# AMRI-1000

Mobile Navigation Interface IC for Navigation Pad Module

AVAGO TECHNOLOGIES

# Data Sheet



## Description

The AMRI-1000 is a low power multi mode navigation sense and interface IC designed for use with the AMRS and AMRT series of navigation pad modules to provide a mouse-like pointing solution for mobile applications.

In addition to mouse-like navigation, the AMRI-1000 combined with AMRS/AMRT navigation pads can be configured to operate as a four or eight-way switch, a joystick and a scroll wheel like input device. The IC also supports combination of mouse and joystick modes for new navigation experience of e.g. web pages providing precise link selection with fast panning of web pages.

The operating mode can be dynamically reconfigured to provide the best user navigation experience for any active application. For example, the user may select joystick mode for a game and scroll wheel mode for phone book scrolling, while menu navigation is done with the backward compatible 4-way switch mode – always optimized and user configurable for any application.

Versus competing solutions, the AMRI-1000 combined with Avago's AMRS/AMRT series navigation pads is unique in its ability to provide superior tactile feedback as well as multiple intuitive to use operating modes in a compact form factor.

## Theory of Operation

The AMRS/AMRT series navigation pads are capacitance-based sensor modules. A sliding disk is held at a center position by a patent pending pseudo-spring system when the pointer is not being used. Cursor navigation is activated when contact with the slider is sensed.

The sliding disk may be moved in any direction with excellent tactile feedback provided by the pseudo-spring system. The on-screen pointer tracks the movement of the sliding disk providing a mobile navigation experience similar to that provided by a PC mouse.

A selection or clicking operation can be performed by fully depressing the sliding disk. A dome switch provides tactile feedback for this operation.

The IC is built in a TQFN package and provides its own internal clock.

## Features

- 360 degree navigation
- Superior tactile response
- Integrated selection switch with tactile feedback moving with disk
- Dynamically Reconfigurable Multimode operation:

  Mouse mode,

  Analog Joystick mode,

  Hybrid Mouse/Joystick mode,

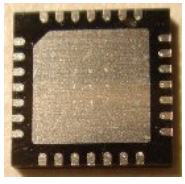
  4-way / 8-way rocker switch emulation modes,

  Scroll wheel mode
- Up to 250Hz screen update rate
- Internal clock
- 7 mW operating power1 (footnote: with 25% run rate while navigating)
- 200 uW standby power with wake on motion2 (footnote: with 1 Hz sampling rate)
- 30 µW power in shutdown mode
- 2.8V Supply Voltage
- 1.8V or 2.8V I/O Voltage
- Compact form factor in standard TQFN package
- Two-wire serial interface or 4-wire SPI interface (selectable)

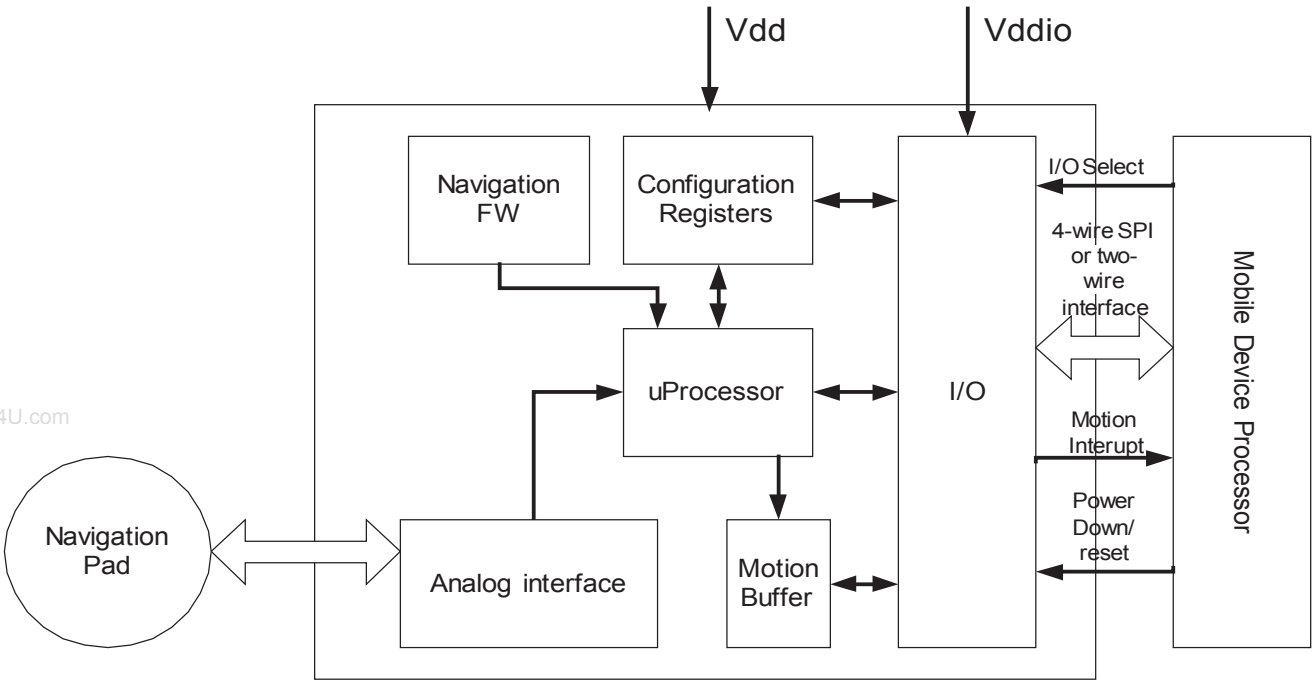
## Applications

- Mobile Phones and Smart Phones
- Computer Peripherals
- Remote Controls
- PDAs, Sub-Notebook and Laptop PCs
- Mobile Multimedia Players
- Video Game Controllers

## Component Image

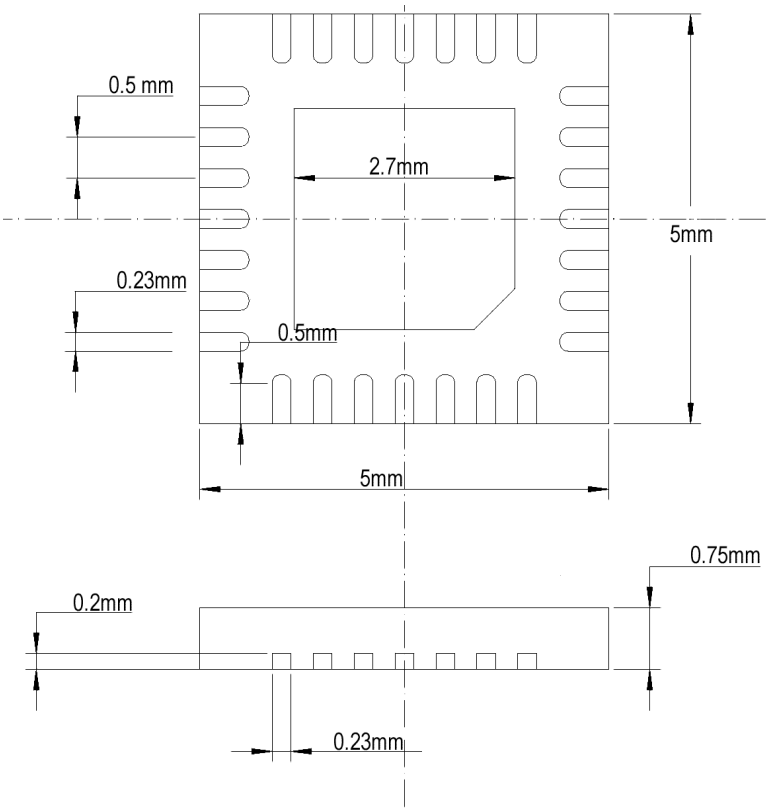
## Block Diagram






## IC Package (TQFN) and connections to navigation pad

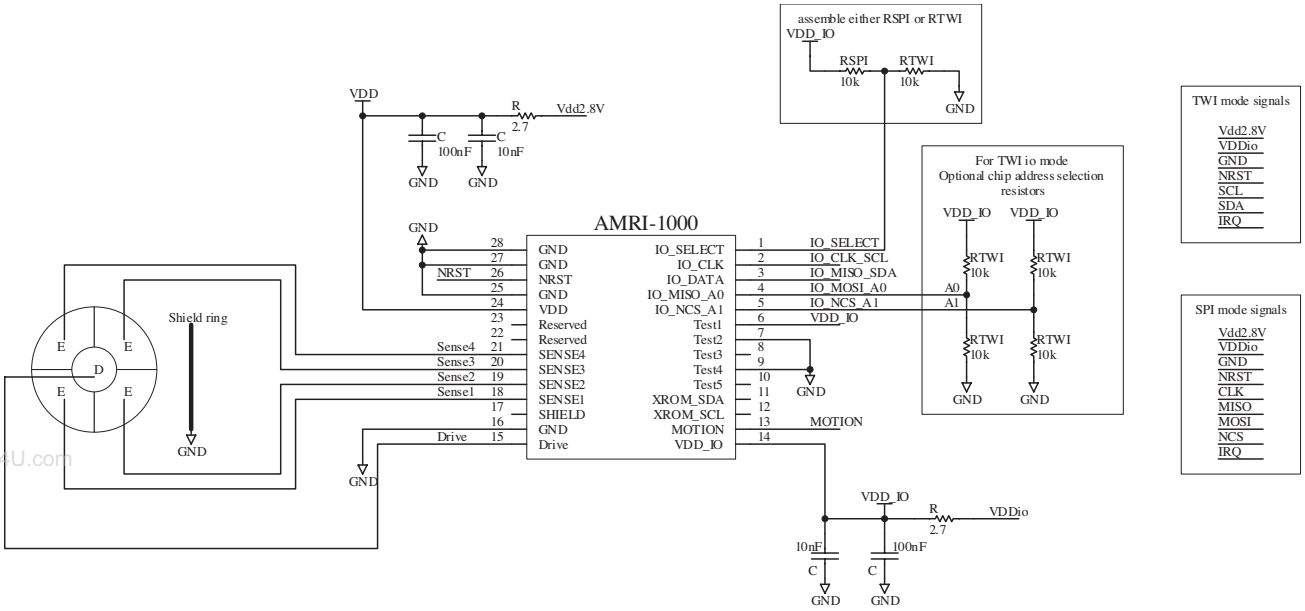
IC Dimensions (bottom and side view):



## Pinout

Note: I/O = digital input/output A = analog P = power

| Pin | Pin Name | SPI | Two-Wire interface (TWI) | I/O | Description |
|---|---|---|---|---|---|
| 1 | IO_SELECT | | | I/O | SPI/TWI Select High = SPI |
| 2 | IO_CLK | SCLK(I) | SCL (I) | I | Serial clock signal |
| 3 | IO_MISO_SDA | MISO(O) | SDA (IO) | I/O | TWI mode: SDA (Serial data) signal<br>SPI mode: MISO (Master in Slave out) signal |
| 4 | IO_MOSI_A0 | MOSI(I) | A0 (I) | I/O | Address select when used as TWI, addr[0], 3 states<br>SPI mode: MOSI (Master out Slave in) signal |
| 5 | IO_NCS_A1 | NCS (I) | A1 (I) | I | Address select when used as TWI, addr[1], 3 states<br>SPI mode: nCS (Chip select) signal |
| 6 | Reserved | | | I | Connect to $V_{DD}$_IO 1.8V or 2.8V Nominal |
| 7 | Reserved | | | I | Connect to Ground |
| 8 | Reserved | | | O | No Connection |
| 9 | Reserved | | | I | Connect to Ground |
| 10 | Reserved | | | O | No Connection |
| 11 | XROM_SDA | | | I/O | If patch code required, connect to a EEPROM (e.g. 24A64) data (SDA) pin, else leave not connected |
| 12 | XROM_SCK | | | O | If patch code required, connect to a EEPROM (e.g. 24A64) clock (SCL) pin, else leave not connected |
| 13 | MOTION | | | O | Motion interrupt pin |
| 14 | $V_{DD}$_IO | | | P | Supply voltage for logic interface |
| 15 | DRIVE | | | O | Analog Drive to center electrode |
| 16 | GND | | | P | Connect to Ground |
| 17 | NC | | | A | No connection |
| 18 | SLIDER_SENSE1 | | | A | Analog Sense |
| 19 | SLIDER_SENSE2 | | | A | Analog Sense |
| 20 | SLIDER_SENSE3 | | | A | Analog Sense |
| 21 | SLIDER_SENSE4 | | | A | Analog Sense |
| 22 | Reserved | | | A | No connection |
| 23 | Reserved | | | A | No connection |
| 24 | $V_{DD}$ | | | P | $V_{DD}$ 2.8V Nominal |
| 25 | GND | | | P | Connect to ground |
| 26 | NRST_NSHD | | | I | Reset and shutdown |
| 27 | GND | | | P | Connect to ground |
| 28 | GND | | | P | Connect to ground |




**AMRI-1000 recommended application schematic**

## Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Units | Notes |
|---|---|---|---|---|---|
| Storage Temperature | $T_S$ | -40 | 85 | °C | |
| Operating Temperature | $T_A$ | -25 | 70 | °C | |
| Supply Voltage | $V_{DD}$ | -0.5 | 3.6 | V | |
| ESD | | | 2 | kV | All pins, human body model MIL 883 Method 3015 |
| Input Voltage Transients | $V_{TR}$ | | +/- 0.3V | V | |
| I/O voltage | $V_{IO}$ | | $V_{DD}$_IO+0.3V | V | |
| Lead Solder Temp | | | 260 | °C | |

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Operating Temperature | $T_A$ | -25 | | 70 | °C | |
| Power supply voltage | $V_{DD}$ | 2.5 | 2.8 | 3.3 | Volts | |
| I/O supply voltage | $V_{DD}$_IO | 1.7 | 1.8/2.8 | VDD | Volts | Supports 1.8V and 2.8V I/Os. I/Os must be below $V_{DD}$ |
| Supply noise | $V_N$ | | | 50 | mV | Peak to peak within 0-1 MHz bandwidth |

## DC Electrical Specifications

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, $V_{DD}$ = 2.8 V, Default register values

| Parameter | | Symbol | Min. | Typ. | Max. | Units | Notes |
|---|---|---|---|---|---|---|---|
| System Current, run mode | | $I_{DD5}$ | | 8 | 12 | mA | NAVG = 0x20 |
| System current, rest modes | | $I_{REST}$ | | Vdd=2.8V, Vddio=1.8/2.8V | Vdd/Vddio = 3.3V | | |
| | Rest1 | | | 4.0/4.1 | 5 | mA | Wakeup time ~20ms, Register 0x26 set to 0x05 |
| | Rest2 | | | 0.5/0.6 | 0.9 | mA | Wakeup time ~100ms, Register 0x2A default value 0x1D |
| | Rest3 | | | 0.07/0.07 | 0.1 | mA | Wakeup time ~1s, Register 0x2E default value 0xFF |
| System Current, shutdown | | $I_{DD5N}$ | | 0.08 | 1.6 | µA | |
| Resolution | | RES | 200 | 1000 | | counts | 200 counts over full mechanical movement. +/-3mm slider travel is ~ 840 cpi resolution. DPISCALE register can increase effective cpi. |
| Input/Output Levels | Input High Voltage | VIH | -0.6 | | 0.3 | V | Voltage is relative to Vddio (0.65 Vddio per Jedec87) |
| | Input Low Voltage | VIL | -0.3 | | 0.6 | V | Voltage is relative to ground (0.35 Vddio per Jedec87) |
| | Output High Voltage | VOH | -0.2 | | 0 | V | Voltage is relative to Vddio (per Jedec87) |
| | Output Low Voltage | VOL | 0 | | 0.2 | V | Voltage is relative to ground (per Jedec87) |
| | Output Low Current | IOL | -1.2 | | | mA | at Vol |
| | Output High Current | IOH | 0.6 | | | mA | at Voh |
| Input Leakage Current | | | | 1.9 | 9.4 | uA | |
| Input Offstate Leakage Current | | | | 0.02 | 0.04 | uA | |

## AC Electrical Specifications

Electrical Characteristics over recommended operating conditions. Typical values at 25 °C, $V_{DD}$=2.8 V

| Parameter | Symbol | Min. | Typ. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Power up delay | $T_{PUP}$ | | | 25 | ms | From the time $V_{DD}$ reaches 2.8V until normal operation |
| Motion refresh rate | $F_{refresh}$ | | | 250 | Hz | |
| Two-Wire Interface Speed | | | | 400 | kHz | |
| 4-wire SPI Interface speed | | | | 2 | MHz | |

## Registers

Complete register definitions are under development

| Address | Register Name | R/W | Default Value |
|---|---|---|---|
| 0x00 | PROD_ID | RO | 0x80 |
| 0x01 | hw_Rev_ID | RO | 0x13 |
| 0x02 | STATUS | RO | NA |
| 0x03 | Delta_X | RO | NA |
| 0x04 | Delta_Y | RO | NA |
| 0x05 | delta_Hi | RO | NA |
| 0x07 | intctl | RW | 0x0C |
| 0x08 | IODL_CTL | RW | NA |
| 0x09 | IODL_DATA | RW | NA |
| 0x0A | CAL_CONTROL | RW | 0xC4 |
| 0x0C | calreset | RW | 0x41 |
| 0x0E | BOOT_STAT | Rw | 0x01 |
| 0x0F | FORCE_HI | R0 | NA |
| 0x10 | FORCE_LO | RO | NA |
| 0x11 | MANUAL_CAL_CTL | RW | 0x04 |
| 0x18 | scrollctl | RW | 0X09 |
| 0x20 | Force_Run_Mode | RW | 0x00 |
| 0x21 | Obs_Run_Modes | RO | 0x01 |
| 0x22 | Run_HB | RW | 0x1D |
| 0x23 | OSC_CTL | RW | 0x03 |
| 0x24 | REST1_DS_HI | RW | 0x01 |
| 0x25 | REST1_DS_LO | RW | 0x90 |
| 0x26 | REST1_HB | RW | 0x1C |
| 0x28 | REST2_DS_HI | RW | 0x01 |
| 0x29 | REST2_DS_LO | RW | 0x97 |
| 0x2A | REST2_HB | RW | 0X1D |
| 0x2C | REST3_DS_HI | RW | 0xD2 |
| 0x2D | REST3_DS_LO | RW | 0xF0 |
| 0x2E | REST3_HB | RW | 0xFF |

| Address | Register Name | R/W | Default Value |
|---|---|---|---|
| 0x35 | HB_COUNT | R0 | NA |
| 0x39 | ANA_GAIN_SPI | RW | NA |
| 0x40 | NAVMODE | RW | 0x00 |
| 0x41 | DPISCALE | RW | 0x20 |
| 0x42 | JOYSTICK_RAD | RW | 0x0A |
| 0x43 | JOYSTICK_THRESHOLD | RW | 0x64 |
| 0x44 | DUAL_RAD | RW | 0x14 |
| 0x45 | DUAL_THRESHOLD | RW | 0x32 |
| 0x46 | ROCKER_SWITCH_RAD | RW | 0x10 |
| 0x47 | ROCKER_SWITCH_INCR | RW | 0x20 |
| 0X48 | DZ_RADIUS | RW | 0x19 |
| 0X49 | MOUSE_ZONE | RW | 0x1E |
| 0x4A | JOYSTICK_FAST_RAD | RW | 0x28 |
| 0x4B | MAX_VEL | RW | 0x32 |
| 0x4D | SENSE_MAP | RW | 0XE4 |
| 0x5C | TOUCH_1_HI | RW | NA |
| 0x5D | TOUCH_1_LO | RW | NA |
| 0x5E | TOUCH_2_HI | RW | NA |
| 0x5F | TOUCH_2_LO | RW | NA |
| 0x60 | ADCLIM_HI | RO | NA |
| 0x61 | ADCLIM_LO | RO | NA |
| 0x62 | CLICK_THRESHOLD_HI | RW | NA |
| 0x63 | CLICK_THRESHOLD_LO | RW | NA |
| 0x66 | TOUCH_3_HI | RW | NA |
| 0x67 | TOUCH_3_LO | RW | NA |
| 0x6D | NAVG | RW | 0x20 |
| 0x7A | Shutdown | WO | NA |
| 0x7D | WD_DISABLE | WO | NA |



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