2XCM-I DIGITAL COMPASS AND TEMPERATURE MODULE

DATA SHEET

DESCRIPTION:

The **2XCM-I** is a high-performance, low-power digital compass module that outputs compass heading via electronic interface (USART) to a host system. It outputs Compass and Temperature readings by host request. The 2XCM-I has a built-in highly advanced calibration routine to compensate for distortion due to nearby ferrous objects and stray fields such as vehicles, etc.

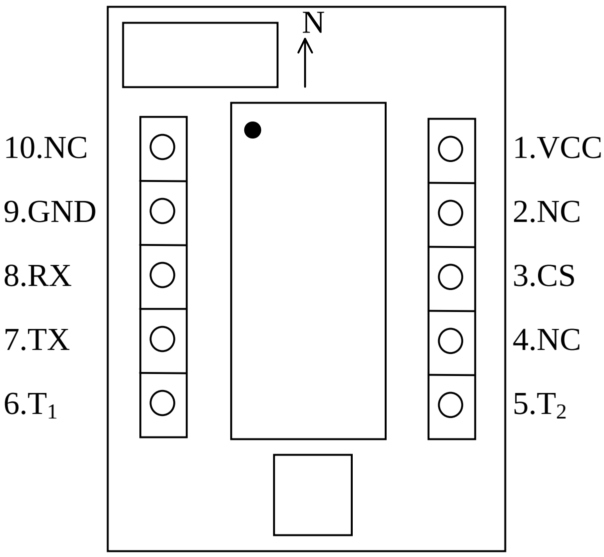
FEATURES:

- Distortion detection: a warning flag displays when magnetic disturbances such as nearby ferrous metals and electrical currents are compromising operation.
- Advance calibration algorithms.

Heading Information:

Accuracy :	± 2°
Resolution :	0.5°
Repeatability :	± 2°
Range :	0.0° ~ 359.5°

Pin Assignment



Temperature Information:

Accuracy :	± 1℃
Resolution :	0.5℃
Repeatability :	± 1℃
Range :	- 40.0℃ ~ +85℃
Distance of remote sensor :	< 10 m

Power Requirements:

Supply Voltage: 5V DC

Current:

Normal mode:	3.8 mA (Average)
Sleep mode:	0.3 mA
Calibration:	17 mA

Environmental Characteristics:

Operation Temperature : - 40 ~ 85℃

Storage Temperature : - 50 ~ 125℃

Dimension:

28.5mm*19.8mm*6mm

Interface:

USART 9600.N.8.1

Pin	Name	Description
1	VCC	Power supply voltage
3	CS	Control signal
5	T_2	Remote Temp. Sensor 2
6	T_1	Remote Temp. Sensor 1
7	TX	Transmitted Data
8	RX	Received Data
9	GND	Ground

DATA FORMAT:

The value of Angle, Temperature and Check sum calculated by the following rules:

Angle = (Θ_{MSB} * 256 + Θ_{LSB}) / 2.

Temperature = (T_{MSB} * 256 + T_{LSB}) / 2.

Check sum = FFH $\oplus$ Data 1 $\oplus$ Data 2 $\oplus$ …… $\oplus$ Data N.

Note:

If the data of T_{MSB} first bit (bit7) is " 1 ", it means the temperature is Negative that is represented by 2's complement. Otherwise, it means the temperature is Positive.

Example:

Θ = 200.5° = 401D = 0191H , then 91H is Θ_{LSB} and 01H is Θ_{MSB}.

T_1 = 25.5℃ = 51D = 0033H , then 33H is T_{1LSB} and 00H is T_{1MSB}.

T_2 = - 30.0℃

30℃ = 60D = 003CH = 0000 0000 0011 1100B

−60D = (003CH ⊕ FFFFH) + 0001H

```
     0000 0000 0011 1100B  (60D)
 ⊕   1111 1111 1111 1111B
 ------------------------------
     1111 1111 1100 0011B
 +   0000 0000 0000 0001B
 ------------------------------
     1111 1111 1100 0100B  (−60D)
```

Input		Output
X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0
True table: X⊕Y=Z		

So : −60D = FFC4H

T_2 = - 30.0℃ = - 60D = FFC4H , then C4H is T_{2LSB} and FFH is T_{2MSB}

At H-command :

Check sum = FFH ⊕ Θ_{LSB} ⊕ Θ_{MSB} = FFH ⊕ 91H ⊕ 01H = 6FH.

So data format is : **91H + 01H + 6FH**

At T-command :

Check sum = FFH ⊕ T_{1LSB} ⊕ T_{1MSB} ⊕ T_{2LSB} ⊕ T_{2MSB}
= FFH ⊕ 33H ⊕ 00H ⊕ C4H ⊕ FFH
= F7H.

So data format is : **33H + 00H + C4H + FFH + F7H**

At M-command :

Check sum = FFH ⊕ Θ_{LSB} ⊕ Θ_{MSB} ⊕ T_{1LSB} ⊕ T_{1MSB} ⊕ T_{2LSB} ⊕ T_{2MSB}
= FFH ⊕ 91H ⊕ 01H ⊕ 33H ⊕ 00H ⊕ C4H ⊕ FFH
= 67H.

So data format is : **91H + 01H + 33H + 00H + C4H + FFH + 67H**

OPERATION :

As soon as power on, the 2XCM-I will be in Normal mode (Normal + H-commend) and start to output heading. **Please note when the device is first setup it may need calibration.**

When calibrating 2XCM-I , be sure that to keep 2XCM-I on the flat and where there is less magnetic interference (not near railroad tracks , metal-framed building , power line or audio speakers).

2XCM-I also provides 3 functions for the users. These are Normal , Sleeping and Calibration mode.

There are three special commands in normal mode, H-command , T-command and M-command. **The default is H-commend.**

OPERATION TABLE :

Operation	Meaning	Host send	2XCM-I respond	Mode after response
	Distortion notice		1st bit (bit7) of data Θ_{MSB} = 1.	
C - command	Start Calibration	'C' (43H)	'O' (4FH) + 'K' (4BH) + 13H	Calibration
D - command	Calibration Done	'D' (44H)	'O' (4FH) + 'K' (4BH) + 13H	Normal
S - command	Sleep	'S' (53H)	'O' (4FH) + 'K' (4BH) + 13H	Sleep
W - command	Wake up	'W' (57H)	'O' (4FH) + 'K' (4BH) + 13H	Normal
H - command	Heading information request	'H' (48H)	'O' (4FH) + 'K' (4BH) + 13H Heading information sent every 0.5 second.	Normal + H-command
T - command	Temperature information request	'T' (54H)	'O' (4FH) + 'K' (4BH) + 13H Temperature information sent every 0.5 second.	Normal + T-command
M - command	Mix information request	'M' (4DH)	'O' (4FH) + 'K' (4BH) + 13H Heading and temperature mixed information sent every 0.5 second.	Normal + M-command

■ Calibration mode :

When distortion is detected , the first bit (bit7) of heading data Θ_{MSB} will be set "1" , then the heading data may be inaccurate.

A distortion warning may be displayed briefly when close to the strong magnetic interference , As soon as the 2XCM-I is moved away , the distortion signal will not be sent and the heading data will be accurate.

The 2XCM-I has a powerful design to shortly against the strong magnetic interference , When distortion is detected , it will temporarily keep on sending the latest accurate heading data.

If the distortion warning displays continuously or display after calibration , then user is suggested to perform calibration again , where there is less magnetic interference.

To perform calibration , Host sends C-command to 2XCM-I and turns the module in two circles. Host sends D-command to 2XCM-I after turning ending.

C-command (Calibration) :

When host sends **'C' (43H)** through RX pin to 2XCM-I, the 2XCM-I will respond **'O' (4FH) + 'K' (4BH) + 13H** to host and will be in calibration mode. Also 2XCM-I will detect new parameter in this mode.

Please turn the module in two circles, then send D-command to 2XCM-I. When 2XCM-I receives the D-command, the following events will happen :

1. 2XCM-I respond 'O' (4FH) + 'K' (4BH) + 13H to host.
2. 2XCM-I Exit Calibration mode and enter into Normal mode. (The last commend of Normal mode).
3. The 2XCM-I can keep the last calibration data in memory which will never lost even power off.

Note: The D-command is the only way to exit the Calibration mode.

D-command (Calibration Done) :

When host sends **'D' (44H)** through RX pin to 2XCM-I , the 2XCM-I will respond **'O' (4FH) + 'K' (4BH) + 13H** to host. Then , 2XCM-I will be in Normal mode. (The last commend of Normal mode).

S-command (Sleep mode) :

When host sends **'S' (53H)** through RX pin to 2XCM-I, the 2XCM-I will respond **'O' (4FH) + 'K' (4BH) + 13H** to host and will be in Sleeping mode. The Sleeping mode is also called Power Saving mode.

When host send 'W' (57H) to 2XCM-I , the 2XCM-I will Wake Up.

W-command (Wake-up)

When host sends **'W' (57H)** through RX pin to 2XCM-I, the 2XCM-I will respond **'O' (4FH) + 'K' (4BH) + 13H** to host. Then , 2XCM-I will be in Normal mode (The last commend of Normal mode).

Host can send the specify commend , H , T or M to change that commend.

■ Normal mode

Normal mode means CS pin is kept at high. The 2XCM-I will send specify information to the host every 0.5 second. **The default command is H-command.**

H-command (Heading information) :

When host sends **'H' (48H)** through RX pin to 2XCM-I, the 2XCM-I will respond **'O' (4FH) + 'K' (4BH) + 13H** to host and will be in Normal mode with H-command.

The 2XCM-I sends heading information through TX pin to host at normal mode with H-command every 0.5 second if CS pin is at high.

T-command (Temperature information) :

When host sends **'T' (54H)** through RX pin to 2XCM-I, the 2XCM-I will respond **'O' (4FH) + 'K' (4BH) + 13H** to host and will be in Normal mode with T-command.

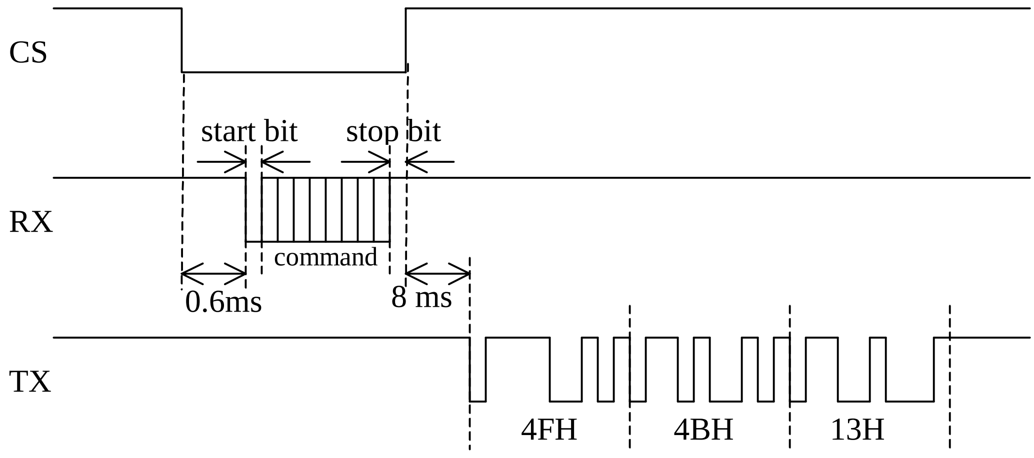
The 2XCM-I sends temperature information through TX pin to host at normal mode with T-command every 0.5 second if CS pin is at high.

M-command (Mixed information) :

When host sends **'M' (4DH)** through RX pin to 2XCM-I, the 2XCM-I will response **'O' (4FH) + 'K' (4BH) + 13H** to host and be in Normal mode with M-command.

The 2XCM-I sends mixed heading and temperature information through TX pin to host at normal mode with M-command every 0.5 second if CS pin is at high.

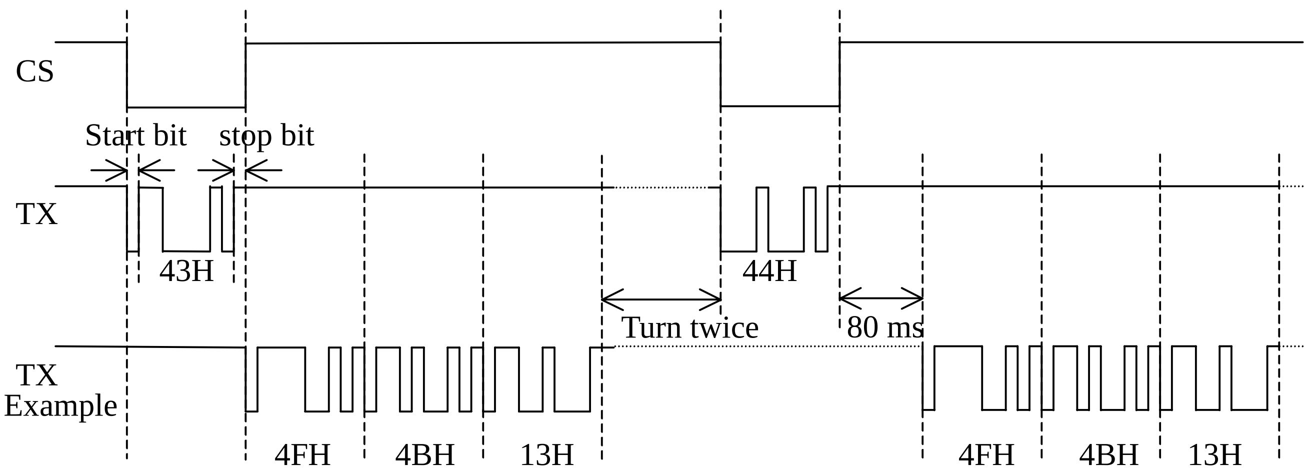
Timing chart (command)



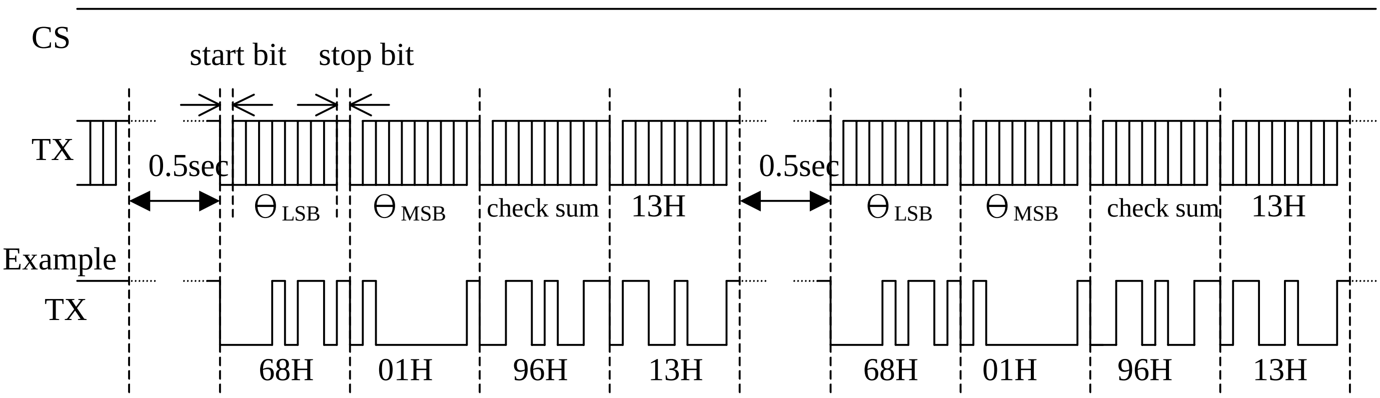
NOTE:

When host sends command through RX pin to the 2XCM-I , the 2XCM-I will respond ‘O’ (4FH) + ‘K’ (4BH) + 13H to host.

Timing chart (Calibration mode)



Timing chart (Normal mode with H-command)



* CS: Normal High

NOTE :

$\Theta = (\Theta_{MSB} * 256 + \Theta_{LSB}) / 2.$

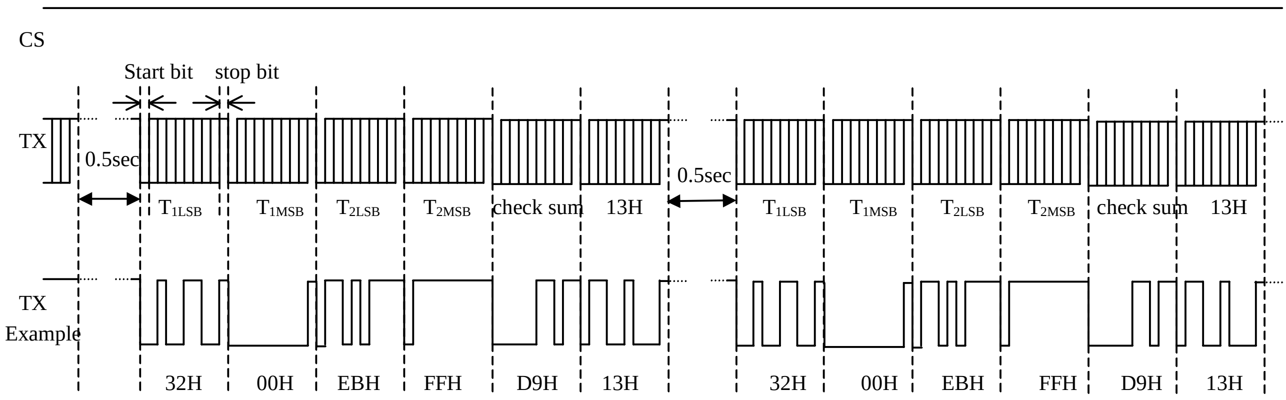
Check sum = FFH $\oplus$ Θ_{LSB} $\oplus$ Θ_{MSB}

At this example :

Θ = (01H * 256 + 68H) / 2.
= (1 * 256 + 104) / 2.
= 180.0°

Check sum = 96H.

Timing chart (Normal mode with T-command)



* CS Normal High

NOTE :

$T_1 = (T_{1MSB} * 256 \ + \ T_{1LSB}) \ / \ 2$

$T_2 = (T_{2MSB} * 256 \ + \ T_{2LSB}) \ / \ 2$

Check sum = FFH $\oplus$ T_{1LSB} $\oplus$ T_{1MSB} $\oplus$ T_{2LSB} $\oplus$ T_{2MSB}

If there is no Temperature Sensor connected to T_1 , then T_1 will send - 40℃.

If there is no Temperature Sensor connected to T_2 , then T_2 will send - 40℃.

At this example:

The data of T_{1MSB} first bit (bit7) is “ 0 “, it means the temperature is Positive.

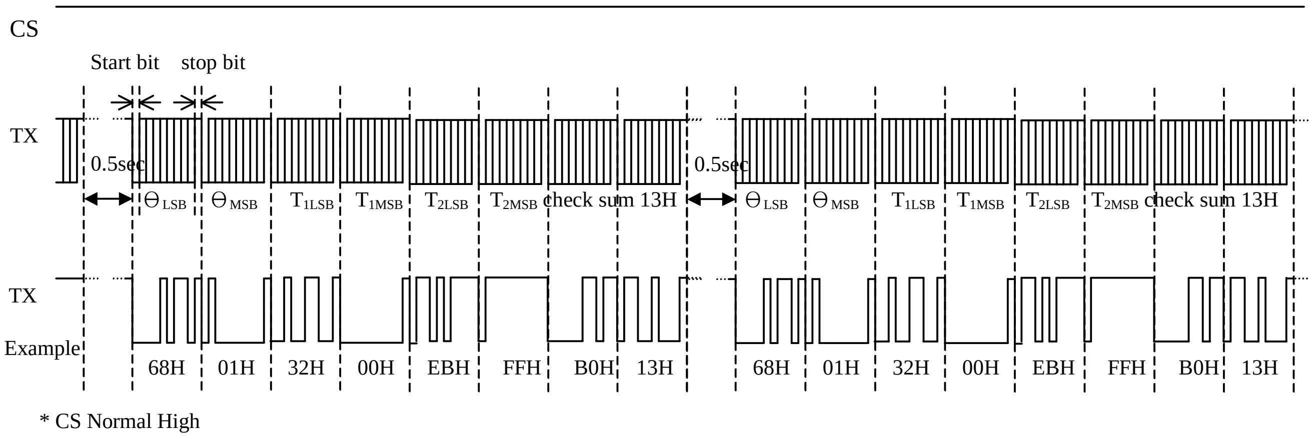
T_1 = (00H * 256 + 32H) / 2.
= (0 * 256 + 50) / 2.
= 25.0℃

The data of T_{2MSB} first bit (bit7) is “ 1 “, it means the temperature is Negative that is represented by 2’s complement.

(FFEBH $\oplus$ FFFFH) + 0001H = 0015H
T_2 = - (00H * 256 + 15H) / 2.
= - (0 * 256 + 21) / 2.
= - 10.5℃

Check sum = D9H.

Timing chart (Normal mode with M-command)



NOTE :

$\Theta = (\Theta_{MSB} * 256 + \Theta_{LSB}) / 2.$

$T_1 = (T_{1MSB} * 256 + T_{1LSB}) / 2$

$T_2 = (T_{2MSB} * 256 + T_{2LSB}) / 2$

Check sum = FFH $\oplus$ Θ_{LSB} $\oplus$ Θ_{MSB} $\oplus$ T_{1LSB} $\oplus$ T_{1MSB} $\oplus$ T_{2LSB} $\oplus$ T_{2MSB}

At this example:

Θ = (01H * 256 + 68H) / 2.
= (1 * 256 + 104) / 2.
= 180.0°

The data of T_{1MSB} first bit (bit7) is “ 0 “, it means the temperature is Positive.

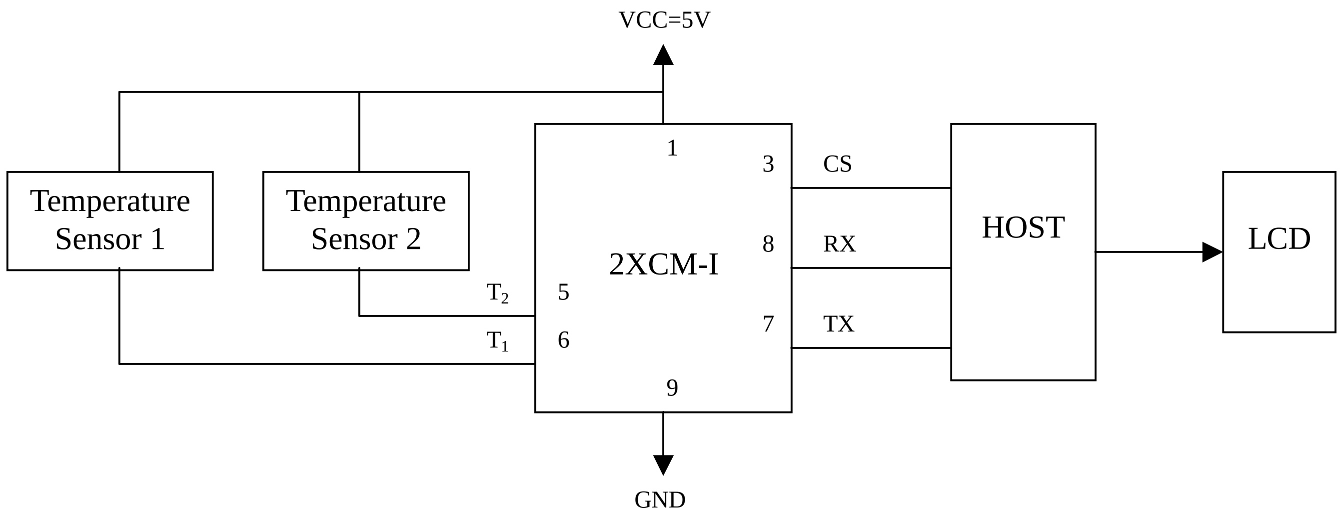
T_1 = (00H * 256 + 32H) / 2.
= (0 * 256 + 50) / 2.
= 25.0℃

The data of T_{2MSB} first bit (bit7) is “ 1 “, it means the temperature is Negative that is represented by 2’s complement.

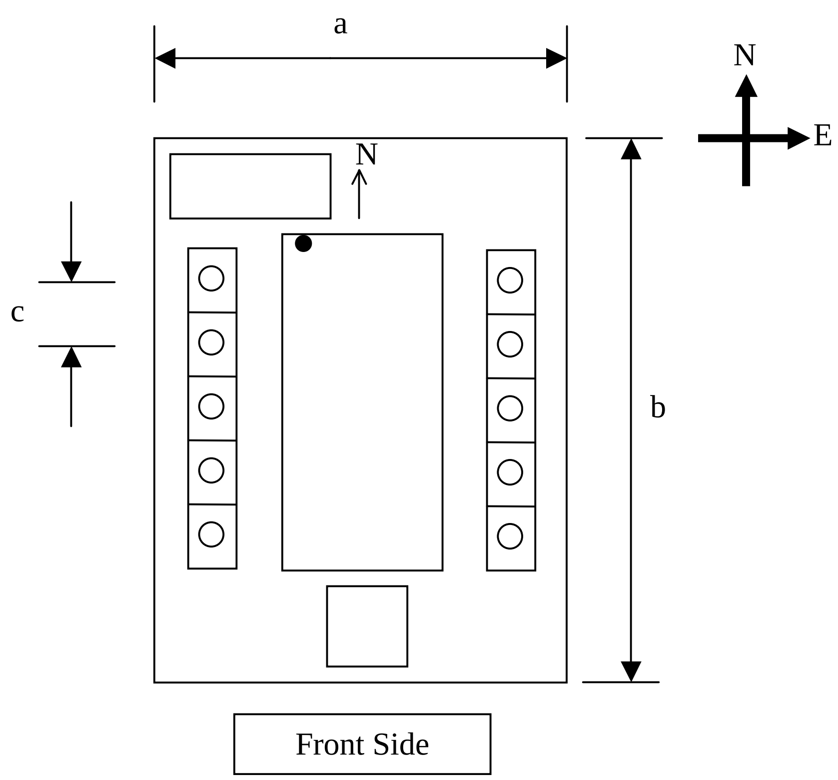
(FFEBH $\oplus$ FFFFH) + 0001H = 0015H
T_2 = - (00H * 256 + 15H) / 2.
= - (0 * 256 + 21) / 2.
= - 10.5℃

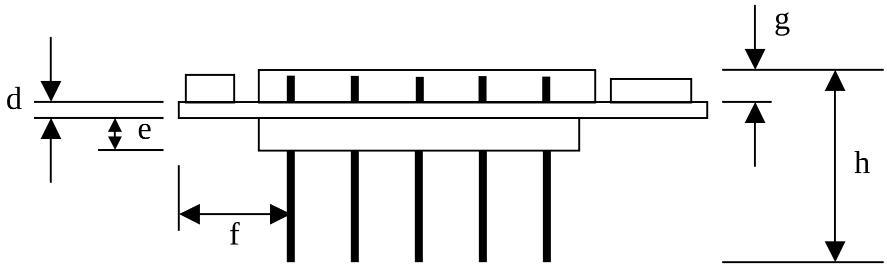
Check sum = B0H.

Application circuit showing 2XCM-I external Connections :

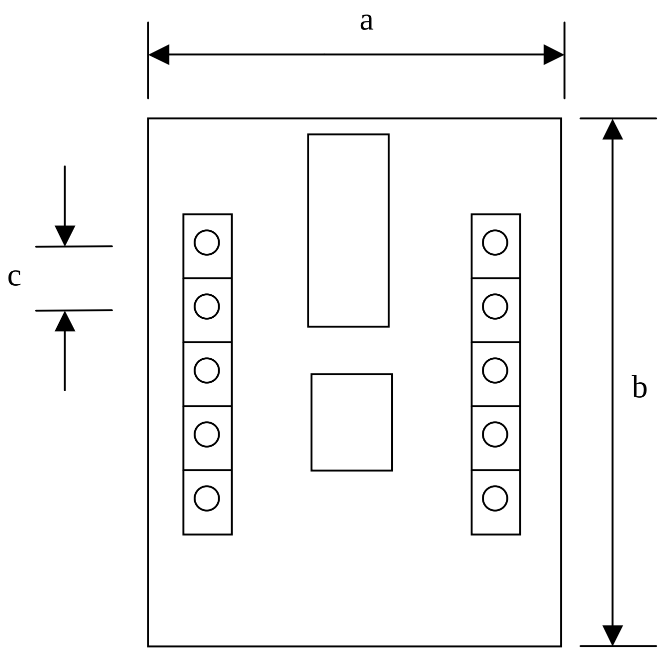


Package drawing :





Left Side



Bottom Side

Symbol	Millimeters	Inches (10^{-3})
	mm	Mil
a	19.8	780
b	28.5	1122
c	2.6	102
d	0.6	24
e	2.6	102
f	8.8	347
g	2.8	110
h	12.2	480