008,0.000753,-0.000007,0.000768,0,0,0,0,0,0,0)\$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

4.5 GOD / Get one package data from M8226CA

Description: To get one package data from M8226CA.

Command Syntax: AT+GOD

Example:

Send: AT+GOD

Response: "DataFormat" // please see "DataFormat" in section 4.9.

4.6 GSD / Get data continuously

Description: To get data continuously.

Command Syntax: AT+GSD

Example:

Send: AT+GSD

Response: "DataFormat"

Send: AT+GSD=STOP //To stop get data continuously

Response: ACK+GSD=STOP\$OK

"DataFormat" is defined as follows:

| Frame Header | PackageLength | PackageNo | Data | SUM |
|--------------|---------------|-----------|----------------------|-------|
| 0xAA ,0x55 | HB,LB | 2Byte | (ChNum*N*DNpCH) Byte | 1Byte |



Note:

✍ 0xAA ,0x55: Frame header of data package.

PackageLength: Unsigned short int,16-bits, highest byte first, The length of data of each channel, which equals to 2+ChNum*N*DNpCH+1(SUM check) or 2+ ChNum*N*DNpCH+4(CRC32 check)

Where

ChNum: Total number of uploading channels, Default value 6

N: the output unit, Default value 4

DNpCH: Number of sampling points to upload in one package, Default value 1

✍ PackageNo: Every package is labeled, which increases in sequence from 0 to 65535.

✍ Data: Uploading data with the lowest byte first.

✍ SUM: The default data validation method is Checksum.

Example:

Send: AT+GOD\r\n

Response: AA 55 00 1B C4 C7 01 6A F4 C0 EF 7D 33 C0 49 62 C9 C0 A2

5C C6 BD A6 19 8F BD AF DA 69 3E 6E

Where

0xAA,0x55: Frame header

00 1B: PackageLength $2+6*4*1+1=27$ bytes;

C4 C7: Package No 50375;

Channel 1 Engineering Unit: 01 6A F4 C0, single-precision float
(C0F46A01) converted into -7.637940;

Channel 2 Engineering Unit: EF 7D 33 C0, single-precision float
(C0337DEF) converted into -2.804561;

Channel 3 Engineering Unit: 49 62 C9 C0, single-precision float
(C0C96249) converted into -6.293248;

Channel 4 Engineering Unit: A2 5C C6 BD, single-precision float
(BDC65CA2) converted into -0.096856;

Channel 5 Engineering Unit: A6 19 8F BD, single-precision float
(BD8F19A6) converted into -0.069873;

Channel 6 Engineering Unit: AF DA 69 3E, single-precision float
(3E69DAAF) converted into 0.228373

SUM Check: 6E

5. Decoupled Calculation

If the M8226CA is purchased together with SRI sensor, the decoupled matrix and calculation unit of SRI sensor have been configured in the M8226CA. 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 rawchn6 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);(1.19167,0.00028,1.20748,0.00224,1.19808,0.00320);(-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)
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 M8226CA. For calculation in M8226CA, 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 |