

# BLM2425M9S20

LDMOS 2-stage power MMIC

Rev. 2 — 17 May 2021

AMPLEON

Product data sheet

## 1. Product profile

### 1.1 General description

20 W, 2-stage power MMIC transistor for use in a variety of Industrial, Scientific, Medical (ISM) and cooking applications at frequencies from 2400 MHz to 2500 MHz.

The BLM2425M9S20 is designed for high power CW applications and is assembled in a high performance plastic package.

Table 1. Application performance measured in class AB demo circuit

| Test signal | f     | V <sub>DS</sub> | P <sub>L</sub> | G <sub>p</sub> | PAE |
|-------------|-------|-----------------|----------------|----------------|-----|
|             | (MHz) | (V)             | (W)            | (dB)           | (%) |
| CW          | 2450  | 32              | 20             | 28             | 49  |

### 1.2 Features and benefits

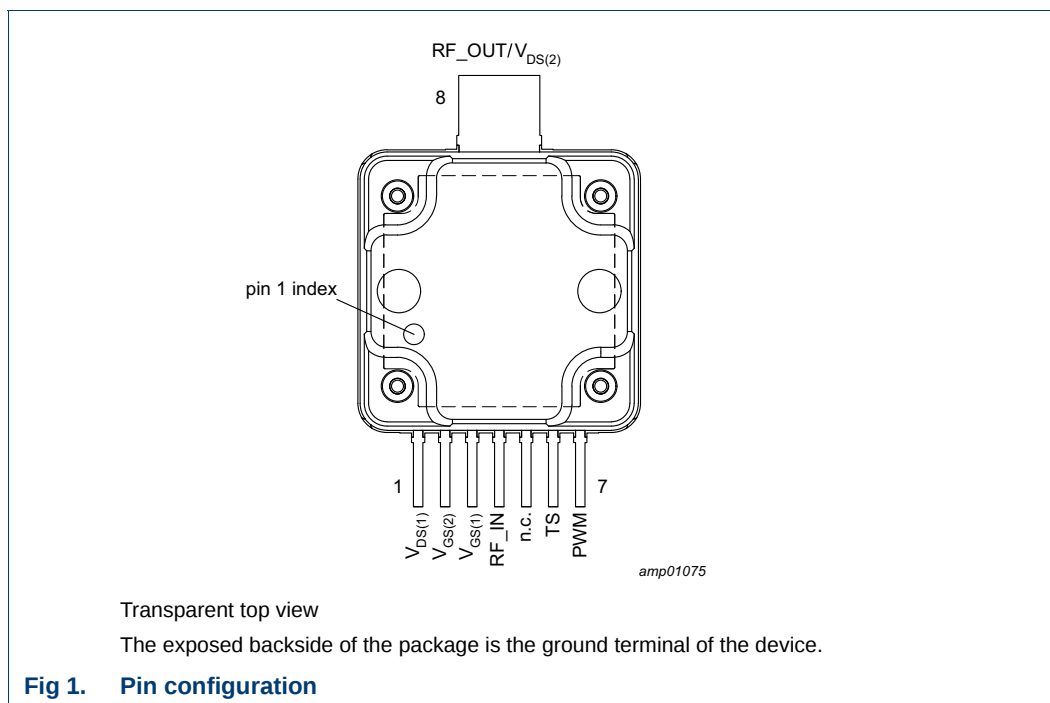
- High efficiency
- High power gain
- Excellent ruggedness
- Excellent thermal stability
- Integrated thermal sensor
- Integrated PWM control circuitry
- Integrated ESD protection
- Biasing of individual stages is externally accessible
- 50  $\Omega$  input matched; output pre-matched
- Designed for broadband operation (frequency 2400 MHz to 2500 MHz)
- For RoHS compliance see the product details on the Ampleon website

### 1.3 Applications

- Professional and consumer cooking applications
- Industrial, Scientific and Medical applications
- Applicable at frequencies from 2400 MHz to 2500 MHz

## 2. Pinning information

### 2.1 Pinning



### 2.2 Pin description

Table 2. Pin description

| Symbol              | Pin | Description                                 |
|---------------------|-----|---------------------------------------------|
| $V_{DS(1)}$         | 1   | drain-source voltage of stage 1             |
| $V_{GS(2)}$         | 2   | gate-source voltage of stage 2              |
| $V_{GS(1)}$         | 3   | gate-source voltage of stage 1              |
| RF_IN               | 4   | RF input                                    |
| n.c.                | 5   | not connected                               |
| TS                  | 6   | temperature sense FET                       |
| PWM <sup>[1]</sup>  | 7   | PWM modulation / RF on/off                  |
| RF_OUT/ $V_{DS(2)}$ | 8   | RF output / drain-source voltage of stage 2 |

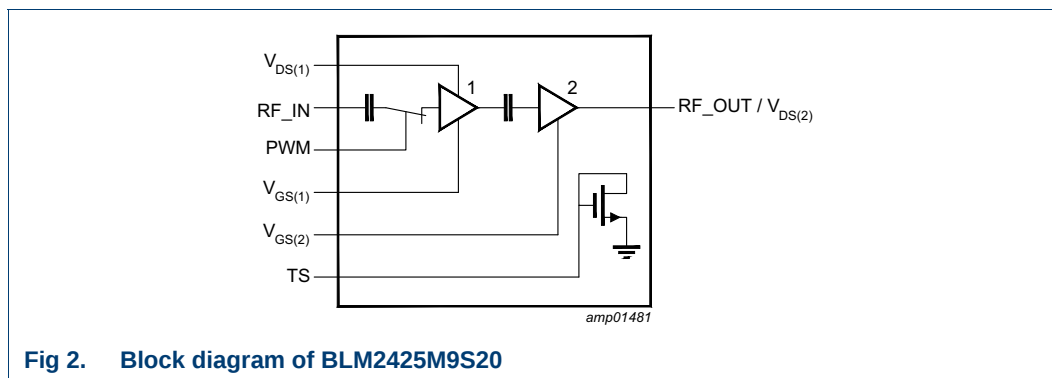
[1] When PWM function is not used, it is advised to connect the pin to ground and not leave it unconnected to avoid unpredictable behavior due to unintended electrical charge on the pin.

## 3. Ordering information

Table 3. Ordering information

| Package name | Orderable part number | 12NC           | Packing description     | Min. orderable quantity (pieces) |
|--------------|-----------------------|----------------|-------------------------|----------------------------------|
| OMP-400-8F-1 | BLM2425M9S20Z         | 9349 603 26517 | Tray; 30-fold; dry pack | 90                               |

## 4. Block diagram



## 5. Limiting values

**Table 4. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol          | Parameter                      | Conditions | Min | Max  | Unit |
|-----------------|--------------------------------|------------|-----|------|------|
| $V_{DS}$        | drain-source voltage           |            | -   | 65   | V    |
| $V_{GS}$        | gate-source voltage            |            | -6  | +13  | V    |
| $V_{GS(sense)}$ | sense gate-source voltage      |            | -6  | +9   | V    |
| $V_{PWM}$       | pulse width modulation voltage |            | -6  | +9   | V    |
| $V_{TS}$        | temperature sensor voltage     |            | -6  | +5.5 | V    |
| $T_{stg}$       | storage temperature            |            | -65 | +150 | °C   |
| $T_j$           | junction temperature           | [1]        | -   | 225  | °C   |
| $T_{case}$      | case temperature               |            | -   | 150  | °C   |

[1] Continuous use at maximum temperature will affect the reliability, for details refer to the online MTF calculator.

## 6. Thermal characteristics

**Table 5. Thermal characteristics**

Measured for total device.

| Symbol        | Parameter                                | Conditions                                                   | Value | Unit     |
|---------------|------------------------------------------|--------------------------------------------------------------|-------|----------|
| $R_{th(j-c)}$ | thermal resistance from junction to case | final stage; $T_{case} = 90\text{ °C}$ ; $P_L = 20\text{ W}$ | [1]   | 1.03 K/W |

[1] When operated with a CW signal.

## 7. Characteristics

Table 6. DC characteristics

| Symbol              | Parameter                        | Conditions                                                    | Min | Typ   | Max | Unit             |
|---------------------|----------------------------------|---------------------------------------------------------------|-----|-------|-----|------------------|
| <b>Final stage</b>  |                                  |                                                               |     |       |     |                  |
| $V_{(BR)DSS}$       | drain-source breakdown voltage   | $V_{GS} = 0 \text{ V}; I_D = 0.181 \text{ mA}$                | 65  | -     | -   | V                |
| $V_{GS(th)}$        | gate-source threshold voltage    | $V_{DS} = 10 \text{ V}; I_D = 18.1 \text{ mA}$                | 1.5 | 1.9   | 2.5 | V                |
| $V_{GSq}$           | gate-source quiescent voltage    | $V_{DS} = 32 \text{ V}; I_D = 20 \text{ mA}$                  | 1.4 | 1.8   | 2.4 | V                |
| $I_{DSS}$           | drain leakage current            | $V_{GS} = 0 \text{ V}; V_{DS} = 32 \text{ V}$                 | -   | -     | 1.4 | $\mu\text{A}$    |
| $I_{DSX}$           | drain cut-off current            | $V_{GS} = V_{GS(th)} + 3.75 \text{ V}; V_{DS} = 10 \text{ V}$ | -   | 3.65  | -   | A                |
| $I_{GSS}$           | gate leakage current             | $V_{GS} = 11 \text{ V}; V_{DS} = 0 \text{ V}$                 | -   | -     | 140 | nA               |
| $g_{fs}$            | forward transconductance         | $V_{DS} = 10 \text{ V}; I_D = 633 \text{ mA}$                 | -   | 1.33  | -   | S                |
| $R_{DS(on)}$        | drain-source on-state resistance | $V_{GS} = V_{GS(th)} + 3.75 \text{ V}; I_D = 0.63 \text{ A}$  | -   | 630   | -   | $\text{m}\Omega$ |
| <b>Driver stage</b> |                                  |                                                               |     |       |     |                  |
| $V_{(BR)DSS}$       | drain-source breakdown voltage   | $V_{GS} = 0 \text{ V}; I_D = 0.037 \text{ mA}$                | 65  | -     | -   | V                |
| $V_{GS(th)}$        | gate-source threshold voltage    | $V_{DS} = 10 \text{ V}; I_D = 3.7 \text{ mA}$                 | 1.5 | 1.9   | 2.5 | V                |
| $V_{GSq}$           | gate-source quiescent voltage    | $V_{DS} = 32 \text{ V}; I_D = 10 \text{ mA}$                  | 1.4 | 1.9   | 2.4 | V                |
| $I_{DSS}$           | drain leakage current            | $V_{GS} = 0 \text{ V}; V_{DS} = 32 \text{ V}$                 | -   | -     | 1.4 | $\mu\text{A}$    |
| $I_{DSX}$           | drain cut-off current            | $V_{GS} = V_{GS(th)} + 3.75 \text{ V}; V_{DS} = 10 \text{ V}$ | -   | 0.74  | -   | A                |
| $I_{GSS}$           | gate leakage current             | $V_{GS} = 11 \text{ V}; V_{DS} = 0 \text{ V}$                 | -   | -     | 140 | nA               |
| $g_{fs}$            | forward transconductance         | $V_{DS} = 10 \text{ V}; I_D = 130 \text{ mA}$                 | -   | 0.264 | -   | S                |
| $R_{DS(on)}$        | drain-source on-state resistance | $V_{GS} = V_{GS(th)} + 3.75 \text{ V}; I_D = 0.4 \text{ A}$   | -   | 2350  | -   | $\text{m}\Omega$ |

Table 7. RF Characteristics

Test signal: CW pulsed;  $t_p = 100 \mu\text{s}$ ;  $\delta = 10 \%$ ; at  $f = 2450 \text{ MHz}$ ; RF performance at  $V_{DS} = 32 \text{ V}$ ;  $I_{Dq1} = 10 \text{ mA}$ ;  $I_{Dq2} = 20 \text{ mA}$ ;  $T_{case} = 25 \text{ }^\circ\text{C}$ ; in a class-AB production test circuit.

| Symbol    | Parameter              | Conditions           | Min  | Typ | Max | Unit |
|-----------|------------------------|----------------------|------|-----|-----|------|
| $G_p$     | power gain             | $P_L = 20 \text{ W}$ | 25.5 | 28  | -   | dB   |
| PAE       | power-added efficiency | $P_L = 20 \text{ W}$ | 42   | 45  | -   | %    |
| $RL_{in}$ | input return loss      | $P_L = 20 \text{ W}$ | -    | -13 | -   | dB   |

## 8. Test information

### 8.1 Ruggedness

The BLM2425M9S20 is capable of withstanding a load mismatch corresponding to  $V_{SWR} = 20 : 1$  through all phases under the following conditions:  $V_{DS} = 36 \text{ V}$ ;  $P_L = 25 \text{ W}$ ;  $f = 2450 \text{ MHz}$ ; CW signal.

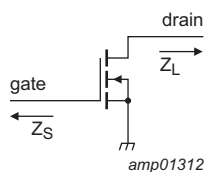
### 8.2 Impedance information

**Table 8. Typical impedance**

*Simulated impedance data of input and output PCB. Typical values unless otherwise specified.*

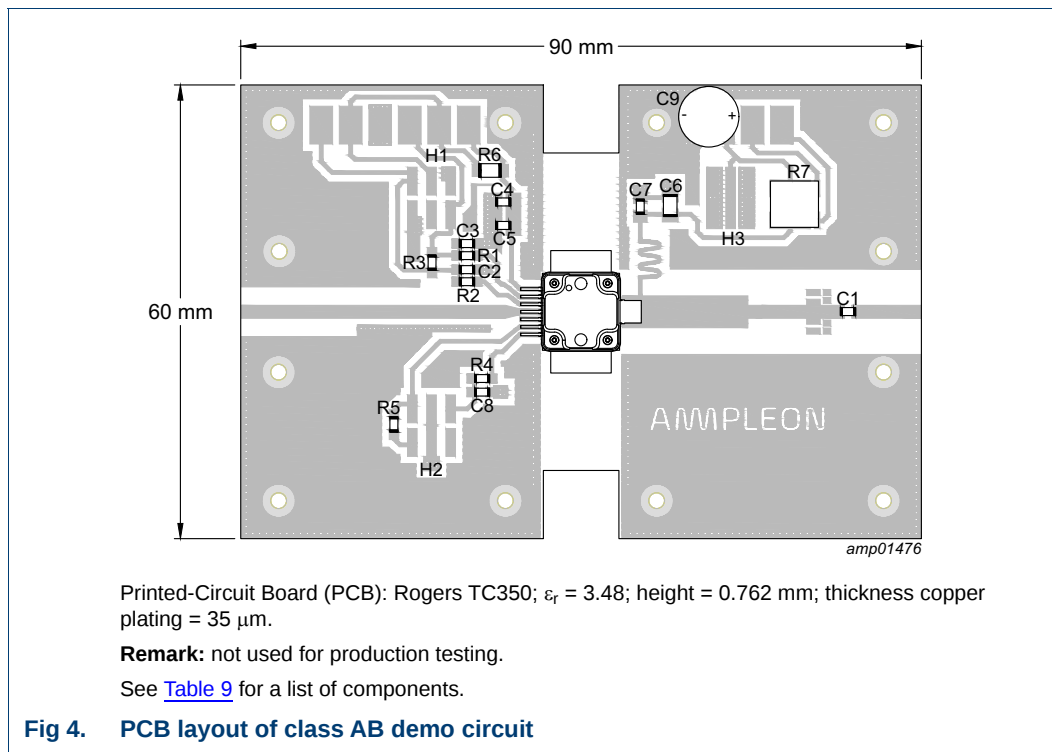
| <b>f</b><br><b>(MHz)</b> | <b><math>Z_S</math> [1]</b><br><b>(<math>\Omega</math>)</b> | <b><math>Z_L</math> [1]</b><br><b>(<math>\Omega</math>)</b> |
|--------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| 2400                     | $52.87 + j10.43$                                            | $17.09 - j1.74$                                             |
| 2450                     | $53.07 + j11.05$                                            | $16.98 - j1.36$                                             |
| 2500                     | $53.32 + j11.63$                                            | $16.89 - j0.98$                                             |

[1]  $Z_S$  and  $Z_L$  defined in [Figure 3](#)



**Fig 3. Definition of transistor impedance**

### 8.3 Demo circuit



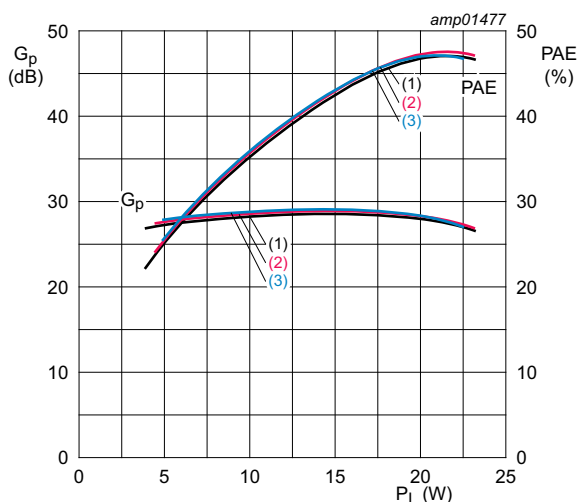
**Table 9. List of components**

See [Figure 4](#) for component layout.

| Component      | Description                       | Value                    | Remarks            |
|----------------|-----------------------------------|--------------------------|--------------------|
| C1, C5, C7     | multilayer ceramic chip capacitor | 20 pF                    | ATC 800A           |
| C2, C3, C4, C8 | multilayer ceramic chip capacitor | 1 $\mu\text{F}$ , 100 V  | SMD 0805           |
| C6             | multilayer ceramic chip capacitor | 4.7 $\mu\text{F}$ , 50 V | SMD 1206           |
| C9             | electrolytic capacitor            | 100 $\mu\text{F}$ , 35 V | Elco               |
| R1, R2         | chip resistor                     | 100 $\Omega$             | SMD 0805           |
| R3             | chip resistor                     | 100 $\Omega$             | optional           |
| R4             | chip resistor                     | 100 $\Omega$             | SMD 0805           |
| R5             | chip resistor                     | 30 $\Omega$              | SMD 0805           |
| R6             | current sense resistor            | 0.1 $\Omega$ , 1 %       | CRM1206-FX-R100ELF |
| R7             | current sense resistor            | 0.01 $\Omega$ , 1 %      | FC4L64R010FER      |
| H1, H2, H3     | 6 pin headers                     |                          | optional           |

**Remark:** When PWM function is not used, it is advised to connect the pin to ground and not leave it unconnected to avoid unpredictable behavior due to unintended electrical charge on the pin.

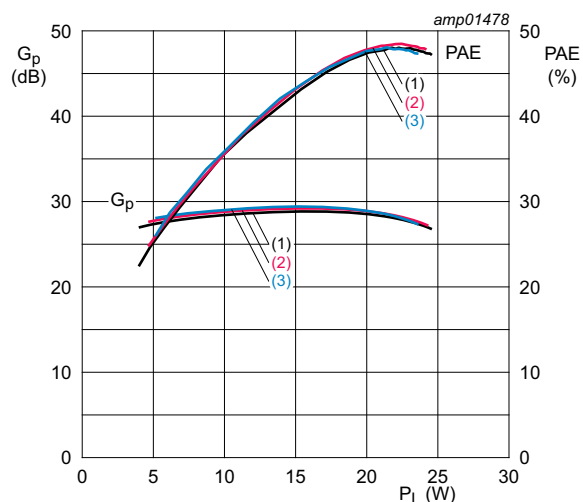
## 8.4 Graphical data



$V_{DS} = 32$  V;  $I_{DQ1} = 10$  mA;  $I_{DQ2} = 20$  mA; CW test signal.

- (1)  $f = 2400$  MHz
- (2)  $f = 2450$  MHz
- (3)  $f = 2500$  MHz

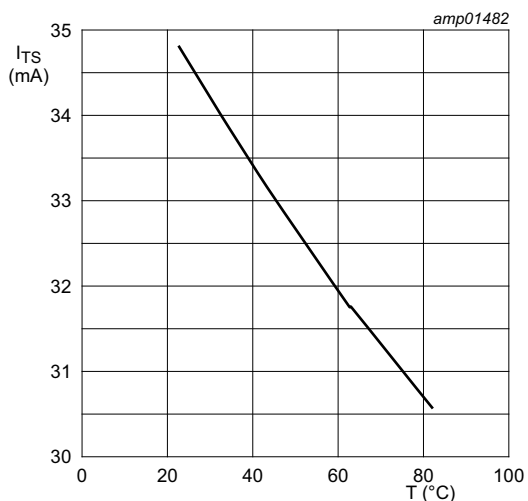
**Fig 5. Power gain and power-added efficiency as function of output power; typical values**



$V_{DS} = 32$  V;  $I_{DQ1} = 10$  mA;  $I_{DQ2} = 20$  mA; CW pulsed test signal:  $t_p = 100$   $\mu$ s;  $\delta = 10$  %.

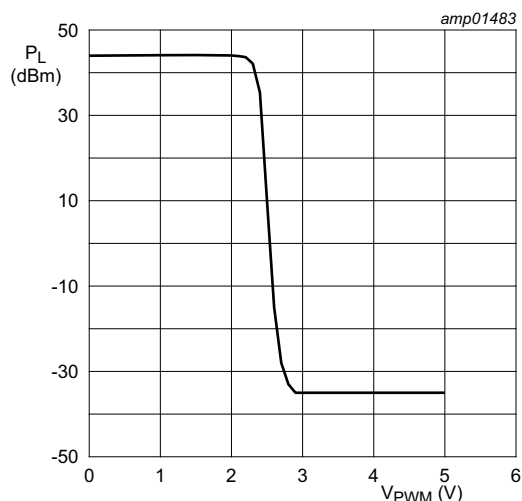
- (1)  $f = 2400$  MHz
- (2)  $f = 2450$  MHz
- (3)  $f = 2500$  MHz

**Fig 6. Power gain and power-added efficiency as function of output power; typical values**



$V_{TS} = 5$  V.

**Fig 7. Temperature sensor current as a function of temperature; typical values**



$V_{DS} = 32$  V;  $P_i = 15$  dBm;  $f = 2450$  MHz;  $I_{DQ1} = 10$  mA;  $I_{DQ2} = 20$  mA;  $T_{water} = 25$   $^{\circ}$ C (at water-cooled heatsink).

**Fig 8. Output power as a function of pulse width modulation voltage; typical values**

9. Package outline

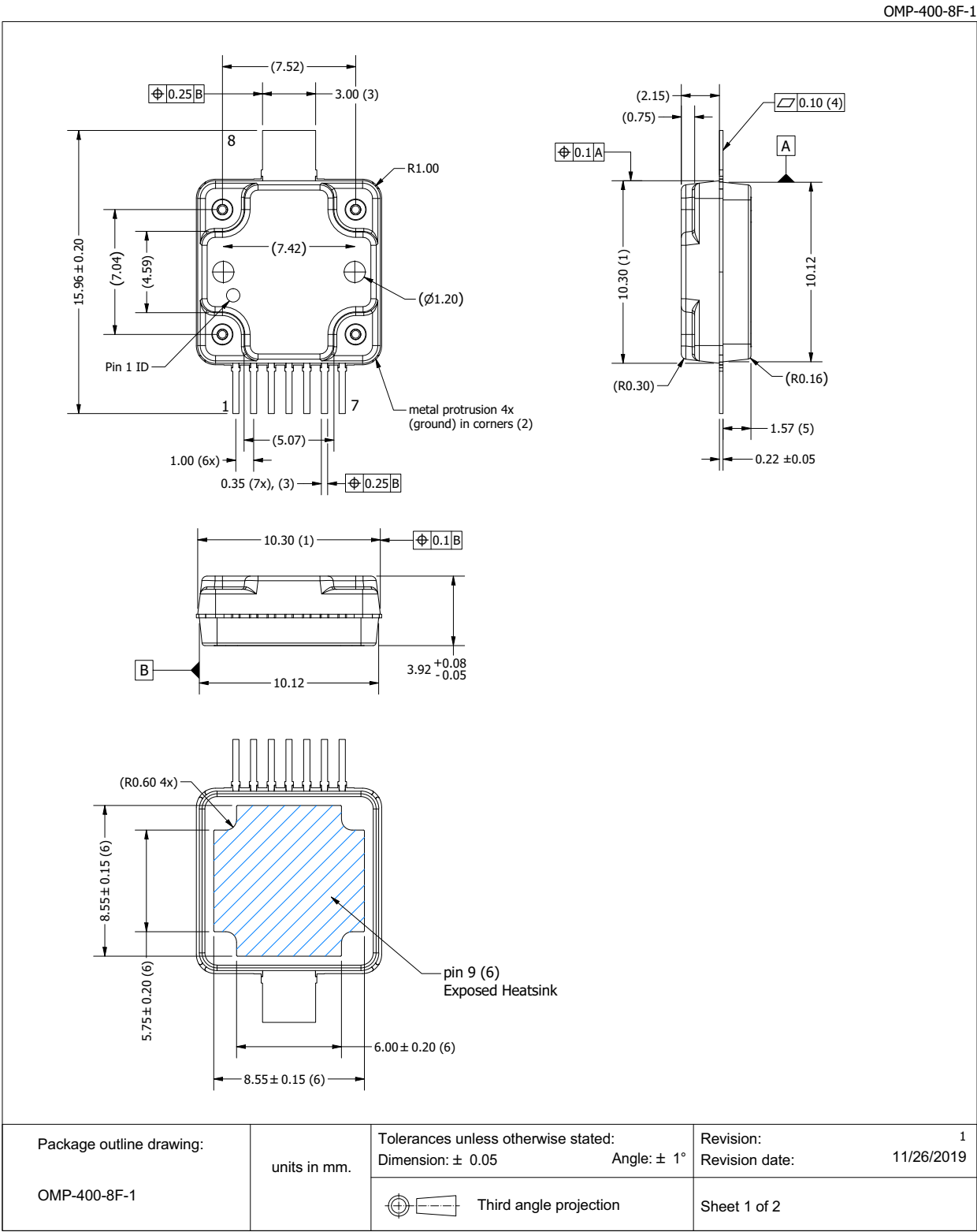
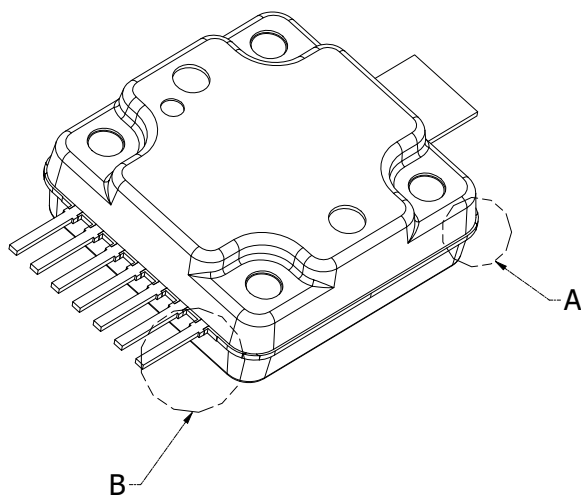


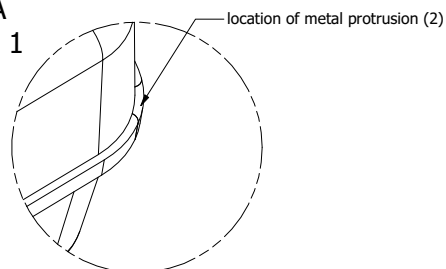
Fig 9. Package outline OMP-400-8F-1 (sheet 1 of 2)

OMP-400-8F-1

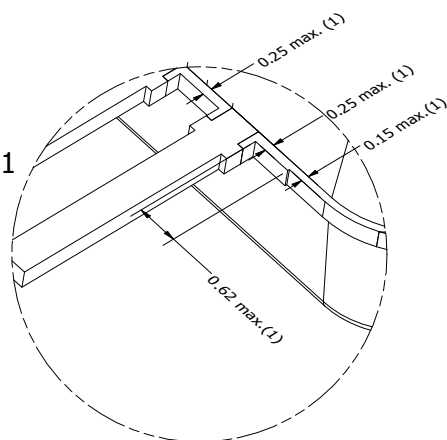
| Drawing Notes |                                                                                                                                                                                                                                                                                                              |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Items         | Description                                                                                                                                                                                                                                                                                                  |
| (1)           | Dimensions are excluding mold protrusion. Areas located adjacent to the leads have a maximum mold protrusion of 0.25 mm (per side) and 0.62 mm max. in length. In between the 7 leads the protrusion is 0.25 mm. max. At all other areas the mold protrusion is maximum 0.15 mm per side. See also detail B. |
| (2)           | The metal protrusion (tie bars) in the corner will not stick out of the molding compound protrusions (detail A).                                                                                                                                                                                             |
| (3)           | The lead dambar (metal) protrusions are not included. Add 0.14 mm max to the total lead dimension at the dambar location.                                                                                                                                                                                    |
| (4)           | The lead coplanarity over all leads is 0.1 mm maximum.                                                                                                                                                                                                                                                       |
| (5)           | Dimension is measured 0.5 mm from the edge of the top package body.                                                                                                                                                                                                                                          |
| (6)           | The hatched area indicates the exposed heatsink. The dimensions represent the values between two opposite points along the original heatsink perimeter.                                                                                                                                                      |
| (7)           | The leads and exposed heatsink are plated with matte Tin (Sn).                                                                                                                                                                                                                                               |



DETAIL A  
SCALE 25 : 1



DETAIL B  
SCALE 25 : 1



|                          |              |                                                                                                            |                                          |
|--------------------------|--------------|------------------------------------------------------------------------------------------------------------|------------------------------------------|
| Package outline drawing: | units in mm. | Tolerances unless otherwise stated:<br>Dimension: $\pm 0.05$ Angle: $\pm 1^\circ$                          | Revision: 1<br>Revision date: 11/26/2019 |
| OMP-400-8F-1             |              |  Third angle projection | Sheet 2 of 2                             |

Fig 10. Package outline OMP-400-8F-1 (sheet 2 of 2)

## 10. Handling information

### CAUTION



This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices.

Such precautions are described in the *ANSI/ESD S20.20*, *IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

**Table 10. ESD sensitivity**

| ESD model                                                                | Class                   |
|--------------------------------------------------------------------------|-------------------------|
| Charged Device Model (CDM); According to ANSI/ESDA/JEDEC standard JS-002 | C2A <a href="#">[1]</a> |
| Human Body Model (HBM); According to ANSI/ESDA/JEDEC standard JS-001     | 1A <a href="#">[2]</a>  |

[1] CDM classification C2A is granted to any part that passes after exposure to an ESD pulse of 500 V.

[2] HBM classification 1A is granted to any part that passes after exposure to an ESD pulse of 250 V.

## 11. Abbreviations

**Table 11. Abbreviations**

| Acronym | Description                                  |
|---------|----------------------------------------------|
| CW      | Continuous Wave                              |
| ESD     | ElectroStatic Discharge                      |
| FET     | Field-Effect Transistor                      |
| LDMOS   | Laterally Diffused Metal Oxide Semiconductor |
| MMIC    | Monolithic Microwave Integrated Circuit      |
| MTF     | Median Time to Failure                       |
| PWM     | Pulse Width Modulation                       |
| RoHS    | Restriction of Hazardous Substances          |
| SMD     | Surface Mounted Device                       |
| VSWR    | Voltage Standing Wave Ratio                  |

## 12. Revision history

**Table 12. Revision history**

| Document ID      | Release date                                                                                                                                                                                                                                                         | Data sheet status  | Change notice | Supersedes       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|------------------|
| BLM2425M9S20 v.2 | 20210521                                                                                                                                                                                                                                                             | Product data sheet | -             | BLM2425M9S20 v.1 |
| Modifications:   | <ul style="list-style-type: none"> <li><a href="#">Table 2 on page 2</a>: added table note</li> <li><a href="#">Table 4 on page 3</a>: changed temperature sensor voltage to 5.5 V</li> <li><a href="#">Section 8.3 on page 6</a>: added remark about PWM</li> </ul> |                    |               |                  |
| BLM2425M9S20 v.1 | 20200924                                                                                                                                                                                                                                                             | Product data sheet | -             | -                |

## 13. Legal information

### 13.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition                                                                            |
|-----------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.ampleon.com>.

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## 15. Contents

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