1. Features

- Industry leading CMOS linear PA
- Multi-mode and multi-band
- HB1 TX RF Port – B38/B40/B41
- MB3 TX RF Port – B1 B3 B34/B39
- LB2 TX RF Port – B5 B8
- Fully programmable Mobile Industry Processor Interface (MIPI) control
- Small, low profile LGA package:
  - 4.0 x 4.0 x 0.7mm
  - 30-pad configuration
- Green Product

2. Applications

- Multiband 3G/LTE handsets
- Multiband 3G/LTE Data Cards
- 3G/LTE MIFI Devices
- Industrial IOT

3. Description

GC0643 is a multi-mode multi-band (MMMB) Power Amplifier Module that supports both 3G and 4G handsets and IoT applications and operates efficiently in WCDMA, TDD LTE and FDD LTE modes. The module is fully controllable via MIPI interface.

GC0643 contains of a block for low, middle, and high bands, a Multi-Function Control block, meets spectral linearity requirements of LTE modulation with QPSK/16QAM up to 20MHz bandwidth, including various resource block allocations, with high PAE.

The CMOS Die and passive components are mounted on a multi-layer laminate substrate. The assembly is encapsulated in a 4.0 mm x 4.0 mm x 0.7mm 30-pad LGA package, which allows for a highly manufacturable, low cost solution.

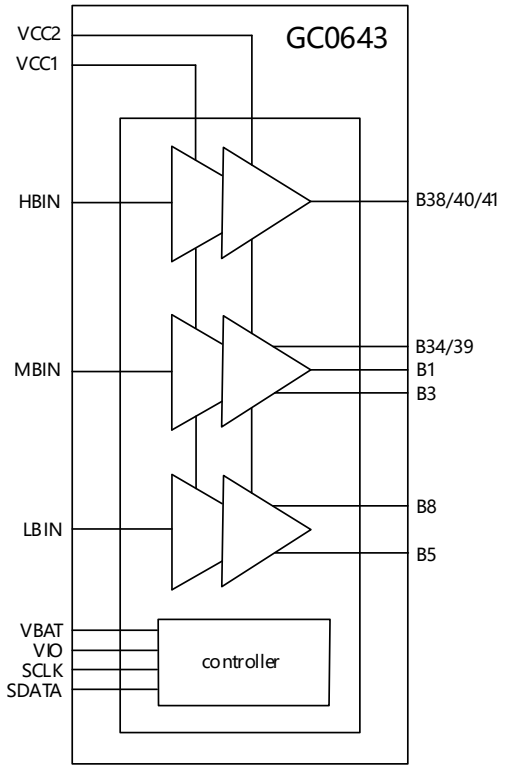


Figure 1 GC0643 Function Block Diagram

CONTENTS

4. Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit	Condition
RF Input Power	PIN			8	dBm	
Supply Voltage	VBAT	0		4.6	Volts	
	VCC1, VCC2	0		5	Volts	Supply Voltage (RF off)
		0		4.35	Volts	Supply Voltage (RF on)2
Digital Control Lines	VIO, CLK, DATA			2	Volts	
Operating Temperature	TCASE	-40		100	°C	
Storage Temperature	TSTG	-40		150	°C	
ESD -Human Body Mode	ESD (HBM)	-2000		2000	Volts	

Table 1

1. Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value.
2. RF output power is 28 dBm.
3. Case Operating Temperature (TCASE) refers to the temperature of the GROUND PAD at the underside of the package.
4. All maximum RF input power ratings assume 50 Ω terminal impedance.

ESD HANDLING: Although this device is designed to be as robust as possible, electrostatic discharge (ESD) can damage this device. This device must be protected at all times from ESD when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.

5. Pin Description

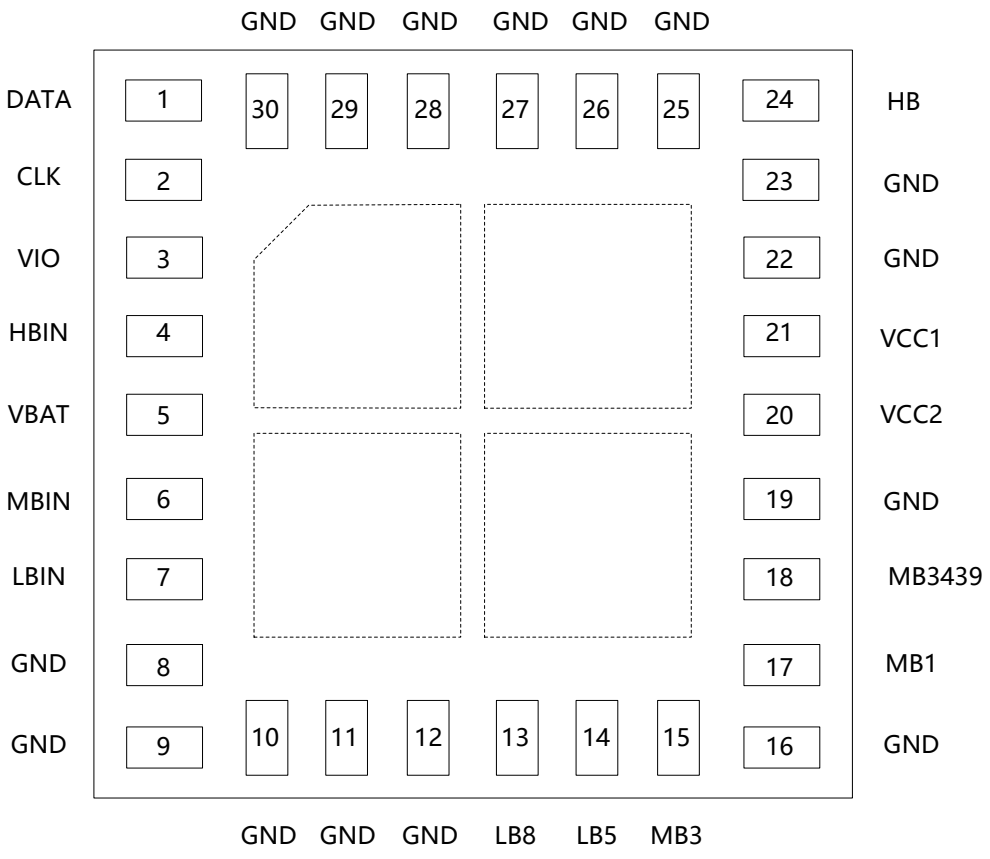


Figure 2 GC0643 Pinout (Top view)

Name	Pin	Description
DATA	1	MIPI Data Bus
CLK	2	MIPI Clock Bus
VIO	3	MIPI Supply
HBIN	4	High Band (HB) Input
VBAT	5	Battery Supply
MBIN	6	Mid Band (MB) Input
LBIN	7	Low Band (LB) Input
GND	8	Ground
GND	9	Ground
GND	10	Ground
GND	11	Ground
GND	12	Ground
LB8	13	Low Band (LB) B8 RF OUT
LB5	14	Low Band (LB) B5 RF OUT
MB3	15	Mid Band (MB) B3 RF OUT
GND	16	Ground
MB1	17	Mid Band (MB) B1 RF OUT
MB3439	18	Mid Band (MB) B34/B39 RF OUT
GND	19	Ground
VCC2	20	2nd Stage PA Drain Supply
VCC1	21	1st Stage PA Drain Supply
GND	22	Ground
GND	23	Ground
HB	24	High Band (HB) B38/B40/B41 RF OUT
GND	25	Ground
GND	26	Ground
GND	27	Ground
GND	28	Ground
GND	29	Ground
GND	30	Ground

Table 2 GC0643 Pinout

6. Recommended Operating Condition

Parameter		Symbol	Specification			Unit
			Min	Typ	Max	
Supply Voltage		VCC1	0.55	3.8	4.2	Volts
		VCC2	0.55	3.8	4.2	
		VBAT	2.1	3.8	4.2	
MIPI RFFE Supply		VIO	1.65	1.8	1.95	Volts
MIPI RFFE Signal Levels for CLK, DATA	Low	VMIPI_LOW	0.0	0.0	0.2×VIO	Volts
	High	VMIPI_HIGH	0.8×VIO	1.8	VIO	
Leakage Current	VBAT=3.4V	I_BAT_LK			1	μA
	VCC1, VCC2=3.4V	I_CC_LK			1	
Case Operating Temperature Range		TRANGE	-40	25	85	°C

Table 3

7. Electrical Specifications

GC0643 ELECTRICAL SPECIFICATIONS FOR NOMINAL OPERATING CONDITIONS – TDD LTE BAND B38/B40/B41.

UNLESS OTHERWISE SPECIFIED: VCC1=VCC2=VBAT = 3.8V; TCASE= 25 °C; LTE SIGNAL = QPSK/10 MHZ/12RB FOR MPR[1] = 0 .

Parameters		Symbol	Min	Typ	Max	Units	Conditions
Operating Frequency		f_0	2300		2690	MHz	
Maximum Output Power		P_{OUT_MAX}		27.5		dBm	MPR = 0[1]
Gain		G_{HIGH}		28		dB	T_{CASE}=25°C P_{OUT}=P_{OUT_MAX}
		G_{MID}		24			
		G_{LOW}		20			T_{CASE}=25°C P_{OUT}=3dBm
Power Added Efficiency		PAE		32		%	P_{OUT} = P_{OUT_MAX}
Adjacent Channel Leakage power Ratio	E-UTRA offset	$E\text{-}UTRA_{\_ACLR}$		-36	-35	dBc	P_{OUT} ≤ (P_{OUT_MAX} – MPR[1])
	UTRA offset	$UTRA_{\_ACLR1}$		-37	-35		
		$UTRA_{\_ACLR2}$					
Harmonic Suppression	Second	$2f_0$		-12		dBm	P_{OUT} ≤ P_{OUT_MAX}
	Third	$3f_0$		-20			
	Fourth	$4f_0$		-29			
Tx Noise in Rx Bands[2]	GPS Rx	$PNRX_{\_GPS}$			-144	dBm/Hz	1574 MHz–1577 MHz
	BT, WLAN	$PNRX_{\_BT}$			-117		2400 MHz–2452 MHz
	Rx Band	$PNRX_{\_LTE}$					2620 MHz–2690 MHz
	WLAN	$PNRX_{\_5GHz}$					4900 MHz–5800 MHz
EVM		EVM		4	5	%	P_{OUT} ≤ P_{OUT_MAX} Load = 50 ohms
Turn On Time		T_{ON}			3	µs	Gain settled to within P_{OUT_MAX} – 0.5 dB
Turn Off Time		T_{OFF}			3	µs	Gain settled to below P_{OUT_MAX} – 30 dB
Input Voltage Standing Wave Ratio		VSWR		2.0:1			
Stability (Spurious output)		S			-36	dBm/MHz	6:1 VSWR All phases
Ruggedness – no damage		Ru		10:1		VSWR	P_{OUT}≤P_{OUT_MAX} mismatch load with all phases applied

Table 4

1. MPR is the maximum power reduction as defined in 3GPP TS36.101
2. Measured with 20 MHz/100RB LTE Waveform.

GC0643 ELECTRICAL SPECIFICATIONS FOR NOMINAL OPERATING CONDITIONS – TDD LTE BAND 34/39

UNLESS OTHERWISE SPECIFIED: VCC1=VCC2=VBATT = 3.8V; TCASE= 25 °C; LTE SIGNAL = QPSK/10 MHZ/12RB FOR MPR[1] = 0 .

Parameters		Symbol	Min	Typ	Max	Units	Conditions
Operating Frequency	Band 34	f_0	2010		2025	MHz	
	Band 39		1880		1920		
Maximum Output Power	Band 34	P_{OUT_MAX}		27.0		dBm	MPR = 0[1]
	Band 39	P_{OUT_MAX}		27.0			MPR = 0[1]
Gain	Band 34	G_{HIGH}		29		dB	T_{CASE}=25°C P_{OUT}=P_{OUT_MAX}
		G_{MID}		23			
		G_{LOW}		20			T_{CASE}=25°C P_{OUT}=3dBm
	Band 39	G_{HIGH}		29			T_{CASE}=25°C P_{OUT}=P_{OUT_MAX}
		G_{MID}		23			
		G_{LOW}		20			T_{CASE}=25°C P_{OUT}=3dBm
Power Added Efficiency	Band 34	PAE		27		%	P_{OUT} = P_{OUT_MAX}
	Band 39			27			
Adjacent Channel Leakage power Ratio	E-UTRA offset	$E\text{-}UTRA_{\_ACLR}$		-36	-35	dBc	P_{OUT} ≤ (P_{OUT_MAX} – MPR[1])
	UTRA offset	$UTRA_{\_ACLR1}$		-37	-35		
Harmonic Suppression	Second	$2f_0$		-17		dBm	P_{OUT} ≤ P_{OUT_MAX}
	Third	$3f_0$		-15			
	Fourth	$4f_0$		-25			
EVM	B34	EVM		4	5	%	P_{OUT} ≤ P_{OUT_MAX} Load = 50 ohms
	B39	EVM		4	5	%	
Turn On Time		T_{ON}			3	μs	Gain settled to within P_{OUT_MAX} – 0.5 dB
Turn Off Time		T_{Off}			3	μs	Gain settled to within P_{OUT_MAX} – 30 dB
Input Voltage Standing Wave Ratio		VSWR		2.0:1			
Stability (Spurious output)		S			-36	dBm/MHz	6:1 VSWR All phases
Ruggedness – no damage		Ru		10:1		VSWR	P_{OUT}≤P_{OUT_MAX} mismatch load with all phases applied

Table 5

1. MPR is the maximum power reduction as defined in 3GPP TS36.101

GC0643 ELECTRICAL SPECIFICATIONS FOR NOMINAL OPERATING CONDITIONS – FDD LTE BAND 1/3

UNLESS OTHERWISE SPECIFIED: VCC1=VCC2=VBATT = 3.8V; TCASE= 25 °C; LTE SIGNAL = QPSK/10 MHZ/12RB FOR MPR[1] = 0.

Parameters		Symbol	Min	Typ	Max	Units	Conditions
Operating Frequency		f_0	1920 1710		1980 1785	MHz	
Maximum Output Power	Band 1	P_{OUT_MAX}		27		dBm	MPR = 0[1]
	Band 3	P_{OUT_MAX}		26			MPR = 0[1]
Gain	Band 1	G_{HIGH}		29		dB	P_{OUT}= P_{OUT_MAX} T_{CASE} = 25 °C
		G_{MID}		23			
		G_{LOW}		21			T_{CASE}=25°C P_{OUT}=3dBm
	Band 3	G_{HIGH}		29			P_{OUT}= P_{OUT_MAX} T_{CASE} = 25 °C
		G_{MID}		23			
		G_{LOW}		20			T_{CASE}=25°C P_{OUT}=3dBm
Power Added Efficiency[2]	Band 1	PAE		27		%	P_{OUT} = P_{OUT_MAX}
	Band 3			20			P_{OUT} = P_{OUT_MAX}
Adjacent Channel Leakage power Ratio		E-UTRA_ACLR		-36	-35	dBc	P_{OUT} ≤ (P_{OUT_MAX} – MPR[1])
		UTRA_ACLR1		-37	-35		
Harmonic Suppression	Second	$2f_0$		-12		dBm	P_{OUT} ≤ P_{OUT_MAX}
	Third	$3f_0$		-25			
	Fourth	$4f_0$		-25			
EVM	B1	EVM		4	5	%	P_{OUT} ≤ P_{OUT_MAX} Load = 50 ohms
	B3	EVM		4	5	%	
Turn On Time	B1	T_{ON}			3	µs	Gain settled to within P_{OUT_MAX} – 0.5 dB
Turn Off Time	B1	T_{Off}			3	µs	Gain settled to within P_{OUT_MAX} – 30 dB
Turn On Time	B3	T_{ON}			3	µs	Gain settled to within P_{OUT_MAX} – 0.5 dB
Turn Off Time	B3	T_{Off}			3	µs	Gain settled to within P_{OUT_MAX} – 30 dB
Noise Power in Rx Band at Duplex Frequency with LTE[2]	B1 f_{TX}=1920-1980 MHz	PNOISE_DPX				dBm/Hz	f_{RX}=f_{TX}+190MHz
	B3 f_{TX}=1710-1785 MHz				-139		f_{RX}=f_{TX}+95MHz
Input VSWR		VSWR_IN		2.0:1		VSWR	POUT ≤ POUT_MAX
Stability (Spurious output)		S			-36	dBm/MHz	6:1 VSWR All phases
Ruggedness – no damage		Ru		10:1		VSWR	P_{OUT}≤P_{OUT_MAX} mismatch load with all phases applied

Table 6

1. MPR is the maximum power reduction as defined in 3GPP TS36.101
2. Measured with 10 MHz/1RB LTE Waveform.

GC0643 ELECTRICAL SPECIFICATIONS FOR NOMINAL OPERATING CONDITIONS – FDD LTE BAND 5/8

UNLESS OTHERWISE SPECIFIED: VCC1=VCC2=VBATT = 3.8V; TCASE= 25 °C; LTE SIGNAL = QPSK/10 MHZ/12RB FOR MPR[1] = 0 .

Parameters		Symbol	Min	Typ	Max	Units	Conditions
Operating Frequency	Band 5	f_0	824		849	MHz	
	Band 8		880		915		
Maximum Output Power	Band 5	P_{OUT_MAX}		27		dBm	MPR = 0[1]
	Band 8	P_{OUT_MAX}		28			MPR = 0[1]
Gain	Band 5	G_{HIGH}		29		dB	P_{OUT}=P_{OUT_MAX} T_{CASE} = 25 °C
		G_{MID}		26			
		G_{LOW}		20			T_{CASE}=25°C P_{OUT}=3dBm
	Band 8	G_{HIGH}		27			P_{OUT}=P_{OUT_MAX} T_{CASE} = 25 °C
		G_{MID}		26			
		G_{LOW}		20			T_{CASE}=25°C P_{OUT}=3dBm
Power Added Efficiency	Band 5	PAE		30		%	P_{OUT} = P_{OUT_MAX}
	Band 8			32			
Adjacent Channel Leakage power Ratio		E-UTRA$_{ACLR}$		-36	-35	dBc	P_{OUT} ≤ (P_{OUT_MAX} – MPR[1])
		UTRA$_{ACLR1}$		-37	-35		
Harmonic Suppression	Second	$2f_0$		-23		dBm	P_{OUT} ≤ P_{OUT_MAX}
	Third	$3f_0$		-26			
	Fourth	$4f_0$		-48			
EVM	B5	EVM		4	5	%	P_{OUT} ≤ P_{OUT_MAX} Load = 50 ohms
	B8	EVM		4	5	%	
Turn On Time	B5	T_{ON}			3	µs	Gain settled to within P_{OUT_MAX} – 0.5 dB
Turn Off Time	B5	T_{Off}			3	µs	Gain settled to within P_{OUT_MAX} – 30 dB
Turn On Time	B8	T_{ON}			3	µs	Gain settled to within P_{OUT_MAX} – 0.5 dB
Turn Off Time	B8	T_{Off}			3	µs	Gain settled to within P_{OUT_MAX} – 30 dB
Noise Power in Rx Band at Duplex Frequency with LTE[2]	B5 f_{TX}=824-849 MHz	PNOISE_DPX				dBm/Hz	f_{RX}=f_{TX}+45MHz
	B8 f_{TX}=880-915 MHz						f_{RX}=f_{TX}+45MHz
Input VSWR		VSWR_IN		2.0:1		VSWR	P_{OUT} ≤ P_{OUT_MAX}
Stability (Spurious output)		S			-36	dBm/MHz	6:1 VSWR All phases
Ruggedness – no damage		Ru		10:1		VSWR	P_{OUT} ≤ P_{OUT_MAX} mismatch load with

						all phases applied

Table 7

1.MPR is the maximum power reduction as defined in 3GPP TS36.101
2.Measured with 10 MHz/1RB LTE Waveform.

8. MIPI RFFE Information

Register 0, Address 0x00 (PA_CTRL0)					
Register 0	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**
[7]	Spare	Trigger0	R/W	0	
[6:3]	PA Band Select Control Mode			0000	Control Mode 0000 = PA's Disabled 0001 = LB5_TX 0010 = LB8_TX 0110=MB34/39_TX 0111 =MB1_TX 1010 =MB3_TX 1011= HB38/40/41_TX
[2:1]	PA Mode			0	00 = PA Off 10 =PA On
[0]	RESERVED			0	
Register 1, Address 0x01 (BIAS_CTRL1)					
Register 1	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**
[7:4]	Secondary PA Bias	Trigger0	R/W	0000	Secondary PA Bias definition
[3:0]	Primary PA Bias	Trigger0	R/W	0000	Primary PA Bias definition
Register 2, Address 0x02 (HB_Select_CTRL)					
Register 2	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**
Register 2	Description	Trigger0	R/W	Default	Notes
[7:5]	Spare			000	Spare
[4:3]	HB Select Control			00	01=B38/41 11=B40
[2:0]	Spare			000	Spare
Register 3, Address 0x03 (Band_optimization&Power Mode_CTRL)					
Register 3	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**
[7]	Spare	Trigger0	R/W	0	0
[6:4]	MB optimization Select Control			000	110=B1/B3/B34/B39 000=B5/B8/B38/B40/B41
[3:0]	PA Bias Pre-amplification			0000	1000=High Power Mode 0011=Low Power Mode

Table 8 MIPI RFFE STANDARD REGISTER MAP

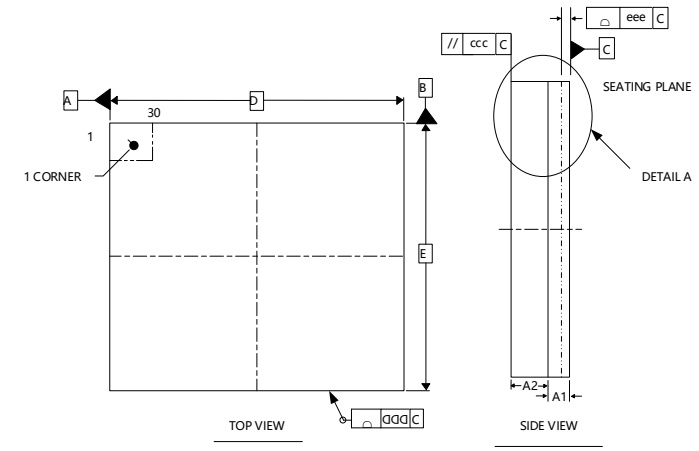
Register 28, Address 0x1C (PM_TRIG)						
Register 28	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**	
[7:6]	PWR_MODE[1:0]	No	R/W	10	00 = Normal Operation (ACTIVE)	10 = Low Power (LOW POWER)
					01 = Default Settings (STARTUP)	11 = Reserved
[5]	TRIGGER_MASK_2			0	0 = Trigger Enable	1 = Trigger Disable
[4]	TRIGGER_MASK_1			0	0 = Trigger Enable	1 = Trigger Disable
[3]	TRIGGER_MASK_0			0	0 = Trigger Enable	1 = Trigger Disable
[2]	TRIGGER_2		W	0	1 = Load Trigger 2 registers	
[1]	TRIGGER_1			0	1 = Load Trigger 1 registers	
[0]	TRIGGER_0			0	1 = Load Trigger 0 registers	
Register 29, Address 0x1D (PROD_ID)						
Register 29	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**	
[7:0]	Product ID	No	R	00100000	Product ID = 0x20	
Register 30, Address 0x1E (MAN_ID)						
Register 30	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**	
[7:0]	Manufacturer ID	No	R	00010101	Manufacturer ID = 0x15	
Register 31, Address 0x01F (USID)						
Register 31	**Description**	**Trigger Support**	**R/W**	**Default**	**Notes**	
[7:6]	Reserved	No	R	10		
[5:4]	MANUFACTURER_ID[9:8]		R	01		
[3:0]	USID		R/W	1111	USID = 0xF	

Table 9 MIPI RFFE STANDARD REGISTER MAP

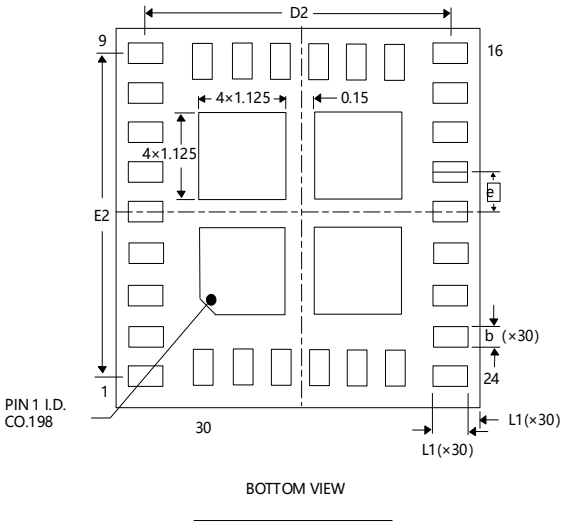
Modulation	Bandwidth (BW)	Resource Block (RB)	MPR
QPSK	1.4MHz	≤5	0
	3.0MHz	≤4	0
	5.0MHz	≤8	0
	10.0MHz	≤12	0
	15.0MHz	≤16	0
	20.0MHz	≤18	0
QPSK	1.4MHz	>5	1
	3.0MHz	>4	1
	5.0MHz	>8	1
	10.0MHz	>12	1
	15.0MHz	>16	1
	20.0MHz	>18	1
16 QAM	1.4MHz	≤5	1
	3.0MHz	≤4	1
	5.0MHz	≤8	1
	10.0MHz	≤12	1
	15.0MHz	≤16	1
	20.0MHz	≤18	1
16 QAM	1.4MHz	>5	2
	3.0MHz	>4	2
	5.0MHz	>8	2
	10.0MHz	>12	2
	15.0MHz	>16	2
	20.0MHz	>18	2

Table 10 GC0643 LTE MAXIMUM POWER REDUCTION (MPR)

9. Package Dimensions



		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.65		0.75
MOLD CAP		A2	---	0.50	---
SUBTRATE THICKNESS		A1	0.17	0.20	0.23
LEAD WIDTH		b	0.17	0.22	0.27
BODY SIZE	X	D	3.90	4.00	4.10
	Y	E	3.90	4.00	4.10
LEAD PITCH		e	0.44 BSC		
EDGE PAD CENTER TO CENTER		D2	3.40 BSC		
		E2	3.52 BSC		
LEAD LENGTH		L	0.35	0.40	0.45
LEAD TIP TO PKG EDGE		L1	0.025	0.10	0.175
PACKAGE EDGE TOLERANCE		aaa	0.10		
MOLD FLATNESS		ccc	0.10		
COPLANARITY		eee	0.08		
LEAD OFFSET		bbb	0.10		
		ddd	0.08		



Notes.
1.ALL DIMENSIONS ARE IN MILLIMETERSANGLES ARE IN DEGREES:
2.DIMENSIONS AND TOLERANCE CONFORM TO ASME Y14.5-2009;

Figure 3

Part Marking

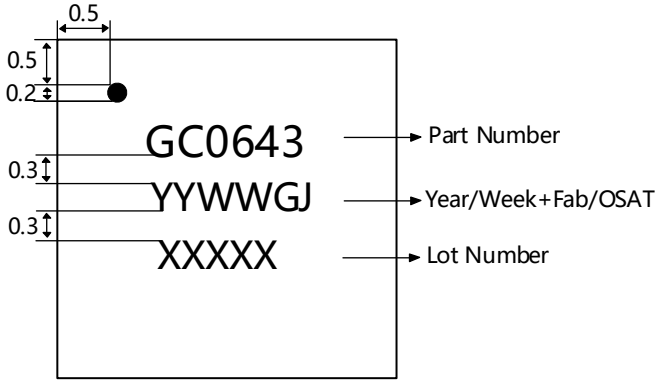


Figure 4 Typical Part Markings (Top View)

10. Ordering Information

Model	Package	Packaging Form	Minimum Order Quantity
G0643	LGA30 4*4	REEL	3000

11. Revision Record

Version	Date	Description
V0.2	2023/07	Add EVM, Turn on/off time, Harmonic test data
V0.3	2023/08	Modify the format,Add G_{MID}
V1.0	2023/12	Update data
V1.1	2024/08	Update data
V1.2	2025/08	Update data

12. Disclaimer

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