



1 INTRODUCTION

GNS-Electronics, developer and manufacturer of module solutions for over 25 years, presents the new GNS5894 ADS-B module for 1090MHz "Virtual Radar" monitoring.

The high-dynamic signal processing circuit allows seamless ADS-B reception from near field to wide range.

The module integrates a sensitive RF frontend, signal processing, a high speed data decoder and an output UART that can be easily connected to a host processor.

GNS5894 features a DSP-based hybrid reception algorithm that eliminates the so called "doughnut effect".

Features

- ADS-B all-in-one module
- Max. sensitivity -105dBm
- No "doughnut effect"
- Small outline 26x15x3.3mm
- Low power consumption : 73mA
- Frame decode indicator output
- Easy to mount stamp hole PCB design
- Evaluation Board with USB bridge available



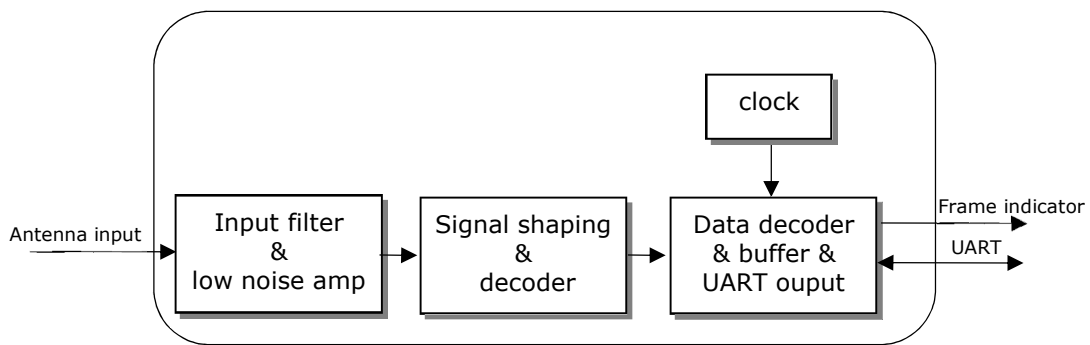
Applications

- Aviation safety
 - "Virtual Radar" for small aircrafts
 - Add-on data for flight navigation
- Ground equipment
 - Virtual Radar for ground based equipment
 - Hand held "plane spotting" devices
 - Data loggers for internet based online Virtual Radar systems

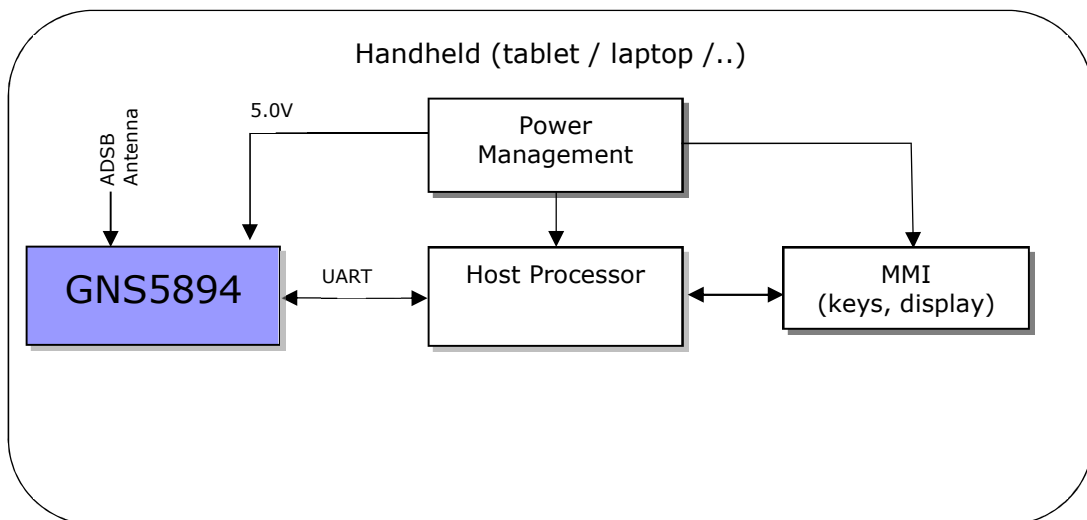
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3 BLOCK DIAGRAM



4 TYPICAL APPLICATION BLOCK DIAGRAM



5 DETAILED DESCRIPTION

GNS5894 is a high performance receiver for ADS-B.

Due to high input sensitivity it can work directly with a passive antenna.

The improved RF architecture and outstanding decoder circuit together with the enhanced firmware provides maximum performance at minimum space and power requirements.

GNS5894 features a special ultra fast level adaption circuit that overcomes the so called "doughnut effect". This input stage allows to receive very strong "near" and very weak "far" signals at the same time without losses.

GNS5894 includes a complete ADS-B receiver. An appropriate power supply of 5.0V and a special antenna must be connected for operation.

- The signal picked from air is filtered and decoded without any host processing requirements.
- ADS-B –S data is provided at the serial UART port with a baudrate of 3Mbaud. An appropriate host system with application must read and interpret the data and present them through the UI.
- No external clocks are required.

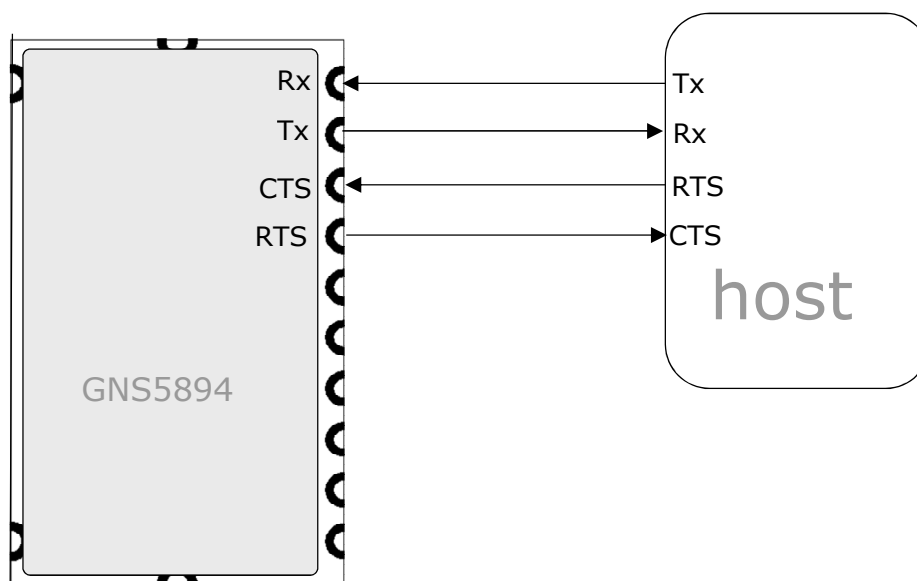
5.1 UART Interface details

GNS5894 must be connected to the host system by a UART Interface.

- The UART interface is used to send ADS-B text messages and receive control messages.
- The default baud rate is 3M baud, this baudrate is needed to transport the data without any data losses.
- For safe communication, implementing hardware handshake via RTS and CTS is recommended.
- I/O levels are 3.3V (see electrical data)

| GPS UART Default Settings | |
|---------------------------|-----------|
| Parameter | Value |
| Baud rate | 3,000,000 |
| Data length | 8 bits |
| Stop bit | 1 |
| Parity | None |
| Handshake | hardware |

The idle state of the UART lines is positive voltage. To interface a standard RS232 UART (e.g. a PC serial interface), please add an inverting level shifter. To interface processors that have a different interfacing voltage level, level shifters are required.



5.2 Power supply

GNS5894 needs a single power supply of 4.3..5.5V. The current consumption is ~75mA at full operation.

5.3 Reset input

The reset input is optional. Drawing this pin to low will reset the internal microprocessor. Reset can be left open for the most applications.

5.4 Frame available output

The frame available signal is used to indicate frames being successfully decoded. The pin will be set to high for 1ms whenever a frame comes in. The signal can be used by a host processor or may drive a LED to provide a visual feedback of the incoming data frames.

5.5 RF input (RFIn)

The RF input pin has a nominal impedance of 50 Ohms. Please keep tracks from module to antenna connector as short as possible. If more than a few millimetres track length is needed, the tracks must be impedance controlled (e.g. microstrip line). Please remember that the signal frequency is over 1 GHz. For connecting the antenna, a SMA or MCX connector should be used. On request, GNS can offer RF-support regarding PCB design.

5.6 ADS-B antenna

Depending on the application, a small rod antenna of just 20cm length can be used. This will provide a range of up to 350km around your location. However, using a high gain antenna will offer much more range and continuous tracking. Both types of antenna are available from GNS. For antenna installation, it's important to know that ADS-B signals will spread linearly only. Any obstacles like buildings, mountains or woods will mute or even totally block ADS-B signals. Antenna should be mounted to have an unobstructed "view" in all directions from a raised location.

ATTENTION: Risk of fire and injury ! For any raised mounted antenna constructions like roof antennas or aerial masts, it's mandatory to follow the rules for lightning protection. In case of doubt please consult a professional specialist

6 ELECTRICAL SPECIFICATION

6.1 Absolute Maximum Ratings

| Parameter | Value | Unit |
|------------------------------------------------|------------------|------|
| Supply voltage range: V_{dd} | 0 to 5.5 | V |
| DC Input voltage to antenna input ¹ | -0.3 to V_{dd} | V |
| Input voltage to all other pins | -0.3 to 4 | V |
| Operating ambient temperature range | -20 to +70 | °C |
| Storage temperature range | -40 to +85 | °C |

6.2 Recommended Operating Conditions

| Parameter | Min | Typ | Max | Unit | Note |
|------------------------------------|-----|-----|-----|------|-------------------------------------|
| V_{dd} | 4.3 | 5.0 | 5.5 | V | Power-supply voltage |
| High level output voltage V_{OH} | 2.4 | | 3.3 | V | IOU _T = 8 mA, pins 5,7,9 |
| Low level output voltage V_{OL} | 0 | | 0.4 | V | IOU _T = 8 mA, pins 5,7,9 |
| High-level input voltage V_{IH} | 1.8 | | 4.0 | V | pins 6,8,10 |
| Low-level input voltage V_{IL} | 0 | | 1.2 | V | pins 6,8,10 |
| Operating temperature | -20 | | 70 | °C | Full specified performance |

6.3 Characteristics

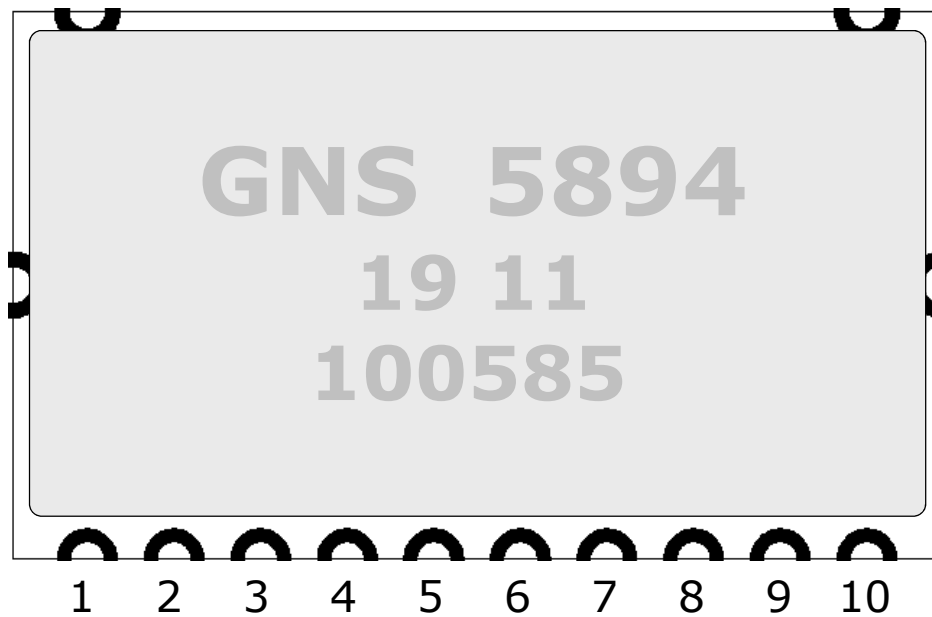
| Parameter | Min | Typ | Max | Unit | Note |
|---------------------------------|------|------|-----|----------|-----------------------|
| general | | | | | |
| Frequency | | 1090 | | MHz | ADS-B – mode S |
| Output data frequency | | 3 | | MBit/sec | Uart baudrate |
| UART baud deviation sensitivity | -105 | | 0.1 | % | |
| | | | +5 | dBm | Frame detection level |
| Power consumption | | | | | |
| Current full operation | | 70 | 75 | mA | |
| Supply voltage | 4.3 | 5.0 | 5.5 | V | |

6.4 RF input characteristics

| Parameter | Min | Typ | Max | Unit | Note |
|---------------------|-----|-----|-----|------|--------------------|
| Input impedance | | 50 | | Ω | |
| Maximum input level | | | +5 | dBm | before destruction |
| Input return loss | | -11 | | dB | |

7 DEVICE PINOUT DIAGRAM

TOP VIEW



| NO | NAME | TYPE | DESCRIPTION |
|----|---------|------|----------------------|
| 1 | RF Gnd | G | RF Ground |
| 2 | RF in | Ana | RF input |
| 3 | Gnd | G | Supply Ground |
| 4 | Vdd | P | Supply voltage 5.0V |
| 5 | F_ind | O | Frame indicator |
| 6 | RESET | I | Reset input |
| 7 | RTS | O | UART Ready to Send |
| 8 | CTS | I | UART Clear to Send |
| 9 | UART Tx | O | UART Serial data out |
| 10 | UART Rx | I | UART Serial data in |

G=Ground; Ana = analogue; P=power supply; O= dig. Output; I=digital Input

8 ADS-B DATA

The output data format is ASCII ADS-B text format and compatible with many common software applications.

There are 25 possible types that will be all available, but for Virtual Radar applications, type 11 and 17&18 (extended squitter) are most important.

The following table shows all types in a short form. For further information, please refer to ADS-B specifications, for example the publications from ICAO (International Civil Aviation Organization).

| Mode-S reply available sentences | | | | | | | | |
|----------------------------------|-------------|--------------|------|--------------|-------|-----------------------|------------------------------------------|----------------------------------|
| DF | Type | | | | | | content | |
| 00000 | VS:1 | 7 | RI:4 | 2 | AC:13 | AP:24 | Short air-air surveillance (ACAS) | |
| 00001 | 27 or 83 | | | | | | P:24 | Reserved |
| 00010 | 27 or 83 | | | | | | P:24 | Reserved |
| 00011 | 27 or 83 | | | | | | P:24 | Reserved |
| 00100 | FS:3 | DR:5 | UM:6 | AC:13 | AP:24 | | Surveillance, altitude reply | |
| 00101 | FS:3 | DR:5 | UM:6 | ID:13 | AP:24 | | Surveillance, identify reply | |
| 00110 | 27 or 83 | | | | | | P:24 | Reserved |
| 00111 | 27 or 83 | | | | | | P:24 | Reserved |
| 01000 | 27 or 83 | | | | | | P:24 | Reserved |
| 01001 | 27 or 83 | | | | | | P:24 | Reserved |
| 01010 | 27 or 83 | | | | | | P:24 | Reserved |
| 01011 | CA:3 | AA:24 | | PI:24 | | All-call reply | | |
| 01100 | 27 or 83 | | | | | | P:24 | Reserved |
| 01101 | 27 or 83 | | | | | | P:24 | Reserved |
| 01110 | 27 or 83 | | | | | | P:24 | Reserved |
| 01111 | 27 or 83 | | | | | | P:24 | Reserved |
| 10000 | VS:1 | 7 | RI:4 | 2 | AC:13 | MV:56 | AP:24 | Long air-air surveillance (ACAS) |
| 10001 | CA:3 | AA:24 | | ME:56 | | PI:24 | Extended squitter | |
| 10010 | CF:3 | AA:24 | | ME:56 | | PI:24 | Extended squitter/non transponder | |
| 10011 | AF:3 | 104 | | | | | | Military extended squitter |
| 10100 | FS:3 | DR:5 | UM:6 | AC:13 | MB:56 | AP:24 | Comm-B, altitude reply | |
| 10101 | FS:3 | DR:5 | UM:6 | ID:13 | MB:56 | AP:24 | Comm-B, identify reply | |
| 10110 | 27 or 83 | | | | | | P:24 | Reserved for military use |
| 10111 | 27 or 83 | | | | | | P:24 | Reserved |
| 11xxx | 1 | KE:1 | ND:4 | MD:80 | | AP:24 | Comm-D (ELM) | |

AA:Address announced ; AC:Altitude code ; AF:Application field ; AP:Address/parity ; AQ:Acquisition ; CA:Capability ; CC:Cross-link capability ; CF:Control field ; CL:Code label ; DF:Downlink format ; DI:Designator identification ; DR:Downlink request ; DS:Data selector ; ELM:Extended length message ; FS:Flight status ; IC:Interrogator code ; ID:Identità ; KE:Control, ELM ; MA:Message, Comm-A ; MB:Message, Comm-B ; MC:Message, Comm-C ; MD:Message, Comm-D ; ME:Message, extended squitter ; MU:Message, ACAS ; MV:Message, ACAS ; NC:Number of C-segment ; ND:Number of D-segment ; PC:Protocol ; PI:Parity/interrogator identifier ; PR:Probability of reply ; RC:Reply control ; RI:Reply information ; RL:Reply length ; RR:Reply request ; SD:Special designator ; UF:Uplink format ; UM:Utility message ; VS:Vertical status

9 COMMAND INTERFACE

Write Commands

- Commands consist always of minimum 2 ASCII characters
- 2 ASCII characters compose 1 binary command or parameter value
- Command and parameter values as well as consecutive parameter values are separated by a delimiter character '-'
- Every command starts with '#'
- Every command is finished by 'Carriage Return' (0x0D)

| 9.1 GNS5894 commands | | | | |
|----------------------|-------|-----------|------------|----------------------------------------------|
| command | value | parameter | example | description |
| Reset Device | FF | none | #FF<CR> | HW-reset of GNS5894 is performed. |
| Read FW version | 00 | none | #00<CR> | Queries f/w version |
| Set ADS-B mode | 43 | mode# | #43-02<CR> | mode 02 (output ALL DF – data) See note 1 |
| | | | | |

| notes | |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <p>GNS5894 can operate in 5 active modes and 1 inactive mode (Mode 0).</p> <p>Mode 0: (mode# = 00) stop data output.</p> <p>Mode 2: (mode# = 02) output all DF – Data.</p> <p>Mode 3: (mode# = 03) output DF17 / DF18 / DF19 – Data only.</p> <p>Mode 2+: (mode# = 82) output all DF – Data with additional Signal Strength Indicator.</p> <p>Mode 3+: (mode# = 83) output DF17 / DF18 / DF19 – Data only with additional Signal Strength Indicator.</p> <p>Mode 4: (mode# = x4) output DF17 / DF18 / DF19 – Data with correct CRC-checksum only.</p> |
| | |
| | |

Command Replies

- Replies consist always of 16 binary values, each value formed of 2 ASCII characters
- Consecutive values are separated by a delimiter character '-'
- Every reply starts with '#'
- Every reply is finished by 'Line Feed + Carriage Return' (0x0A 0x0D)
- 1st and following reply values represent the echo of the previous command. Unused values are padded with '00'
- In case of command error the 1st value is 'FF'
- In case of parameter error the 2nd value is 'FF'

9.2 GNS5894 command reply examples

| prev. Command | Reply | Note |
|---------------|---------------------------------------------------------------|-------------------------------------------------------------------------|
| #FF<CR> | #FF-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00<LF CR> | Device performs a cold start |
| #43-02<CR> | #43-02-00-00-00-00-00-00-00-00-00-00-00-00-00-00<LF CR> | Command accepted |
| #00<CR> | #00-00-80-04-fw-yy-ww-00-00-00-00-00-00-00-00-00-00<LF CR> | ww – week (HEX coded) yy – year (HEX coded) fw – firmware version |
| #55<CR> | #FF-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00<LF CR> | Unknown command |
| #43-14<CR> | #43-04-00-00-00-00-00-00-00-00-00-00-00-00-00-00<LF CR> | Wrong parameter |

9.3 ADS-B data frame reception

9.3.1.1 mode 2 (reception of all DF-Data)

In case of ADS-B mode 2 (reception of all DF-Data) the 56bit or 112bit raw data frames are output as 14 bytes ASCII frames , or 7 bytes ASCII frames, MSB first.

Every ASCII frame begins with an '*' and is finished by ';' + <CR><LF>.

Example:

```
...
*8D4B1621994420C18804887668F9;
*02E1991058EF31;
*20000CB10D89FB;
*20001196553C25;
*02E198BFAF8676;
*02C18CB14E2D98;
*02E198BFAF8676;
*200015301CB296;
*20000F971E4582;
*200015B3EF4577;
*583E1BDABC2735;
*280008006C738F;
*5D3C5961BAAB6C;
*8D4CA27A608145305B0B09EAD8B5;
*02E19838575F0A;
```

Remark:

*8D.... is DF18 **Extended squitter**
*5D.... is DF11 **All-call reply**

9.3.1.2 mode 2+ (recept. of all DF-Data with add. Signal Strenght Indicator)

In case of ADS-B mode 2+ (reception of all DF-Data with additional Signal Strenght Indicator) the 56bit or 112bit raw data frames are output as 15 bytes ASCII frames , or 8 bytes ASCII frames, MSB first.

Every ASCII frame begins with an '+' and is finished by ';' + <CR><LF>.

The first byte following the '+' is the signal strength indicator of the current ADS-B frame.

The following bytes represent the received ADS-B data.

Example:

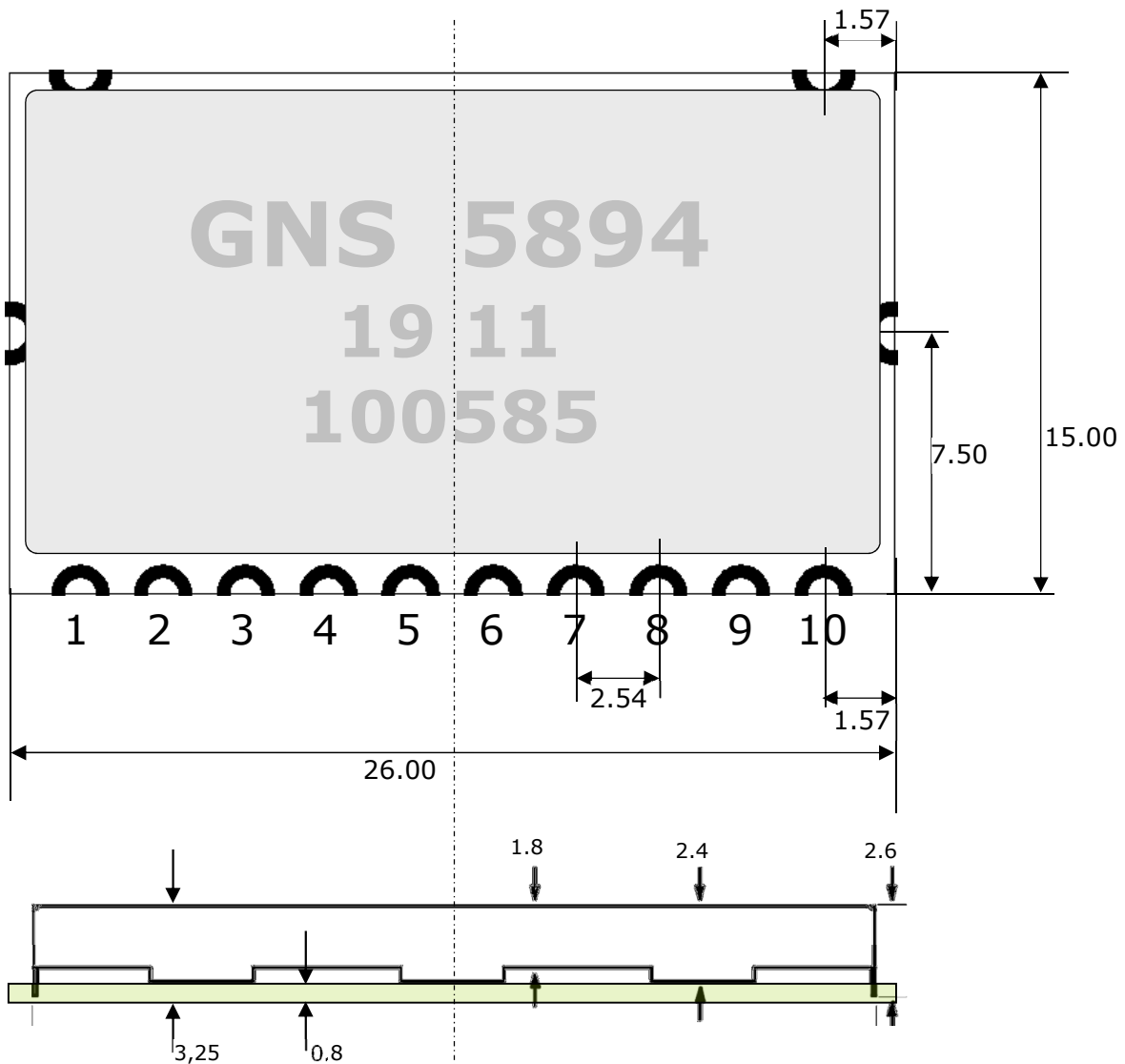
```
...
+218D406AE9990D3A19B004438721F4;
+2502E197187D90C5;
+21A00015B8C2680030A800004DFECE;
+2B8F471EE1EA13A864011C087DD2A6;
+275D40622B4E91A9;
+2702E197B07628F4;
+2128000C9453B470;
+23A8000821FFF9A134BFFCE51A6E88;
+21A8000821CF9A2131200C008672C4;
+27280000BA1A7AD8;
+215DAE027297612F;
+268D4CA97E58C386190B61D17C85EE;
+27A0281718D12A1131FFDC0185BBC5;
+225D40622B4E91A9;
+29A0281718C65000305400004835A6;
+27A000069D2010C23440D820B901DC;
+28200017B070F0BE;
+54A00017192015A676C50320F6CB14;
+83200005228A9442;
+268D3C49C9994169ACA00842E6CE77;
+28280000BA1A7AD8;
+34A0001838E159EF30FFFC0169CC03;
+3643B09E02A6481C;
+2002A18711E53A86;
+33A0001838CA380030A80000D50B50;
+285D40622B4E91D8;
+2102A18437F6ECC7;
+34200018385D2A25;
+23A0000437201571F6058820C1EA12;
...
```

Important note

The Signal Strength Indicator preceded by the data is only an indicator of the field strength of the received frame and not a measured value from which the distance to the transmitter can be derived. The range of the value is approximately between 0x20 (far distance signals) and 0xd5 (near distance signals).

10 PHYSICAL DIMENSIONS

TOP VIEW



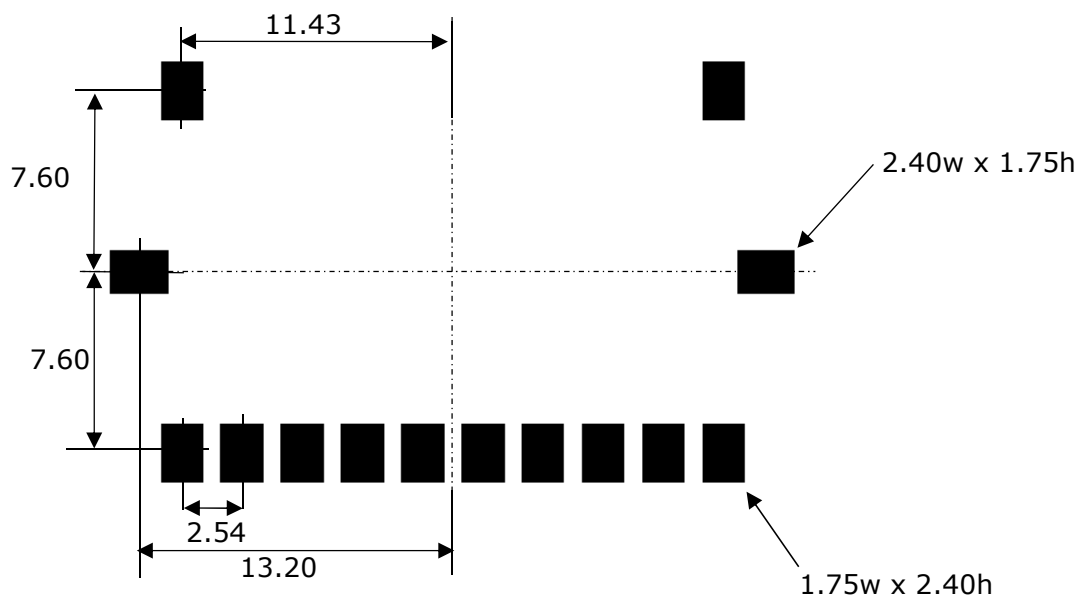
all units in mm

tolerance +/- 0.1 mm



11 RECOMMENDED PAD LAYOUT

TOP VIEW



all units in mm

12 MATERIAL INFORMATION

12.1 Shield Material Information

"German Silver " , CuNi18Zn27

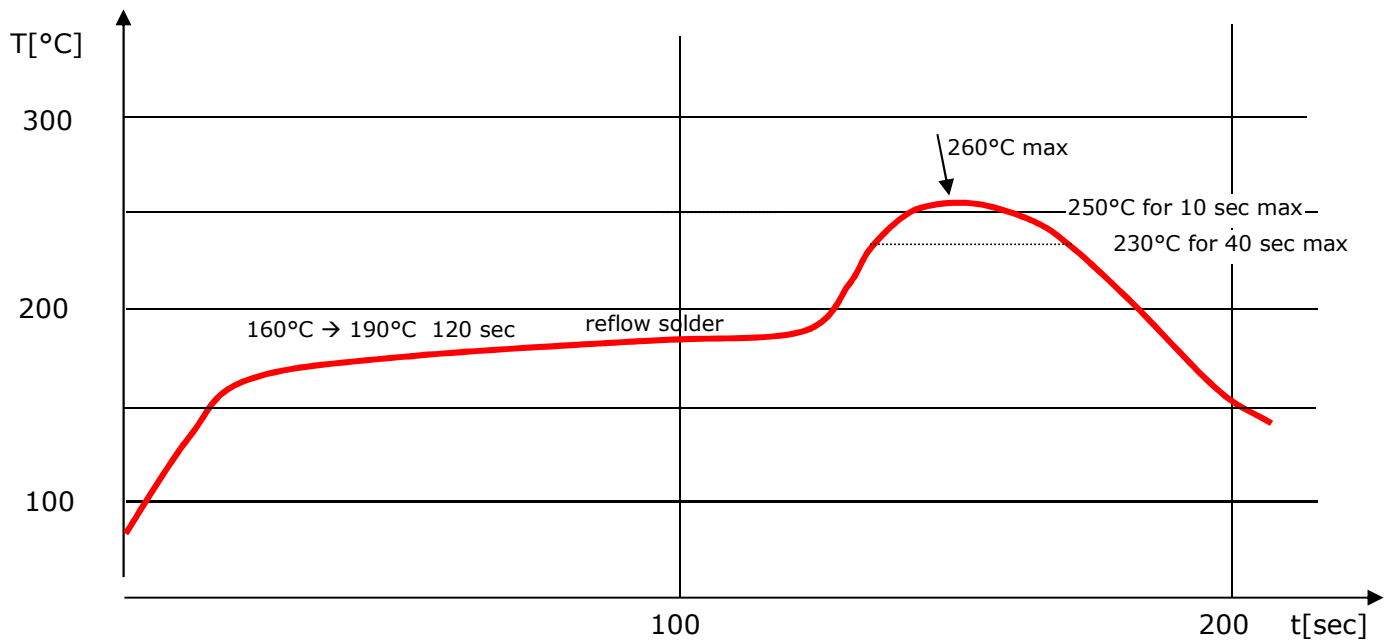
Cu: 53.5..56.5%

Ni : 16.5..19.5%

Zn : 24..30%

thickness :0.2mm

13 RECOMMENDED SOLDERING REFLOW PROFILE

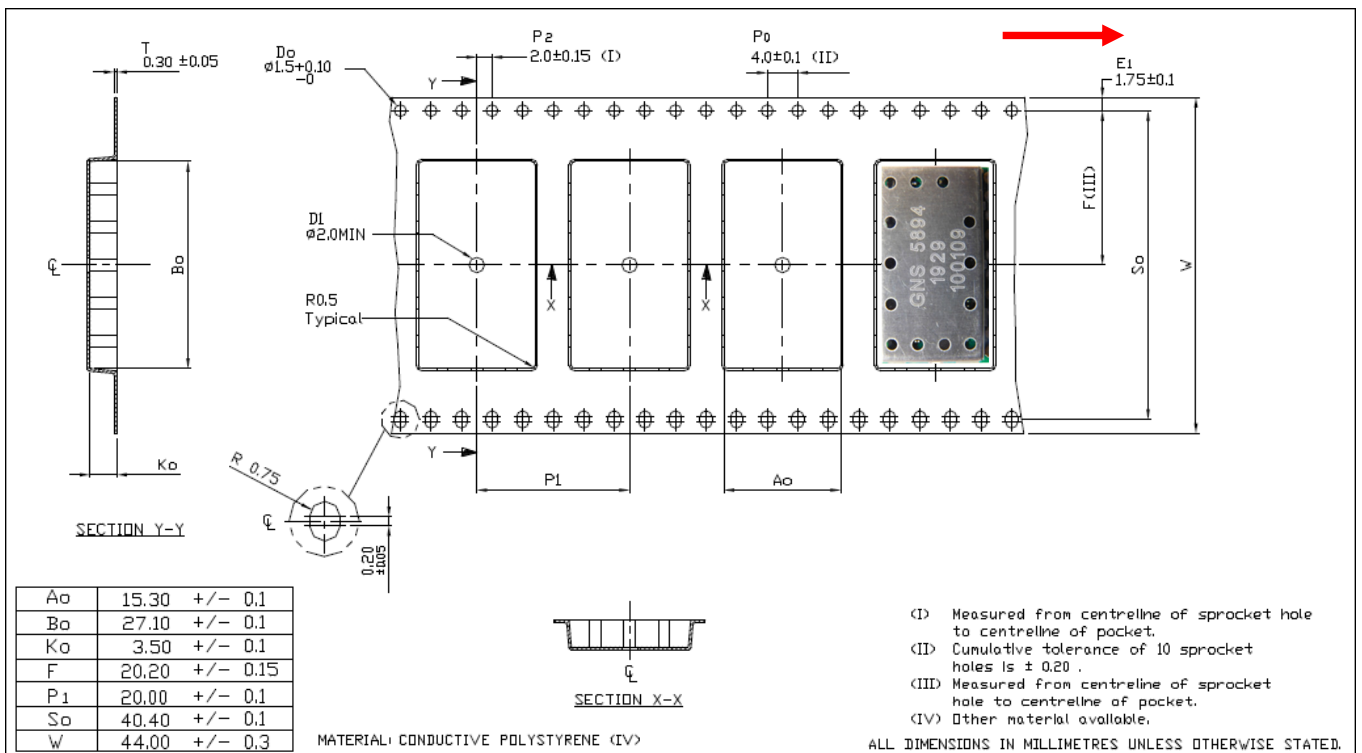


Notes:

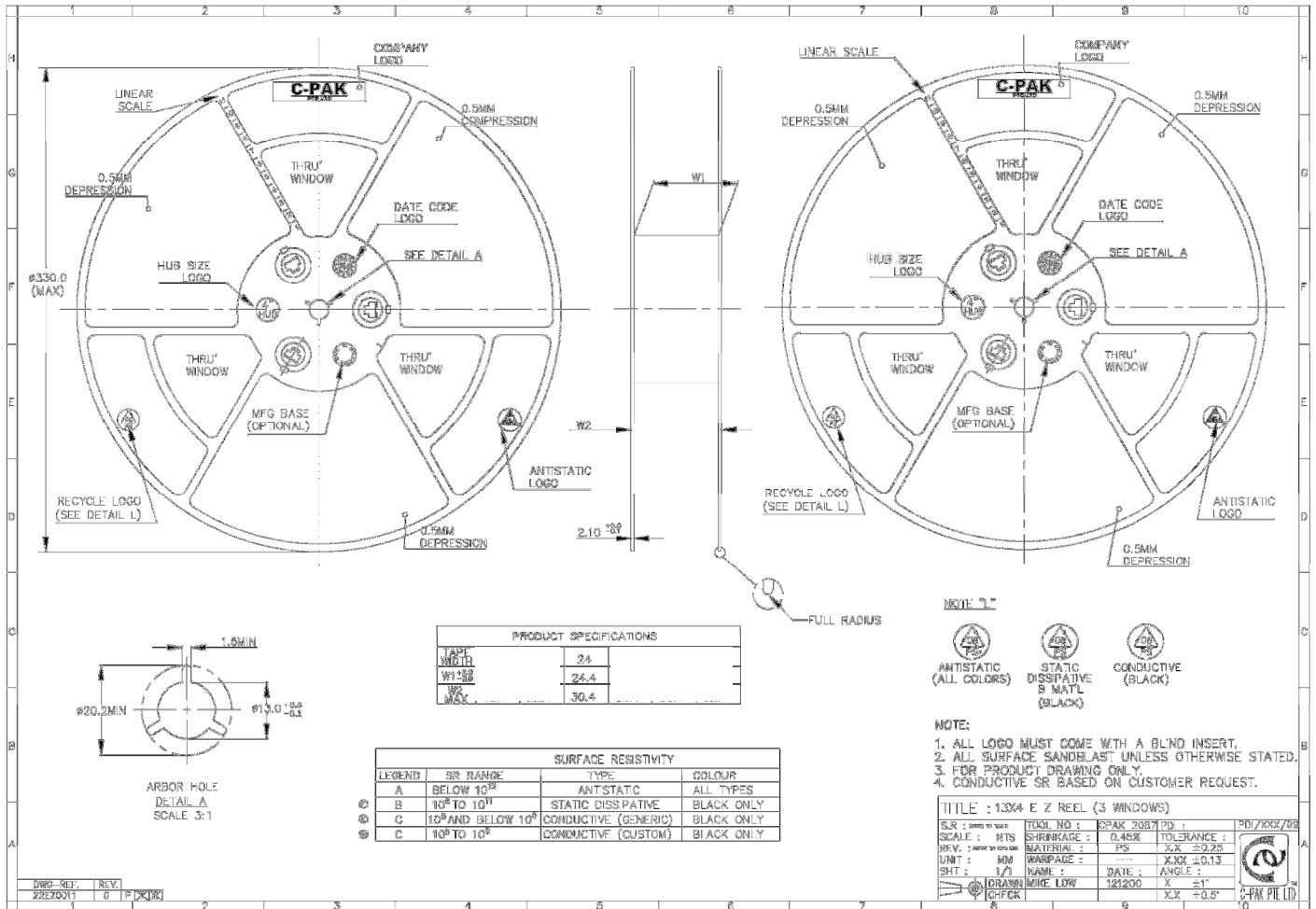
1. GNS5894 should be soldered in upright soldering position. In case of head-over soldering, please prevent shielding / GNS5894 Module from falling down.
2. Do never exceed maximum peak temperature
3. Reflow cycles allowed : 1 time
4. Do not solder with Pb-Sn or other solder containing lead (Pb)
5. This device is not applicable for flow solder processing
6. This device is not applicable for solder iron process

14 TAPE INFORMATION

Component orientation:
arrow shows open-end
direction of tape



15 REEL INFORMATION



no. of devices : 500 pcs / reel

16 ORDERING INFORMATION

| Ordering information | | | |
|-----------------------|---------------|----------------------------------|---------------------|
| Type | Part# | Laser marking | Description |
| GNS 5894 ADS-B module | 4037735104793 | GNS 5894 <yy cw> <serial#> | ADS-B serial module |

17 ENVIRONMENTAL INFORMATION

This product is free of environmental hazardous substances and complies to “RoHS II” 2011/95/EU (Recast 2002/95/EG) and further applicable Delegated Directive 2015/863/EU. (“RoHS III”).

18 MOISTURE SENSITIVITY

| | |
|----------------------------------|-------------|
| Shelf life | Unlimited |
| Storage conditions | ≤30°C/85%RH |
| Moisture Sensitivity Level (MSL) | 3 |
| Possible prebake recommendations | None |

19 DOCUMENT REVISION HISTORY

| | | | |
|------|-------------|--------------|--------------------------------------------------|
| V0.1 | Sep 13 2019 | M.Heinzel | initial |
| V0.2 | Sep 16 2019 | SL / CD / MH | Minor changes and additions |
| V0.3 | Sep 17 2019 | M.Heinzel | Correction of 'Electrical Specification' section |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

20 DISCLAIMER

THE USE OF THE DATA RECEIVED WITH GNS 5894 MODULE IS STRICTLY LIMITED TO PERSONAL ENTHUSIAST ACTIVITIES (I.E. FOR ENTERTAINMENT PURPOSES), WHICH SPECIFICALLY EXCLUDE ANY ACTIVITIES THAT MIGHT ENDANGER YOURSELF OR THE LIVES OF OTHERS. UNDER NO CIRCUMSTANCES, GNS WILL BE HELD RESPONSIBLE FOR INCIDENTS RESULTING FROM THE USE AND/OR INTERPRETATION OF THE DATA RECEIVED.

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