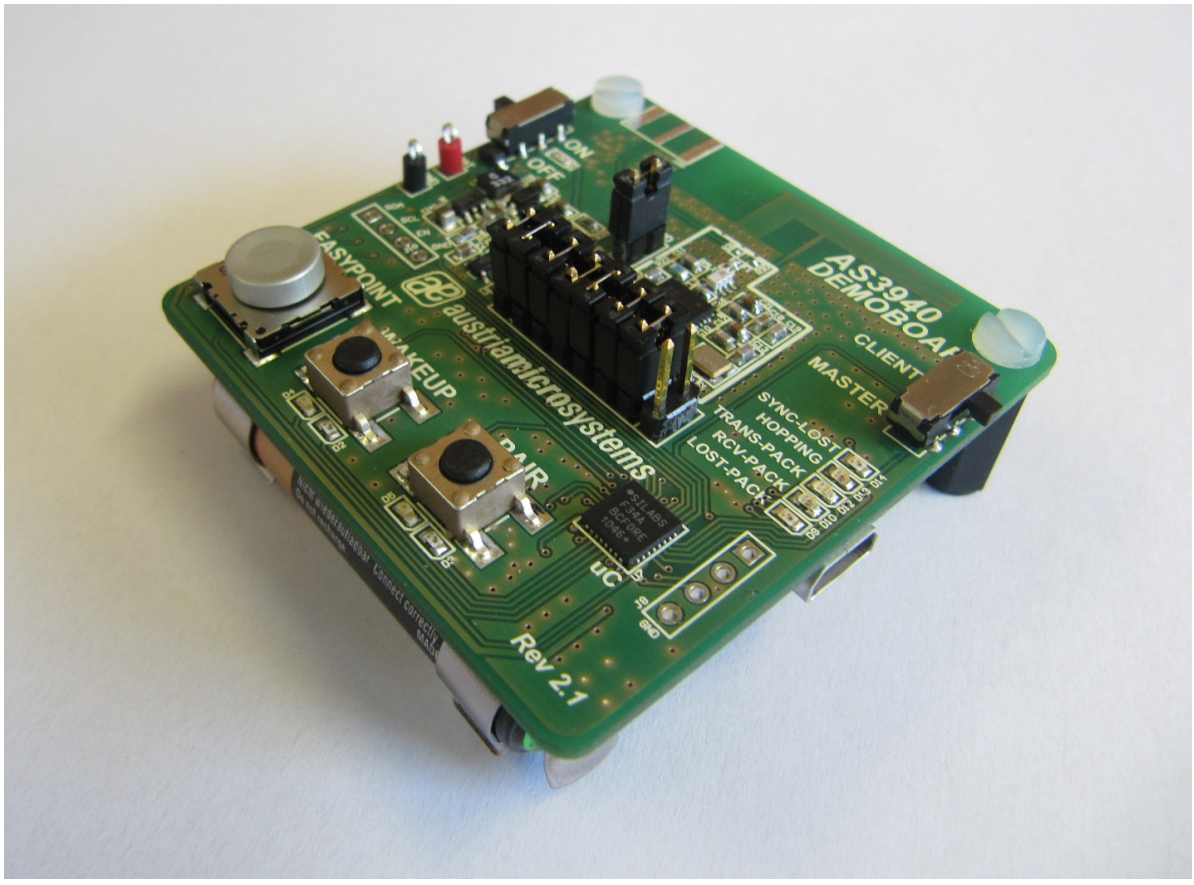
AS3940 Demo Board Manual

AS3940

2.4 GHz Low Power Multi-Channel FSK Transceiver

www.austriamicrosystems.com



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General Description

Board Description

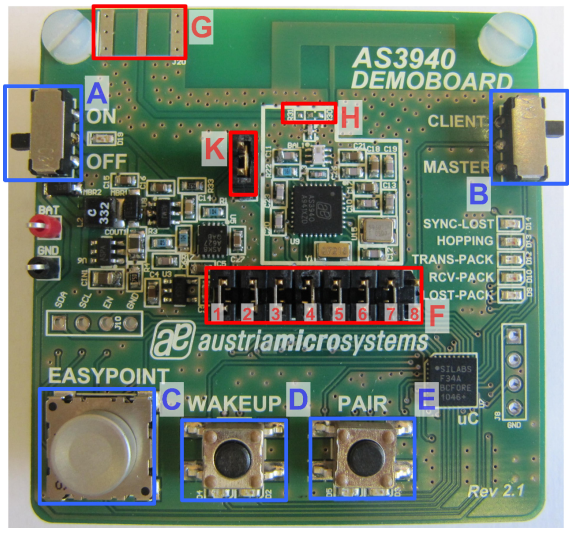


Figure 1: Board Description Top – User Interface

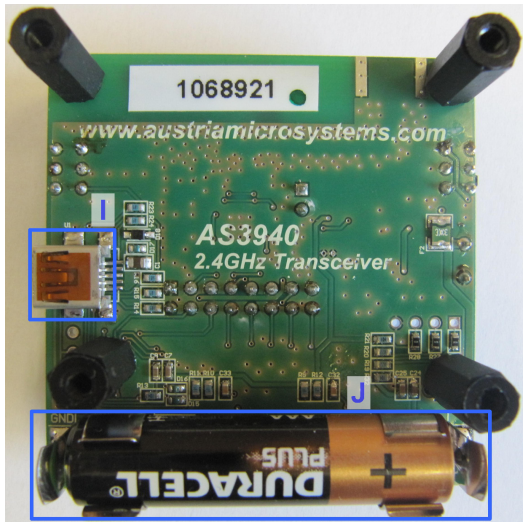


Figure 2: Board Description Bottom – Connectors

User Interface Description

Label	Name	Description	Info
A	**POWER**	ON/OFF Switch	Power on/off the Demoboard. Source (Battery or USB) is automatically selected
B	**MASTER/CLIENT**	Master/Client – Selection Switch	Selects board to operate as master or client
C	**SENSOR**	EASYPOINT Sensor	Data of the EASYPOINT-sensor is transmitted from the client to the master over the UHF link.
D	**WAKEUP**	Wakeup – Button	Initiates wakeup to start the communication
E	**PAIR**	Pair – Button	Initiates pairing to establish network
I	**USB – Connector**	Mini USB 5-pin Connector	Connects Master/Client to a standard USB port of the PC.
J	**BATTERY**	1.5V AAA Battery	Supplies the Demoboard

Buttons

Button	Press	MASTER	CLIENT
PAIR	Short Press (<1.5s)	Master opens the receive window for the ID-exchange (pairing-procedure).	Client starts to transmit for the ID-exchange (pairing procedure).
	Re-Press (<1.5s)	In order to re-pair one client or to pair an additional client, the PAIR button is pressed again. The procedure (short press) is repeated.	After successful pairing, short press (re-press) is disabled.
	Long Press (>1.5s)	Master disconnects all paired Clients from the network and the ID-Table with all serial numbers of the Clients is deleted. Pairing procedure can be restarted with new settings via short press.	Client sets the pairing status to “unpaired”. The ID-Table with the serial numbers of the Master is deleted. Pairing procedure can be restarted with new settings via short press.
	Timeout (20s)	If pairing is not successful within 20s the receive window is closed again.	If pairing is not successful within 20s the Client stops transmitting packages.

WAKEUP	Short Press (<1.5s)	Master opens the receive window to start the data communication with all Clients which are in wakeup mode. The pre-condition is that the pairing has been done. Prior the wakeup (or re-wakeup), all settings for the communication with all different Clients can be changed via the GUI.	Client sends the wakeup to start the data communication. The pre-condition is that the pairing has been done.
	Long Press (>1.5s)	Master stops the communication with all Clients. In this mode all settings for the communication to all different Clients can be changed via the GUI.	Client stops the communication with the Master.
	Timeout	If the communication to all paired Clients can not be established, the Master starts the communication with the available Clients. The timeout of the Master is determined by the maximum trials multiplied by the timecode, which can be set in the GUI.	If the communication to the Master can not be established the Client stops transmitting packages. The timeout of the Client is determined by the maximum trials multiplied by the timecode, which can be set in the GUI.

Indication LEDs

LEDs	Blinking Colour	MASTER	CLIENT
PAIR	Red LED	The receive window of the Master is open for the ID-exchange. The red led is continuously on, if timeout is reached.	Client is sending pair packets containing the ID-exchange. The red led is continuously on, if timeout is reached.
	Green LED	Master found a Client during pair procedure and successfully paired with it.	Client is successfully paired to the Master.
WAKEUP	Red LED	Wakeup procedure is active to start the communication with all paired Clients. The red LED is continuously on, if the timeout is reached.	Wakeup is active to start the data communication. The red LED is continuously on, if the timeout is reached.
	Green LED	Data Communication to all paired Clients is successfully established.	Client transmits successfully data.
SYNC-LOST	Red LED	Synchronization between Client and Master is lost. Communication is stopped.	
HOPPING	Orange LED	Communication Frequency is changed.	
TRANS-PACK	Green LED	Data packet is transmitted.	
RCV-PACK	Orange LED	Data packet is received	
LOST-PACK	Red LED	Data packet is lost	

Connector Description

Jumper	Name	Description	Info
K	**IDD**	Supply Current	The supply current of the AS3940 can be measured.
G	**UHF Out**	SMB Connector (50 Ohm)	Output Power of the AS3940 can be measured here.
H	**UHF Out Selector**	0 Ohm resistors (R30, R31)	Determine whether the UHF path is routed to the INF-antenna or to the SMB connector. Solder R30 with a 0 Ohm resistor to route the UHF output to the SMB connector. Solder R31 with a 0 Ohm resistor to route the UHF output to the INF-antenna.

F		Microcontroller - Interface	The SDI –Interface from the microcontroller can be replaced by an proprietary solution
	F1	SEN	Serial Digital Interface Enable
	F2	CE	Chip Enable
	F3	MOSI	SPI Interface Master Out Slave In
	F4	MISO	SPI Interface Master In Slave Out
	F5	SCLK	SPI Interface Clock
	F6	INT0	External Interrupt for Microcontroller
	F7	GND	Ground

Note: To use the UHF front end with the own microcontroller, remove all Jumpers on “F” and connect all necessary lines.

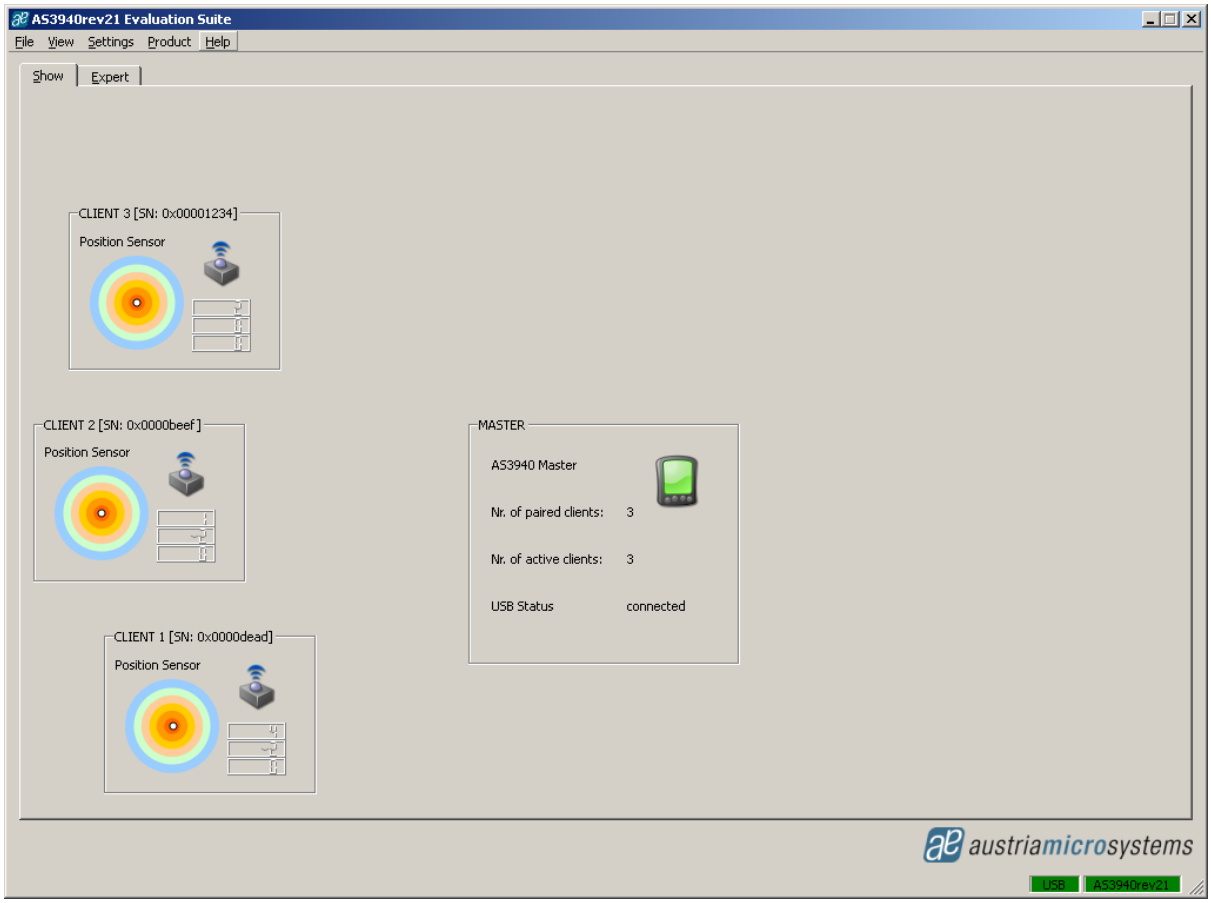
Getting started with the AS3940 Demokit

- Allocate 1 board as Master and 1-8 boards as Client via switch **“B”**.
- Insert the 1.5V AAA battery into **“J”**. As soon as USB is connected to the board the PCB is supplied automatically via USB.
- Connect the Master to the PC via the provided USB Cable on **“I”** and start the GUI.
- Turn on all boards. When turning on the boards, all indication-LEDs flash up once.
- Press the PAIR – button **“E”** at one Clients, in order to start the Clients for the pairing procedure. The PAIR led is blinking red. The Client can be paired to one Master only. After successful pairing the PAIR – LED is green.
- Press the PAIR –button **“E”** at the Master. One Client will get visible on the GUI. The PAIR - LED is green. Pair all Clients one by one before starting the wakeup procedure.
- Press the WAKEUP – button **“D”** at all paired Clients to be waked up, in order to prepare the Clients for the data transmission. The wakeup led is blinking red. After successful wakeup, the TRANS-PACK Led starts to blink green.
- Press the WAKEUP – button **“D”** at the Master to start the communication. The EASYPOINT sensor gets visible at the GUI. The WAKEUP - LEDs are green. The RCV-PACK Led starts to blink orange.
- Move the EASYPOINT sensor **“C”** at the Clients. The current position of the sensor is visualized on the GUI. The default time code is set to 0.5s (update rate of the sensor data).

Install the GUI:

1. Execute the AS39xx_EvalSW.msi
2. Follow the installation guide
3. Run the GUI → AS39XX_EvalSW.exe

Note: If the Master is correctly connected, the USB field in the lower left corner is green. Afterwards the GUI is ready to run the following procedure to establish the network.



How to execute a Firmware Update:

1. Connect AS3940 Demoboard with the PC and turn on the board.
2. Go to Help → Firmware Update (Ctrl + F)
3. Select and load latest Firmware (*.bin – File)

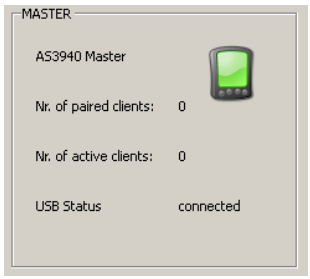
Note: After a Firmware Update it is recommended to restore the default settings from flash, in order to get a working setup. Go to the Expert Mode and press the button **"restore default settings"**.

GUI description in Demo Mode

This demo board comes with one 1.5V battery and one USB-cable.

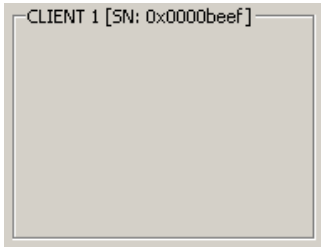
Prepare the Hardware

1. Drive the IC on the demo board only with the recommended settings and values as described in the datasheet. If not present get the datasheet for the AS3940 from www.austriamicrtosystem.com.
2. Connect the Master via USB to the PC. The following window will appear:



PAIR the Clients to the Master

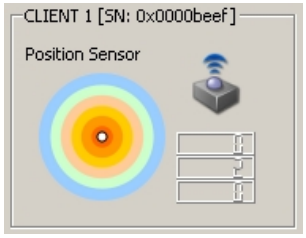
1. Press the “PAIR” Button **“E”** at one Client. The “PAIR” Button is blinking red.
2. Press the “PAIR” Button **“E”** at the Master. If the Master gets a valid ID the PAIR LED switch from blinking red to green. This mean, that the Master has recognized one Client for the network.
3. The GUI at the Master shows the valid Client with their appropriate address.
   An empty field appears for each Client that is “PAIRED” to the Master



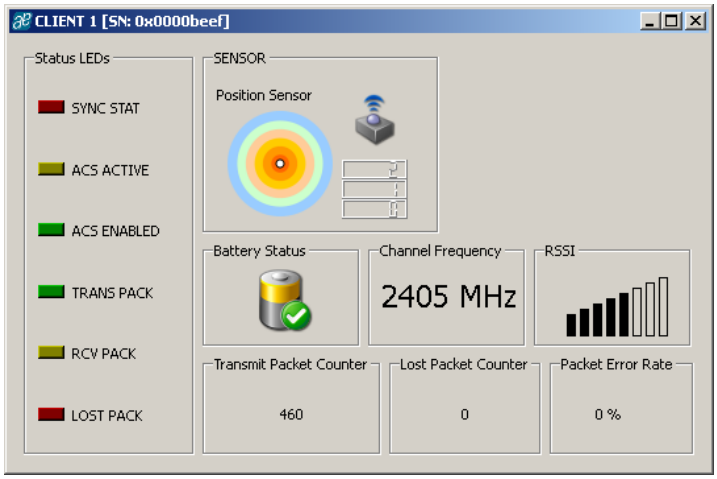
WAKEUP to start the communication

After the clients are successfully paired, they are automatically switched into a Standby Mode. In order to start the data communication, the Clients need to be woken up:

1. Press the “WAKEUP” Button **“D”** at the Client. The “WAKEUP” Button is blinking red. As soon as the communication is running the WAKEUP Led is green.
2. Press the “WAKEUP” Button **“D”** at the Master. The Master starts again the communication and the Clients begin to send data. As soon as the Master receives valid data, the WAKEUP Led at the Master is green as well.
3. Transmitted, received and lost packages are indicated via LEDs “**TRANS-PACK”**, **“RCV-PACK”** and **“LOST-PACK”** as well as **“HOPPING”** and **“SYNC-LOST”**.
4. The EASYPOINT sensor can be seen on the GUI (Master) and actual data can be changed at the Clients by moving the sensor.



5. The details of each Client can be read by clicking onto the Client symbol.
   - **Status LED's** identify transmitted, received and lost packets in the same way they are shown on the PCB.
   - **ACS Enabled/Active** displays the Adaptive Channel Switching. The ACS can be enabled in the communication settings and is blinking as soon as the frequency is changed. The frequency is changed as soon as an lost packet occur.
   - **Sensor Field** displays the position of the EASYPOINT Sensor
   - **Battery Status** displays if the Client has enough battery.
   - **Channel Frequency** displays the current transmission frequency.
   - **RSSI Field** display the Received Signal Strength of the particular Client
   - **Transmission Statistics** displays the transmitted and lost packages and the Packet Error Rate.



6. Once the connection to one Client is lost, the appropriate Client starts blinking **"LOST-PACK"** until the maximum trial counter reaches its maximum. After that "**SYNC-LOST"** goes red.

Note: Pressing the WAKEUP Button **"D"** at the Master and Client, starts (short press) and stops (long press) the communication.

Description of Expert Mode

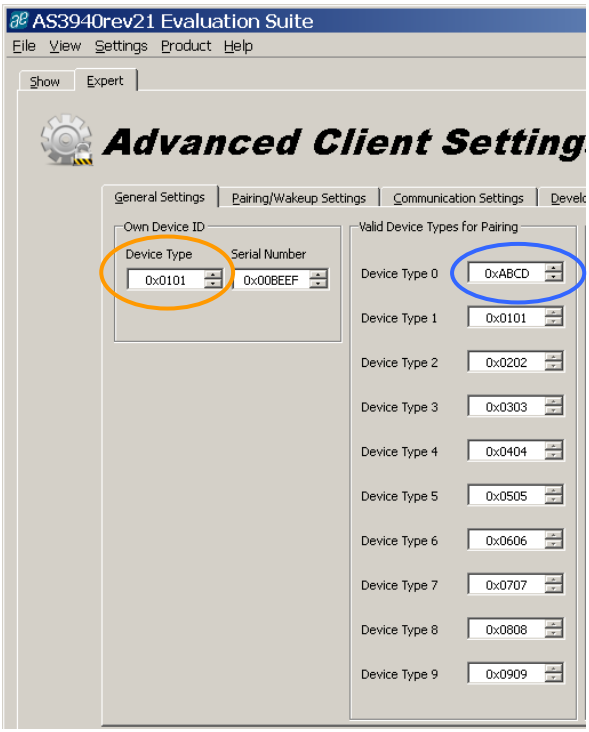
When selecting the tab “Expert” in the GUI, all register settings can be adjusted, at the Master and at the Client. Which type is connected is displayed in this field.

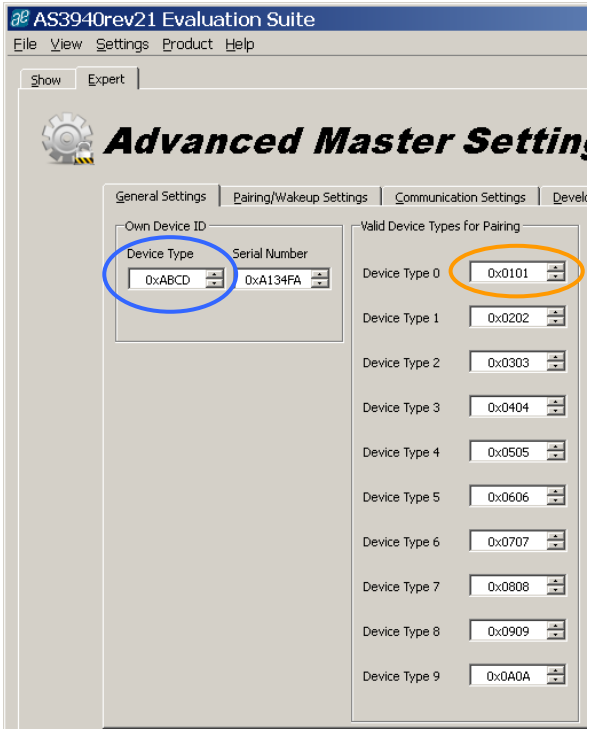
All adjustments can be saved via **“Save Settings”** in the bottom area of the expert mode. If all settings should be reset to the default values, choose **“Restore Default Settings”**. To get the actual firmware version, press **“Get Firmware Version”**. All settings can be saved and loaded from file via **“Load Settings from File”** and **“Save Settings to File”**.

The “Expert Mode” is structured into four tabs:

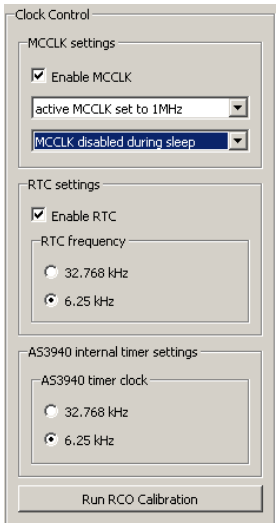
General Settings

- Own Device ID: The Serial Number and the Device Type of the connected Device, Client and Master, can be set.
- Valid Device Types for Pairing: The Master and the Client have a table that defines the permitted device types for the pairing procedure. Make sure that the Device Type of the Master is inserted into the Client Device Type Table and the Device Type of the Client is inserted into the Master Device Type Table.





- MCCLK settings: The Clock for the external MCU can be enabled and set to 1, 2, 4 or 8 MHz. During the AS3940 is in sleep mode the MCCLK can be active, disabled or set to 6.25 kHz. MCCLK can be measured on the MCCLK test pin.
- RTC settings: The Real Time clock can be enabled and set to 32.768 or 6.25 kHz. RTC can be measured on the RTC test pin.
- AS3940 internal timer settings: The Link Manager is timed ether by the external 32.768 kHz crystal or the internal 6.25 kHz clock. The internal 6.25 kHz clock can be calibrated by pressing "Run RCO Calibration". The calibration is needed before establishing the data communication and if temperature is changing.

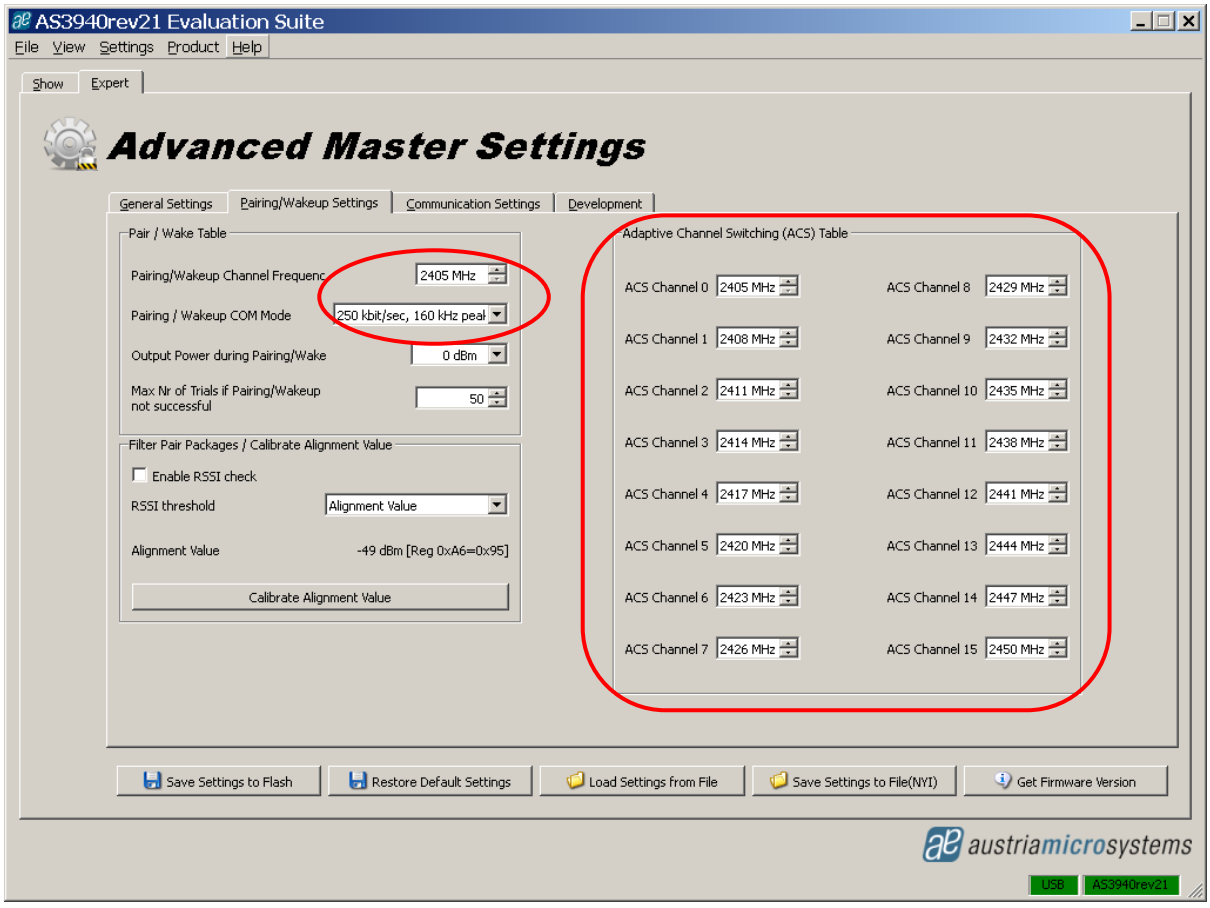


Pairing/Wakeup Settings

Before the Pairing/Wakeup is executed, the according settings can be adjusted at the Master and the Client.

- Pair / Wake Table: The **Pairing / Wakeup Channel Frequency** and the **Pairing / Wakeup COM Mode** must be the same at the Client and the Master. Otherwise Pairing/Wakeup is not possible. By default the Frequency is 2405 MHz, data rate is 250kbps and deviation frequency is 160 kHz.
- **Output Power:** The output power can be set individually, values between 0dBm and -24dBm are possible.
- **Max Nr of Trials:** After the maximum number of Pairing / Wakeup trials, the Master/Client stops to receive/transmit pairing packages. The timeout is calculated by timecode x timecode scaling x number of trials. The timeout can be between 0.2s and 512s. The default value for timecode x timecode scaling = 0.5s.
- **Filter Pair Packages:** The pairing range can be limited by checking the **enabling the RSSI check**. By default the **RSSI threshold** equals to the alignment value which is -50dBm, allowing Clients to pair to the Master that RSSI value is bigger than this limit. This RSSI threshold can be changed ±50 dB to the alignment value. The **alignment value** itself can be calibrated, by pressing the button.
- **Adaptive Channel Switching Table:** This table is used in normal communication. As soon as a package is lost, the channel frequency is changed to the next ACS channel. The ACS table must be equal at Master and Clients. ACS can be enabled for each individual Client in the Communication Settings.

Note: All red labelled fields must be set to the same values at the Master and Clients.



Communication Settings

As soon as one Client is paired to the Master, the communication settings can be adjusted. For each individual Client, the settings can be adjusted differently. All these settings must only be set at the Master. The Client is updated automatically, during the wakeup procedure by the link manager.

Note: Make sure that Client and Master are in Standby before changing these values. Press the WAKEUP button for more than 1.5s to force Master/Client into Standby. Short press the WAKEUP button again to run the network with the new communication settings.

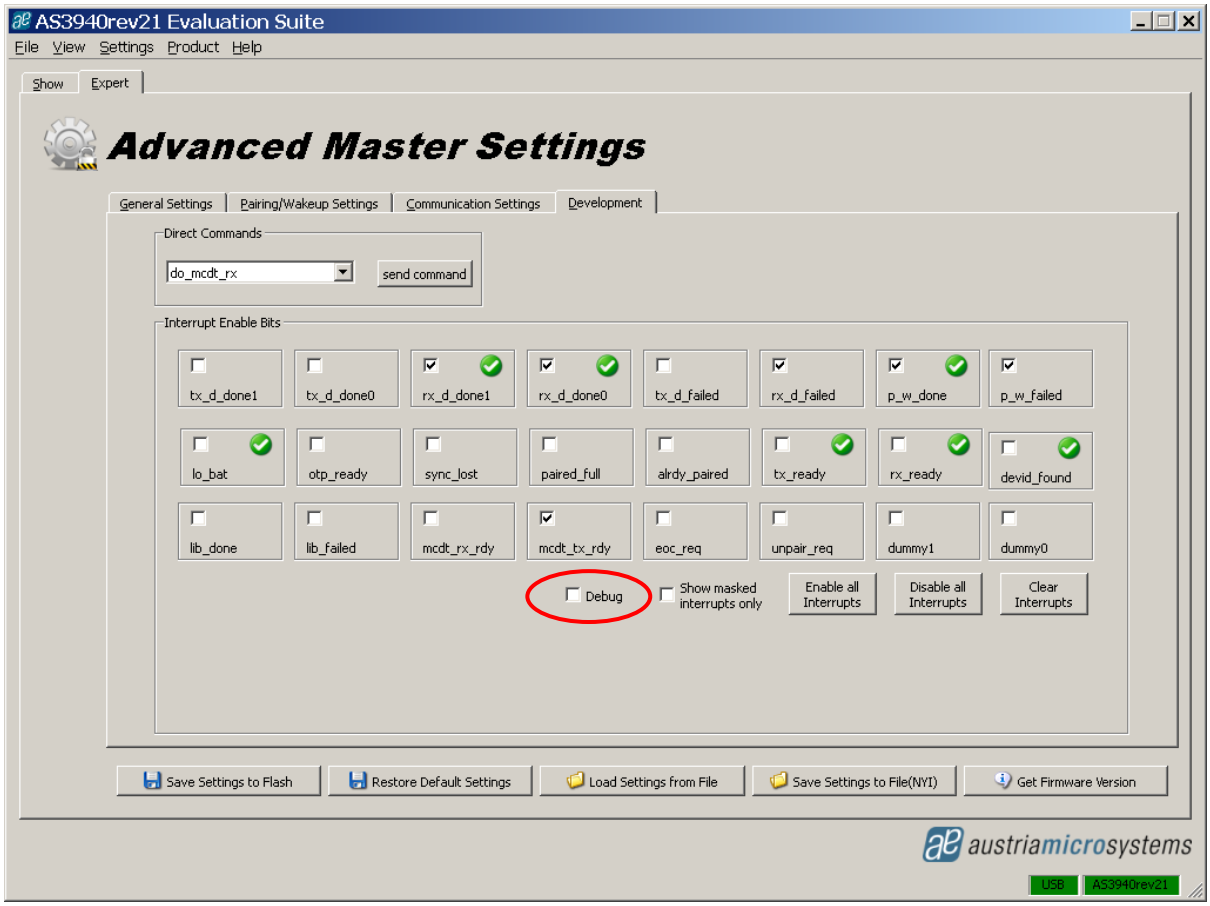
- **Client Selection:** Select the Client which communication settings want to be changed. On the right side the values for the actual Client can be set.
- **Data Channel Frequency:** Nominal Communication Frequency if ACS is disabled.
- **ACS enable:** Enabling the ACS (Adaptive Channel Switching) changes the data channel frequency to the next channel in the ACS table.
- **Data COM Mode:** Data Rate and Communication Frequency can be set individually for each Client.
- **Output Power during Data:** The output power for the communication can be changed individually for each Client, when having e.g. different range requirements.
- **Max. Number of Retransmissions:** If a packet is lost, it will be retransmitted for n times.
- **Number of Consecutively Failed Communication Slots:** If the Master/Client can not acknowledge a communication after n communication slots, the synchronization is lost.
- **Time Code:** Cycle time (Communication Slot) of individual Client. In Burst Mode the time code can be selected between 250ms, 500ms, 1s and 2s. The time code is **randomly** taken if enabled.
- **Streaming Mode:** Data streaming is continuous transmission of payload packages from Client to Master with a certain duty cycle. The **duty cycle** can be set between 12.5% and 100%.

Development

The Development tab enables the user to set Direct Commands and monitor Interrupts.

- **Direct Commands:** Send specific direct commands for e.g. to establish a network manually, to trigger certain interrupts, to measure currents, to try out features …
- **Interrupt Enable Bits:** In the demo mode the enabling and disabling of all interrupts is handled by the firmware of the microcontroller. Whenever an external interrupt via the INT0 line occurs, the microcontroller reads the whole interrupt register in order to identify which interrupt exactly occurred. All indicated interrupts are green coloured for highlighting. All interrupts that occurred are accumulated and are not cleared in the GUI automatically. To do so, just press the button **"Clear Interrupts"**.
  Enable/Disable all interrupts fasten up your interrupt selection. Interrupts that are not selected do not affect the INT0 line, but they might have occurred and got visible during readout of the INT_STATUS register. Enable the checkbox "**Show masked interrupts only**" to get not informed about disabled interrupts.
  Debug: This bit disables all automatic routines in the microcontroller that are applied for the Demo mode. When enabling the Debug mode, all wanted actions need to be done manually via the Direct Commands and the Register map.

Note: It is important to disable the Debug Mode for normal operation again.

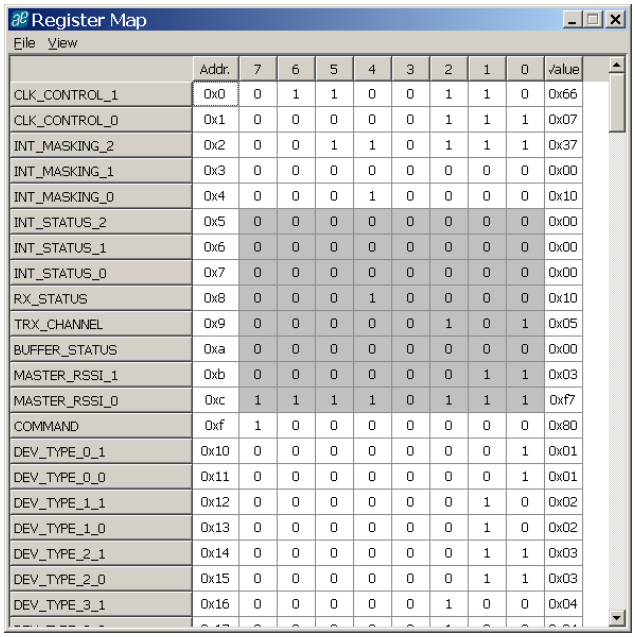


Register Map

All registers of the AS3940 are available via View/Register Map (CTRL+M). For detail information concerning the register settings, please have a look into the AS3940 datasheet.

- **Readout Register:** Select File/Readout Registers (CTRL+R) to update all register
- **Write Register:** Set certain bits in the Register map, writes the according byte via the SPI interface into the AS3940.

Note: Changes in the GUI will automatically update the Register Map and visa versa.



	Addr.	7	6	5	4	3	2	1	0	Value
CLK_CONTROL_1	0x0	0	1	1	0	0	1	1	0	0x66
CLK_CONTROL_0	0x1	0	0	0	0	0	1	1	1	0x07
INT_MASKING_2	0x2	0	0	1	1	0	1	1	1	0x37
INT_MASKING_1	0x3	0	0	0	0	0	0	0	0	0x00
INT_MASKING_0	0x4	0	0	0	1	0	0	0	0	0x10
INT_STATUS_2	0x5	0	0	0	0	0	0	0	0	0x00
INT_STATUS_1	0x6	0	0	0	0	0	0	0	0	0x00
INT_STATUS_0	0x7	0	0	0	0	0	0	0	0	0x00
RX_STATUS	0x8	0	0	0	1	0	0	0	0	0x10
TRX_CHANNEL	0x9	0	0	0	0	0	1	0	1	0x05
BUFFER_STATUS	0xa	0	0	0	0	0	0	0	0	0x00
MASTER_RSSI_1	0xb	0	0	0	0	0	0	1	1	0x03
MASTER_RSSI_0	0xc	1	1	1	1	0	1	1	1	0xf7
COMMAND	0xf	1	0	0	0	0	0	0	0	0x80
DEV_TYPE_0_1	0x10	0	0	0	0	0	0	0	1	0x01
DEV_TYPE_0_0	0x11	0	0	0	0	0	0	0	1	0x01
DEV_TYPE_1_1	0x12	0	0	0	0	0	0	1	0	0x02
DEV_TYPE_1_0	0x13	0	0	0	0	0	0	1	0	0x02
DEV_TYPE_2_1	0x14	0	0	0	0	0	0	1	1	0x03
DEV_TYPE_2_0	0x15	0	0	0	0	0	0	1	1	0x03
DEV_TYPE_3_1	0x16	0	0	0	0	0	1	0	0	0x04

Layout of Demo Board

Board schematics

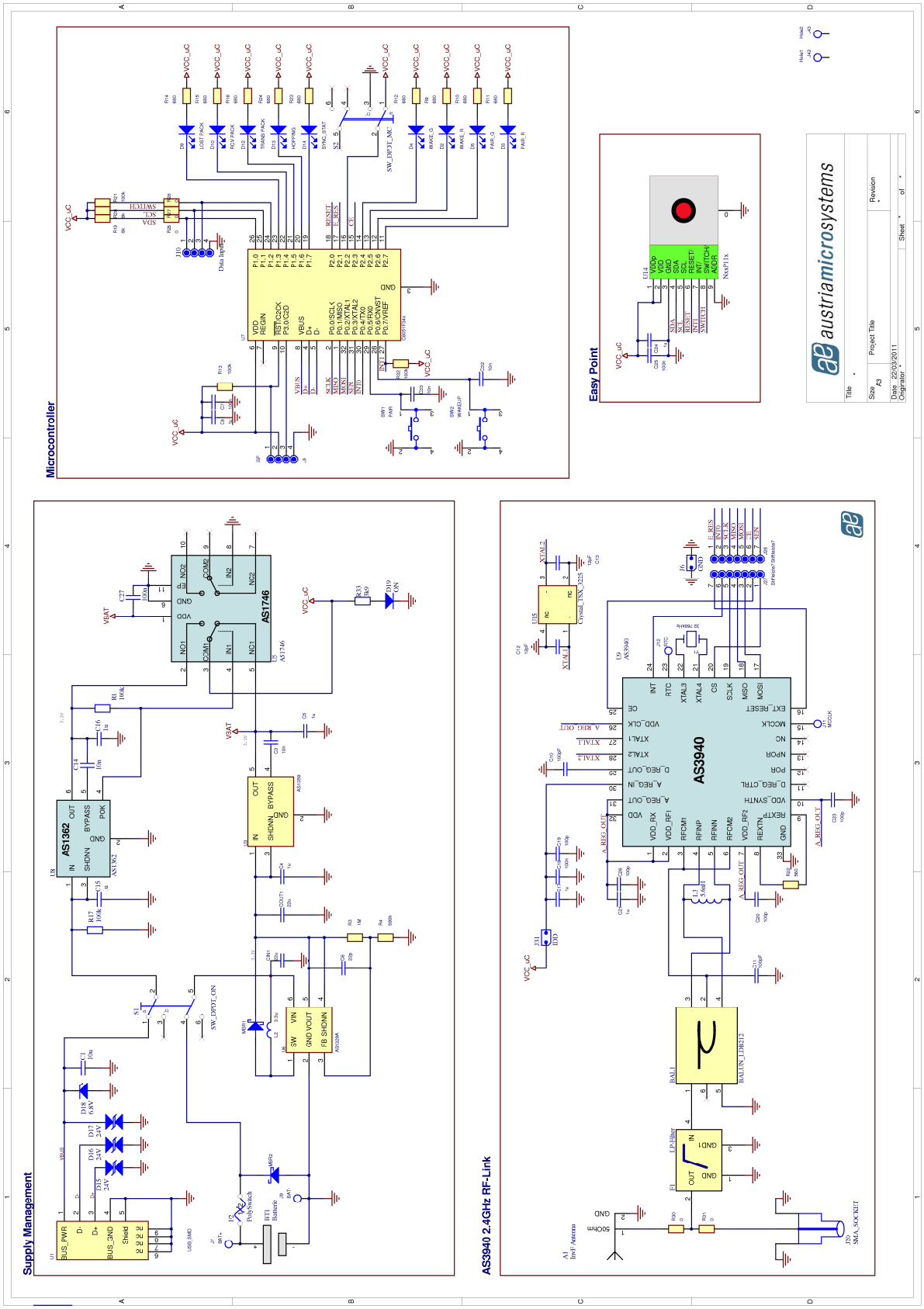


Figure 3: Schematics

Board Layout

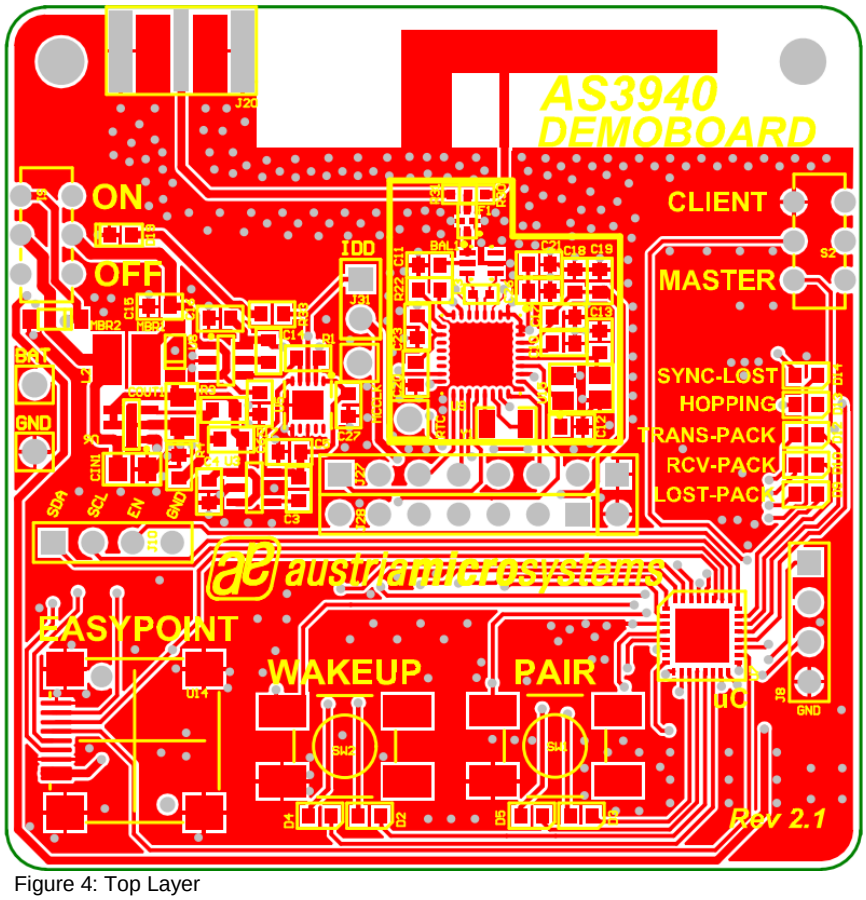


Figure 4: Top Layer

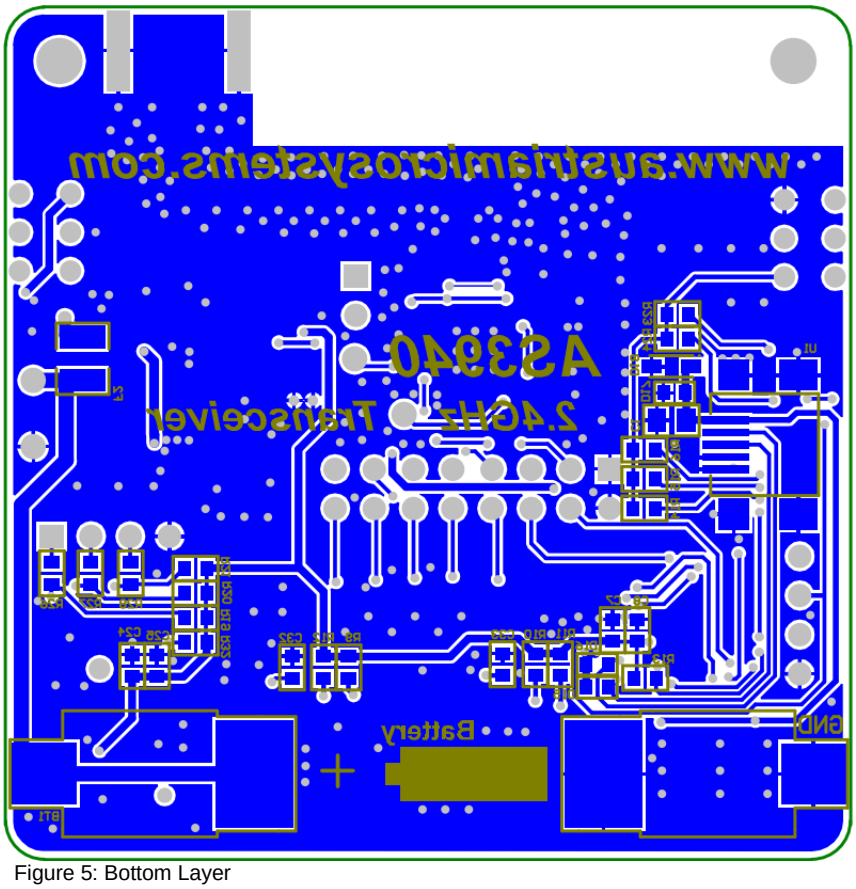


Figure 5: Bottom Layer

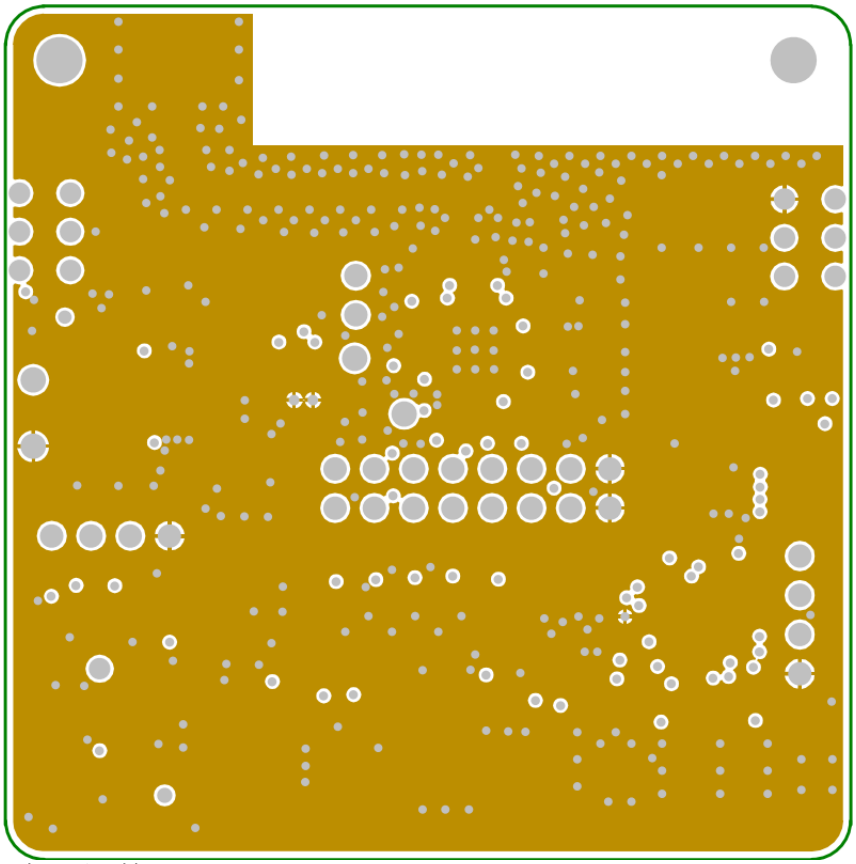


Figure 6: Mid Layer 1

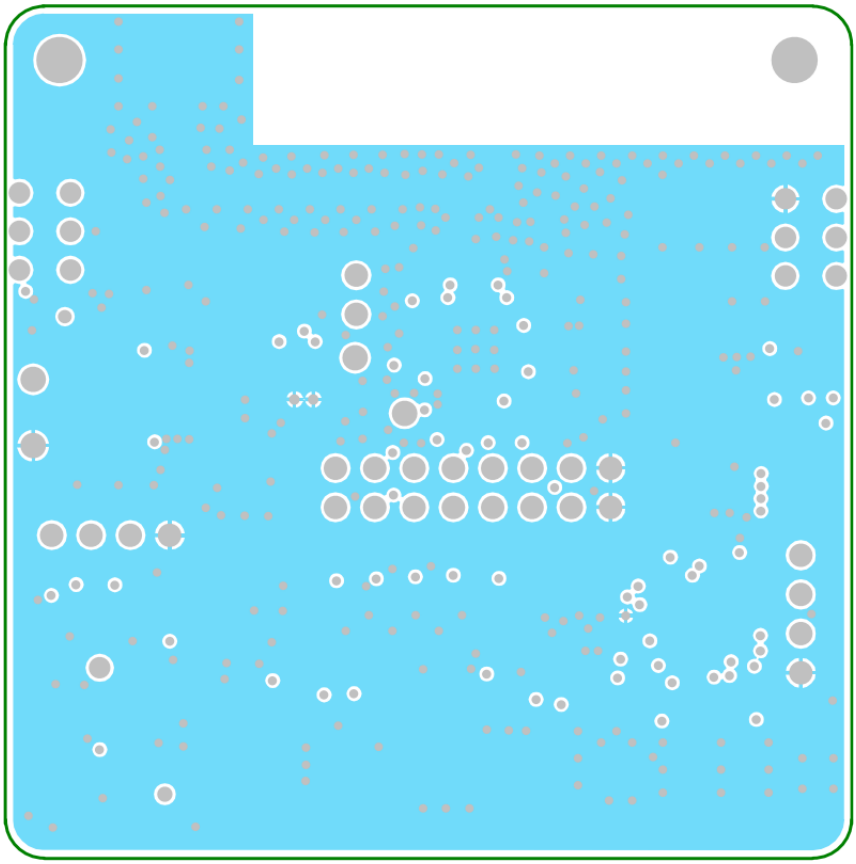
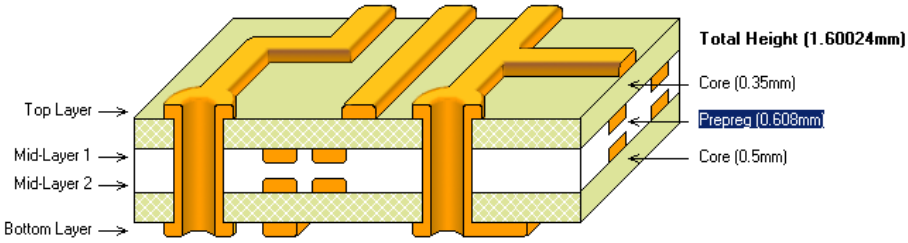


Figure 7: Mid Layer 2

Layerstack



- PCB Material: FR4 1.6mm
- 4 layer Impedance controlled board
- Solder surface: chemical - tin
- Width of copper: 35µm
- Silk screen top/bottom: white

Bill of Material

Integrated Circuits (IC)	**Part**
U6	AS1329A-BTTT
U3	AS1359-BTTT-31
U8	AS1362-BTTT-30
U5	AS1746-BTDT
U9	AS3940-BQFT
U7	C8051F34A-GM
U14	N35P112 EASYPOINT
Resistor	
R3	1M/5%/0.1W/0603
R4	590k/1%/0.1W/0603
R1,R13,R17,R21, R32	100k/5%/0.1W/0603
R9,R10,R11,R12,R14,R15,R16, R23, R24	680/5%/0.1W/0603
R19, R20	8k/5%/0.1W/0603
R22	560/5%/0.1W/0603
R30	0/0402
R26, R27, R28	0/0603
R33	3k9/5%/0.1W/0603
Capacitors	
COUT1, CIN1	22uF/6.3V/X5R/0805
C1	10µF/16V/X5R/0805
C3,C14, C32, C33	10nF/10V/X5R/0603
C4,C5,C8,C15,C16,C17,C21, C24	1µF/10V/X5R/0603
C7,C18,C25, C27	100nF/10V/X5R/0603
C6	22pF/10V/X5R/0603
C12,C13	12pF/10V/X5R/0603
C10, C11, C19,C20,C23, C26	100pF/10V/X5R/0603
Balun/Filter	
BAL1	LDB212G4020C-001
F1	LFL152G45TC1A219
F2	MICROSMD035F-2
Oscillators	
Y1	CC7V-T1A
U15	TSX-3225/16MHZ/10PPM/9PF

Diodes	
MBR1, MBR2	MBR0520-TP
D4,D5,D12	0603/SUPER BRT
D2,D3,D9, D14, D19	0603/SUPER BRT
D10, D13	0603/SUPER BRT
D15, D16, D17	0603/SUPPRESSOR
D18	SOD323/6.8V/200mW
Coils	
L2	XFL3012-332MEC
L3	LQW15AN5N6C10D
Switches	
S1, S2	DPDT
SW1, SW2	Miniature Pushbutton
Mechanical components	
Batterie	AAA/1.5V/1200mAh
BT1	SMD Batteryholder
U1	USB_MINI - Connector
J31	Header 2.54 mm
J27,J28	Header 2.54 mm
J9	Testpoint
J7, MCCLK, RTC	Testpoint

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