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# Datasheet DS0010

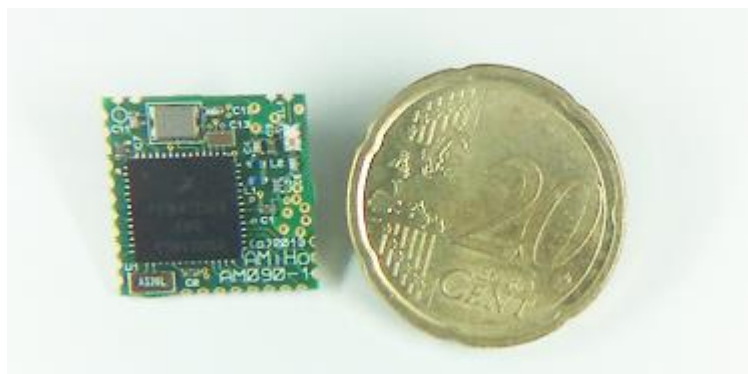
## AM090 Wireless Meter-Bus 868MHz Narrowband Modem

### Advance Information

### Production Status – Production

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**Important Information – The information contained in this document is subject to change without notice. Please contact AMIHO Technology before using this information to design your product.**



The AM090 Wireless Meter-bus (W-MBus) 868MHz modem uses the Freescale MKW01Z128: ARM Cortex M0+/Narrow band transceiver MCU to form an ultra-compact 20mW module. The module uses an AT command interface and supports a very low current standby modes for battery powered applications. It is designed specifically for use in Wireless Meter-Bus applications and is supplied with an EN13757-compliant Wireless Meter-Bus software stack, but is also suitable for other 868MHz ISM-band applications including KNX.

### Features

- *Wireless Modem:* Use in stand-alone modem mode, or embed user application alongside stack.
- *RF modes:* Suitable for narrow-band and wideband operation throughout 868MHz ISM band
- *Hardware:* ARM® 32-bit Cortex M0+ MCU with built-in 128KB Program flash, 16KB RAM and built-in 32kHz RTC. High-speed precision ADC and DAC for audio and measurement applications, additional UART and I2C.
- *Application Support:* Application notes for antenna selection and for meter and concentrator applications, including sample software. AE090 Evaluation Kit with example applications. Code Warrior Project files available on request.
- *Software Support:* Full low level platform, drivers and EN13757-4:2005/2013 Wireless M-Bus RF stack level drivers provided plus utilities and sample application code. Supports S, R and T modes, and optionally C mode, as well as AES128 encryption.
- *Software Upgrade:* Extension of software stack to include OMS and EN13757-5:2008 software modules.
- *Compliance:* The design complies with European Union radio standards (EN300-220).
- *Tools:* Utilities available to help debug user application; supported by Freescale CodeWarrior

### Specification

<i>Microcontroller &amp; RF transceiver</i>	Freescale MKW01Z128
<i>Program memory</i>	128 KB flash
<i>RTC oscillator</i>	32.768 kHz clock fitted
<i>Data memory</i>	16KB RAM
	Dataflash driver for user storage
<i>Supply Voltage</i>	1.8 – 3.6 V
<i>Maximum output power</i>	+13 dBm
<i>Sensitivity</i>	-114 dBm / 4.8 kbits/sec
	-105 dBm / 32.768 kbits/sec
	-101 dBm / 100 kbits/sec
<i>Current Consumption (provisional)</i>	18 mA / receive
	20 mA / transmit (0dBm)
	33 mA / transmit (+10dBm)
	1.2 uA / sleep (timed wake-up)
	0.1 uA / deep sleep
<i>Temperature range</i>	-40 °C * / +85 °C (* -30 °C for R mode)

### Physical / Hardware

<i>Dimensions</i>	15.2 x 15.2 x 2.5 mm approximate size
<i>Connections</i>	1.27 mm pitch SMD edge connectors for PCB mounting
	CMOS-level UART interface
	6 Analogue inputs/GPIO
	6 additional GPIO, including special functions such I2C, SPI and UART
<i>Programming/debug</i>	SWD debug interface

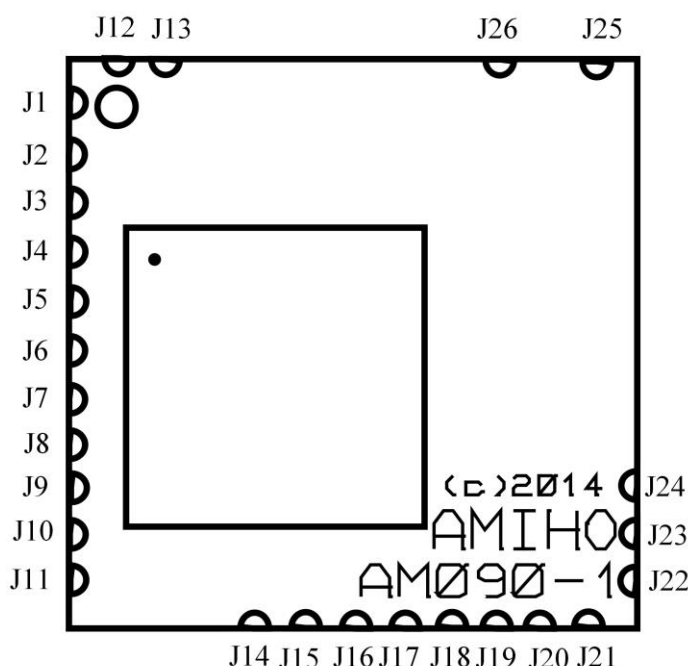
### Software

EN13757-4:2005/ 2013 wireless meter-bus stack	API to allow other protocols to be added
AT command interface for stand-alone modem operation	Packet sniffer mode
Built-in profiles for rapid mode switching	Network formation mode
M-bus S, R, T and C mode packet interface	Pulse counter application
API to add higher layer M-bus protocols	Power management
	Example gas meter application

### Ordering Information

Part Number	Description
AM090-00	Base modem supporting Modes S, T and R2 according to EN13757-4:2005
AM090-01	Base modem with dedicated OMS application layer
AM090-02	Extended modem supporting Modes S, T and R2 and C according to EN13757-4:2013
AM090-03	Extended modem with dedicated OMS application layer according to EN13757-4:2013
AM090-06	915 MHz version with pseudo-W-Mbus modes
AE090	Evaluation kit for AM090 and AM092 modems

## I Module Pinout



<b>Application Connector</b>			
Edge connector is 1.27mm pitch half-holes, 0.75mm diameter.			
Pin Number	Pin Name	Description	MKW01 Signal
J1	I/O1	Radio GPIO	Transceiver GPIO Bit 4
J2	GND	System Ground	GND
J3	I/O2	Optionally programmed as ClkOut to supply MCU clock when connected to J11	Transceiver GPIO Bit 5 / ClkOut
J4	VDD	System Power	MCU VDD supply
J5	AN1	Spare GPIO / Analogue input	PTE16/ ADC0_DP1/ ADC0_SE1/ SPI0_PCS0/ TPM/UART2_TX
J6	SWD_DIO	Serial Wire Data DIO	PTA3/ SWD_DIO/ TSI0_CH4/ IIC1_SCL/ TPM0_CH0
J7	AN2	Spare GPIO/Analogue Input/Output	PTE30/DAC0_OUT/ ADC0_SE23/ CMP0_IN4/ TPM0_CH3/ TPM_CLKIN1
J8	SWD_CLK	Serial Wire Data Clock	PTA3/ SWD_DIO/ TSI0_CH4/ IIC1_SCL/ TPM0_CH0
J9	I/O3	Spare GPIO / NMI	PTA4/ NMI_b/ TSI0_CH5/ IIC1_SDA/ TPM0_CH1
J10	TXD0	Serial Port 0 Tx/Spare GPIO	PTA2/ TSI0_CH3/UART0_TX/ TPM2_CH1
J11	I/O4	Spare GPIO / External clock in	PTA18/ EXTAL0/ UART1_RX/ TPM_CLKIN0
J12	I/O5	Radio GPIO	Transceiver GPIO Bit 3
J13	I/O6	Radio GPIO	Transceiver GPIO Bit 2

J14	RXD0	Serial Port 0 Rx/Spare GPIO	PTA1/ TSI0_CH2/ UART0_RX/ TPM2_CH0
J15	AN3	Spare GPIO / Analogue input	PTB1/ ADC0_SE9/ TSI0_CH6/ IIC0_SDA/ TPM1_CH1
J16	GND	System Ground	GND
J17	I/O7	Spare GPIO / Serial Port 1 Tx / Wake-Up Input	PTC4/ LLWU_P8/ SPI0_PCS0/ UART1_TX/ TPM0_CH3
J18	AN4	Spare GPIO / Analogue input	PTC2/ ADC0_SE11/ TSI0_CH15/ IIC1_SDA/ TPM0_CH1
J19	I/O8	Spare GPIO / Serial Port 1 Rx / Data Available	PTC3/ LLWU_P7/ UART1_RX/ TPM0_CH2/ CLKOUTa
J20	I/O9	Spare GPIO	PTD4/ LLWU_P14/ SPI1_PCS0/ UART2_RX/ TPM0_CH4
J21	AN5	Spare GPIO / SPI1_CLK / Analogue input	PTD5/ ADC0_SE6b/ SPI1_SCK/ UART2_TX/ TPM0_CH5
J22	AN6	Spare GPIO / SPI1 MOSI_MISO / Analogue input	PTD6/ ADC0_SE7b/ LLWU_P15/ SPI1_MOSI/ UART0_RX/ SPI1_MISO
J23	I/O10	Spare GPIO / SPI1 MOSI	PTD7/ SPI0_MISO/ UART0_TX/ SPI1_MOSI
J24	RESETb	Spare GPIO /MCU Reset	PTA20/ RESETB
J25	ANT	RF signal out	RF_OUT
J26	ANT_GND	RF ground for the antenna connection	GND_RF

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## **2 Module Description**

The AM090 is an 868 MHz narrowband modem with a 20mW transmission output, low-power, embedded module based on a Freescale MKW01Z128 MCU/RF transceiver. The MKW01 integrates a Freescale Kinetis ARM CortexM0+ MCU and a Smart Sub-1GHz radio transceiver into a single package.

Included on the module is an integrated filter for 868MHz operation and associated matching network for a 50 ohm output impedance. For optimum performance the user must add any additional network components required to match the antenna to a 50 ohm impedance off-module.

The MCU handles the protocol, provides hardware interface and the software platform to run user application code. It also includes a dedicated data flash memory for system and application data storage.

The Transceiver provides the RF interface and low-level RF protocol handling as well as part of the network security. A programming / debug interface enables in-circuiting reprogramming and processor-level development and debug using the Freescale Code Warrior IDE.

### **2.1 Functionality Overview**

The integrated microcontroller is pre-loaded with an AMIHO firmware image which hosts an AT command interface and supports very low current standby modes for battery powered applications. It is designed for use specifically in Wireless-MBus applications and is accompanied by a software stack to implement the low-level drivers, Wireless-MBus stack and core software platform.

The module may be used as a stand-alone modem, or as an embedded module which allows the user to run their application on the module.

The module design and software stack is also suitable to be used as a reference for embedding into a third party design.

The AM090 has the following features:

- A programming / debug interface enables in-circuiting reprogramming and processor-level development and debug using Freescale Code Warrior or other suitable software tool.
- Header pads along the edges of the module give access to the UART used for AT command modem control. Thus the AM090 may be used as a stand-alone modem, and according to application software may include a pulse counter and wake-up interrupt.
- Further analogue inputs and output, GPIO and processor peripherals are also brought out to header pads. These may be used in a custom module application.

For further cost reduction it is possible to purchase a version of the AM090 without the on-board 32KHz crystal fitted. In this case if there is a requirement to use low power modes whilst maintaining an internal real time clock (RTC) then an external oscillator source must be supplied to J11. For non-power critical applications, an alternative source of high precision clock may be obtained by using the ClkOut feature of the smart radio by connecting J3 to J11.

The detailed use of the GPIO and peripheral functionality of any pin of the AM090 is fully specified in the Freescale datasheets and reference manuals for the MKW01Z128. Refer to these for further technical detail.

## 2.2 Firmware Overview

The AM090 is pre-loaded with the AMIHO Wireless-Mbus stack and by default will start automatically from power-up and run an AT-command set modem interface on the UART serial lines.

For further information about the interface protocol, firmware and the use of the module for Wireless-MBus applications, please refer to the following AMIHO documents:

TD0014\_AT\_Command\_Set  
TD0015 for information on the use of W-Mbus.

The default serial link is:

- RS232 at CMOS level. Full Duplex
- 57600 baud
- 8bits
- No parity
- No flow control

### 2.2.1 Configuration

Configuration data for the module is stored in the non-volatile data flash on the microcontroller. This holds the network addresses, encryption keys and module behaviour including radio profiles transmission modes, transmission times etc.

Unreserved space is available for the user application.

### 2.2.1 Wake-Up and Data Available

The modem is designed to use a single pair of UART RX/TX lines for handshaking and control.

#### Wake-Up

By default the modem uses a CLI command (a null character) to wake up from sleep. Optional configuration enables the modem to be woken on a GPIO line.

#### Data Available

By default, the modem uses a store and forward methodology, and the host polls the modem to check for new data, allowing the host to sleep or do other tasks until it is ready to read the message. This is the recommended method. Optional configuration options allow the modem to signal that a message has been received either by asserting the *data available* line or placing a dummy character on the UART RX line. It is also possible to enable the modem to output message data on the UART RX line immediately.

## 2.2.2 Configuration Rebooting

The module is expected to run continuously, entering a low-power state when not transmitting or receiving. The unit may be rebooted deliberately by re-powering the unit, or by issuing a software reboot command.

Diagnostic information, including 'up-time' is held in the unit.

## 2.2.3 Re-programming

Access is given, via the edge connectors to the Freescale SWD pins for debugging purposes. The user may reload the AM090 with custom firmware using a suitable software development environment. AMIHO may additionally undertake the development of alternative firmware under a customer contract.

# 3 Operating Characteristics / DC Electrical Characteristics / AC Electrical Characteristics

### Absolute Maximum Ratings

Parameter	Min	Max	Unit
Supply Voltage	-0.3	3.8	V
Voltage on any pin	-0.3	VDD + 0.3V	V
Input RF level		6	dBm
Storage temperature	-55	115	°C

### Recommended Operating Conditions

Parameter	Min	Max	Unit
Supply Voltage	1.8	3.6	V
Logic Input Voltage Low	-0.3	20% VDD	V
Logic Input Voltage High	80% VDD	VDD	V
Logic Output Voltage Low (I <sub>max</sub> = -1 mA)	0	10% VDD	
Logic Output Voltage High (I <sub>max</sub> = 1 mA)	90% VDD	VDD	
Input RF level		0	dBm
Operating temperature	-40	85	°C

## 4 Mechanical Specification

The AM090 module is a 0.8mm thick PCB-based radio-modem design. It is suitable for SMD PCB mounting and is designed to be operated without additional electrical screening or mechanical protection.

### 4.1 Module Dimension

The overall module size is 15.2mm x 15.2mm x 2.5mm, with components only on one side of the board.

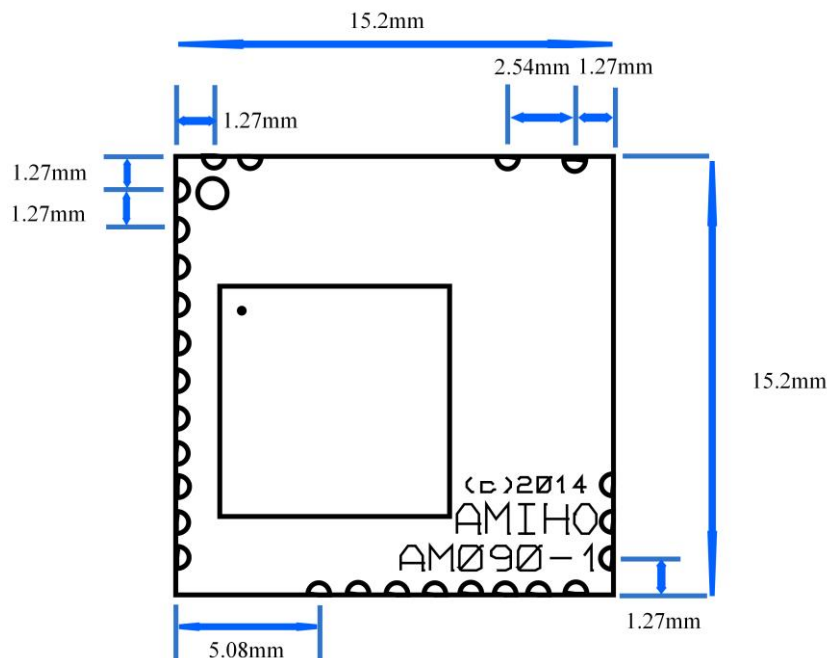
### 4.2 Mounting

The AM090 is suitable for surface-mount pick and place operation. During assembly it is to be mounted onto the top side only of a customer PCB, unless special manufacturing precautions are taken.

#### 4.2.1 Soldering

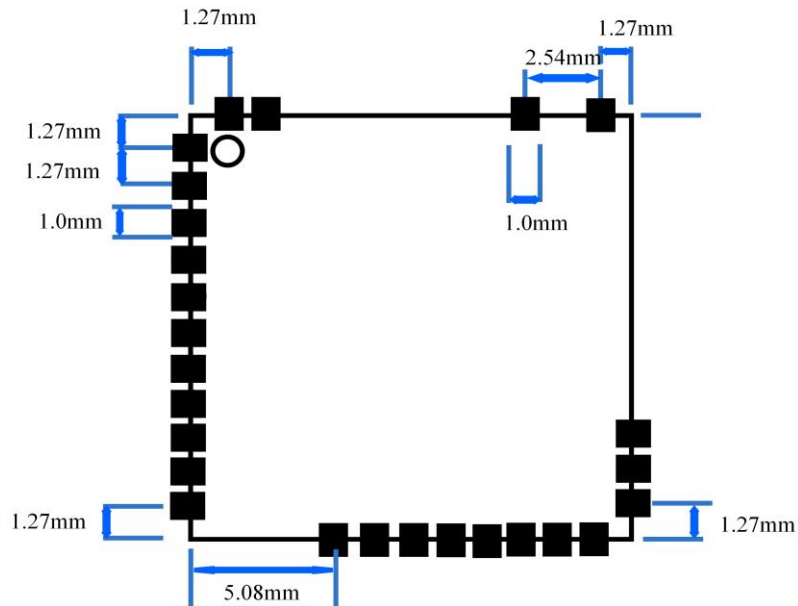
The module **MUST** pass through a reflow soldering process with the components on the top side. Reflow-soldering the module upside down may result in damage to the module.

#### 4.2.2 Module Detail

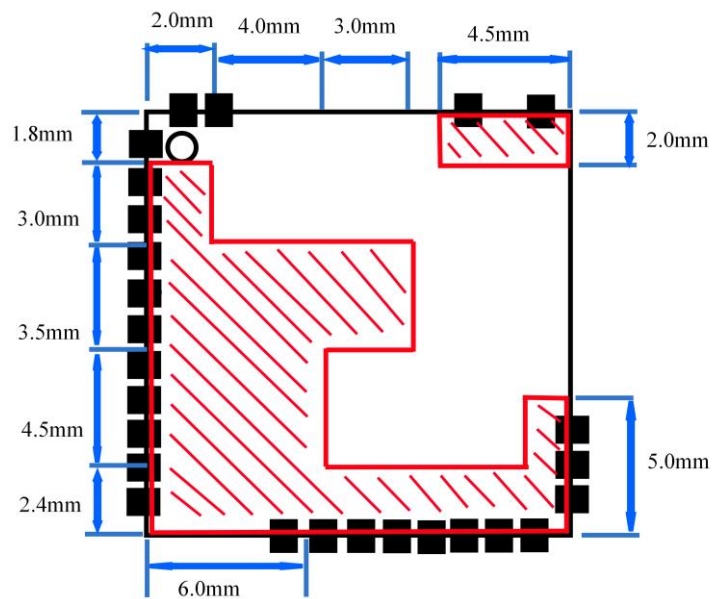




### 4.2.3 Recommended Solder Pad Pattern



### 4.2.4 Keepout Area



There must be no signals routed within the red keep-out zone on the top layer of the PCB to which the AM090 is mounted.

Any routing under the AM090 are to be low frequency signals only, unless the PCB is multi-layer and the layer immediately under the AM090 is a ground plane.

### 4.3 Power supply decoupling

There is local decoupling on the MCU power pins within the AM090. The power supply to the AM090 must be decoupled closely to the power connections. There must be a minimum of a low ESR 10uF capacitor is e.g.:

Murata 10uF 6.3V 0603 ceramic, part no. GRM188R60J106ME47D.

### 4.4 RF Layout

To ensure optimal performance from the module it is important that a good RF layout is achieved:

- The module ground pins must be connected to a solid ground plane.
- Connect the antenna ground to the ground plane with a single connection.
- Fill all unused PCB area around the module with ground plane.
- If the ground plane is on the bottom of the PCB only, then use several metal vias to connect the ground pins to the ground plane to minimise inductance.

#### 4.4.1 Antenna connection

The AM090 has been designed with a 50ohm output for direct connection to a matching impedance antenna. AMIHO have matching circuits detailed for the use of other antennae – see application note TN020.

## 5 Operating environment

- The AM090 is designed for operating temperature range:
  - Normal: -40 °C (-30 °C for R mode) / +85 °C
- The AM090 would normally form part of a static installation and would either be incorporated into a larger unit or designed into the circuitry of a larger unit. Care should be taken to ensure that conductive materials mounted close to the board do not adversely affect the RF performance of the unit.
- The normal equipment environment for the product in use might be indoors or outdoors.
- The AM090 is suitable for both continuous and discontinuous operation.
- It is not expected to require servicing

## 6 Ordering Information

The AM090 series of modules are available in a number of customer build and software options – see the table on page 2 for current and planned versions e.g.:

#### **AM090-00-01.01**

i.e. EN13757-4:2005 Wireless-MBus stack; AT modem s/w release 1.01; 868MHz operation

Other versions can be built to order and may also be available off the shelf or with a short lead time. These include variations in software functionality and components fitted. The build options are defined as follows:

AM090-xx-yy.zz

where: **xx** denotes the s/w type; **yy** is the major version, **y** is the minor version

## **7 Standards and regulations**

Radio stack and Data Interface: EN13757-4

Radio Approvals: EN 300 220 Pt 2

RoHS Compliance: Directive 2002/95/EC

## **8 Contact / Further Information**

Contact AMIHO Technology for further information at:

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## **9 Document History**

<b>Revision</b>	<b>Date</b>	<b>Changes</b>
0.1	18/02/2014	Draft
0.9	25/04/2014	Release draft
1.0	03/06/2014	First issue. Wake-up and data available signal details added