# 磁場感應器 MTC-100 資料格式之逆向工程筆記

MTC-100 SERIES SENSORS Data Format Reverse Engineering Notes

支援產品型號:

## MTC-185

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版本: v20241002a

# 更新紀錄:

| 日期 | 版本 | 說明 |
|------|------|------|
| 2024-10-02 | v20241002a | 初版 |

# 更新紀錄:

## 說明:

MTC-100 系列磁場感應器是 Phoenix Geophysics 販售的磁場感應器，主要應用在大地電磁法研究中。其磁場感應器之頻率響應資訊儲存在*.scal 檔案中。可使用原廠已授權之分析軟體 EMPower 將其資訊輸出，但在未授權情況下僅可瀏覽其響應曲線及相關資料但不可輸出。該軟體僅支援圖形化介面之應用程式，可安裝在 Windows、Linux、MacOS 等作業系統中，但無法在終端機模式下運行。

為了能在網頁伺服器、瀏覽器、終端機的環境下取得頻率響應資料，在原廠不提供資料格式文件的情況下，嘗試利用逆向工程技術了解資料儲存機制以利移植輸出功能至可運行在目標環境之程式語言中。

目前依照 EMPower 輸出之結果，推測目前逆向工程的目標檔案為格式 v1.0。

```
"file_version": "1.0"
```

目前針對磁場感應器型號為 MTC-185

範例檔案 binary 值(版本 v1.0):

| Position(0=start) | Binary Value(0~255) | Value | Description |
|---|---|---|---|
| 0 | 5 | | Unknown |
| 1 | 7 | | Unknown |
| 2 | 0 | | Unknown |
| 3 | 1 | | Unknown |
| 4 | 238 | 64F0A5EE | 運行校正工作的起始 GPS 時間 (32-bit unsigned hexadecimal label indicating the GPS timestamp of the start time of the recording, which along with the serial number, makes a unique ID for the recording. This timestamp is Unix-epoch based, but uses GPS time instead of GMT time as its base. Note that for time series with versions previous to 4 (before instrument firmware v2.0), this timestamp was one second behind the real GPS time due to an issue between the GPS chip hardware and its driver. Raw time series version 4 and up have the correct timestamp.) |
| 5 | 165 | | |
| 6 | 240 | | |
| 7 | 100 | | |
| 8 | 49 | 10291 | 運行校正工作的主機序號 (char[]) |
| 9 | 48 | | |
| 10 | 50 | | |

範例檔案 binary 值(版本 v1.0):

| | | | |
|---|---|---|---|
| 11 | 57 | | (Instrument serial numbe, Example: 99999 (Last two characters should be filled with null chars)) |
| 12 | 49 | | |
| 13 | 0 | | |
| 14 | 0 | | |
| 15 | 0 | | |
| 16 | 0 | | Unknown |
| 17 | 0 | | Unknown |
| 18 | 4 | MTU-8A | 主機類型? (uns. Byte) (instrument_type 0=MTU-8A,1=MTU-5C,2=MTU-5D,3=MTU-2C,4=MTU-8A,5=RXU-8A,6=RXU-8,7=MTU-8,8=TXD-1) |
| 19 | 48 | 0319CA | Unknown Char[]? |
| 20 | 51 | | |
| 21 | 49 | | |
| 22 | 57 | | |
| 23 | 67 | | |
| 24 | 65 | | |
| 25 | 0 | | |
| 26 | 0 | | |
| 27 | 0 | | Unknown |
| 28 | 0 | | Unknown |
| 29 | 66 | BTM01-I | Unknown Char[]? |
| 30 | 84 | | |
| 31 | 77 | | |
| 32 | 48 | | |
| 33 | 49 | | |
| 34 | 45 | | |
| 35 | 73 | | |
| 36 | 32 | | |
| 37 | 0 | | |
| 38 | 0 | | |
| 39 | 50 | 2CF5 | Unknown Char[]? |
| 40 | 67 | | |

| | | | |
|---|---|---|---|
| 41 | 70 | | |
| 42 | 53 | | |
| 43 | 0 | | |
| 44 | 0 | | |
| 45 | 0 | | |
| 46 | 0 | | |
| 47 | 0 | | Unknown |
| 48 | 0 | | Unknown |
| 49 | 48 | 00010034X | Unknown Char[]? |
| 50 | 48 | | |
| 51 | 48 | | |
| 52 | 49 | | |
| 53 | 48 | | |
| 54 | 48 | | |
| 55 | 51 | | |
| 56 | 52 | | |
| 57 | 88 | | |
| 58 | 0 | | |
| 59 | 53 | 53495 | 磁場感應器序號 (char[]) (sensor_serial, Example: 99999 (Last two characters should be filled with null chars)) |
| 60 | 51 | | |
| 61 | 52 | | |
| 62 | 57 | | |
| 63 | 53 | | |
| 64 | 0 | | |
| 65 | 0 | | |
| 66 | 0 | | |
| 67 | 0 | | Unknown |
| 68 | 0 | | Unknown |
| 69 | 77 | MTC-185 | 磁場感應器類型 (char[]) |
| 70 | 84 | | |
| 71 | 67 | | |
| 72 | 45 | | |
| 73 | 49 | | |
| 74 | 56 | | |
| 75 | 53 | | |
| 76 | 0 | | |
| 77 | 0 | | Unknown |

| 78 | 0 | : | Unknown |
|---|---|---|---|
| 79 | 85 | UNK_HWV | Unknown Char[]? |
| 80 | 78 | | |
| 81 | 75 | | |
| 82 | 95 | | |
| 83 | 72 | | |
| 84 | 87 | | |
| 85 | 86 | | |
| 86 | 0 | | |
| 87 | 0 | | Unknown |
| 88 | 0 | | Unknown |
| 89 | 85 | UNK_FWV | Unknown Char[]? |
| 90 | 78 | | |
| 91 | 75 | | |
| 92 | 95 | | |
| 93 | 70 | | |
| 94 | 87 | | |
| 95 | 86 | | |
| 96 | 0 | | |
| 97 | 0 | | Unknown |
| 98 | 0 | | Unknown |
| 99 | 70 | FP_XYZ | Unknown Char[]? |
| 100 | 80 | | |
| 101 | 95 | | |
| 102 | 88 | | |
| 103 | 89 | | |
| 104 | 90 | | |
| 105 | 0 | | |
| 106 | 0 | | |
| 107 | 0 | | Unknown |
| 108 | 0 | | Unknown |
| 109 | 2 | | Unknown |
| 110 | 0 | | 評分幾顆星 (uns. Byte) (0=☆ ，  1=☆☆  ， 2=☆☆☆，3=☆☆☆☆， 4=☆☆☆☆☆) |

| | | | |
|---|---|---|---|
| 111 | 128 | 43.83544921875000 | 運行校正工作的位置 GPS 緯度 GPS Latitude [degrees] (float32, WGS84) |
| 112 | 87 | | |
| 113 | 47 | | |
| 114 | 66 | | |
| 115 | 209 | -79.11292266845703 | 運行校正工作的位置 GPS 經度 GPS Longitude [degrees] (float32, WGS84) |
| 116 | 57 | | |
| 117 | 158 | | |
| 118 | 194 | | |
| 119 | 124 | 69.63375854492188 | 運行校正工作的位置 GPS 高程 GPS Elevation Above Mean Sea Level [m] (float32, WGS84) |
| 120 | 68 | | |
| 121 | 139 | | |
| 122 | 66 | | |
| 123 | 0 | | Unknown |
| 124 | 0 | | Unknown |
| 125 | 82 | RMT05 | Unknown Char[]? |
| 126 | 77 | | |
| 127 | 84 | | |
| 128 | 48 | | |
| 129 | 53 | | |
| 130 | 0 | | |
| 131 | 0 | | Unknown |
| 132 | 0 | | Unknown |
| 133 | 32 | | Unknown |
| 134 | 33 | | Unknown |
| 135 | 64 | | Unknown |
| 136 | 6 | | Unknown |
| 137 | 0 | | Unknown |
| 138 | 0 | | Unknown |
| 139 | 0 | | Unknown |
| 140 | 0 | | Unknown |
| 141 | 0 | | Unknown |
| 142 | 0 | | Unknown |
| 143 | 0 | | Unknown |
| 144 | 2 | | Unknown |
| 145 | 16 | | Unknown |

| 146 | 0 | | Unknown |
| --- | --- | --- | --- |
| 147 | 0 | | Unknown |
| 148 | 0 | | Unknown |
| 149 | 0 | | Unknown |
| 150 | 0 | | Unknown |
| 151 | 0 | | Unknown |
| 152 | 0 | | Unknown |
| 153 | 0 | | Unknown |
| 154 | 0 | | Unknown |
| 155 | 0 | | Unknown |
| 156 | 0 | | Unknown |
| 157 | 0 | | Unknown |
| 158 | 0 | | Unknown |
| 159 | 0 | | Unknown |
| 160 | 0 | | Unknown |
| 161 | 0 | | Unknown |
| 162 | 0 | | Unknown |
| 163 | 0 | | Unknown |
| 164 | 0 | | Unknown |
| 165 | 0 | | Unknown |
| 166 | 0 | | Unknown |
| 167 | 0 | | Unknown |
| 168 | 0 | | Unknown |
| 169 | 0 | | Unknown |
| 170 | 0 | | Unknown |
| 171 | 0 | | Unknown |
| 172 | 0 | | Unknown |
| 173 | 0 | | Unknown |
| 174 | 0 | | Unknown |
| 175 | 0 | | Unknown |
| 176 | 0 | | Unknown |
| 177 | 0 | | Unknown |
| 178 | 0 | | Unknown |
| 179 | 0 | | Unknown |
| 180 | 0 | | Unknown |
| 181 | 0 | | Unknown |
| 182 | 0 | | Unknown |

| | | | |
|---|---|---|---|
| 183 | 0 | | Unknown |
| 184 | 0 | | Unknown |
| 185 | 0 | | Unknown |
| 186 | 0 | | Unknown |
| 187 | 0 | | Unknown |
| 188 | 0 | | Unknown |
| 189 | 0 | | Unknown |
| 190 | 0 | | Unknown |
| 191 | 0 | | Unknown |
| 192 | 0 | | Unknown |
| 193 | 0 | | Unknown |
| 194 | 0 | | Unknown |
| 195 | 0 | | Unknown |
| 196 | 0 | | Unknown |
| 197 | 0 | | Unknown |
| 198 | 0 | | Unknown |
| 199 | 0 | | Unknown |
| 200 | 0 | | Unknown |
| 201 | 0 | | Unknown |
| 202 | 62 | | Unknown |
| 203 | 64 | | Unknown |
| 204 | 1 | | Unknown |
| 205 | 0 | | Unknown |
| 206 | 0 | | Unknown |
| 207 | 0 | | Unknown |
| 208 | 0 | | Unknown |
| 209 | 0 | | Unknown |
| 210 | 0 | | Unknown |
| 211 | 0 | | Unknown |
| 212 | 0 | | Unknown |
| 213 | 0 | | Unknown |
| 214 | 0 | | Unknown |
| 215 | 0 | | Unknown |
| 216 | 0 | | Unknown |
| 217 | 0 | | Unknown |
| 218 | 0 | | Unknown |
| 219 | 0 | | Unknown |

| 220 | 0 | | Unknown |
|---|---|---|---|
| 221 | 0 | | Unknown |
| 222 | 0 | | Unknown |
| 223 | 0 | | Unknown |
| 224 | 0 | | Unknown |
| 225 | 0 | | Unknown |
| 226 | 0 | | Unknown |
| 227 | 0 | | Unknown |
| 228 | 0 | | Unknown |
| 229 | 0 | | Unknown |
| 230 | 0 | | Unknown |
| 231 | 0 | | Unknown |
| 232 | 0 | | Unknown |
| 233 | 0 | | Unknown |
| 234 | 0 | | Unknown |
| 235 | 0 | | Unknown |
| 236 | 124 | | Unknown |
| 237 | 232 | | Unknown |
| 238 | 228 | | Unknown |
| 239 | 190 | | Unknown |
| 240 | 200 | | Unknown |
| 241 | 126 | | Unknown |
| 242 | 178 | | Unknown |
| 243 | 0 | | Unknown |
| 244 | 120 | | Unknown |
| 245 | 126 | | Unknown |
| 246 | 178 | | Unknown |
| 247 | 0 | | Unknown |
| 248 | 144 | | Unknown |
| 249 | 233 | | Unknown |
| 250 | 228 | | Unknown |
| 251 | 190 | | Unknown |
| 252 | 76 | | Unknown |
| 253 | 233 | | Unknown |
| 254 | 1 | | Unknown |
| 255 | 0 | | Unknown |
| 256 | 48 | 0313ED | Unknown |

| 257 | 51 | | Char[]? |
|---|---|---|---|
| 258 | 49 | | |
| 259 | 51 | | |
| 260 | 69 | | |
| 261 | 68 | | |
| 262 | 0 | | |
| 263 | 0 | | |
| 264 | 0 | | Unknown |
| 265 | 0 | | Unknown |
| 266 | 66 | BCM01-K | Unknown Char[]? |
| 267 | 67 | | |
| 268 | 77 | | |
| 269 | 48 | | |
| 270 | 49 | | |
| 271 | 45 | | |
| 272 | 75 | | |
| 273 | 32 | | |
| 274 | 0 | | |
| 275 | 0 | | Unknown |
| 276 | 0 | | Unknown |
| 277 | 48 | 001001FX | Unknown Char[]? |
| 278 | 48 | | |
| 279 | 49 | | |
| 280 | 48 | | |
| 281 | 48 | | |
| 282 | 49 | | |
| 283 | 70 | | |
| 284 | 88 | | |
| 285 | 0 | | |
| 286 | 72 | H3 | Unknown Char[]? |
| 287 | 51 | | |
| 288 | 0 | | |
| 289 | 0 | | |
| 290 | 0 | | Unknown |
| 291 | 0 | | Unknown |
| 292 | 0 | | Unknown |
| 293 | 0 | | Unknown |

| | | | |
|---|---|---|---|
| 294 | 0 | | Unknown |
| 295 | 0 | | Unknown |
| 296 | 0 | | Unknown |
| 297 | 0 | | Unknown |
| 298 | 0 | | Unknown |
| 299 | 0 | | Unknown |
| 300 | 0 | | Unknown |
| 301 | 0 | | Unknown |
| 302 | 0 | | Unknown |
| 303 | 0 | | Unknown |
| 304 | 0 | | Unknown |
| 305 | 0 | | Unknown |
| 306 | 0 | | Unknown |
| 307 | 0 | | Unknown |
| 308 | 0 | | Unknown |
| 309 | 0 | | Unknown |
| 310 | 0 | | Unknown |
| 311 | 0 | | Unknown |
| 312 | 0 | | Unknown |
| 313 | 0 | | Unknown |
| 314 | 0 | | Unknown |
| 315 | 0 | | Unknown |
| 316 | 0 | | Unknown |
| 317 | 0 | | Unknown |
| 318 | 0 | | Unknown |
| 319 | 0 | | Unknown |
| 320 | 0 | | Unknown |
| 321 | 0 | | Unknown |
| 322 | 0 | | Unknown |
| 323 | 0 | | Unknown |
| 324 | 0 | | Unknown |
| 325 | 0 | | Unknown |
| 326 | 0 | | Unknown |
| 327 | 1 | | Unknown |
| 328 | 0 | | Unknown |
| 329 | 0 | | Unknown |
| 330 | 19 | | Unknown |

| 331 | 0 | | Unknown |
|---|---|---|---|
| 332 | 0 | | Unknown |
| 333 | 0 | | Unknown |
| 334 | 0 | | Unknown |
| 335 | 128 | | Unknown |
| 336 | 0 | | Unknown |
| 337 | 0 | | Unknown |
| 338 | 0 | | Unknown |
| 339 | 75 | | 校正資訊數量 (uns. Byte) (num_records) |
| 340 | 0 | 10240 | 校正資訊的頻率#01 [Hz] (freq_Hz, float32, #01) |
| 341 | 0 | | |
| 342 | 32 | | |
| 343 | 70 | | |
| 344 | 121 | -0.69325977563858 | 校正資訊的實部#01 [mV/nT] (real part, float32, #01) |
| 345 | 121 | | |
| 346 | 49 | | |
| 347 | 191 | | |
| 348 | 124 | -26.37035369873047 | 校正資訊的虛部#01 [mV/nT] (imaginary part, float32, #01) |
| 349 | 246 | | |
| 350 | 210 | | |
| 351 | 193 | | |
| 352 | 176 | | Unknown |
| 353 | 180 | | Unknown |
| 354 | 178 | | Unknown |
| 355 | 0 | | Unknown |
| 356 | 2 | | Unknown |
| 357 | 0 | | Unknown |
| 358 | 0 | | Unknown |
| 359 | 0 | | Unknown |
| 360 | 143 | | Unknown |
| 361 | 194 | | Unknown |
| 362 | 117 | | Unknown |
| 363 | 62 | | Unknown |
| 364 | 94 | | Unknown |
| 365 | 11 | | Unknown |

| 366 | 125 | | Unknown |
|---|---|---|---|
| 367 | 65 | | Unknown |
| 368 | 189 | | Unknown |
| 369 | 201 | | Unknown |
| 370 | 92 | | Unknown |
| 371 | 65 | | Unknown |
| 372 | 0 | 9600 | 校正資訊的頻率#02 [Hz] (freq_Hz, float32, #02) |
| 373 | 0 | | |
| 374 | 22 | | |
| 375 | 70 | | |
| 376 | 11 | 1.44833505153656 | 校正資訊的實部#02 [mV/nT] (real part, float32, #02) |
| 377 | 99 | | |
| 378 | 185 | | |
| 379 | 63 | | |
| 380 | 156 | -26.94707489013672 | 校正資訊的虛部#02 [mV/nT] (imaginary part, float32, #02) |
| 381 | 147 | | |
| 382 | 215 | | |
| 383 | 193 | | |
| 384 | 176 | | Unknown |
| 385 | 180 | | Unknown |
| 386 | 178 | | Unknown |
| 387 | 0 | | Unknown |
| 388 | 2 | | Unknown |
| 389 | 0 | | Unknown |
| 390 | 0 | | Unknown |
| 391 | 0 | | Unknown |
| 392 | 143 | | Unknown |
| 393 | 194 | | Unknown |
| 394 | 117 | | Unknown |
| 395 | 62 | | Unknown |
| 396 | 94 | | Unknown |
| 397 | 11 | | Unknown |
| 398 | 125 | | Unknown |
| 399 | 65 | | Unknown |
| 400 | 189 | | Unknown |
| 401 | 201 | | Unknown |
| 402 | 92 | | Unknown |

| | | | |
|---|---|---|---|
| 403 | 65 | | Unknown |
| 404 | 0 | 9216 | 校正資訊的頻率#03 |
| 405 | 0 | | [Hz] |
| 406 | 16 | | (freq_Hz, float32,#03) |
| 407 | 70 | | |
| 408 | 82 | 2.86708498001099 | 校正資訊的實部#03 |
| 409 | 126 | | [mV/nT] |
| 410 | 55 | | (real part, float32, #03) |
| 411 | 64 | | |
| 412 | 16 | -27.19192504882813 | 校正資訊的虛部#03 |
| 413 | 137 | | [mV/nT] |
| 414 | 217 | | (imaginary part, |
| 415 | 193 | | float32, #03) |
| 416 | 176 | | Unknown |
| 417 | 180 | | Unknown |
| 418 | 178 | | Unknown |
| 419 | 0 | | Unknown |
| 420 | 2 | | Unknown |
| 421 | 0 | | Unknown |
| 422 | 0 | | Unknown |
| 423 | 0 | | Unknown |
| 424 | 143 | | Unknown |
| 425 | 194 | | Unknown |
| 426 | 117 | | Unknown |
| 427 | 62 | | Unknown |
| 428 | 94 | | Unknown |
| 429 | 11 | | Unknown |
| 430 | 125 | | Unknown |
| 431 | 65 | | Unknown |
| 432 | 189 | | Unknown |
| 433 | 201 | | Unknown |
| 434 | 92 | | Unknown |
| 435 | 65 | | Unknown |
| … | … | … | … |
| 2676 | 171 | 1e-05 | 校正資訊的頻率#74 |
| 2677 | 197 | | [Hz] |
| 2678 | 39 | | (freq_Hz, float32,#74) |

| | | | |
|---|---|---|---|
| 2679 | 55 | | |
| 2680 | 136 | 0.00000006871147 | 校正資訊的實部#74 [mV/nT] (real part, float32, #74) |
| 2681 | 142 | | |
| 2682 | 147 | | |
| 2683 | 51 | | |
| 2684 | 42 | 0.00142801296897 | 校正資訊的虛部#74 [mV/nT] (imaginary part, float32, #74) |
| 2685 | 44 | | |
| 2686 | 187 | | |
| 2687 | 58 | | |
| 2688 | 0 | | Unknown |
| 2689 | 0 | | Unknown |
| 2690 | 0 | | Unknown |
| 2691 | 0 | | Unknown |
| 2692 | 8 | | Unknown |
| 2693 | 123 | | Unknown |
| 2694 | 178 | | Unknown |
| 2695 | 0 | | Unknown |
| 2696 | 0 | | Unknown |
| 2697 | 0 | | Unknown |
| 2698 | 0 | | Unknown |
| 2699 | 0 | | Unknown |
| 2700 | 0 | | Unknown |
| 2701 | 0 | | Unknown |
| 2702 | 0 | | Unknown |
| 2703 | 0 | | Unknown |
| 2704 | 0 | | Unknown |
| 2705 | 0 | | Unknown |
| 2706 | 0 | | Unknown |
| 2707 | 0 | | Unknown |
| 2708 | 188 | 8e-06 | 校正資訊的頻率#75 [Hz] (freq_Hz, float32,#75) |
| 2709 | 55 | | |
| 2710 | 6 | | |
| 2711 | 55 | | |
| 2712 | 121 | 0.00000004393812 | 校正資訊的實部#75 [mV/nT] (real part, float32, #75) |
| 2713 | 182 | | |
| 2714 | 60 | | |
| 2715 | 51 | | |

| | | | |
|---|---|---|---|
| 2716 | 238 | 0.00114241032861 | 校正資訊的虛部#75 [mV/nT] (imaginary part, float32, #75) |
| 2717 | 188 | | |
| 2718 | 149 | | |
| 2719 | 58 | | |
| 2720 | 0 | | |
| 2721 | 0 | | |
| 2722 | 0 | | |
| 2723 | 0 | | |
| 2724 | 8 | | |
| 2725 | 123 | | |
| 2726 | 178 | | |
| 2727 | 0 | | |
| 2728 | 0 | | |
| 2729 | 0 | | |
| 2730 | 0 | | |
| 2731 | 0 | | |
| 2732 | 0 | | |
| 2733 | 0 | | |
| 2734 | 0 | | |
| 2735 | 0 | | |
| 2736 | 0 | | |
| 2737 | 0 | | |
| 2738 | 0 | | |
| 2739 | 0 | | |

Matlab 範例程式碼

```matlab
%*************************************************************************
%    Name: MTC100_SCAL_read_example_v20241002a.m
%    Copyright:
%    Author: HsiupoYeh
%    Version: v20241002a
%    Description: example code for PHOENIX MTU-185 *.scal file read
%    REF: MTC-100_SERIES_SENSORS_DataFormat_Reverse_Engineering_Notes_v20241002a.pdf
%*************************************************************************
clear;clc;close all
%============================
% Input FileName
SCAL.FileName='53495_64F0A5EE.scal';
disp(['Input SCAL FileName = ',SCAL.FileName])
%--
% read all the binary data to buffer
f1=fopen(SCAL.FileName);
temp_data=fread(f1);
fclose(f1);
%--
% get FileSize
SCAL.FileSize.Header={'[Bytes]'};
SCAL.FileSize.Data=length(temp_data);
disp(['Input SCAL FileSize = ',num2str(SCAL.FileSize.Data), ' [Bytes]'])
%--
% get NumberOfRecords
SCAL.NumberOfRecords.Header={'[Count]'};
SCAL.NumberOfRecords.Data=temp_data(340);
disp(['Input SCAL NumberOfRecords = ',num2str(SCAL.NumberOfRecords.Data), ' [Count]'])
%--
% double check FileSize
if (SCAL.FileSize.Data == 340+SCAL.NumberOfRecords.Data*32)
    disp('double check FileSize : PASS')
else
    disp('double check FileSize : FAIL')
    return
end
%============================
```

```matlab
disp('--')
%=============================
% get important information & Data
%--
SCAL.GPSTimestampHexString=sprintf('%X%X%X%X%X',temp_data(8),temp_data(7),temp_data(6),temp_data(5));
% --
% Instrument_Serial
SCAL.Instrument_Serial=char(temp_data(9:16)');
SCAL.Instrument_Serial=strrep(SCAL.Instrument_Serial,char(0),'');
%--
% Sensor_Serial
SCAL.Sensor_Serial=char(temp_data(60:67)');
SCAL.Sensor_Serial=strrep(SCAL.Sensor_Serial,char(0),'');
%--
% Sensor_Type
SCAL.Sensor_Type=char(temp_data(70:77)');
SCAL.Sensor_Type=strrep(SCAL.Sensor_Type,char(0),'');
%--
% GPSLatitude
SCAL.GPSLatitude.Header={'[degrees]'};
SCAL.GPSLatitude.Data=double(typecast(uint8(temp_data(112:115)),'single'));
%--
% GPSLongitude
SCAL.GPSLongitude.Header={'[degrees]'};
SCAL.GPSLongitude.Data=double(typecast(uint8(temp_data(116:119)),'single'));
%--
% GPSElevationAboveMeanSeaLevel
SCAL.GPSElevationAboveMeanSeaLevel.Header={'[m]'};
SCAL.GPSElevationAboveMeanSeaLevel.Data=double(typecast(uint8(temp_data(120:123)),'single'));
%--
temp_Freq_array=zeros(SCAL.NumberOfRecords.Data,1);
temp_Real_array=zeros(SCAL.NumberOfRecords.Data,1);
temp_Imag_array=zeros(SCAL.NumberOfRecords.Data,1);
temp_Magnitude_array=zeros(SCAL.NumberOfRecords.Data,1);
temp_PhaseInDegrees_array=zeros(SCAL.NumberOfRecords.Data,1);
%--
first_freq_index=341;
```

```matlab
for i=1:SCAL.NumberOfRecords.Data
    temp_Freq_array(i)=typecast(uint8(temp_data(first_freq_index:first_freq_index+3)),'single');
    temp_Real_array(i)=typecast(uint8(temp_data(first_freq_index+4:first_freq_index+4+3)),'single');
    temp_Imag_array(i)=typecast(uint8(temp_data(first_freq_index+8:first_freq_index+8+3)),'single');
    temp_Magnitude_array(i)=abs(complex(temp_Real_array(i),temp_Imag_array(i)));
    temp_PhaseInDegrees_array(i)=angle(complex(temp_Real_array(i),temp_Imag_array(i)))*180/pi;
    first_freq_index=first_freq_index+32;
end
%--
SCAL.FrequencyResponse.Header={'Frequency[Hz]',    'Real    Part[mV/nT]',    'Imaginary    Part[mV/nT]',
'Magnitude[mV/nT]', 'Phase[degrees]'};
SCAL.FrequencyResponse.Data=[temp_Freq_array,temp_Real_array,temp_Imag_array,temp_Magnitude_array,temp_PhaseInDegrees_array];
%=============================
%=============================
% Show important information & Data
%--
disp('Calibration Infomation:')
disp(['Sensor Type = ',SCAL.Sensor_Type])
disp(['Sensor Serial = ',SCAL.Sensor_Serial])
%------------------------------------------------------------------
% convert to datetime
%--
% UNIX time
JulianDate_datetime=datenum(1970,1,1,0,0,0);
%--
% elapsed_time_in_seconds
elapsed_time_in_seconds=hex2dec(SCAL.GPSTimestampHexString);
%--
% get GPS +00:00 time
GPS_date_str=datestr(JulianDate_datetime+elapsed_time_in_seconds/86400,'yyyy-mm-dd HH:MM:SS');
disp(['Timestamps(GPS) = ',GPS_date_str,' (GPS +00:00)'])
%--
% get GPS +08:00 time
GPS_date_plus8_str=datestr(JulianDate_datetime+elapsed_time_in_seconds/86400+3600*8/86400,'yyyy-mm-dd HH:MM:SS');
disp(['Timestamps(GPS) = ',GPS_date_plus8_str,' (GPS +08:00)'])
%------------------------------------------------------------------
```

```matlab
disp(['Receiver Serial = ',SCAL.Instrument_Serial])
disp(['Latitude[degrees] = ',sprintf('%.14f',SCAL.GPSLatitude.Data)])
disp(['Longitude[degrees] = ',sprintf('%.14f',SCAL.GPSLongitude.Data)])
disp(['Altitude[m] = ',sprintf('%.14f',SCAL.GPSElevationAboveMeanSeaLevel.Data)])
%--
disp('--')
%--
fprintf('%s,%s,%s,%s,%s\n',SCAL.FrequencyResponse.Header{:})
fprintf('%16.13f,%16.10f,%16.10f,%16.10f,%16.10f\n',SCAL.FrequencyResponse.Data')
disp('--')
%=============================
```