



Application Note: AS3932-AN01 – Demo Kit Manual

AS3932

3D Low Frequency Wake-up Receiver

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Revision History

| Revision | Date | Owner | Description |
|----------|------------|-------|--|
| 2.0 | 06.02.2013 | JRY | Update of existing Appnote to new corporate format |

1 General Description

The AS3932 Demo Board demonstrates the main features of the AS3932. These include 3D wake-up pattern detection, readout of false wake-ups, possibility to measure current consumption in different operating modes, and measurement access to SPI communication and data output. Additional features are accessible via USB through the GUI that was developed for easy access to the register map. Features such as the programmable wake-up pattern, adjustable sensitivity level, low power listening modes and several more can be programmed via the GUI. The influence different settings have on the detection efficiency can be observed right away by using the 125 kHz Wake-up Transmitter Board.

1.1 Kit Content

The AS3932 Demo Kit contains the following items:

- 1x AS3932 Demo Board
- 1x 125kHz Wake-up Transmitter Board
- 1x 9V power supply
- 2x CR2032 Coin Cell
- 1x USB stick
- 1x USB Cable

2 Getting Started

- Connect the +9V DC Power Supply at “**F**” on the 125 kHz Wake-up Transmitter Board.
- Start to transmit Wake-up Patterns via AUTO “**C**” or PATTERN “**B**”.
- Insert the +3V Battery at “**H**” of the AS3932 Demo Board.
- Turn on the AS3932 Demo Board via the ON/OFF – switch “**C**”. When turning on the boards all indication-LEDs flash up once.
- As soon as the AS3932 Demo Board receives a Wake-up Pattern, the RSSI LEDs flash up for 0.5s and show the actual Received Signal Strength. At the same time the X, the Y, or the Z LED flashes up and indicates which channel got the strongest signal.

3 Hardware Description

3.1 AS3932 Receiver Board

Figure 1: Demo Board Description

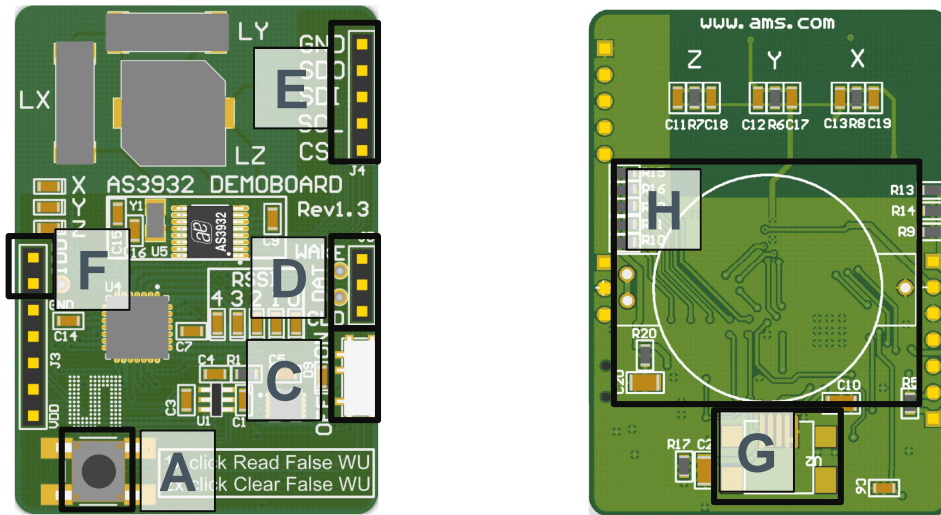


Figure 2: Mechanical Elements

| Label | Name | Description | Info |
|-------|---------------|---|---|
| A | BUTTON | 1x short press reads the false wake-ups | The number of false wake-ups can be read out and are displayed via the RSSI-LEDs |
| A | BUTTON | 2x short press (double-click) clears false wake-ups | Pressing the button twice in quick succession resets the number of false wake-ups. Each RSSI-LED lights up shortly. |
| C | ON/OFF | ON/OFF – Switch | Power on/off the demo board. The power source (battery or USB) is automatically detected. |
| G | USB-Connector | Mini USB 5-pin Connector | USB interface for the GUI |
| H | CR2032 | Battery Holder | Insert CR2032 coin cell here |

Figure 3: Indication LEDs

| LEDs | Blinking Colour | Info |
|---------------|-----------------|--|
| RSSI (5 bits) | Red LEDs | Received Signal Strength Indication. Displays the received signal strength whenever a wake-up occurs. When pressing the False Wake-up button these LEDs display the number of false wake-ups that have occurred since the False Wake-up register was last reset. |
| X | Red LED | Strongest wake-up signal received on channel 1 (X) |
| Y | Red LED | Strongest wake-up signal received on channel 2 (Y) |
| Z | Red LED | Strongest wake-up signal received on channel 3 (Z) |

Figure 4: Jumper Description

| Jumper | Name | Description | Info |
|--------|------|---------------------------|---|
| F | IDD | Supply Current | The supply current of the AS3932 can be measured. Set this jumper for normal operation. |
| D | | AS3932 specific outputs | |
| | D1 | WAKE | Wake output interrupt |
| | D2 | DAT | Data output |
| | D3 | CL_DAT | Manchester recovered clock |
| | | Microcontroller Interface | The SDI interface from the microcontroller can be replaced by a proprietary solution |
| E | E1 | CS | Serial digital interface chip select |
| | E2 | SCL | Serial digital interface clock |
| | E3 | SDI | Serial digital interface input |
| | E4 | SDO | Serial digital interface output |
| | E5 | GND | Ground (0V) |

Note: Before connecting the AS3932 to the GUI it is necessary to RESET the device. This can be done by turning the board OFF and ON via switch “C” or by pressing buttons “A” and “B” at the same time before connecting the USB cable.

3.2 125 kHz Wake-up Transmitter Board

Figure 5: Transceiver Board Description

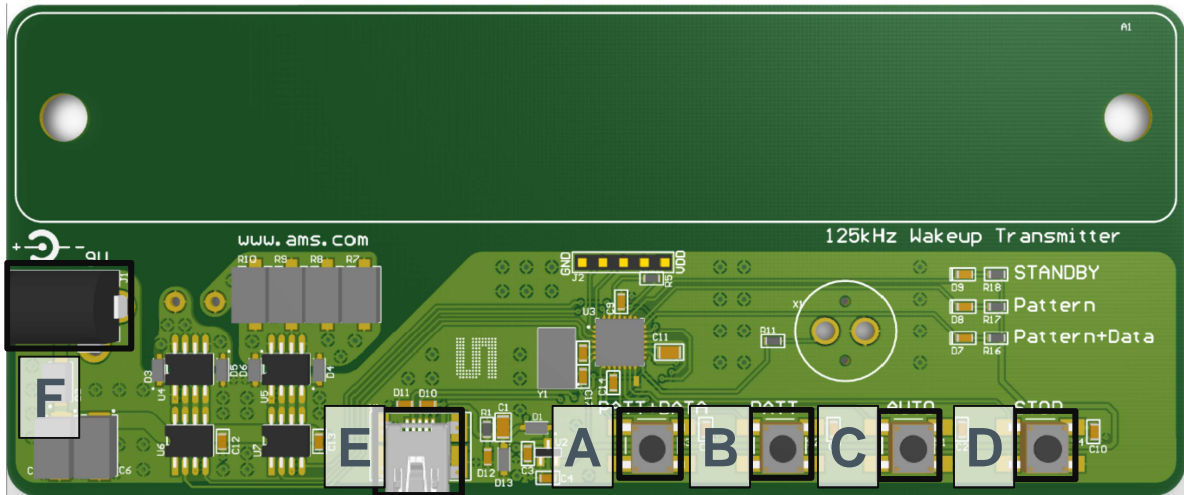


Figure 6: User Interface Description

| Label | Name | Description | Info |
|-------|---------------|----------------------------|---|
| A | PATT+DATA | Pattern+Data – Button | Pressing this button the transmitter sends continuously the wake-up pattern plus data (01010101). |
| B | PATT | Single Pattern – Button | Pressing this button the transmitter sends a single wake-up pattern. |
| C | AUTO | Automatic Pattern – Button | Pressing this button the transmitter automatically sends a wake-up pattern every 1s |
| D | STOP | Stop Pattern – Button | This button stops sending the continuous wake-up pattern |
| E | USB-Connector | Mini USB 5-pin Connector | USB Interface for the GUI |
| F | Power Supply | +9V DC Power Supply (2A) | Insert power adapter here. |

Figure 7: Indication LEDs/Buzzer

| LEDs | Blinking Color | Info |
|--------------|----------------|---|
| G | Buzzer | Whenever a wake-up pattern is transmitted the buzzer signals shortly. The buzzer can be disabled via the GUI. |
| STANDBY | Red LED | Transmitter is on standby. No wake-up pattern is sent. |
| Pattern | Red LED | Wake-up pattern is transmitted |
| Pattern+Data | Red LED | Wake-up pattern plus data is transmitted |

Note: Before the 125 kHz Wake-up Transmitter is connected to the GUI via USB it is necessary to stop transmitting Wake-up Patterns by pressing the button “D”.

4 Software Description

4.1 Installing the GUI

- Execute the AS393x_EvalSW_v2.1.6b.msi which can be found on the USB stick in the folder ‘Software_Firmware’
- Follow the installation guide
- Run the GUI → AS393x_EvalSW.exe
- Attach the respective board (Demo Board or Transmitter Board) with the USB cable
- From the pop up window ‘Choose Plugin’ choose the ‘AS3932_plugin.dll’

Note: Before connecting the 125 kHz Wake-up Transmitter Board with the USB cable press “D” to stop transmitting wake-up patterns.

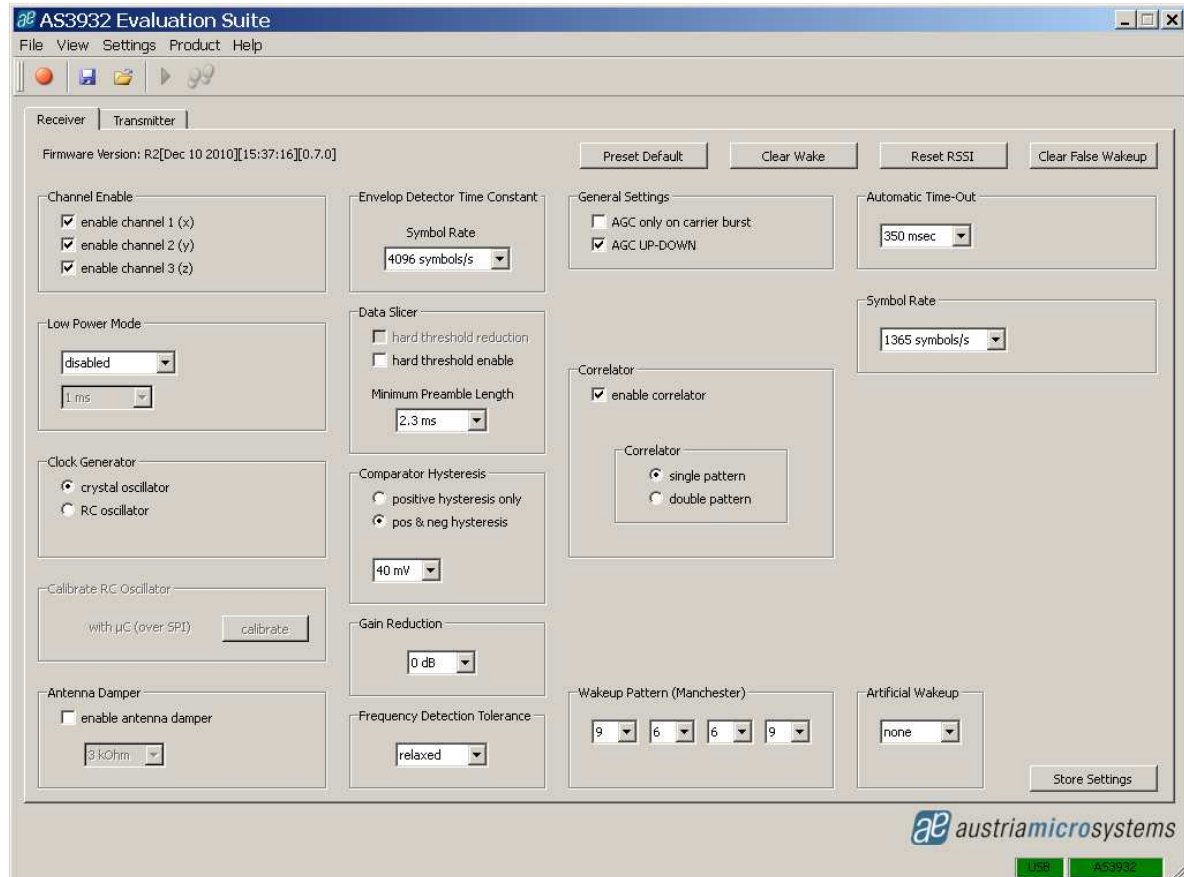
4.2 Description of the GUI for the AS3932 Demo Board

The settings shown in the GUI correspond to the respective settings in the register map. Changing any setting via the GUI writes the according values to the AS3932’s registers. The register map can be viewed via View/Register Map (Ctrl+M). All registers can be updated manually via File/Readout Registers (Ctrl+R) or the update of the registers is done automatically via File/Automatic Update (Ctrl+U). It is also possible to write to the register map by directly clicking on the bits in the ‘Register Map’ window. This is possible for all white fields. Grey fields are read only.

All adjustments that are made to the settings can be saved via “**Store Settings**” in the lower right corner of the ‘Receiver’ tab. The settings can be reset to the default configuration by pushing the button ‘**Preset Default**’.

Note: A possible firmware update can be done via Help/Firmware Update (Ctrl+F). Load the latest *.bin file for the receiver and update the firmware.

Figure 8: Graphical User Interface (GUI) for the AS3932 Demo Board



4.2.1 Setting Descriptions

4.2.1.1 Channel Enable

The AS3932 Demo Board has a three dimensional antenna. In the 'Channel Enable' field each of these three antenna inputs can be enabled or disabled.

4.2.1.2 Low Power Mode

The AS3932 features two low power modes: scanning mode and on/off mode. These can be selected here. By default no power saving mode is enabled. This means that the selected channels are active all the time. The other modes save power by regularly switching the channels on and off (on/off mode), or by having only one channel active at one time (scanning mode). Further details are given in the AS3932 datasheet.

4.2.1.3 Clock Generator

The clock source for the AS3932 can be selected here. The AS3932 Demo Board features an on board crystal oscillator which is used by default. In addition the AS3932 internal RC oscillator can be enabled.

4.2.1.4 Calibrate RC Oscillator

When the RC oscillator is enabled it can be calibrated to achieve better receiver sensitivity. The oscillator is calibrated via the microcontroller.

4.2.1.5 Antenna Damper

In case the signal levels at the input of the AS3932 are too high or the surrounding noise level is high the antenna damper can be enabled. A resistor inside the AS3932 is then switched parallel to the antenna. The value of the resistor can be selected between 1k Ω to 27k Ω to achieve different quality factors of the antenna tank.

4.2.1.6 Envelope Detector Time Constant

The performance of the demodulator can be optimized according to the bit rate and preamble length. If the bit rate gets higher the time constant needs to get lower. Adjust this ED time constant according to your symbol rate. The recommended time constants for different symbol rates are listed in the datasheet.

4.2.1.7 Data Slicer

The threshold of the data slicer can be set to a fixed level by setting the 'hard threshold enable' bit. This hard threshold can be reduced by setting the 'hard threshold reduction' bit. Otherwise, the threshold will be dynamically set according to the incoming data signal.

In case the dynamic threshold is used (i.e. the 'hard threshold enable' bit is not set), the data slicer's noise immunity can be adjusted via the data slicer's time constant. The bigger this time constant is, the better its noise immunity will be. However, increasing the time constant is only effective if also the preamble length is increased. Otherwise, the threshold will not have enough time to settle to the correct value. Therefore, the data slicer's time constant is linked to the minimum preamble length. The recommended minimum preamble lengths for different data slicer time constants are listed in the datasheet.

4.2.1.8 Comparator Hysteresis

The comparator hysteresis of the data slicer can be adjusted between 20mV and 40mV. Furthermore, the data slicer hysteresis can be either selected only for positive edges or for both positive and negative edges.

4.2.1.9 Gain Reduction

The gain reduction of the channel amplifier can be selected between 0dB up to -24dB.

4.2.1.10 Frequency Detection Tolerance

The frequency detection tolerance can be tighter or more relaxed. For details please see the datasheet.

4.2.1.11 General Settings

- AGC only on carrier burst: The automatic gain control is acting only on the first carrier burst.

- AGC UP-DOWN: The automatic gain control is operating in both directions (up and down).

The channel amplifier always starts with the highest gain setting at the beginning of reception. As soon as a signal is detected, the AGC starts reducing the gain to achieve the optimum signal amplification. If AGC UP-DOWN is disabled the AGC can only decrease the gain for the duration of data reception. In this mode the system holds the RSSI peak.

4.2.1.12 Wake-up Pattern (Manchester)

Select the desired wake-up pattern here. Each field defines 4 bit. If the pattern that is transmitted by the Wake-up Pattern Transmitter matches the selected pattern of the AS3932 Demo Board, a wake-up interrupt is generated at the WAKE pin. The WAKE pin goes high.

4.2.1.13 Correlator

The Correlator needs to be enabled to configure the AS3932 to wake up upon pattern detection. Otherwise, if it is disabled, the AS3932 will wake up after detecting the carrier burst. In case it is enabled, after the carrier burst it searches for the preamble bits and then for data pattern (Manchester encoded wake-up pattern). Should the pattern correlation be disabled, the AS3932 goes directly in data receiving mode after the carrier burst.

Single pattern: The wake-up pattern is 16 bits long.

Double pattern: The single pattern is sent twice in a row.

4.2.1.14 Automatic Time-Out

The Automatic Time-Out resets the WAKE pin automatically after a certain time. The AS3932 then goes back into listening mode. This time can be selected between 0ms and 350ms.

4.2.1.15 Clear Wake

The Clear Wake Button resets the WAKE pin manually.

4.2.1.16 Symbol Rate

The symbol rate can be adjusted between 512 symbols/s and 4096 symbols/s. The symbol rate defines the duration of one bit via the 32.768 kHz clock in order to recover the data.

4.2.1.17 Artificial Wake-up

The artificial wake-up automatically puts the chip into data receiving mode. This can be useful to measure the surrounding noise and adjust sensitivity settings accordingly. The period of the artificial wake-up can be adjusted between 1s and 2 hours.

4.2.1.18 Clear False Wake-up

The false wake-up register counts the number of frequency detections that do not match the wake-up pattern. The actual number of False Wake-ups can be deleted via the Clear False Wake-up button.

4.2.1.19 Reset RSSI

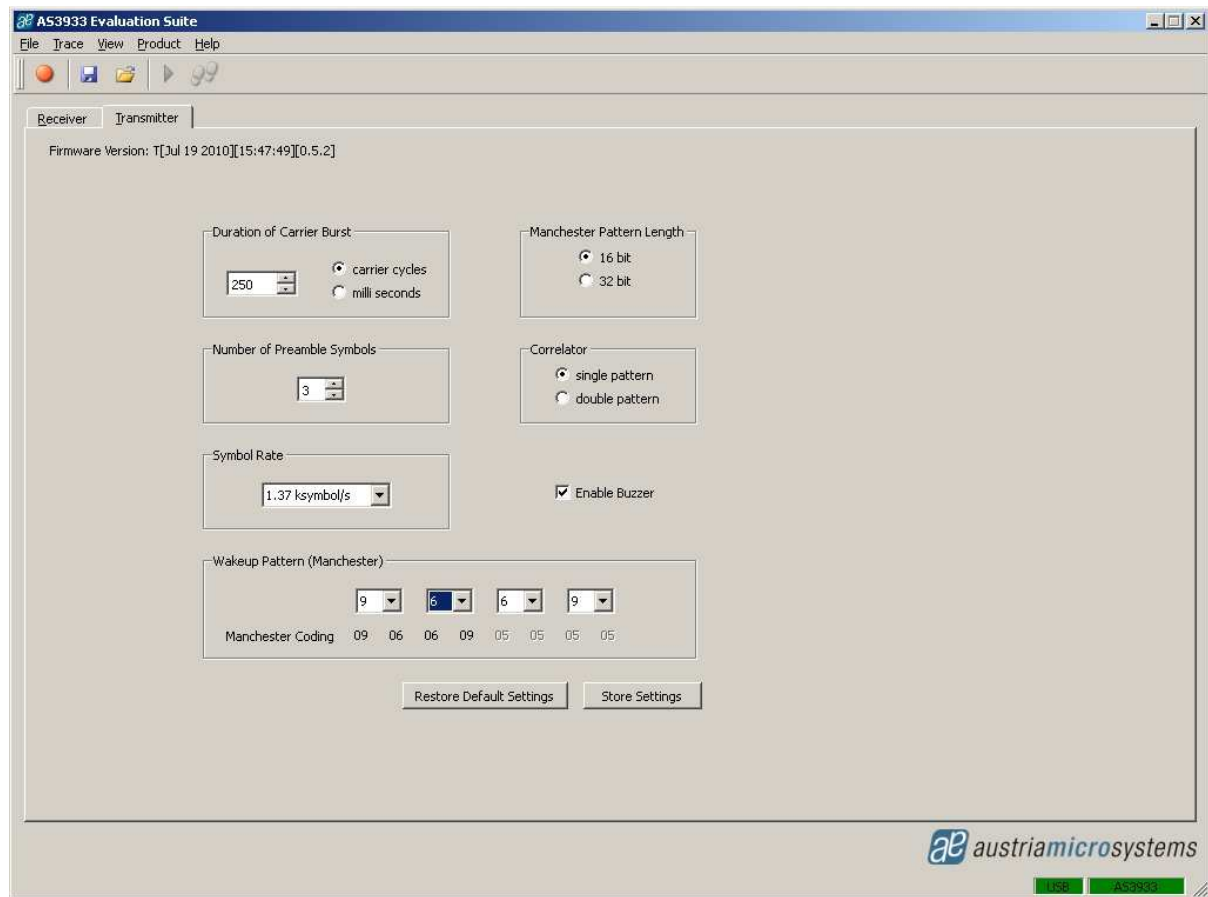
Reset the current RSSI measurement and restarts the AGC.

4.3 Description of the GUI for the Wake-up Transmitter Board

All adjustments that are made to the settings can be saved via “**Store Settings**” in the lower right corner of the ‘Transmitter’ tab. The settings can be reset to the default configuration by pushing the button “**Restore Default Settings**”.

Note: A possible Firmware Update can be done via Help/Firmware Update (Ctrl+F). Load the latest *.bin file for the transmitter and update the firmware.

Figure 9: Graphical User Interface (GUI) for the 125 kHz Wake-up Transmitter Board



4.3.1 Settings Description

4.3.1.1 Duration of Carrier Burst

The duration of the carrier burst can be set in multiples of carrier cycles (0-500 x 8 μ s) or in milliseconds (1-3).

4.3.1.2 Number of Preamble Symbols

The carrier burst must be followed by a separation bit and at least 3 symbols preamble. The number of preamble symbols that are sent can be adjusted here.

4.3.1.3 Symbol Rate

The symbol rate can be adjusted between 512 symbols/s and 4096 symbols/s. The symbol rate must be the same as the symbol rate set for the AS3932.

4.3.1.4 Enable Buzzer

The Wake-up Transmitter Board sends out an acoustic signal whenever a packet is transmitted. This signal can be disabled.

4.3.1.5 Wake-up Pattern (Manchester)

The wake-up pattern of the transmitter must be the same as the pattern defined for the receiver in order to generate a successful wake-up at the receiver.

4.3.1.6 Manchester Pattern Length

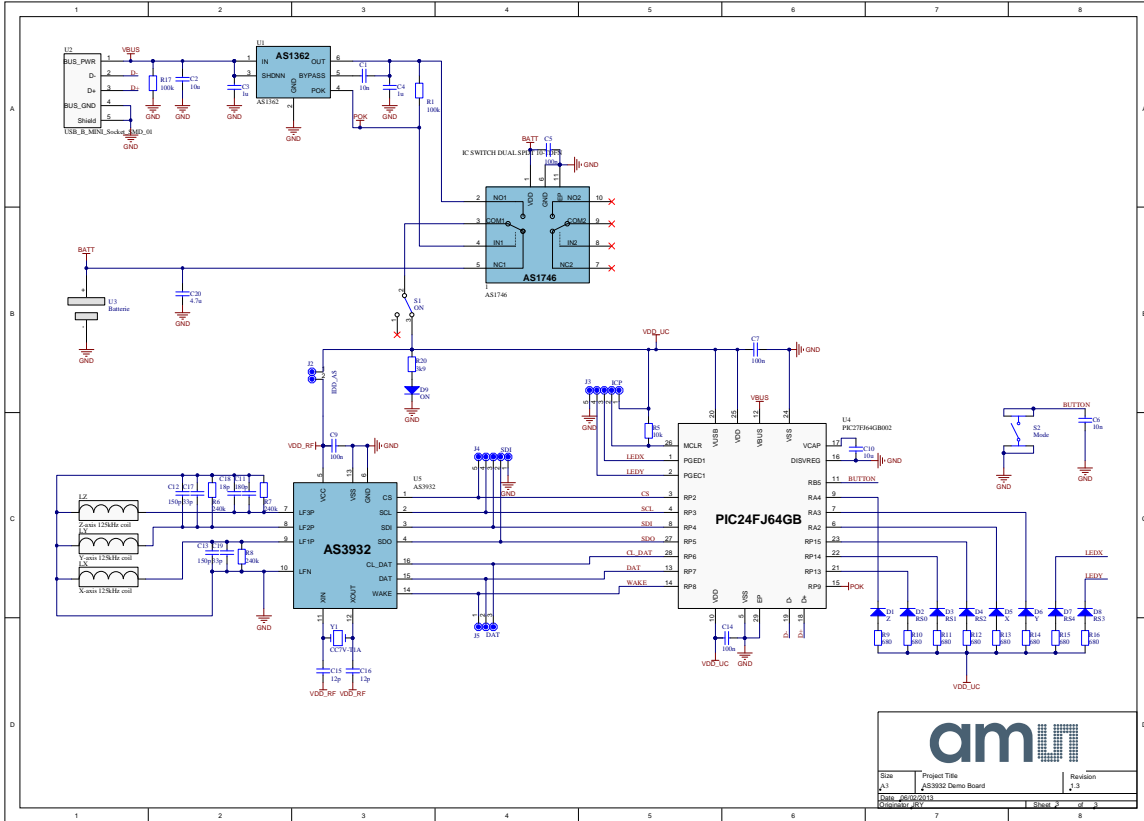
This setting must also be the same as defined for the receiver to generate a successful wake-up.

4.3.1.7 Correlator

This setting must also be the same as defined for the receiver to generate a successful wake-up.

5 Board Schematics, Layout and BOM

5.1 AS3932 Demo Board Schematics



5.2 AS3932 Demo Board Layout

Figure 10: AS3932 Demo Board Layout – Top Layer

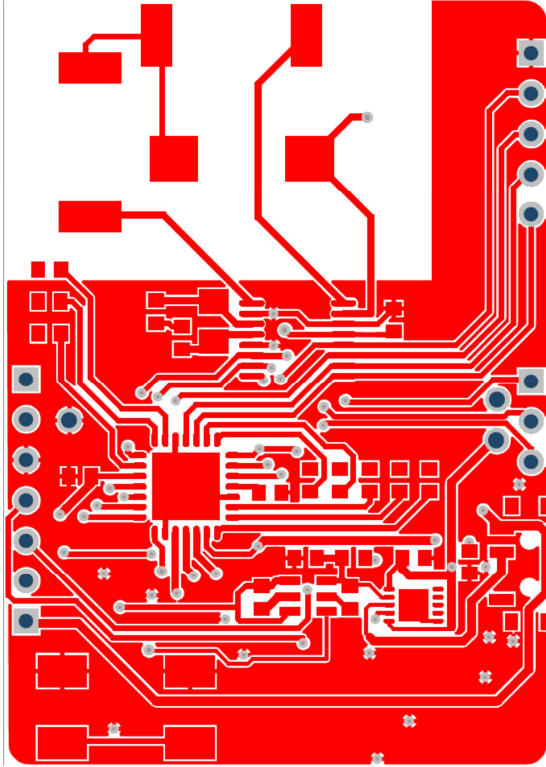
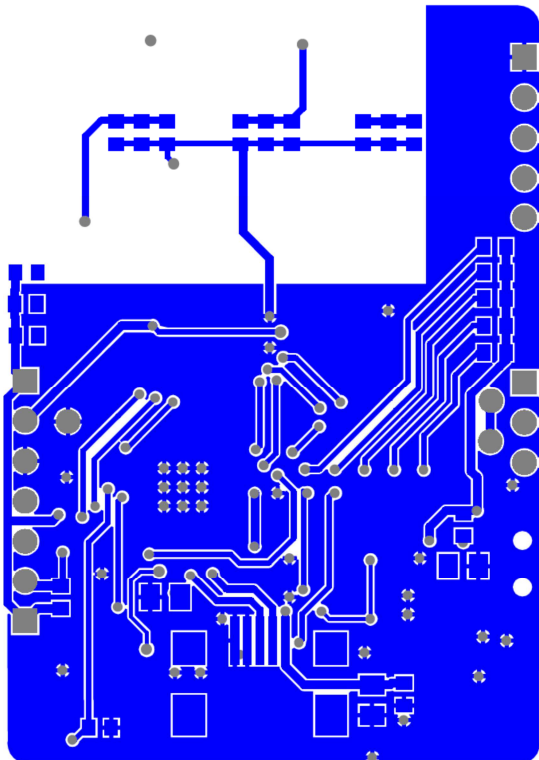


Figure 11: AS3932 Demo Board Layout – Bottom Layer

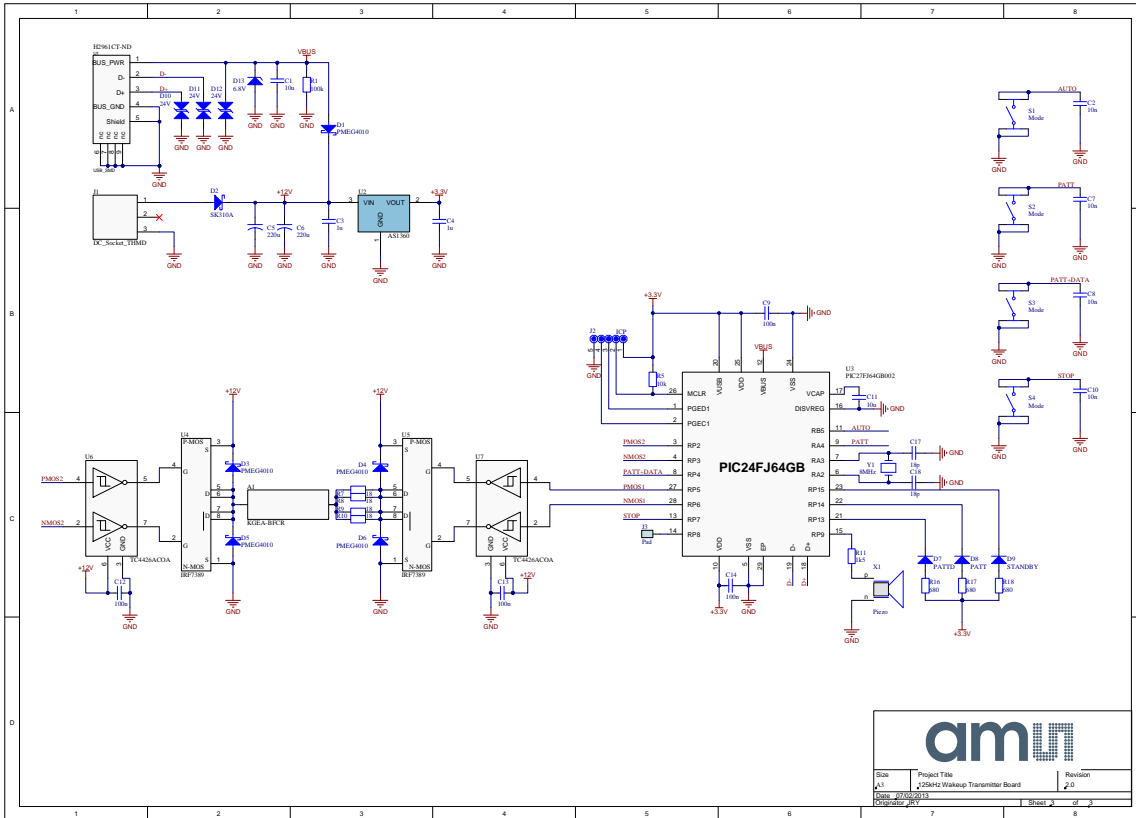




5.3 AS3932 Demo Board BOM

| Bill of Materials | | | AS3932 Demo Board | | | |
|-------------------|------------------------------|--------------------------|--------------------------|------------------------|---------------------------------|----------|
| Company: | | | ams AG | | | |
| Originator: | | | JRY | | | |
| PCB Name: | | | AS3932 Demo Board | | | |
| PCB Version: | | | 1.3 | | | |
| Report Date: | | | 06/02/2013 | | | |
| # | Designator | Comment | Component Description | Manufacturer | Manufacturer Part Number | Quantity |
| 1 | 1 | AS1746 | IC SWITCH DUAL SPDT 10- | ams | AS1746-BTDT | 1 |
| 2 | C1, C6 | 10n | C0603/10V/X5R | | | 2 |
| 3 | C2, C10 | 10u | C0805/6.3V/X5R | | | 2 |
| 4 | C3, C4 | 1u | Multilayer Ceramic | Yageo | CC0603KRX5R6B105 | 2 |
| 5 | C5, C7, C9, C14 | 100n | C0603/10V/X5R | | | 4 |
| 6 | C11 | 180p | Multilayer Ceramic | Murata | GRM1885C1H181GA01D | 1 |
| 7 | C12, C13 | 150p | Multilayer Ceramic | Murata | GRM1885C1H151GA01D | 2 |
| 8 | C15, C16 | 12p | TDK - | TDK | C1608COG1H120J080AA | 2 |
| 9 | C17, C19 | 33p | Multilayer Ceramic | Murata | GRM1885C2A330GA01D | 2 |
| 10 | C18 | 18p | Multilayer Ceramic | Murata | GRM1885C1H180GA01D | 1 |
| 11 | C20 | 4.7u | C0805/6.3V/X5R | | | 1 |
| 12 | D1 | Z | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 13 | D2 | RS0 | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 14 | D3 | RS1 | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 15 | D4 | RS2 | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 16 | D5 | X | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 17 | D6 | Y | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 18 | D7 | RS4 | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 19 | D8 | RS3 | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 20 | D9 | ON | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 21 | J2 | IDD_AS | 2 pole pin header | | | 1 |
| 22 | J3 | ICP | not assembled | | | 1 |
| 23 | J4 | SDI | 5 pole pin header | | | 1 |
| 24 | J5 | DAT | 3 pole pin header | | | 1 |
| 25 | LX | X-axis 125kHz coil | 7.2mH +/- 5% @ 125kHz | Premo | SDTR1103-0720J | 1 |
| 26 | LY | Y-axis 125kHz coil | 7.2mH +/- 5% @ 125kHz | Premo | SDTR1103-0720J | 1 |
| 27 | LZ | Z-axis 125kHz coil | 7.2mH +/- 5% @ 125kHz | Premo | ZC1003-0720J | 1 |
| 28 | R1, R17 | 100k | R0603/5%/0.1W | | | 2 |
| 29 | R5 | 10k | R0603/5%/0.1W | | | 1 |
| 30 | R6, R7, R8 | 240k | R0603/5%/0.1W | | | 3 |
| 31 | R9, R10, R11, R12, R13, R14, | 680 | R0603/5%/0.1W | | | 8 |
| 32 | R20 | 3k9 | R0603/5%/0.1W | | | 1 |
| 33 | S1 | ON | C & K COMPONENTS - | C & K COMPONENTS | PCM12SMTR | 1 |
| 34 | S2 | Mode | TE CONNECTIVITY / | TE CONNECTIVITY / | FSM2JSMA | 1 |
| 35 | U1 | AS1362 | IC REG LDO 3V, 3A TSOT23 | ams | AS1362-BTIT-30 | 1 |
| 36 | U2 | USB_B_MINI_Socket_SMD_01 | CONN RECEPT MINI USB2.0 | Hirose Electric Co Ltd | UX60A-MB-SST | 1 |
| 37 | U3 | Batterie | RENATA - HU2032-LF - | RENATA | HU2032-LF | 1 |
| 38 | U4 | PIC27FJ64GB002 | MICROCHIP - | MICROCHIP | PIC24FJ64GB002-IML | 1 |
| 39 | U5 | AS3932 | IC RF PROGRAM 16-TSSOP | ams | AS3932-BTST | 1 |
| 40 | Y1 | CC7V-T1A | MICRO CRYSTAL - CC7V- | MICRO CRYSTAL | CC7V-T1A 32.768KHZ +/-20PPM 9PF | 1 |
| Approved | | | Notes | | | 59 |

5.4 125 kHz Wake-up Transmitter Board Schematics



5.5 125 kHz Wake-up Transmitter Board Layout

Figure 12: 125 kHz Wake-up Transmitter Board Layout – Top Layer

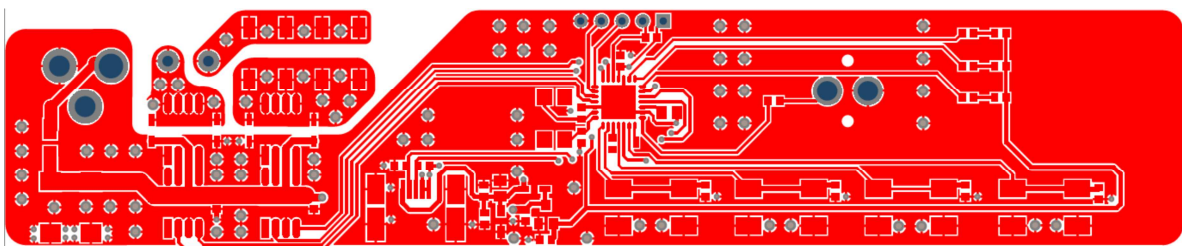
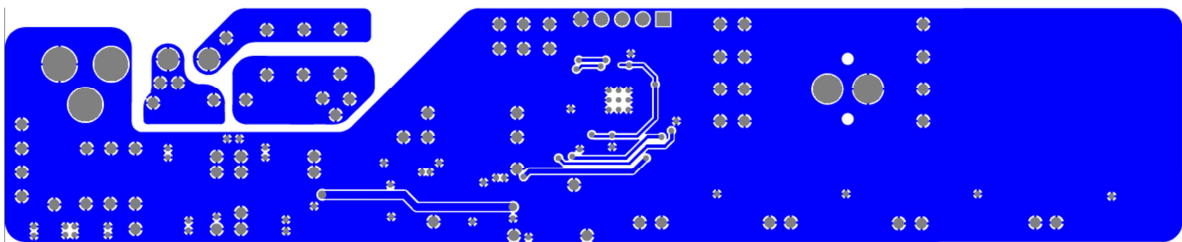


Figure 13: 125 kHz Wake-up Transmitter Board Layout – Bottom Layer



5.6 125 kHz Wake-up Transmitter Board BOM

| Bill of Materials | | | 125kHz Wakeup Transmitter Board | | | |
|-------------------|--------------------|----------------|---------------------------------|-------------------------|--------------------------|----------|
| Company: | | | ams AG | | | |
| Originator: | | | JRY | | | |
| PCB Name: | | | 125kHz Wakeup Transmitter Board | | | |
| PCB Version: | | | 2.0 | | | |
| Report Date: | | | 07/02/2013 | | | |
| # | Designator | Comment | Component Description | Manufacturer | Manufacturer Part Number | Quantity |
| 1 | A1 | KGEA-BFCR | LF Antenna/KGEA-BFCR-B- | | | 1 |
| 2 | C1, C11 | 10u | C080516V/X5R | | | 2 |
| 3 | C2, C7, C8, C10 | 10n | C060310V/X5R | | | 4 |
| 4 | C3, C4 | 1u | MULTICOMP - | MULTICOMP | MC0603X105M160CT | 2 |
| 5 | C5, C6 | 220u | KEMET - T491D227K016ZT - | KEMET | T491D227K016ZT | 2 |
| 6 | C9, C12, C13, C14 | 100n | C060310V/X5R | | | 4 |
| 7 | C17, C18 | 18p | C060350V/X5R | | | 2 |
| 8 | D1, D3, D4, D5, D6 | PMEG4010 | NXP - PMEG4010CEJ,115 - | NXP | PMEG4010CEJ,115 | 5 |
| 9 | D2 | SK310A | TAIWAN SEMICONDUCTOR - | TAIWAN SEMICONDUCTOR | SK310A | 1 |
| 10 | D7 | PATTD | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 11 | D8 | PATT | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 12 | D9 | STANDBY | MULTICOMP - OVS-0608 - | MULTICOMP | OVS-0608 | 1 |
| 13 | D10, D11, D12 | 24V | COOPER BUSSMANN - | COOPER BUSSMANN | 0603ESDA-TR1 | 3 |
| 14 | D13 | 6.8V | ON SEMICONDUCTOR - | ON SEMICONDUCTOR | MM3Z6V8T1G | 1 |
| 15 | J1 | DC_Socket_THMD | LUMBERG - NEB 21 R - | LUMBERG | NEB 21 R | 1 |
| 16 | J2 | ICP | 5 pole pin header/2.54mm | | | 1 |
| 17 | R1 | 100k | R06035%0.1W | | | 1 |
| 18 | R5 | 10k | R06035%0.1W | | | 1 |
| 19 | R7, R8, R9, R10 | 18 | TE CONNECTIVITY / CGS - | TE CONNECTIVITY / CGS | SMW218RJT | 4 |
| 20 | R11 | 1k5 | R06035%0.1W | | | 1 |
| 21 | R16, R17, R18 | 680 | VISHAY DRALORIC - | VISHAY DRALORIC | CRCW0603680RFKEAHP | 3 |
| 22 | S1, S2, S3, S4 | Mode | TE CONNECTIVITY / | TE CONNECTIVITY / | FSM2J5MA | 4 |
| 23 | U1 | USB_SMD | CONN RECEPT USB 5POS | Molex Connector | 56579-0576 | 1 |
| 24 | U2 | AS1360 | IC REG LDO 3.3V .15A | ams | AS1360-33-T | 1 |
| 25 | U3 | PIC27FJ64GB002 | MICROCHIP - | MICROCHIP | PIC24FJ64GB002-JML | 1 |
| 26 | U4, U5 | IRF7389 | INTERNATIONAL RECTIFIER - | INTERNATIONAL RECTIFIER | IRF7389TRPBF | 2 |
| 27 | U6, U7 | MC33151 | ON SEMICONDUCTOR - | ON SEMICONDUCTOR | MC33151DG | 2 |
| 28 | X1 | Piezo | MURATA - | MURATA | PKM13EPYH4002-B0 | 1 |
| 29 | Y1 | 8MHz | ABRACON - ABMM2- | ABRACON | ABMM2-8.000MHZ-E2-T | 1 |
| Approved | | | Notes | | | 55 |

6 Ordering Information

Figure 14: Ordering Information

| Ordering Code | Type | Marking | Delivery Form ¹ | Delivery Quantity |
|---------------|--------------|---------|----------------------------|-------------------|
| AS3932-BTST | 16-pin TSSOP | AS3932 | 7 inches Tape & Reel | 1000 pcs |
| AS3932-BQFT | QFN 4x4 16LD | AS3932 | 7 inches Tape & Reel | 1000 pcs |

1. Dry Pack: Moisture Sensitivity Level (MSL) = 3, according to IPC/JEDEC J-STD-033A.

Note: All products are RoHS compliant and ams green.

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