
Shortform Datasheet DS0016 AM094 LoRa / LoRaWAN / Wireless Meter-Bus 868MHz Narrowband Modem

Production Status – Sampling

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The AM094 LoRa / LoRaWAN / Wireless Meter-bus (WM-Bus) 868MHz modem uses the Freescale KL16 Microcontroller and Semtech SX1272 LoRa / Narrow band transceiver to form a compact 25mW 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 LoRa, LoRaWAN and Wireless Meter-Bus applications and is supplied with a combined LoRa / EN13757-compliant Wireless Meter-Bus software stack. It 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 32kHz RTC. High-speed precision ADC and DAC for audio and measurement applications, UART and I²C.
- ◆ *Application Support:* Application notes for antenna selection and for meter and concentrator applications, including sample software. AE093 Evaluation Kit with example applications. Freescale CodeWarrior 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, T and C mode, as well as AES128 encryption.

- ◆ *Software Upgrade:* Extension of software stack available by request.
- ◆ *Compliance:* The design complies with European Union radio standards (EN300-220).

Specification

<i>Microcontroller</i>	NXP Kinetis KL16Z128
<i>RF transceiver</i>	Semtech SX1272
<i>Program memory</i>	128 KB flash
<i>RTC oscillator</i>	32.768 kHz clock fitted
<i>Data memory</i>	16KB RAM
	Dataflash for user storage
<i>Supply Voltage</i>	1.8 – 3.6 V (min 2.4V for +14dB output power)
<i>Maximum output power</i>	+14 dBm
<i>Sensitivity</i>	-117 dBm / 4.8 kbits/sec
	-107 dBm / 32.768 kbits/sec
	-104 dBm / 100 kbits/sec
	-137dBm / xx bps, spread spectrum modulation
<i>Current Consumption</i>	11 mA / receive
	13 mA / transmit (0dBm)
	29 mA / transmit (+10dBm)
	37 mA / transmit (+13dBm)
	2.2 uA / deep sleep
<i>Temperature range</i>	-40 °C * / +85 °C (* -30 °C for R mode)

Physical / Hardware

<i>Dimensions</i>	20.3 x 17.8 x 2.0 mm approximate size
<i>Connections</i>	1.27 mm pitch SMD edge connectors for PCB mounting
	CMOS-level UART interface
	12 I/O configurable including:
	5 analogue inputs
	1 analogue output
	Additional GPIO, including I ² C, SPI and UART
<i>Programming/debug</i>	SWD debug interface

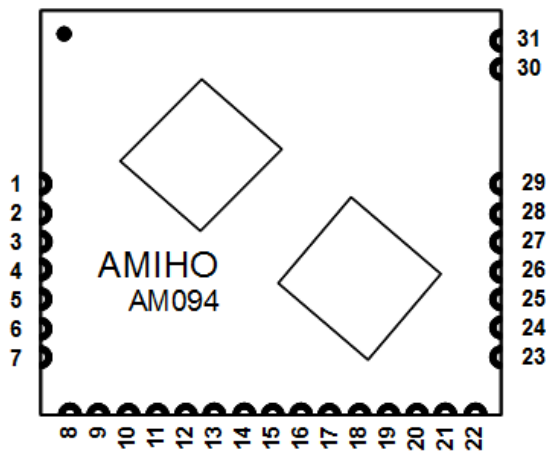
Software

EN13757-4:2013 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
AM094-00	Extended modem supporting LoRa and WM-Bus Modes S, T and R2 and C according to EN13757-4:2013
AM094-02	Modem supporting LoRaWAN
AE093	Evaluation kit for AM0091, AM093 and AM094 modems

I Module Pinout



Pin No.	Internal Connection	Function	Pin No.	Internal Connection	Function
1	GND	GND	17	PTB0	Spare GPIO
2	PTA4	Spare GPIO	18	PTC2	Analogue input/GPIO
3	DIO1	Radio i/o	19	PTE19	Analogue input/GPIO
4	DIO0	Radio i/o	20	PTE18	Analogue input/GPIO
5	DIO2	Radio i/o	21	RxD2	Spare UART RX /GPIO
6	DIO3	Radio i/o	22	TxD2	Spare UART TX /GPIO
7	PTE30	Spare GPIO/DAC	23	SWD_clk	Debug clock
8	VDD	VDD	24	SWD_dio	Debug data
9	GND	GND	25	nReset	Reset / Programming RST
10	PTB1	Spare GPIO	26	PTA19	External RTC XTAL 2
11	PTC3	Data Available	27	PTA18	External RTC XTAL 1
12	PTE0	Spare GPIO	28	GND	Antenna GND
13	PTE1	Spare GPIO	29	RFIO	Antenna
14	PTD7	Spare GPIO	30	GND	RF GND
15	TxD0	Module UART TX out	31	NC	NC
16	RxD0	Module UART RX in			

2 Module Description

The AM094 is an 868 MHz narrowband modem with a 25mW transmission output, low-power, embedded module based on an NXP Kinetis KL16 microcontroller and Semtech LoRa SX1272 radio transceiver.

Included on the module is a 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 NXP Codewarrior IDE and SWD debugging tool such as the Segger j-Link.

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 M-Bus applications and is accompanied by a software stack to implement the low-level drivers, Wireless M-Bus 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 AM094 has the following features:

- A programming / debug interface enables in-circuiting reprogramming and processor-level development and debug using the NXP Codewarrior IDE or other suitable software tool and SWD interface.
- 'Half-hole' connector pads along the edges of the module give access to the UART used for AT command modem control. Thus the AM094 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, GPIO and processor peripherals are also brought out to the edge connector pads. These may be used in a custom module application.

For further cost reduction it is possible to purchase a version of the AM094 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 or clock source must be supplied to J26/J27.

The detailed use of the GPIO and peripheral functionality of any pin of the AM094 is fully specified in the NXP Kinetis KL16 datasheets and reference manuals. Refer to these for further technical detail.

2.2 Firmware Overview

The AM094 is pre-loaded with the Amiho Wireless M-Bus 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 M-Bus applications, please refer to the following Amiho documents:

- TD0014 AT Command Set
- TD0015 for information on the use of WM-bus.
- TD0032 LoRa Command Set Extensions

2.2.1 Host Interface Connection

The default serial link is:

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

2.2.2 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.

2.2.3 Wake-Up and Data Available

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

2.2.3.1 Wake-Up

By default the modem uses a CLI command (a null character) to wake up from sleep.

2.2.3.2 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. Additionally a data-available output is provided on J11. This is set logic high on the reception of a RF packet, and cleared low when the packet is read over the UART.

2.2.4 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.

2.2.5 Re-programming

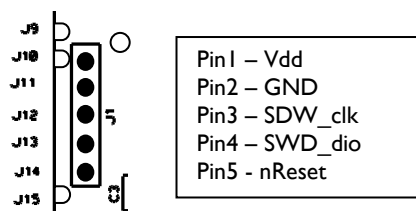
Access is given, via the edge connectors to the NXP debug pins for debugging purposes for use with a suitable SWD debugger/programmer such as the Segger j-Link. The user may reload the AM094

with custom firmware using a suitable software development environment. Amiho may additionally undertake the development of alternative firmware under a customer contract.

The relevant pins on the module edge are:

Pin No.	Internal Connection	Function
23	SWD_clk	SWD clock input
24	SWD_data	SWD bidirectional data line
25	nReset	Reset / Programming RST

Amiho use a 5 pin, 1.27mm pitch header connection on module carrier boards for reprogramming, and can supply suitable adaptor for connection with an SWD debugger. Recommended connection is:



IMPORTANT – the debugger and supply voltage **MUST** be set to 3.3V otherwise permanent damage to the radio modem may occur. Supplying the board power via the USB interface on the AE09x evaluation board will ensure correct voltage supply for the AM094.

2.2.6 LoRaWan

The AM094 has been manufactured with the physical connections implemented between the SX1272 and the KL16 processor as detailed in the Semtech LoRa documentation. A firmware option for the AM094 implements the LoRaWAN stack.

The on-module physical connections are:

SX1272 pin	KL16 pin	Description
DIO0	PTD7	TxDone, RxDone
DIO1	PTD6	RxTimeout
DIO2	PTD5	
DIO3	PTD4	ValidHeader

DIO0-3 come out to edge connectors and may therefore be utilised by a user application if not required by the module modem firmware.

3 Operating Characteristics / DC Electrical Characteristics / AC Electrical Characteristics / RF Characteristics

3.1 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		10	dBm
Storage temperature	-55	115	°C

3.2 Recommended Operating Conditions

Parameter	Min	Max	Unit
Supply Voltage	1.8	3.6	V
Logic Input Voltage Low	-0.3	30% VDD	V
Logic Input Voltage High	75% VDD	VDD	V
Logic Output Voltage Low (I _{max} = -1 mA)	0	10% VDD	
Logic Output Voltage High (I _{max} = 1 mA)	90% VDD	VDD	
Input RF level		10	dBm
Operating temperature	-40	85	°C

3.3 RF Performance

Typical Maximum Output Power: +14dBm

4 Mechanical Specification

The AM094 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 20.3 x 17.8 x 2.0 mm, with components only on one side of the board.

4.2 Mounting

The AM094 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.

There must be no signals routed within the red keep-out zone on the top layer of the PCB to which the AM094 is mounted.

Any routing under the AM094 is to be low frequency signals only, unless the PCB is multi-layer and the layer immediately under the AM094 is a ground plane.

4.2.5 Power supply decoupling

There is local decoupling on the MCU power pins within the AM094. The power supply to the AM094 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.

4.2.6 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.

4.2.7 Antenna connection

The AM094 has been designed with a 50 ohm output for direct connection to a matching impedance antenna.

5 Operating environment

- The AM094 is designed for operating temperature range:
 - Normal: -40 °C (-30 °C for R mode) / +85 °C
- The AM094 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 AM094 is suitable for both continuous and discontinuous operation.
- It is not expected to require servicing

6 Standards and regulations

Radio stack and Data Interface: ENI3757-4:2013

Radio Approvals: EN 300 220 Part 2

RoHS Compliance: Directive 2002/95/EC

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7 Contact / Further Information

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8 Document History

Revision	Date	Changes
1.0	05/07/2016	First Draft