InvenSense Motion Sensor ICM-20789 Evaluation Board (EVB) Application Note

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1 PURPOSE

This document describes the hardware and circuitry on the ICM-20789 EVB. It also covers the key signals, circuit functions, hardware jumper settings, and port connections.

1.1 USAGE

This ICM-20789 EVB provides up to seven axes of motion sensing comprised of:

- Digital output of ultra-high Accuracy Pressure sensor
- Digital-output of 3-axis gyroscope with user-programmable full-scale ranges
- Digital-output of 3-axis accelerometer with user-programmable full-scale ranges
- On-chip temperature sensor
- Data is measured using on-chip ADCs and is transmitted over I²C or SPI interfaces (see datasheet for specific interfaces to the 6-axis motion sensor and pressure sensor).

The ICM-20789 EVB may be used by itself utilizing SPI or I²C serial communications interfaces (see datasheet for specific interfaces to the 6-axis motion sensor and pressure sensor). Alternatively, it may be connected to the InvenSense ARM Controller Board for connectivity to a host computer via USB interface.

The ICM-20789 EVB is lead-free and RoHS compliant.

1.2 RELATED DOCUMENTS

Please refer to the product specification of the main motion sensor and pressure sensor for electrical characteristics, pinout and applications details. Sensor product specifications can be found at www.invensense.com. For product specifications for unreleased parts, please contact the InvenSense sales department at sales@invensense.com.

2 ICM-20789 EVB OVERVIEW

The ICM-20789 EVB hosts ICM-20789 which is a 6-axis motion sensor combined with a ultra-high accuracy pressure sensor and integrated temperature sensor. The ICM-20789 device combines a 3-axis gyroscope, a 3-axis accelerometer, and ultra-high accuracy pressure sensor in a small 4x4x1.365mm (24-pin LGA) package.

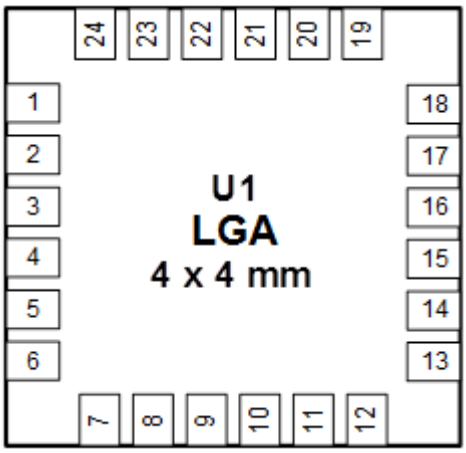

Figure 1. U1 (LGA24_4x4 mm)

The ICM-20789 EVB is populated with components only on its top side (Figure 2) to achieve ease of measurement access. A 10 x 2 connector (CN50) is designed to interface with the InvenSense ARM Controller Board, which is a host microcontroller board useful for programming the registers of the sensor on the ICM-20789 EVB and accessing sensor data via a PC or laptop through the USB port.

A 3-pin power selection header (JP50) is provided to choose the voltage level for VDD. Similarly, a 3-pin VDDIO selection header (JP51) allows the user to select the power source for the board's/sensor's digital I/O voltage.

2.1 KEY FUNCTIONS AND PINOUTS

The EVB is a fully assembled and tested evaluation board, allowing for simple and swift evaluation of the device's X-/Y-/Z-axis angular rate gyroscope, X-/Y-/Z-axis accelerometer and ultra-high accuracy integrated pressure sensor.

The 6-axis motion sensing device utilizes InvenSense's proprietary MEMS technology with driven vibrating masses. The ultra-low power, low noise barometric pressure and temperature sensor IC is based on an innovative capacitive pressure sensor design that can measure pressure differences with an accuracy of ±1 Pa, capable of measuring altitude differentials down to 8.5 cm without the penalty of increased power consumption or reduced sensor throughput.

The motion processing unit incorporates X-/Y-/Z-axis low-pass filters and an EEPROM for on-chip factory calibration of the sensor. Factory-trimmed scale factors eliminate the need for external active components and end-user calibration. A built-in Proportional-To-Absolute-Temperature (PTAT) sensor provides temperature compensation information. Refer to the product specification document for ICM-20789 sensor to obtain more details on specific features.

2.2 I²C/SPI BUS CONNECTIONS

The ICM-20789 EVB communicates with a system processor (e.g. InvenSense ARM controller board) through the custom header using either the I²C or the SPI serial interface. The device always acts as a slave when communicating with the system processor.

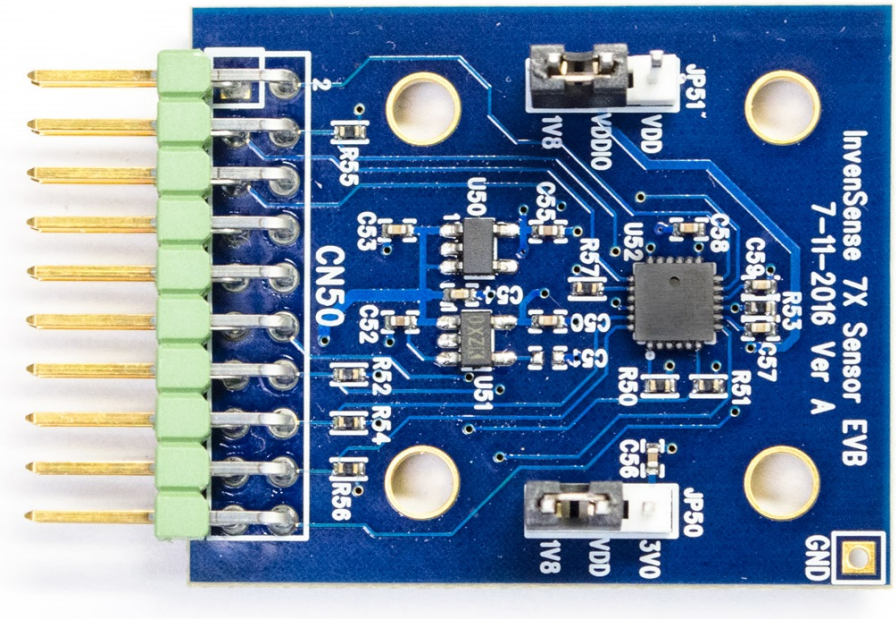

Figure 2. Top Side of the ICM-20789 EVB

3 SCHEMATIC

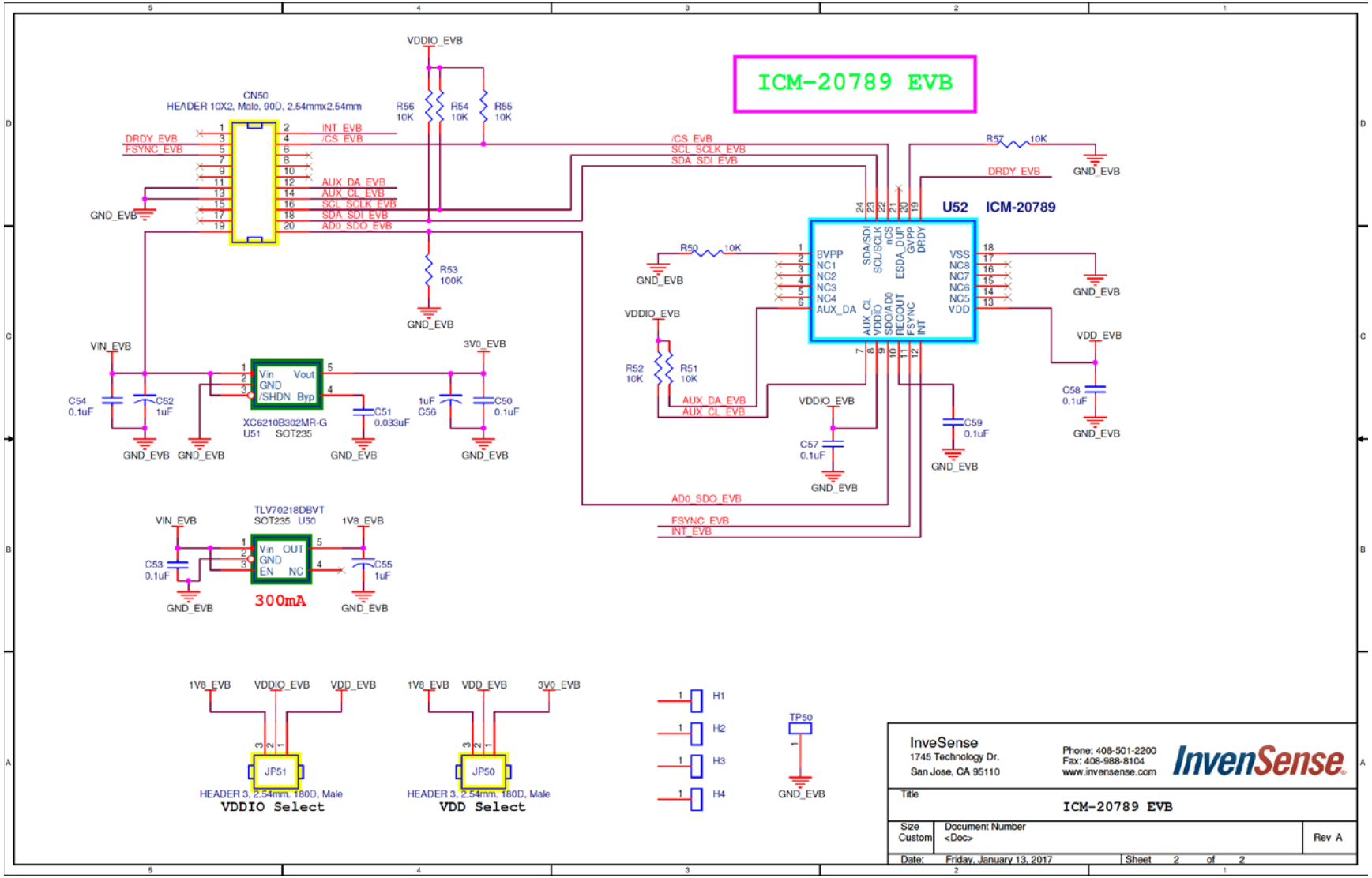

Figure 3. ICM-20789 EVB Circuit Schematic

4 BILL OF MATERIAL (BOM)

The BOM for ICM-20789 EVB is provided in Table 1.

4.1 BILL OF MATERIAL

ITEM	QUANTITY	REFERENCE	PART	PCB FOOTPRINT
1	1	CN50	Header 10 x 2, M, 90D, 2.54 x 2.54 mm	HDB2X14NRA
2	2	JP50, JP51	3-Pin Header, 2.54 x 2.54 mm, Male	SIP-3P
3	6	C50,C53,C54,C57,C58,C59	0.1 µF	C0402
4	3	C52, C55, C56	1.0 µF	C0402
5	7	R50,R51,R52,R54,R55,R56,R57	10 kΩ	R0402
6	1	R53	100 kΩ	R0402
7	1	U50	TLV70218DBVT	SOT23-5
8	1	U51	XC6210B302MR-G	SOT23-5
9	1	U52	ICM-20789	QFN24_4x4 mm

Table 1. Bill of Material

5 POWER SUPPLY CONNECTIONS

JP50 and JP51 are 3-pin headers, which allow the user to select between an on-board LDO (Low-Voltage Dropout Regulator, U50 and U51) and an external DC supply (VIN) to power the motion sensor. For details, please refer to Table 2

5.1 POWER SELECTION JUMPERS (JP50, JP51)

JP50 PIN NUMBER	SIGNAL DESCRIPTION
1-2 Shunted	VDD = 3V (from LDO, VIN > 3.1V, net name 3V0)
2-3 Shunted	VDD = VIN (from an external source)
JP51 PIN NUMBER	**SIGNAL DESCRIPTION**
1-2 Shunted	VDDIO = VDD
2-3 Shunted	VDDIO = 1.8V (from an external source, net name 1V8)

Table 2. Power Selection Jumpers (JP50, JP51)

The on-board low-noise 3V LDO offers an output that is called 3V0 (Figure 3). Using this will ensure that the sensor performance will meet data sheet specifications.

Selecting VIN to power the chip/board is generally done while designing and evaluating an embedded platform, where the host processor and related electronics need full control over the motion processing chipset's power supply.

If a user intends to use the on-board 3V power source, an external VIN must be provided within the range of 3.1V-6.0V to ensure the LDO works properly.

If the user provides a VIN power level of ≥3.6V, JP51 must be shunted across pins 2-3, since the device VDDIO operational range is 1.71V to 1.98V.

6 ICM-20789 EVB CONNECTOR SIGNALS DESCRIPTIONS

CN50 is a 10x2 right-angle male header. Connector signals are defined below.

6.1 USER INTERFACE CONNECTOR SIGNALS (CN50)

CN50 PIN NUMBER	CN50 SIGNAL NAME	SIGNAL DESCRIPTION
1	1V8	1V8 Power. Receive power from InvenSense ARM controller board or an external source.
2, 5, 6, 7, 8, 9, 10, 12, 14, 15	N.C.	N.C. Do not connect to these pins.
3	INT	INT. Interrupt output signal to controller.
4	$\overline{CS}$	Test Signal. Not used in I²C mode; used as chip-select pin in SPI mode.
11, 13	GND	GND. Ground connection.
16	SCL_SCLK	SCL/SCLK. I²C or SPI primary serial clock signal.
17	FSYNC	FSYNC. Frame synchronization input for camera applications.
18	SDA_SDI	SDA/MOSI. I²C primary data or SPI MOSI signal.
19	VIN	Power. Receive power from InvenSense ARM controller board or an external source.
20	AD0_SDO	AD0/MISO. Lowest (LSB) address bit in I²C mode or SPI MISO signal in SPI mode.

Table 3. User Interface Connector Signals (CN50)

6.2 CONNECTING THE FSYNC LINE

The FSYNC line is intended for use in a camera's image-stabilization system. It is an input from the camera platform to the EVB, and is intended to synchronize the motion-sensor serial-bus transfer with the master timing set by the camera system.

6.3 SERIAL BUS LEVELS, SPEEDS, AND TERMINATIONS

- The ICM-20789 EVB supports I²C communications up to 400 kHz, or SPI communications up to 8 MHz clock rates for reading and writing. The I²C bus open-drain pull-up resistors (10 kΩ) are connected to VDDIO. See datasheet for specific interfaces to the 6-axis motion sensor and pressure sensor.

7 DATA GATHERING OPTIONS

The motion sensor's digital sensor data is available on the ICM-20789 EVB's header CN50. Alternatively, for connectivity with a host PC, an InvenSense ARM controller board may be used.

7.1 CONNECTION TO THE INVENSENSE ARM CONTROLLER BOARD

For communications via USB with a host computer, the ICM-20789 EVB can be connected to the InvenSense ARM controller board. InvenSense provides a software tool to support the collection of sensor data through the EVB/ARM controller board combo connected to a PC/laptop via a USB port. Please refer to the *InvenSense Data Logger (IDL) Application Notes* document for additional instructions on how to use the software to obtain sensor data. This information can be provided by your local field team on an as-needed basis.

Figure 4 shows the connection of the ICM-20789 EVB to the InvenSense ARM controller board. Connections between the two boards are made via header CN50 on the ICM-20789 EVB and connector JP6 on the InvenSense ARM Controller Board.

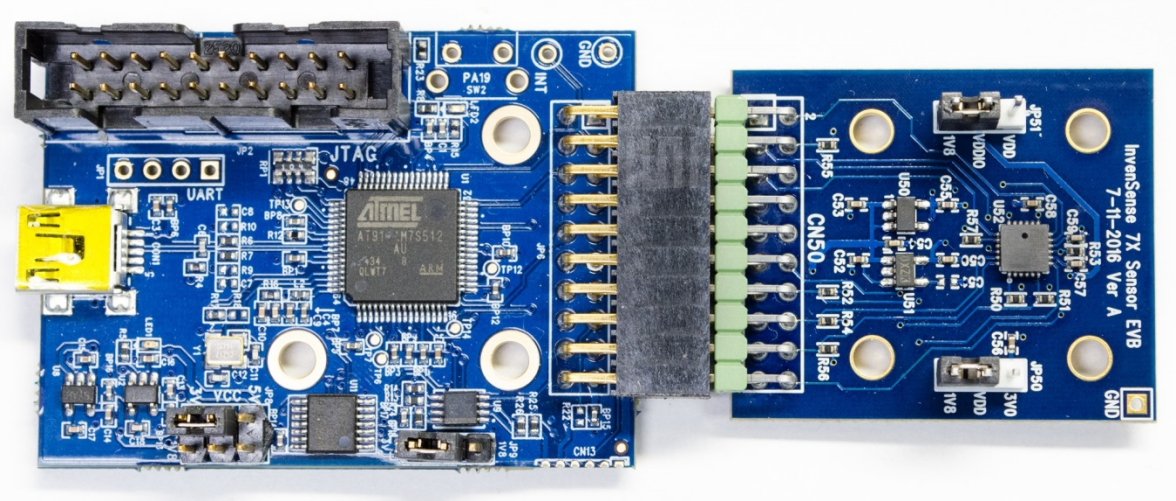

Figure 4. ICM-20789 EVB connected to the InvenSense ARM Controller Board

7.2 USE OF THE ICM-20789 EVB WITHOUT AN ARM CONTROLLER BOARD

I²C and SPI signals are made available on header CN50. Users may develop their own tools to communicate with the ICM-20789 EVB as there is no bus mode selection setting required.

8 SPECIAL INSTRUCTIONS

8.1 ELECTROSTATIC DISCHARGE SENSITIVITY

The motion sensors can be permanently damaged by electrostatic discharge (ESD). ESD precautions for handling and storage must be taken to avoid damage to the devices.

8.2 BOARD LAYOUT AND FOOTPRINT DISCUSSION

The ICM-20789 EVB is a 4-layer FR-4 PCB design with the dimensions: 30.6 x 36.5 x 1.6 mm (1205 x 1440 x 62 mil). See Figure 5 and Figure 6 for a detailed top and bottom view of the ICM-20789 EVB.

The sensor land pattern is designed large enough, to offer ease of use, reliable contact with the sensor, hand-solder and debugging capabilities.

Solder mask (also called solder resist is a layer of protective coating for PCB's copper traces, which helps to prevent undesired solder bridges and shorts) dimensions will not be provided as they are dependent upon the manufacturing process and the clearance capabilities of the chosen fabrication house. Contact your PCB vendor to determine the minimum required clearance between pin pads (usually 4 mil to 6 mil or 0.102 mm to 0.152 mm) and traces allowing them enough room to print an adequate solder mask.

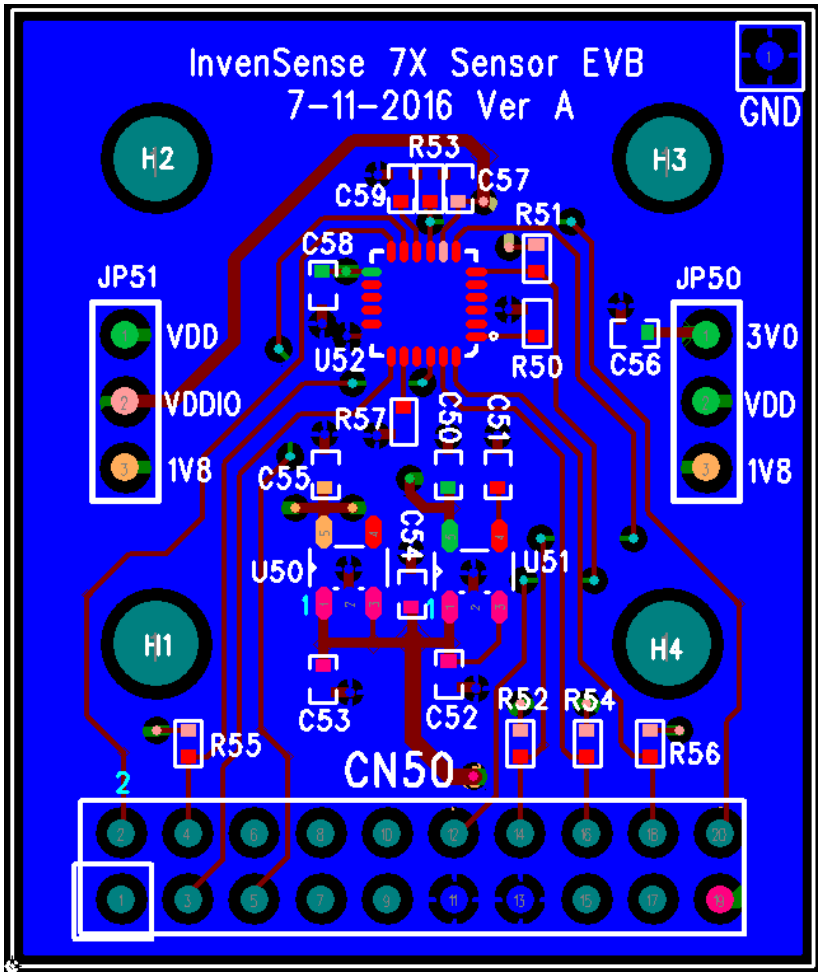

Figure 5. Top View of the ICM-20789 EVB Board Layout

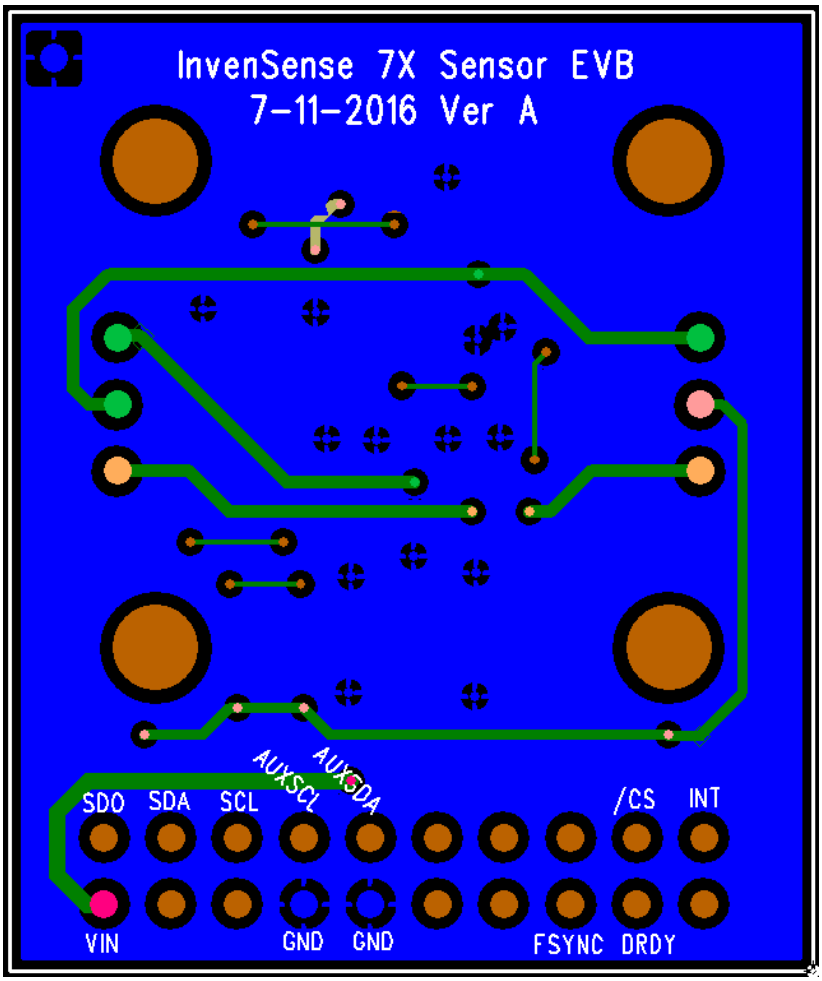

Figure 6. Bottom View of the ICM-20789 EVB Board Layout

8.3 REVISION HISTORY

DATE	REVISION	DESCRIPTION
01/13/17	1.0	Initial Release

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