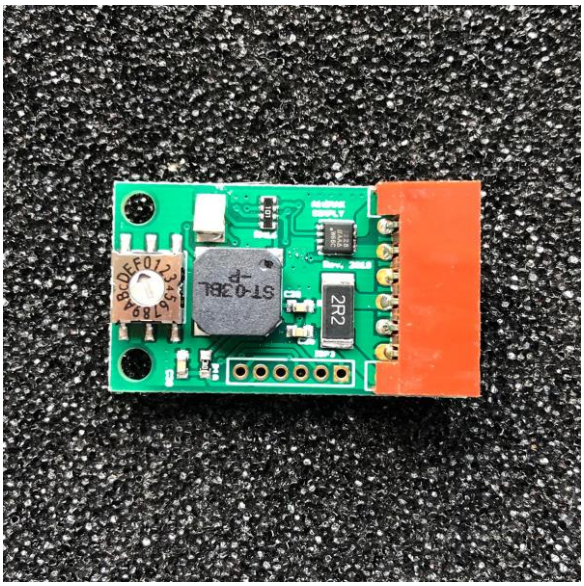
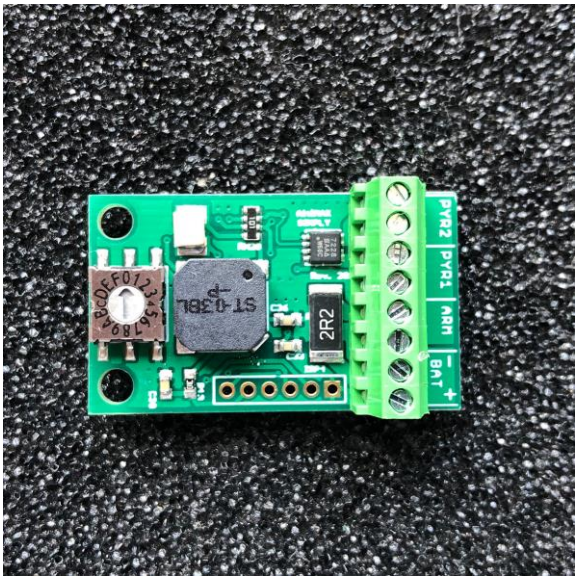
AltiMAX! Rocketry Altimeter

Manual
AltiMAX! Simply 2018

01.01.2020





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Handling

Like every electronic module, the ALTIMAX is also sensitive to ESD, i.e. static discharge, within limits. All conceivable safety precautions have been taken to keep the sensitivity as low as possible. The ALTIMAX has an electrically insulating protective layer that is unique in the rocket sector and protects the contacts from contact. Nevertheless, the contacts of the ALTIMAX should never be touched directly with the fingers. The protective layer also keeps water and dirt away, even black powder vapours cannot harm the ALTIMAX, but you should still protect it from them. For storage, each AltiMAX is delivered in an antistatic box, please keep your AltiMAX in it even if it is not in a rocket.

Technical data

	Altimax Simply
Dimensions	40x20 mm
Weight	5 g
Input voltage:	3,3 – 15 V
Power consumption	Ca.5 mA
Pressure area	10 – 1200 hpa
Height range	-170 – 31000 m AGL
Pyro outputs	2
Ignition duration	1 sec
Ignition voltage	=Battery voltage
Max. ignition current	9A
Resolution Height	ca. +- 0,15 m
Sampling rate Pressure	204.800 sps

Functions

The <Simply >is a simple rocket altimeter, with very simple operation. It can be used for one or two stage recovery or as a backup for another altimeter. It measures the altitude barometrically, determines the exact apogee point using a digital Kalman filter and can activate ignition outputs at the apogee, 2 seconds after the apogee or at adjustable altitudes. Typically, channel 1 ejects a drogue chute, channel 2 the main parachute.

The following functions can be set <Simply >by turning the rotary switch:

0: Standard: Channel 1 is ignited at the apogee, channel 2 at the descent to 150m (Same as No. 4)

1: Channel 1 is ignited at the apogee, channel 2 when descending to 60m
2: Channel 1 is ignited at the apogee, channel 2 when descending to 90m
3: Channel 1 is ignited at the apogee, Channel 2 when descending to 120m
4: Channel 1 is ignited at the apogee, Channel 2 when descending to 150m
5: Channel 1 is ignited at the apogee, Channel 2 when descending to 200m

A: Channel 1 is ignited 2 seconds after reaching the apogee, Channel 2 at 60m
B: Channel 1 is ignited 2 seconds after reaching the apogee, Channel 2 at 90m
C: Channel 1 is ignited 2 seconds after reaching the apogee, Channel 2 at 120m
D: Channel 1 is ignited 2 seconds after reaching the apogee, Channel 2 at 150m
E: Channel 1 is ignited 2 seconds after reaching the apogee, Channel 2 at 200m

Zu A-E: The delayed ignition of channel 1 (i.e. 2 seconds after the apogee) is useful when using the <Simply >as a backup to another altimeter. The 2 second delay is useful to prevent two charges from being ignited at the same time, this could damage the model.

Special functions:

F: Automatic ignitor test, which activates an alarm sound when the unit is switched on for 20 seconds. After these 20 seconds channel 1 is ignited. Then follows 5 beeps, one per second. Then channel 2 is ignited. This function allows ejection tests on the ground with the rocket ready to fly. Remember: Function "F" as in "fire."

Functions 6 to 9 are intended for air ignition:

6: Channel 1 is ignited at the peak, channel 2 as soon as the start is detected by the system, that is somewhere between 6 and 12 m height.
7: Channel 1 is ignited at the peak, channel 2 at approx. 30 m
8: Channel 1 is ignited at the peak, channel 2 at approx. 60 m
9: Channel 1 is ignited at the peak, channel 2 at approx. 90 m

Beep tones

The <Simply >is deliberately kept simple to save costs, so it has no other means of communication than an LED and a beeper, the LED flashes at the same rate as the beeps, the light is helpful when you can't hear the beeps, a small hole in the rocket's hull allows you to see the light of the LED.

The beeps are used to output data. On the one hand, the status of the ignition outputs, i.e. the conductivity of connected igniters, is indicated by this: continuity is always indicated by a double beep, no continuity by a long beep. Since it has two ignition outputs, channel 1 and channel 2 follow each other.

Example:

Channel 1 and channel 2 have continuity:	Peep-Peep ---- Peep Peep
Channel 1 has continuity, channel 2 does not:	Peep-Peep --- Peeeeep
Channel 1 has no continuity, channel 2 has continuity:	Peeeeep --- Peep-Peep

After switching on, the status of the pyros is first beeped, followed by a short pause and the last altitude reached:

The height is output in single digits starting with the highest decimal place:

123 m will sound as peep --- peep peep --- peep peep peep
1 2 3

A zero is indicated by a long beep:

204 m sound like this: peep peep --- peeeeeep --- peep peep peep peep
2 0 4

After that there is a long beep, which signals the arming. At this point the <Simply >is armed, it is now waiting for the rocket to take off, which is done by measuring lower air pressure. (This can be tested on the ground by putting the <Simply >switched on in a bag and vacuuming it with a vacuum cleaner)

In this armed state, the pyro states are now output repeatedly.

After take-off the internal flight program follows, the ignition channels are switched according to the switch settings. At some point each rocket lands, which the <Simply >recognizes by a constant air pressure. After landing, the height reached is continuously beeped out. Here you can switch off Simply, because when you switch it on again, the last altitude is always beeped out once.

The beep sequence is therefore as follows:

- Status channel 1
- Status channel 2
- Last flight altitude
- Arming tone
- Constant repeating Status channel 1 and channel 2
- Flight operation (no sound, flies high above the earth)
- Touchdown: Repeatedly established flight level in meters.

Startup procedure

1. **Switching on**
   The AltiMAX performs the self test, if the test is not passed a loud alarm sounds. If the test is passed, stage 2 follows:
2. **Output of the igniter states channel 1 and channel 2**
   Two short beeps for "continuity", one long beep for "interruption",
   first pyro 1 and then pyro 2 are displayed.
   beep-beep ----------beep beep = All 2 igniters OK
   beep-beep ----------beeeeeeep = Pyro1 OK, Pyro2 not!
3. **Output of the last height**
   The altitude of the last flight is indicated by beeps. Each digit of the altitude is beeped out individually, e.g. at 123 m e.g. beep --- beep beep --- beep beep beep between the digits is a pause, a zero is output as a long beep.
4. **Calibration**
   The <Simply >then measures the current pressure values on the pad and calculates its flight parameters from this. The status is switched to "armed". All this takes place in a few milliseconds.
5. **Arming**
   A very long beep indicates “arming”. At this point <Simply >waits for the start
6. **Current igniter test (As in point 2)**
   The igniters are measured and the status is indicated by beeps:
   Two short beeps for "continuity", one long beep for "interruption",
   first pyro 1 and then pyro 2 are displayed.
   beep-beep ----------beep beep = All 2 igniters OK
   beep-beep ----------beeeeeeep = Pyro1 OK, Pyro2 not!
   In this state the AltiMAX waits for the start, which it detects when a height of about 6-12 m above the pad has been exceeded.
7. **Event control**
   During the flight the <Simply >searches for the peak or for the points at which outputs should be switched.
8. **Descend until landing**
   During the descent the AltiMAX continues to measure the altitude to determine if the "Altitude Descent" is undercut. At this altitude the channel 2 is then switched
9. **Landing**
   The landing is detected 4 seconds after the real landing, for 4 seconds the height must be within 2 m. After the landing, the height reached is continuously displayed. You can then switch off, the altitude will be displayed once again when you switch it on again before the <Simply >is armed again (see point 4).

Technology

CPU-Kernel:
The <Simply >has an 8 MHz fast controller Mega644p from Atmel, this has 64 KByte Flash for the program, which is used to approx. 55%. The whole system runs with 3.3V.
The operating system was written in E-Lab Pascal and has a multitasking kernel, the individual processes for control run quasi-parallel.

Power supply:
The core runs with 3.3 V operating voltage generated by an LDO voltage regulator. Therefore a 3.7 V battery voltage is sufficient for operation, for safety reasons the AltiMAX blocks from 2.7V voltage. Attention: The operating voltage may drop briefly to 2.7V, as long as the core and the sensors continue to function. We recommend using a 2s-lipo with 7.4V!

Sensors:
The <Simply >has only one pressure sensor on board, which is highly accurate and temperature compensated. It is calibrated very accurately at the factory and can even be used to calibrate pressure gauges. The expected height resolution is only +-15cm. The pressure gauge is used to measure heights and find the peak.

Outputs:
2 ignition outputs, these are switched with a dual mosfet transistor over a 2 ohm resistor as current limiter. The maximum output current is 2.4A at 7.4V operating voltage and 1.2A at 3.7V operating voltage. The <Simply >is only suitable for bridge igniter A! The current limiter prevents the battery voltage from dropping too much during ignition.

System test
When the electronics are started, the system performs a comprehensive system test, testing the memory, sensors, battery voltage, altitude values and ignition outputs. If a problem is detected, an alarm sounds and the AltiMAX blocks.

Function

To determine the altitude the Altimax measures the air pressure. For this purpose there must be a connection from the electronics chamber to the outside, usually some holes are drilled into the rocket case. Due to the decreasing air pressure during ascent, the altitude can be calculated very accurately.

After the altimeter is switched on, a self-test is carried out; if it is successful, it waits for an adjustable time, the "assembly time". After that the altimeter is armed, the sensors are set to "0". From then on the control unit waits for the rocket to take off, which it can detect by decreasing pressure. At a height of about 12 m an ascent is recognized as a start. From then on the different stages are waited for and reacted according to the set actions.

The AltiMAX measures air pressure over 200,000 times per second. The pressure value is fed into a filter and every 5 ms an average value is calculated from 1024 measured values. This average value is used for the evaluation. Values that are significantly above the average value (spikes) are ignored. Thus, disturbances caused by wind and errors in the sensor are filtered out.

Through the continuous measurement the control system "knows" in which position the rocket is located, for this purpose a flight status is set internally. This then ranges from "start" to "landing", whereby there are various flight stages in between, including engine burn, peak, overshoot, undershoot, etc.

If no change in altitude is detected for 4 seconds after reaching the summit, the landing mode is activated. All flight data is saved, then the reached flight altitude is displayed.

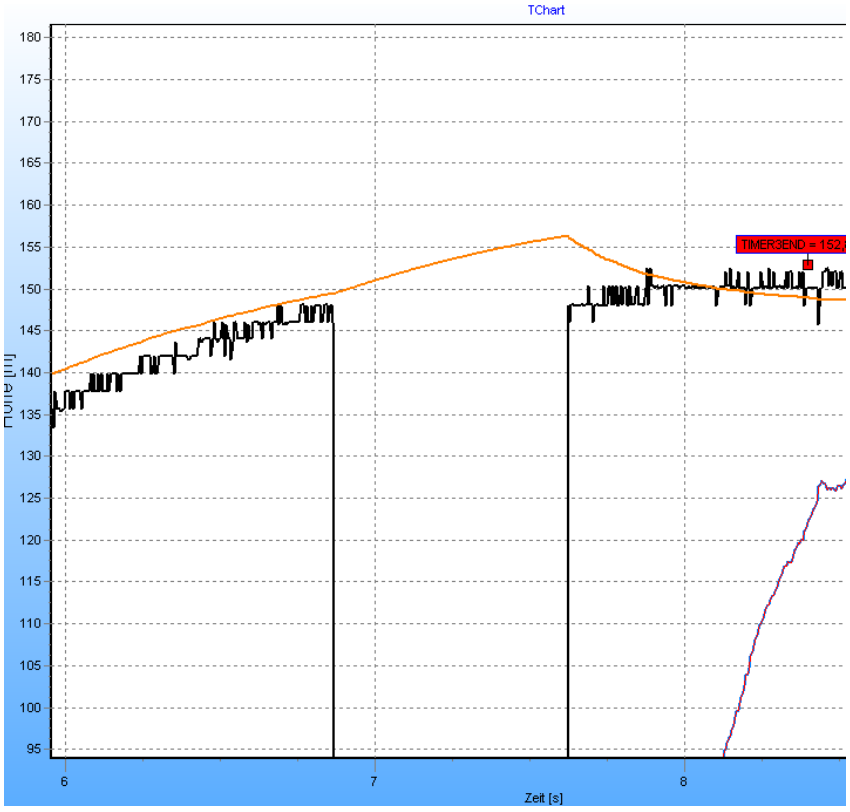
Kalman Filter

The Altimax <Simply >is one of the few rocket altimeters that use a digital Kalman filter for evaluation. For this purpose, the pre-filtered data is evaluated by the digital Kalman filter. The filter provides an estimated value for the air pressure, but also the velocity and acceleration of the rocket. For this purpose, it compares the measured values with a theoretical model of the rocket. From these data, the filter determines the pressure value, the acceleration and the velocity.

You can imagine: A mathematical model of the rocket flight is stored in the memory, functions that describe the relationship between pressure change, acceleration and speed. The filter calculates from the measured pressure values with these functions how the values for the next moment will probably be. So it looks into the future, so to speak, and predicts the flight data. At the same time it determines the maximum error that the sensor could deliver.

This error estimation can be used to filter out wrong values which cannot be so based on the flight movement. For example, strong pressure fluctuations occur during supersonic flight, which would be interpreted as strong flight movements without a filter. The Kalman filter "knows", however, that the rocket is currently flying straight upwards at high speed, so the pressure values cannot be correct. Therefore it <Simply >ignores these fluctuations. Failures of the pressure sensor are also ignored within certain limits, the filter then continues to calculate with the estimated value.

This is shown nicely in this graphic: The pressure values from the sensor are black, they are completely interrupted here for almost a whole second, the sensor is off. The orange curve (the values from the filter) is almost unimpressed by this! Without filter, a peak passage would have been detected here.

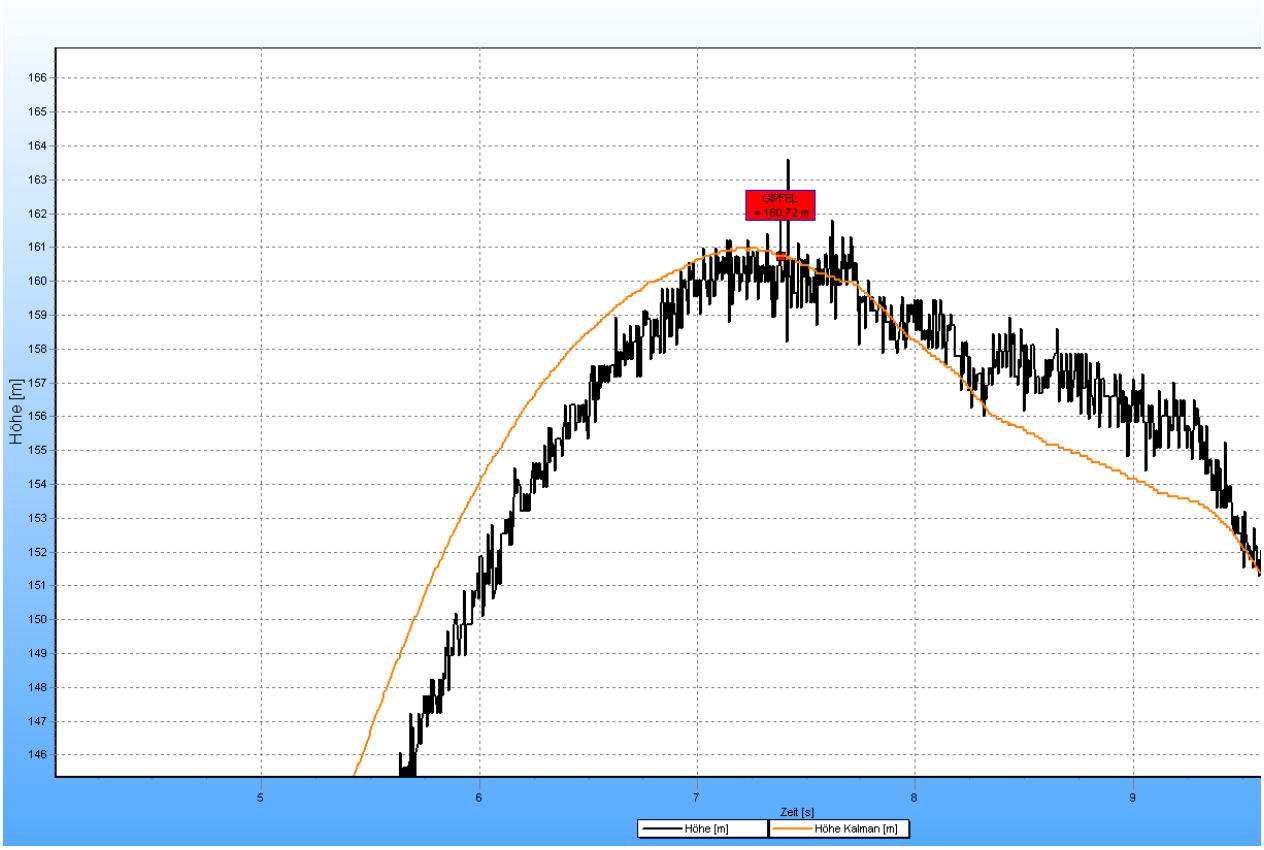


By the way, the Apollo Guidance Computer was one of the first computers to use a Kalman filter to filter position data. The filter contributed significantly to the very high precision and was a decisive factor in the success of the Apollo program.

From the filter data the position of the rocket is determined continuously, 200 times per second. If the vertical velocity is zero, this is detected as a peak event. This is the point with the lowest vertical velocity.

This elaborate filtering makes it possible to detect the peak much more accurately than with the old method, which waited for an increase in pressure. Even "turning" rockets are intercepted safely in this way, because the point of return to the ground is always recognized as the peak.

Example: peak detection exactly in the peak



Installation

The following things must be taken into account during installation:

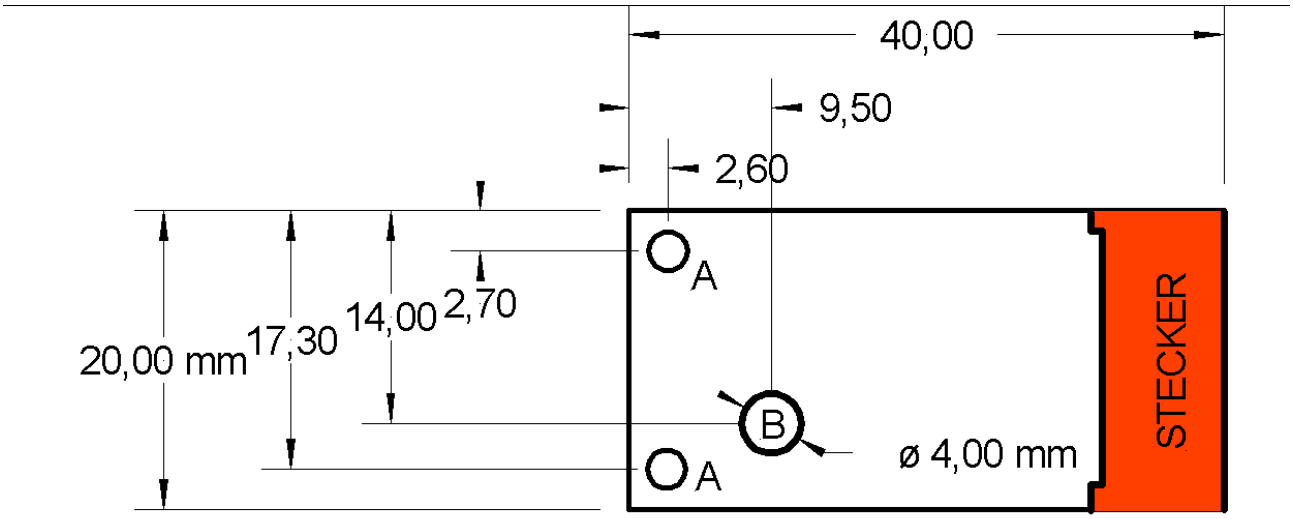
- Drill 3 ventilation holes of approx. 1.5 mm - Without ventilation holes no external pressure can be measured, ergo no recovery can be controlled.

- Stable attachment, the altimeter must not come loose during flight!

- Pressure-tight installation - No black powder vapours from the ejection charges may enter the electronics chamber, these cause the contacts to corrode. The overpressure of an exploding charge can damage the pressure sensor
- Distance to the base approx. 4-5 mm or more so that the pressure sensor below has enough air.

  The exact installation dimensions can be found here, fixing with M2.5 screws Please note the ventilation hole B, approx. 4-5 mm large, so that sufficient air can reach the pressure sensor.

Installation dimensions:



A = mounting hole 3,2 mm
B = Ventilation hole if distance to base < 4mm

Power supply

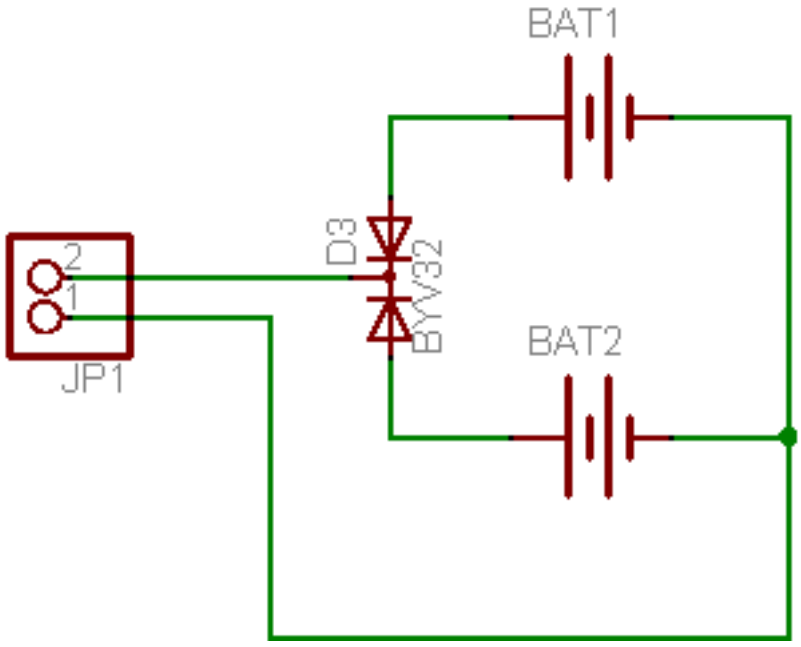
The AltiMAX <Simply >requires at least 3.3 V voltage, below this voltage it refuses to operate and beeps with a continuous alarm tone. In this case NEVER START, but 7.4V is recommended. 3.3V is the absolute minimum.

I recommend the use of LIPO batteries, these are defined to charge and can deliver high currents, small and light they are also, so ideal for rockets. For the AltiMAX I recommend 2S lipos with a nominal voltage of 7.4 V. A 30x20 mm small 300 mAH battery can power the AltiMAX for a good 60 hours.

9V blocks are available in many versions, and only with new ones do you know how full they really are. Cheap types can fail at high accelerations, so watch out!

The power supply is one of the main reasons for failure in recovery. Correct dimensioning is therefore very important.

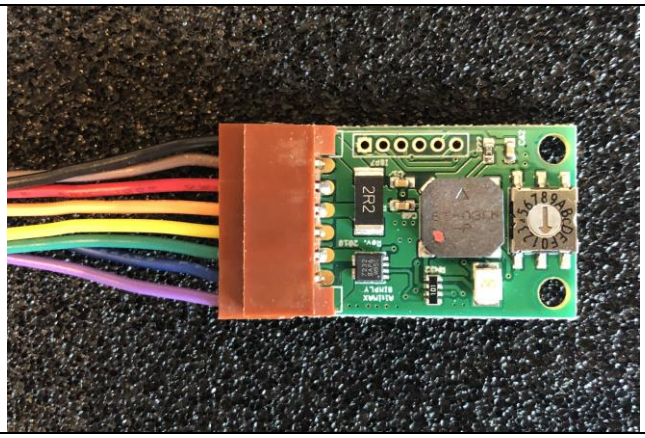
Redundancy:
Ideal is the supply from 2 batteries which are decoupled with a Schottky diode. If one battery fails, the other takes over. A BYV32 diode in a TO220 housing is an indestructible choice.



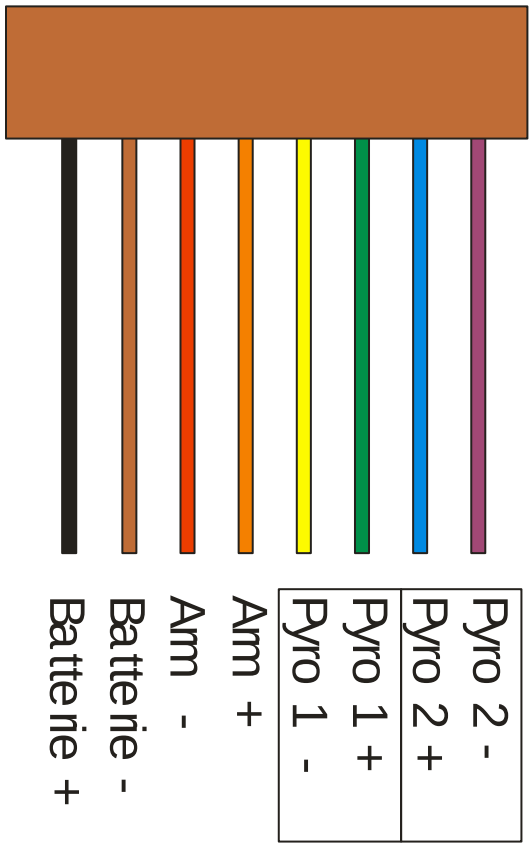
Electrical connection AltiMAX Simply

The connection is made with directly to the cables of the plug. The plugs are board connectors, 8-pin. These can be ordered from me, or from Reichelt under the Reichelt No PS 258W BR
The <Simply >is also available with screw terminals which have the same designation.

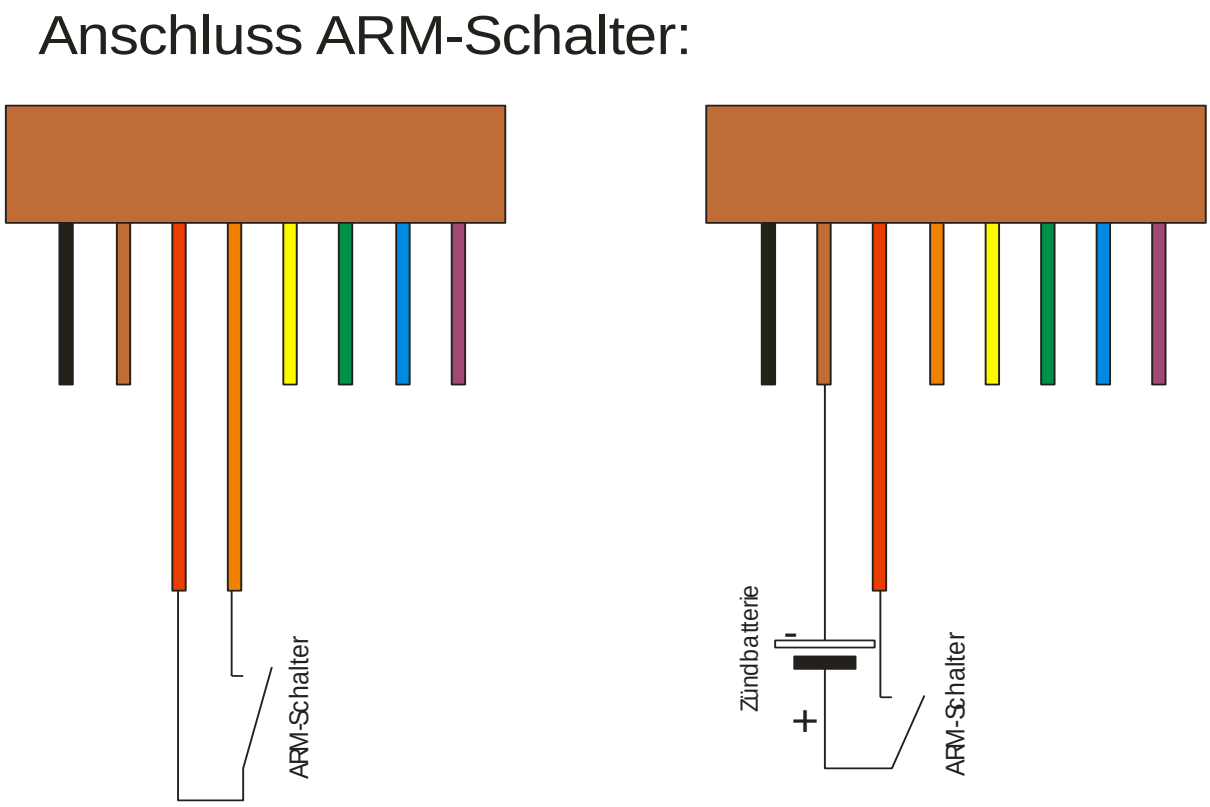
Use batteries with >3.3V, i.e. at least full 1s lipos or 9V block. Maximum voltage 15V! Please note that the black cable is the PLUSPOLE!

Signal	Cable colour	
Battery + Battery -	Black Brown	
Arming + Arming -	Red Orange	
Pyro 1 + Pyro 1 -	Yellow Green	
Pyro 2 + Pyro 2 -	Blue Purple	

AltiMAX Simply



ARM-Switch



ATTENTION:
It is essential to provide an arming switch
-or –
connect the two contacts

OTHERWISE NO IGNITER WILL BE TRIGGERED!

For normal models I recommend the use of a wire bridge, because the many tests have shown that a false triggering practically does not occur. A bridge switch can be forgotten at the start, a fixed bridge cannot!

External ignition battery

For high ignition currents, a separate ignition battery can be connected to the arming connector, positive pole via an ARM switch to terminal 3, negative pole to terminal 2 (see figure above). The FETs on the AltiMAX <Simply >can switch continuous current up to 9A, so be careful with external batteries! Lipos easily deliver 40A and more in case of short circuit.

Igniters and expelling charges:

The AltiMAX <Simply >can only fire low current ignite bridge igniter A (SN0)!
Never use high current igniters, they are not reliably ignited or damage the output stages.

Automatic pyro test:

An automatic pyro test is possible. This test runs automatically after activation by turning the rotary switch to "F" like "Fire".

After switching on, the test starts:
You hear an alternating tone sounds for 20 seconds.
After this, 5 tones are sounded at 1-second intervals, then igniter 1 is triggered for 3 seconds, then again 5 tones are sounded at 1-second intervals, then igniter 2 is triggered for 3 seconds

Power-on
Alternating tone for 20 seconds
Peep – peep – peep- peep – peeeep – Ignition Igniter 1 for 3 s
Peep – peep – peep- peep – peeeep – Ignition Igniter 2 for 3 s

The test is aborted by <Simply >switching off the AltiMAX.
The total test takes a minimum of 36 seconds, 20 seconds waiting time, 5 seconds before each ignition, the igniters are activated for 3 seconds each.

Exclusion of liability and warranty

The use of the ALTIMAX is at your own risk. The function of the ALTIMAX must always be protected by a differently working safety system, for example an engine output or other electronics.

The manufacturer is not liable for damages of any kind, which have occurred in any connection with the use of the ALTIMAX, not even to third parties. Software cannot be developed absolutely error-free according to the current state of the art, therefore any liability by the manufacturer is excluded even in the case of demonstrable program errors or other malfunctions.

The ALTIMAX is covered by a limited warranty of one year from the date of purchase, at the manufacturer's discretion. This expressly does not include damage caused by crashes or incorrect handling by the user. As the manufacturer has no influence on the handling of the module, which contains electrostatically sensitive components, damage caused by ESD (electrostatic discharge) is also excluded from the warranty. Repair or replacement free of charge will only be granted in case of obvious manufacturing defects,

Contact

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