AGM-810 Product Datasheet 產品規格書

1. PRODUCT OVERVIEW / 產品概述

AGM-810 是一款工業級航姿參考系統 (AHRS) 與全球導航衛星系統 (GNSS) 整合模組。其結合了 L1/L5 雙頻定位技術與 10 軸陣列式 (10-axis Array) 高精度 MEMS 慣性感測單元，能在複雜動態環境下提供公尺級定位精度與精準的航向姿態數據。

- SYSTEM ARCHITECTURE/系統架構

圖 1.1顯示了模組的簡化架構。AGM-810 模組包含了陀螺儀、加速度計、磁力計、氣壓計和 MCU。MCU 負責調節各種感測器的同步操作，並運行 AWAN 的專用演算法，該演算法能夠輸出精準的三軸姿態角，並提供最高 100 Hz 的輸出速率。透過彈性的 UART 與 CAN Bus 通訊介面，開發者可輕易將精準的姿態數據整合至系統中。

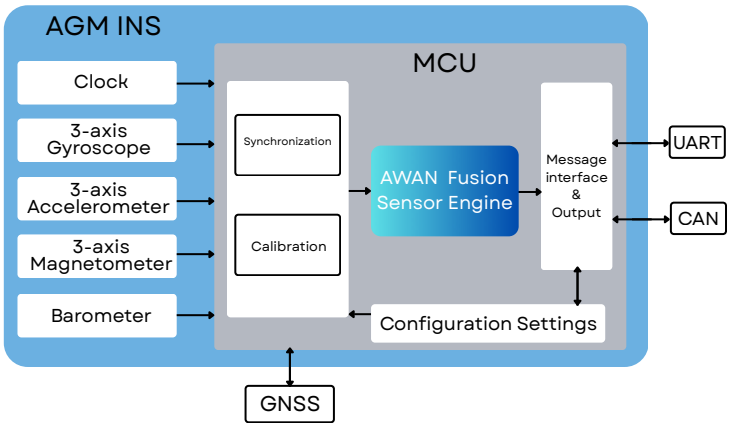

FIGURE 1.1 AGM INS ARCHITECTURE DIAGRAM

2. PERFORMANCE SPECIFICATIONS / 性能規格

2.1 System Accuracy/系統綜合精度

模組的精確度受演算法、量程、環境因素和感測器製造誤差的影響。以下的性能規格（見表 2.1）係為產品測試數據之典型值 (Typical values)。實際應用時必要的運動測試和校準均為工廠自動化生產過程的一部分，所提供之規格數據可大幅縮短系統整合時間，並確保系統的高度精確性與可靠性。

*Unless stated otherwise, all specifications are typical. Specifications subject to change without notice.

Parameter (項目)	AGM-810 Specification
Measurement Range (量程)	± 180° (Roll) / ± 85° (Pitch) / ± 180° (Yaw)
Dynamic Accuracy (動態精度)	< 0.4° (Roll / Pitch)
	< 0.8° (Yaw)
Velocity Accuracy (速度精度)	0.1 m/s RMS
Resolution (解析度)	0.0055°

TABLE 2.1 SYSTEM ACCURACY SPECIFICATIONS

2.2 SENSOR SPECIFICATIONS / 感測器規格

AGM-810 模組整合了高性能 IMU 與 GNSS 定位單元，各項感測器參數如下表：

Category(類別)	Parameter (技術項目)	Value (規格數值)	Unit (單位)
Gyroscope (陀螺儀)	Full Scale (標準全量程)	±2000	°/s (deg/s)
	Bandwidth (頻寬)	539	Hz
	Resolution (解析度)	0.07	deg/s
	In-run Bias Stability (零偏穩定性)	3	°/h (deg/h)
	Noise Density (噪聲密度)	0.005	°/s/√Hz
	Sensitivity Tolerance (靈敏度公差)	±5	%

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Category (類別)	Parameter (技術項目)	Value (規格數值)	Unit (單位)
Accelerometer (加速度計)	Full Scale (標準全量程)	±16	g
	Resolution (解析度)	0.488	mg/LSB
	Bandwidth (頻寬)	10 ~ 3000	Hz
	In-run Bias Stability (零偏穩定性)	0.03	mg
	Temperature Drift (溫度飄移)	±0.10	mg/ °C
	Noise Density (噪聲密度)	60	μg/√Hz
Magnetometer (磁力計)	Dynamic Range (動態範圍)	4915.2	μT
	Resolution (解析度)	0.25	mG
	RMS Noise (RMS 噪聲)	3	mG
Barometer (氣壓計)	Standard Full Range (標準量程)	300 ~ 1100	hPa
	Total RMS Noise (總噪聲)	1	Pa
GNSS	Frequency Support (頻段支援)	L1 / L5	Dual-Band (雙頻)
	Positioning Accuracy (定位精度)	1	m (CEP)

TABLE 2.2 SENSOR SPECIFICATIONS

2.3 MECHANICAL DIMENSIONS / 機械尺寸

AGM-810 模組採用堅固的 ABS 外殼，總重量為 42 g，外觀尺寸為 49.2 x 61.3 x 23 mm。模組機械尺寸與外觀規格如下：

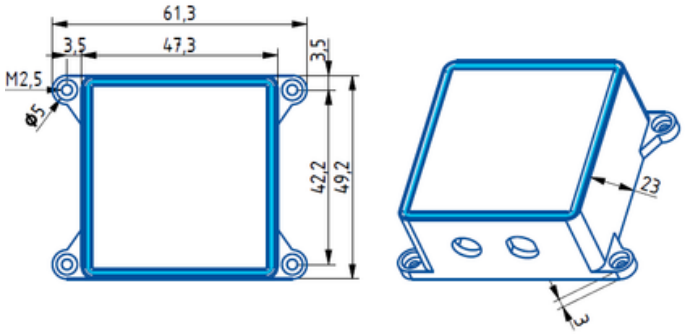


Figure 2.3 Mechanical Dimensions (Unit:mm)

2.4 ELECTRICAL & INTERFACE SPECIFICATIONS / 電氣與介面規格

AGM-810模組的電氣特性與通訊介面功能說明，供系統整合參考。

Category(類別)	Parameter (技術項目)	Value (規格數值)	Description (說明)
Electrical (電氣特性)	Operating Voltage (工作電壓)	4.75 V ~ 5.25 V	DC Power Supply
	Power Consumption (功耗)	< 1.5 W	Typical operating power
Environmental (環境特性)	Operating Temperature (工作溫度)	-40°C ~ +85°C	Industrial grade wide temperature range
Interfaces (介面與 I/O)	Hardware Interfaces (硬體介面)	UART, CAN	M8 8-pin Molded Connector
	Output Frequency (輸出頻率)	25 ~ 100 Hz	Configurable via software
	Protocols (支援協議)	AWAN Standard, MAVLink, NMEA, UBX	Standardized communication
	Clock Drift (時鐘漂移)	30 ppm	Precision timing reference

TABLE 2.4 ELECTRICAL AND INTERFACE SPECS

2.5 GNSS ANTENNA REQUIREMENTS / GNSS 天線要求

為了確保 GNSS 定位性能達到最佳化，建議外接天線需符合以下規格：

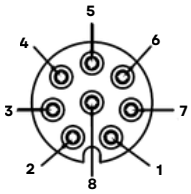
Parameter (項目)	Specification (規格要求)
Antenna Type (天線類型)	Active dual-band GNSS antenna (主動式雙頻天線)
Frequency Support (頻段支援)	L1 / L5
Polarization (極化方式)	RHCP (右旋圓極化)
Impedance (阻抗)	50 Ω
Connector Type (接頭類型)	SMA
Recommended LNA Gain (建議 LNA 增益)	25 ~ 40 dB
Recommended Noise Figure (建議雜訊指數)	< 2 dB
L5 Band Coverage (L5 頻段範圍)	1166 ~ 1187 MHz

TABLE 2.5 RECOMMENDED GNSS ANTENNA SPECIFICATIONS

3. Connector Pinout and Function Description / 連接器腳位和功能說明

AGM-810 模組可支援 UART 與 CAN 通訊協議，採 M8 8-Pin 公頭 (Male, A-Code) 連接器。腳位說明如下：

Module Side



Cable Side

Pin	1	2	3	4	5	6	7	8
Wire Color	Black	Red	Yellow	Green	Blue	Grey	White	Brown
Signal	GND	5V_IN	UART_RX	UART_TX	CAN_H	CAN_L	DIO_1	DIO_2

*Wire colors apply to the factory-supplied cable only

TABLE 3.1 UART / CAN PINOUT DEFINITION

4. COMMUNICATION PROTOCOL / 傳輸協議

本產品數據傳輸採用 BIG-ENDIAN（大端序）格式，通訊架構分為六個核心部分。為確保 AGM-810 數據傳輸的準確性，系統會透過偵測固定起始位並進行校驗位驗證，以確保數據完整性。除 AWAN 標準協議外，本模組亦支援 MAVLINK 協議，可與開源飛控系統無縫對接。

4.1 FRAME STRUCTURE OVERVIEW / 數據幀結構總覽

下表定義了標準數據封包的組成結構：

Byte Index	Field Name	Length (Byte)	Value / Example	Description (數據定義說明)
Byte 0	Start Byte (起始位)	1	0xAA	Frame header
Byte 1	Device ID (裝置別)	1	0x81	Hardware ID for AGM-810
Byte 2	Length (長度)	1	L	Formula: Tag (1) + Payload (N)
Byte 3	Data Tag (資料標籤)	1	See Table 4.2	Identifier for data type
Byte 4~80	Payload (數據位)	77	Sensor Data	Actual measurement values
Byte N	Checksum (校驗位)	1	uint8_t	Sum of Byte[0] to Byte[N-1]

TABLE 4.1 FRAME STRUCTURE

4.2 DATA TAG AND IDENTIFIER MAPPING / 資料標籤與識別碼彙整

針對 AGM-810 支援的各種通訊介面，各項數據的識別碼與數據長度定義如下：

Category (數據類別)	UART Tag	CAN ID	長度(Tag/ID + Payload Bytes)	Data Description (數據定義說明)
Reserved(保留位)	0xFF	-	1	Reserved for future use
Accelerometer(加速度計)	0xA0	050	7	3-axis acceleration
Gyroscope(陀螺儀)	0xB0	051	7	3-axis angular rate
Magnetometer(磁力計)	0xC0	052	7	3-axis magnetic field
Euler Angles(歐拉角)	0xD0	053	7	Roll / Pitch / Yaw orientation
Quaternions(四元數)	0xD1	054	9	Quaternion orientation
Temperature(溫度計)	0xE0	055	3	Module internal temperature
Barometer(氣壓計)	0xE1	056	5	Barometric pressure in hPa
GNSS	0xF0	-	23	Full GNSS data packet
	-	057	9	Latitude and Longitude
		058	9	Altitude, Speed, Fix Status, and Sat Count
		059	7	3-axis world frame velocity vector[1]
Timestamp(時間戳)	0xF1	05A	9	Timestamp in μs

Note 1：Bytes 0-1: v[0] NWU: v[0]=N, v[1]=W, v[2]=U
Bytes 2-3: v[1] NED: v[0]=N, v[1]=E, v[2]=D
Bytes 4-5: v[2] ENU: v[0]=E, v[1]=N, v[2]=U

TABLE 4.2 DATA IDENTIFIER MAPPING

4.3 DATA PAYLOAD (EFFECTIVE PAYLOAD) / 數據位（有效負載）

本產品定義向前為 +X，向左為 +Y，向上為 +Z。旋轉方向遵循右手定則。角速度 [RX,RY,RZ]對應姿態[ROLL,PITCH,YAW]。
NOTE：資料傳輸以先高(BYTE)後低(BYTE)方式傳輸。

Category (數據類別)	標籤(Tag)	Field Members (欄位成員, e.g., Ax, Ay, Az)	長度 (Byte)	Notes (備註)
Reserved (保留位)	0xFF	-	1	固定值，供協議擴展
Accel (加速度)	0xA0	Ax, Ay, Az (各 2-byte)	1+6	單位：m/s^2
Gyro (角速度)	0xB0	Rx, Ry, Rz (各 2-byte)	1+6	單位：deg/s
Mag (磁場強度)	0xC0	Mx, My, Mz (各 2-byte)	1+6	單位：μT
Euler (歐拉角)	0xD0	Roll, Pitch, Yaw (各 2-byte)	1+6	單位：度 (°)
Quaternion (四元數)	0xD1	i, j, k, w (各 2-byte)	1+8	Dimensionless (無單位)
Temperature (溫度)	0xE0	攝氏溫度 (2-byte)	1+2	單位：°C
Pressure (氣壓)	0xE1	氣壓值 (4-byte)	1+4	單位:hPa
GNSS	0xF0	緯, 經, 高度, 地速, Vx、Vy、Vz、定位狀態, 衛星數	1+22	See Table 4.3.2
Timestamp (時間戳)	0xF1	timestamp_us(8-byte)	1+8	單位: μs;模組內部時間基準，非UTC/GNSS絕對時間

TABLE 4.3.1 MAIN PAYLOAD STRUCTURE (0XFF FULL FUNCTION PACKET)

Data	GNSS								
	標籤 (0xF0)	緯度 (Lat)	經度 (Lon)	高度 (Alt)	速度 x (Spd x)	速度 y (Spd y)	速度 Z (Spd Z)	定位狀態 (Fix)	衛星數 (Sat)
Byte	1	4	4	4	2	2	2	1	1

TABLE 4.3.2 GNSS

Data	Pressure (氣壓)	
	標籤 0xE1	氣壓值(hPa)
Byte	1	4

TABLE 4.3.3 PRESSURE

Data	Timestamp (時間戳)	
	標籤 0xF1	時間戳記(μs)
Byte	1	8

TABLE 4.3.4 TIMESTAMP

4.4 CHECKSUM CALCULATION / 校驗位 (校驗和)

CHECKSUM 是指從起始位加總至數據位末尾的所有位元組總和，並取其低位元組 (LOW BYTE)。

```
uint8_t get_Checksum(uint8_t *payload, uint8_t payload_length)
{
  register unsigned int sum = 0;
  uint8_t CheckSum;

  // 只加總到倒數第二個字節，排除 checksum 本身
  for (uint8_t index = 0; index < payload_length - 1; index++)
  {
    sum += (uint8_t)payload[index];
  }

  CheckSum = (uint8_t)(sum & 0xff);
  return CheckSum;
}
```

FIGURE 4.4 CHECKSUM CALCULATION CODE

4.5 EXAMPLE PACKET WALKTHROUGH / 舉例說明

- Interface / 接口類型：CAN / UART
- Baud Rate / 傳輸速率： Default 921600 bps (9600 to 921600 configurable)
- Output Rate / 輸出頻率： Default 100 Hz (25 to 100Hz configurable)
- Byte Order / 字節順序： BIG-ENDIAN (MSB First)

Byte Offset	Field Name	Content / Tag	Data Type	Byte Length	Description / Receiver Action
0	Start Byte	0xAA	uint8_t	1	Start of Data Frame Marker
1	Device ID	(ex: 0x81)	uint8_t	1	Sender Device ID
2	Data Length	L	uint8_t	1	Number of Valid Data Bytes (from the next byte up to the checksum)
--- Start of Valid Data (Payload, Length = L) ---					
3	Reserved	0xFF	uint8_t	1	The current version is fixed at 0xFF. The receiver should read and ignore this byte. It is reserved for future protocol extension.
4	Acceleration Tag	0xA0	uint8_t	1	
5	Acceleration X		int16_t	2	Acceleration X (m/s^2) = Raw × 0.00488
7	Acceleration Y		int16_t	2	Acceleration Y (m/s^2) = Raw × 0.00488
9	Acceleration Z		int16_t	2	Acceleration Z (m/s^2) = Raw × 0.00488
11	Angular Rate Tag	0xB0	uint8_t	1	
12	Angular Rate X		int16_t	2	Angular rate X (°/s) = Raw × 0.0153
14	Angular Rate Y		int16_t	2	Angular rate Y (°/s) = Raw × 0.0153
16	Angular Rate Z		int16_t	2	Angular rate Z (°/s) = Raw × 0.0153
18	Magnetic Field Tag	0xC0	uint8_t	1	
19	Magnetic Field X		int16_t	2	Magnetic field X (μT) = Raw × 0.1
21	Magnetic Field Y		int16_t	2	Magnetic field Y (μT) = Raw × 0.1
23	Magnetic Field Z		int16_t	2	Magnetic field Z (μT) = Raw × 0.1
25	Euler Angles Tag	0xD0	uint8_t	1	

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Byte Offset	Field Name	Content / Tag	Data Type	Byte Length	Description / Receiver Action
26	Roll		int16_t	2	Roll (°) = Raw × 0.0055
28	Pitch		int16_t	2	Pitch (°) = Raw × 0.0055
30	Yaw		int16_t	2	Yaw (°) = Raw × 0.0055
32	Quaternion Tag	0xD1	uint8_t	1	
33	Quaternion qx		int16_t	2	qx = Raw × 0.00006
35	Quaternion qy		int16_t	2	qy = Raw × 0.00006
37	Quaternion qz		int16_t	2	qz = Raw × 0.00006
39	Quaternion qw		int16_t	2	qw = Raw × 0.00006
41	Temperature Tag	0xE0	uint8_t	1	
42	Temperature		int16_t	2	Temperature (°C) = Raw × 0.01
44	Barometer Tag	0xE1	uint8_t	1	
45	Barometric Pressure		int32_t	4	Barometric Pressure (hpa) = Raw × 0.1
49	GNSS Tag	0xF0	uint8_t	1	
50	Latitude		int32_t	4	Latitude = RAW x 1e-7
54	Longitude		int32_t	4	Longitude = RAW x 1e-7
58	Altitude		int32_t	4	Altitude = RAW x 1e-7
62	Speed		int16_t	2	Speed = RAW x 0.01
64	Speed_x		int16_t	2	Speed_x = RAW x 0.01
66	Speed_y		int16_t	2	Speed_y = RAW x 0.01
68	Speed_Z		int16_t	2	Speed_Z = RAW x 0.01
70	Fix Status		uint8_t	1	0=無效, 1=GPS, 2=DGPS, 4=RTK Fixed...
71	Satellite Count		uint8_t	1	Number of Satellites Used for Positioning
72	Timestamp Tag	0xF1	uint8_t	1	Timestamp data identifier (時間戳資料標籤)
73	Timestamp		uint64_t	8	Timestamp (μs) = Raw
--- End of Valid Data (Payload) ---					
81(i.e., 3 + L)	Checksum		uint8_t	1	Checksum: Sum of all bytes from 0xAA to the last data byte.

TABLE 4.5.1 MEMORY MAP & DATA OFFSET

- 輸出數據單位:下表彙整了將原始整數數據轉換為工程單位所需的解析度/縮放比例。

Category (數據類別)	Output Unit (輸出單位)	Scale Factor (比例係數)
Quaternions (四元數)	Dimensionless (無)	0.00006
Euler Angles (歐拉角)	度 (°)	0.0055
Angular Rate (角速率)	度每秒(deg/s)	0.0153
Acceleration (加速度)	公尺/秒² (m/s²)	0.00488
Magnetic Field (磁場強度)	微特斯拉(μT)	0.1
Temperature (溫度)	攝氏度（℃）	0.01
GNSS Lat/Lon (經緯度)	度 (°)	1e-7

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Category (數據類別)	Output Unit (輸出單位)	Scale Factor (比例係數)
GNSS Altitude (高度)	公尺 (m)	0.01
GNSS Speed (速度)	公尺/秒 (m/s)	0.01
Pressure (氣壓)	百帕 (hPa)	0.01

TABLE 4.5.2 SCALE FACTOR

5. CONTROL COMMANDS / 控制命令

- Host端送出字串命令，命令要附加結束符號\r 或\n 或k，命令如下:

Category (功能分類)	Command (指令)	Description (設定說明)
Baud Rate (波特率)	UART1 ~ UART8	Set UART baud rate: 9600 to 921600 (Default 921600)
	CAN9 ~ CAN16	Set CAN baud rate: 10k to 1M bps
Output Rate (輸出頻率)	ODR2	Set output frequency to 25Hz
	ODR3	Set output frequency to 50Hz
	ODR4	Set output frequency to 100Hz (Default)
Output Format (輸出格式)	PRO1	AWAN binary / Default CAN output format
	PRO2	MAVLink output, auto-switch to UART8, fixed NED frame
	PRO3	NMEA0183 fused positioning output
	PRO4	UBX fused positioning output
	PRO5	DroneCAN output, auto-switch to CAN14, fixed NED frame
CAN ID 設定	CAN0x050	Set CAN Base ID, fixed Hex format
	RCAN	Read current CAN Base ID
GPS Management (GPS 輸入管理)	GPSA	Auto-select internal or external GPS signal
	GPSI	Force use of internal GPS module signal
	GPSE	Force use of external GPS / host UART RX signal
	RGPS	讀取 GPS input mode、目前來源與封包 age
Coordinate System (座標系)	FRM0	Set output coordinate system to NWU
	FRM1	Set output coordinate system to NED
	FRM2	Set output coordinate system to ENU
	RFRM	Read current coordinate system
Lever Arm (模組安裝偏移)	LVR,x,y,z	Set distance from CoM to module center, unit: m (Body frame)
	RLVR	Read current module offset
Antenna Offset (GPS 天線偏移)	GLVR,x,y,z	Set distance from IMU/INS to GPS antenna phase center, unit: m (Body frame)
	RGLVR	Read current GPS antenna offset
Fusion Control (感測融合控制)	FUSEON	Enable Magnetometer Fusion
	FUSEOFF	Disable Magnetometer Fusion

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Category (功能分類)	Command (指令)	Description (設定說明)
Mounting (安裝角補償)	MNT,r,p,y	Set mounting rotation compensation (Roll/Pitch/Yaw), unit: deg
	MNTZ	Auto level mounting roll/pitch
	MNTY,yaw	Set mounting yaw angle only, unit: deg
	CMNT	Clear mounting compensation settings
	RMNT	Read current mounting compensation settings
Relative Attitude (相對姿態)	ZRO	Set current attitude as temporary relative zero
	SZRO	Save the configured relative zero
	CZRO	Clear the saved relative zero
	RZRO	Read the saved relative zero
System (系統操作)	RESET	System Restart
	UPFM	Enter Firmware Update Mode
	CONFIG	Read current version, interface, and status
	STOP	Stop packet stream output
	STRT	Start packet stream output
	RPAR	Read full configuration parameters [Replaces original CONFIG command]

TABLE 5.1 CONTROL COMMAND SET

6. 解封包舉例說明 / DATA DECODING EXAMPLE

- Acceleration Z-Axis Data Decoding Example

The acceleration data is transmitted as a signed 16-bit two's-complement integer in big-endian byte order, with the most significant byte transmitted first.

The conversion formula is:

Acceleration Z (m/s^2) = Raw Acceleration Z × 0.00488

where 0.00488 m/s^2/LSB is the acceleration scale factor.

Example 1: Positive Acceleration

Assume that the two Accelerometer Z data bytes in the packet are:

07 D0

Because the data uses big-endian byte order:

Raw hexadecimal value = 0x07D0
Raw signed integer value = 2000

The physical acceleration is calculated as:

Acceleration Z = 2000 × 0.00488
= 9.76 m/s^2
≈ +0.995 g

Therefore:

07 D0 → +9.76 m/s^2 ≈ +0.995 g
Example 2: Negative Acceleration

Assume that the two Accelerometer Z data bytes in the packet are:

F8 30

Because the data uses big-endian byte order:

Raw hexadecimal value = 0xF830

The most significant bit is 1, indicating a negative value in signed 16-bit two's-complement format. The signed integer value is calculated as:

Raw signed integer value = 0xF830 − 0x10000
= 63536 − 65536
= −2000

The physical acceleration is calculated as:

Acceleration Z = −2000 × 0.00488
= −9.76 m/s^2
≈ −0.995 g

Therefore:

F8 30 → −9.76 m/s^2 ≈ −0.995 g

Note: The conversion between m/s^2 and g in the examples is based on 1 g = 9.80665 m/s^2.