Outdoor Environment Monitoring Sensor

Featuring LoRaWAN®

EM500 Series

Communication Protocol

Revision History

Date	Doc Version	Description
June 8, 2021	V 1.0	Initial version
July 13, 2021	V 1.1	Add Soil Moisture Definition
April 12, 2022	V 1.2	Add reboot downlink command
May 25, 2023	V 1.3	Add downlink commands, history enquiry and temperature mutation threshold feature

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1. Overview

EM500 Series use the standard Milesight IoT payload format based on IPSO. All data are based on following format:

Channel1	Type1	Data1	Channel2	Type2	Data2	Channel 3	...
1 Byte	1 Byte	N Bytes	1 Byte	1 Byte	M Bytes	1 Byte	...

Note:

1) All explanations and examples in this document are based on HEX format.
2) Data part uses little endian.
3) For all Milesight IoT product decoder examples please find files on https://github.com/Milesight-IoT/SensorDecoders

2. Uplink Payload

Uplink payloads of UC51x Series are made up of device information and sensor data.

2.1 Device Information

EM500 series report basic information of device whenever joining the network.

Channel	Type	Description
ff	01(Protocol Version)	01=>V1
	09 (Hardware Version)	01 40 => V1.4
	0a (Software Version)	01 14 => V1.14
	0b (Power On)	Device is on
	0f (Device Type)	00: Class A, 01: Class B, 02: Class C
	16 (Device SN)	16 digits

Example:

ff0101 ff090140 ff0a0114 ff166410908243750001					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
ff	01(Protocol Version)	01=>V1	ff	09 (Hardware Version)	01 40 => V1.4
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
ff	0a(Software Version)	01 14 => V1.14	ff	16 (Device SN)	6410908243750001

2.2 Sensor Data

EM500 series report different types of uplinks:

1. First sensor data packet after join: report battery level + sensor data
2. Periodic packet: report sensor data according to reporting interval (10 min by default)
3. Battery level packet: every 24 hours or when battery level is lower than 10%
4. Normal threshold alarm: report the sensor data which reaches the threshold

Sensor	Type ID (hex)	Data Type	Data Resolution	Model
Temperature	67	INT16	0.1 °C	EM500-PT100, EM500-SMTC, EM500-CO_2
Humidity	68	UINT8	0.5 %RH	EM500-CO_2,

				EM500-SMT/SMTC
Barometric Pressure	73	UINT16	0.1 hPa	EM500-CO_2
Battery	75	UINT8	1 %	All
Depth	77	INT16	1 cm	EM500-SWL
Pressure	7b	UINT16	1 kPa	EM500-PP
Concentration	7d	UINT16	1 ppm	EM500-CO_2
Conductivity	7f	UINT16	1 us/cm	EM500-SMTC
Distance	82	UINT16	1 mm	EM500-UDL
Light	94	UINT32	1 Lux	EM500-LGT
Soil Moisture	ca	UINT16	0.01%RH	EM500-SMT/SMTC

Examples:

EM500-CO_2

017564 03671001 046871 057d6704 06736827					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
01	75 (Battery)	64 => 100%	03	67 (Temperature)	10 01=>01 10 =272*0.1=27.2° C
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
04	68 (Humidity)	71=>113*0 .5=56.5%	05	7d (CO_2)	67 04 => 04 67 =1127 ppm
Channel	**Type**	**Data**			
06	73 (Barometric Pressure)	68 27=>27 68=10088* 0.1=1008. 8 hPa			

EM500-LGT

017564 039432870000					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
01	75 (Battery)	64 => 100%	03	94(Light)	32 87 00 00=> 00 00 87 32 =34610 Lux

EM500-PP

017564 037b0a00					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
01	75 (Battery)	64 => 100%	03	7b(Pressure)	0a 00=>00 0a =10 kPa

EM500-PT100

017564 0367faff					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
01	75 (Battery)	64 => 100%	03	67 (Temperature)	fa ff=>ff fa = -6*0.1= -0.6°C

EM500-SMT/SMTC

017564 03671001 04cad804 057ff000					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
01	75 (Battery)	64 => 100%	03	67 (Temperature)	10 01=>01 10 =272*0.1 =27.2°C
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
04	ca (Soil Moisture)	d8 04=>04 d8=1240 Hum=1240* 0.01=12.4%	05	7f (Conductivity)	f0 00 => 00 f0=240 μs/cm

Note: if hardware version is 1.x and firmware version is below 2.34, the soil moisture type ID is 68 and resolution is 0.5% RH.

EM500-SWL

017564 03770200					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
01	75 (Battery)	64 => 100%	03	77(Depth)	02 00=>00 02 =2 cm

EM500-UDL

017564 03821e00					
Channel	**Type**	**Data**	**Channel**	**Type**	**Data**
01	75 (Battery)	64 => 100%	03	82(Distance)	1e 00=>00 1e =30 mm

2.3 Temperature Mutation Threshold

EM500-CO2/PT100/SMTC supports to report temperature mutation threshold alarm which has a different format with normal threshold alarm.

Channel	Type	Description
83	d7 (Mutation Threshold Alarm)	Temperature(2B) + Mutation Value(2B) + 02

Example:

1. Normal Temperature Threshold Alarm Packet

03675201 01		
Channel	**Type**	**Value**
03	67 (Temperature)	52 01 => 01 52 => 338*0.1 = 33.8°C

2. Temperature Mutation Alarm Packet

83d722010c0002		
Channel	**Type**	**Value**
83	d7 (Temperature Mutation Threshold)	Temperature: 22 01 => 01 22 => 290*0.1 = 29°C Mutation Value: 0c 00 => 00 0c => 12*0.1=1.2°C 02 => Mutation Alarm

3. Downlink Command

Downlink is used for controlling the EM500 via network server remotely. Downlink port (Application port) is 85 by default and can be configured via ToolBox.

Note: only device with hardware V2.x and later supports below commands.

Channel	Type	Description
ff	03 (Reporting Interval)	2 Bytes, unit: s
	10 (Reboot)	ff (Reserved)

	17 (Time Zone)	2 Bytes, UTC timezone * 10
	18 (Sensor Collection)	Sensor Type (1B) + Status (1B) Status: 00: disable, 01: enable EM500-CO2 Sensor Type: 00: all 01: temperature 02: humidity 05: CO_2 06: barometric pressure EM500-SMTC Sensor Type: 00: all 01: temperature 02: moisture 03: electric conductivity
	1a (CO_2 Calibration)	00: Factory Calibration Restored 03: Manual Calibration
	39 (CO_2 Auto Background Calibration)	5 Bytes, **Byte 1:** 00-disable, 01-enable **Bytes 2-5:** b4009001
	68 (Data Storage)	00: disable, 01: enable
	69 (Data Retransmission)	00: disable, 01: enable
	6a (Data Retransmission Interval)	3 Bytes Byte 1: 00 Byte 2-3: interval time, unit:s range: 30~1200s (600s by default)

Example:

1. Configure Reporting Interval as 20 mins

ff 03 b0 04		
Channel	**Type**	**Data**
ff	03(Set Reporting Interval)	b0 04 => 04 b0 = 1200s=20 mins

2. Reboot the device.

ff10ff		
Channel	**Type**	**Value**
ff	10 (Reboot)	ff (Reserved)

3. Set the time zone as UTC-2.

ff17ecff		
Channel	**Type**	**Value**
ff	17	ec ff => ff ec = -20 the time zone is UTC-2

4. Disable humidity collection of EM500-CO_2 sensor.

ff180200		
Channel	**Type**	**Value**
ff	18	02=Humidity, 00=Disable

4. Historical Data Enquiry

EM500 series support sending downlink commands to enquire historical data for specified time point or time range. Before that, ensure the device time is correct and data storage feature was enabled to store the data.

Command format:

Channel	Type	Description
fd	6b (Enquire data in time point)	4 Bytes, unix timestamp
fd	6c (Enquire data in time range)	Start time (4 bytes) + End time (4 bytes), Unix timestamp
fd	6d (Stop query data report)	ff
ff	6a (Report Interval)	3 Bytes Byte 1: 01 Byte 2-3: interval time, unit:s range: 30~1200s (60s by default)

Reply format:

Channel	Type	Description
fc	6b/6c	00: data enquiry success 01: time point or time range invalid 02: no data in this time or time range
20	ce (Historical Data)	Data time stamp (4 Bytes) + Data (Mutable)

Data format:

Sensor	Description
EM500-CO_2	CO_2 (2B) + Pressure (2B) + Temperature (2B) + Humidity (1B)
EM500-LGT	Light (4B)
EM500-PP	Pressure (2B)
EM500-PT100	Temperature (2B)
EM500-SMT	Moisture(2B)
EM500-SMTC	Electric Conductivity (2B) + Temperature (2B) + Moisture(2B)
EM500-SWL	Depth (2B)
EM500-UDL	Distance (2B)

Note:

1. The device only uploads no more than 300 data records per range enquiry.
2. When enquiring the data in time point, it will upload the data which is closest to the search point within the reporting interval range. For example, if the device reporting interval is 10 minutes and users send command to search for 17:00's data, if the device find there is data stored in 17:00, it will upload this data; if not, it will search for data between 16:50 to 17:10 and upload the data which is closest to 17:00.

Example:

1. Enquire historical data between 2023/03/09 17:00:00 to 2023/03/09 17:10:40.

fd6c 2cc26164 84c46164		
Channel	**Type**	**Value**
fd	6c (Enquire data in time range)	Start time: 2cc26164 => 6461c22c = 1684128300 =2023/05/15 13:25:00 End time: 84c46164 => 6461c484 = 1684128900 =2023/05/15 13:35:00

Reply:

fc6c00		
Channel	**Type**	**Value**
fc	6c (Enquire data in time range)	00: data enquiry success

20ce b1c36164 c9036427010175			
Channel	**Type**	**Time Stamp**	**Value**
20	ce (Historical Data)	b1c36164 => 6461c3b1=2023/05/15 13:31:00	CO2: c9 03 => 03 c9 = 969ppm Pressure: 64 27 => 2764=10084*0.1=1008.4 hPa

			Temperature: 0101=>101=257*0.1=25.7°C Humidity: 75=>117*0.5=58.5%

-END-