130W Packaged Power Transistor

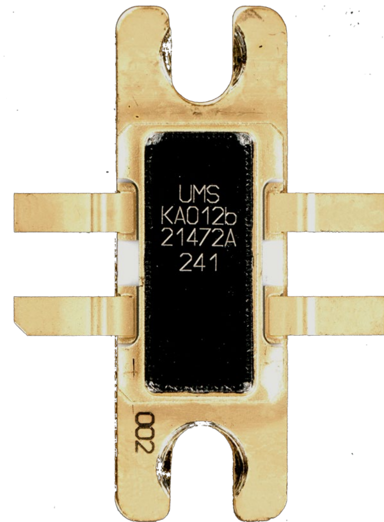
GaN HEMT on SiC in ceramic-metal flange package

Description

The CHKA012bSYA is an unmatched packaged Gallium Nitride High Electron Mobility Transistor. This power bar offers general purpose and broadband solutions for a variety of RF power applications. It is well suited for multi-purpose applications such as radar and telecommunication.

The CHKA012bSYA is developed on a 0.5µm gate length GaN HEMT process. It requires an external matching circuitry.

The CHKA012bSYA is supplied in an hermetic ceramic-metal flange power package, compliant with the RoHs N°2011/65 and REACH N°1907/2006 directives.



Main Features

- Wide band capability: up to 6GHz
- Pulsed and CW operating modes
- High Output power > 90W
- High Power Added Efficiency: up to 58%
- DC bias: V_{DS} = 50V @ I_{D_Q} = 640 mA
- MTTF > 10^6 hours @ Tj = 200°C

Main Electrical Characteristics

Tcase= +25°C, V_{DS}=+50V, freq. = 1.3 GHz, I_{D_Q} = 640 mA, Pulsed Mode (25µs-10%s)

Symbol	Parameter	Min	Typ	Max	Unit
G_{SS}	Small signal gain		19		dB
P_{SAT}	Saturated output power	90	130		W
PAE	Power Added Efficiency		58		%
G_{PAE_MAX}	Associated Gain at Max PAE		16		dB

United Monolithic Semiconductors S.A.S.
Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Specifications

Tcase. = +25°C, V_{DS} = +50V, I_{D_Q} = 640mA, Pulsed Mode (25µs-10%), freq. = 1.3GHz

Symbol	Parameter	Min	Typ	Max	Unit
G_{SS}	Small signal gain		19		dB
P_{SAT}	Saturated output power	90	130		W
PAE	Power Added Efficiency		58		%
G_{PAE_MAX}	Associated Gain at Max PAE		16		dB
I_D	Drain current in saturation		3.9		A

These values are representative of board measurements made in the board connector's access planes.

Recommended Operating Ratings (ROR)

Tcase.= +25°C

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range			6	GHz
V_{DS}	Drain source voltage		50	50	V
V_{GS}	Gate source voltage (2)		-1.85		V
I_{D_Q}	Quiescent drain current		0.64	2.05	A
I_{G_MAX}	Gate Current (forward mode) (3)		0	100	mA
T_{OP_CASE}	Case operating temperature range(1)	-40		85	°C
T_{j_MAX}	Junction temperature			200	°C

(1) Max junction temperature must be considered
(2) Typical value for I_{D_Q} = 640 mA, V_{DS}=+50V
(3) Currents are provided at saturation (with RF signal)

Absolute Maximum Ratings (1) (AMR)

Tcase.= +25°C

Symbol	Parameter	Values	Unit
V_{DS}	Drain source biasing voltage	60	V
V_{GS}	Gate source biasing voltage (2)	-10 to +2	V
I_{G_MAX}	Maximum Gate Current (forward mode) (4)	+200	mA
I_{G_MIN}	Maximum Gate Current (reverse mode) (4)	-13	mA
I_{D_MAX}	Maximum drain current	12(3)	mA
Tj	Junction temperature	230	°C
Ta	Operating temperature range	See note (3)	°C
Tstg	Storage temperature range	-55 to +150	°C

(1) Operation of this device above anyone of these parameters may cause permanent damage
(2) Linked to and limited by I_{G_MAX} and I_{G_MIN} values. Maximum input power depends on frequency and should not exceed 2dB above PAE_{MAX}
(3) Max junction temperature must be considered
(4) Currents are provided at saturation (with RF signal)

Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Biasing sequence

"Power ON" sequence

1. Bias HPA gate voltage at V_{GS} close to Vpinch-off (Typically: Vg ≈ -5V)
2. Apply V_{DS} bias voltage (Typically: V_{DS} = 50V)
3. Increase slowly V_{GS} up to quiescent bias drain current Idq (pulsed applied on the gate)
4. Apply RF signal

"Power OFF" sequence

1. Turn off RF signal
2. Bias HPA gate voltage at V_{GS} close to Vpinch-off (Typically: V_{GS} ≈ -5V)
3. Turn V_{DS} bias voltage to 0V
4. Turn V_{GS} bias voltage to 0V

The quiescent current steady state must be carefully controlled as it is influenced by the operating mode, the temperature and the overall thermal resistance.
A drain current control is recommended on the biasing network.

Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Device thermal information

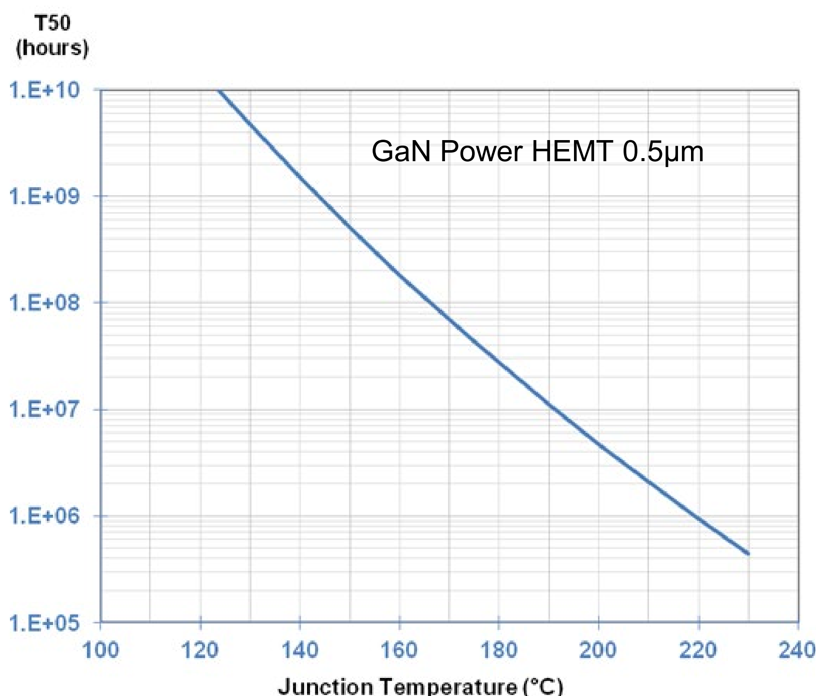
All the figures given in this section are obtained assuming that the package is cooled down by conduction through the package baseplate (no convection mode considered).
The thermal performances of the device are based on UMS rules to evaluate the junction temperature (Tj). This temperature is defined as the peak temperature in the channel area.
This same procedure is the basis for junction temperature evaluation of the samples used to derive the Median lifetime and activation energy for the particular technology on which the power bar is fabricated (GaN Power HEMT 0.5µm).
The temperature Tcase is monitored, and defined, at the package backside interface.
The thermal resistance (Rth) is given for the full power bar, in “equivalent” CW operating mode.
The system maximum temperature must be adjusted in order to guarantee that Tjunction remains below the maximum value specified in the Absolute Maximum Ratings table.
So, the system PCB must be designed to comply with this requirement.
Thermal analysis is recommended. More information is available on request.

Parameters	Symbol	Conditions	Value	Unit
Typical Thermal Resistance	Rth	Tcase = 96°C, Pdiss* = 82.7, CW	1.26	°C/W
Junction Temperature	Tj		200	°C

The reference temperature (Tcase) is defined at the package backside.
The package carrier plate is made up of 1.5mm Cu/Mo/Cu.

*Pdiss=82.7W; Pout=50.6dBm; Pin=37dBm, Id=3.85A

Median Life Time versus Junction Temperature



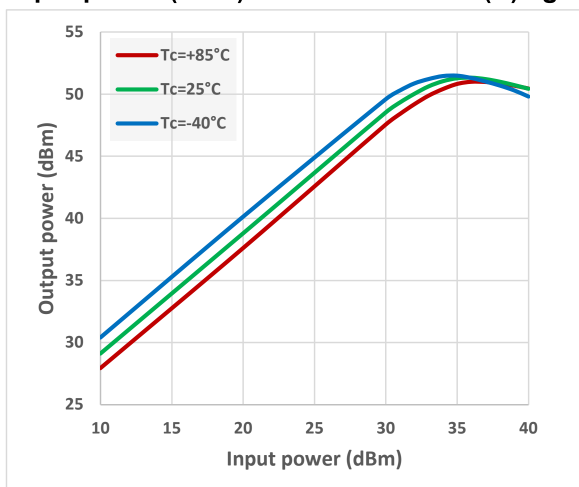
Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

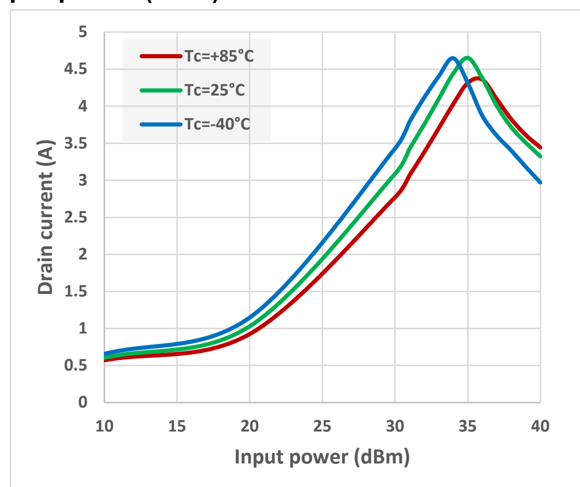
Typical Performance on Demonstration Board

Calibration and measurements are done on the connector reference accesses of the demonstration board.

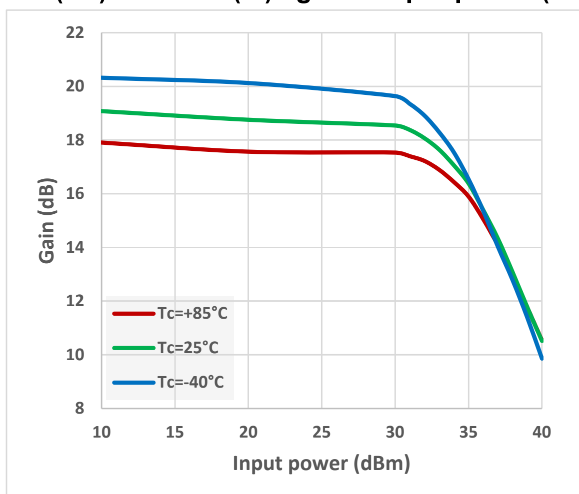
Freq.=1.3 GHz, V_D=+50V, pulsed (250µs/10%), I_{D_Q}=640mA (set at 25°C)

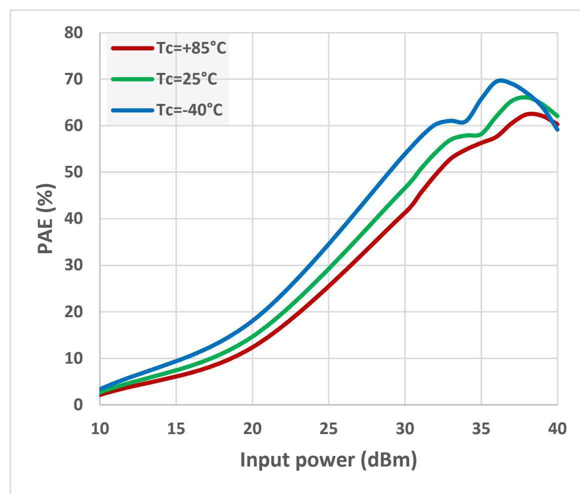
Output power (dBm) and Drain current (A) against input power (dBm)





Gain (dB) and PAE (%) against input power (dBm)

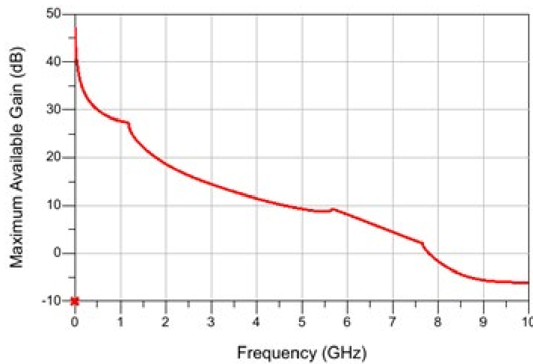


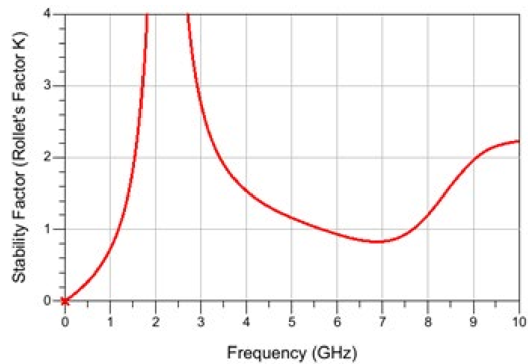


Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Simulated maximum Gain & Stability Characteristics

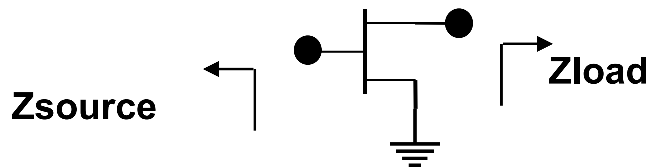
Tcase= +25°C, CW mode, V_D=50V, I_{D_Q}=640mA





Simulated Source and Load Impedance for trade-off between Pout & PAE performances

V_{DS} = 50V, I_{D_Q} = 640mA

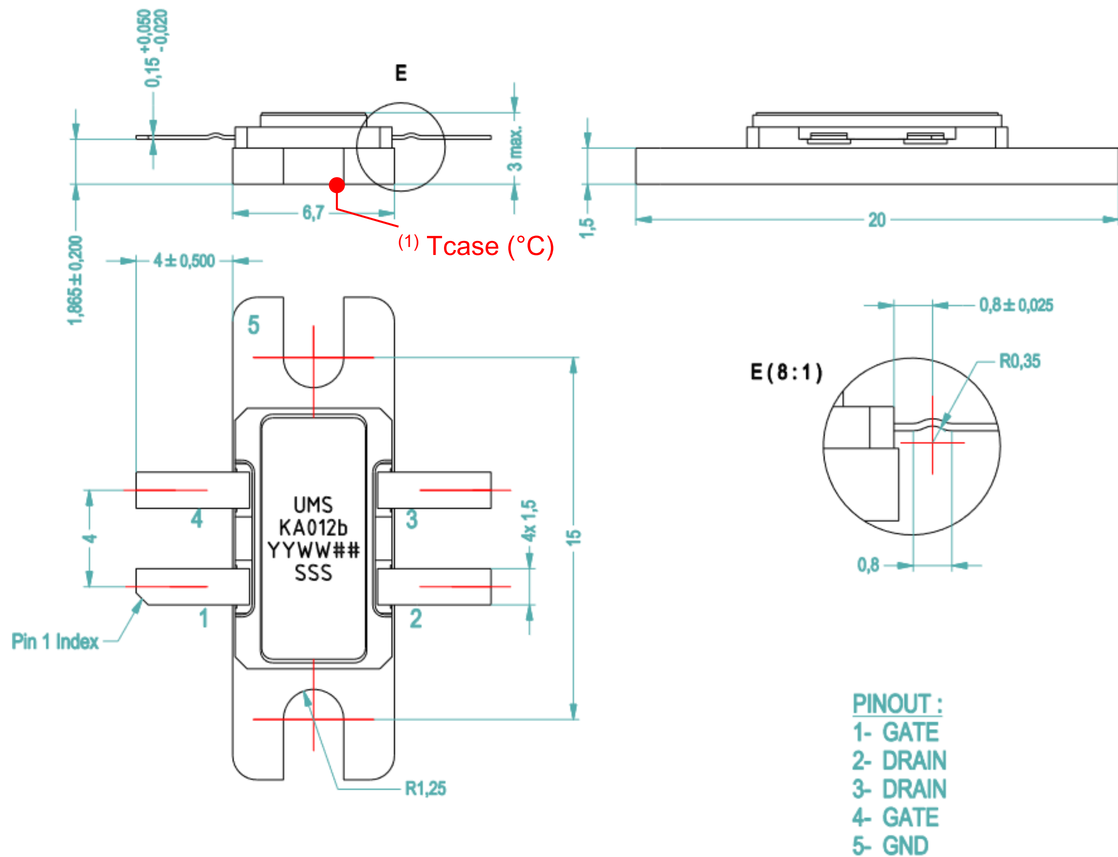


Frequency (MHz)	Source H1	Source H2	Load H1	Load H2	Pout (dBm)	PAE (%)
1000	0.5-j	1-j*5	5.6+j*5	1+j*20	50.7	70
2000	0.9-j5	1-j*30	2.5-j*2.2	0	51.05	58.8
3000	1.2-j*9	1-*90	1.6-j*5.2	1-j*10	50.4	51
4000	1.8-j*14	1-j*20	2-j*9	1-j*20	50	33
5000	3.5-j*22	1-j*50	2.5-j*15	0.5-j*30	50	22.5
6000	12-j*40	1-j*75	4.5-j*20	0.5-j*40	49.4	12

These values are given in the reference plane defined by the connection between the package leads and the PCB.

Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Package outline



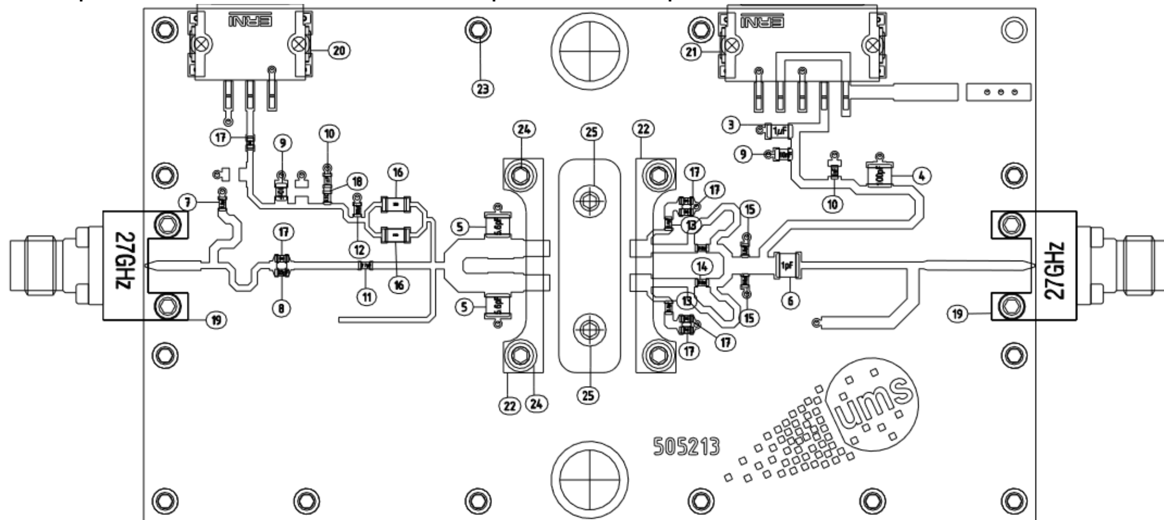
Ni/Au finish on leads		1-	Gate
Units :	mm	2-	Drain
		3-	Drain
Ni/Au finish on leads		4-	Gate
Ni/Au finish on Cu/Mo/Cu package		5-	Gnd

(1) Tcase locates the reference point used to monitor the device temperature. This point has been taken at the device / system interface to ease system thermal design.
Chamfer on leads indicates the gate access of the transistor

Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Demonstration board

The measurements of the component are performed on an evaluation board whose description can be found below. It is optimized for operation around 1.3 GHz.



Bill of materials

Drawing ref.	Type	Designation	Quantity
1	Heatsink	Aluminium baseplate 104X60X7	1
2	PCB substrate	RF35P, Er=3.5, h=508µm	1
3	Capacitor	1206 1 µF ±10% 100V	1
4	Capacitor	100pF 1111 500V	1
5	Capacitor	1111 5,6pF 500V	2
6	Capacitor	1111 1pF 500V	1
7	Capacitor	0603 1.2pF± 0.1pF 250V	1
8	Capacitor	0603 33pF± 5% 250V	1
9	Capacitor	0805 10nF±10% 100V	2
10	Capacitor	0603 COG 1nF ±5% 100V	2
11	Capacitor	0603 2.7pF± 0.1pF 250V	1
12	Capacitor	0603 100pF± 5% 250V	1
13	Capacitor	0603 0.4pF± 0.05pF 250V	2
14	Capacitor	0603 0.6pF± 0.05pF 250V	2
15	Capacitor	0603 0.8pF± 0.05pF 250V	2
16	Resistor	1206 25Ω±2% 2.45W	2
17	Resistor	0603 50Ω±2% 1.5W	6
18	Resistor	0603 5.1Ω±1% 0.1W	1
19	RF connector	Connector RF SMA (DC-27 GHz)	2
20	DC ERNI connector	CMS angle male 3 cts	1
21	DC ERNI connector	CMS angle male 5 cts	1
22	Mechanical element	Mechanical pressor	2
23	Screw	Vis CHc M1.6X6 A2	13
24	Screw	Vis CHc M2x10 A2	4
25	Screw	Vis CHc M2x6 A2	2

Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com

Recommended environmental management

UMS products are compliant with the regulation in particular with the directives RoHS N°2011/65 and REACh N°1907/2006. More environmental data are available in the application note AN0019 also available at https://www.ums-rf.com.

Recommended ESD management

Refer to the application note AN0020 available at https://www.ums-rf.com for ESD sensitivity and handling recommendations for the UMS package products.

Ordering Information

Ceramic-metal package: CHKA012bSYA/XY

Tray: XY = 26

Information furnished is believed to be accurate and reliable. However **United Monolithic Semiconductors S.A.S.** assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of **United Monolithic Semiconductors S.A.S.**. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. **United Monolithic Semiconductors S.A.S.** products are not authorised for use as critical components in life support devices or systems without express written approval from **United Monolithic Semiconductors S.A.S.**

Bât. Charmille - Parc Mosaic - 10, Avenue du Québec - 91140 VILLEBON-SUR-YVETTE - France
Tel.: +33 (0) 1 69 86 32 00 - Fax: +33 (0) 1 69 86 34 34 - www.ums-rf.com