TEF6621

Tuner on main-board IC

Rev. 01.04 — 7 August 2008 **Objective data sheet**

1. General description

The TEF6621 is an AM/FM radio including Phase-Locked Loop (PLL) tuning system. The system is designed in such a way, that it can be used as a world-wide tuner covering common FM and AM bands for radio reception. All functions are controlled by the I^{2}C-bus. Besides the basic feature set it provides a good weak signal processing function.

2. Features

- FM tuner for Japan, Europe and US reception
- AM tuner for Long Wave (LW) and Medium Wave (MW) reception
- Integrated AM Radio Frequency (RF) selectivity
- Integrated PLL tuning system; controlled via I^{2}C-bus
- Fully integrated Local Oscillator (LO)
- No alignment needed
- Very easy application on the main board
- No critical RF components
- Fully integrated Intermediate Frequency (IF) filters and FM stereo decoder
- Fully integrated FM noise blanker
- Field strength (LEVEL), multipath [Wideband AM (WAM)] and noise [UltraSonic Noise (USN)] dependent stereo blend
- Field strength (LEVEL), multipath (WAM) and noise (USN) dependent High-Cut Control (HCC)
- Field strength (LEVEL), multipath (WAM) and noise (USN) dependent soft mute
- Single power supply

founded by Philips

3. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage	on pins V_{CC1} and V_{CC2}	8	8.5	9	V
I_{CC}	supply current	into pins V_{CC1}, V_{CC2} and VREGSUP				
		FM	90	120	140	mA
		AM	100	134	150	mA
FM path						
f_{RF}	RF frequency	FM tuning range	76	-	108	MHz
$V_{i(sens)}$	input sensitivity voltage	(S+N)/N = 26 dB; including weak signal handling	-	5	-	dBμV
(S+N)/N	signal plus noise-to-noise ratio	$V_{i(RF)}$ = 1 mV; Δf = 22.5 kHz	55	60	-	dB
THD	total harmonic distortion	mono; Δf = 75 kHz; $V_{i(RF)}$ = 1 mV	-	0.4	0.8	%
α_{image}	image rejection	$f_{RF(image)} = f_{RF(wanted)} \pm 2 \times f_{IF}$	45	60	-	dB
α_{cs}	channel separation	$V_{i(RF)}$ = 1 mV; data byte Fh bits CHSEP[2:0] = 100	26	40	-	dB
AM path						
f_{RF}	RF frequency	AM (LW) tuning range	144	-	288	kHz
		AM (MW) tuning range	522	-	1710	kHz
$V_{i(sens)}$	input sensitivity voltage	S/N = 26 dB; data byte 3h bits DEMP[1:0] = 10				
		MW	-	34	-	dBμV
		LW	-	40	-	dBμV
(S+N)/N	signal plus noise-to-noise ratio	$V_{i(RF)}$ = 10 mV	50	56	-	dB
THD	total harmonic distortion	$V_{i(RF)}$ = 1 mV; m = 80 %	-	0.7	1	%
α_{image}	image rejection	$f_{RF(image)} = f_{RF(wanted)} \pm 2 \times f_{IF}$	40	55	-	dB

4. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
TEF6621T	SO32	plastic small outline package; 32 leads; body width 7.5 mm	SOT287-1

5. Block diagram

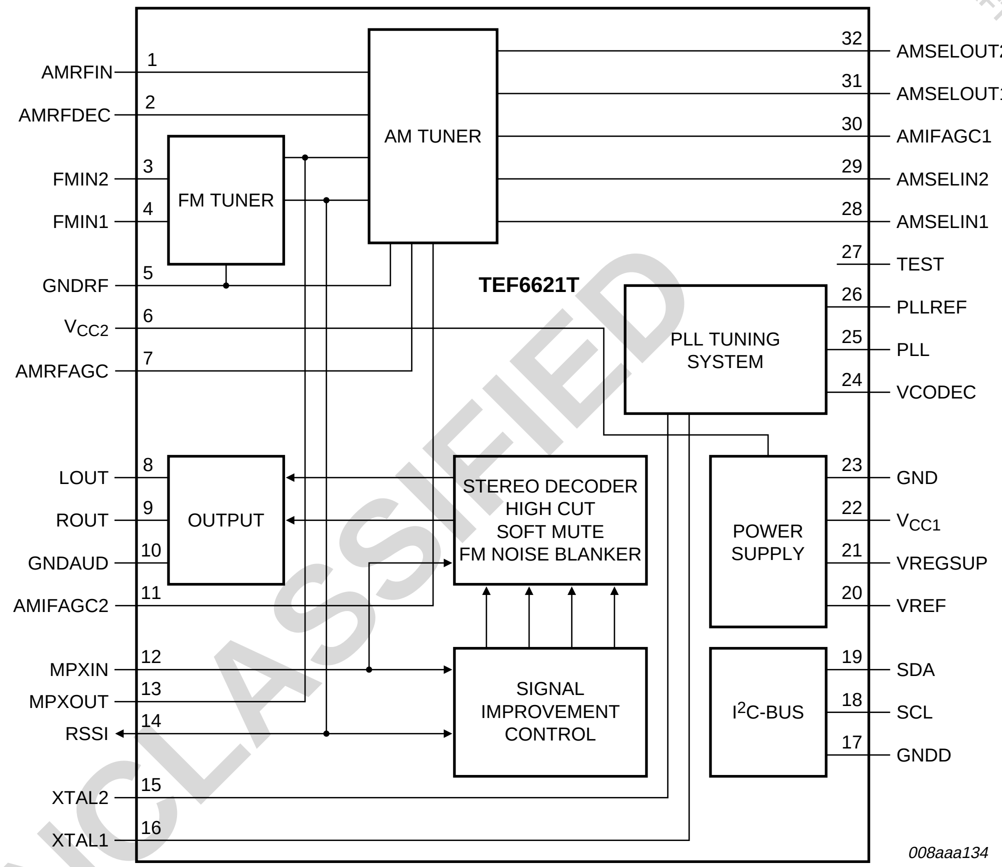


Fig 1. Block diagram of TEF6621T

6. Pinning information

6.1 Pinning

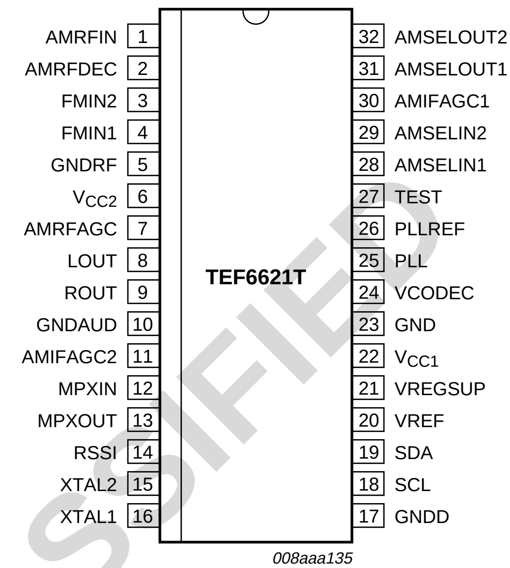


Fig 2. Pin configuration

6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
AMRFIN	1	AM RF single-ended input
AMRFDEC	2	AM RF decoupling
FMIN2	3	FM RF differential input 2
FMIN1	4	FM RF differential input 1
GNDRF	5	RF ground
V_{CC2}	6	supply voltage 2
AMRFAGC	7	AM RF Automatic Gain Control (AGC)
LOUT	8	audio left output
ROUT	9	audio right output
GNDAUD	10	audio ground
AMIFAGC2	11	AM IF AGC 2
MPXIN	12	FM Multiplex (MPX) and AM audio input to stereo decoder
MPXOUT	13	FM MPX and AM audio output from tuner part
RSSI	14	Received Signal Strength Indication (RSSI)
XTAL2	15	4 MHz crystal oscillator pin 2
XTAL1	16	4 MHz crystal oscillator pin 1
GNDD	17	digital ground
SCL	18	I^2C-bus clock input

Table 3. Pin description *...continued*

Symbol	Pin	Description
SDA	19	I^2C-bus data input and output
VREF	20	reference voltage decoupling
VREGSUP	21	supply voltage internal voltage regulators
V_{CC1}	22	supply voltage 1
GND	23	ground
VCODEC	24	decoupling for Voltage-Controlled Oscillator (VCO) supply voltage
PLL	25	PLL tuning voltage
PLLREF	26	PLL reference voltage
TEST	27	test pin; leave open in normal operation
AMSELIN1	28	AM selectivity input 1
AMSELIN2	29	AM selectivity input 2
AMIFAGC1	30	AM IF AGC 1
AMSELOUT1	31	AM selectivity output 1
AMSELOUT2	32	AM selectivity output 2

7. Functional description

7.1 FM tuner

The RF input signal is mixed to a low IF with inherent image suppression. The IF signal is filtered and demodulated. The complete signal path is fully integrated.

7.2 AM tuner

The RF signal is filtered and mixed to a low IF with inherent image suppression. The IF signals are filtered and demodulated. The signal path is highly integrated.

7.3 PLL tuning system

The PLL tuning system includes a fully integrated VCO. To avoid problems with unwanted signals on image side, the receiver controls automatically high-side or low-side injection.

7.4 FM stereo decoder

The MPX signal from the FM tuner is translated by the stereo decoder into a left and right audio channel. Good channel separation is achieved without alignment.

7.5 Weak signal processing and noise blanker

The reception quality of the station received is measured by a combination of detectors: field strength (LEVEL), multipath (WAM) and noise (USN). The audio processing functions soft mute, HCC and stereo blend are controlled accordingly to maintain the best possible audio quality in case of poor signal conditions. Audio disturbances like e.g. ignition noise are suppressed by the noise blanker circuit, using USN detection on MPX and spike detection on the level signal.

9. Limiting values

Table 57. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage	on pins V_{CC1} and V_{CC2}		–0.3	+10	V
ΔV_{CCn}	voltage difference between any supply pins	between pins V_{CC1} and V_{CC2}		–0.3	+0.3	V
V_{SCL}	voltage on pin SCL			–0.3	+6	V
V_{SDA}	voltage on pin SDA			–0.3	+6	V
$V_{AMRFDEC}$	voltage on pin AMRFDEC			–0.3	+6	V
V_{AMRFIN}	voltage on pin AMRFIN			–0.3	+6	V
$V_{AMRFAGC}$	voltage on pin AMRFAGC			–0.3	+6	V
$V_{AMIFAGC2}$	voltage on pin AMIFAGC2			–0.3	+6	V
V_{RSSI}	RSSI voltage			–0.3	+6	V
V_{VCODEC}	voltage on pin VCODEC			–0.3	+6	V
V_{PLL}	voltage on pin PLL			–0.3	+6	V
V_{PLLREF}	voltage on pin PLLREF			–0.3	+6	V
V_{TEST}	voltage on pin TEST			–0.3	+6	V
$V_{AMIFAGC1}$	voltage on pin AMIFAGC1			–0.3	+6	V
V_{VREF}	voltage on pin VREF			–0.3	+6	V
V_n	voltage on any other pin			–0.3	$+V_{CC}$	V
T_{stg}	storage temperature			–40	+150	°C
T_{amb}	ambient temperature			–20	+85	°C
T_j	junction temperature			-	150	°C
V_{esd}	electrostatic discharge voltage	human body model	[1]	–2000	+2000	V
		machine model	[2]	–200	+200	V

[1] Class 2 according to JESD22-A114.

[2] Class B according to EIA/JESD22-A115.

10. Thermal characteristics

Table 58. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air; single layer board with a copper thickness of 35 µm; see Figure 28	[1]	48	K/W
Ψ_{j-top}	thermal characterization parameter from junction to top of package			4.5	K/W

[1] The thermal resistance depends strongly on the PCB design. An application different to Figure 28 must ensure that the thermal resistance is below 54 K/W to avoid violation of the maximum junction temperature; see Table 57.

11. Static characteristics

Table 59. Static characteristics

V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage	on pins V_{CC1} and V_{CC2}	8	8.5	9	V
I_{CC}	supply current	into pins V_{CC1}, V_{CC2} and VREGSUP				
		FM	90	120	140	mA
		AM	100	134	150	mA
$V_{VREGSUP}$	voltage on pin VREGSUP	T_{amb} = −20 °C to +85 °C	6.35	-	-	V
Power-on reset						
$V_{P(POR)}$	power-on reset supply voltage	reset at power-on	6.5	6.75	7.0	V
$V_{hys(POR)}$	power-on reset hysteresis voltage		-	0.2	-	V
t_{start}	start time	series resistance of crystal R_s = 150 Ω	-	10	100	ms
Logic pins SDA and SCL (voltage referenced to pin GNDD)						
V_{IH}	HIGH-level input voltage	[1]	1.58	-	5.5	V
V_{IL}	LOW-level input voltage	[1]	−0.5	-	+1.04	V

[1] SDA and SCL HIGH and LOW internal thresholds are specified according to an I²C-bus voltage of 2.5 V ± 10 % or 3.3 V ± 5 %. The I²C-bus interface tolerates also SDA and SCL signals from a 5 V I²C-bus, but does not fulfill the 5 V I²C-bus specification completely. The TEF6621 complies with the fast-mode I²C-bus protocol. The maximum I²C-bus communication speed is 400 kbit/s.

12. Dynamic characteristics

Table 60. Dynamic characteristics

V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.
FM condition: all RF voltages refer to an unterminated RMS voltage with a source impedance 75 Ω; f_{mod} = 1 kHz, Δf = 22.5 kHz, de-emphasis = 50 µs, f_{RF} = 97.1 MHz; unless otherwise specified.
AM condition: all RF voltages are RMS values measured at the input of a 15 pF/60 pF dummy aerial; f_{mod} = 400 Hz, m = 30 %, f_{RF} = 990 kHz; unless otherwise specified.
All values measured in a test circuit according to Figure 29; default settings; audio signals measured at LOUT and ROUT with IEC tuner filter (200 Hz to 15 kHz; IEC 60315-4); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Crystal oscillator; pins XTAL1 and XTAL2						
f_{xtal}	crystal frequency	fundamental frequency	-	4	-	MHz
$\Delta f_{xtal}/f_{xtal}$	relative crystal frequency variation	device inaccuracy	−45	-	+45	10^{-6}
C_i	input capacitance	input capacitance from pin XTAL1 and pin XTAL2 to ground	1	3	4	pF
R_i	input resistance		-	-	−750	Ω

Table 60. Dynamic characteristics *…continued*

V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.
FM condition: all RF voltages refer to an unterminated RMS voltage with a source impedance 75 Ω; f_{mod} = 1 kHz, Δf = 22.5 kHz, de-emphasis = 50 µs, f_{RF} = 97.1 MHz; unless otherwise specified.
AM condition: all RF voltages are RMS values measured at the input of a 15 pF/60 pF dummy aerial; f_{mod} = 400 Hz, m = 30 %, f_{RF} = 990 kHz; unless otherwise specified.
All values measured in a test circuit according to Figure 29; default settings; audio signals measured at LOUT and ROUT with IEC tuner filter (200 Hz to 15 kHz; IEC 60315-4); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Tuning system						
C/N_{LO}	LO carrier-to-noise ratio	f_{LO} = 100 MHz; Δf = 10 kHz	-	98	-	dBc/√Hz
t_{tune}	tuning time	FM (Europe/USA/Japan) f_{RF} = 87.5 MHz to 108 MHz	-	1.8	-	ms
		AM (MW) f_{RF} = 0.53 MHz to 1.7 MHz	-	9	-	ms
		AM (LW) f_{RF} = 0.144 MHz to 0.288 MHz	-	3.5	-	ms
f_{RF}	RF frequency	FM tuning range	76	-	108	MHz
		AM (LW) tuning range	144	-	288	kHz
		AM (MW) tuning range	522	-	1710	kHz
$f_{tune(step)}$	step of tuning frequency	FM (Europe/USA/Japan)	-	50	-	kHz
		AM (LW and MW)	-	1	-	kHz
FM path						
$V_{i(sens)}$	input sensitivity voltage	(S+N)/N = 26 dB; without weak signal handling	-	5.5	-	dBµV
		(S+N)/N = 26 dB; including weak signal handling	-	5	-	dBµV
		(S+N)/N = 46 dB; including weak signal handling	-	16	-	dBµV
NF	noise figure		-	6	9	dB
(S+N)/N	signal plus noise-to-noise ratio	$V_{i(RF)}$ = 1 mV; Δf = 22.5 kHz	55	60	-	dB
α_{ripple}	ripple rejection	V_{ripple} / V_{audio}; V_{ripple} = 100 mV; f_{ripple} = 100 Hz	34	44	-	dB
f_{IF}	IF frequency		-	150	-	kHz
α_{image}	image rejection	$f_{RF(image)} = f_{RF(wanted)} \pm 2 \times f_{IF}$	45	60	-	dB
IP3	third-order intercept point	$f_{RF(unw)1}$ = 97.5 MHz; $f_{RF(unw)2}$ = 97.9 MHz; $V_{i(RF)}$ = 80 dBµV	106	113	-	dBµV
S_{dyn}	dynamic selectivity	$V_{i(RF)}$ = 10 µV; $\Delta f_{RF(unw)}$ = 22.5 kHz; (S+N)/N = 26 dB; mono; f_{AF} = 1 kHz				
		Δf_{RF} = 100 kHz	-	3	-	dB
		Δf_{RF} = 200 kHz	-	55	-	dB
S_{stat}	static selectivity	maximum IF bandwidth				
		$f_{i(RF)}$ ± 100 kHz	10	14	25	dB
		$f_{i(RF)}$ ± 200 kHz	54	64	74	dB
		$f_{i(RF)}$ ± 300 kHz (excluding image)	65	75	90	dB
$\alpha_{sup(AM)}$	AM suppression	AM: f_{AF} = 1 kHz; m = 30 %				
		$V_{i(RF)}$ = 0.05 mV to 20 mV	45	55	-	dB
		$V_{i(RF)}$ = 20 mV to 500 mV	40	50	-	dB

Table 60. Dynamic characteristics *...continued*

V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.
FM condition: all RF voltages refer to an unterminated RMS voltage with a source impedance 75 Ω; f_{mod} = 1 kHz, Δf = 22.5 kHz, de-emphasis = 50 µs, f_{RF} = 97.1 MHz; unless otherwise specified.
AM condition: all RF voltages are RMS values measured at the input of a 15 pF/60 pF dummy aerial; f_{mod} = 400 Hz, m = 30 %, f_{RF} = 990 kHz; unless otherwise specified.
All values measured in a test circuit according to Figure 29; default settings; audio signals measured at LOUT and ROUT with IEC tuner filter (200 Hz to 15 kHz; IEC 60315-4); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
FM front-end; pins FMIN1 and FMIN2						
$R_{i(dif)}$	differential input resistance	f_{RF} = 97.1 MHz; maximum gain	200	300	400	Ω
$C_{i(dif)}$	differential input capacitance	f_{RF} = 97.1 MHz	-	4	7	pF
FM RF AGC						
$V_{start(AGC)}$	AGC start voltage	RF input voltage for first AGC step; $V_{i(RF)}$ value, at which the RF gain decreases by 6 dB with increasing $V_{i(RF)}$; data byte 2h				
		bits RFAGC[1:0] = 00	83	86	89	dBµV
		bits RFAGC[1:0] = 01	81	84	87	dBµV
		bits RFAGC[1:0] = 10	79	82	85	dBµV
		bits RFAGC[1:0] = 11	77	80	83	dBµV
$V_{i(RF)AGC(hys)}$	hysteresis of AGC RF input voltage	hysteresis of AGC start	1	-	5	dB
FM IF AGC						
$V_{i(RF)AGC}$	AGC RF input voltage	$V_{i(RF)}$ value, at which the IF gain decreases by 6 dB with increasing $V_{i(RF)}$; start of AGC; first step	71	76	81	dBµV
$V_{i(RF)AGC(hys)}$	hysteresis of AGC RF input voltage	hysteresis of AGC start	1	-	6	dB
FM RSSI; pin RSSI						
V_{RSSI}	RSSI voltage	$V_{i(RF)}$ = −20 dBµV	0.6	0.8	1.0	V
		$V_{i(RF)}$ = 20 dBµV	1.6	1.9	2.2	V
		$V_{i(RF)}$ = 40 dBµV	2.5	2.9	3.3	V
$\Delta V_{RSSI}/\Delta L_{i(RF)}$	RSSI voltage difference to RF input level difference ratio	between $V_{i(RF)}$ = 20 dBµV and $V_{i(RF)}$ = 40 dBµV	45	50	55	mV/dB
FM IF counter						
$f_{IFc(res)}$	IF counter frequency resolution		-	5	-	kHz
FM demodulator; pin MPXOUT						
R_o	output resistance		-	-	100	Ω
R_L	load resistance		5	-	-	kΩ
C_L	load capacitance		-	-	20	pF
Δf_{max}	maximum frequency deviation	THD = 3 %; $V_{i(RF)}$ = 10 mV	115	140	-	kHz
V_o	output voltage	Δf = 22.5 kHz; f_{AF} = 1 kHz	180	230	300	mV

Table 60. Dynamic characteristics *…continued*

V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.
FM condition: all RF voltages refer to an unterminated RMS voltage with a source impedance 75 Ω; f_{mod} = 1 kHz, Δf = 22.5 kHz, de-emphasis = 50 µs, f_{RF} = 97.1 MHz; unless otherwise specified.
AM condition: all RF voltages are RMS values measured at the input of a 15 pF/60 pF dummy aerial; f_{mod} = 400 Hz, m = 30 %, f_{RF} = 990 kHz; unless otherwise specified.
All values measured in a test circuit according to Figure 29; default settings; audio signals measured at LOUT and ROUT with IEC tuner filter (200 Hz to 15 kHz; IEC 60315-4); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Audio part; pin MPXIN						
R_i	input resistance	data byte 3h bit LOCUT = 0 (FM or AM)	-	220	-	kΩ
		data byte 3h bit LOCUT = 1 (AM)	-	16	-	kΩ
$\alpha_{bal(ch)}$	channel balance	balance between R and L channel	–1	-	+1	dB
$\alpha_{sup(pilot)}$	pilot suppression	9 % pilot; f_{pilot} = 19 kHz; referenced to 91 % FM modulation	30	40	-	dB
m_{pilot}	modulation degree of pilot tone	threshold for pilot detection				
		stereo on	2	3.9	5.8	%
		stereo off	1.2	3.1	5	%
$\alpha_{hys(pilot)}$	pilot hysteresis		0.7	0.8	1.6	%
$t_{det(pilot)}$	pilot detection time		-	30	100	ms
Audio output; pins LOUT and ROUT						
V_o	output voltage	Δf = 22.5 kHz; f_{AF} = 1 kHz				
		data byte 3h bit OUTA = 1	200	290	410	mV
		data byte 3h bit OUTA = 0	80	120	175	mV
α_{AF}	AF attenuation	mono; pre-emphasis = 50 µs; referenced to f_{AF} = 1 kHz				
		f_{AF} = 50 Hz	–0.6	–0.1	+0.4	dB
		f_{AF} = 15 kHz	–1.5	0	+1.5	dB
α_{cs}	channel separation	$V_{i(RF)}$ = 1 mV; data byte Fh bits CHSEP[2:0] = 100	26	40	-	dB
THD	total harmonic distortion	mono; Δf = 75 kHz; $V_{i(RF)}$ = 1 mV	-	0.4	0.8	%
		stereo; Δf = 67.5 kHz; L or R	-	-	1	%
R_L	load resistance		10	-	-	kΩ
C_L	load capacitance		-	-	20	pF
FM noise blanker						
(S+N)/N	signal plus noise-to-noise ratio	noise pulses at RF input signal t_p = 5 ns; t_r < 1 ns; t_f < 1 ns; f_p = 100 Hz; V_p = 500 mV; $V_{i(RF)}$ = 40 dBµV; quasi peak; audio filter according *"ITU-R BS.468-4"*	-	30	-	dB
AM path						
$V_{i(sens)}$	input sensitivity voltage	S/N = 26 dB; data byte 3h bits DEMP[1:0] = 10				
		MW	-	34	-	dBµV
		LW	-	40	-	dBµV
$V_{n(i)(eq)}$	equivalent input noise voltage	C_{source} = 100 pF	-	1	-	nV/√Hz

Table 60. Dynamic characteristics *...continued*

V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.
FM condition: all RF voltages refer to an unterminated RMS voltage with a source impedance 75 Ω; f_{mod} = 1 kHz, Δf = 22.5 kHz, de-emphasis = 50 µs, f_{RF} = 97.1 MHz; unless otherwise specified.
AM condition: all RF voltages are RMS values measured at the input of a 15 pF/60 pF dummy aerial; f_{mod} = 400 Hz, m = 30 %, f_{RF} = 990 kHz; unless otherwise specified.
All values measured in a test circuit according to Figure 29; default settings; audio signals measured at LOUT and ROUT with IEC tuner filter (200 Hz to 15 kHz; IEC 60315-4); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
(S+N)/N	signal plus noise-to-noise ratio	$V_{i(RF)}$ = 10 mV	50	56	-	dB
f_{IF}	IF frequency		-	25	-	kHz
α_{image}	image rejection	$f_{RF(image)} = f_{RF(wanted)} \pm 2 \times f_{IF}$	40	55	-	dB
$B_{fltr(IF)}$	IF filter bandwidth	–3 dB bandwidth	5	6.5	8	kHz
S_{stat}	static selectivity	f_{tune} ± 10 kHz	40	48	-	dB
		f_{tune} ± 20 kHz	65	78	-	dB
$V_{i(RF)(max)}$	maximum RF input voltage	THD = 10 %; m = 80 %; active antenna 50 Ω	120	135	-	dBµV
IP2	second-order intercept point		150	170	-	dBµV
IP3	third-order intercept point	Δf = 40 kHz	116	127	-	dBµV
AM LNA and AM RF AGC; input pins AMRFIN and AMRFDEC						
R_i	input resistance	f_{RF} = 990 kHz	-	20	-	Ω
C_i	input capacitance	AGC maximum gain [1][2]	-	530	-	pF
MW band with passive antenna (measured with dummy aerial 15 pF/60 pF)						
$V_{i(RF)AGC}$	AGC RF input voltage	switched LNA AGC: $V_{i(RF)}$ value, at which the LNA gain decreases with increasing $V_{i(RF)}$; m = 0 %; start of AGC; first step	110	113	116	dBµV
$V_{i(RF)AGC(hys)}$	hysteresis of AGC RF input voltage	hysteresis of AGC start	1	4	7	dB
MW band with active antenna (measured with dummy aerial 50 Ω)						
$V_{i(RF)AGC}$	AGC RF input voltage	switched LNA AGC: $V_{i(RF)}$ value, at which the LNA gain decreases with increasing $V_{i(RF)}$; m = 0 %; start of AGC; first step	78	81	84	dBµV
$V_{i(RF)AGC(hys)}$	hysteresis of AGC RF input voltage	hysteresis of AGC start	1	3	6	dB
LW band with passive antenna (measured with dummy aerial 15 pF/60 pF)						
$V_{i(RF)AGC}$	AGC RF input voltage	switched LNA AGC: $V_{i(RF)}$ value, at which the LNA gain decreases with increasing $V_{i(RF)}$; f_{RF} = 207 kHz; m = 0 %; start of AGC; first step	-	104	-	dBµV
$V_{i(RF)AGC(hys)}$	hysteresis of AGC RF input voltage	hysteresis of AGC start	1	4	7	dB

Table 60. Dynamic characteristics *...continued*

V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.
FM condition: all RF voltages refer to an unterminated RMS voltage with a source impedance 75 Ω; f_{mod} = 1 kHz, Δf = 22.5 kHz, de-emphasis = 50 µs, f_{RF} = 97.1 MHz; unless otherwise specified.
AM condition: all RF voltages are RMS values measured at the input of a 15 pF/60 pF dummy aerial; f_{mod} = 400 Hz, m = 30 %, f_{RF} = 990 kHz; unless otherwise specified.
All values measured in a test circuit according to Figure 29; default settings; audio signals measured at LOUT and ROUT with IEC tuner filter (200 Hz to 15 kHz; IEC 60315-4); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
LW band with active antenna (measured with dummy aerial 50 Ω)						
$V_{i(RF)AGC}$	AGC RF input voltage	switched LNA AGC: $V_{i(RF)}$ value, at which the LNA gain decreases with increasing $V_{i(RF)}$; f_{RF} = 207 kHz; m = 0 %; start of AGC; first step	-	80	-	dBµV
$V_{i(RF)AGC(hys)}$	hysteresis of AGC RF input voltage	hysteresis of AGC start	1	4	7	dB
Continuous AM RF AGC						
$V_{i(RF)AGC}$	AGC RF input voltage	linear RF AGC: $V_{i(RF)}$ at which AGC starts; m = 0 %				
		data byte 2h bits RFAGC[1:0] = 00	87	90	93	dBµV
		data byte 2h bits RFAGC[1:0] = 01	85	88	91	dBµV
		data byte 2h bits RFAGC[1:0] = 10	83	86	89	dBµV
		data byte 2h bits RFAGC[1:0] = 11	81	84	87	dBµV
t_s	settling time	$V_{i(RF)}$ = 10 mV to 600 mV	-	64	-	ms
		$V_{i(RF)}$ = 600 mV to 10 mV	-	3.2	-	s
$I_{source(AGC)}$	AGC source current	AGC attack; $V_{i(RF)M}$ = 105 dBµV (peak); normal mode	25	35	50	µA
		AGC attack; fast mode after tuning and AGC switching	0.7	1	1.4	mA
$I_{sink(AGC)}$	AGC sink current	AGC release; normal mode	0.7	1	1.4	µA
		AGC release; fast mode after tuning and AGC switching	17.5	25	35	µA
Continuous IF AGC 1						
$V_{i(RF)AGC}$	AGC RF input voltage	linear IF AGC 1: $V_{i(RF)}$ at which AGC starts; m = 0 %	59	62	65	dBµV
$I_{source(AGC)}$	AGC source current	AGC attack; $V_{i(RF)M}$ = 80 dBµV (peak); normal mode	35	50	70	µA
		AGC attack; fast mode after tuning and AGC switching	0.875	1.25	1.75	mA
$I_{sink(AGC)}$	AGC sink current	AGC release; normal mode	0.7	1	1.4	µA
		AGC release; fast mode after tuning and AGC switching	17.5	25	35	µA
Continuous IF AGC 2						
$V_{i(RF)AGC}$	AGC RF input voltage	linear IF AGC 2: $V_{i(RF)}$ at which AGC starts; m = 0 %	19	22	25	dBµV
$I_{source(AGC)}$	AGC source current	AGC attack; $V_{i(RF)M}$ = 50 dBµV (peak); normal mode	4	6	8	µA
		AGC attack; fast mode after tuning and AGC switching	100	150	200	µA

Table 60. Dynamic characteristics *...continued*

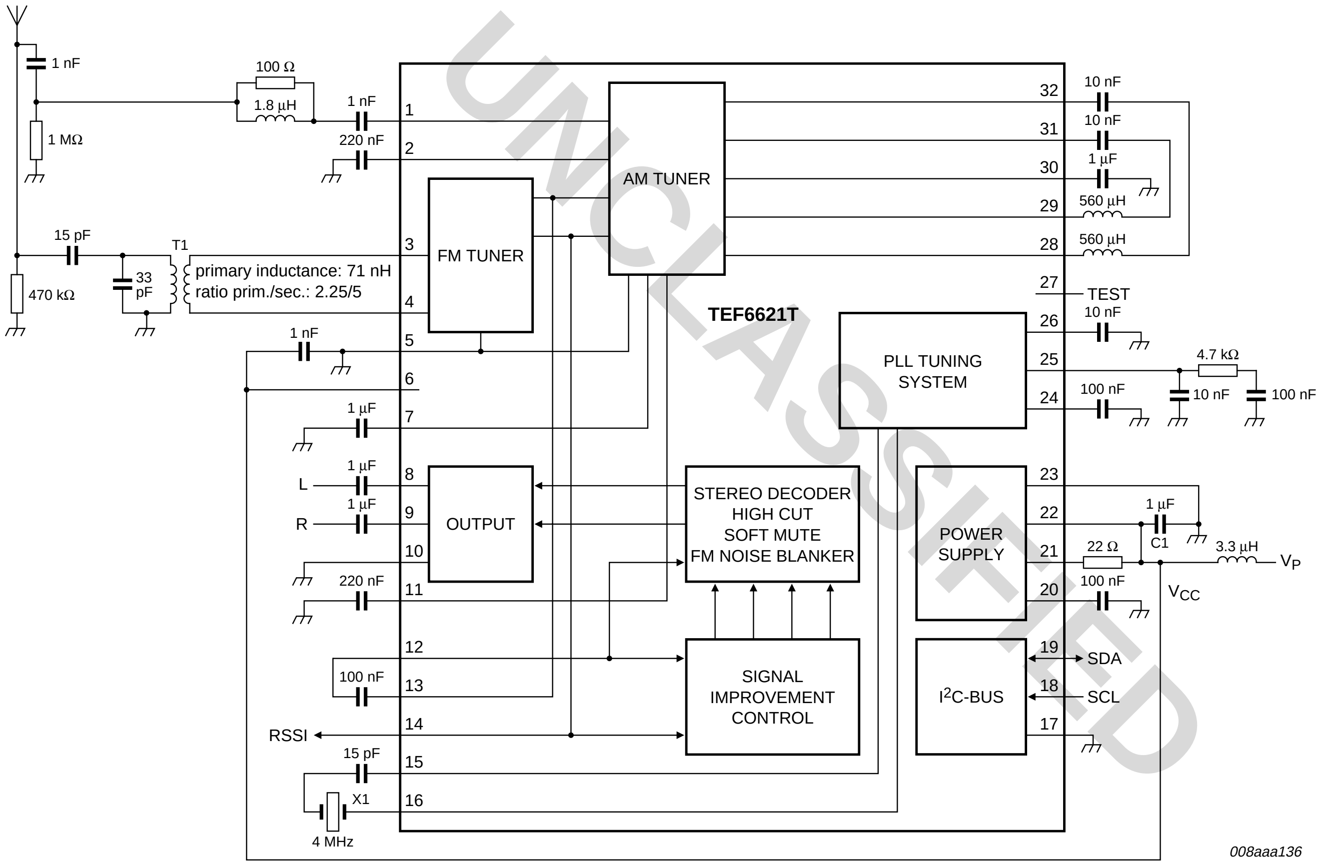
V_{CC} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.
FM condition: all RF voltages refer to an unterminated RMS voltage with a source impedance 75 Ω; f_{mod} = 1 kHz, Δf = 22.5 kHz, de-emphasis = 50 µs, f_{RF} = 97.1 MHz; unless otherwise specified.
AM condition: all RF voltages are RMS values measured at the input of a 15 pF/60 pF dummy aerial; f_{mod} = 400 Hz, m = 30 %, f_{RF} = 990 kHz; unless otherwise specified.
All values measured in a test circuit according to Figure 29; default settings; audio signals measured at LOUT and ROUT with IEC tuner filter (200 Hz to 15 kHz; IEC 60315-4); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{sink(AGC)}$	AGC sink current	AGC release; normal mode	0.7	1	1.4	µA
		AGC release; fast mode after tuning and AGC switching	17.5	25	35	µA
AM demodulator; pin MPXOUT						
V_o	output voltage	m = 30 %	175	210	250	mV
Audio output; pins LOUT and ROUT						
V_o	output voltage	m = 30 %; f_{AF} = 400 Hz; data byte 3h bits DEMP[1:0] = 10				
		data byte 3h bit OUTA = 1	200	270	355	mV
		data byte 3h bit OUTA = 0	85	115	150	mV
α_{AF}	AF attenuation	referenced to f_{AF} = 400 Hz; 210 mV input at pin MPXIN				
		f_{AF} = 100 Hz; data byte 3h bit LOCUT = 1	–4.5	–3	–1.5	dB
		f_{AF} = 1.5 kHz; data byte 3h bits DEMP[1:0] = 10	–4.5	–3	–2	dB
		f_{AF} = 5 kHz; data byte 3h bits DEMP[1:0] = 10	–24	–21	–18	dB
THD	total harmonic distortion	$V_{i(RF)}$ = 1 mV; m = 80 %	-	0.7	1	%
α_{ripple}	ripple rejection	V_{ripple} / V_{audio}; V_{ripple} = 100 mV; f_{ripple} = 100 Hz	30	37	-	dB
AM RSSI; pin RSSI						
V_{RSSI}	RSSI voltage	$V_{i(RF)}$ = –20 dBµV at dummy aerial input	0.9	1.1	1.25	V
		$V_{i(RF)}$ = 14 dBµV at dummy aerial input	1.6	1.9	2.2	V
		$V_{i(RF)}$ = 34 dBµV at dummy aerial input	2.6	2.9	3.2	V
$\Delta V_{RSSI}/\Delta L_{i(RF)}$	RSSI voltage difference to RF input level difference ratio	5 µV < $V_{i(RF)}$ < 50 µV	45	50	55	mV/dB
AM IF counter						
$f_{IFc(res)}$	IF counter frequency resolution		-	500	-	Hz

[1] The switched input capacitance is part of the switched RF AGC function.

[2] The input impedance of the AM LNA depends on the AGC state.

13. Application information



For list of components see Table 61 and for crystal specification see Table 62.

Fig 27. Application diagram of TEF6621T

13.1 Printed-circuit board

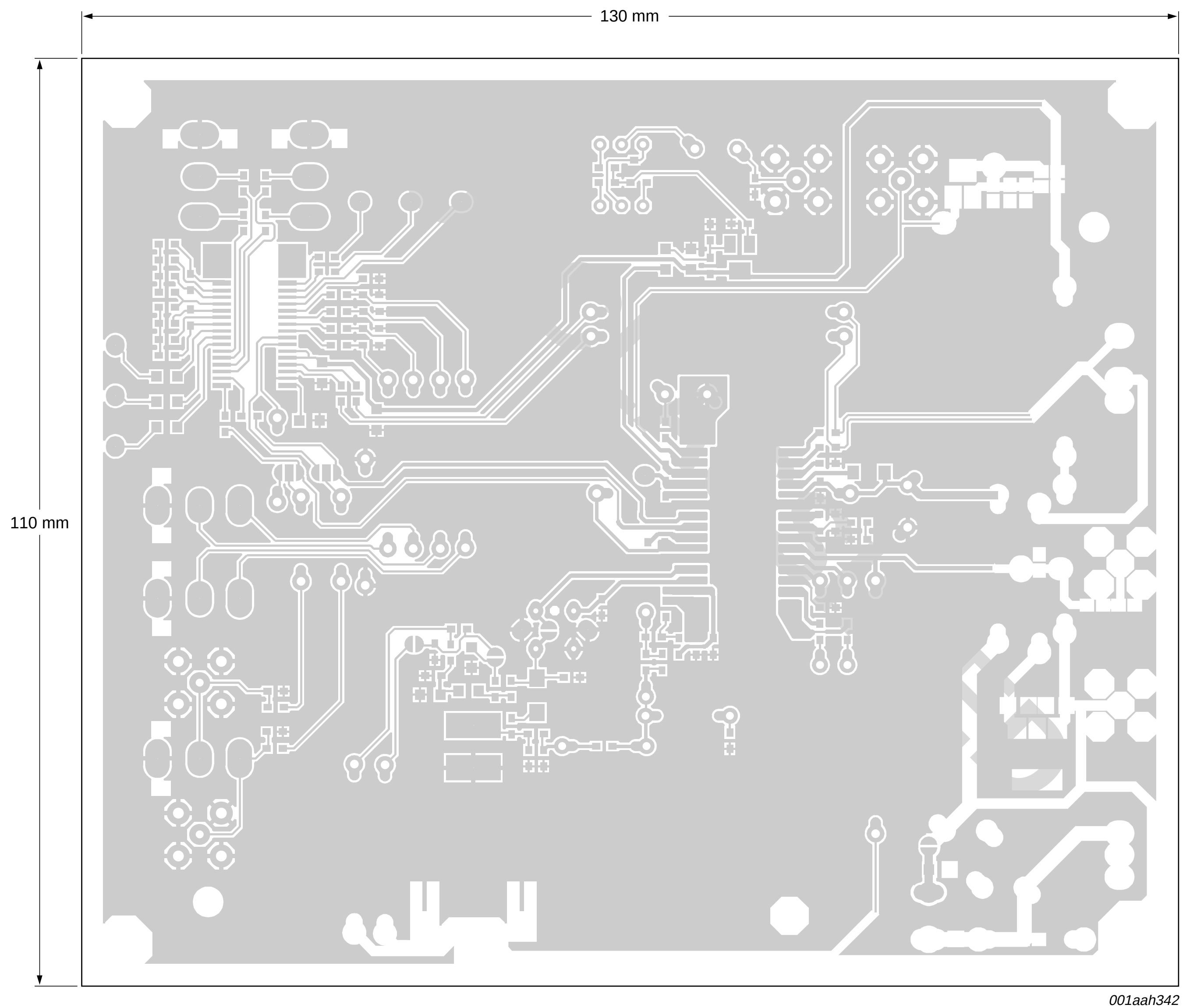
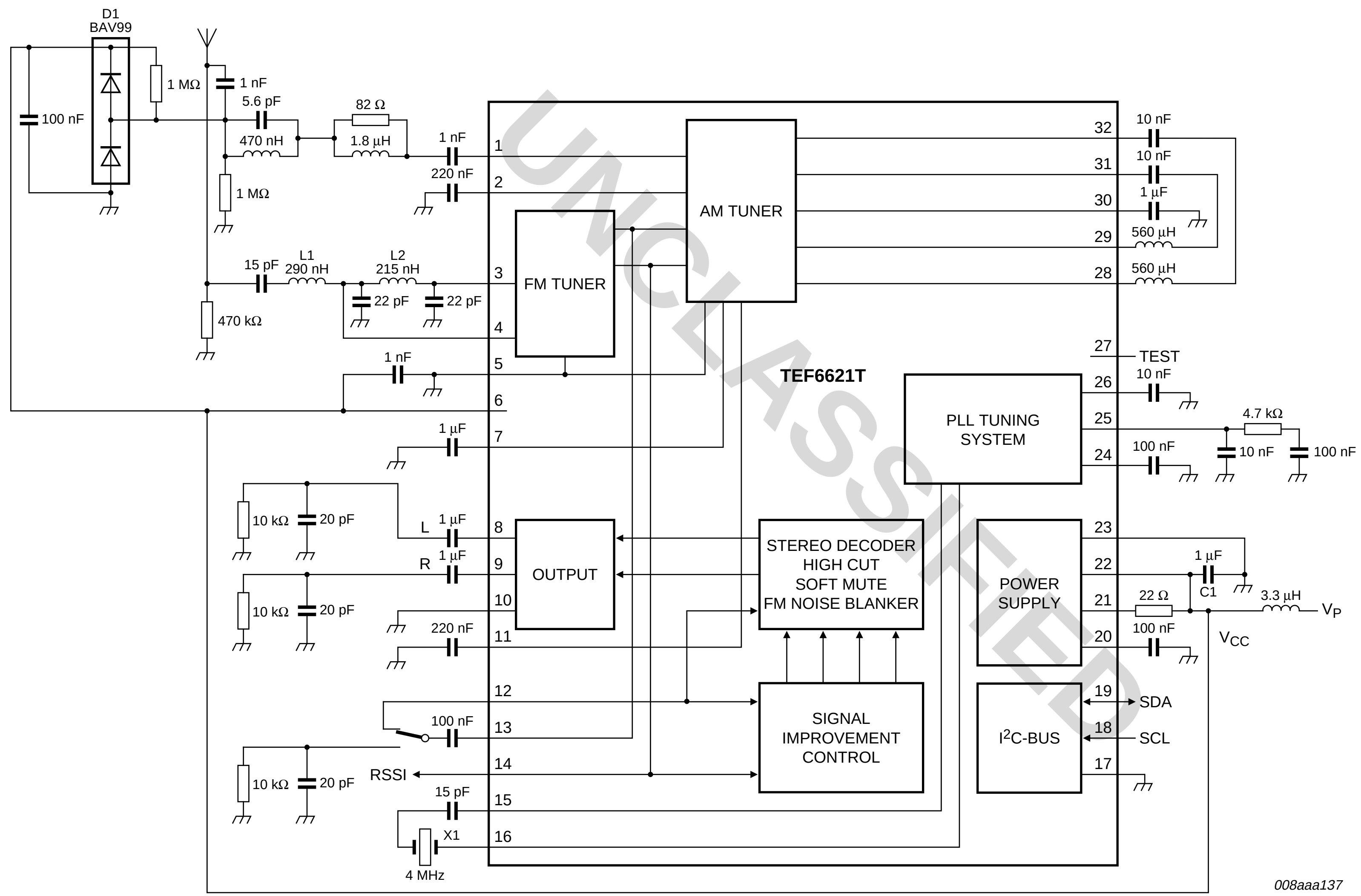


Fig 28. Printed-circuit board layout, suggested for application (this layout has been used in the NXP GH989 reference design, 35 μm)

14. Test information



For list of components see Table 61 and for crystal specification see Table 62.

Fig 29. Test circuit of TEF6621T

Table 61. List of components for Figure 27 and Figure 29

Symbol	Component	Type	Manufacturer
C1	decoupling capacitor	1 μF; X7R 0805	any
D1	ESD protection diode	BAV99	NXP Semiconductors
L1	FM RF input 1	290 nH; LQH31HNR29K03L	Murata
L2	FM RF input 2	215 nH; LQH31HNR21K01L	Murata
T1	transformer	#P600ENS-10959QH	TOKO
X1	crystal 4 MHz	LN-G102-1413	NDK

Table 62. 4 MHz crystal specification for Figure 27 and Figure 29

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{xtal}	crystal frequency	fundamental frequency	-	4.000	-	MHz
C_L	load capacitance		-	18	-	pF
C_{shunt}	shunt capacitance		-	-	7	pF
C_1	motional capacitance		-	10	-	fF
R_s	series resistance		-	-	150	Ω
$\Delta f_{xtal}/f_{xtal}$	relative crystal frequency variation	at 25 °C	–25	-	+25	10^{-6}
		caused by ageing	–5	-	+5	10^{-6}
		caused by temperature	–30	-	+30	10^{-6}
T_{amb}	ambient temperature		–20	-	+85	°C

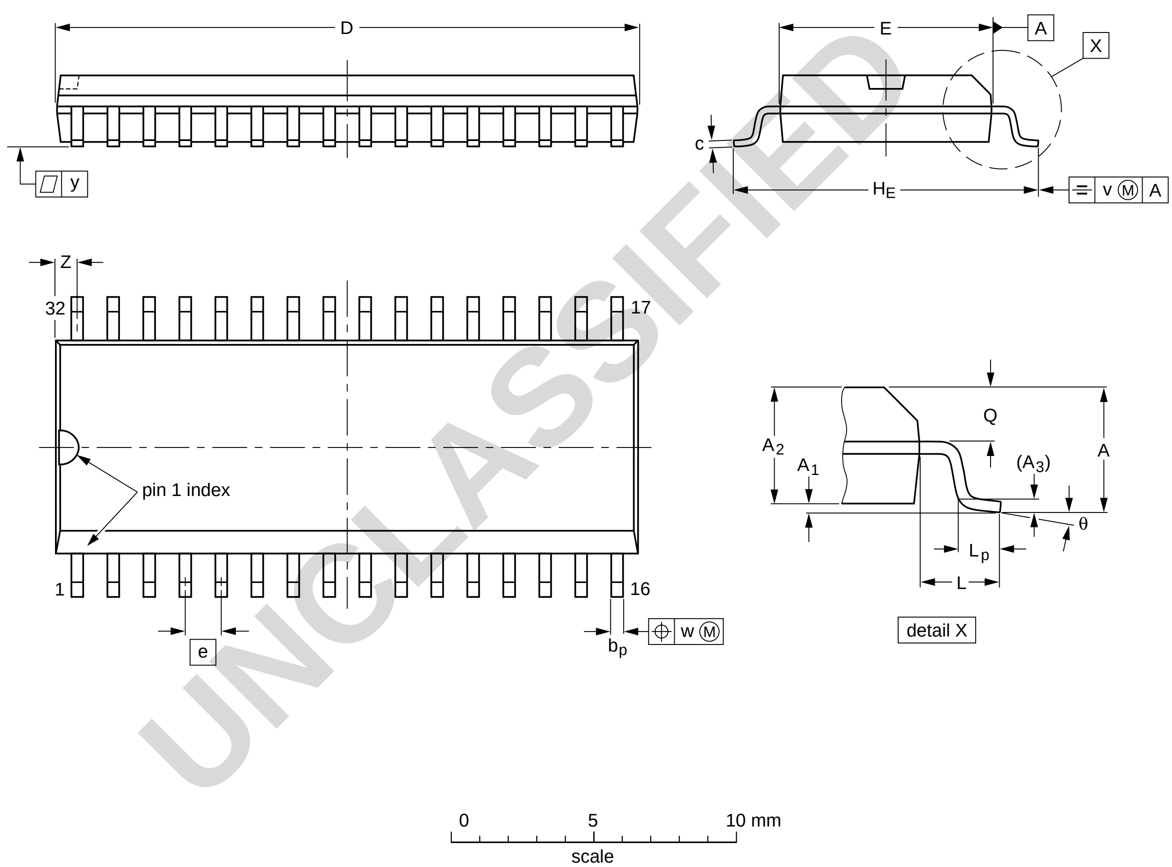
Table 63. DC operating points

V_{CC2} = 8.5 V; V_{CC1} = 8.5 V; $V_{i(RF)}$ = 0 μV; audio output gain low; unless otherwise specified.

Symbol	Pin	Unloaded DC voltage (V)					
		AM mode			FM mode		
		Min	Typ	Max	Min	Typ	Max
AMRFIN	1	-	2.85	-	-	-	-
AMRFDEC	2	-	4.1	-	-	-	-
FMIN2	3	-	-	-	-	3.1	-
FMIN1	4	-	-	-	-	3.1	-
GNDRF	5	external GND			external GND		
V_{CC2}	6	external 8.5			external 8.5		
AMRFAGC	7	-	1.8	-	-	-	-
LOUT	8	-	3.8	-	-	3.8	-
ROUT	9	-	3.8	-	-	3.8	-
GNDAUD	10	external GND			external GND		
AMIFAGC2	11	-	-	-	-	-	-
MPXIN	12	-	3.7	-	-	3.7	-
MPXOUT	13	-	4	-	-	4	-
RSSI	14	-	1.2	-	-	0.8	-
XTAL2	15	-	6.5	-	-	6.5	-
XTAL1	16	-	6.5	-	-	6.5	-
GNDD	17	external GND			external GND		
SCL	18	external I^2C-bus voltage			external I^2C-bus voltage		
SDA	19	external I^2C-bus voltage			external I^2C-bus voltage		
VREF	20	3.9	4.0	4.1	3.9	4.0	4.1
VREGSUP	21	5.6	6.5	7	5.6	6.5	7
V_{CC1}	22	external 8.5			external 8.5		
GND	23	external GND			external GND		
VCODEC	24	-	5.7	-	-	5.7	-
PLL	25	1.2	-	5.5	1.2	-	5.5
PLLREF	26	-	2.25	-	-	2.25	-
TEST	27	-	-	-	-	-	-
AMSELIN1	28	1.2	1.55	1.9	-	-	-
AMSELIN2	29	1.2	1.55	1.9	-	-	-
AMIFAGC1	30	-	5.5	-	-	-	-
AMSELOUT1	31	6.5	6.8	7.15	-	-	-
AMSELOUT2	32	6.5	6.8	7.15	-	-	-

15. Package outline

SO32: plastic small outline package; 32 leads; body width 7.5 mm **SOT287-1**



DIMENSIONS (inch dimensions are derived from the original mm 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	2.65	0.3 0.1	2.45 2.25	0.25	0.49 0.36	0.27 0.18	20.7 20.3	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.2 1.0	0.25	0.25	0.1	0.95 0.55	8^o 0^o
inches	0.1	0.012 0.004	0.096 0.089	0.01	0.02 0.01	0.011 0.007	0.81 0.80	0.30 0.29	0.05	0.419 0.394	0.055	0.043 0.016	0.047 0.039	0.01	0.01	0.004	0.037 0.022	

Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT287-1		MO-119				~~00-08-17~~ 03-02-19

Fig 30. Package outline SOT287-1 (SO32)

16. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

16.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

16.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

16.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

16.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see Figure 31) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with Table 64 and 65

Table 64. SnPb eutectic process (from J-STD-020C)

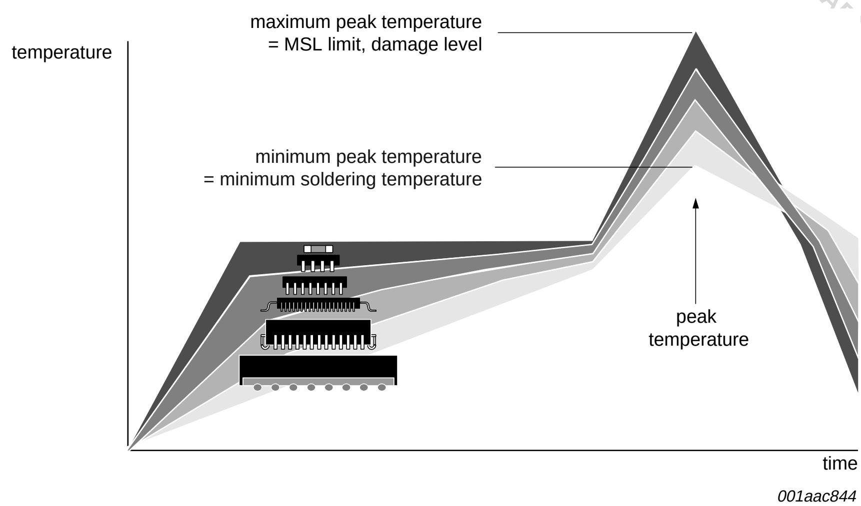
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm^3)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

Table 65. Lead-free process (from J-STD-020C)

Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm^3)		
	< 350	350 to 2000	> 2000
< 1.6	260	260	260
1.6 to 2.5	260	250	245
> 2.5	250	245	245

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see Figure 31.



MSL: Moisture Sensitivity Level

Fig 31. Temperature profiles for large and small components

For further information on temperature profiles, refer to Application Note *AN10365 “Surface mount reflow soldering description”*.

17. Abbreviations

Table 66. Abbreviations

Acronym	Description
AGC	Automatic Gain Control
HCC	High-Cut Control
I^2C-bus	Inter IC bus
IF	Intermediate Frequency
LO	Local Oscillator
LW	Long Wave
MPX	Multiplex
MW	Medium Wave
PLL	Phase-Locked Loop
RF	Radio Frequency
RSSI	Received Signal Strength Indication
USN	UltraSonic Noise
VCO	Voltage-Controlled Oscillator
WAM	Wideband AM

18. Revision history

Table 67. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TEF6621_1	yyyymmdd	Objective data sheet	-	-

19. Legal information

19.1 Data sheet status

Document status[1][2]	Product status[3]	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.nxp.com.

19.2 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

Short data sheet — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

19.3 Disclaimers

General — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in medical, military, aircraft, space or life support equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors accepts no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

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

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

Terms and conditions of sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at http://www.nxp.com/profile/terms, including those pertaining to warranty, intellectual property rights infringement and limitation of liability, unless explicitly otherwise agreed to in writing by NXP Semiconductors. In case of any inconsistency or conflict between information in this document and such terms and conditions, the latter will prevail.

No offer to sell or license — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Quick reference data — The Quick reference data is an extract of the product data given in the Limiting values and Characteristics sections of this document, and as such is not complete, exhaustive or legally binding.

19.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

I²C-bus — logo is a trademark of NXP B.V.

20. Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

21. Contents

For more information, please visit: http://www.nxp.com
For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 7 August 2008

Document identifier: TEF6621_1