

BGY288

Power amplifier with integrated control loop for GSM850, EGSM900, DCS1800 and PCS1900

Rev. 01 — 2 February 2005

Preliminary data sheet

1. Product profile

1.1 General description

The BGY288 is a power amplifier module in a SOT775 surface mounted package with a plastic cap. In the module, a mix of state of the art technologies as InGaP, Si-Bicmos and Si passive integration are used to combine high performance with a small size. The module comprises two functional sections, one for low-band (GSM850/EGSM900) and one for high-band (DCS1800/PCS1900) with internal power detection, power control loop, input and output matching; see [Figure 2](#). The power control circuit ensures a stable RF power output which is set by the voltage level on pin PC. The power control circuit is stabilized to compensate for variations in supply voltage, input power and temperature, and has a control range fully compliant with European Telecommunication Standards Institute (ETSI) time mask and power spectrum requirements.

1.2 Features

1.2.1 General features

- Quad band GSM amplifier
- 34 dBm controlled output power for GSM850/EGSM900
- Suited for GPRS class 12 (duty cycle $\delta = 4 : 8$)
- Integrated power control loop
- 3.6 V nominal supply voltage
- Very small size (8 mm × 8 mm)
- 32.5 dBm controlled output power for DCS1800/PCS1900
- Easy on/off and band select by digital control voltage
- Internal input and output matching
- Specification based on 3GPP TS 45.005

1.2.2 RF performance

RF performance with a typical pulsed, controlled output power at $T_{mb} = 25\text{ °C}$; $V_{BAT} = 3.6\text{ V}$; $V_{STAB} = 2.8\text{ V}$; $Z_S = Z_L = 50\text{ }\Omega$; $P_{D(LB)} = 2\text{ dBm}$ / $P_{D(HB)} = 0\text{ dBm}$; $\delta = 2 : 8$.

- $f = 824\text{ MHz to }849\text{ MHz}$; $\eta @ P_{SAT} = 50\%$; $P_L = 34\text{ dBm}$
- $f = 880\text{ MHz to }915\text{ MHz}$; $\eta @ P_{SAT} = 55\%$; $P_L = 34\text{ dBm}$
- $f = 1710\text{ MHz to }1785\text{ MHz}$; $\eta @ P_{SAT} = 50\%$; $P_L = 32.5\text{ dBm}$
- $f = 1850\text{ MHz to }1910\text{ MHz}$; $\eta @ P_{SAT} = 50\%$; $P_L = 32.5\text{ dBm}$

1.3 Applications

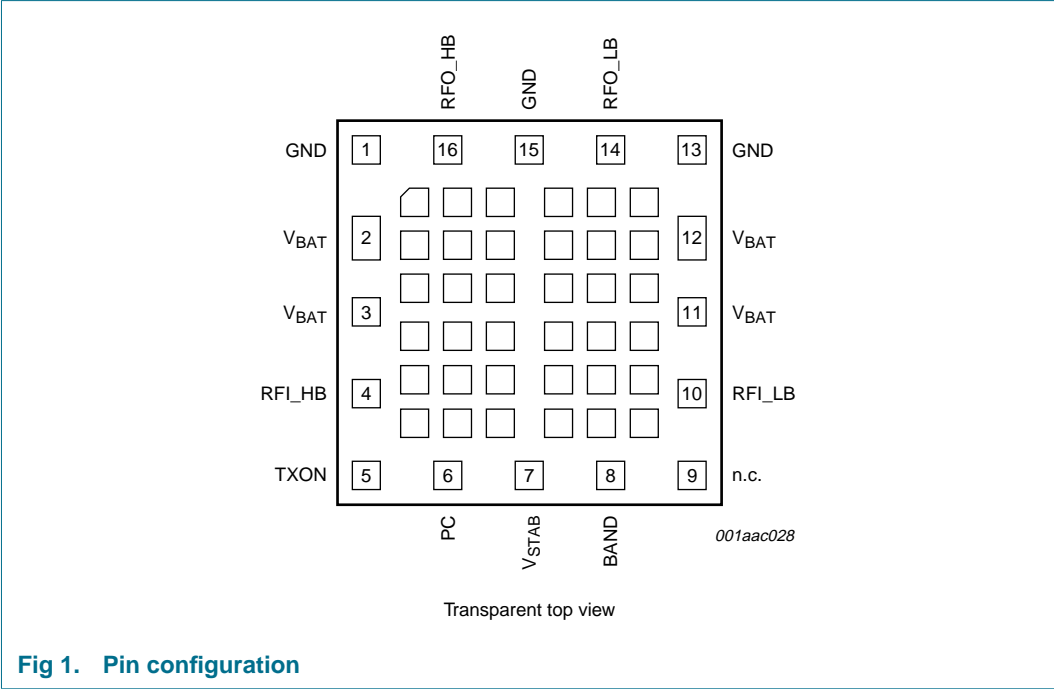
- Digital cellular radio systems with Time Division Multiple Access (TDMA) operation (GSM systems) in four frequency bands: 824 MHz to 849 MHz, 880 MHz to 915 MHz, 1710 MHz to 1785 MHz and 1850 MHz to 1910 MHz.

PHILIPS



2. Pinning information

2.1 Pinning



2.2 Pin description

Table 1: Pin description

Symbol	Pin	Type	Description
GND	1, 13, 15	ground	ground
V _{BAT} ^[1]	2, 3	supply	battery supply voltage for DCS1800/PCS1900 section
	11, 12	supply	battery supply voltage for GSM850/EGSM900 section
RFI_HB	4	analog input	DCS1800/PCS1900 transmit RF input
TXON	5	logic input	RF power control enable input
PC	6	analog input	RF power control input
V _{STAB}	7	supply	stabilized supply voltage
BAND	8	logic input	Low-Band (LB) (GSM850/EGSM900) or High-Band (HB) (DCS1800/PCS1900) select input
n.c.	9		not connected
RFI_LB	10	analog input	GSM850/EGSM900 transmit RF input
RFO_LB	14	analog output	GSM850/EGSM900 transmit RF output
RFO_HB	16	analog output	DCS1800/PCS1900 transmit RF output
	inner pads	ground	ground

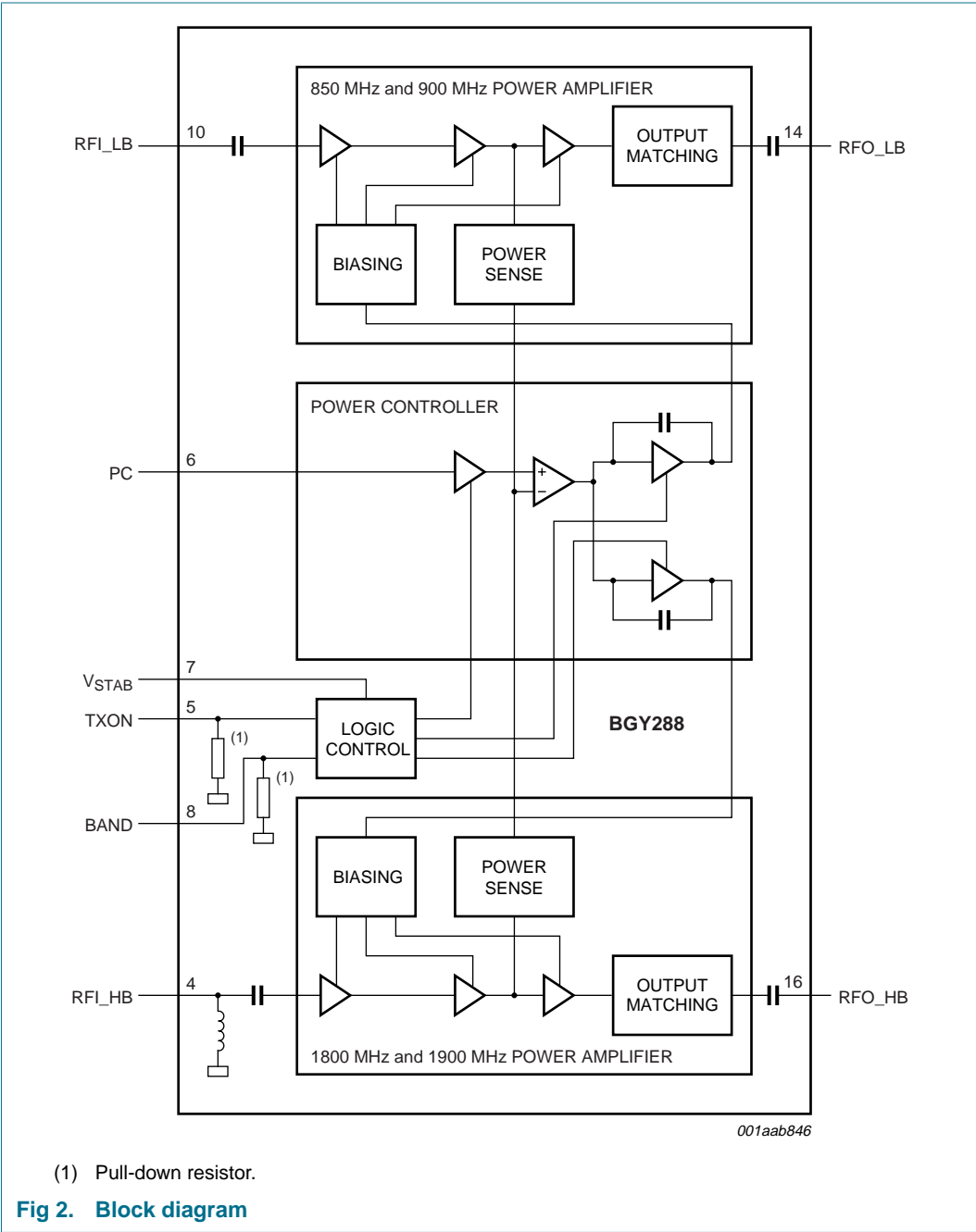
[1] Pins 2, 3, 11 and 12 (V_{BAT}) are not internally connected and must all be connected to the battery supply voltage.

3. Ordering information

Table 2: Ordering information

Type number	Package		
	Name	Description	Version
BGY288	-	leadless surface mounted package; plastic cap; 16 terminations	SOT775A

4. Block diagram



5. Functional description

5.1 Operating conditions

The BGY288 is designed to meet the 3GPP TS 45.005 technical specification for the ETSI.

5.2 Power amplifier

The low band (GSM850 and EGSM900) and the high band (DCS1800 and PCS1900) channel power amplifiers each comprises three cascaded gain stages, input and output matching and harmonic filters. The output power of each amplifier is determined by the bias on each of its 3 gain stages and is controlled by an internal signal generated in the power controller block. Each power amplifier block generates a power sense signal which is routed internally to the power control block.

5.3 Control logic

The control logic block generates the various signals to control the complete BGY288 depending on the signal levels on pins TXON and BAND, as indicated in [Table 3](#). The control logic block supply voltage is via pin V_{STAB}. When pin V_{STAB} = 0 V, the BGY288 is in Idle mode and the battery current consumption is almost zero. The power control block is enabled when pin TXON goes HIGH. The low band (GSM850/EGSM900) channel is enabled when pin BAND goes LOW and the high band (DCS1800/PCS1900) channel is enabled when pin BAND goes HIGH. Both TXON and BAND inputs have pull-down resistors of approximately 1 MΩ.

5.4 Power controller

The main inputs to the power controller block are the RF power control signal via pin PC and the output power sense signal internally generated by each power amplifier block. The PC signal is the reference voltage for the requested level of output power, and is usually generated by an external digital-to-analog converter. The PC signal is buffered and compared with the output power sense signal. The resultant error signal is then amplified by one of two integrators, the selection of which being dependant on the level of the BAND signal. The output of the selected integrator is the internal signal which controls the biasing circuits of the selected channel.

5.5 Mode control

Table 3: Mode control

Mode	Mode description	V _{STAB} (V)	TXON	BAND	PC (V)
Idle	power amplifier fully off; minimal leakage current	0	LOW	LOW	< 0.15
Standby	control logic functioning; power amplifier off	2.6 to 3	LOW	HIGH or LOW	< 0.15
LB TX	low-band transmit mode (GSM850/EGSM900)	2.6 to 3	HIGH	LOW	< 2.5
HB TX	high-band transmit mode (DCS1800/PCS1900)	2.6 to 3	HIGH	HIGH	< 2.5

6. Timing

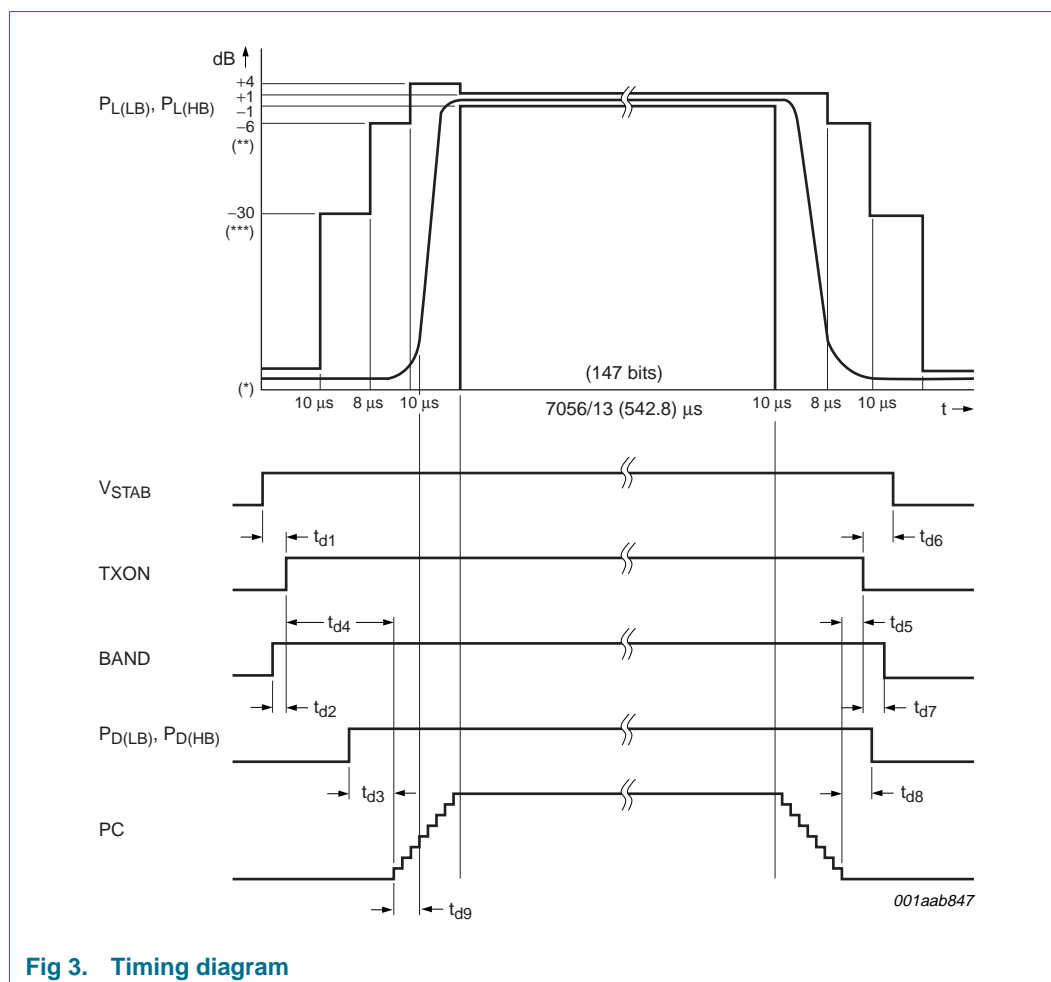


Fig 3. Timing diagram

Table 4: Timing characteristics

$Z_S = Z_L = 50 \Omega$; $P_{D(LB)} = 0 \text{ dBm to } 4 \text{ dBm}$ / $P_{D(HB)} = -2 \text{ dBm to } +2 \text{ dBm}$; $V_{BAT} = 3.1 \text{ V to } 4.6 \text{ V}$; $V_{STAB} = 2.6 \text{ V to } 3.0 \text{ V}$; $T_{mb} = -20^\circ\text{C to } 85^\circ\text{C}$; $\delta = 1 : 8 \text{ to } 4 : 8$; unless otherwise specified.

Symbol	Parameter	Min	Typ	Max	Unit
t_{d1}	delay time; V_{STAB} to high voltage before TXON goes HIGH	0	-	-	μs
t_{d2}	delay time; BAND to LOW or HIGH before TXON goes HIGH	0	-	-	μs
t_{d3}	delay time; RF signal on RFI_HB or RFI_LB before PC ramp-up	0	-	-	μs
t_{d4}	delay time; PC start of ramp-up after TXON goes HIGH	10	-	-	μs
t_{d5}	delay time; TXON to LOW after transition of PC to off condition	0	-	-	μs
t_{d6}	delay time; V_{STAB} to 0 V, after TXON goes LOW	10	-	-	μs
t_{d7}	delay time; change of BAND after TXON goes LOW	0	-	-	μs
t_{d8}	delay time; removal of RF signal on RFI_HB or RFI_LB after transition of PC to off condition	0	-	-	μs
t_{d9}	time between PC ramp-up and actual P_L increase	-	-	3	μs

6.1 Ramp-up

V_{STAB} voltage must be available at minimum t_{d1} before TXON goes HIGH (power control loop activates).

BAND selects the correct transmit channel (GSM850/EGSM900, or DCS1800/PCS1900). BAND must be at the correct value before the rising edge of TXON.

The transition of TXON to HIGH enables the power control loop; the TXON minimum t_{d4} period is a set-up time which allows the correct internal biasing conditions and the charge on the integration capacitors to be at the correct starting value before PC starts to increase. RF power must be present at the input of the selected channel ($P_{D(LB)}$ or $P_{D(HB)}$) before PC starts to ramp-up.

The required RF output power level is reached by increasing PC in steps to the corresponding voltage level. The sequence of PC steps can be chosen to have approximately a quarter cosine wave ramp-up of $P_{L(LB)}$ or $P_{L(HB)}$ in order to prevent violation of the GSM power mask, and at the same time prevent violation of the spectrum due to transients.

To avoid violation of the lowest power level in the GSM power mask (indicated by *; see [Figure 3](#)), the BGY288 provides sufficient isolation when TXON goes HIGH with PC at minimum value and RF power at input of power amplifier.

In LB TX mode, the system specification for maximum output power of the handset is -36 dBm. In HB TX mode, the system specification for maximum output power of the handset is -48 dBm. In BGY288 transmit mode, the handset antenna switch can be used to provide isolation between the power amplifier and the antenna by setting the antenna switch to Rx mode. This condition is used for the transmit mode isolation parameters given in [Section 9](#).

6.2 Ramp-down

PC steps down from the voltage level for the current power level to off state. The sequence of PC steps can be chosen to have approximately a quarter cosine wave ramp-down of $P_{L(LB)}$ or $P_{L(HB)}$ in order to prevent violation of the GSM power mask, and at the same time prevent violation of the spectrum due to transients.

The power control loop can be switched off (TXON goes LOW) as soon as PC has reached the off state level. At the same time, BAND is allowed to change polarity and the RF input power at the selected channel ($P_{D(LB)}$ or $P_{D(HB)}$) can be removed. When input power is removed, there is no additional isolation specification required to meet the GSM system specification. In LB TX mode, the system specification for maximum output power of the handset is -54 dBm. In HB TX mode the system specification for maximum output power is -48 dBm.

At minimum t_{d6} after TXON goes LOW (power control loop deactivates) and when all charge in the power control loop capacitors is removed, the BGY288 can go into Idle mode ($V_{\text{STAB}} = 0 \text{ V}$).

7. Limiting values

Table 5: Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
V _{BAT}	DC supply voltage	Idle mode	-	7	V
		HB TX or LB TX mode	-	5.3	V
V _{STAB}	stabilized DC supply voltage		-0.5	+3.3	V
I _{STAB}	stabilized supply current		-	2	mA
V _{PC}	DC output power control voltage		-	3	V
I _{PC}	current into output power control input		-2	+2	mA
P _{D(HB)} , P _{D(LB)}	input drive power on RFI_HB or RFI_LB		-	10	dBm
P _{L(LB)}	load power on RFO_LB		-	37	dBm
P _{L(HB)}	load power on RFO_HB		-	35	dBm
V _{BAND}	band switch voltage		-0.5	+3.3	V
I _{BAND}	band switch current		-2	+2	mA
V _{TXON}	transmit control signal		-0.5	+3.3	V
I _{TXON}	current into transmit control input		-2	+2	mA
P _{BAT}	power from supply during pulse	HB TX mode	-	4	W
		LB TX mode	-	7	W
I _{BAT}	current from supply during pulse	HB TX mode	-	1.6	A
		LB TX mode	-	2.2	A
T _{stg}	storage temperature		-40	+100	°C
T _{mb}	mounting base temperature	δ = 2 : 8	-30	+100	°C
		δ = 4 : 8	-30	+90	°C
V _{esd}	electrostatic discharge voltage	human body model	[1] -	±500	V
		machine model	[2] -	±50	V

[1] Class 1B according to EIA/JESD22-A114B

[2] Class A according to EIA/JESD22-A115A

8. Static characteristics

Table 6: Static characteristics

Z_S = Z_L = 50 Ω; P_{D(HB)}, P_{D(LB)} = 0 mW; V_{BAT} = 3.6 V; V_{STAB} = 2.8 V; T_{mb} = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Voltage supply						
V _{BAT}	battery supply voltage		[1] 2.9	-	3.1	V
		typical operating range	3.1	3.6	4.6	V
			[2] 4.6	-	5.2	V
I _{BAT}	leakage current	Standby mode	-	-	1.5	mA
		Idle mode	-	-	10	μA
V _{STAB}	supply voltage	Standby, HB TX or LB TX mode	2.6	2.8	3.0	V
		Idle mode	0	-	0.2	V

Table 6: Static characteristics ...continued

$Z_S = Z_L = 50\ \Omega$; $P_{D(HB)}$, $P_{D(LB)} = 0\ \text{mW}$; $V_{BAT} = 3.6\ \text{V}$; $V_{STAB} = 2.8\ \text{V}$; $T_{mb} = 25\ ^\circ\text{C}$; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{STAB}	current consumption	HB TX or LB TX mode	-	-	1	mA
		Standby mode	-	-	1	mA

Digital inputs: TXON, BAND [3]

V_{IL}	LOW-level input voltage	0	-	0.5	V
V_{IH}	HIGH-level input voltage	1.4	-	3	V
I_{IL}	LOW-level input current	-	-	3	μA
I_{IH}	HIGH-level input current	-	-	15	μA
C_i	input capacitance	-	4	-	pF

Analog inputs: PC [3]

V_{PC}	power control voltage	0	-	2.5	V
I_{PC}	power control current	-100	-	-	μA
C_{PC}	PC input capacitance	-	4	-	pF
R_{PC}	PC input resistance	-	1.2	-	M Ω

[1] Power amplifier is functional from 2.9 V to 3.1 V, but will not meet all electrical specification points.

[2] Power amplifier is functional from 4.6 V to 5.2 V under 50 Ω conditions, but will not meet all electrical specification points.

[3] $P_{D(LB)} = 0\ \text{dBm}$ to 4 dBm / $P_{D(HB)} = -2\ \text{dBm}$ to +2 dBm; $V_{BAT} = 3.1\ \text{V}$ to 4.6 V; $V_{STAB} = 2.6\ \text{V}$ to 3.0 V; $T_{mb} = -20\ ^\circ\text{C}$ to +85 $^\circ\text{C}$; $\delta = 1 : 8$ to 4 : 8; unless otherwise specified.

9. Dynamic characteristics

Table 7: Dynamic characteristics GSM850 and EGSM900 transmit mode

$Z_S = Z_L = 50\ \Omega$; $V_{BAT} = 3.6\ \text{V}$; $V_{STAB} = 2.8\ \text{V}$; $T_{mb} = 25\ ^\circ\text{C}$; $\delta = 1 : 8$ to 4 : 8; $t_p = 575\ \mu\text{s}$ to 2300 μs ; $P_{D(LB)} = 2\ \text{dBm}$; spurious signals on $P_{D(LB)} < -50\ \text{dBm}$; LB TX mode selected;

$f = 824\ \text{MHz}$ to 849 MHz for GSM850; $f = 880\ \text{MHz}$ to 915 MHz for EGSM900; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{D(LB)}$	RF input power		0	2	4	dBm
V_{PC}	reference voltage to set output power	$f = 897.5\ \text{MHz}$ for EGSM900; $f = 836.5\ \text{MHz}$ for GSM850; $P_{L(LB)} = 35\ \text{dBm}$	-	-	2	V
		$f = 897.5\ \text{MHz}$ for EGSM900; $f = 836.5\ \text{MHz}$ for GSM850; $P_{L(LB)} = 3\ \text{dBm}$	0.2	-	-	V

Table 7: Dynamic characteristics GSM850 and EGSM900 transmit mode ...continued

$Z_S = Z_L = 50 \Omega$; $V_{BAT} = 3.6 \text{ V}$; $V_{STAB} = 2.8 \text{ V}$; $T_{mb} = 25^\circ\text{C}$; $\delta = 1 : 8$ to $4 : 8$; $t_p = 575 \mu\text{s}$ to $2300 \mu\text{s}$; $P_{D(LB)} = 2 \text{ dBm}$; spurious signals on $P_{D(LB)} < -50 \text{ dBm}$; LB TX mode selected;

$f = 824 \text{ MHz}$ to 849 MHz for GSM850; $f = 880 \text{ MHz}$ to 915 MHz for EGSM900; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$P_{L(LB)}$	available output power	GSM850					
		$V_{PC} = 2.2 \text{ V}$	34.2	35	-	dBm	
		$V_{PC} = 2.0 \text{ V}$; $V_{BAT} = 3.2 \text{ V}$; $P_{D(LB)} = 0 \text{ dBm}$; $\delta = 2 : 8$	32.8	-	-	dBm	
		$V_{PC} = 2.0 \text{ V}$; $V_{BAT} = 3.2 \text{ V}$; $P_{D(LB)} = 0 \text{ dBm}$; $\delta = 2 : 8$; $T_{mb} = 85 \text{ }^{\circ}\text{C}$	32.3	-	-	dBm	
		EGSM900					
		$V_{PC} = 2.2 \text{ V}$	35.2	36	-	dBm	
		$V_{PC} = 2.0 \text{ V}$; $V_{BAT} = 3.2 \text{ V}$; $P_{D(LB)} = 0 \text{ dBm}$; $\delta = 2 : 8$	33.8	-	-	dBm	
		$V_{PC} = 2.0 \text{ V}$; $V_{BAT} = 3.2 \text{ V}$; $P_{D(LB)} = 0 \text{ dBm}$; $\delta = 2 : 8$; $T_{mb} = 85 \text{ }^{\circ}\text{C}$	33.3	-	-	dBm	
η	efficiency GSM850	saturated power	-	50	-	%	
		$P_{L(LB)} = 34 \text{ dBm}$	-	45	-	%	
	efficiency EGSM900	saturated power	-	55	-	%	
		$P_{L(LB)} = 34 \text{ dBm}$	-	50	-	%	
$\Delta P_{L(LB)}$	output power variation at nominal temperature range	$P_{L(LB)} = 31 \text{ dBm}$ to 34 dBm for EGSM900 and $P_{L(LB)} = 31 \text{ dBm}$ to 33 dBm for GSM850; set by PC	[1] [2]	-0.7	-	+0.7	dB
		$P_{L(LB)} = 13 \text{ dBm}$ to 31 dBm ; set by PC	[1] [2]	-1.5	-	+1.5	dB
		$P_{L(LB)} = 6 \text{ dBm}$ to 13 dBm ; set by PC	[1] [2]	-2	-	+2	dB
	output power variation at extreme temperature range	$P_{L(LB)} = 31 \text{ dBm}$ to 34 dBm for EGSM900 and $P_{L(LB)} = 31 \text{ dBm}$ to 33 dBm for GSM850; set by PC	[1] [3]	-1.2	-	+1.2	dB
		$P_{L(LB)} = 13 \text{ dBm}$ to 31 dBm ; set by PC	[1] [3]	-2	-	+2	dB
		$P_{L(LB)} = 6 \text{ dBm}$ to 13 dBm ; set by PC	[1] [3]	-3	-	+3	dB
	output power variation of frequency	$P_{L(LB)} = 31 \text{ dBm}$ to 34 dBm ; set by PC	[1] [4]	-0.3	-	+0.3	dB
	H_2 to H_{13}	harmonics	$P_{L(LB)} \leq 34 \text{ dBm}$	-	-	-5	dBm
		isolation H_2 into DCS1800/PCS1900	measured at RFO_HB; $P_{L(LB)} = 34 \text{ dBm}$	-	-	-15	dBm
isolation H_3 into DCS1800/PCS1900		measured at RFO_HB; $P_{L(LB)} = 34 \text{ dBm}$	-	-	-25	dBm	
isolation		$P_{D(LB)} = 4 \text{ dBm}$; $V_{PC} = 0.15 \text{ V}$; Standby mode	-	-	-36	dBm	
		$P_{D(LB)} = 4 \text{ dBm}$; $V_{PC} = 0.15 \text{ V}$; LB TX mode	-	-	-36	dBm	
$VSWR_{in}$	input VSWR	$P_{L(LB)} < 6 \text{ dBm}$	-	-	6 : 1		
		$P_{L(LB)} = 6 \text{ dBm}$ to 34 dBm ;	-	2 : 1	3 : 1		

Table 7: Dynamic characteristics GSM850 and EGSM900 transmit mode ...continued

$Z_S = Z_L = 50 \Omega$; $V_{BAT} = 3.6 \text{ V}$; $V_{STAB} = 2.8 \text{ V}$; $T_{mb} = 25^\circ\text{C}$; $\delta = 1 : 8 \text{ to } 4 : 8$; $t_p = 575 \mu\text{s to } 2300 \mu\text{s}$; $P_{D(LB)} = 2 \text{ dBm}$; spurious signals on $P_{D(LB)} < -50 \text{ dBm}$; LB TX mode selected;
 $f = 824 \text{ MHz to } 849 \text{ MHz}$ for GSM850; $f = 880 \text{ MHz to } 915 \text{ MHz}$ for EGSM900; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
P_n	noise power	RBW = 100 kHz; $f_0 = 897.5 \text{ MHz}$ for EGSM900; $f_0 = 836.5 \text{ MHz}$ for GSM850				
		$f_0 + 27.5 \text{ MHz}$; $P_{L(LB)} < 34 \text{ dBm}$	-	-	-73	dBm
		$f_0 + 37.5 \text{ MHz}$; $P_{L(LB)} < 34 \text{ dBm}$	-	-	-82	dBm
		$f \geq 1805 \text{ MHz}$; $P_{L(LB)} < 34 \text{ dBm}$	-	-	-77	dBm
CG	conversion gain	$f_0 = 915 \text{ MHz}$ for EGSM900; $f_0 = 849 \text{ MHz}$ for GSM850; $P_{L(LB)} = 6 \text{ dBm to } 34 \text{ dBm}$; $f_{SS1} = f_0 - 20 \text{ MHz}$; $P_{SS1} = -40 \text{ dBm}$; $CG = P_{L(CON)} - P_{SS1}$; see Figure 4	-	-	28	dB
SSG	small signal gain	$f_0 = 915 \text{ MHz}$ for EGSM900; $f_0 = 849 \text{ MHz}$ for GSM850; $P_{L(LB)} = 6 \text{ dBm to } 34 \text{ dBm}$; $f_{SS2} = f_0 + 20 \text{ MHz}$; $P_{SS2} = -40 \text{ dBm}$; $SSG = P_{L(SS2)} - P_{SS2}$; see Figure 4	-	-	31	dB
AM/AM	AM/AM conversion	$P_{L(LB)} = 6 \text{ dBm to } 34 \text{ dBm}$; 6.5 % AM modulation with				
		$f_{mod} = 67 \text{ kHz}$ at RFI_LB	-	5	8	%
		$f_{mod} = 140 \text{ kHz}$ at RFI_LB	-	8	13	%
		$f_{mod} = 271 \text{ kHz}$ at RFI_LB	-	14	20	%
AM/PM	AM/PM conversion	$P_{D(LB)} = 1.5 \text{ dBm to } 2.5 \text{ dBm}$; $P_{L(LB)} = 6 \text{ dBm to } 34 \text{ dBm}$	-	2	4	deg/dB
	maximum control slope	$P_{L(LB)} = 6 \text{ dBm to } 34 \text{ dBm}$	-	-	200	dB/V
t_r, t_f	carrier rise and fall time	$P_{L(LB)} = 5 \text{ dBm to } 34 \text{ dBm}$ or 34 dBm to 5 dBm	-	-	2	μs
f_{CL}	control loop bandwidth		-	200	-	kHz
	stability	$P_{L(LB)} \leq 34 \text{ dBm}$; $VSWR \leq 7 : 1$ through all phases; $V_{BAT} = 3.2 \text{ V to } 4.6 \text{ V}$	-	-	-36	dBm
	ruggedness	$V_{BAT} = 3.2 \text{ V to } 4.6 \text{ V}$; $P_{L(LB)} \leq 34 \text{ dBm}$; $\delta = 4 : 8$; $VSWR \leq 8 : 1$ through all phases	no degradation			

- [1] Condition to set V_{PC} : $V_{BAT} = 3.6 \text{ V}$; $\delta = 2 : 8$; $P_{D(LB)} = 2 \text{ dBm}$; $T_{mb} = 25^\circ\text{C}$; $f = 897.5 \text{ MHz}$ for EGSM900; $f = 836.5 \text{ MHz}$ for GSM850.
- [2] Conditions for power variation: $P_{D(LB)} = 0 \text{ dBm to } 4 \text{ dBm}$; $f = 824 \text{ MHz to } 849 \text{ MHz}$ for GSM850; $f = 880 \text{ MHz to } 915 \text{ MHz}$ for EGSM900; $T_{mb} = 15^\circ\text{C to } 70^\circ\text{C}$; $V_{BAT} = 3.2 \text{ V to } 4.2 \text{ V}$; $V_{STAB} = 2.8 \text{ V} \pm 20 \text{ mV}$.
- [3] Conditions for power variation: $P_{D(LB)} = 0 \text{ dBm to } 4 \text{ dBm}$; $f = 824 \text{ MHz to } 849 \text{ MHz}$ for GSM850; $f = 880 \text{ MHz to } 915 \text{ MHz}$ for EGSM900; $T_{mb} = -20^\circ\text{C to } +90^\circ\text{C}$; $V_{BAT} = 3.2 \text{ V to } 4.2 \text{ V}$; $V_{STAB} = 2.8 \text{ V} \pm 20 \text{ mV}$.
- [4] Conditions for power variation: $P_{D(LB)} = 2 \text{ dBm}$; $f = 824 \text{ MHz to } 849 \text{ MHz}$ for GSM850; $f = 880 \text{ MHz to } 915 \text{ MHz}$ for EGSM900; $T_{mb} = 25^\circ\text{C}$; $V_{BAT} = 3.6 \text{ V}$; $V_{STAB} = 2.8 \text{ V} \pm 20 \text{ mV}$.

Table 8: Dynamic characteristics DCS1800/PCS1900 transmit mode

$Z_S = Z_L = 50 \Omega$; $V_{BAT} = 3.6 \text{ V}$; $V_{STAB} = 2.8 \text{ V}$; $T_{mb} = 25^\circ \text{C}$; $\delta = 1 : 8 \text{ to } 4 : 8$; $t_p = 575 \mu\text{s to } 2300 \mu\text{s}$; $P_{D(HB)} = 0 \text{ dBm}$; spurious signals on $P_{D(HB)} < -50 \text{ dBm}$; HB TX mode selected;

$f = 1710 \text{ MHz to } 1785 \text{ MHz}$ for DCS1800; $f = 1850 \text{ MHz to } 1910 \text{ MHz}$ for PCS1900; unless otherwise specified.

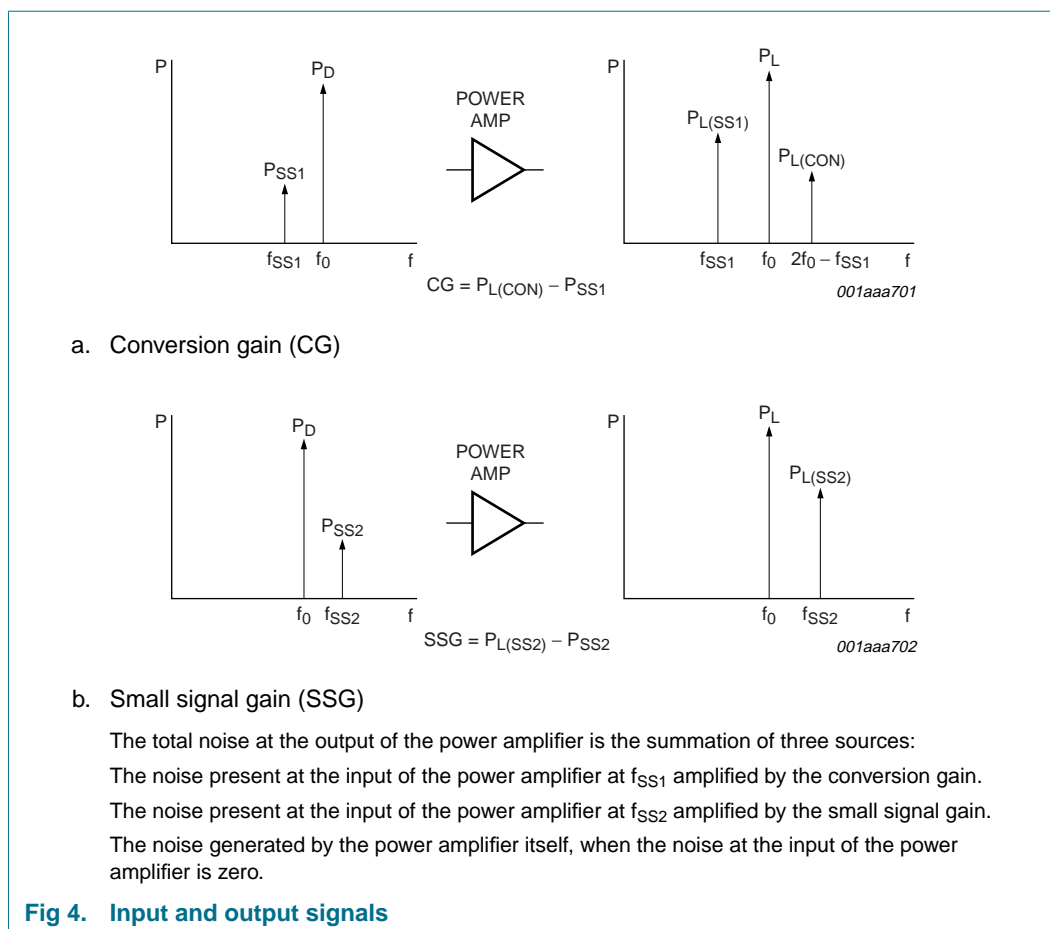
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{D(HB)}$	RF input power		-2	0	+2	dBm
V_{PC}	reference voltage to set output power	$f = 1747.6 \text{ MHz}$ for DCS1800; $f = 1880 \text{ MHz}$ for PCS1900; $P_{L(HB)} = 32.5 \text{ dBm}$	-	-	2	V
		$f = 1747.6 \text{ MHz}$ for DCS1800; $f = 1880 \text{ MHz}$ for PCS1900; $P_{L(HB)} = -3 \text{ dBm}$	0.2	-	-	V
$P_{L(HB)}$	available output power	$V_{PC} = 2.2 \text{ V}$	32.7	33.5	-	dBm
		$V_{PC} = 2.0 \text{ V}$; $V_{BAT} = 3.2 \text{ V}$; $P_{D(HB)} = -2 \text{ dBm}$; $\delta = 2 : 8$	31.8	-	-	dBm
		$V_{PC} = 2.0 \text{ V}$; $V_{BAT} = 3.2 \text{ V}$; $P_{D(HB)} = -2 \text{ dBm}$; $\delta = 2 : 8$; $T_{mb} = 85^\circ \text{C}$	31.3	-	-	dBm
η	efficiency DCS1800	saturated power	-	50	-	%
		$P_{L(HB)} = 31.3 \text{ dBm}$	-	45	-	%
	efficiency PCS1900	saturated power	-	50	-	%
		$P_{L(HB)} = 31.3 \text{ dBm}$	-	45	-	%
$\Delta P_{L(HB)}$	output power variation at nominal temperature range	$P_{L(HB)} = 28 \text{ dBm to } 32 \text{ dBm}$; set by PC	[1][2] -0.7	-	+0.7	dB
		$P_{L(HB)} = 15 \text{ dBm to } 28 \text{ dBm}$; set by PC	[1][2] -1	-	+1	dB
		$P_{L(HB)} = 5 \text{ dBm to } 15 \text{ dBm}$; set by PC	[1][2] -2	-	+2	dB
		$P_{L(HB)} = 0 \text{ dBm to } 5 \text{ dBm}$; set by PC	[1][2] -3	-	+3	dB
	output power variation at extreme temperature range	$P_{L(HB)} = 28 \text{ dBm to } 32 \text{ dBm}$; set by PC	[1][3] -1.2	-	+1.2	dB
		$P_{L(HB)} = 15 \text{ dBm to } 28 \text{ dBm}$; set by PC	[1][3] -1.5	-	+1.5	dB
		$P_{L(HB)} = 5 \text{ dBm to } 15 \text{ dBm}$; set by PC	[1][3] -2.5	-	+2.5	dB
		$P_{L(HB)} = 0 \text{ dBm to } 5 \text{ dBm}$; set by PC	[1][3] -3.5	-	+3.5	dB
	output power variation of frequency	$P_{L(HB)} = 30 \text{ dBm to } 32 \text{ dBm}$; set by PC	[1][4] -0.3	-	+0.3	dB
$H_2 \text{ to } H_7$	harmonics	$P_{L(HB)} \leq 32 \text{ dBm}$	-	-	-5	dBm
	isolation	$P_{D(HB)} = 2 \text{ dBm}$; $V_{PC} = 0.15 \text{ V}$; Standby mode	-	-	-36	dBm
		$P_{D(HB)} = 2 \text{ dBm}$; $V_{PC} = 0.15 \text{ V}$; HB TX mode	-	-	-36	dBm
$VSWR_{in}$	input VSWR	$P_{L(HB)} < 0 \text{ dBm}$	-	-	6 : 1	
		$P_{L(LB)} = 2 \text{ dBm to } 32 \text{ dBm}$	-	2 : 1	3 : 1	
P_n	noise power	$f_0 = 1785 \text{ MHz}$ for DCS1800; $f_0 = 1910 \text{ MHz}$ for PCS1900; $f_0 + 20 \text{ MHz}$; RBW = 100 kHz; $P_{L(HB)} < 32 \text{ dBm}$	-	-	-77	dBm
CG	conversion gain	$f_0 = 1785 \text{ MHz}$ for DCS1800; $f_0 = 1910 \text{ MHz}$ for PCS1900; $P_{L(HB)} = 0 \text{ dBm to } 32 \text{ dBm}$; $f_{SS1} = f_0 - 20 \text{ MHz}$; $P_{SS1} = -40 \text{ dBm}$; $CG = P_{L(CON)} - P_{SS1}$; see Figure 4	-	-	25	dB

Table 8: Dynamic characteristics DCS1800/PCS1900 transmit mode ...continued

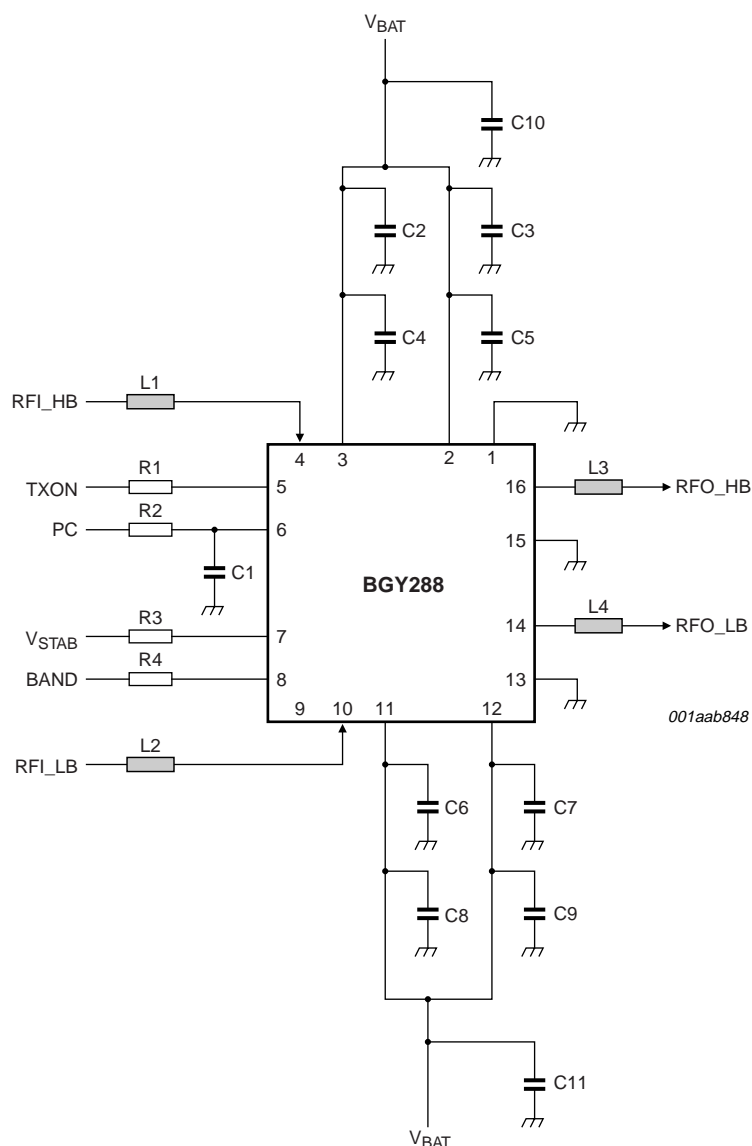
$Z_S = Z_L = 50 \Omega$; $V_{BAT} = 3.6 \text{ V}$; $V_{STAB} = 2.8 \text{ V}$; $T_{mb} = 25^\circ\text{C}$; $\delta = 1 : 8$ to $4 : 8$; $t_p = 575 \mu\text{s}$ to $2300 \mu\text{s}$; $P_{D(HB)} = 0 \text{ dBm}$; spurious signals on $P_{D(HB)} < -50 \text{ dBm}$; HB TX mode selected;
 $f = 1710 \text{ MHz}$ to 1785 MHz for DCS1800; $f = 1850 \text{ MHz}$ to 1910 MHz for PCS1900; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SSG	small signal gain	$f_0 = 1785 \text{ MHz}$ for DCS1800; $f_0 = 1910 \text{ MHz}$ for PCS1900; $P_{L(HB)} = 0 \text{ dBm}$ to 32 dBm ; $f_{SS2} = f_0 + 20 \text{ MHz}$; $P_{SS2} = -40 \text{ dBm}$; $SSG = P_{L(SS2)} - P_{SS2}$; see Figure 4	-	-	33	dB
AM/AM	AM/AM conversion	$P_{L(HB)} = 0 \text{ dBm}$ to 32 dBm ; 6.5 % AM modulation with				
		$f_{mod} = 67 \text{ kHz}$ at RFI_HB	-	5	8	%
		$f_{mod} = 140 \text{ kHz}$ at RFI_HB	-	8	13	%
		$f_{mod} = 271 \text{ kHz}$ at RFI_HB	-	14	20	%
AM/PM	AM/PM conversion	$P_{D(HB)} = -0.5 \text{ dBm}$ to $+0.5 \text{ dBm}$; $P_{L(HB)} = 0 \text{ dBm}$ to 32 dBm	-	2	4	deg/dB
	maximum control slope	$P_{L(HB)} = 0 \text{ dBm}$ to 32 dBm	-	-	200	dB/V
t_r, t_f	carrier rise and fall time	$P_{L(HB)}$ from 0 dBm to 32 dBm and from 32 dBm to 0 dBm	-	-	2	μs
f_{CL}	control loop bandwidth		-	200	-	kHz
	stability	$P_{L(HB)} \leq 32 \text{ dBm}$; $VSWR \leq 7 : 1$ through all phases; $V_{BAT} = 3.2 \text{ V}$ to 4.6 V	-	-	-36	dBm
	ruggedness	$V_{BAT} = 3.2 \text{ V}$ to 4.6 V ; $P_{L(HB)} \leq 32 \text{ dBm}$; $\delta = 4 : 8$; $VSWR \leq 8 : 1$ through all phases	no degradation			

- [1] Condition to set V_{PC} : $V_{BAT} = 3.6 \text{ V}$; $\delta = 2 : 8$; $P_{D(HB)} = 0 \text{ dBm}$; $T_{mb} = 25^\circ\text{C}$; $f = 1747.6 \text{ MHz}$ for DCS1800; $f = 1880 \text{ MHz}$ for PCS1900.
- [2] Conditions for power variation: $P_{D(HB)} = -2 \text{ dBm}$ to $+2 \text{ dBm}$; $f = 1710 \text{ MHz}$ to 1785 MHz for DCS1800;
 $f = 1850 \text{ MHz}$ to 1910 MHz for PCS1900; $T_{mb} = 15^\circ\text{C}$ to 70°C ; $V_{BAT} = 3.2 \text{ V}$ to 4.2 V ; $V_{STAB} = 2.8 \text{ V} \pm 20 \text{ mV}$.
- [3] Conditions for power variation: $P_{D(HB)} = -2 \text{ dBm}$ to $+2 \text{ dBm}$; $f = 1710 \text{ MHz}$ to 1785 MHz for DCS1800;
 $f = 1850 \text{ MHz}$ to 1910 MHz for PCS1900; $T_{mb} = -20^\circ\text{C}$ to $+90^\circ\text{C}$; $V_{BAT} = 3.2 \text{ V}$ to 4.2 V ; $V_{STAB} = 2.8 \text{ V} \pm 20 \text{ mV}$.
- [4] Conditions for power variation: $P_{D(HB)} = 0 \text{ dBm}$; $f = 1710 \text{ MHz}$ to 1785 MHz for DCS1800; $f = 1850 \text{ MHz}$ to 1910 MHz for PCS1900;
 $T_{mb} = 25^\circ\text{C}$; $V_{BAT} = 3.6 \text{ V}$; $V_{STAB} = 2.8 \text{ V} \pm 20 \text{ mV}$.



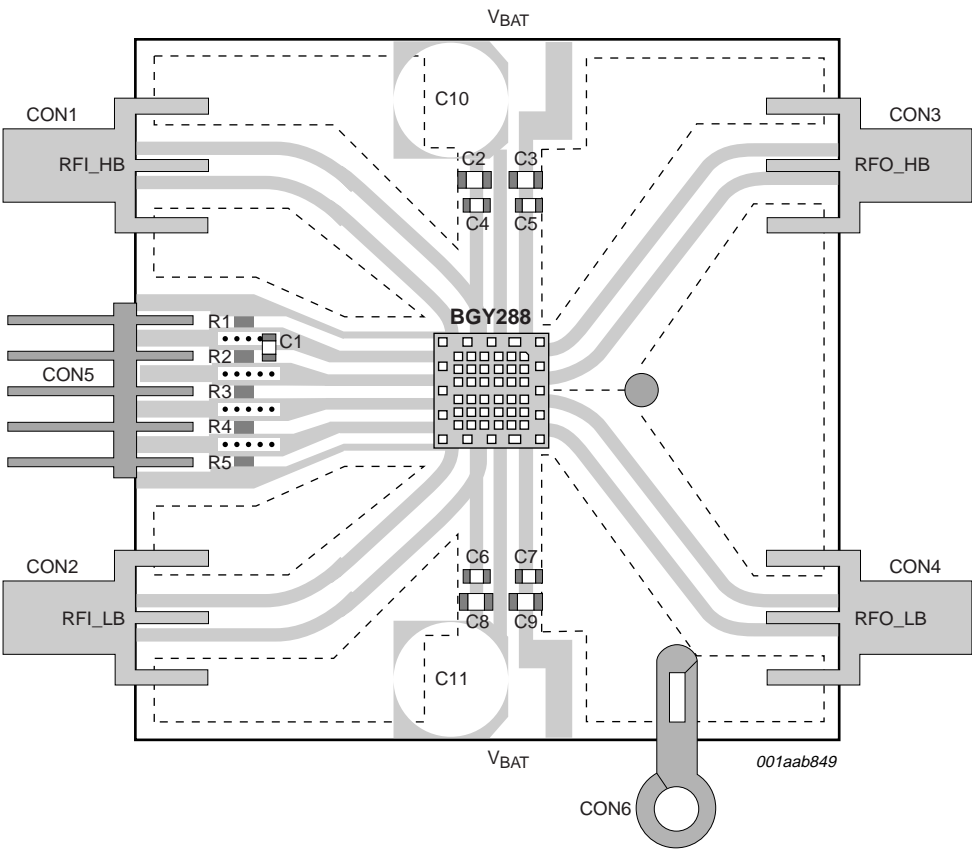
10. Application information



Drive signals must not be applied to pin 9.

Components listed in [Table 9](#).

Fig 5. Test circuit



Components listed in [Table 9](#).

Fig 6. Printed-circuit board test circuit

Table 9: List of components

Component	Description	Value	Dimensions	Supplier
PCB	printed-circuit board	PB005H1		Roland Haefele
CON1, CON2, CON3, CON4	jack assembly end launch SMA connector	142-0701-881		Johnson Components
CON5	DC connector 5 pin			
CON6	solder ring			
C1	SMD capacitor	2.7 nF	0603 size	
C2, C3, C8, C9	SMD capacitor	100 nF	0805 size	
C4, C5	SMD capacitor	10 pF	0603 size	
C6, C7	SMD capacitor	33 pF	0603 size	
C10, C11	electrolytic capacitor ^[1]	47 µF; 35 V		Matsushita
R1, R3, R4, R5	SMD resistor	0 Ω	0605 size	
R2	SMD resistor	1 kΩ; 0.1 W	0603 size	
L1, L2, L3, L4	stripline ^[2]	Z ₀ = 50 Ω	width 1.4 mm	

[1] C10 and C11 smooth the DC supply voltage (V_{BAT}).
[2] The striplines are on a double etched printed-circuit board (ε_r = 4.6); thickness 0.8 mm.



11. Package outline

Leadless surface mounted package; plastic cap; 16 terminations

SOT775A

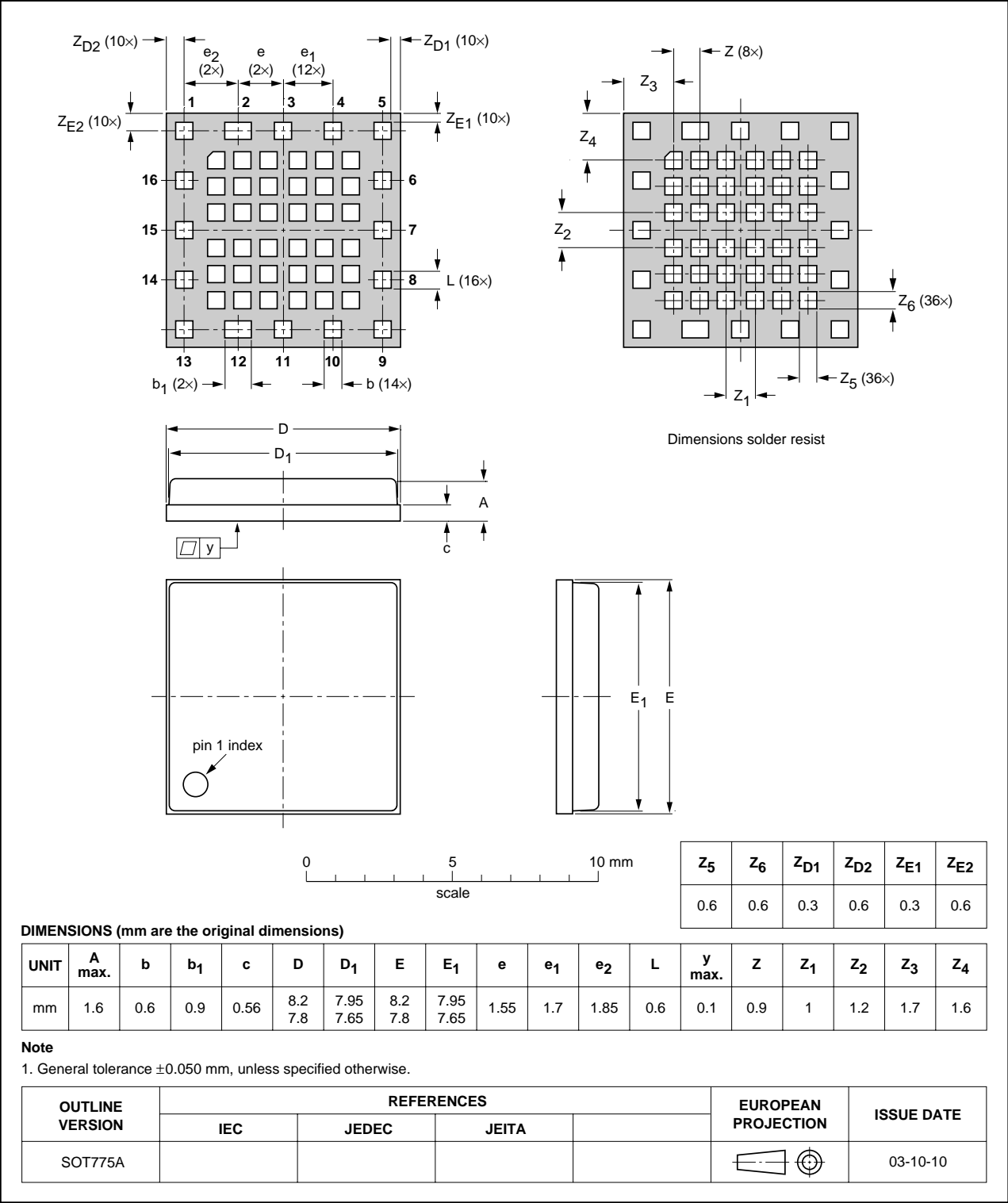


Fig 7. Package outline SOT775A

12. Soldering Recommendations

12.1 Reflow profile

The BGY288 is a laminate-based power amplifier module in a Leadless Grid Array (LGA) package. The module can be assembled using a standard Surface Mount Technology (SMT) reflow process in a convection or IR-oven. The minimum and maximum limits of the temperature profile are shown in [Figure 8](#). The actual profile has to be within these limits, and will depend on the printed-circuit board material, the number and size of the components to be assembled, and the type of solder which is being used.

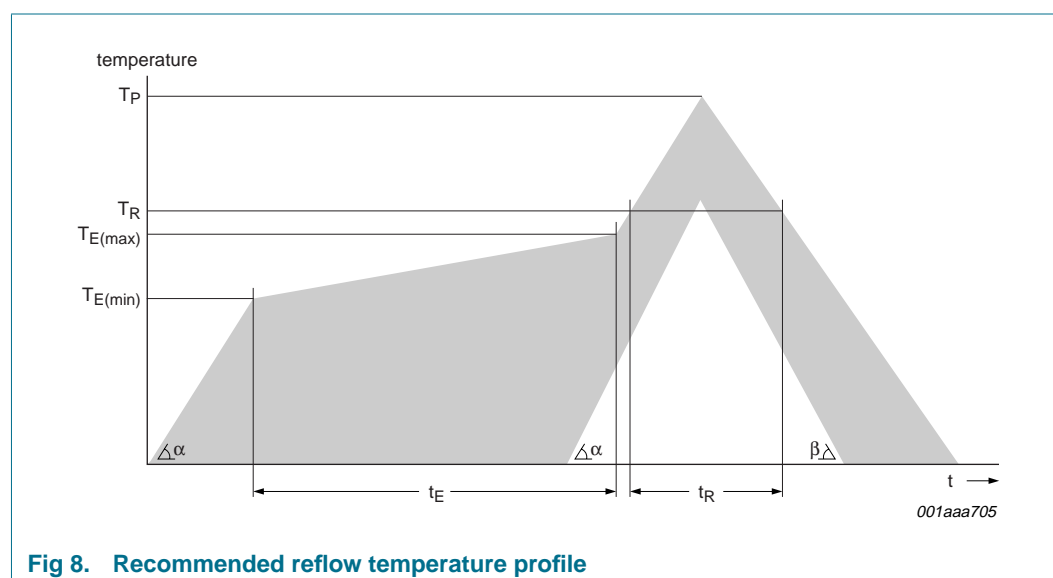


Fig 8. Recommended reflow temperature profile

It is recommended to use a standard no-clean solder paste like SnPb for profiles having leads containing solder, or SnAgCu for lead-free assembly processes. The parameters and corresponding values for SnPb and SnAgCu solder are given in [Table 10](#).

Table 10: Reflow soldering parameters

Symbol	parameter	SnPb Solder	SnAgCu solder	Unit
α	temperature gradient	≤ 3	≤ 3	$^{\circ}\text{C/s}$
T_E	pre-heat (soak) temperature	100 to 150	150 to 200	$^{\circ}\text{C}$
t_E	pre-heat time	60 to 120	60 to 180	s
T_R	reflow temperature	> 183	> 217	$^{\circ}\text{C}$
t_R	reflow time	60 to 150	60 to 150	s
T_P	maximum peak temperature	240	260	$^{\circ}\text{C}$
β	temperature gradient	< 5	< 5	$^{\circ}\text{C/s}$
	time 25 $^{\circ}\text{C}$ to peak temperature	6 minutes max.	8 minutes max.	

12.2 Printed-circuit board layout

The printed-circuit board footprint layout is a copy of the metal pattern on the underside of the LGA package. It is recommended that the printed-circuit board is designed with a large ground plane, and that the solder lands of the ground plane solder mask are defined as shown in [Figure 9](#).

12.3 Stencil design

The recommended dimensions of the solder stencil are given in [Figure 9](#) and are based on a stencil thickness of 125 µm. Using a thinner or thicker stencil will require the stencil aperture dimensions to be adjusted.

12.4 Rework

If rework is required, it is recommended that a BGA rework station with a programmable top and bottom heater is used. The first step of the rework process is to pre-heat the printed-circuit board with the bottom heater of the rework station. When the board has reached the pre-heat temperature, the top heater can be used to increase the temperature above the melting point of the solder. The component which has to be replaced can be picked up with a vacuum nozzle. Before placing a new component the remaining solder on the board must be removed. Fresh solder can be dispensed, a new component placed, and the board heated as described previously.

12.5 Moisture sensitivity level

The BGY288 is tested according to the JEDEC standard JESD 22-A113C. The BGY288 is classified on MSL3 for a lead soldering profile with a peak temperature of 240 °C, and on MSL4 for a lead-free soldering profile with a peak temperature of 260 °C.

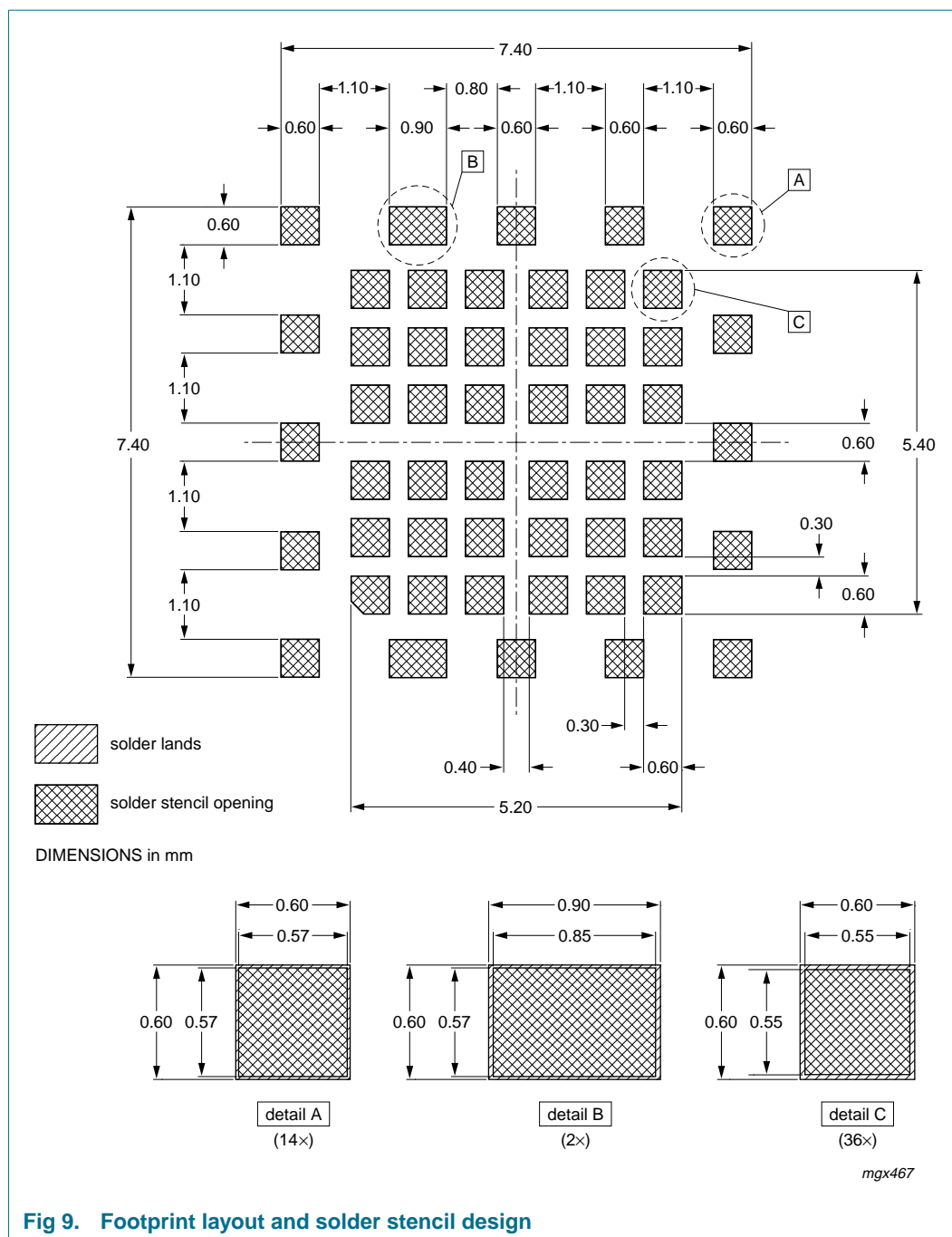


Fig 9. Footprint layout and solder stencil design



13. Revision history

Table 11: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
BGY288_1	20050202	Preliminary data sheet	-	9397 750 14011	-

14. Data sheet status

Level	Data sheet status ^[1]	Product status ^{[2] [3]}	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

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

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

15. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

Application information — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such application.

Right to make changes — Philips Semiconductors reserves the right to make changes in the products - including circuits, standard cells, and/or software - described or contained herein in order to improve design and/or performance. When the product is in full production (status 'Production'), relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN). Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified.

ICs with GSM or 3G functionality — Purchase of a Philips IC with GSM functionality does not convey an implied license under any patent right on the GSM or 3G Standard. A license for the Philips portfolio of GSM and 3G patents needs to be obtained via Philips Intellectual Property & Standards (www.ip.philips.com), e-mail: info.licensing@philips.com.

16. Disclaimers

Life support — These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips Semiconductors

17. Contact information

For additional information, please visit: <http://www.semiconductors.philips.com>

For sales office addresses, send an email to: sales.addresses@www.semiconductors.philips.com

18. Contents

1	Product profile	1
1.1	General description	1
1.2	Features	1
1.2.1	General features	1
1.2.2	RF performance	1
1.3	Applications	1
2	Pinning information	2
2.1	Pinning	2
2.2	Pin description	2
3	Ordering information	3
4	Block diagram	3
5	Functional description	4
5.1	Operating conditions	4
5.2	Power amplifier	4
5.3	Control logic	4
5.4	Power controller	4
5.5	Mode control	4
6	Timing	5
6.1	Ramp-up	6
6.2	Ramp-down	6
7	Limiting values	7
8	Static characteristics	7
9	Dynamic characteristics	8
10	Application information	14
11	Package outline	16
12	Soldering Recommendations	17
12.1	Reflow profile	17
12.2	Printed-circuit board layout	17
12.3	Stencil design	18
12.4	Rework	18
12.5	Moisture sensitivity level	18
13	Revision history	20
14	Data sheet status	21
15	Definitions	21
16	Disclaimers	21
17	Contact information	21



© Koninklijke Philips Electronics N.V. 2005

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner. The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Date of release: 2 February 2005
Document number: 9397 750 14011

Published in The Netherlands