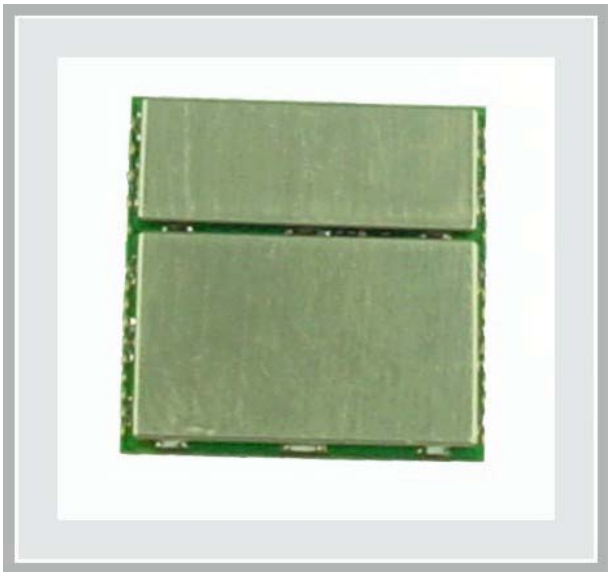
GPS-Receiver JP7

Description



Version 1.02

Contents

Version history

Version number	Author	Changes
1.00	Fadil Beqiri	Initial version
1.01	Fadil Beqiri	Chapter “Technical data” at bullet “protocol”
1.02	Fadil Beqiri	JP7 does not support the trickle power mode.

0 Introduction

0.1 General

This description is focussed on the GPS receiver of the FALCOM JP7 series from FALCOM GmbH. It contains short information about purpose and use of the FALCOM JP7 . The JP7 is a single-board 12 parallel channel receiver intended as a component for OEM products. The GPS receiver continuously tracks all satellites in view, thus providing accurate satellite position data. The highly integrated digital receiver uses the SiRFstarII-Low Power chipset.
Please consult SiRF (www.sirf.com) for special information about the SiRFstarII-Low Power chipset.

Information furnished herein by FALCOM GmbH is believed to be accurate and reliable. However, no responsibility is assumed for its use. Also the information contained herein is subject to change without notice.

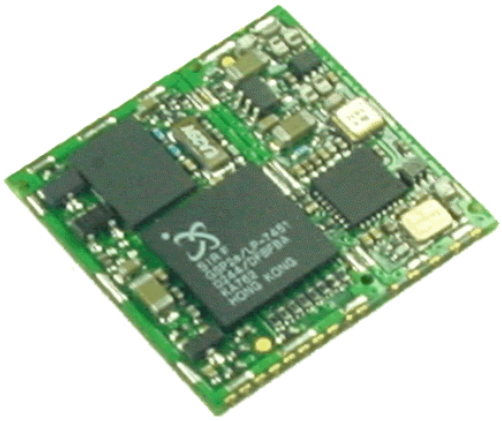


Figure 1: The FALCOM JP7 GPS receiver (top view)

Users are advised to proceed quickly to the chapter "Security" and read the hints carefully.

0.2 Used abbreviations

Abbreviation	Description
DGPS	Differential GPS
DOP	Dilution of Precision
GPS	Global Positioning System
GGA	GPS Fixed Data

Abbreviation	Description
LNA	Low Noise Amplifier
NMEA	National Maritime Electronics Association
PRN	Pseudorandom Noise Number – The Identity of GPS satellites
RF	Radio Frequency
RP	Receive Protocol
RTC	Real Time Clock
RTCM	Radio Technical Commission for Maritime Services
RXD	Data input
TXD	Data output
SA	Selective Availability
WAAS	Wide Area Augmentation System
MSK	Minimum Shift Keying
PCB	Printed Circuit Board

0.3 Related documents

[1.] SiRF binary and NMEA protocol specification;
www.falcom.de/service/downloads/manual/SiRF
[2.] SiRF- demo;
www.falcom.de/service/downloads/manual/SiRF

1 Security

This chapter contains important information for the safe and reliable use of the GPS receiver. Please read this chapter carefully before starting to use the GPS receiver.

1.1 General information

The Global Positioning System uses satellite navigation, an entirely new concept in navigation. GPS has become established in many areas, for example, in civil aviation or deep-sea shipping. It is making deep inroads in vehicle manufacturing and before long everyone of us will use it this way or another.
The GPS system is operated by the government of the United States of America, which also has sole responsibility for the accuracy and maintenance of the system. The system is constantly being improved and may entail modifications effecting the accuracy and performance of the GPS equipment.

1.2 Restricted use

Certain restrictions on the use of the GPS receiver may have to be observed on board a plane, in hospitals, public places or government institutions, laboratories etc. Follow these instructions.

1.3 Children

Do not allow children to play with the GPS receiver. It is not a toy and children could hurt themselves or others. The GPS receiver consists of many small parts which can come loose and could be swallowed by small children. Thoughtless handling can damage the GPS receiver.

1.4 Operation/antenna

Operate the GPS receiver with an antenna connected to it and with no obstruction between the receiver and the satellite.
Make absolutely sure that the antenna socket or antenna cable is not shorted as this would render the GPS receiver dysfunctional.
Do not use the receiver with a damaged antenna. Replace a damaged antenna without delay. Use only a manufacturer-approved antenna. Use only the supplied or an approved antenna with your GPS receiver. Antennas from other manufacturers which are not authorized by the supplier can damage the GPS receiver.
Technical modifications and additions may contravene local radio-frequency emission regulations or invalidate the type approval.

Authorized GPS antennas:
FALCOM ANT-006 (active)

1.5 Electrostatic Discharge (ESD)

The JP7 GPS receiver contains class 1 devices. The following Electrostatic Discharge (ESD) precautions are recommended:

- Protective outer garments.
- Handle device in ESD safeguarded work area.
- Transport device in ESD shielded containers.
- Monitor and test all ESD protection equipment.
- Treat the JP7 GPS receiver as extremely sensitive to ESD.

2 Safety standards

The GPS receiver meets the safety standards for RF receivers and the standards and recommendations for the protection of public exposure to RF electromagnetic energy established by government bodies and professional organizations, such as directives of the European Community, Directorate General V in matters of radio frequency electromagnetic energy.

3 Technical data

FEATURES

- OEM single board 12 channel GPS receiver
- dimensions: 25,4 x 25,4 x 3 mm
- weight: 2,5 g (without shielding)
- operating voltage: 3.3 V DC ±5 %
- power consumption: 220 mW (continuous mode with Low Power chipset)
- temperature range: -40 to +85 °C (operation, transportation and storage)
- protocol: RXA/TXA:
  NMEA 9600 baud, Msg.: GLL, GGA, RMC, VTG, GSV, GSA
  8 data bits, no parity, 1 stop bit
  RXB/TXB:
  RTCM, 9600 baud

4 Technical Description

4.1 Receiver Architecture

The JP7 OEM GPS receiver from FALCOM is a new OEM GPS receiver product that features the SiRFstarII-Low Power chipset. This complete 12 channel, WAAS-enabled GPS receiver provides a vastly superior position accuracy performance in a much smaller package. The SiRFstarII architecture builds on the high-performance SiRFstarI core, adding an acquisition accelerator, differential GPS processor, multipath mitigation hardware and satellite-tracking engine. The JP7 delivers major advancements in GPS performance, accuracy, integration, computing power and flexibility.

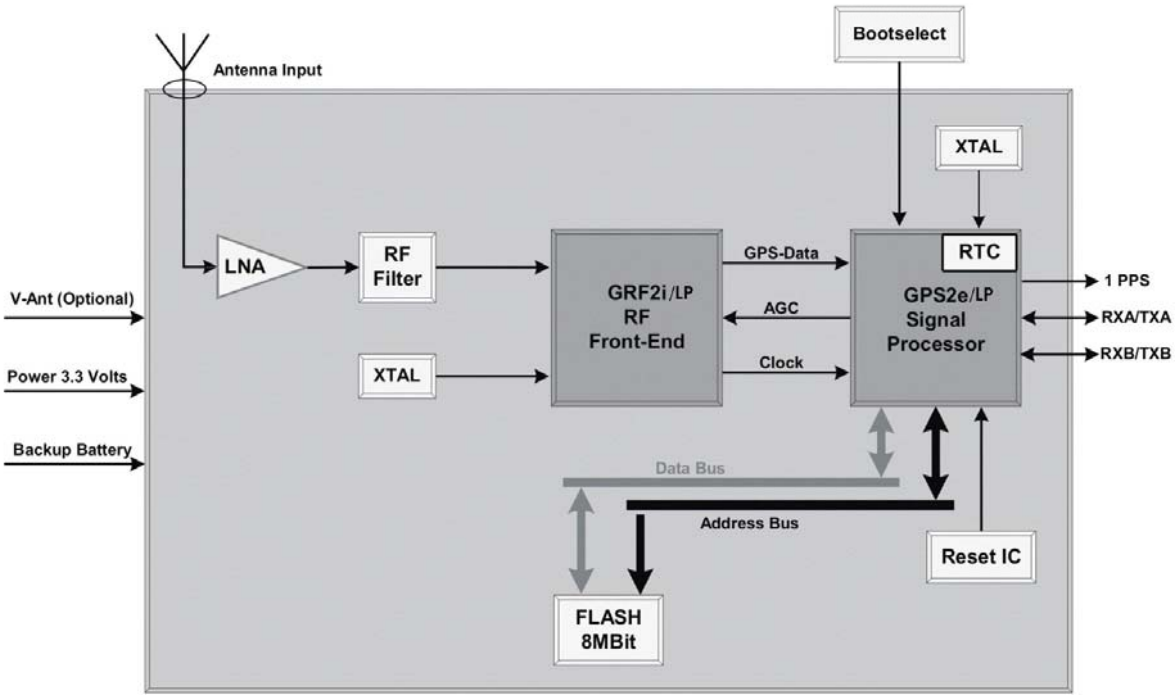


Figure 3: Receiver architecture of the GPS receiver JP7

4.2 Product applications

- Handheld GPS receiver applications
- Automotive applications
- Marine navigation applications
- Aviation applications
- Timing applications

4.3 Technical specifications

4.3.1 Electrical Characteristics

4.3.1.1 General

Frequency	L1, 1575.42 MHz
C/A code	1.023 MHz chip rate
Channels	12

4.3.1.2 Accuracy

Position	10 meters CEP without SA
Velocity	0.1 meters/second, without SA
Time	1 microsecond synchronized to GPS time

4.3.1.3 DGPS Accuracy

Position	1 to 5 meters, typical
Velocity	0.05 meters/second, typical

4.3.1.4 Datum

WGS-84

4.3.1.5 Acquisition Rate

Snap start	< 3 sec., average
Hot start	< 8 sec., average
Warm start	< 38 sec., average
Cold start	< 45 sec., average

4.3.1.6 Dynamic Conditions

Altitude	18,000 meters (60,000 feet) max.
Velocity	< 515 meters/second (1000 knots) max.
Acceleration	4 g, max.
Jerk	20 meters/second³, max.

4.3.1.7 DC Power

Main power	+ 3.3 V DC ±5 %
Continuous mode	65 mA at 3.3 V DC
Backup battery power	typical 3 V DC (min. 1.85 V, max. 3.6 V)

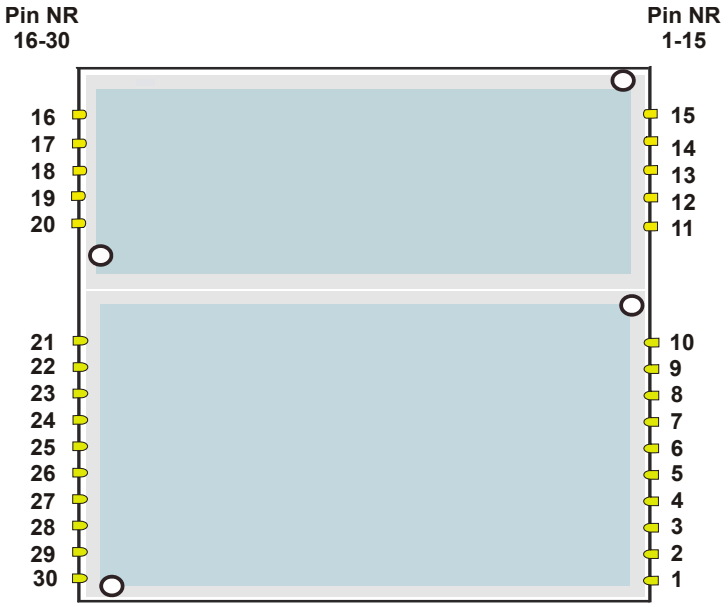
4.3.1.8 Serial Port

Electrical interface	Two full duplex serial communication, CMOS.
Protocol messages	SiRF binary and NMEA-0183, version 2.20 with a baud rate selection SiRF binary – position, velocity, altitude, status and control NMEA – GGA, GLL, GSA, GSV, RMC and VTG
DGPS protocol	RTCM SC-104, version 2.00, type 1, 5 and 9

4.3.1.9 Time – 1PPS Pulse

Level	CMOS
Pulse duration	100 ms
Time reference	At the pulse positive edge
Measurements	Aligned to GPS second, ± microsecond

4.4 Hardware interface



Pin	Name	I/O	Description	Level
1	VCC	I	Supply voltage	3.3 V DC
2	GND		Digital ground	
3	BOOTSELECT	I	Boots in debug mode, if high	CMOS
4	RXA	I	Serial Data Input A	CMOS
5	TXA	O	Serial Data Output B	CMOS

Pin	Name	I/O	Description	Level
6	TXB	O	Serial Data Output B	CMOS
7	RXB	I	Serial Data Input A	CMOS
8	GPIO3	I/O	See chapter 4.4.4	
9	RF_ON	O	High if RF part on RF chip is on	CMOS
10	GND		Digital ground	
11	RF_GND		Analog ground	
12	RF_GND		Analog ground	
13	RF_GND		Analog ground	
14	RF_GND		Analog ground	
15	RF_GND		Analog ground	
16	RF_GND		Analog ground	
17	RF_IN	I	50 Ohms @ 1.575 GHz	
18	RF_GND		Analog ground	
19	V_ANT	I	Power supply for active antenna	CMOS
20	VCC_RF	O	2.85V of RF section	CMOS
21	V_BAT		Power for RTC	
22	RESET_N	I	Resets the unit if low	CMOS
23	GPIO10		See chapter 4.4.4	CMOS
24	GPIO6		See chapter 4.4.4	CMOS
25	GPIO5		See chapter 4.4.4	CMOS
26	GPIO7		See chapter 4.4.4	CMOS
27	GPIO0		See chapter 4.4.4	CMOS
28	GPIO1		See chapter 4.4.4	CMOS
29	T-MARK	O	One pulse per second	CMOS
30	GND		Digital ground	

Table 1: Pin assignment of the interface connector

4.4.1 Configuration and timing signals

RESET_N (Pin 22) This pin provides an active-low reset input to the board. It causes the board to reset and start searching for satellites. Reset is an optional input and, if not utilized, it may be left open.

T-MARK (Pin 29) This pin provides 1 pulse per second output from the board, which is synchronized to within 1 microsecond of GPS time. The output is a CMOS level signal.

BOOT_SELECT (Pin 3) Set this Pin to high for programming the flash of the JP7 (for instance updating to a new firmware for the JP7).

4.4.2 Serial communication signals

The board supports two full duplex serial channels. All four connections are at CMOS levels. All support variable baud rates and all can be controlled from the appropriate screens in SiRFdemo software. You can directly communicate with a PC serial port.

RXA (Pin 4) This is the main receiving channel and is used to receive software commands to the board from SiRFdemo software or from user written software.

RXB (Pin 7) This is the auxiliary receiving channel and is used to input differential corrections to the board to enable DGPS navigation.

TXA (Pin 5) This is the main transmitting channel and is used to output navigation and measurement data to SiRFdemo or user written software.

TXB (Pin 6) For user's application.

4.4.3 DC input signals

VCC (Pin 1)	This is the main DC power supply for 3,3 V powered board JP7 .
V_ANT (Pin 19)	This pin is reserved for an external DC power supply for active antenna. This pin is optional and hardware changing is required upon request. **Note: The GPS receiver JP7 has to be connected with an active 3 V GPS antenna (max. current of 25 mA). The antenna voltage is provided by the internal power management.**

4.4.4 General purpose input/output (Pin 8, 23, 24, 25, 26, 27 and 28)

Several I/O's of the CPU are connected to the hardware interface connector of the JP7. They are reserved for customer specific applications.
For example:

- For realization a SPI-Bus
- For realization an Antenna-indication.

These pins are not supported by the current GPS firmware.

5 Software interface

The FALCOM JP7 supports NMEA-0183 and SiRF binary protocols. A short description of these protocols are provided herein.
For more detailed information please refer to the SiRFstarII message set specification available in the section "service/downloads/manuals" at FALCOM homepage.

5.1 SiRF binary data message

Table 2 lists the message list for the SiRF output messages.

Hex	ASCII	Name	Description
0 x 02	2	Measured Navigation Data	Position, velocity and time
0 x 03	3	True Tracker Data	Not implemented
0 x 04	4	Measured Tracking Data	Satellite and C/No information
0 x 06	6	SW Version	Receiver software
0 x 07	7	Clock Status	Current clock status
0 x 08	8	50 BPS Subframe Data	Standard ICD format
0 x 09	9	Throughput	Navigation complete data
0 x 0A	10	Error ID	Error coding for message failure
0 x 0B	11	Command Acknowledgement	Successful request
0 x 0C	12	Command No Acknowledgement	Unsuccessful request
0 x 0D	13	Visible List	Auto Output
0 x 0E	14	Almanac Data	Response to Poll
0 x 0F	15	Ephemeris Data	Response to Poll
0 x 10	16	Test Mode 1	For use with SiRFtest (Test Mode 1)
0 x 11	17	Differential Corrections	Received from DGPS broadcast
0 x 12	18	Ok To Send	CPU ON/OFF (Trickle Power)
0 x 13	19	Navigation Parameters	Response to Poll
0 x 14	20	Test Mode 2	Additional test data (Test Mode 2)
0 x 1C	28	Nav. Lib. Measurement Data	Measurement Data

Hex	ASCII	Name	Description
0 x 1D	29	Nav. Lib. DGPS Data	Differential GPS Data
0 x 1E	30	Nav. Lib. SV State Data	Satellite State Data
0 x 1F	31	Nav. Lib. Initialization Data	Initialization Data
0 x FF	255	Development Data	Various status messages

Table 2: SiRF Output Messages

Table 3: lists the message list for the SiRF input messages.

Hex	ASCII	Name	Description
0 x 55	85	Transmit Serial Message	User definable message
0 x 80	128	Initialize Data Source	Receiver initialization and associated parameters
0 x 81	129	Switch to NMEA Protocol	Enable NMEA message, output rate and baud rate
0 x 82	130	Set Almanac (upload)	Sends an existing almanac file to the receiver
0 x 84	132	Software Version (Poll)	Polls for the loaded software version
0 x 85	133	DGPS Source Control	DGPS correction source and beacon receiver information
0 x 86	134	Set Main Serial Port	Baud rate, data bits, stop bits and parity
0 x 87	135	Switch Protocol	Obsolete
0 x 88	136	Mode Control	Navigation mode configuration
0 x 89	137	DOP Mask Control	DOP mask selection and parameters
0 x 8A	138	DGPS Mode	DGPS mode selection and timeout value
0 x 8B	139	Elevation Mask	Elevation tracking and navigation masks
0 x 8C	140	Power Mask	Power tracking and navigation masks
0 x 8D	141	Editing Residual	Not implemented
0 x 8E	142	Steady-State Detection – not used	Not implemented

Hex	ASCII	Name	Description
0 x 8F	143	Static Navigation	Configuration for static operation
0 x 90	144	Poll Clock Status (Poll)	Polls the clock status
0 x 91	145	Set DGPS Serial Port	DGPS port baud rate, data bits, stop bits and parity
0 x 92	146	Poll Almanac	Polls for almanac data
0 x 93	147	Poll Ephemeris	Polls for ephemeris data
0 x 94	148	Flash Update	On the fly software update
0 x 95	149	Set Ephemeris (upload)	Sends an existing ephemeris to the receiver
0 x 96	150	Switch Operating Mode	Test mode selection, SV ID and period
0 x 97	151	Set Trickle Power Parameters	Push to fix mode, duty cycle and on time
0 x 98	152	Poll Navigation Parameters	Polls for the current navigation parameters
0 x A5	165	Set UART Configuration	Protocol selection, baud rate, data bits, stop bits and parity
0 x A6	166	Set Message Rate	SiRF binary message output rate
0 x A7	167	Low Power Acquisition Parameters	Low power configuration parameters
0 x B6	182	Set UART Configuration	Obsolete

Table 3: SiRF Input Messages

5.2 NMEA data message

The SiRFstarIIe evaluation receiver is capable of outputting data in the NMEA-0183 format as defined by the National Marine Electronics Association (NMEA), Standard for Interfacing Marine Electronic Devices, Version 2.20, January 1, 1997.

5.2.1 NMEA output messages

Table 4 lists all NMEA output messages supported by SiRFstarIIe evaluation receiver and a brief description.

Option	Description
GGA	Time, position and fix type data.
GLL	Latitude, longitude, UTC time of position fix and status.
GSA	GPS receiver operating mode, satellites used in the position solution and DOP values.
GSV	The number of GPS satellites in view satellite ID numbers, elevation, azimuth and SNR values.
MSS	Signal-to-noise ratio, signal strength, frequency and bit rate from a radio-beacon receiver.
RMC	Time, date, position, course and speed data.
VTG	Course and speed information relative to the ground.

Table 4: NMEA Output Messages

5.2.2 NMEA input messages

Message	MID[1]	Description
Set Serial Port	100	Set PORT A parameters and protocol
Navigation Initialization	101	Parameters required for start using X/Y/Z[2]
Set DGPS Port	102	Set PORT B parameters for DGPS input
Query/Rate Control	103	Query standard NMEA message and/or set output rate
LLA Navigation Initialization	104	Parameters required for start using Lat/Lon/Alt[3]
Development Data On/Off	105	Development Data messages On/Off
MSK Receiver Interface	MSK	Command message to a MSK radio-beacon receiver.

Table 5: NMEA Input Messages

1. Message Identification (MID).
2. Input co-ordinates must be WGS84.
3. Input co-ordinates must be WGS84.

Note: NMEA input messages 100 to 105 are SiRF proprietary NMEA messages. The MSK NMEA string is as defined by the NMEA 0183 standard.

5.2.3 Transport Message

Start Sequence	Payload	Checksum	End Sequence
$PSRF<MID>[1]	Data[2]	*CKSUM[3]	<CR> <LF>[4]

1. Message Identifier consisting of three numeric characters. Input messages begin at MID 100.
2. Message specific data. Refer to a specific message section for <data>...<data>definition.
3. CKSUM is a two-hex character checksum as defined in the NMEA specification. Use of checksums is required on all input messages.
4. Each message is terminated using Carriage Return (CR) Line Feed (LF) which is \r\n which is hex 0D 0A. Because \r\n are not printable ASCII characters, they are omitted from the example strings, but must be sent to terminate the message and cause the receiver to process that input message.

Note: All fields in all proprietary NMEA messages are required, none are optional. All NMEA messages are comma delimited.

6 Mechanical draw

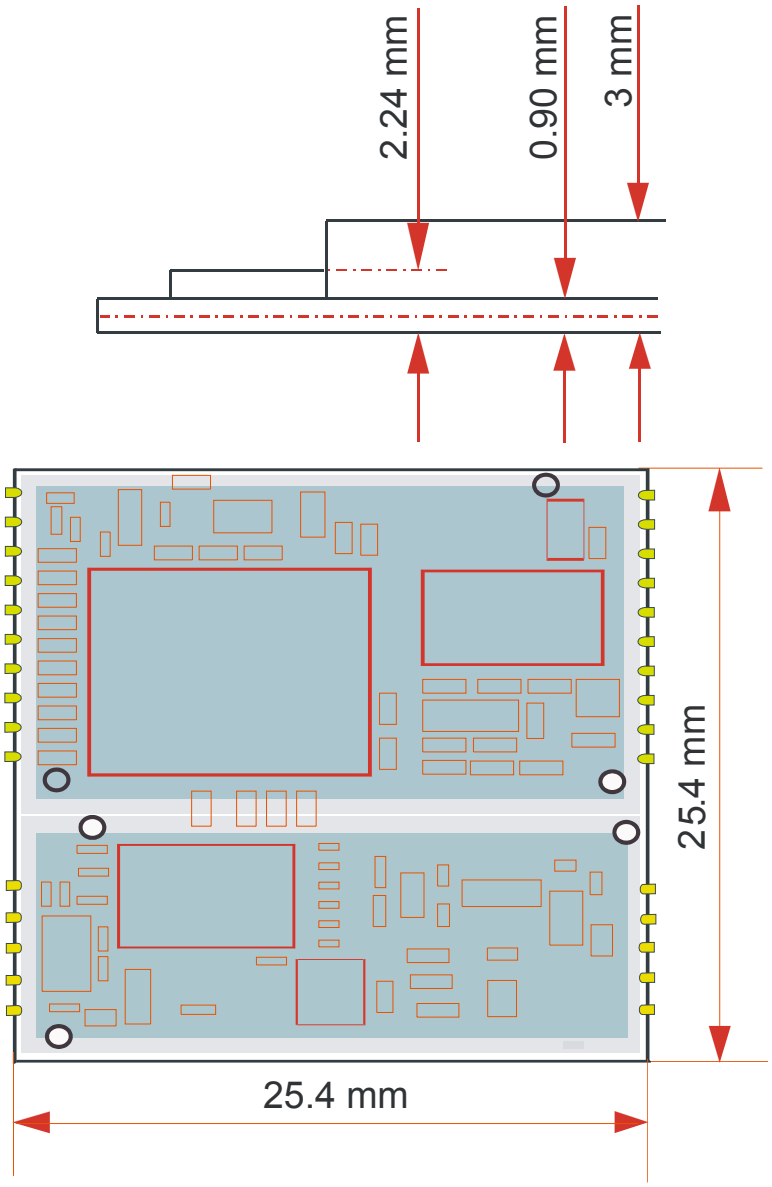


Figure 4: The mechanical draw of the JP7

7 Layout recommendation

7.1 Ground planes

JP7 GPS receiver needs two different ground planes. The pins RF_GND (Pins 11, 12, 13, 14, 15, 16, 18) shall be connected to analog ground, the pins GND (Pins 2, 10, 30) to digital ground.

The two ground planes shall be separated :

- the planes are connected inside the receiver (see Figure 5).

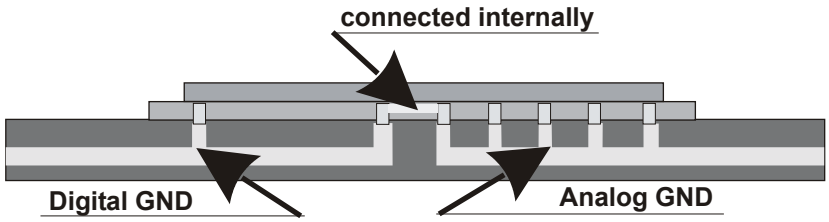


Figure 5: Ground plane of the JP7 GPS receiver

7.2 RF connection

The JP7 GPS receiver can be connected to a passive patch antenna or an antenna connector without expensive RF cables. The RF connection is on the PCB and connects the RF pin (pin 17) with the antenna feed points or the signal pin of the connector, respectively (see Figure 5)

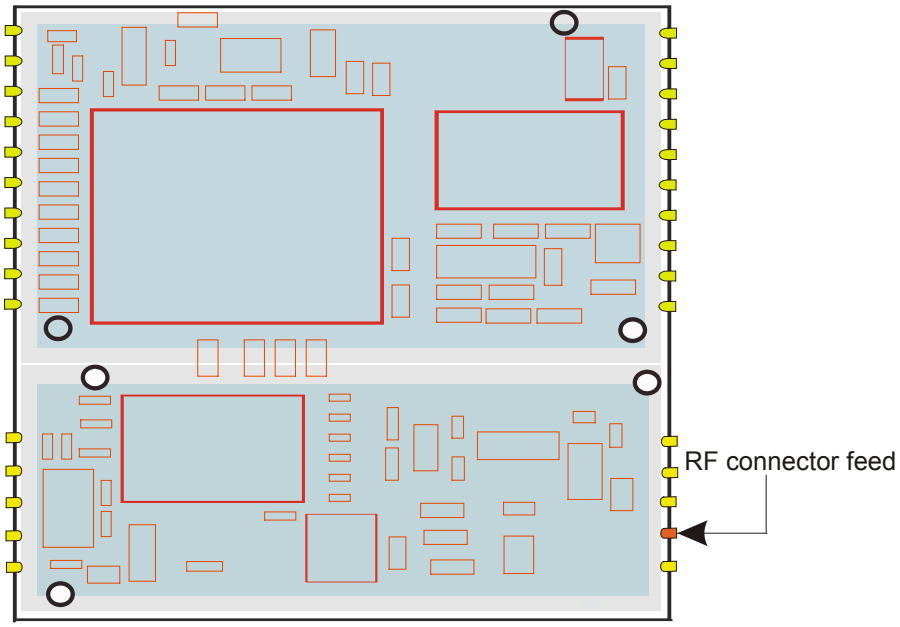


Figure 6: RF connection to antenna feed of the JP7 GPS receiver.

Recommendations for layout, pads and soldering

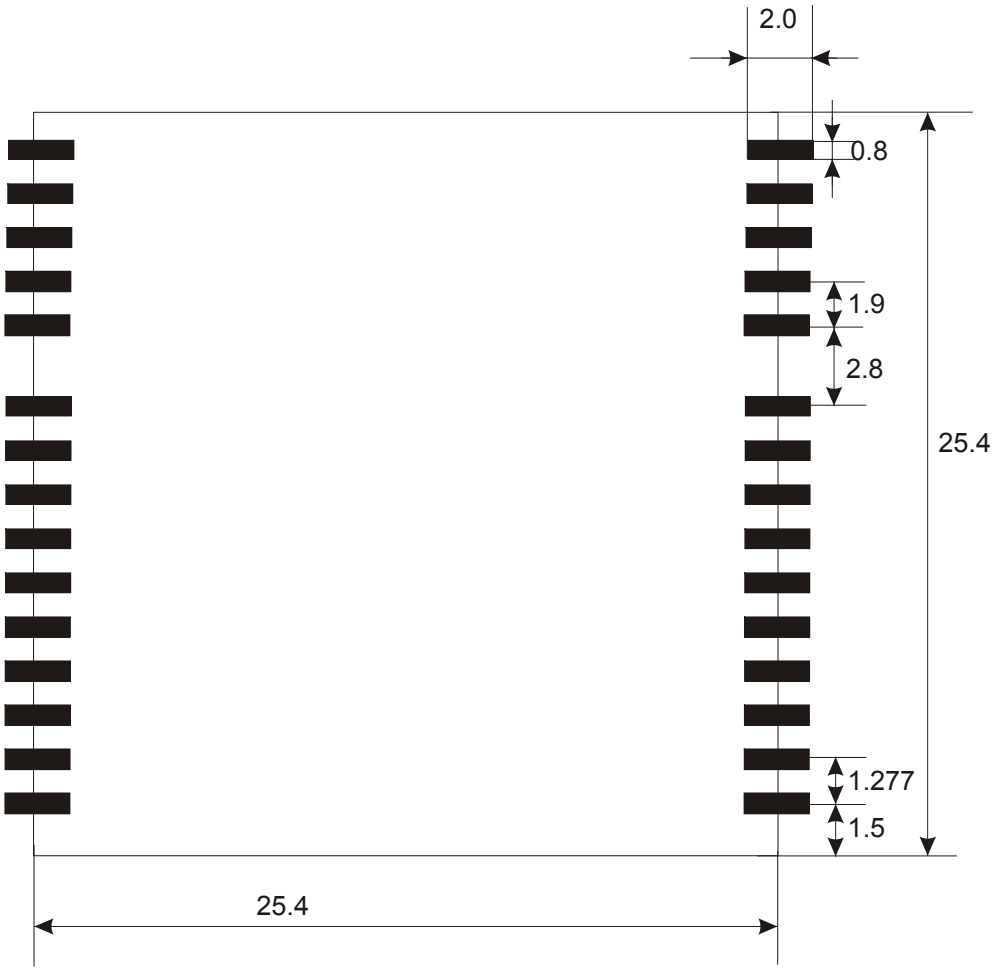


Figure 7: Recommendations for layout and pads.

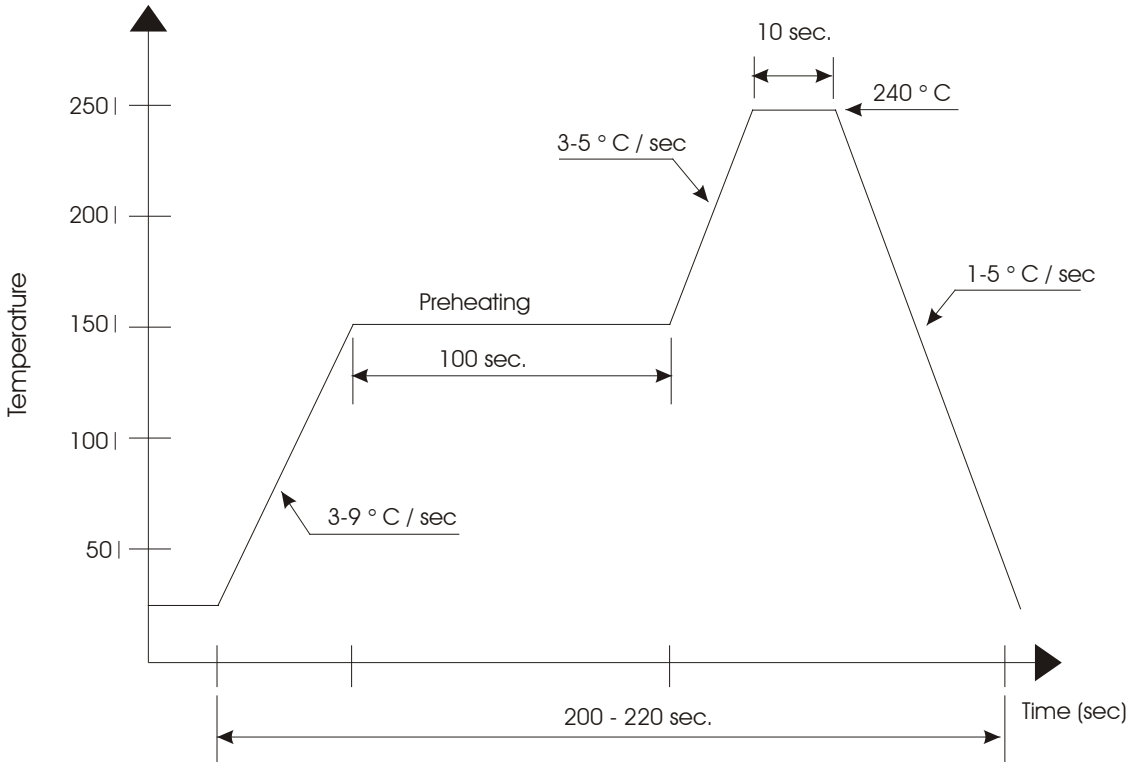


Figure 8: Typical solder conditions (temperature profile, reflow conditions).

The figure below shows the bottom-side of the JP7 GPS receiver.
The four solderable rectangles on the bottom side of the JP7 are soldering pads, that ensure a better mechanical stability. The four pads must not be connected among themselves and not to the Ground.
See also section 7.

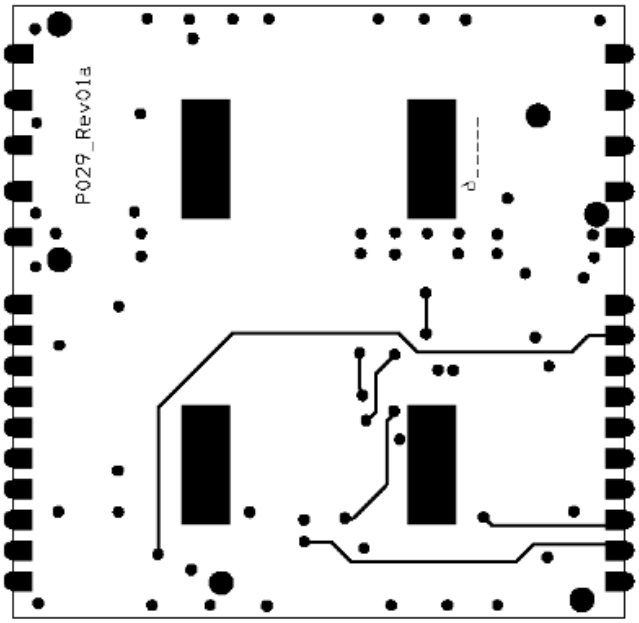


Figure 9: Bottom-side of the JP7 GPS receiver

8 First steps to make it work

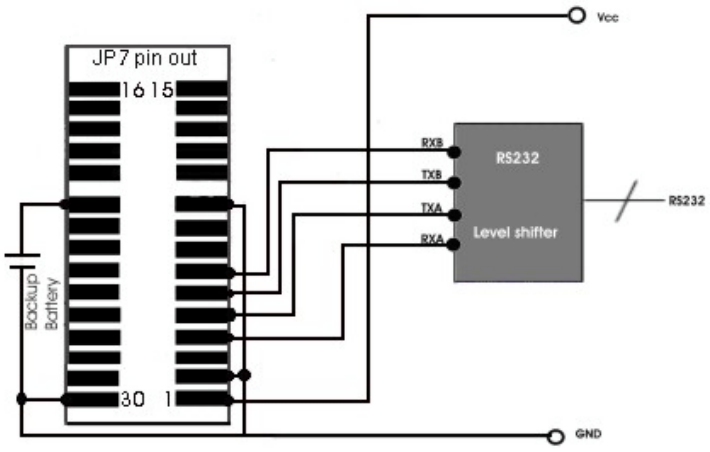


Figure 10 :

- **Antenna**: The connection to the antenna has to be routed on the PCB. Use a controlled impedance line to connect RF_IN to the antenna or antenna connector of your choice.

- **Power:** Connect GND pins to ground, and connect Vcc pin to 3.3 V. The power supply should be capable of delivering a sustained current of at least 200 mA. A proper RESET signal is internally generated.

- **Serial Interface:** Pins RXA, RXB and TXA, TXB are 3.3 V CMOS compatible. The RX inputs and the TX outputs are 5 V TTL compatible. If you need different voltage levels, use appropriate level shifters. E. g. in order to obtain RS232 compatible levels use the 3 V compatible MAX3232 from Maxim or equivalent. GPS data will be transmitted through port A, if an active antenna is connected, which has a good view to sky (No obstacle). You can use port B to feed in DGPS correction data. Pull-up (100 kΩ) unused RX inputs.

- **Active Antenna Bias Voltage:** The output voltage at the antenna cable can be used to power the bias voltage of the antenna, provided can make sure that the antenna runs down to 2.7 V bias voltage and the current does not exceed 20 mA.

- **Backup Battery** It is recommended to connect a backup to VBatt in order to enable the warm and hot start features of the receivers. The voltage at this pin can be anywhere between 1.85 V and 3.6 V. If you don't intend to use a backup battery, connect this pin to GND or leave it open. Do not use a super cap for the battery backup supply (recommended by SiRF).

The quickest way to get first results with the JP7 is to use the JP7 Evaluation board together with the program SiRFdemo.

Figure 11: JP7 Evaluation board

The Evaluation board contains:
- Evaluation Box
- JP7 sample with soldered antenna cable.
- power supply
- active GPS antenna
- RS232 level shifter
- RS232 cable to your computer.

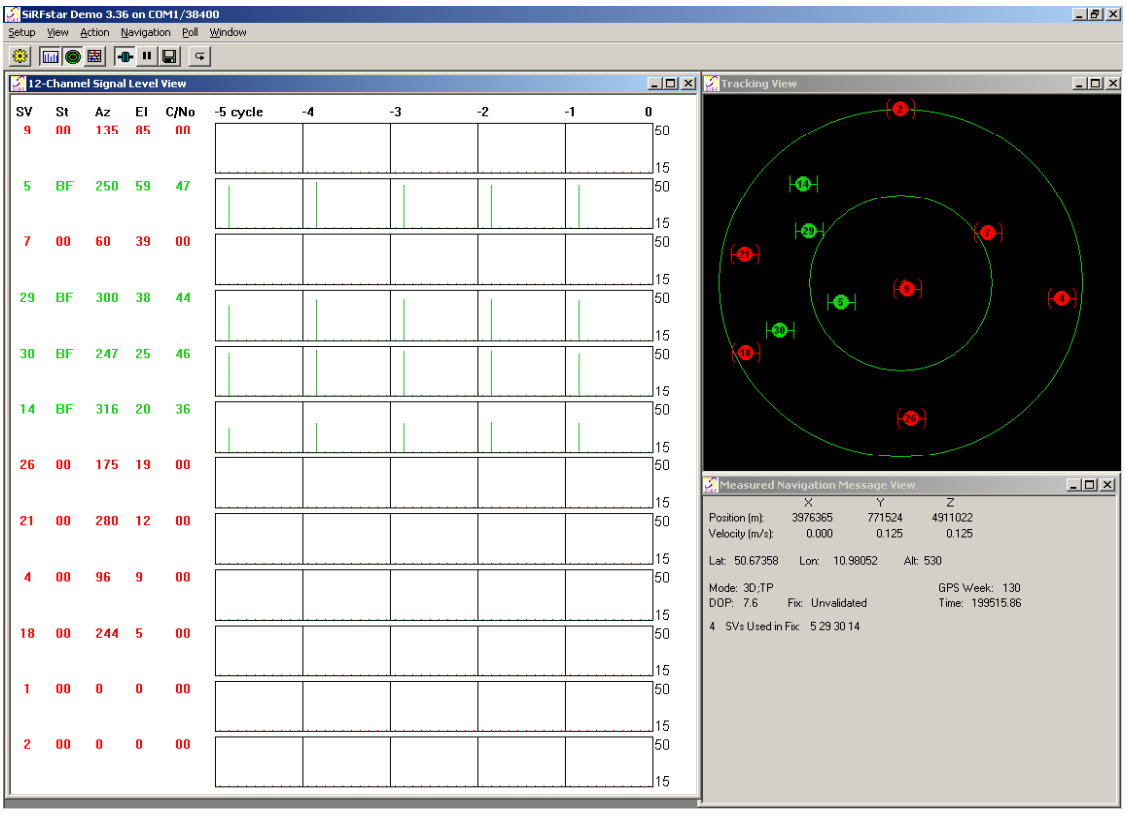


Figure 12: Example of using of the SiRFdemo

The SiRFdemo Software is available on the Falcom's Website for free download:

➔ www.falcom.de/service/downloads/manual/SiRF