

1 INTRODUCTION

GNS-Electronics introduces the new GNS 5851 AIS receiver module for the maritime market.

The GNS 5851 is a highly sensitive single-channel receiver, which can either be used stand-alone as a channel-hopping receiver or as a chained pair to form a complete two-channel solution depending on customer needs.

The module integrates a sensitive RF frontend, signal processing and a data decoder with standard NMEA AIS output via a UART that can be easily connected to a host processor. A secondary UART is provided for module chaining.

Features

- Standard AIS NMEA output
- Sensitivity -117 dBm
- Selectable Channel A, B or A & B (hopping)
- Small outline 26x15x3.3mm
- Ultra-Low power consumption : 20 mA
- Frame decode indicator output
- Easy to mount stamp-hole PCB design
- Evaluation Board with USB bridge available



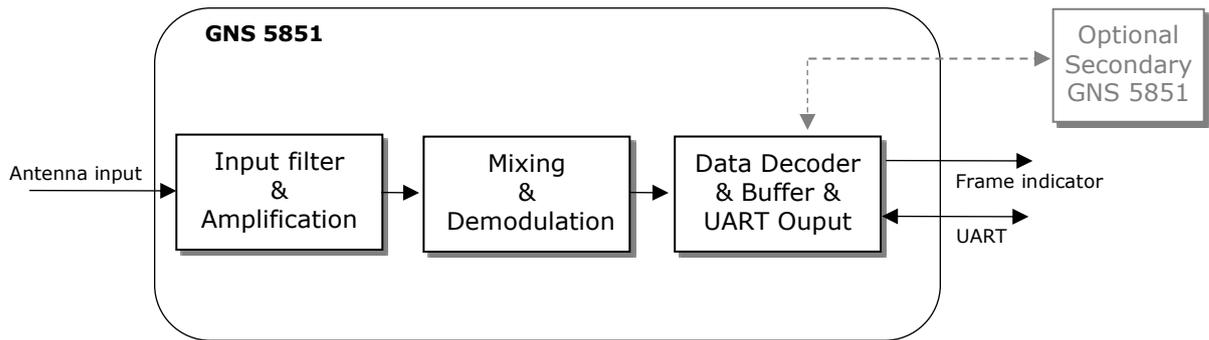
Applications

- Maritime safety
- Shore/Harbor equipment
- Data loggers for internet based online marine tracking systems

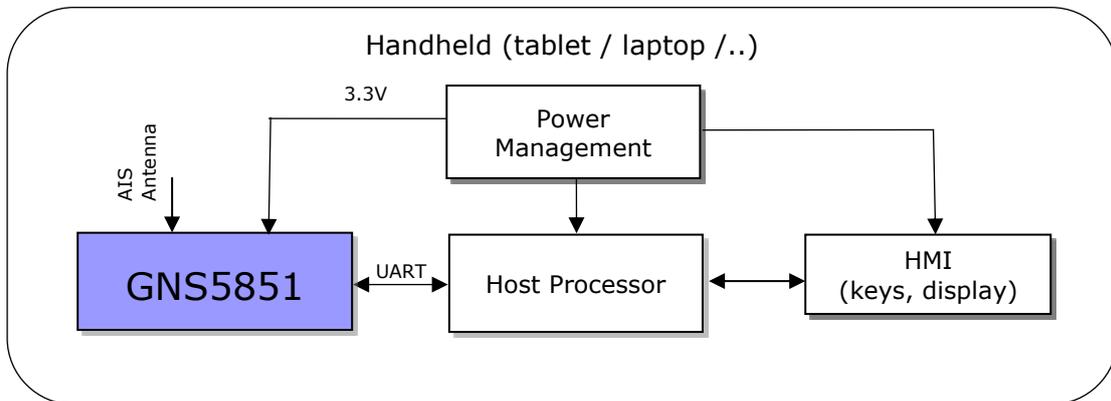
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3 BLOCK DIAGRAM



4 TYPICAL APPLICATION BLOCK DIAGRAM



5 DETAILED DESCRIPTION

GNS 5851 is a high performance single channel receiver for the marine Automatic Identification System (AIS). It receives the Marine Band channels 87B (Ch. A) and 88B (Ch. B) at 161.975 MHz and 162.025 MHz respectively and can be configured to statically receive either channel or to automatically hop between channels. Two GNS 5851 can be chained to form a continuous two-channel AIS receiver if necessary.

Only an appropriate power supply of 3.3V and a suitable antenna must be connected for operation, no external clocks are required.

The GNS 5851 outputs all received AIS data as standard NMEA messages via its UART at 115200 baud using 3.3V levels.

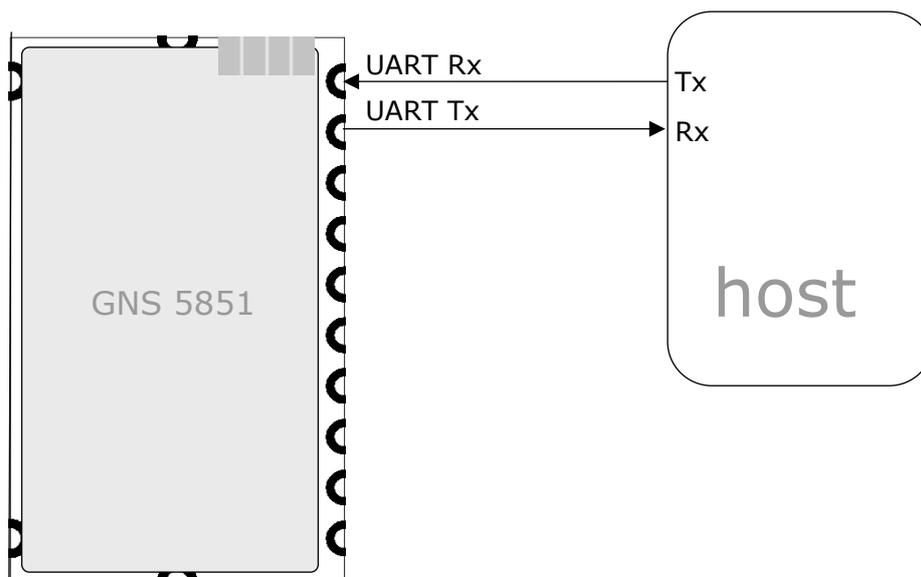
5.1 Main UART Interface details

GNS 5851 must be connected to the host system via a UART Interface.

Transmission protocol is industry standard NMEA 0183 using VDM sentences for received vessel data, see <https://www.nmea.org> for reference.

I/O levels are 3.3V (see electrical data), baud rate is either 115200 bps or 38400 bps using 8 data bits, one stop bit and no parity ('8-N-1'). The baud rate for the hopping receiver can be selected via the Mode Selection bits (see §5.4), the master/slave combination is fixed at 38400 bps..

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

GNS 5851 needs a single power supply of 3.1 .. 3.5V. The current consumption is ~20 mA 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 Mode selection

The device can act as a stand-alone hopping single-channel receiver or, starting with firmware version 23.20.01, can form a true 2-channel receiver when used together with a secondary GNS5851. As a single channel receiver, two baud rates (38400 and 115200 bps) are supported, the 2-channel receiver is fixed at 38400 bps. Baud rate (main UART) and mode can be selected via the Mode Selection pins MD0 and MD1:

Mode	MD1	MD0	BPS	Mode
0	0	0	38400	2-Channel Master (Receives channel A. Channel B data via UART2)
1	0	1	38400	2-Channel Slave (Receives channel B)
2	1	0	38400	Hopping single-channel
3	1	1	115200	Hopping single-channel (<i>default</i>)

Both MD0 and MD1 are sampled once at power-on/reset and feature an internal pull-up resistor that will result in a logic '1' if the pins are left open. Connect to ground for logic '0'. The resulting default configuration with MD0/1 unconnected is hopping single-channel @ 115200 bps, which is consistent with firmware versions prior to v23.20.01.

5.5 Chaining interface / UART2

The chaining interface is only used when the GNS5851 is configured as a 2-Channel Master (Mode #0). In this mode, the module expects channel B data from another GNS5851 configured as slave (Mode #1) on UART2. The master will combine its own received channel A data with the channel B data to output a merged data stream on the main UART to the host.

2-Channel Setup:

- Configure one GNS5851 as Master (Mode #0) and connect its main UART to the host.
- Configure the second GNS5851 as Slave (Mode #1) and connect its main UART to UART2 of the Master (Slave UART-TX_D to Master UART2-RX_D and Slave UART-RX_D to Master UART2-TX_D)
- Using an antenna splitter (or two antennas), feed RF to both Master and Slave.

Additional details can be found in the respective application note (*to be released later*).

5.6 Frame available output

The frame available signal is used to indicate frames being successfully decoded. The pin will be set to high whenever a frame is decoded. The signal can be used by a host processor or may drive a LED to provide a visual feedback of the incoming data frames. If the device is configured as a master (Mode #0), only frames from channel A are indicated. Channel B frames are indicated by the slave module.

5.7 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).

On request, GNS can offer RF-support regarding PCB design.

5.8 AIS VHF antenna

For antenna installation, keep in mind that VHF signals will spread near-linear only ("line-of-sight"). Any obstacles like buildings, mountains or woods will attenuate or even totally block the signal.

The VHF antenna should be mounted at an elevated location with an unobstructed "view" in the desired direction.

**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 3.8	V
DC Input voltage to antenna port	-0.3 to $V_{dd} + 0.3$	V
Max. RF input to antenna port (in-band & out-of-band)	+10	dBm
Input voltage to all other pins	-0.3 to $V_{dd} + 0.3$	V
Operating ambient temperature range	-40 to +85	°C
Storage temperature range	-40 to +85	°C

6.2 Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit	Note
V_{dd}	3.1	3.3	3.5	V	Power-supply voltage
High level output voltage V_{OH}	2.4		V_{dd}	V	$I_{source} = 3 \text{ mA}$
Low level output voltage V_{OL}	0		0.7	V	$I_{sink} = 3 \text{ mA}$
Operating temperature	-40		+80	°C	Full specified performance

6.3 Characteristics

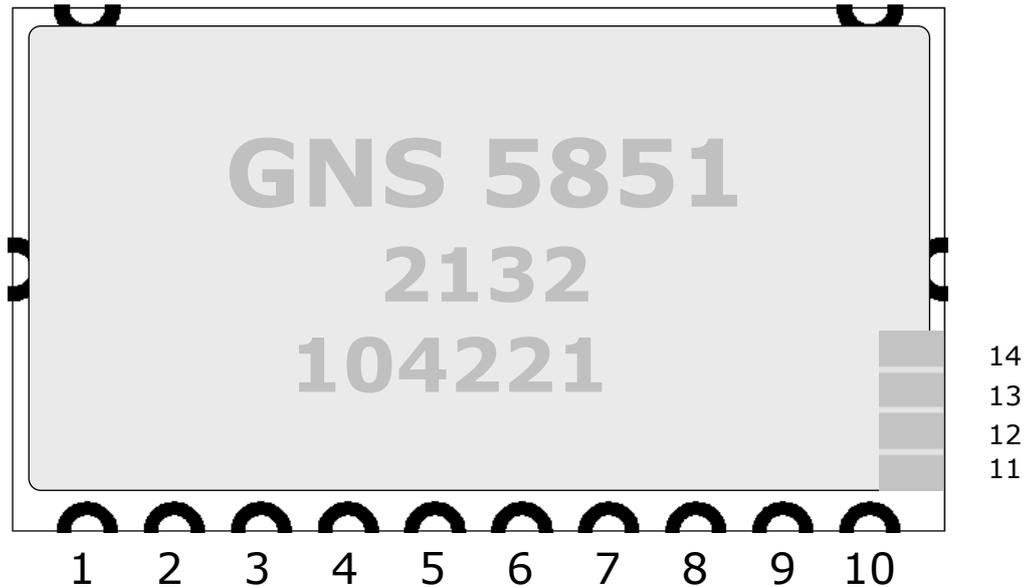
Parameter	Min	Typ	Max	Unit	Note
General					
Frequency	161.95		162.05	MHz	Marine Band VHF channels 87B & 88B
Output data bit rate	38400		115200	Bit/sec	NMEA 0183 protocol
UART baud deviation			0.7	%	
Sensitivity	-115	-117	-118	dBm	
Max. Usable Input Level			+10	dBm	
Power Consumption					
Average current (full operation)	19.5	19.9	21.0	mA	
Supply voltage	3.1	3.3	3.5	V	

6.4 RF input characteristics

Parameter	Min	Typ	Max	Unit	Note
Input impedance		50		Ω	
Maximum input level			+10	dBm	before destruction

7 DEVICE PINOUT DIAGRAM

TOP VIEW



Pin	Name	I/O	Description & Note
1	RF Gnd	G	Antenna Ground
2	RF in	Ana	RF input AIS VHF signal input pin.
3	Gnd	G	Supply Ground
4	Vdd	P	Main Supply voltage 3.3V
5	F_ind	O	Frame indicator Outputs positive pulses when receiving single AIS frames or groups of AIS frames.
6	RESET	I	Reset input. Low active, causes the module to reset. Internally pulled up by 40 kOhm, if not used keep floating.
7	NC	-	Do not connect. Leave pin open.
8	NC	-	Do not connect. Leave pin open.
9	UART TX _D	O	Main UART. Data from GNS 5851 -> Host
10	UART RX _D	I	Main UART. Commands from Host -> GNS 5851
11	MD0	I	Mode Select Bit 0 Internally pulled up, keep floating for default configuration.
12	UART2 TX _D	O	Secondary UART. Commands to slave module (chaining interface, optional)
13	UART2 RX _D	I	Secondary UART. Data from slave module (chaining interface, optional)
14	MD1	I	Mode Select Bit 1 Internally pulled up, keep floating for default configuration.

G=Ground; Ana = analogue; P=power supply; O= dig. output (3.3V); I=digital input(3.3V)

8 AIS DATA

AIS data itself is defined in ITU-R standard M.1371-5 which is freely available from the ITU website:

<https://www.itu.int/rec/R-REC-M.1371/en>

The encoding as NMEA 0183 VDM sentence is defined in the NMEA 0183 standard that can be obtained from the NMEA: https://www.nmea.org/content/STANDARDS/NMEA_0183_Standard

As an overview we can highly recommend Eric S. Raymond's excellent and very readable description of AIS and its encoding as part of the open-source GPSD project: <https://gpsd.gitlab.io/gpsd/AIVDM.html>

9 COMMAND INTERFACE

The command interface is NMEA 0183 based using private sentences that start with '\$PGNS'.

The general command structure is

```
$PGNS, C [, param1 [, param2 ...]] *XX<CR><LF>
```

C is a single upper-case character unique for each command
param1... are optional parameters for a specific command
XX is the standard NMEA 0183 checksum

Each command will be answered with a reply that has the following structure:

```
$PGNS, 0, C [, rpl1 [, rpl2 ...]] *XX<CR><LF>
```

C is the same single upper-case character as the command
rpl1... are optional reply data for a specific command/reply
XX is the standard NMEA 0183 checksum

9.1 Command Sentences (Host → Device)

The following paragraphs describe each command/reply in detail.

9.1.1 Version Request

Command: \$PGNS, **V***70<CR><LF>

Reply: \$PGNS, 0, **V**, GNS5851, <fw-version>, <loader-version>, [<Mode>,]xxx*XX<CR><LF>

Mode is only available on firmware versions starting from 23.20.1.
Values: 'H' = Hopping, 'M' = Master, 'S' = Slave

Example: -> \$PGNS, V*70
<- \$PGNS, 0, V, GNS5851, 23.20.1, 1.0-1, H, S01*5A
Firmware Version is 23.20.1, Mode is 'Hopping Receiver'

9.1.2 Set Receiver Mode

This command is only valid if the device is configured as a single-channel receiver (Modes #2 and #3)

Command: \$PGNS,**M**,<mode>*XX<CR><LF>

<mode> - Reception mode:

'A' - Channel A only

'B' - Channel B only

'H' - Alternating channel A and B (hopping)

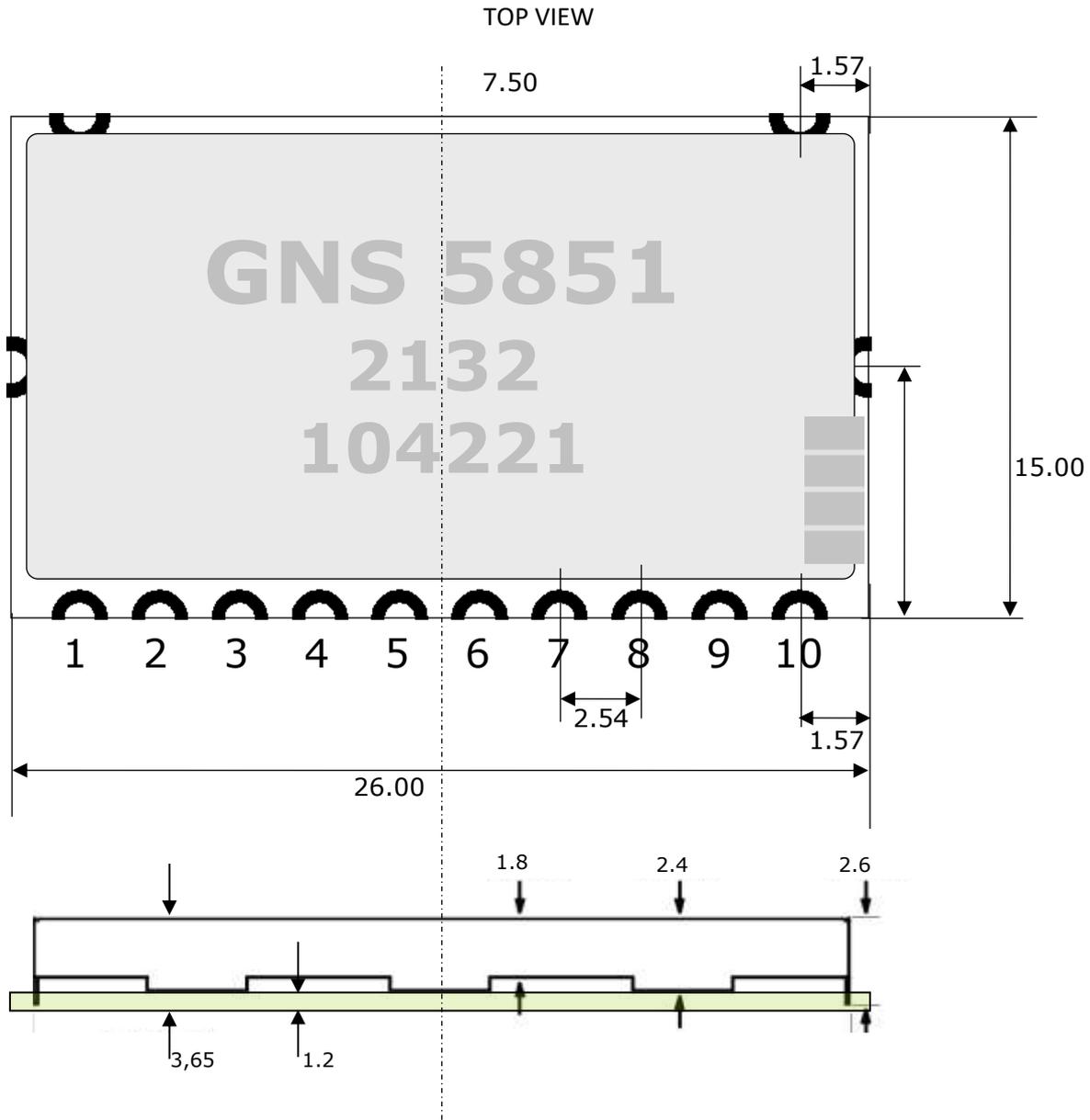
Reply: \$PGNS,0,**M**,OK*5F<CR><LF>

Example: Receive channel A only:

-> \$PGNS,M,A*06

<- \$PGNS,0,M,OK*5F

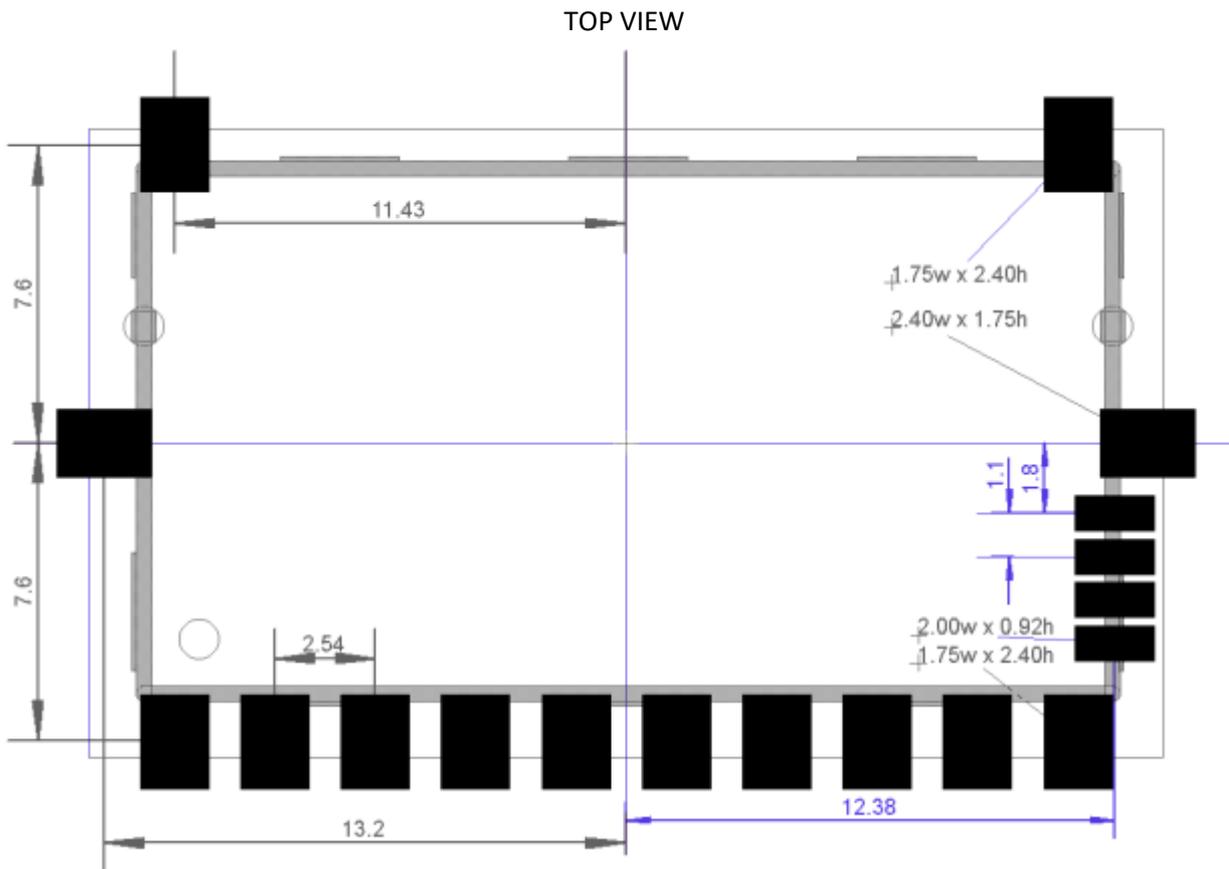
10 PHYSICAL DIMENSIONS



all units in mm

tolerance +/- 0.1 mm

11 RECOMMENDED PAD LAYOUT



all units in mm

12 MATERIAL INFORMATION

12.1 Shield Material Information

"German Silver ", CuNi18Zn27

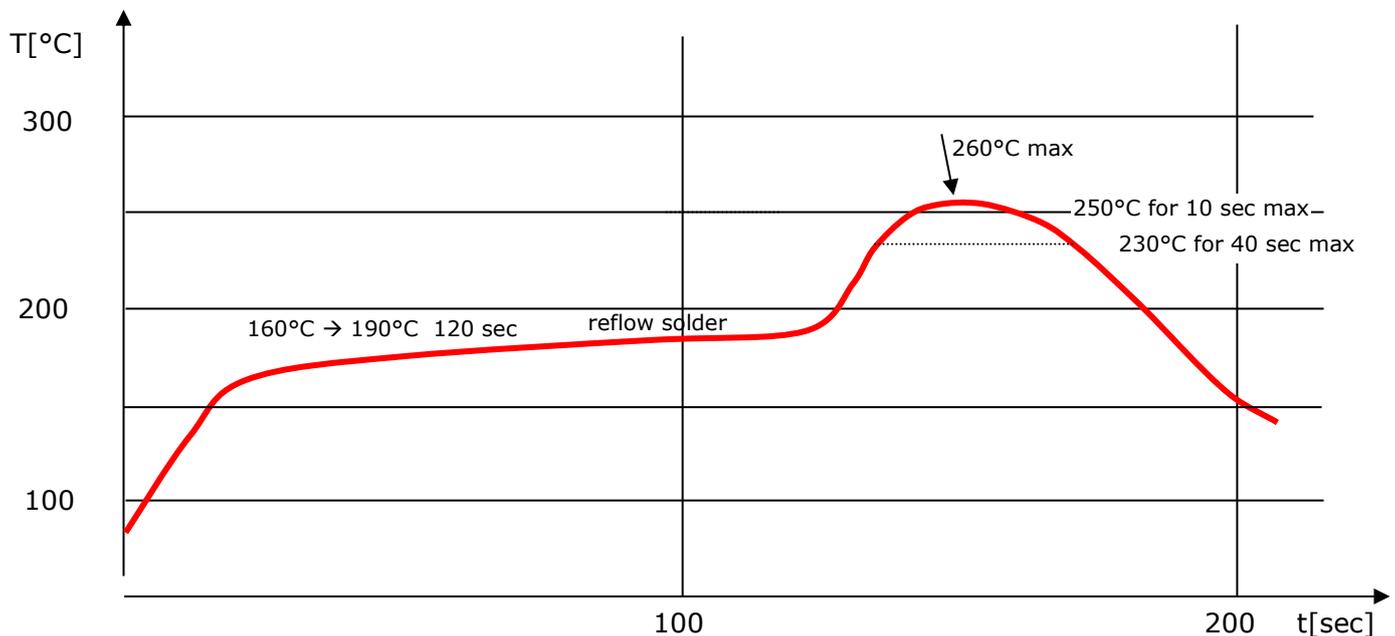
Cu: 53.5..56.5%

Ni : 16.5..19.5%

Zn : 24..30%

thickness :0.2mm

13 RECOMMENDED SOLDERING REFLOW PROFILE

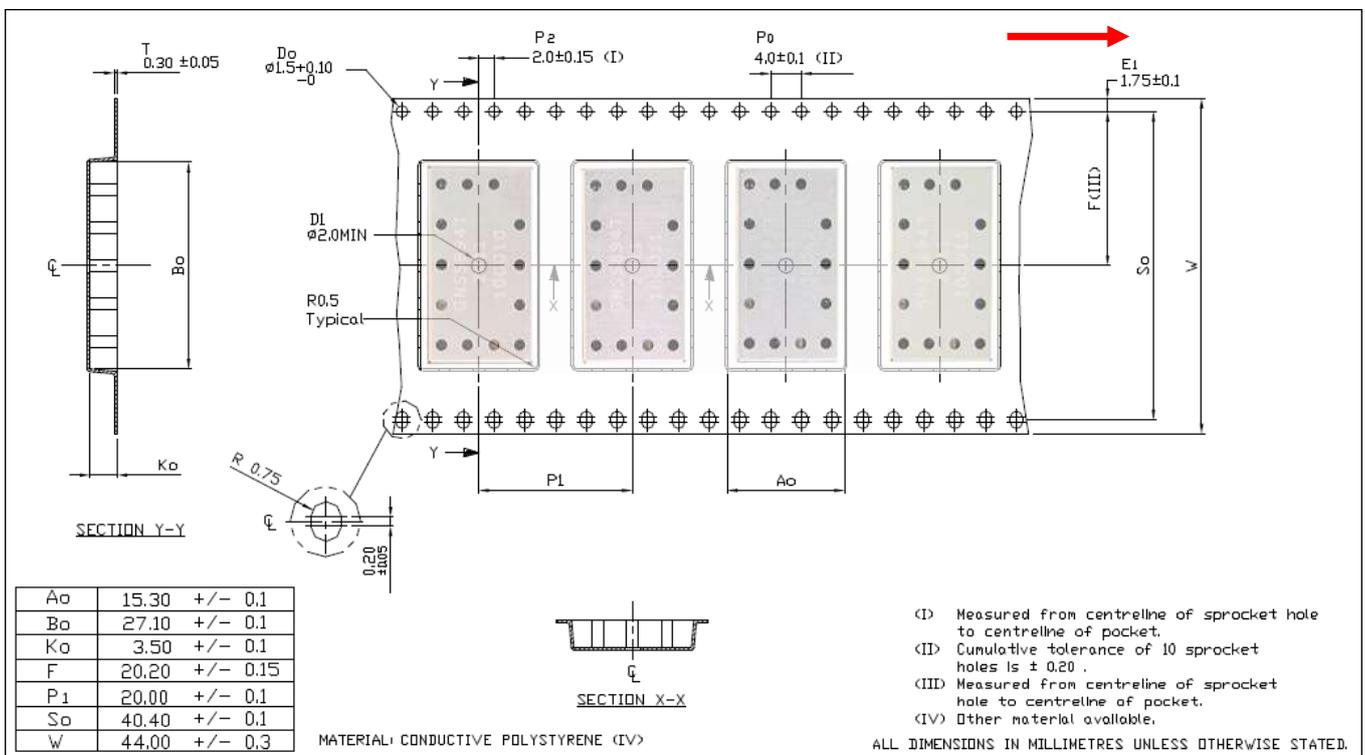


Notes:

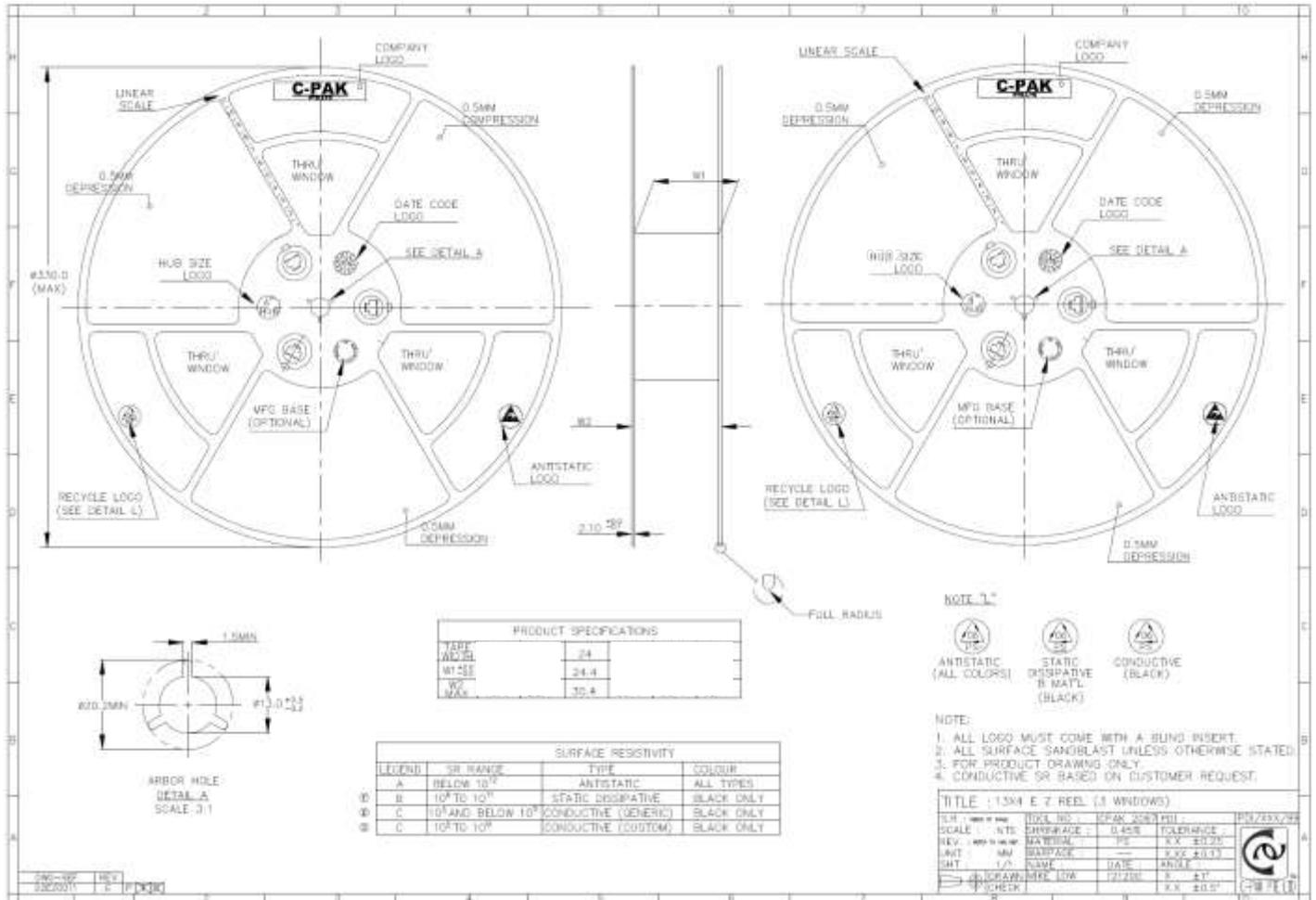
1. GNS 5851 should be soldered in upright soldering position. In case of head-over soldering, please prevent shielding / GNS 5851 Module from falling down.
2. Do never exceed maximum peak temperature
3. Reflow cycles allowed : 1 time
4. Do not solder with Pb-Sn or other solder containing lead (Pb)
5. 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 5851 AIS module	4037735100718	GNS 5851 <yy cw> <serial# >	AIS module

17 ENVIRONMENTAL INFORMATION

This product is free of environmental hazardous substances and complies to 2015/863/EU. (RoHS 3 directive).

17.1 Quality and Environmental Specifications

Test	Standard	Parameters
PCB Inspection	IPC-6012B, Class 2. Qualification and Performance Specification for Rigid Printed Boards - Jan 2007	
Assembly Inspection	IPC-A-610-D, Class 2 "Acceptability of electronic assemblies"	
Temperature Range	ETSI EN 300 019-2-7 specification T 7.3	-30 °C, +25 °C, +85 °C, operating
Damp Heat	ETSI EN 300 019-2-7 specification T 7.3	+70 °C, 80% RH, 96 hrs, non-operating
Thermal Shock	ETSI EN 300 019-2-7 specification T 7.3 E	-40 °C ... +85 °C, 200 cycles
Vibration	ISO16750-3	Random vibration, 10~1000Hz, 27.8m/s ² , 8hrs/axis, X, Y, Z 8hrs for each 3 axis non-operating
Shock	ISO16750-3	Half-sinusoidal 50g, 6ms, 10time/face, ±X, ±Y and ±Z non-operating
ESD Sensitivity	JEDEC, JESD22-A114 ESD Sensitivity Testing Human Body Model (HBM), Class 2 JEDEC, JESD22-A115 ESD Sensitivity Testing Machine Model (MM), Class B	+2000V - Human hand assembly +250V - Machine automatic final assembly
Moisture/Reflow Sensitivity	IPC/JEDEC J-STD-020	MSL3
Storage (Dry Pack)	IPC/JEDEC J-STD-033C	MSL3
Solderability	EN/IEC 60068-2-58 Test Td	More than 90% of the electrode should be covered by solder. Solder temperature 245 °C ± 5 °C

Moisture Sensitivity

GNS ships all devices dry packed in tape on reel with desiccant and moisture level indicator sealed in an airtight package. If on receiving the goods the moisture indicator is pink in color or a puncture of the airtight seal packaging is observed, then follow J-STD-033 "Handling and Use of Moisture/Reflow Sensitive Surface Mount Devices".

Storage (Out of Bag)

The GNS 5851 modules meet MSL Level 3 of the JEDEC specification J-STD-020D – 168 hours Floor Life (out of bag) ≤30 °C/60% RH. If the stated floor life expires prior to reflow process then follow J-STD-033 "Handling and Use of Moisture/Reflow Sensitive Surface Mount Devices".

18 DOCUMENT REVISION HISTORY

Version	Revision	Date	Author	comment
V0.9	Preliminary	2021-08-30	C. Diehl	First version based on existing production hardware
V0.9.1	Preliminary	2023-04-25	C. Diehl	Added chaining interface
V1.0	Production	2023-06-06	C. Diehl	Finalized chaining interface description

Document status

- Objective: Objective specification, document content for design purpose, informal release
- Preliminary: Key customer preview version, document content has been preliminarily tested and verified, indicators may be fine-tuned later
- Beta: Document content is verified by complete product testing and content indicators
- Production: The document is complete and final

19 DISCLAIMER

THE USE OF THE DATA RECEIVED WITH GNS 5851 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.

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