ELFA

Datum 981218

PRODUKTINFORMATION

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73-104-77 FR1216 Radio & TV tuner

DATA SHEET

FR1216
Desktop video & radio module system CCIR B/G

Preliminary specification

1996 Jun 05

File under Display Components, DC03

Philips Components

PHILIPS

Desktop video & radio module system CCIR B/G

FR1216

FEATURES

- System CCIR B/G and FM radio broadcast
- True 5 V device (low power dissipation)
- Full TV frequency range from channel 2 (48.25 MHz) to channel 69 (855.25 MHz)
- FM band coverage from 87.5 to 108 MHz
- PLL controlled tuning
- True-synchronous vision IF demodulator (PLL)
- Demodulated video output, AF sound output, second sound IF output
- 10.70 MHz IF for external FM demodulation circuit
- I^2C-bus control of tuning, address selection, AFC status information
- Complies with European regulations on radiation, signal handling and immunity *("CENELEC 55020, 55013''* and *''Amtsblatt 15/92")*
- Small horizontally mounted metal housing.

DESCRIPTION

The FR1216 desktop TV/radio RF module is a combination of an FM radio, a TV VHF/UHF tuner and an IF demodulator in one small size metal case. It is designed to meet a wide range of RF applications in the PC Multi-Media environment.

The FR1216 has two 75 Ω inputs for both TV and audio FM broadcast reception. The input connectors are available in either standard Phono (female/female sockets) or IEC (female for TV/male for FM).

The tuning, bandswitching and input switching (both for TV and FM) are performed through the built-in digitally controlled I^2C bus.

The PLL tuning system used enables tuning with step-size programmable between 31.25, 50.0 or 62.5 kHz. A DC-DC converter is built around the PLL synthesizer IC to provide the tuning voltage, thus making the FR1216 video & radio module a true 5 V device.

The FR1216 type offers a 10.70 MHz FM-IF output which can be connected to an external FM demodulation circuit. The automatic gain control (AGC) and analog-to-digital converter (ADC) functions are also made accessible via the pins in the FR1216 for external control of the overall gain and tuning in the FM mode.

The FR1216 meets the input immunity, signal handling and radiation requirements of CENELEC.

ORDERING INFORMATION

TYPE	DESCRIPTION	CATALOGUE NUMBERS
FR1216/HM/PH	standard phono	3139 147 13351
FR1216/HM/IEC	IEC	3139 147 13361

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.

INTERMEDIATE FREQUENCIES

SYSTEM	FREQUENCY(1) (MHz)
	PAL B/G
Picture carrier	38.90
Colour	34.47
Sound 1	33.40
Sound 2	33.16
NICAM	33.05

Note

1. The oscillator frequency is above the input signal frequency.

CHANNEL COVERAGE

BAND	CHANNELS
FM band	87.50 to 108 MHz
Low band	48.25 to 170.00 MHz
Mid band	170.00 to 450.00 MHz
High band	450.00 to 855.25 MHz

BLOCK DIAGRAM

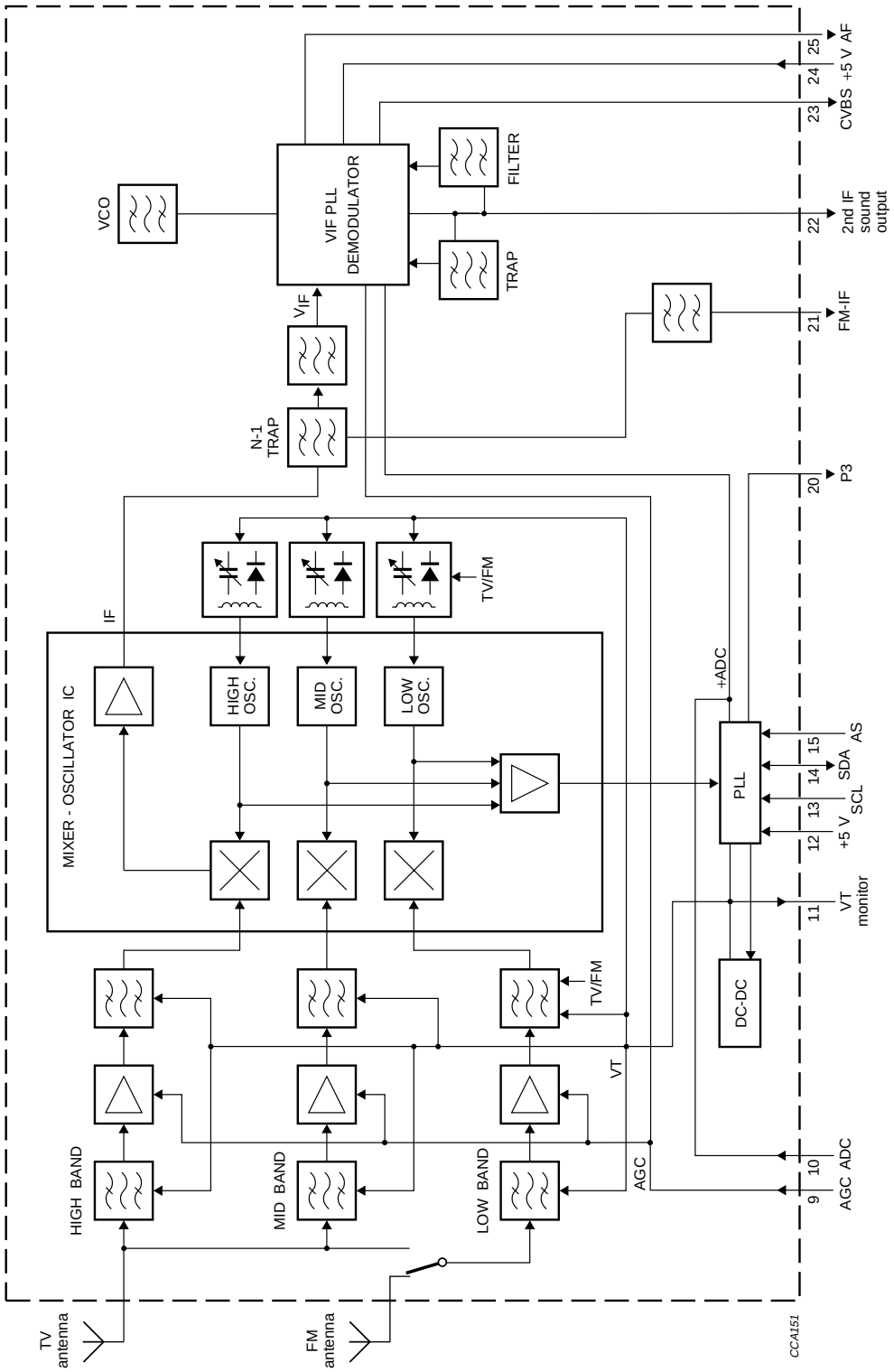


Fig.1 Electrical block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
AGC	9	automatic gain control voltage
ADC	10	analog-to-digital converter input
V_T	11	tuning voltage (monitor)
$V_{S(tuner)}$	12	supply voltage tuner section +5 V
SCL	13	I^2C-bus serial clock
SDA	14	I^2C-bus serial data
AS	15	I^2C-bus address select
P3	20	system switch
FM-IF	21	10.70 MHz output
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)

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
Z_{IAGC}	AGC input source impedance	9	–	–	500	Ω
Z_{IADC}	ADC input source impedance	10	–	–	500	Ω
$V_{S(tuner)}$	supply voltage	12	4.75	5.00	5.25	V
$V_{S(ripple)}$	peak-to-peak ripple voltage susceptibility (at 5 V ±5%); note 1					
	20 Hz to 100 kHz		–	–	20	mV
	>100 kHz to 500 kHz		–	–	10	mV
$I_{S(tuner)}$	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
Z_{IF}	2nd IF sound output load impedance:	22				
	DC		0.5	–	–	kΩ
	AC		0.5	–	–	kΩ
Z_{CVBS}	Composite Video Baseband Signal load impedance:	23				
	DC		–	75	–	Ω
	AC		–	75	–	Ω
t_L	CVBS load time constant		–	–	100	ns
$V_{S(IF)}$	IF supply voltage	24	4.75	5.0	5.25	V
$V_{IF(ripple)}$	peak-to-peak ripple voltage susceptibility (at 5 V ±5%); note 1					
	20 Hz to 100 kHz		–	–	20	mV
	>100 kHz to 500 kHz		–	–	10	mV
$I_{S(IF)}$	IF supply current		–	–	100	mA
Z_{AF}	AF sound output load impedance:	25				
	DC		1.0	–	–	kΩ
	AC		0.6	–	–	kΩ

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; criteria for FM interference >40 dB.
   Conditions: FM deviation = 22.5 kHz; external filter 300 Hz to 20 kHz; 50 μs de-emphasis.
2. For detailed information about the address decoding, refer to Chapter “Application information”.

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

SYMBOL	PARAMETER	VALUE	UNIT
T_{amb}	ambient temperature	25 ±5	°C
RH	relative humidity	60 ±15	%
$V_{S(tuner)}$	supply voltage (tuner section)	5 ±0.125	V
$V_{S(IF)}$	supply voltage (IF section)	5 ±0.125	V
Z_{CVBS}	video output load impedance (DC)	75	Ω
Z_{IF}	2^{nd} IF sound output load impedance	>500	Ω
t_{pr}	pre-heating time (+5 V at pin 24)	10	minute
$Z_{S(AE)}$	aerial source impedance (unbalanced)	75	Ω

TUNER SECTION

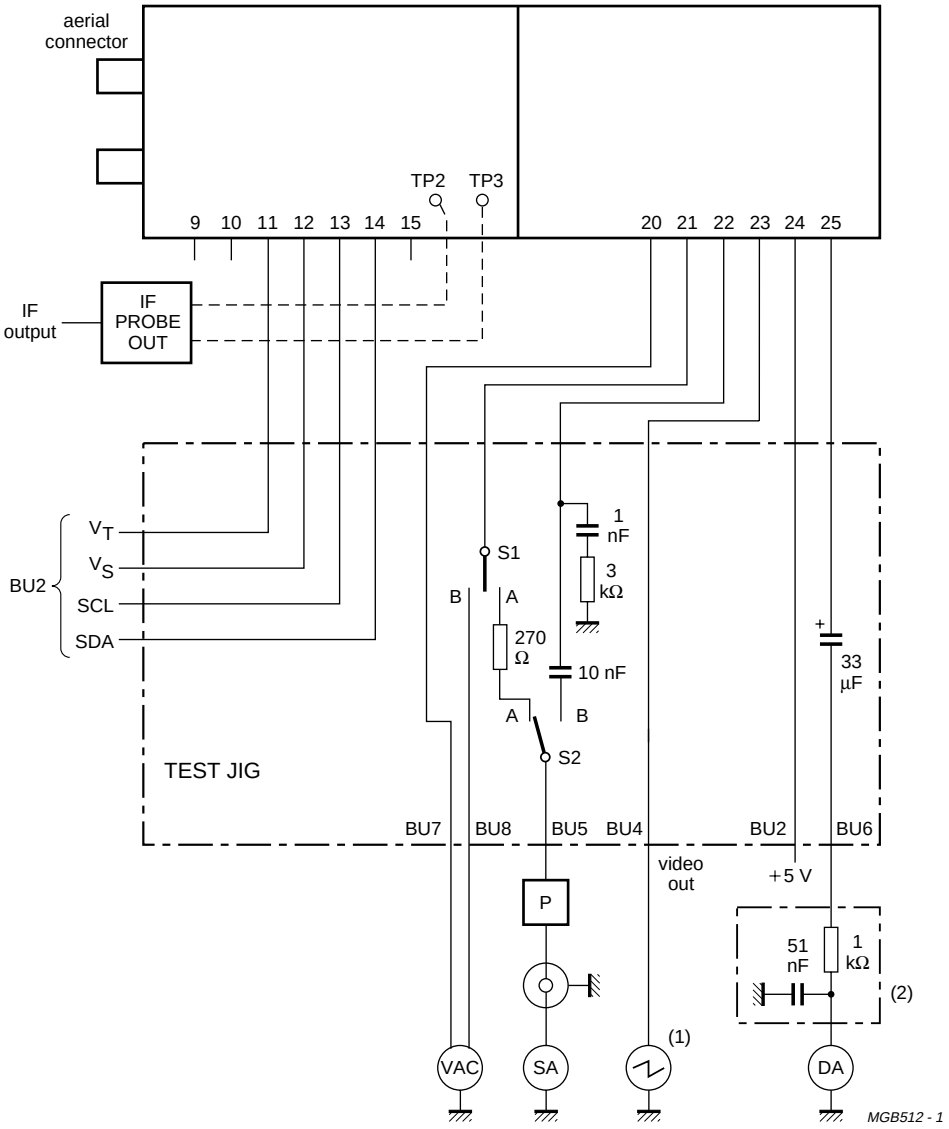
Tuner characteristics

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	MΩ
Oscilloscope	input impedance:		
	resistance	>1	MΩ
	capacitance	<15	pF
Spectrum analyzer	input impedance	50	Ω
FET probe	input impedance:		
	resistance	1	MΩ
	capacitance	3.5	pF
	output impedance	50	Ω
	voltage gain	0	dB



(1) BU4 loaded with 75 Ω.
(2) 50 µs de-emphasis.
SA = Spectrum Analyzer.
P = FET probe.
DA = Distortion Analyzer.
VAC = dual channel AC voltmeter (Z_i = 600 Ω)

Fig.2 Typical test set up.

Definitions of test signals (see Fig.2)

TEST SIGNAL	FREQ. (MHz)	AMPLITUDE	MODULATION	
			VIDEO	AUDIO
A0: unmodulated vision carrier	480.25	60 dBμV		
A1: CCIR B/G standard signal with video modulation	480.25	60 dBμV (top sync)	100% (rest carrier 10%) 2T pulse and bar	
B1: unmodulated sound carrier B/G system	485.75	−13 dB w.r.t. A0 to A1		
B2: FM modulated sound carrier B/G system	485.75	−13 dB w.r.t. A0 to A1		1 kHz; modulation frequency deviation ±27 kHz; 50 μs pre-emphasis
B3: unmodulated sound carrier B/G system	478.75	−13 dB w.r.t. A0 to A1		
C1: FM modulated sound carrier	87.5	60 dBμV		1 kHz; modulation frequency deviation ±75 kHz; 10% pilot carrier (L = R)
C2: FM modulated sound carrier	98.0	60 dBμV		1 kHz; modulation frequency deviation ±75 kHz; 10% pilot carrier (L = R)
C3: FM modulated sound carrier	108.0	60 dBμV		1 kHz; modulation frequency deviation ±75 kHz; 10% pilot carrier (L = R)
C4: FM modulated sound carrier	98.0	60 dBμV		1 kHz; modulation frequency deviation ±22.5 kHz
C5: unmodulated sound carrier	98.0	60 to 100 dBμV		

Antenna input characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
VSWR	reflection coefficient	referred to 75 Ω impedance (TV mode: worst case on or between picture and sound carrier at maximum gain)			
	TV mode		–	5	
	FM mode		–	4	
V_{PSM}	surge protection voltage		5	–	kV
V_{ant}	antenna connection disturbance voltage	<1.75 GHz	–	46	dBμV

General characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_b	frequency range:					
	FM band		87.50	–	108.00	MHz
	low band		48.25	–	168.25	MHz
	mid band		175.25	–	447.25	MHz
	high band		455.25	–	855.25	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		70	–	–	dB
	mid band	<300 MHz	66	–	–	dB
	mid band	>300 MHz	60	–	–	dB
	high band		50	–	–	dB
α_{IF}	IF rejection (picture)		60	–	–	dB
Z_{IF}	½ IF susceptibility:					
	E2 to E12		75	–	–	dBµV
	E21 to E69		60	–	–	dBµV
α_S	sound-chrominance moiré rejection:					
	off-air	up to 40 dB gain control	56	–	–	dB
	UHF	up to 30 dB minimum gain control	56	–	–	dB
m_x	cross modulation:					
	in-channel		70	–	–	dBµV
	in-band					
	low band (n ±2)		78	–	–	dBµV
	mid band (n ±3)		78	–	–	dBµV
	high band (n ±5)		84	–	–	dBµV
	out of band		–	100	–	dBµV
	breakthrough susceptibility:					
	E2 to E12; E21 to E69		60	–	–	dBµV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{osc}	oscillator voltage at all pins		–	–	70	dBμV
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 μPa)		40	–	–	dB
V_{ESD}	electrostatic discharge (ESD) on all pins	note 1	2	–	–	kV
FM radio characteristics						
$G_{V(FM)}$	FM voltage gain	test signal C1	35	–	–	dB
$\alpha_{i(FM)}$	FM image rejection		57	–	–	dB
$\alpha_{IF(FM)}$	FM IF rejection		60	–	–	dB
$Z_{IF(FM)}$	1st repeat spot interference		75	–	–	dBμV

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")*.

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	0.7	–	1.1	V
DC level sync pulse at pin 23	A1	BU4	–	0.35	–	V
Video amplitude drop with respect to modulation 0.1 MHz at T_{amb} = 45 °C:						
at 1 MHz	A1	BU4	–1.0	–	+1.0	dB
at 2 MHz	A1	BU4	–1.5	–	+1.5	dB
at 3 MHz	A1	BU4	–2.5	–	+1.5	dB
at 4 MHz	A1	BU4	–4.0	–	+2.0	dB
at 4.43 MHz	A1	BU4	–6.0	–	+2.0	dB
Sound carrier rejection	A1 (1 MHz) + B1	BU4	40	–	–	dB
Residual 40.4 MHz signal in video channel: level of 1.5 MHz	A1 + B3	BU4	–	–	68	dBμV
Residual 77.8 MHz signal in video channel	A1	BU4	–	–	80	dBμV
Second IF sound output level at level of 5.5 MHz	A1 + B1	BU5	84	–	–	dBμV
Test on 2T pulse at T_{amb} = 45 °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	dBμV
Audio characteristics:						
AF output level measured via LP 20 kHz filter, RMS detector, 50 μs de-emphasis	A1 + B2	BU6	0.25	0.35	0.50	V
THD (Total Harmonic Distortion) measured via LP 20 kHz filter, RMS detector, 50 μs de-emphasis	A1 + B2	BU6	–	–	0.5	%
S/N measured via CCIR filter, peak CCIR detector, 50 μs de-emphasis	A1 (6 kHz sine wave, black-to-white) + B1	BU6	41	–	–	dB
AF 3 dB response measured via LP 20 kHz filter, RMS detector, de-emphasis off	A1 (black) + B1	BU6	16	–	–	kHz
AM suppression ratio	A1 + B2	BU6	40	–	–	dB

‘Digital AFC status

PARAMETER	CONDITIONS	FREQUENCY (kHz)	DIGITAL READ-OUT
ADC word at I^2C-bus during read operation	input voltage at pin 10: 0.0 to $0.15V_{S(tuner)}$	–125	00
	input voltage at pin 10: 0.15 to $0.30V_{S(tuner)}$	–62.5	01
	input voltage at pin 10: 0.30 to $0.45V_{S(tuner)}$	0	02
	input voltage at pin 10: 0.45 to $0.60V_{S(tuner)}$	+62.5	03
	input voltage at pin 10: 0.60 to $1.00V_{S(tuner)}$	+125	04

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

$V_{S(tuner)}$ = +5 V (PLL supply voltage)

MA1	MA0	ADDRESS(1)	VOLTAGE AT PIN 15
0	0	#C0	0 to $0.1V_{S(tuner)}$
0	1	#C2	0.2 to $0.3V_{S(tuner)}$
1	0	#C4	0.4 to $0.6V_{S(tuner)}$
1	1	#C6	0.9 to $1.0V_{S(tuner)}$

Note

1. If the address select pin (AS, pin 15) 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.

Test mode settings:

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

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 (for slow picture search)
1	1	62.5 kHz (for normal picture search)

PORTS BYTE

Band switching

BAND	BIT(1)							
	P0	P1	P2	P3(2)	P4	P5	P6	P7
Low band	0	0	0	X	0	1	0	1
Mid band	0	0	0	X	1	0	0	1
High band	0	0	0	X	1	1	0	0
FM band	0	0	1	X	0	1	0	1

Notes

1. X = don’t care; P0 to P7 are output ports on the PLL device.
2. P3 is a system switch output for customer applications.

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.

Remark: for channel selection involving band switching, and to ensure smooth tuning to the desired channel without causing unnecessary charge pump action, it is recommended to consider the difference between wanted channel frequency (f_w) and the current channel frequency (f_c):

- If $f_w > f_c$, use telegram as:

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

- If $f_w < f_c$, use telegram as:

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

Unnecessary charge pump action will result in very low tuning voltage ($V_T \approx 0$ V) which may drive the oscillator to extreme conditions.

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 $V_{S(tuner)}$ 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 7.8125 kHz reference frequency 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 I/O port P6. AFC information to the controller of the IF section is available on pin 10 (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.

Video buffer

A video buffer is built into the video & radio module, to enable the unit to drive a 75 Ω load directly. In case it is required to use the FR1216 as a replacement for the FI1216 in the same videocard, it is necessary to replace the 75 Ω series resistor in the video card by a 0 Ω series resistor. At the same time the 22 kΩ series resistor in the tuning supply must be removed.

I²C-bus load

The FR1216 contains a series resistor (R = 100 Ω) in the SCL and SDA lines. Both lines also have a capacitive load of typical 56 pF (see Fig.3).

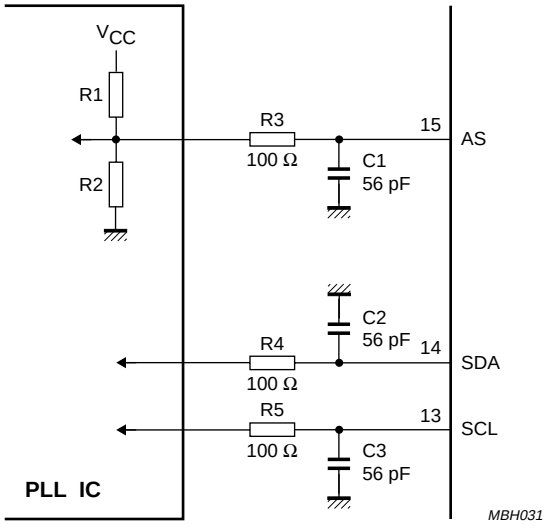
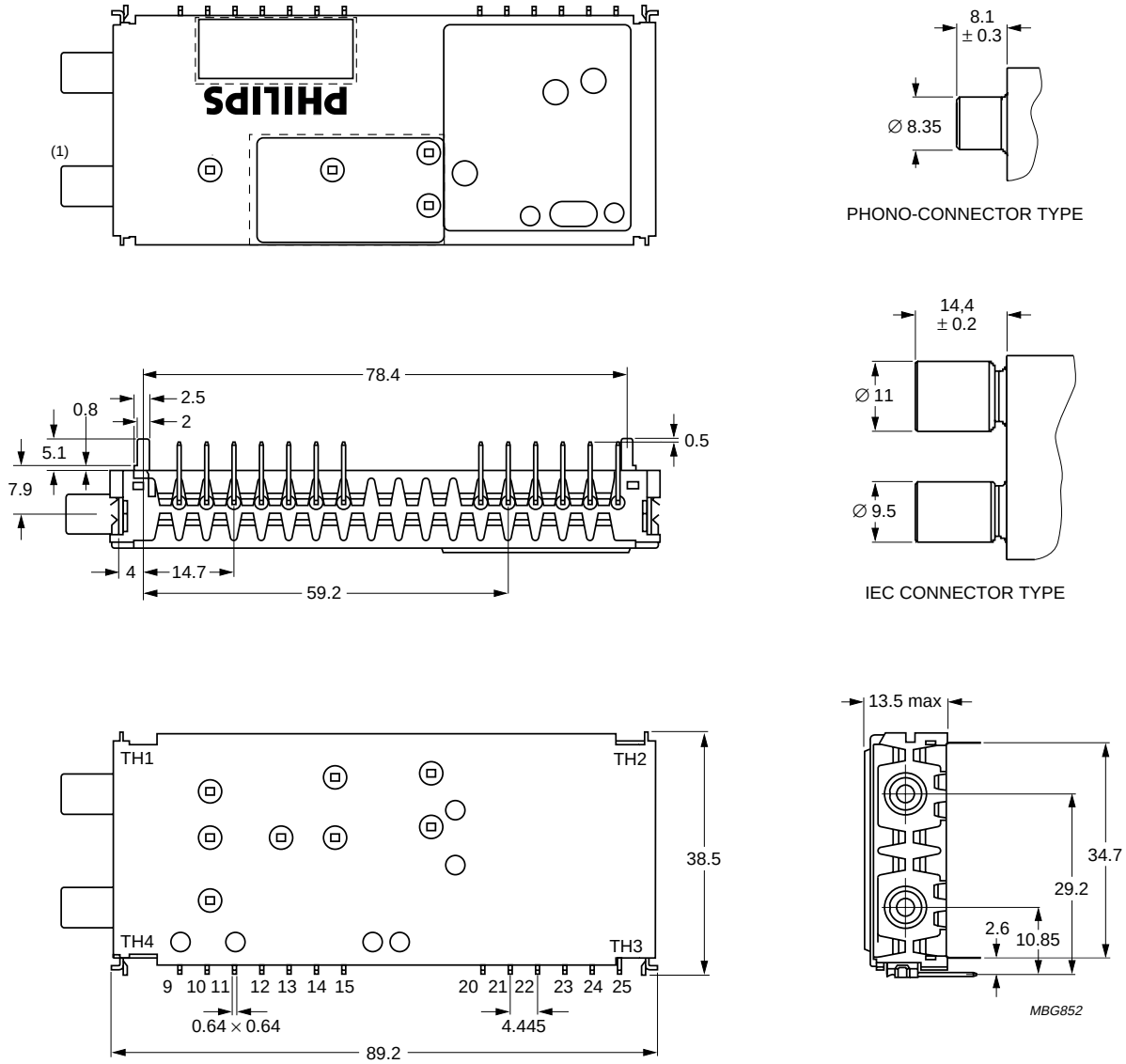


Fig.3 I²C-bus load.

MECHANICAL DATA



Dimensions in mm.

(1) Standard-phono socket female 75 Ω.

Fig.4 Mechanical outline.

Aerial connections

Standard-phono socket female 75 Ω and IEC female (TV) and male (radio).

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 °C for 2 s), results in a wetted area of 95%. No de-wetting will occur when soldered at 260 °C for 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 °C for 10 ±1 s).

Mass

Approximately 50 g.

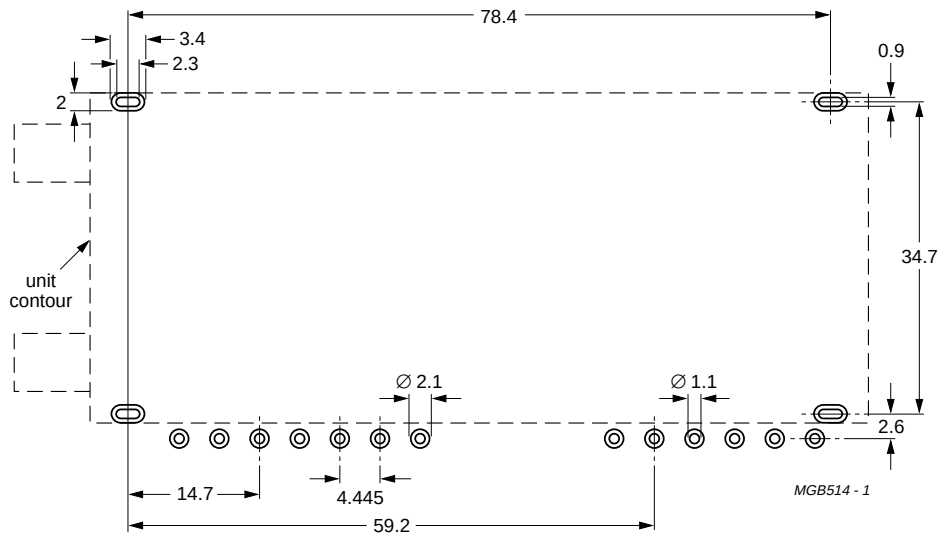
Robustness of pins

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

- Test Ua1, tensile of 10 N in axial direction
- Test Ua2, thrust of 4 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).



Dimensions in mm.

Fig.5 Punching pattern seen from solder side.

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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