

DATA SHEET

FM1236

**Desktop video & FM radio module
system M, N**

Preliminary specification
File under BU Tuners, DC03

1997 Feb 03

Desktop video & FM radio module system M, N

FM1236

FEATURES

- System M and N, and FM radio broadcast
- True 5 V device (low power dissipation)
- Full frequency range from channel 2 (55.25 MHz) to channel 69 (801.25 MHz)
- FM band coverage from 76.0 MHz to 108.0 MHz
- PLL controlled tuning
- Programmable PLL step size (31.25, 50 or 62.5 kHz)
- True-synchronous vision IF demodulator (PLL)
- Ultra linear FM PLL demodulator for FM broadcast
- Demodulated video output, AF sound output, second sound IF output
- I²C-bus control of tuning, address selection, AFC status information
- Complies with FCC, DOC and JIS regulations on radiation
- Small horizontally mounted metal housing.

DESCRIPTION

The FM1236 front-end is designed to receive both TV and FM stereo signals in the PC Multimedia environment. The units are available with separate 75 Ω inputs for TV and FM broadcast reception. The input connectors available are either standard phono or F type. The tuning, bandswitching and antenna selection are made through the I²C bus.

The front-end covers the TV bands from 55.25 MHz to 801.25 MHz, inclusive of the Japanese TV bands from 91.25 MHz to 765.25 MHz. The FM band covers the standard 87.50 MHz to 108.00 MHz and also the Japanese FM band (76.00 MHz to 91.00 MHz). An RDS decoder can be connected to the AF-MPX output. The FM1236 meets the input immunity and radiation requirements of the FCC, DOC and JIS.

The FM1236 consists of a TV tuner, an FM radio tuner and an IF section, all designed on a single PCB. The front-end is assembled in a metal housing made of a rectangular tin-plated steel frame, with front and rear covers, which have soldered contacts to the frame. The two phono or F antenna connectors (female) are mounted on one side of the frame for the TV/FM signal inputs. All other connections are made via pins at the bottom.

The TV IF section uses an intercarrier SAW filter, followed by a true-synchronous vision IF demodulator (PLL) IC. The analog AFC voltage is fed to the 5-level A/D converter in



the PLL tuning IC, so that the AFC status can be read via the I²C-bus.

In the FM radio mode, the level detector and AFT functions are provided for the auto-search routines. The level detector and AFT status can be read from the A/D bits in the status-byte. The mute function is also provided to suppress the audio output signal, if required.

The tuner AGC for both TV and FM radio operation, is generated with a novel AGC detector which measures the IF signal level directly at the tuner IF output terminals. As opposed to the conventional AGC detector, this new circuit allows a higher take-over level and offers superior immunity against tuner overload.

The demodulation of the TV sound (4.5 MHz) and FM IF (10.70 MHz) is done with a PLL demodulation circuit contained in the IF IC. In the FM radio mode, the multiplexed AF signal is then channelled to a stereo decoder IC which extracts the left/right analog signals. The multiplexed audio signal is also available at pin 25 to support RDS or BTSC implementations. The 2nd IF sound output is provided to connect external (analog 2 carrier or digital) stereo processing.

ORDERING INFORMATION

TYPE	DESCRIPTION	CATALOGUE NUMBERS
FM1236/HM/PH	standard phono	3139 147 13411
FM1236/HM/F	F	3139 147 13421

MARKING

The following items of information are printed on a sticker that is on the top cover of the tuner:

- Type number
- Code number
- Origin letter of factory
- Change code
- Year and week code.

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INTERMEDIATE FREQUENCIES

SYSTEM	FREQUENCY (MHz)
Picture carrier	45.75
Colour	42.17
Sound	41.25
FM	10.70

CHANNEL COVERAGE

BAND	OFF-AIR CHANNELS		CABLE CHANNELS	
	CHANNEL	FREQUENCY (MHz)	CHANNEL	FREQUENCY (MHz)
FM band	–	76.00 to 108.00	–	–
Low band	2 to 6	55.25 to 83.25	A-2 to G	109.25 to 157.25
Mid band	7 to 13	175.25 to 211.25	H to I	163.25 to 169.25
			J to ZZ	217.25 to 451.25
High band	14 to 69	471.25 to 801.25	AAA to BBB (+6 MHz)	457.25 to 469.26

PINNING

SYMBOL	PIN	DESCRIPTION
V _T	11	tuning voltage (monitor)
V _{S(tuner)}	12	supply voltage tuner section +5 V
SCL	13	I ² C-bus serial clock
SDA	14	I ² C-bus serial data
AS	15	I ² C-bus address select
AF O/P right	20	FM right channel
AF O/P left	21	FM left channel
2 nd IF O/P	22	second IF sound output
CVBS	23	Composite Video Baseband Signal (CVBS) output
V _{S(IF)}	24	supply voltage IF section +5 V
AF O/P	25	AF sound output
–	TH1, TH2, TH3 and TH4	mounting tags (ground)

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BLOCK DIAGRAM

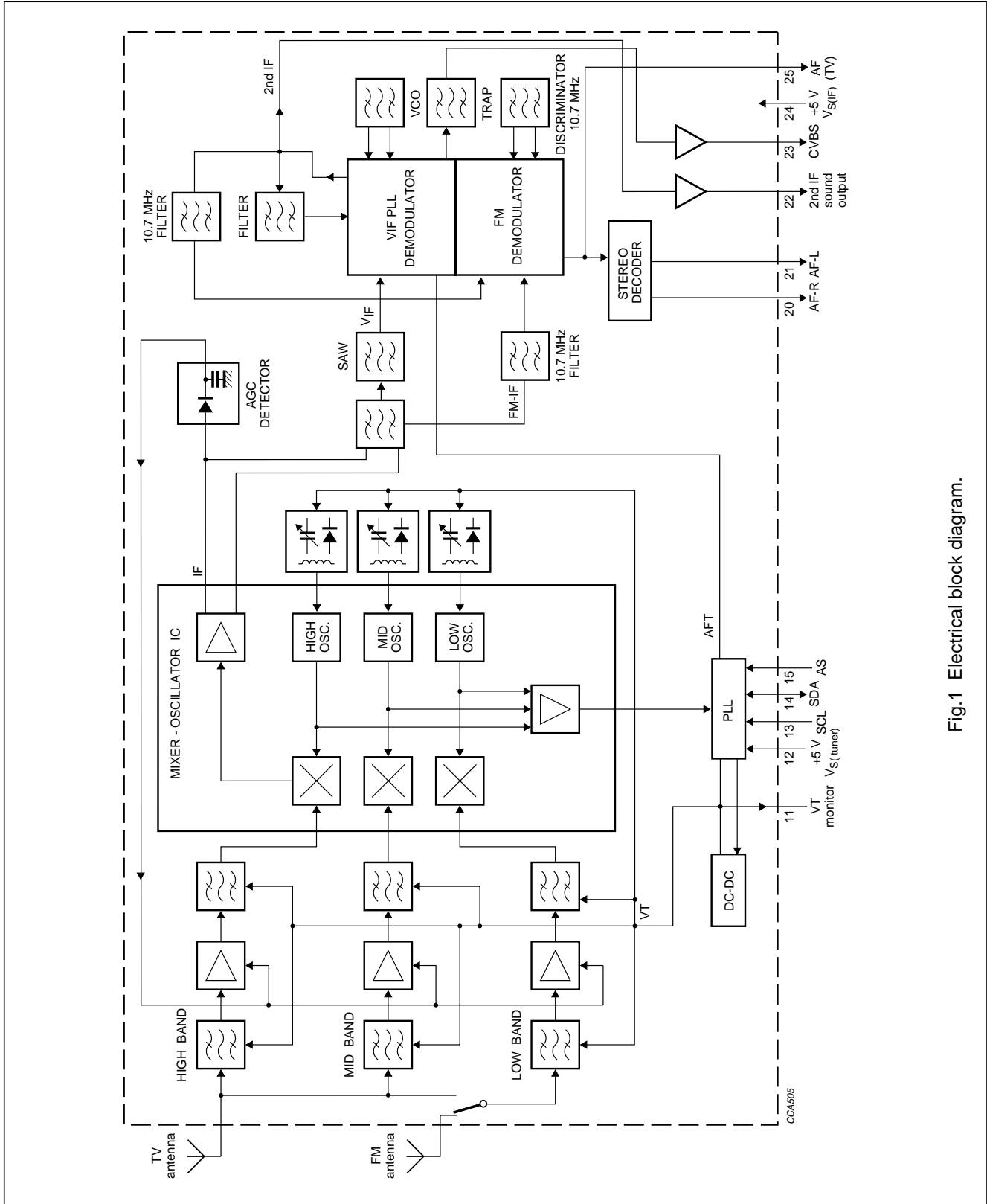


Fig.1 Electrical block diagram.

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LIMITING VALUES

Limiting values under operational conditions

The tuner can be guaranteed to function properly under the following conditions.

SYMBOL	PARAMETER	PIN	MIN.	TYP.	MAX.	UNIT
V_S	supply voltage	12	4.75	5.00	5.25	V
$V_{S(\text{ripple})}$	peak-to-peak ripple voltage susceptibility (at 5 V $\pm 5\%$); note 1: 20 Hz to 100 kHz >100 kHz to 500 kHz		–	–	5	mV
			–	–	10	mV
$I_{S(\text{tuner})}$	supply current		–	–	120	mA
V_{SCL}	SCL bus input voltage	13	–0.3	–	+5.25	V
V_{SDA}	SDA bus input voltage	14	–0.3	–	+5.25	V
I_{SDA}	SDA bus current (open collector)		–1	–	+5	mA
V_{AS}	address select voltage; note 2	15	–	–	+5.25	V
$V_{AFright(FM)}$	FM right channel DC voltage	20	–	1.0	–	V
$Z_{AFright(FM)}$	FM right channel load impedance parallel connected: resistive value capacitive value		–	40	–	k Ω
			–	9	–	pF
$V_{AFleft(FM)}$	FM left channel DC voltage	21	–	1.0	–	V
$Z_{AFleft(FM)}$	FM left channel load impedance: resistive value capacitive value		–	40	–	k Ω
			–	9	–	pF
Z_{IF}	2 nd IF sound output load impedance	22	0.5	–	–	k Ω
Z_{CVBS}	Composite Video Baseband Signal load impedance	23	–	75	–	Ω
t_L	CVBS load time constant		–	–	100	ns
$V_{S(IF)}$	IF supply voltage	24	4.75	5.0	5.25	V
$I_{S(IF)}$	IF supply current		–	–	150	mA
Z_{AF}	AF sound output load impedance parallel connected: resistive value capacitive value	25	5.0	–	–	k Ω
			–	–	4	nF

Notes

1. Sinusoidal ripple voltage superimposed on the 5 V supply voltage in the frequency range of 20 Hz to 500 kHz.
Criteria for TV interference >57 dB.
2. For detailed information about the address decoding, refer to Chapter "Application information".

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Environmental conditions

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Non-operational conditions						
T _{amb}	ambient temperature		-25	-	+85	°C
RH	relative humidity		-	-	100	%
g _B	bump acceleration	25 g	-	-	245	m/s ²
g _S	shock acceleration	50 g	-	-	490	m/s ²
	vibration amplitude	10 to 55 Hz	-	0.35	-	mm
Operational conditions						
T _{amb}	ambient temperature		-10	-	+60	°C
RH	relative humidity		-	-	95	%

OVERALL PERFORMANCE

Conditional data

Unless otherwise specified, all electrical values for Chapter "Overall performance" apply at the following conditions.

SYMBOL	PARAMETER	VALUE	UNIT
T _{amb}	ambient temperature	25 ±5	°C
RH	relative humidity	60 ±15	%
V _S	supply voltage (tuner and IF section)	5 ±0.125	V
Z _{CVBS}	video output load impedance (DC)	75	Ω
Z _{IF}	2 nd IF sound output load impedance (DC)	0.5	kΩ
Z _{AF}	AF sound output load impedance	100	kΩ
t _{pr}	pre-heating time (+5 V at pin 24)	10	minute
Z _{S(AE)}	aerial source impedance (asymmetrical)	75	Ω

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TUNER CHARACTERISTICS

For detailed information about the PLL programming, refer to Chapter "Application information".

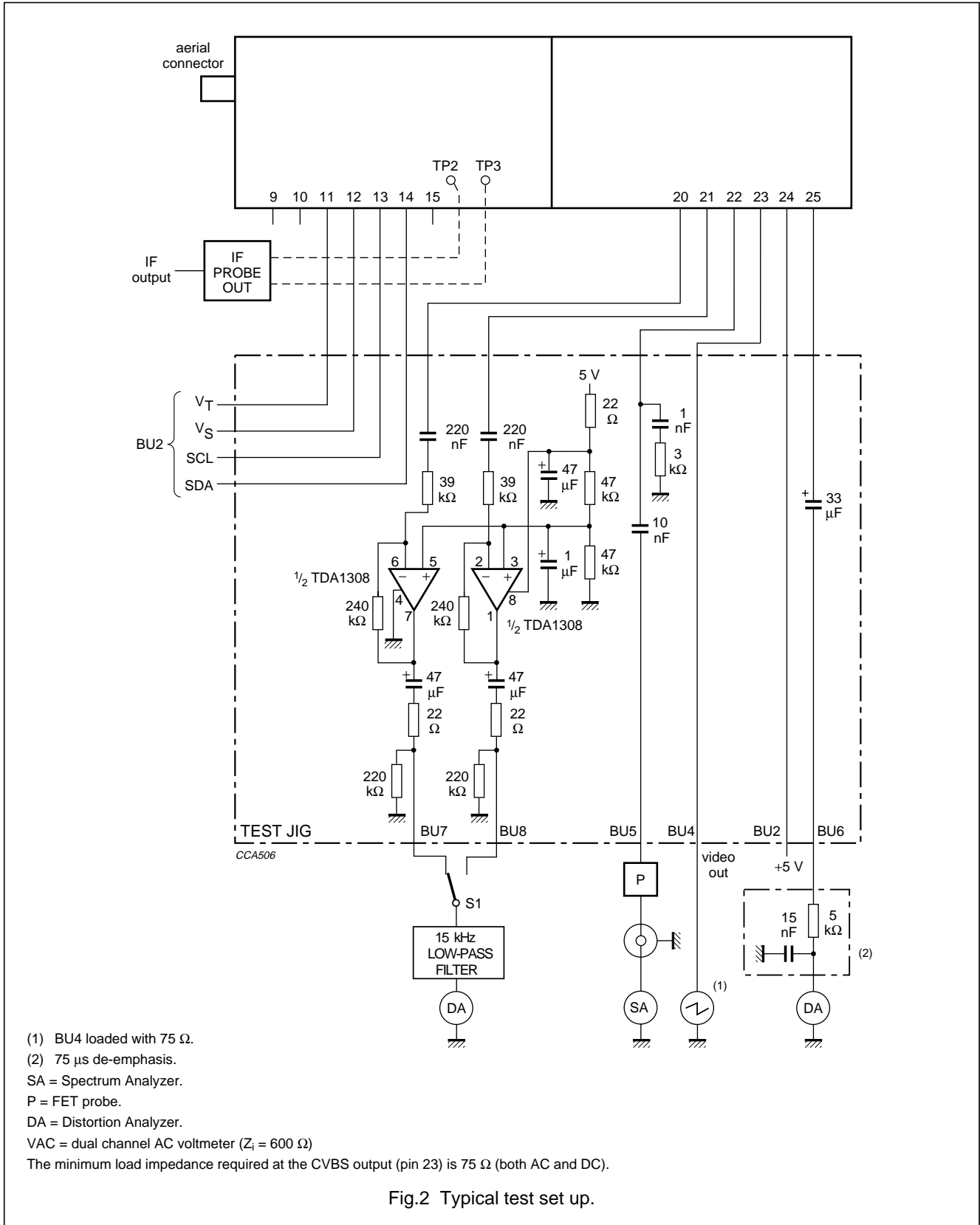
The desktop video tuner is guaranteed to function properly within the specified operational conditions, but a certain deterioration of performance parameters may occur at the limits of the operational conditions.

Required data for test equipment to be used

EQUIPMENT	PARAMETER	VALUE	UNIT
DC voltmeter	input impedance	>1	M Ω
Oscilloscope	input impedance: resistance capacitance	>1 <15	M Ω pF
Spectrum analyzer	input impedance	50	Ω
FET probe	input impedance: resistance capacitance	1 3.5	M Ω pF
	output impedance	50	Ω
	voltage gain	0	dB
AC millivoltmeter	input impedance	>100	k Ω

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Definitions of test signals (see Fig.2)

TEST SIGNAL	FREQ. (MHz)	AMPLITUDE	MODULATION	
			VIDEO	AUDIO
A0: unmodulated vision carrier	477.25	60 dB μ V		
A1: RF M, N standard signal with video modulation	477.25	60 dB μ V (top sync)	100% (rest carrier 12.5%) 2T pulse and bar	
B1: unmodulated sound carrier M, N system	481.25	-7 dB w.r.t. A0 to A1		
B2: FM modulated sound carrier M, N system	481.25	-7 dB w.r.t. A0 to A1		1 kHz; modulation frequency deviation ± 25 kHz; 75 μ s pre-emphasis
B3: unmodulated sound carrier M, N system	483.25	-12 dB w.r.t. A0 to A1		
C1: FM modulated sound carrier	98.00	60 dB μ V		1 kHz; modulation frequency deviation ± 22.5 kHz
C2: FM modulated sound carrier	97.70 or 98.30	60 dB μ V		1 kHz; modulation frequency deviation ± 22.5 kHz
C3: FM modulated sound carrier	98.00	60 dB μ V		1 kHz; modulation frequency deviation ± 75 kHz; 10% pilot carrier (L = R); 75 μ s pre-emphasis

Aerial input characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V _{SWR}	reflection coefficient	referred to 75 Ω impedance (worst case on or between picture and sound carrier at maximum gain): all channels in TV mode FM (centre of channel)	-	5 4	
V _{PSM}	surge protection voltage		5	-	kV
V _{ant}	antenna connection disturbance voltage	1 to <54 MHz	-	10	dB μ V
		54 to <300 MHz	-	34	dB μ V
		300 to <1000 MHz	-	50	dB μ V

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General characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_b	frequency range:					
	FM band		76.00	–	108.00	MHz
	low band		55.25	–	157.25	MHz
	mid band		163.25	–	451.25	MHz
	high band		457.25	–	801.25	MHz
Δf_b	margin:					
	for FM band		3	–	–	MHz
	for low band		1.5	–	–	MHz
	for mid/high band		3	–	–	MHz
α_i	image rejection (nominal gain to 10 dB gain reduction):					
	low band (channel 2 to 6)		60	–	–	dB
	mid band (channel 7 to 13)		60	–	–	dB
	high band (channel 14 to 69)		45	–	–	dB
α_{IF}	IF rejection (picture)		60	–	–	dB
Z_{IF}	$\frac{1}{2}$ IF susceptibility:					
	E2 to E13		75	–	–	dB μ V
	E14 to E69		60	–	–	dB μ V
m_x	cross modulation:					
	in-channel		65	–	–	dB μ V
	in-band					
	low band ($n \pm 2$)		78	–	–	dB μ V
	mid band ($n \pm 3$)		78	–	–	dB μ V
high band ($n \pm 5$)		84	–	–	dB μ V	
	out of band		–	100	–	dB μ V
	breakthrough susceptibility:					
	channel 2 to 69		60	–	–	dB μ V
V_{osc}	oscillator voltage at all pins		–	–	70	dB μ V
t_{li}	oscillators lock-in time	charge pump set logic HIGH	–	–	150	ms
α_{vs}	the video signal-to-sound interference ratio with the tuner exposed to sound signals in the audio frequency range 100 Hz to 10 kHz and sound pressure levels up to 105 dB (20 μ Pa)		40	–	–	dB
	audio S/N ratio		40	–	–	dB
V_{ESD}	electrostatic discharge (ESD) on all pins	note 1	2	–	–	kV

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
FM radio characteristics						
α_{26}	limiting sensitivity for (S+N)/N	test signal C1	–	5	30	dB μ V
α_{50}		test signal C3	–	30	40	dB μ V
	S/N ratio: mono at f = 22.5 kHz mono at f = 75 kHz stereo	test signal C1	55	58	–	dB
			65	68	–	dB
		test signal C3	55	63	–	dB
$\alpha_{i(FM)}$	FM image rejection	test signal C1	53	60	–	dB
	effective selectivity S_{300}	test signal C1 + C2	50	–	–	dB
	frequency response: lower –3 dB point upper –3 dB point	test signal C3; –3 dB points	–	20	40	Hz
			14	18	–	kHz
	AM suppression	test signal C1	38	–	–	dB
	FM AF output level at terminal 20/21 (RMS value): mono stereo	test signal C1	40	57	74	mV
		test signal C3	120	175	230	mV
	stereo separation	test signal C3; 1 kHz	28	35	–	dB
	total harmonic distortion: stereo at 1 kHz during overmodulation at f = ± 100 kHz	test signal C3	–	0.8	1.5	%
			–	1.5	3	%

Note

1. All the pins of the desktop video tuner are protected against electrostatic discharge (ESD) up to 2 kV. The product is classified in category B ("MIL-STD-883C").

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Video and audio characteristics (see Fig.2)

PARAMETER	TEST SIGNAL	TEST POINT	MIN.	TYP.	MAX.	UNIT
CVBS characteristics:						
video amplitude signal at pin 23	A1 (peak-to-peak value)	BU4	0.75	0.95	1.15	V
DC level sync pulse at pin 23	A1	BU4	–	0.35	–	V
Video amplitude drop with respect to modulation 1 MHz at $T_{amb} = 45\text{ }^{\circ}\text{C}$:						
at 2 MHz	A1	BU4	–1.5	–	+1.0	dB
at 3 MHz	A1	BU4	–2.5	–	+1.5	dB
at 3.58 MHz	A1	BU4	–4.0	–	+2.0	dB
Sound carrier rejection	A1 (1 MHz) + B1	BU4	40	–	–	dB
Residual 47.25 MHz signal in video channel: level of 1.5 MHz	A1 + B3	BU4	–	–	68	dB μ V
Residual 91.5 MHz signal in video channel	A1	BU4	–	–	80	dB μ V
Second IF sound output level at level of 4.5 MHz	A1 (black) + B1	BU5	84	–	–	dB μ V
Test on 2T pulse at $T_{amb} = 45\text{ }^{\circ}\text{C}$:						
2T pulse/bar response	A1	BU4	–2.5	–	+2.5	%
2T pulse response	A1	BU4	–	–	+3.0	%
CVBS S/N (unweighted)	A1 + B1	BU4	41	–	–	dB
Gain limited sensitivity at 1 dB reduction of video output	A1	BU4	–	–	30	dB μ V
Maximum usable single input signal	A1	BU4	90	–	–	dB μ V
Audio characteristics:						
AF output level measured via LP 200 kHz filter, RMS detector, 75 μ s de-emphasis	A1 + B2	BU6	0.21	0.31	0.41	V
THD (Total Harmonic Distortion) measured via LP 200 kHz filter, RMS detector, 75 μ s de-emphasis	A1 + B2	BU6	–	–	0.5	%
S/N measured via CCIR filter, peak CCIR detector, 75 μ s de-emphasis	A1 (full field colour bar) + B1	BU6	38	–	–	dB
AM suppression ratio	A1 (black) + B2	BU6	40	–	–	dB
Aerial input level for S/N = 41 dB	A1 (black) + B2	BU6	–	–	45	dB μ V

Digital AFC status

ADC word at I²C-bus during read operation

DIGITAL READ-OUT	FREQUENCY (kHz)
00	–125
01	–62.5
02	0
03	+62.5
04	+125

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APPLICATION INFORMATION

A detailed description of the I²C-bus specification, with applications, is given in brochure "The I²C-bus and how to use it". This brochure may be ordered using the code number 9398 393 40011.

WRITE mode

BYTE	BITS								
	7 MSB	6	5	4	3	2	1	0 LSB	A ⁽¹⁾
Address byte	1	1	0	0	0	MA1	MA0	0	A
Program divider byte 1	0	n14	n13	n12	n11	n10	n9	n8	A
Program divider byte 2	n7	n6	n5	n4	n3	n2	n1	n0	A
Control information byte 1	1	CP	T2	T1	T0	RSA	RSB	OS	A
Control information byte 2	P7	P6	P5	P4	P3	P2	P1	P0	A

Note

1. A = Acknowledge.

ADDRESS SELECTION

V_S = +5 V (PLL supply voltage)

MA1	MA0	ADDRESS	VOLTAGE AT PIN 15 (see note 1)
0	0	C0	0 to 0.1V _S
0	1	C2	0.2 to 0.3V _S
1	0	C4	0.4 to 0.6V _S
1	1	C6	0.9V _S to V _S

Note

1. If the AS pin is left floating, the internal bias will automatically set the address to C2.

PROGRAMMABLE DIVIDER SETTINGS (BYTES 1 AND 2)

Divider ratio:

$N = 16 \times \{f_{RF(pc)} + f_{IF(pc)}\}$, where (pc) is picture carrier and f_{RF} and f_{IF} are expressed in MHz

$f_{osc} = N/16$ (MHz).

$N = (8192 \times n13) + (4096 \times n12) + (2048 \times n11) + (1024 \times n10) + (512 \times n9) + (256 \times n8) + (128 \times n7) + (64 \times n6) + (32 \times n5) + (16 \times n4) + (8 \times n3) + (4 \times n2) + (2 \times n1) + n0$

CONTROL BYTE

Charge pump settings:

CP = 1, for fast tuning

CP = 0, for moderate speed tuning with slightly better residual oscillator FM.

It is recommended to set CP = 1 at all times in the TV mode. In the FM radio mode, set CP = 1 only during the search tuning. Once the wanted channel is obtained, set CP = 0 to get the best signal-to-noise ratio.

Test mode settings:

T2 = T1 = 0; T0 = 1, for normal operation.

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PLL disabling:

OS = 0, for normal operation

OS = 1, for switching the charge pump to the high impedance state.

Ratio select bits

RSA	RSB	STEP SIZE
X	0	50 kHz
0	1	31.25 kHz
1	1	62.5 kHz

PORTS BYTE

FUNCTION	BIT							
	P7	P6	P5	P4	P3	P2	P1	P0
TV/FM bandswitching								
FM band	1	0	1	0		1		
Low band	1	0	1	0		0		
Mid band	1	0	0	1		0		
High band	0	0	1	1		0		
TV mode								
Power down mode; see note 1					0	0	0	1
System M, N negative mode					0	0	0	0
FM radio mode								
AFC; see note 2					0	1	0	1
R _{IF} ; see note 3					0	1	0	0
Mono					0	1	1	0
Mute					1	1	0	0

Notes

1. If the TV function is not required, the tuner can be switched to power-down mode. In this mode the tuner reduces the current consumption by up to 100 mA.
2. By this setting the FM radio AFC status can be read from the A/D bits in the status byte.
3. By this setting the RF input level can be read from the A/D bits in the status byte.

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TELEGRAM EXAMPLES (WRITE MODE)

Start - Adb - Ack - Db1 - Ack - Db2 - Ack - Cb - Ack - Pb - Ack - Stop.

Start - Adb - Ack - Cb - Ack - Pb - Ack - Db1 - Ack - Db2 - Ack - Stop.

Start - Adb - Ack - Db1 - Ack - Db2 - Ack - Cb - Ack - Stop.

Start - Adb - Ack - Db1 - Ack - Db2 - Ack - Stop.

Where:

Start = start condition

Adb = address byte

Ack = acknowledge

Db1 = divider byte 1

Db2 = divider byte 2

Cb = control byte

Pb = ports byte

Stop = stop condition.

READ mode

The in-lock can be read by setting the R/W bit to 1.

BYTE	BITS								
	7 MSB	6	5	4	3	2	1	0 LSB	A ⁽⁵⁾
Address byte	1	1	0	0	0	MA1	MA0	1	A
Status byte	POR ⁽¹⁾	FL ⁽²⁾	I2 ⁽³⁾	I1 ⁽³⁾	I0 ⁽³⁾	A2 ⁽⁴⁾	A1 ⁽⁴⁾	A0 ⁽⁴⁾	A

Notes

1. POR = Power On Reset. POR is internally set to 1 in case V_S drops below 3 V. The POR bit is reset when an end of data is detected by the PLL IC.
2. FL = In-lock flag; FL = 1: loop is phase-locked. The loop must be phase-locked during at least 8 periods of the internal reference frequency (either 7.8125 kHz, 3.90625 kHz or 6.25 kHz) before the FL flag is internally set to 1.
3. I2, I1 and I0 = digital information for I/O ports P2, P1 and P0 respectively.
4. A2, A1 and A0 = built-in 5-level A/D converter on the internal I/O port P6 (see Table "Digital AFC status").
5. A = Acknowledge.

TELEGRAM EXAMPLES (READ MODE)

Start - Adb - Ack - STB - Ack - STB - - Stop (no Ack from processor = End-of-data).

Start - Adb - Ack - STB - - Stop (no Ack from processor = End-of-data).

Where:

STB = Status byte.

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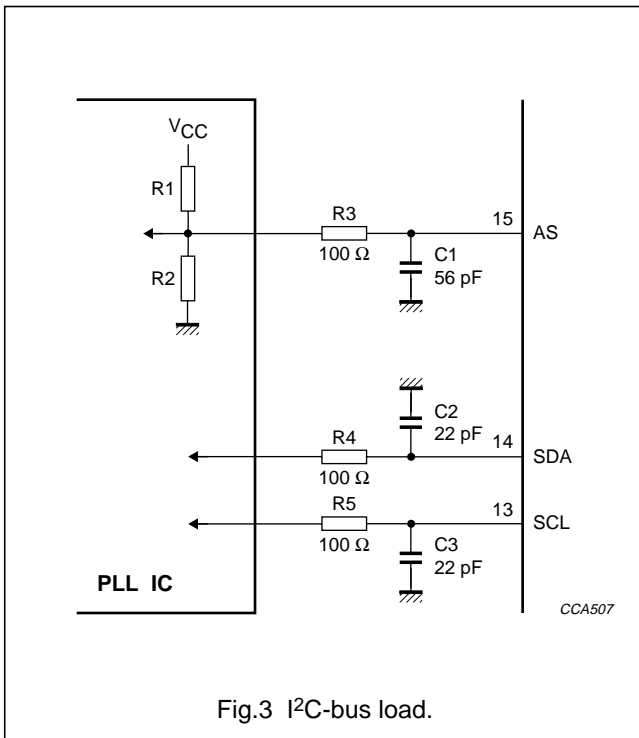


Fig.3 I²C-bus load.

Video buffer

A video buffer is built into the video module to enable the unit to drive a 75 Ω load directly.

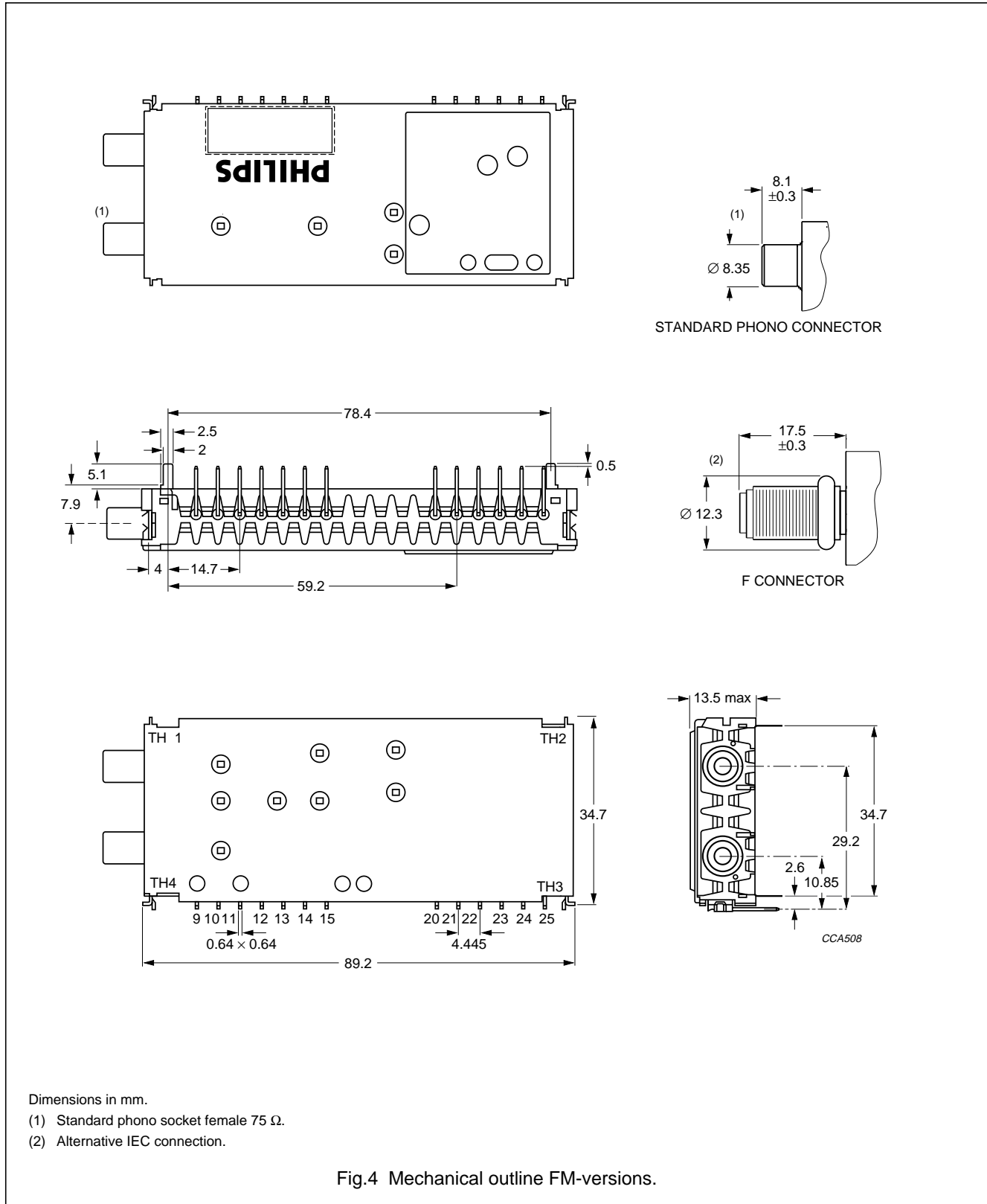
I²C-bus load

The FM1236 contains a series resistor ($R = 100 \Omega$) in the SCL and SDA lines. Both lines also have a capacitive load of typical 22 pF (see Fig.3).

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MECHANICAL DATA



Dimensions in mm.

- (1) Standard phono socket female 75 Ω .
- (2) Alternative IEC connection.

Fig.4 Mechanical outline FM-versions.

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Aerial connections

Standard-phono socket female 75 Ω or F (female).

Solderability

The solderability of pins and mounting tags when tested initially and after 16 hours steam ageing in accordance with "IEC 68-2-20", test Ta, method 1 (solder bath 235 ±5 °C for 2 ±5 s), results in a wetted area of 95%. No de-wetting will occur when soldered at 260 ±5 °C for 5 ±0.5 s.

Resistance to soldering heat

The product will not be damaged when tested in accordance with "IEC 68-2-20", test Tb, method 1A (solder bath 260 ±5 °C for 5 ±1 s).

Mass

Approximately 50 g.

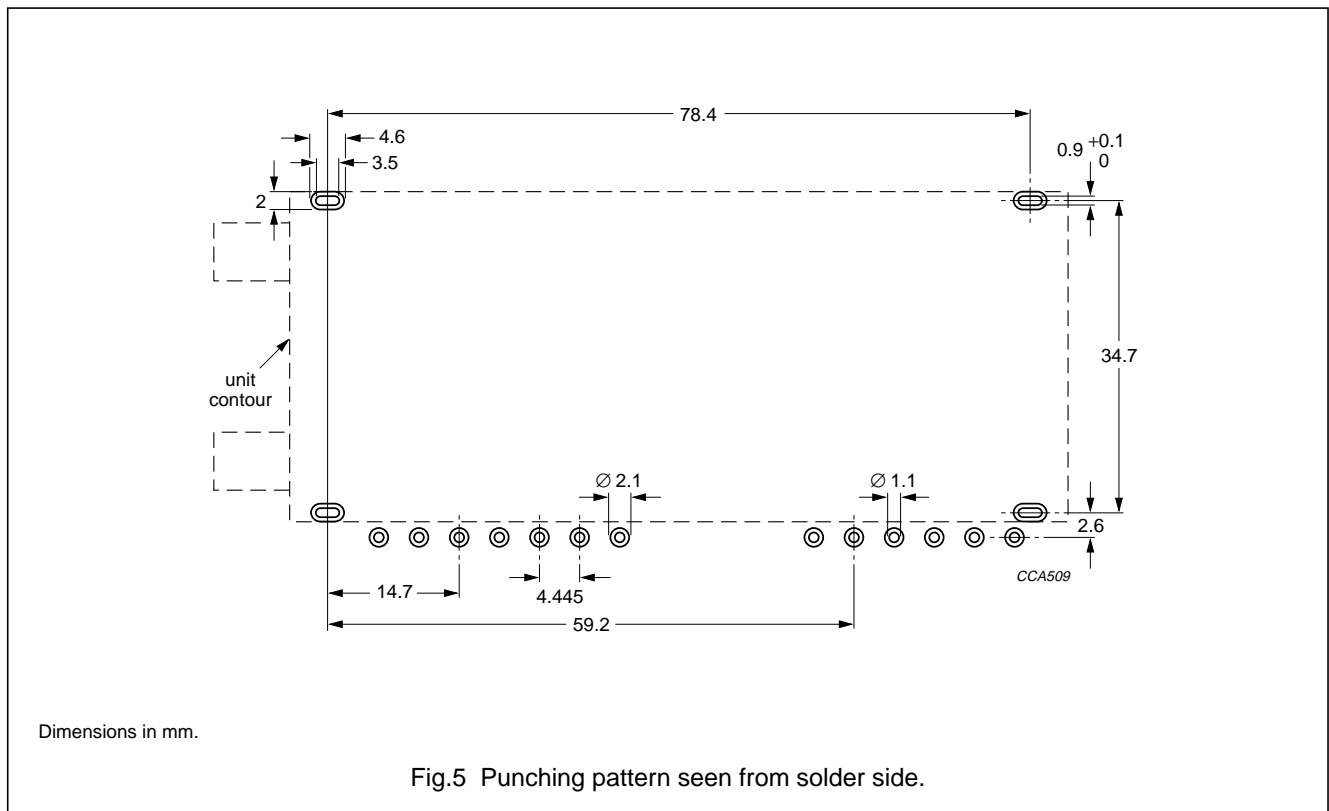
Robustness of pins

The pins will not be damaged when tested in accordance with "IEC 68-2-21" :

- Test Ua1, tensile of 20 N in axial direction
- Test Ua2, thrust of 4 N in axial direction
- Test Ua2, thrust of 2 N in axial direction.

Punching pattern of chassis PCB

Field rejects are often related to broken tag joints. Therefore, the following punching pattern is recommended (see Fig.5).



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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.
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.

PURCHASE OF PHILIPS I²C COMPONENTS



Purchase of Philips I²C components conveys a license under the Philips' I²C patent to use the components in the I²C system provided the system conforms to the I²C specification defined by Philips. This specification can be ordered using the code 9398 393 40011.

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