DATA SHEET

UAA2073M
Image rejecting front-end for GSM applications

Product specification
Supersedes data of July 1995
File under Integrated Circuits, IC03

1995 Dec 07

Philips Semiconductors

PHILIPS

FEATURES

- Low-noise, wide dynamic range amplifier
- Very low noise figure
- Dual balanced mixer for at least 30 dB; on-chip image rejection
- IF I/Q combination network for 50 to 100 MHz
- Down-conversion mixer for closed-loop transmitters
- Independent TX/RX fast **on/off** power-down modes
- Very small outline packaging
- Very small application (no image filter).

APPLICATIONS

- 900 MHz front-end for GSM hand-portable equipment
- Compact digital mobile communication equipment
- TDMA receivers.

GENERAL DESCRIPTION

UAA2073M contains both a receiver front-end and a high frequency transmit mixer intended for GSM (Global System for Mobile communications) cellular telephones. Designed in an advanced BiCMOS process it combines high performance with low power consumption and a high degree of integration, thus reducing external component costs and total front-end size.

The main advantage of the UAA2073M is its ability to provide over 30 dB of image rejection. Consequently, the image filter between the LNA and the mixer is suppressed and the duplexer design is eased, compared with a conventional front-end design.

Image rejection is achieved in the internal architecture by two RF mixers in quadrature and two all-pass filters in I and Q IF channels that phase shift the IF by 45° and 135° respectively. The two phase shifted IFs are recombined and buffered to furnish the IF output signal.

For instance, signals presented at the RF input at LO + IF frequency are rejected through this signal processing while signals at LO – IF frequency can form the IF signal. An internal switch allows to reject the upper or lower image frequency. Image rejection is at an optimum when the IF is 71 MHz and local oscillator is above the wanted signal.

The receiver section consists of a low-noise amplifier that drives a quadrature mixer pair. The IF amplifier has on-chip 45° and 135° phase shifting and a combining network for image rejection.The IF driver has differential open-collector type outputs.

The LO part consists of an internal all-pass type phase shifter to provide quadrature LO signals to the receive mixers. The all-pass filters outputs are buffered before been fed to the receive mixers.

The transmit section consists of a down-conversion mixer and a transmit IF driver stage. In the transmit mode an internal LO buffer is used to drive the transmit IF down-conversion mixer.

All RF and IF inputs or outputs are balanced to reduce EMC issues.

Fast power-up switching is possible. A synthesizer-on (synthon) mode enables LO buffers independent of the other circuits. When SYNTHON pin is HIGH, all internal buffers on the LO path of the circuit are turned **on**, thus minimizing LO pulling when remainder of receive chain is powered-up.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
UAA2073M	SSOP20	plastic shrink small outline package; 20 leads; body width 4.4 mm	SOT266-1

QUICK REFERENCE DATA

Note 1.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	supply voltage	3.6	3.75	5.3	V
$I_{CC(RX)}$	receive supply current	21	26	32	mA
$I_{CC(TX)}$	transmit supply current	9	12	15	mA
NF	noise figure on demonstration board (including matching and PCB losses)	–	3.25	4.3	dB
G_{CP}	conversion power gain	20	23	26	dB
IR	image frequency rejection	30	37	–	dB
T_{amb}	operating ambient temperature	–30	+25	+85	°C

Note

1. For conditions see Chapters “DC characteristics” and “AC characteristics”.

BLOCK DIAGRAM

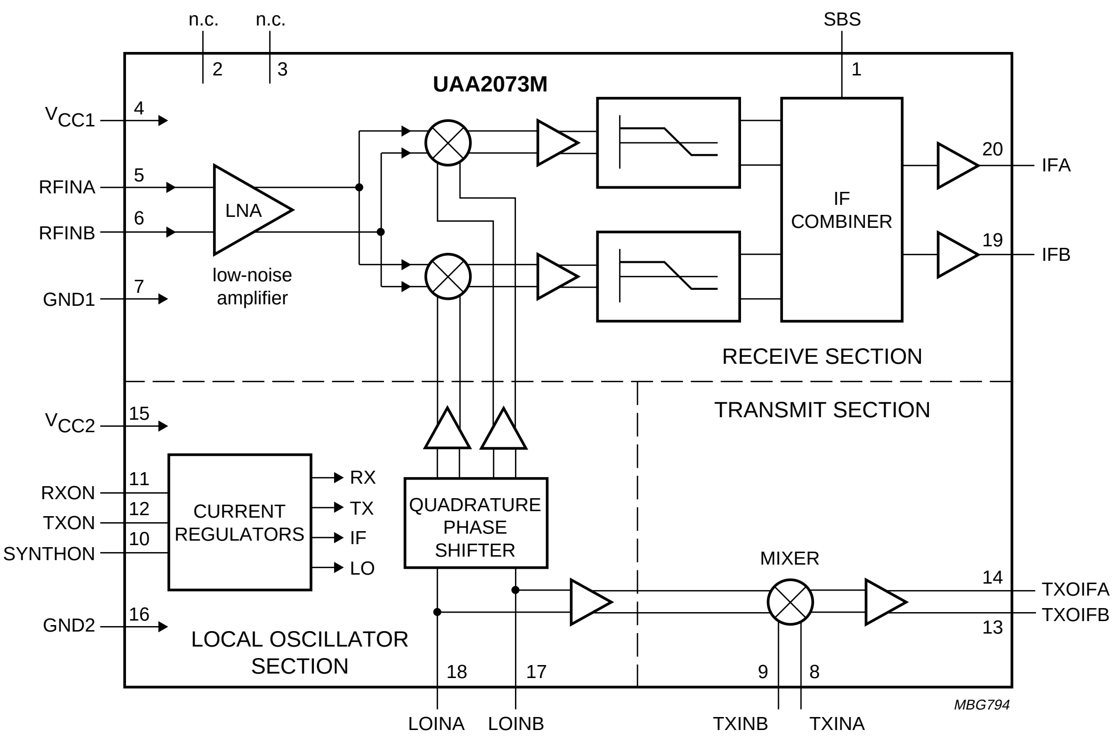


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
SBS	1	sideband selection
n.c.	2	not connected
n.c.	3	not connected
V_{CC1}	4	supply voltage for receive and transmit sections
RFINA	5	RF input A (balanced)
RFINB	6	RF input B (balanced)
GND1	7	ground 1 for receive and transmit sections
TXINA	8	transmit mixer input A (balanced)
TXINB	9	transmit mixer input B (balanced)
SYNTHON	10	hardware power-on of LO section (including buffers to RX and TX)
RXON	11	hardware power-on for receive section and LO buffers to RX
TXON	12	hardware power-on for transmit section and LO buffers to TX
TXOIFB	13	transmit mixer IF output B (balanced)
TXOIFA	14	transmit mixer IF output A (balanced)
V_{CC2}	15	supply voltage for LO section
GND2	16	ground 2 for LO section
LOINB	17	LO input B (balanced)
LOINA	18	LO input A (balanced)
IFB	19	IF output B (balanced)
IFA	20	IF output A (balanced)

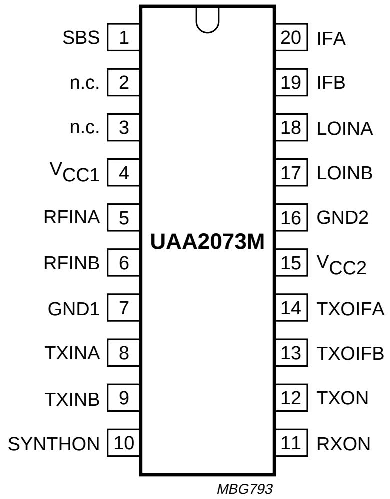


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

Receive section

The circuit contains a low-noise amplifier followed by two high dynamic range mixers. These mixers are of the Gilbert-cell type. The whole internal architecture is fully differential.

The local oscillator, shifted in phase to 45° and 135°, mixes the amplified RF to create I and Q channels. The two I and Q channels are buffered, phase shifted by 45° and 135° respectively, amplified and recombined internally to realize the image rejection.

Pin SBS allows sideband selection:

- $f_{LO} < f_{RF}$ (SBS = 1)
- $f_{LO} > f_{RF}$ (SBS = 0).

Balanced signal interfaces are used for minimizing crosstalk due to package parasitics. The RF differential input impedance is 150 Ω (parallel real part), choosen to minimize current consumption at best noise performance.

The IF output is differential and of the open-collector type, tuned for 71 MHz. Typical application will load the output with a differential 500 Ω load; i.e. a 500 Ω resistor load at each IF output, plus a 1 kΩ to x Ω narrow band matching network (x Ω being the input impedance of the IF filter). The path to V_{CC} for the DC current is achieved via tuning inductors. The output voltage is limited to $V_{CC} + 3V_{be}$ or 3 diode forward voltage drops.

Fast switching, **on/off**, of the receive section is controlled by the hardware input RXON.

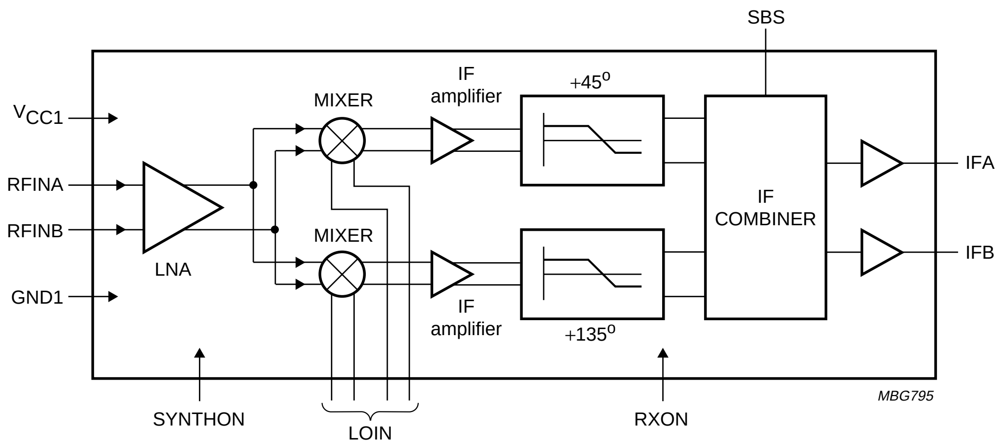


Fig.3 Block diagram, receive section.

Local oscillator section

The local oscillator (LO) input directly drives the two internal all-pass networks to provide quadrature LO to the receive mixers.

The LO differential input impedance is 50 Ω (parallel real part).

A synthesizer-on (synthon) mode is used to power-up the buffering on the LO inputs, minimizing the pulling effect on the external VCO when entering transmit or receive modes.

This mode is active when the SYNTHON input is HIGH. Table 1 shows status of circuit in accordance with TXON, RXON and SYNTHON inputs.

Transmit mixer

This mixer is used for down-conversion to the transmit IF. Its inputs are coupled to the transmit RF and down-convert it to a modulated transmit IF frequency which is phase locked with the baseband modulation.

The transmit mixer provides a differential input at 200 Ω and a differential output driver buffer for a 1 kΩ load. The IF outputs are low impedance (emitter followers).

Fast switching, **on/off**, of the transmit section is controlled by the hardware input TXON.

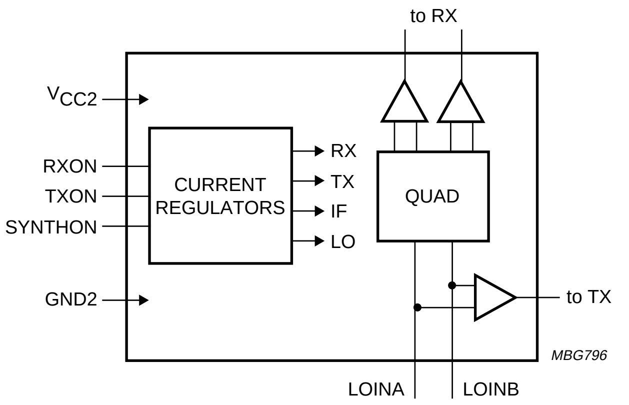


Fig.4 Block diagram, LO section.

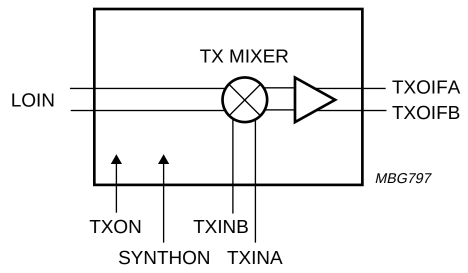


Fig.5 Block diagram, transmit mixer.

Table 1 Control of power status

EXTERNAL PIN LEVEL			CIRCUIT MODE OF OPERATION
TXON	RXON	SYNTHON	
LOW	LOW	LOW	power-down mode
LOW	HIGH	LOW	RX mode: receive section and LO buffers to RX **on**
HIGH	LOW	LOW	TX mode: transmit section and LO buffers to TX **on**
LOW	LOW	HIGH	synthon mode: complete LO section **on**
LOW	HIGH	HIGH	SRX mode: receive section **on** and synthon mode active
HIGH	LOW	HIGH	STX mode: transmit section **on** and synthon mode active
HIGH	HIGH	LOW	receive and transmit sections **on**; specification not guaranteed
HIGH	HIGH	HIGH	receive and transmit sections **on**; specification not guaranteed

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{CC}	supply voltage	–	9	V
ΔGND	difference in ground supply voltage applied between GND1 and GND2	–	0.6	V
$P_{I(max)}$	maximum power input	–	+20	dBm
$P_{dis(max)}$	maximum power dissipation in quiet air	–	250	mW
$T_{j(max)}$	maximum operating junction temperature	–	+150	°C
T_{stg}	storage temperature	–65	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air	120	K/W

HANDLING

Every pin withstands the ESD test in accordance with MIL-STD-883C class 2 (method 3015.5).

DC CHARACTERISTICS

V_{CC} = 3.75 V; T_{amb} = 25 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Pins V_{CC1} and V_{CC2}						
V_{CC}	supply voltage	over full temperature range	3.6	3.75	5.3	V
$I_{CC(RX)}$	supply current in RX mode		21	26	32	mA
$I_{CC(TX)}$	supply current in TX mode		9	12	15	mA
$I_{CC(SX)}$	supply current in synthon mode		4.4	5.6	6.6	mA
$I_{CC(SRX)}$	supply current in SRX mode		23	28	34	mA
$I_{CC(STX)}$	supply current in STX mode		12.5	15.0	19.5	mA
$I_{CC(PD)}$	supply current in power-down mode		–	0.01	50	µA
Pins SYNTHON, RXON, TXON and SBS						
V_{th}	CMOS threshold voltage	note 1	–	1.25	–	V
V_{IH}	HIGH level input voltage		$0.7V_{CC}$	–	V_{CC}	V
V_{IL}	LOW level input voltage		–0.3	–	0.8	V
I_{IH}	HIGH level static input current	pin at V_{CC} – 0.4 V	–1	–	+1	µA
I_{IL}	LOW level static input current	pin at 0.4 V	–1	–	+1	µA
Pins RFINA and RFINB						
$V_{I(RFIN)}$	DC input voltage level	receive section **on**	2.0	2.2	2.4	V
Pins IFA and IFB						
$I_{O(IF)}$	DC output current	receive section **on**	2.3	3.0	3.8	mA
Pins TXINA and TXINB						
$V_{I(TXIN)}$	DC input voltage level	transmit section **on**	2.1	2.4	2.6	V
Pins TXOIFA and TXOIFB						
$V_{O(TXOIF)}$	DC output voltage level	transmit section **on**	1.8	1.9	2.1	V
Pins LOINA and LOINB						
$V_{I(LOIN)}$	DC input voltage level	receive section **on**	2.3	2.5	2.8	V
		transmit section **on**	2.3	2.5	2.8	V

Note

1. The referenced inputs should be connected to a valid CMOS input level.

AC CHARACTERISTICS

V_{CC} = 3.75 V; T_{amb} = –30 to +85 °C; unless otherwise specified.

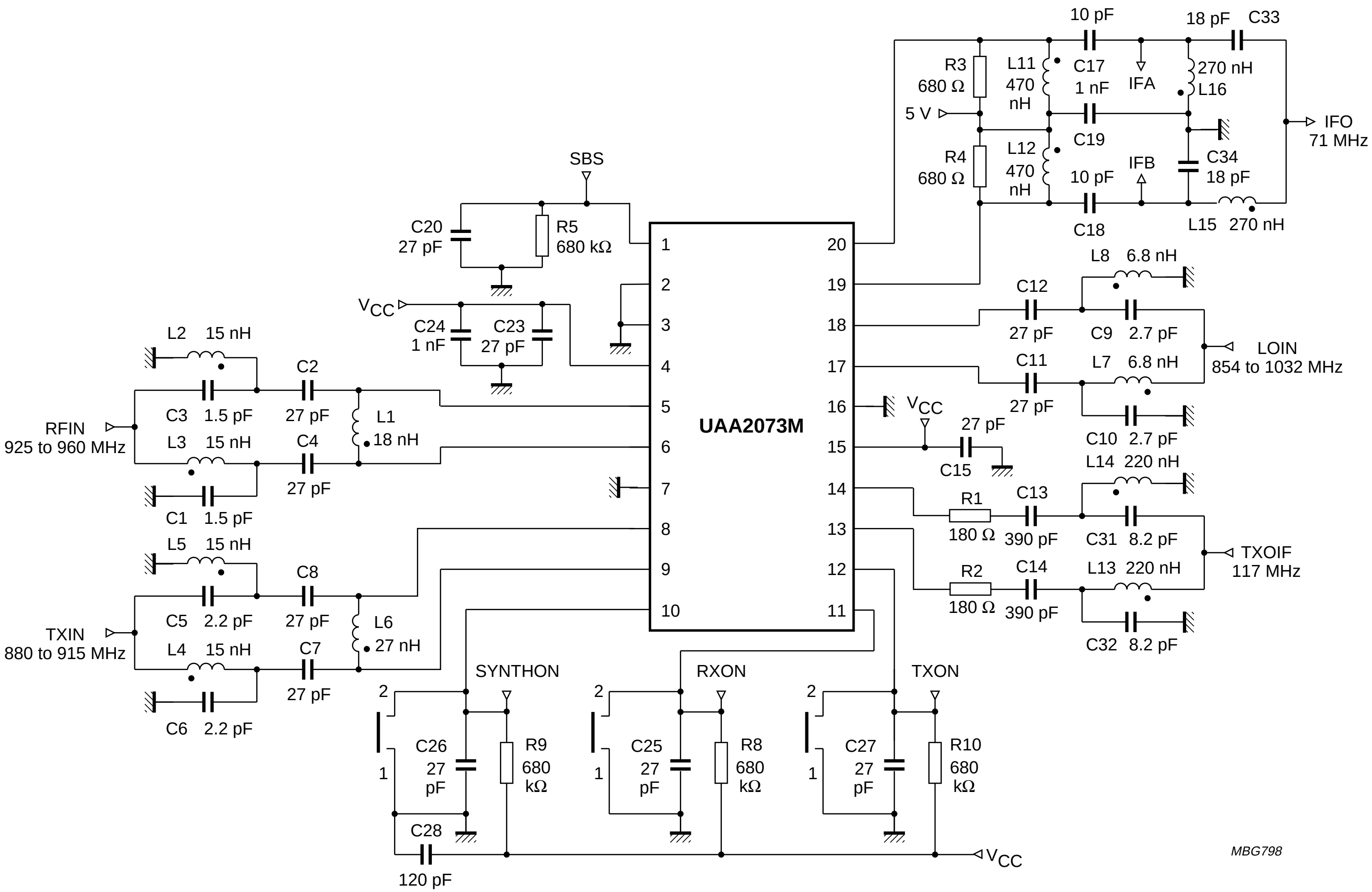
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Receive section (receive section on)						
Z_{RF}	RF input impedance (real part)	balanced parallel	–	150	–	Ω
f_{RF}	RF input frequency		925	–	960	MHz
RL_{RF}	return loss on matched RF input	note 1	15	20	–	dB
G_{CP}	conversion power gain	differential RF input to differential IF output matched to 1 kΩ differential	20	23	26	dB
G_{rip}	gain ripple as a function of RF frequency	note 2	–	0.2	0.5	dB
ΔG/T	gain variation with temperature	note 2	–20	–15	–10	mdB/K
DES1	1 dB desensitization input power	interferer frequency offset 3 MHz	–	–30	–	dBm
$CP1_{RX}$	1 dB input compression point	note 1	–24.5	–23.0	–	dBm
$IP2D_{RX}$	2nd order intercept point referenced to the RF differential input	differential output; note 2	+30	+40	–	dBm
$IP3_{RX}$	3rd order intercept point referenced to the RF input	note 2	–18	–15	–	dBm
NF_{RX}	overall noise figure	RF input to differential IF output; notes 2 and 3	–	3.25	4.30	dB
$R_{L(IF)}$	typical application IF output load resistor	between pin and V_{CC}	–	500	–	Ω
$C_{L(IF)}$	IF output load capacitance	unbalanced	–	–	2	pF
f_{IF}	IF frequency range	$f_{LO} > f_{RF}$	50	71	100	MHz
		$f_{LO} < f_{RF}$	50	71	100	MHz
IR	image frequency rejection		30	37	–	dB
Local oscillator section (RXON or TXON or SYNTHON = 1)						
f_{LO}	LO input frequency		850	–	1100	MHz
Z_{LO}	LO input impedance	balanced	–	50	–	Ω
ΔZ_{LO}	impedance change when switching from synthon mode to SRX or STX mode	mUnits measured on Smith chart; note 1	–	20	–	Ω
RL_{LO}	return loss on matched input (including power-down mode)	note 2	10	15	–	dB
$P_{i(LO)}$	LO input power level		–7	–4	0	dBm
RI_{LO}	reverse isolation	LOIN to RFIN at LO frequency; note 2	40	–	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Transmit section (transmit section on)						
$Z_{O(TX)}$	TX IF output impedance		–	–	200	Ω
$Z_{L(TX)}$	TX IF load impedance		–	1	–	kΩ
$C_{L(TX)}$	TX IF load capacitance		–	–	2	pF
$Z_{i(TX)}$	TX RF input impedance	balanced	–	200	–	Ω
$f_{i(TX)}$	TX input frequency		880	–	915	MHz
RL_{TX}	return loss on matched TX input	note 1	15	20	–	dB
G_{CP}	conversion power gain	from 200 Ω to 1 kΩ output; note 2	5	7.4	10	dB
$f_{o(TX)}$	TX output frequency		40	–	200	MHz
$CP1_{TX}$	1 dB input compression point	note 1	–22	–17.5	–	dBm
$IP2_{TX}$	2nd order intercept point		–	+20	–	dBm
$IP3_{TX}$	3rd order intercept point		–12	–9	–	dBm
NF_{TX}	noise figure	double sideband; notes 2 and 3	–	9.8	12	dB
RI_{TX}	reverse isolation	TXIN to LOIN; note 2	40	–	–	dB
I_{TX}	isolation	LOIN to TXIN; note 2	40	–	–	dB
Timing						
t_{start}	start-up time of each block		1	5	20	µs

Notes

1. Measured and guaranteed only on Philips UAA2073M demonstration board at T_{amb} = +25 °C.
2. Measured and guaranteed only on Philips UAA2073M demonstration board.
3. This value includes printed-circuit board and balun losses on Philips UAA2073M demonstration board over full temperature range.

APPLICATION INFORMATION



All matching is to 50 Ω for measurement purposes.
Different values will be used in a real application.

Fig.6 Philips demonstration board diagram for GSM applications.

Table 2 UAA2073M demonstration board parts list

PART	VALUE	SIZE	LOCATION
Resistors			
R1	180 Ω	0805	TXOIF
R2	180 Ω	0805	TXOIF
R3	680 Ω	0805	IFO
R4	680 Ω	0805	IFO
R5	680 kΩ	0805	SBS
R8	680 kΩ	0805	RXON
R9	680 kΩ	0805	SYNTHON
R10	680 kΩ	0805	TXON
Capacitors			
C1	1.5 pF	0805	RFIN
C2	27 pF	0805	RFIN
C3	1.5 pF	0805	RFIN
C4	27 pF	0805	RFIN
C5	2.2 pF	0805	TXIN
C6	2.2 pF	0805	TXIN
C7	27 pF	0805	TXIN
C8	27 pF	0805	TXIN
C9	2.7 pF	0805	LOIN
C10	2.7 pF	0805	LOIN
C11	27 pF	0805	LOIN
C12	27 pF	0805	LOIN
C13	390 pF	0805	TXOIF
C14	390 pF	0805	TXOIF
C15	27 pF	0805	V_{CCLO}
C17	10 pF	0805	IFO
C18	10 pF	0805	IFO
C19	1 nF	0805	IF/V_{CC}
C20	27 pF	0805	SBS
C23	27 pF	0805	V_{CCLNA}
C24	1 nF	0805	V_{CCLNA}
C25	27 pF	0805	RXON
C26	27 pF	0805	SYNTHON
C27	27 pF	0805	TXON
C28	120 pF	0805	V_{CC}
C31	8.2 pF	0805	TXOIF
C32	8.2 pF	0805	TXOIF
C33	18 pF	0805	IFO
C34	18 pF	0805	IFO

PART	VALUE	SIZE	LOCATION
Inductors			
L1	18 nH	0805	RFIN
L2	15 nH	0805	RFIN
L3	15 nH	0805	RFIN
L4	15 nH	0805	TXIN
L5	15 nH	0805	TXIN
L6	27 nH	0805	TXIN
L7	6.8 nH	0805	LOIN
L8	6.8 nH	0805	LOIN
L11	470 nH	1008	IFO
L12	470 nH	1008	IFO
L13	220 nH	0805	TXOIF
L14	220 nH	0805	TXOIF
L15	270 nH	1008	IFO
L16	270 nH	1008	IFO

Other components

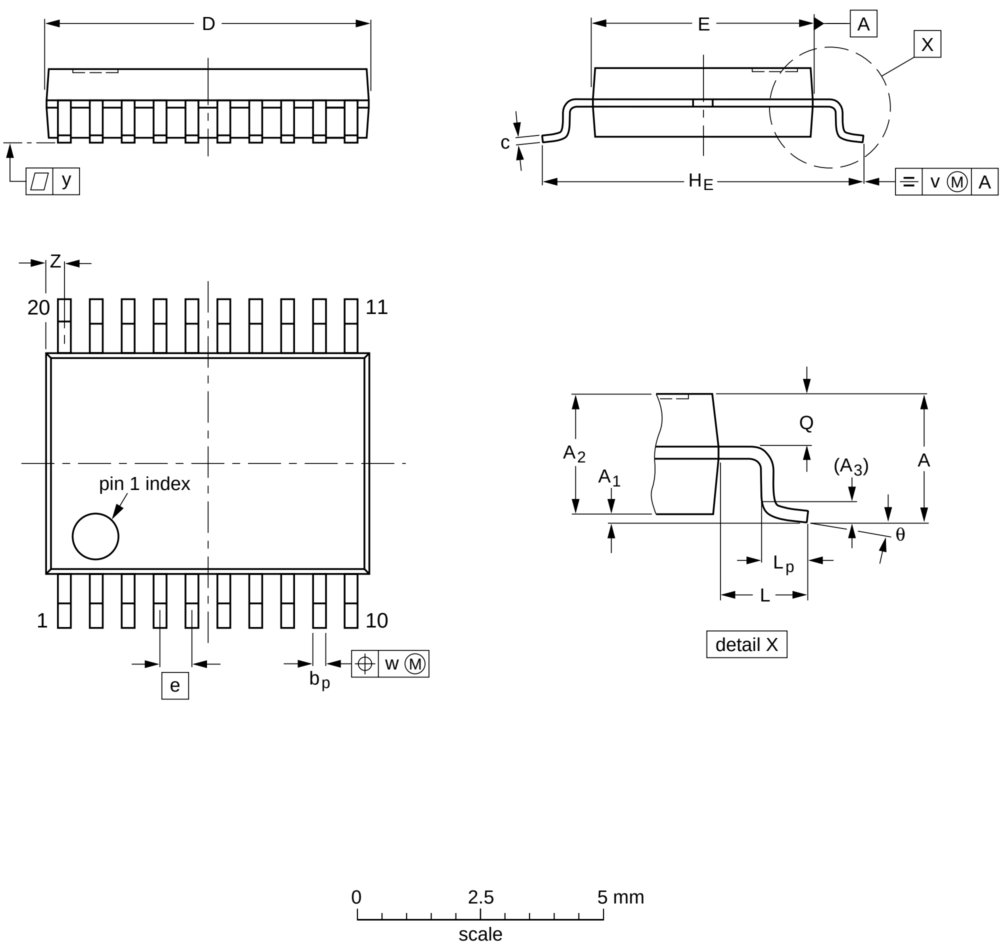
COMPONENT	DESCRIPTIONS
IC1	UAA2073M
SMA/RIM	sockets for RF and IF inputs/outputs
SMB	V_{CC} socket

Component manufacturers

All surface mounted resistors and capacitors are from Philips Components. The small value capacitors are multilayer ceramic with NPO dielectric. The inductors are from Coilcraft UK.

PACKAGE OUTLINE

SSOP20: plastic shrink small outline package; 20 leads; body width 4.4 mm **SOT266-1**

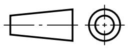


DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.5	0.15 0	1.4 1.2	0.25	0.32 0.20	0.20 0.13	6.6 6.4	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.45	0.65 0.45	0.2	0.13	0.1	0.48 0.18	10° 0°

Note

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES					EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ				
SOT266-1							~~90-04-05~~ 95-02-25

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

Reflow soldering

Reflow soldering techniques are suitable for all SSOP packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

Wave soldering

Wave soldering is **not** recommended for SSOP packages. This is because of the likelihood of solder bridging due to closely-spaced leads and the possibility of incomplete solder penetration in multi-lead devices.

If wave soldering cannot be avoided, the following conditions must be observed:

- **A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.**
- **The longitudinal axis of the package footprint must be parallel to the solder flow and must incorporate solder thieves at the downstream end.**

Even with these conditions, only consider wave soldering SSOP packages that have a body width of 4.4 mm, that is SSOP16 (SOT369-1) or SSOP20 (SOT266-1).

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). 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	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

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

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