DHX91 DHAN Module

DECT-ULE Platform

Datasheet

Version 1.4

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1. Introduction

1.1. General Description

The DSPG DHAN module is based on the state-of-the-art DHX91 - a 4th generation DECT SOC. The DHAN module is appropriate for the battery powered ULE Node (Data and/or Voice empowered) operating in a star network with a ULE-certified Controller at the hub. The DHAN is also suited for low-powered devices operating in legacy, GAP-compliant DECT systems.

The DHAN is a "turn-key" solution providing the user with a jump-start in developing a ULE Node Application. It is easily integrated into the smallest of ULE Nodes, providing excellent range with minimal drain on the battery, allowing the designer to focus on developing the application. The complete platform includes an SDK, API GUI, and user documentation.

The DHAN module can be used as a standalone solution (with the application running on the DHX91 CPU) or it can provide the wireless connectivity channel for a sensor application running on an external MCU. In the latter case, the MCU communicates with the DHAN via serial UART interface.

1.2. Block Diagram

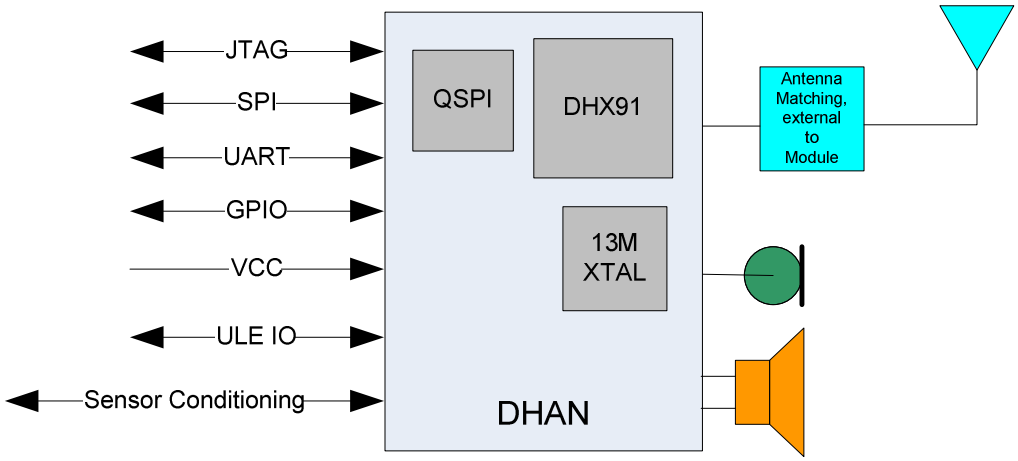


Figure 1-1: DXH91 DHAN Module Block Diagram

1.3. Features

General

- Appropriate for both battery powered and AC-powered ULE Nodes and Legacy-DECT devices
- Includes embedded HAN-FUN ULE SW Stack with well-documented API for control via external application MCU
- Processor (ARM926EJ-S™ 32-bit RISC Controller) and memory appropriate for standalone DHAN solutions (requires SW customization)
- Best-in-class radio performance
  - Tx power: +23.5dBm
  - Rx sensitivity:

  -96dBm@1000 ppm
- Hibernation mode: low power (<2 uA)
- Support for EU, US and other regional DECT bands
- Compliance with EN301406, FCC part 15.329 & ARIB STD-T101
- Small form factor: 15 mm x 32.5 mm x 3.8 mm
- Low external BOM
- Well matched RF Port, easily connected to an off-module 50-Ohm antenna
- Operating temperature: -40° C to +85° C

Applications

- Home automation
- Home security
- Voice Pendants and Emergency Units
- Connected appliances
- Smart energy

2. Pin and Signal Description

2.1. Pin List

Table 2-1: DHAN Module Pinout

PIN NO.	NAME	DESCRIPTION/TYPE
1	GND	GND
2	DCINS	NC (Not Connected)
3	DCIN3	Used to monitor battery level via this ADC input.
4	RSTN	Pull to GND to force reset. Optionally connect to external MCU output or to a SPST switch (for manual reset) or leave NC
5	SCL	I2C Clock I/O. Not used by HAN_FUN. Can be left as NC
6	SDA	I2C Data I/O, Not used by HAN_FUN. Can be left as NC
7	IIC_ACK	I2C ACK, Not used by HAN_FUN. Can be left as NC
8	GPIO7	General Purpose I/O. Can be configured for SPIDI
9	GPIO8	General Purpose I/O. Can be configured for SPIDO
10	RxD (GPIO9)	UART Rx. Can be configured for SPICLK
11	TDI	JTAG Data In, If not needed, can be left NC
12	TMS	JTAG Mode Select, If not needed, can be left NC
13	TDO	JTAG Data Out, If not needed, can be left NC
14	TCK	JTAG Clock, If not needed, can be left NC
15	RTCK	JTAG Reset, If not needed, can be left NC
16-17	GND	GND
18	TxD (GPIO10)	UART Tx. Can be configured for SPICS
19	VDD_APU	1.8V test point. 0V during hibernate. Leave NC
20	VDD	1.2V test point. 0V during hibernate. Leave NC
21	VCC	Power Supply Input. Connect to Battery or regulated supply
22	DOUBCAP2P	ULE I/O (See Application Notes for limitations). Pull down with 1M if VCC ≥ 3.1V
23	DCIN2	Leave Unconnected
24	VCC3V	3V Output. 0V during hibernate.
25	LEDSINK/DCIN	ULE I/O. Should be left as NC when VCC ≥ 3.3V

PIN NO.	NAME	DESCRIPTION/TYPE
26-27	GND	GND
28	AMP2_OUT	ULE I/O. If not used, can be left NC
29	AMP1_P	ULE non-inverting sensor conditioning input
30	AMP1_OUT	ULE I/O. If not used, can be left NC
31	MPWR/ANA2_IN	ULE Input (or Microphone Power). If not used, can be left NC
32	MIN	If not used, can be left as NC
33	MIP	If not used, can be left as NC
34	ANA_IN1	ULE I/O. If not used, can be left NC
35	SPOUTP	If not used, can be left as NC
36	SPOUTN	If not used, can be left as NC
37	PWM0	Analog Output
38	XIN_32K	Leave NC
39	XOUT_32K	Leave NC
40	VDD_ULE	1.8V test point. Active during hibernate. Leave NC
41	VccRF	Power Supply Input to RF
42-50	GND	GND
51	Antenna	RF In/Out, 50 Ohm
52	GND	GND

3. Module Electrical Specifications

All parameters are for 25ºC.

3.1. Absolute Maximum Rating

Table 3-1: Absolute Maximum Rating

PIN NAME	PIN	MIN	MAX	UNIT
VCC	21	-0.3	4.6	V
VccRF	41	-0.3	4.6	V
I2C	5, 6, 7	-0.3	4.6	V
JTAG	11, 12, 13, 14, 15	-0.3	4.6	V
GPIO	8, 9, 10, 18	-0.3	4.6	V
DCINs,DCIN1,2,3	2, 3, 23, 25	-0.3	4.6	V
Storage Temperature	-	-45	+90	°C

Note: Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

3.2. Recommended Operating Conditions

Table 3-2: Recommended Operating Conditions

RATING	CONDITIONS	MIN	TYP	MAX	UNIT
Operating ambient temperature		-40	+25	+85	°C
VccRF, VCC		1.95	3.0	3.6	V
JTAG, UART	VIL VIH VOL VOH (VCC is at nominal 3V)	 2.0 2.4		0.8 0.4	V
DCIN3		1.95	3.0	VCC	V

3.3. Power Consumption

Table 3-3: Power Consumption

PARAMETER	TEST CONDITIONS	TYP	MAX	UNIT
Tx Current	VccRF=3 V VCC=3 V Band=EU @ 23dBm	400	480	mA
Tx Current	VccRF=3 V VCC=3 V Band=US @ 21 dBm	250	300	mA
Rx Current	VccRF=3 V VCC=3 V	125	135	mA
Hibernation	VccRF=3 V VCC=3 V	1.7	2.5	uA

3.4. Transmitter

Table 3-4: Tx Characteristics

CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
NTP	VccRF=3 V VCC=3 V Band=EU	22	23	24	dBm
NTP	VccRF=3 V VCC=3 V Band=US	19	20	21	dBm
Harmonics	VccRF=3 V VCC=3 V Band=EU & US		-40	-35	dBm
Transmission Mask	EN 301406 Paragraph 5.3.3		Comply		N/A
Frequency Offset	EN 301406 Paragraph 5.3.1	-50	8	+50	KHz
Frequency Drift	EN 301406 Paragraph 5.3.5	-15	0	+15	KHz/Slot
Emission Due Modulation	EN 301406 Paragraph 5.3.6.2 M±1 M±2 M±3 M>±3		 -20 -42 -47 -50	 -8 -30 -40 -44	dBm

3.5. Receiver

Table 3-5: Rx Characteristics

CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Sensitivity, BER < 1000ppm	VccRF=3 V VCC=3 V		-96	-93	dBm
Maximum input power	VccRF=3 V VCC=3 V			15	dBm

4. Modifying Module Software and Adjusting Parameters

The DHAN module is loaded with the standard HAN-FUN image, configured for application control by an external MCU via the UART CMND Node Interface. It is also configured for European band operation, with a generic ID (IPEI in DECT nomenclature) and it will identify itself as a smoke detector. These latter 3 items are configurable ULE parameters that can be modified by the user and stored back into the module non-volatile memory. However, if the user application is using the DHX91 as a standalone processor (ie no external MCU) or requires some means other than the UART CMND interface for communication between the external MCU and the DHAN – customization and reloading of the software image running on the DHAN is required.

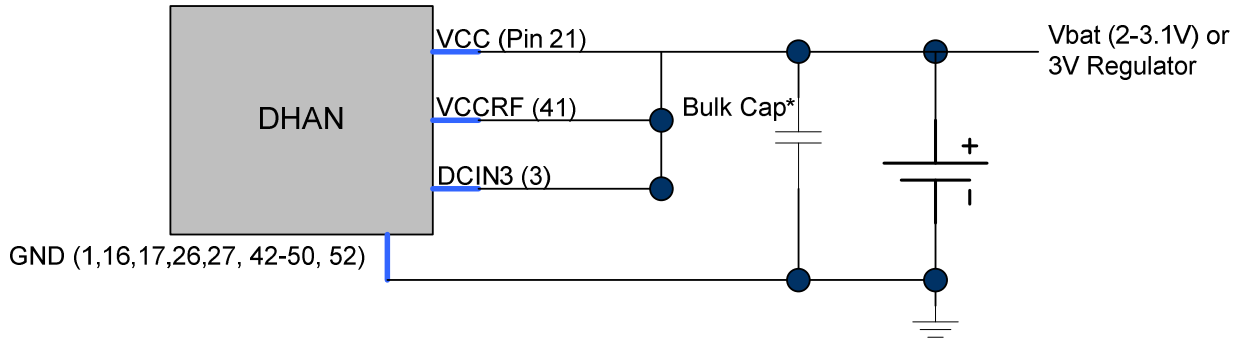
Customized software images can be updated via the JTAG I/F. DSP Group will supply a tool (Vega Memory Tool) to accomplish both image update and parameter modification using the JTAG I/F. So it is recommended that the customer include test points in the application board layout to access the JTAG port (see schematic tips later on).

The UART CMND API also includes commands for updating parameters using the UART I/F. So the user should expose this I/F as well for connection to his production rack. If the application board includes an external MCU, then its UART I/F will need to be tri-stated during this production phase.

5. Application Schematic Guide

This section describes how to connect the DHAN to various power supply schemes, to an external MCU via UART or SPI and to LED indicators.

5.1. Power Supply and Battery Check



Notes:

1) Bulk cap is not required when using lithium batteries such CR123A or CR2. Suggest 100µF cap for AA or AAA applications and 500mF for CR2032 Coin-Cell operation
2) DCIN3 is an input to an ADC that monitors the battery level

Figure 5-1: Power Supply and 3V Battery Detect Interconnect

If the DHAN VCC/VCCRF is supplied by a 3.3V regulator, the DCIN3 pin requires a voltage divider as shown below:

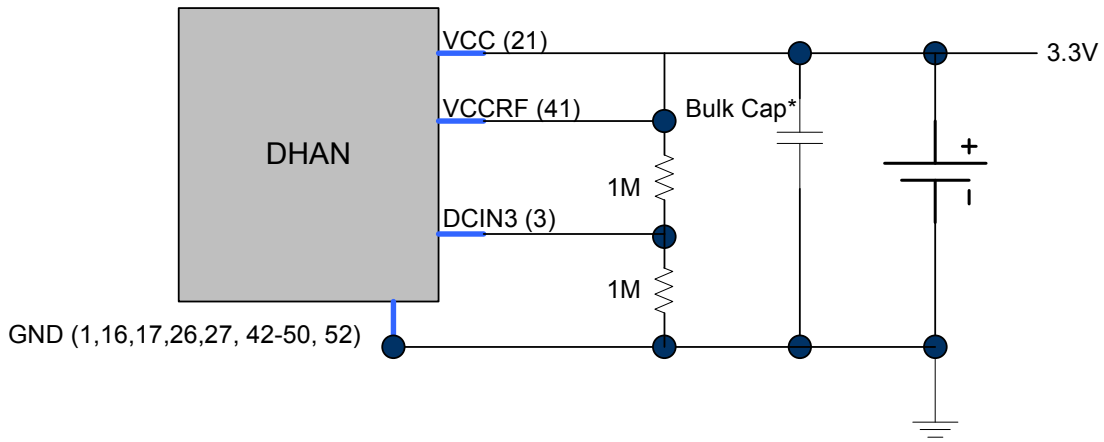


Figure 5-2: Power Supply and 3.3V Detect Interconnect

5.2. UART Interface and Wakeup (Applications running on external MCU)

In circumstances where the external MCU detects an event that needs to be communicated to the DHAN, it will need to wake up the DHAN from its low current hibernation mode, wait ~10mS for the DHX91 to reboot and then signal to the DHX91 via UART I/F. There are two options for the external MCU to wake the DHAN from hibernation:

1) Apply a rising edge to one of the ULE I/O (configured as a Digital Wakeup), wait ~10mS and begin communication with the DHX91 DHAN via UART. See Figure 5-3

2) Begin communication via UART, with the expectation that it will take ~10mS for the ext MCU to obtain a response from the awaking DHAN. See Figure 5-4

In other circumstances, an over the air incoming Page or Alert from the Controller will be detected by the DHAN. If the external MCU is in Sleep Mode, the DHAN will need to first awake the MCU. Most MCUs will wake upon sensing transitions on the DHAN UART TxD line. However, some may require (prefer) to be woken up by application of a rising edge to a generic digital input at the MCU. This option is also called out in Figure 5-3.

If the DHAN (and external MCU) is supplied by a regulated voltage ≥3.3V, the interconnect shown in Figure 5-4 is recommended.

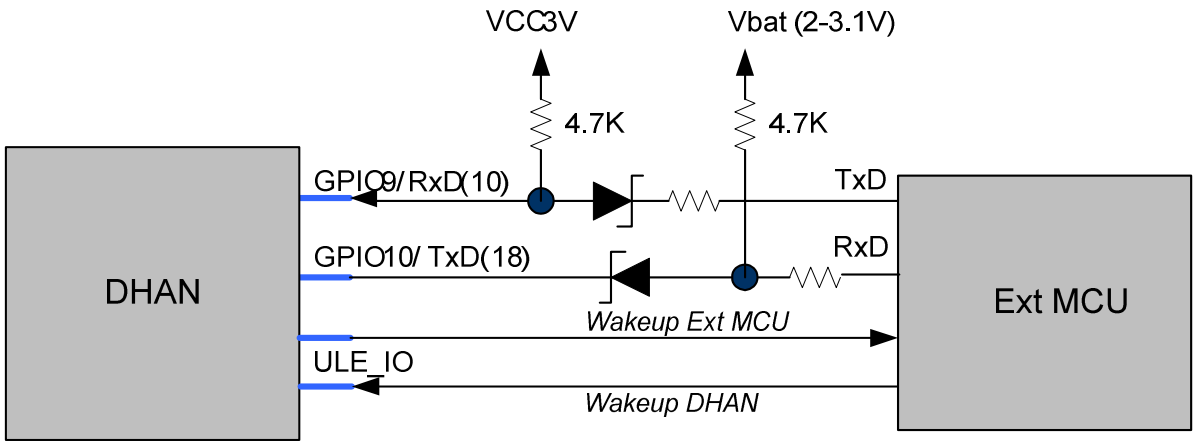


Figure 5-3: UART I/F with bi-directional, dedicated signals for wakeup

Note: ULE IOs that can be used for wakeup are pins 25, 28, 30, 31, 34. Pin 22 (DOUBCAP2P) should not be used for ULE wakeup

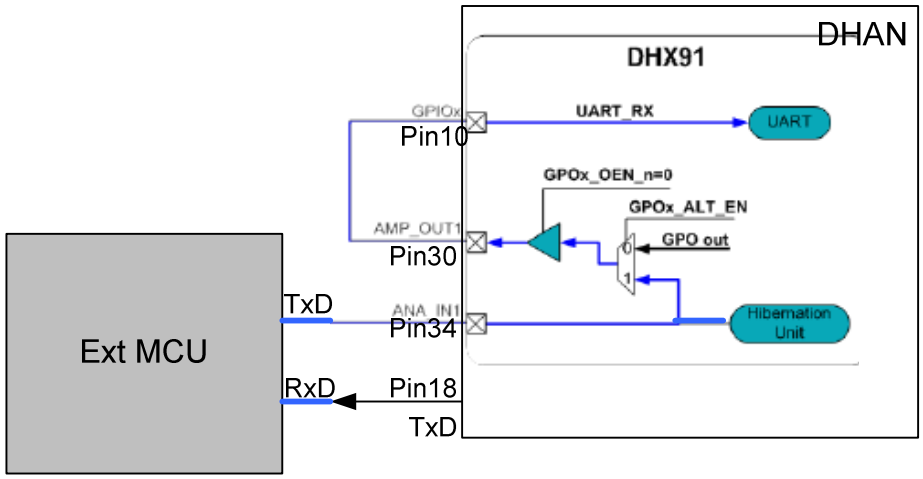


Figure 5-4: UART I/F used for wakeup of DHAN

5.4. SPI Interface

The DHAN can also support an SPI Interface as shown below:

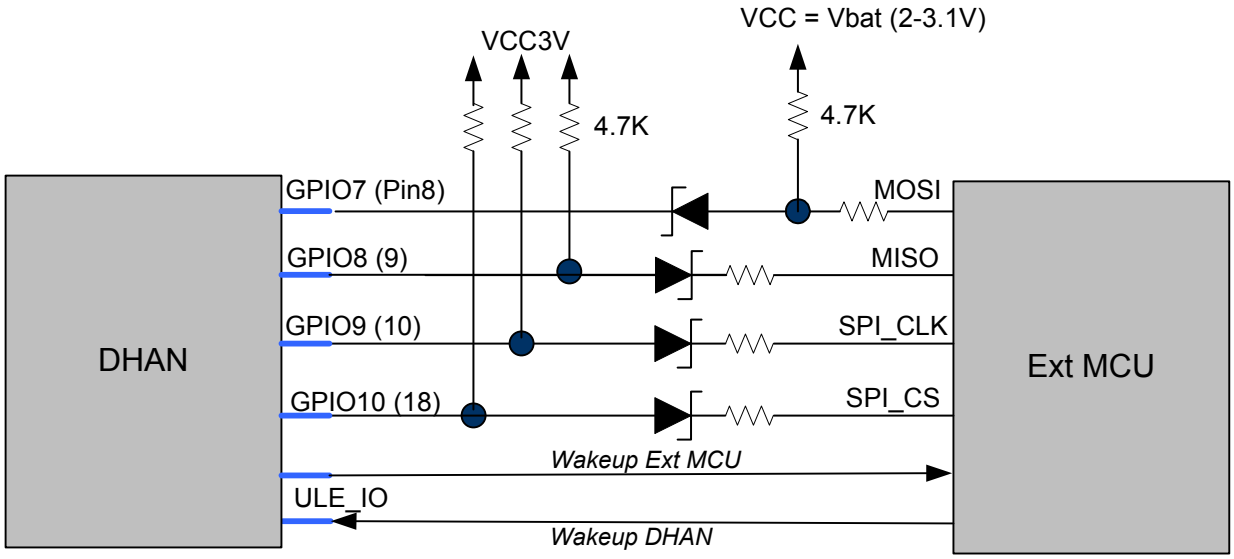


Figure 5-5: SPI I/F with Wakeup

5.5. Support of LEDs

Any of the ULE IOs can be used to drive an LED. These LEDs should be powered by Active Low logic. For consistent illumination as the battery level drops, the positive node should be connected to Pin24 (VCC3V) – as shown below. Typically, ULE IO ANA_IN1 is used by the SDK to indicate Registration Open/Success as well as ULE Activity.

An LED that needs to operate while the DHAN is in hibernation should utilize the LEDSINK pin (25) which features a PWM with sink capability. In this case, the LED should be sourced by VCC source (not VCC3V, as this supply is off during hibernate)

5.6. DHAN Standalone Applications

The DHX91 ULE block includes a Sensor Conditioning Module which can facilitate many types of ULE applications. This module is a highly configurable analog circuit that can be used to interface to a wide variety of sensor transducers.

The module is built around the following sub-circuits:

- Two analog operational amplifiers (op-Amps) with shared bias source
- Two analog comparators with digital output
- One configurable digital potentiometer
- Three configurable ratiometric voltage references with selectable source
- Several analog distribution MUXes
- Several sample-and-hold (S&H) mechanisms

For more information about the Sensor Conditioning Module, please contact DSP Group.

6. Application PCB Design Recommendations

It is recommended that unused pads on the Application PCB not be left as isolated islands of copper but rather be anchored with via to inner layers of the PCB. It is also recommend that GND vias be applied liberally in the vicinity of the antenna pin output (Pin 51) and the associated GND pins (42-50 and 52).

The following layout recommendations need to be apply on Main Board:

1. Implement a solid ground under the DHAN module.
2. Do not route signal traces under the module. Use the bottom layer for signal routing.
3. Make sure no components are near the antenna.
4. Locate the antenna on the edge of the PCB.
5. Use coplanar wave-guide trace between the DHAN module and antenna, it should be designed to be as short as possible with 50Ω impedance.
6. Add GND vias alongside the RF trace.
7. Route the RF trace with gradual bends and no sharp corners.
8. Design the antenna position according to the common usage/position of the ULE product for optimal range.

6.1. Antenna Recommendations

A Pi-scheme should be added between the DHAN module antenna port and the antenna. This circuit will be used for antenna matching, if needed.

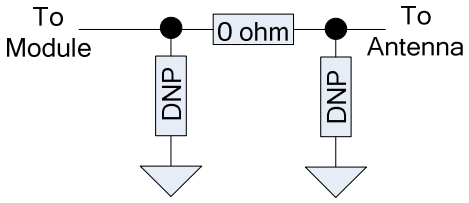


Figure 6-1: Pi-Scheme for Antenna Matching

Applications can use chip, wire or printed antennas – the latter being the most cost-effective and assembly-friendly. However it requires space on the application PCB.

6.1.1. Wire Antennas

The wire antenna should be bent according to the cabinet structure one should try to implement minimal of parallel structures. The total length of the wire antenna should be ¼ Lambda (~40.0 mm). It is important to ensure an adequate ground plane near the antenna port in order to obtain maximal antenna gain and efficiency.

6.1.2. Chip Antennas

P/N	Manufacture
ANT8868LL00R1880A	Yageo
CAN4311112001881K	Yageo
W3022	Pulse Elect

6.1.3. Printed Antennas

The most popular are INV-F-Antenna and monopole antenna, RF CAD tools are recommended to use when designing such, below one can find typical INV-F-Antenna dimensions for DECT band.

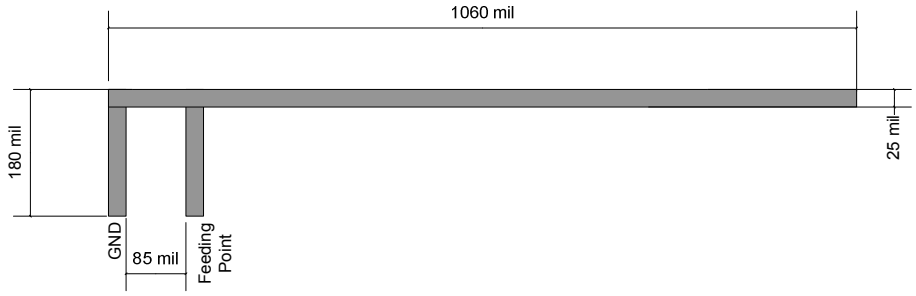


Figure 6-2: INV-F-Antenna Dimension

A practical, more compact version of this inverted-F is shown below. Contact DSPG to obtain the design file.

7. Assembly Information

7.1. Mechanical Outline and PCB Footprint

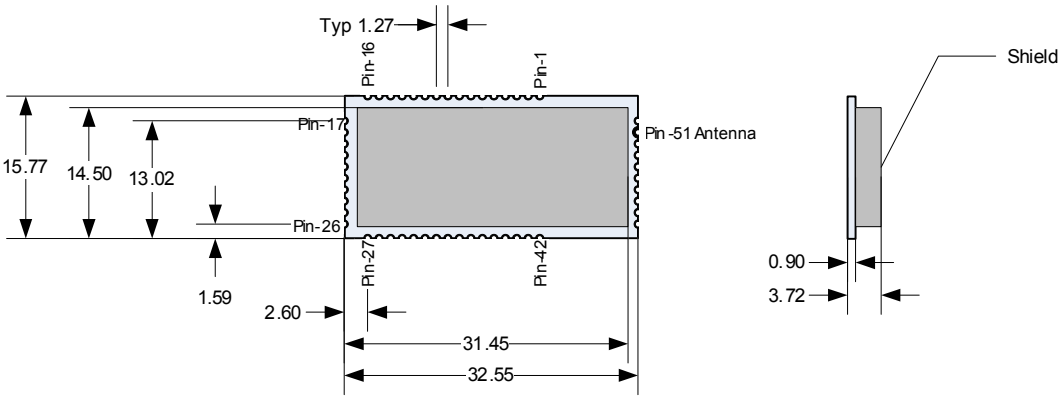


Figure 7-1: Module Mechanical Outline

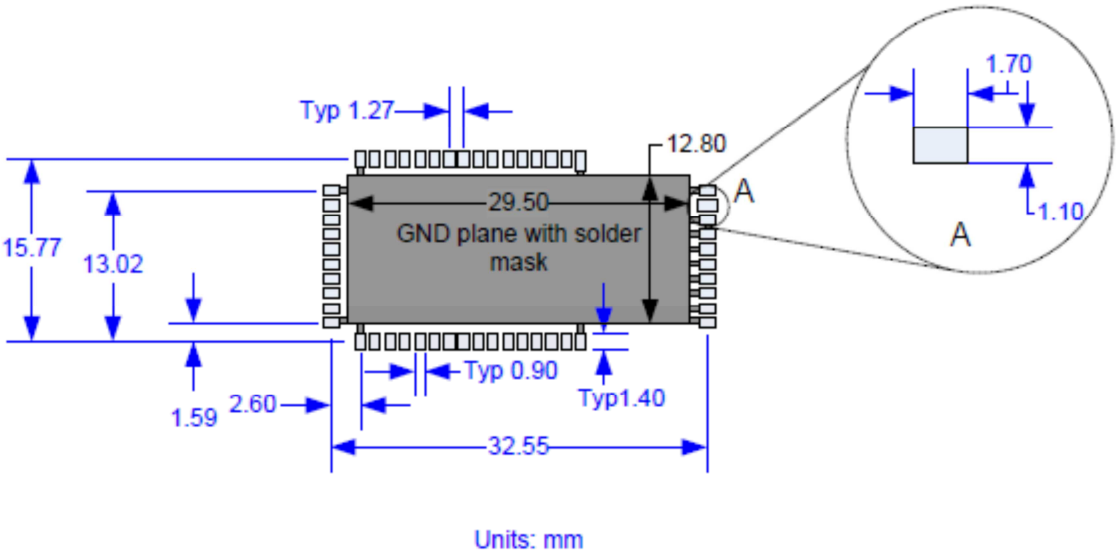


Figure 7-2: Recommended PCB Footprint

7.2. Pick & Place, Reflow

The DHAN module uses a flat shield cover for a fully automatic assembly process. For backing and reflow recommendations, use MSL 3 in the JEDEC/IPC standard J-STD-20b. The temperature classification (TC) for the module is 245° C.

8. Supplementary Information

8.1. Photo

8.2. Labeling (appended to module shield)

1) Year
2) Week
3) 6-digit serial#
4) HW Version
5) SW Version

8.3. Purchasing EMC

The customer is responsible for applying to ETSI for an EMC (Equipment Manufacturers Code) and loading it into the DHAN EEPROM. Typically it is used as part of the device ID (IPUI in DECT nomenclature). EMC is a special code that a manufacturer purchases from ETSI to use to identify their products and to implement vendor specific features.

8.4. Ordering Information

Part #: DHX91MDMCFAE5AMI

8.5. Change Log

Table 8-1: List of Changes

REVISION	DATE	DESCRIPTION
1.0	July 2014	First release
1.1	December 2014	Corrected App Schematic
1.2	February 2015	*Clarified that printed antenna is not incorporated in the module. *Added recommendations for application board PCB
1.3	June 2015	*Add Application Schematic and Layout *Add PCB footprint *Corrected Part# in Ordering Info
1.4	September 2015	*Introduction: Add reference to non-ULE (ie Voice) applications *Pin Description: DOUBCAP2P. Need Pull-Down when VCC ≥ 3.1V. Avoid using this as input for ULE Wakeup *Pin Description: LEDSINK. Should be left NC when VCC ≥ 3.3V *Section 4: SW images loaded by JTAG only (no UART) *Modify Figure 5-1: Power Supply and Battery Detect *Add Figure 5-2: Battery Detect for 3.3V systems *Modify Figure 5-3: Direct UART I/F *Add Figure 5-5: SPI (Slave) I/F *Add Figure 5-6: Control of LEDs *Section 8: Add photo and labeling information *Section 8: Customer required to purchase EMC

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