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Objective Data Sheets

CD1300L

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Released by: Development

Product Marketing

VER020301

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1.Brief Product Description

CD1300L tuners are based on the single conversion concept, covering the entire frequency range from 51MHz to 858MHz (channel center) while it's subdivided into three bands.
Development focus was concentrated on the digital cable applications of which a flat responds curve and low oscillator phase noise are essential.
A European version (CD1316, 36.13MHz IF) and a US version (CD1336, 44MHz IF) are available.
The tuners are equipped with a digital programmable (I^2C bus) phase-locked-loop tuning system that controls beside the tuning routine also the band switching.
Tuner internally the tuning voltage is derived from the supply voltage by means of a DC-DC converter so that only a 5V supply voltage is needed.
CD1300L tuners are equipped with an active power splitter (loopthrough) that feeds the incoming RF-spectrum through to the RF-output connector for further usage.
This active splitter is separately powered to enable the stand-by mode with main (tuner) supply voltage switched off while the splitter remains active.
The internal 4MHz crystal reference is available at one of the tuner pin terminals to drive a second unit.

CD1300 tuners provide a balanced IF-output that is able to directly drive a SAW-filter load; the output impedance is low with about $|80\Omega|$ in the IF-range.
Besides the symmetrical (balanced) applications, the CD1300L can be loaded asymmetrical as well whereby the unused IF-terminal must be connected to ground.

This specification describes the performance data of tuners CD1316L, CD1336L .

Frequency allocation table:

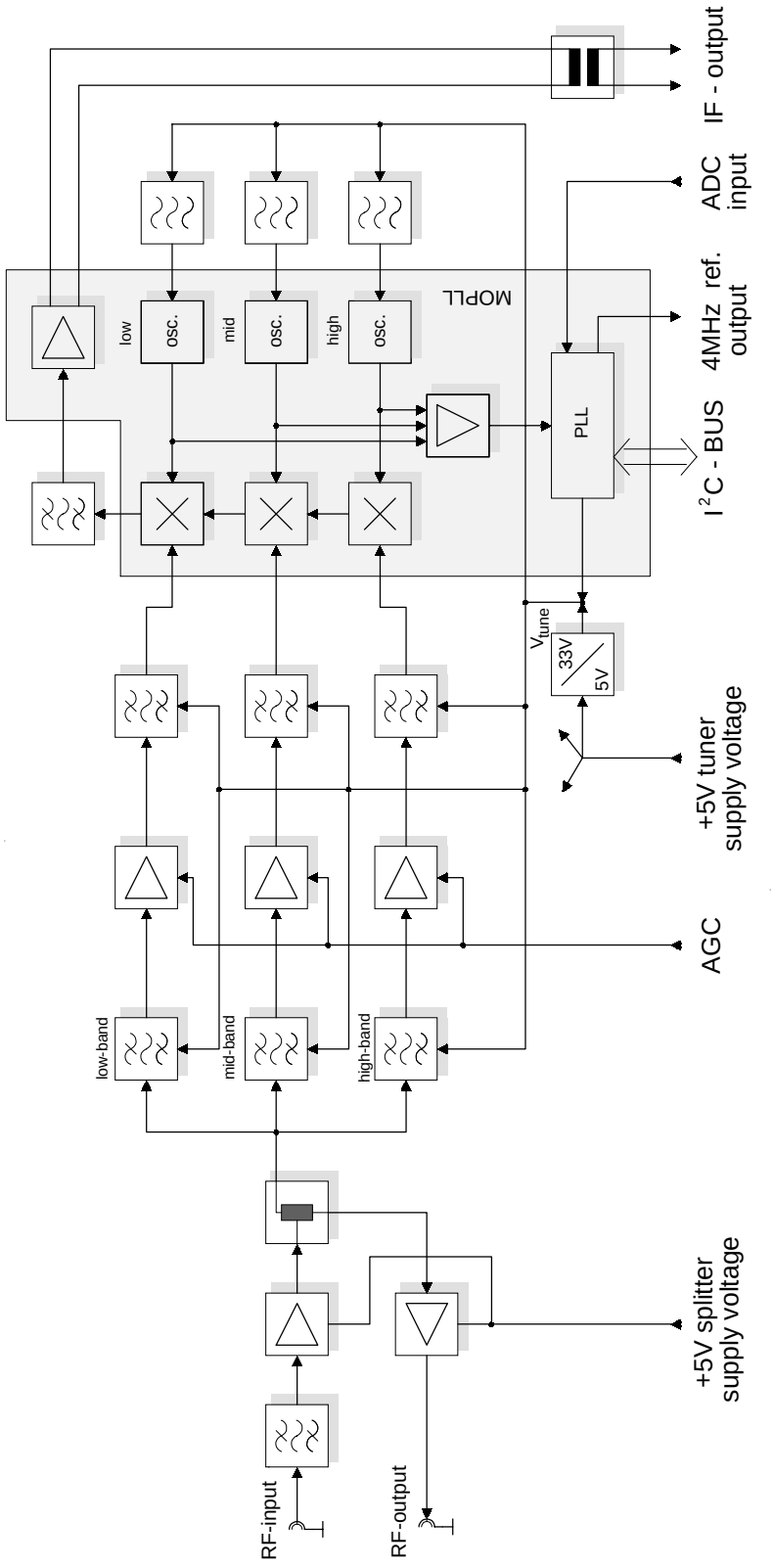
	CD1316L	CD1336L
RF Frequency range	51 MHz – 858 MHz (*)	57 MHz – 863 MHz (*)
IF Center Frequency	36.13 MHz	44.00 MHz
Channel Bandwidth	7/8 MHz (<300MHz/>301MHz)	6 MHz
RF input/output connectors	standard IEC female/male	standard F-connectors

(*) data refers to RF channel center frequency

2. Features

- High performance and cost effective single conversion tuner
- I^2C–Bus 3.3 V , 400 kHz compatible
- Fast PLL tuning speed (min. step-size 62.5kHz)
- 0 to 3.3 V AGC voltage
- only +5V supply voltages required
- Flat overall frequency response
- Low oscillator phase noise
- Power-safe-mode with tuner supply off and RF-loopthrough still active
- Buffered 4MHz crystal reference output
- Horizontal or vertical mounting
- The tuners comply with European Standard EN55020 (CD1316) and FCC part 15 (CD1336) with regard to requirements of radiation, signal handling capability and immunity

Electrical blockdiagram:



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3. Ratings

Non-operational conditions:

- ambient temperature : -25C to +90C
- relative humidity : 100% max
- bump acceleration : 245 m/s^2 max

Operational conditions:

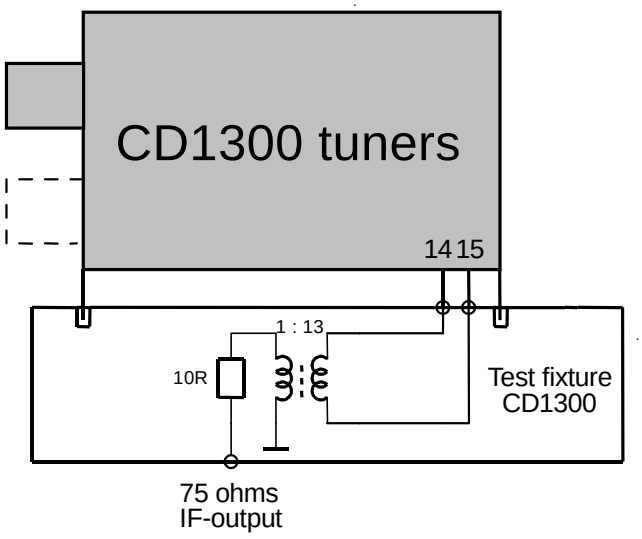
- +5V tuner supply voltage : 5V ± 5%
- +5V splitter supply voltage : 5V ± 5%
- AGC voltage : 0V to 4V
- address select voltage : 0V to 5.5V
- A-to-D converter input voltage : 0V to 5.5V
- serial data input voltage : 0V to 5.5V
- serial clock input voltage : 0V to 5.5V
- I^2C clock frequency : 400kHz max.
- max. permissible IF-load : 1kohms min. // 25pF max.
- ambient temperature : -10C to +60C

4. Specification Data

If not otherwise stated the electrical performance refers to:

- ambient temperature : 22°C ±2°C
- relative humidity : 60% ±10%
- supply voltages : 5V ±0.1V
- gain control voltage : 3.3V ±0.1V

(used test-fixture)



The tuner has to be tuned as such that the RF-channel center coincides with IF-center frequency.

Next specification data refer to the overall performance from RF-input to IF-output:

	min.	typ.	max.
Frequency ranges: *CD1316* Low-band Mid-band High-band *CD1336* Low-band Mid-band High-band (Note 1)	 51MHz (49MHz) 178MHz (173MHz) 458MHz (454MHz) 57MHz (54MHz) 165MHz (162MHz) 459MHz (455MHz)		 171MHz (173MHz) 450MHz (454MHz) 858MHz (862MHz) 159MHz (162MHz) 453MHz (455MHz) 863MHz (866MHz)
RF voltage gain:	41 dB		49 dB
Overall gain taper			6dB
RF AGC range: *Low band* *Mid band* *High band*	 40 dB 40 dB 35 dB		
AGC slope *(within the spec. range)*		60dB/V	
Image rej.: *(ref. to IF-center)* *low- mid-band* *high-band* (CD1316L) *high-band* (CD1336L)	 67dB 58dB 60dB	 72dB 63dB 63dB	
Osc. voltage at *Aerial input(75Ω):* *(f < 1000MHz)* *(f > 1000MHz)*		 <10dBuV	 15dBuV tbc
RF-input return loss: *(referred to 75ohms)*	6dB	>8dB	
In-channel return loss: *RF-channel center ± 3MHz* *(referred to 75ohms)*	8dB	>10dB	
Osc. phase noise: *(10kHz)* *(100kHz)*	 - 86 dBc/Hz -106 dBc/Hz	 - 90dBc/Hz -108dBc/Hz	

	Min.	Typ.	max.
Overloading causing 1dB gain compression		78dBuV	
RF-input signal level (single carrier)			95dBuV
Noise figure: (at nom. Gain)		7.5 dB	9 dB
ESD protection of Terminals	2kV		
Surge protection at RF-input	6kV		

Cross-modulation:

Definition: The cross-modulation is defined as the transfer of the adjacent channels' modulation depth to the wanted carrier.

Measurement: Unwanted carriers (f_{unw}) = wanted carrier (f_w) ± 7MHz for CD1316L
Unwanted carriers (f_{unw}) = wanted carrier (f_w) ± 6MHz for CD1336L
Level of all carriers = 70dBµV
Modulation = AM, 50%, 15kHz
IF-ouput loaded with 1kohms // 25pF // 820nH (load compensation)
IF-output level limited to 105dBuV by activating of the RF-input amplifier gain control
Spec. limit: max. cross-modulation is less or equal 1% (typ. 0.3%)

Flatness (tilt) of response curve:

Definition: Tilt of the overall response curve is defined in the specified IF-range from highest to lowest gain point at nom. gain

CD1316L: in the range IF-center ± 3.0MHz : 2.5dB max.
in the range IF-center ± 4.0MHz : 3.5dB max.

NOTE: below 90MHz the flatness of curve is slightly deteriorated in the range IF-center ± 4MHz; the limit here is : 4.0dB max.

CD1336L: in the range IF-center ± 3.0Mhz : 2.5dB max.
in the IF-range 46.25MHz to 42.0MHz : 1.5dB max.

Deterioration of flatness during AGC (0dB to 30dB) : 1.0dB max.

4MHz reference output (terminal 10):

Frequency accuracy : <80ppm

Max. permissible load : 500ohms

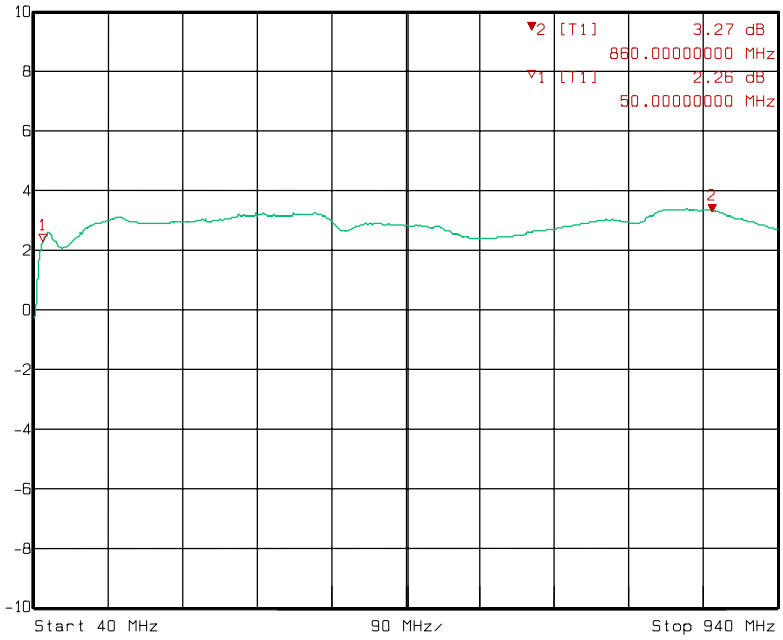
Output level : >800mVpp
(0°C - 60°C ;
supply voltage terminal 11 +5V±5% ;
loaded with min.500ohms)

Phase Noise @ 1kHz : < -103dBc/Hz

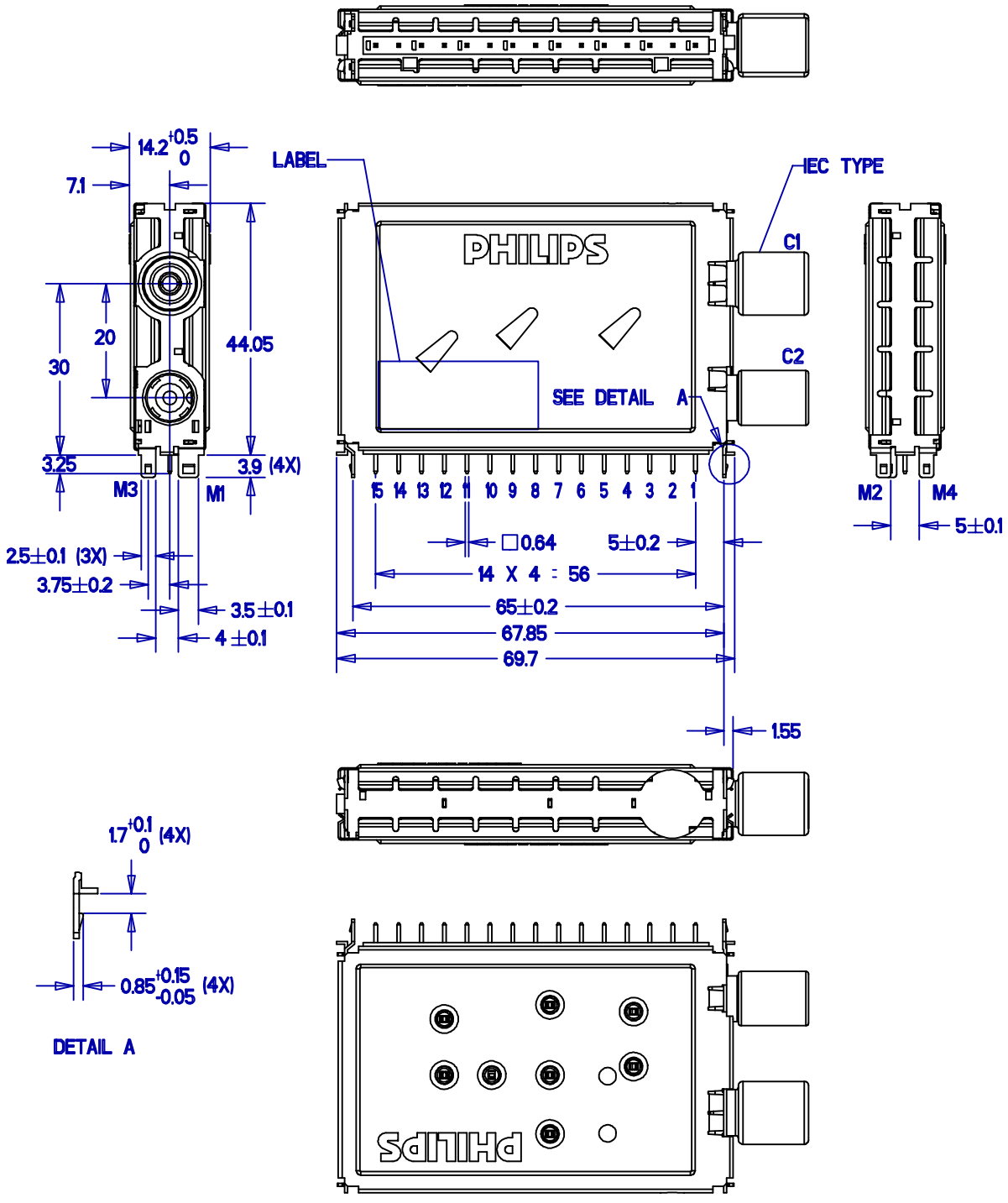
Next specification data refer to the overall performance from RF-input to RF-output:

Parameter	Min.	Typ.	Max.
Power gain	1.5dB	3dB	3.5dB
Noise figure		8dB	9dB
Overl. 1dB gain compression		> 95dBµV	
CSO / CTB	t.b.f.		
Return loss RF-output		> 10dB	
27MHz citizen band suppression		> 15dB	

Typical transfer gain of splitter from RF-in to RF-out:



5. Mechanical Dimensions (dimensions in: mm)



Note:
- General Tolerance ±0.5 mm unless otherwise stated.
- All dimensions are in millimeter.
- Drawing not to scale.

VERTICAL MOUNTING

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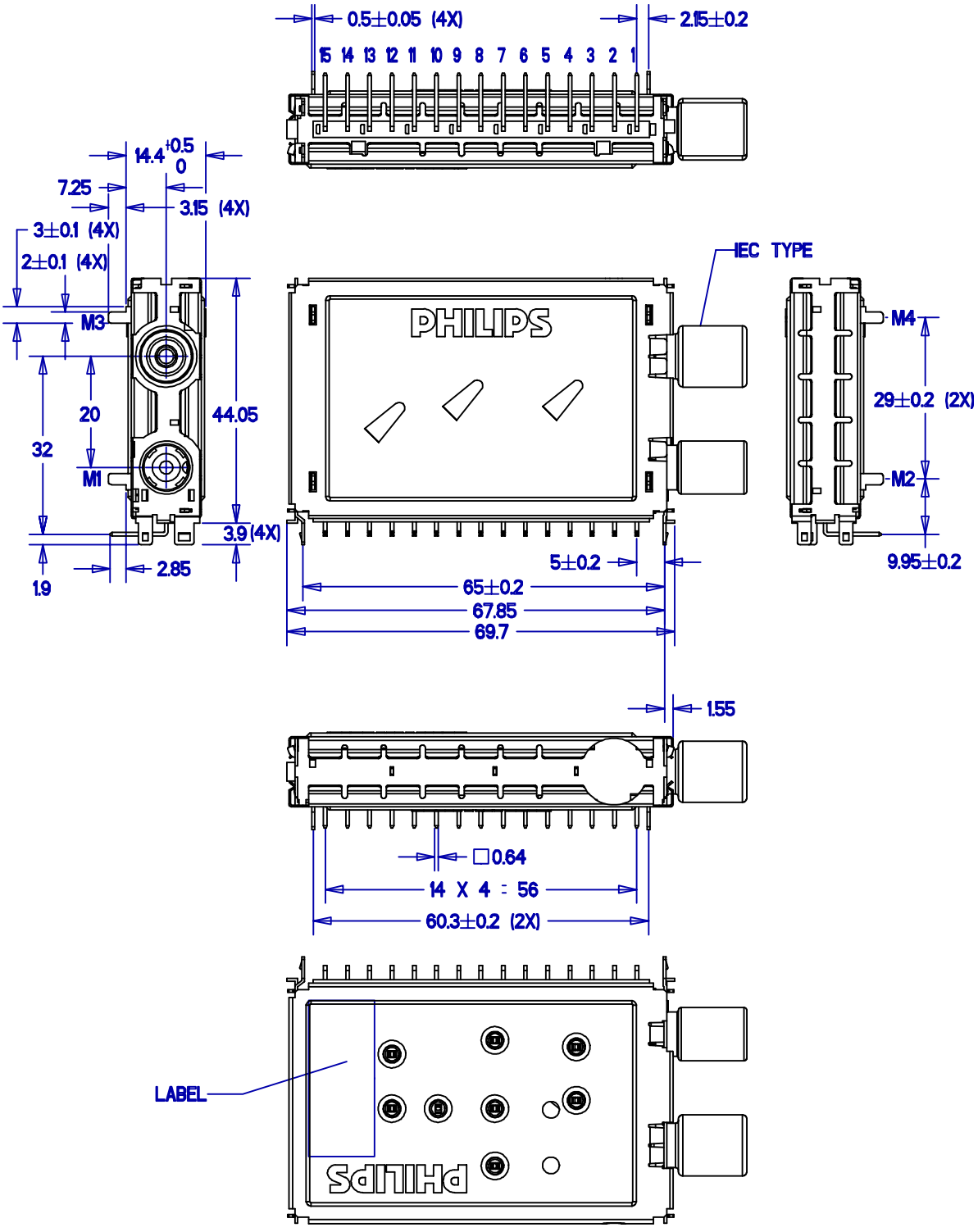

HORIZONTAL MOUNTING

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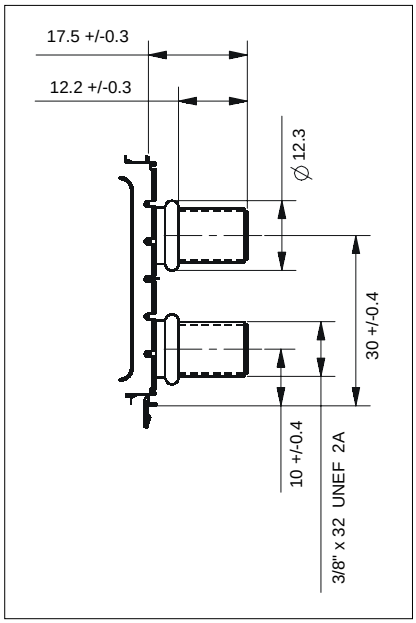
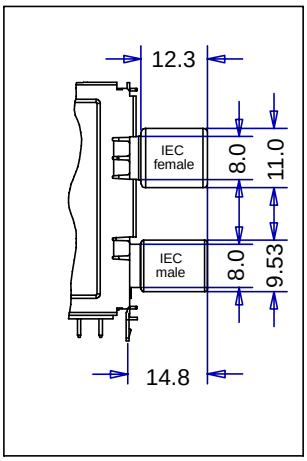
Connector units and punching pattern:

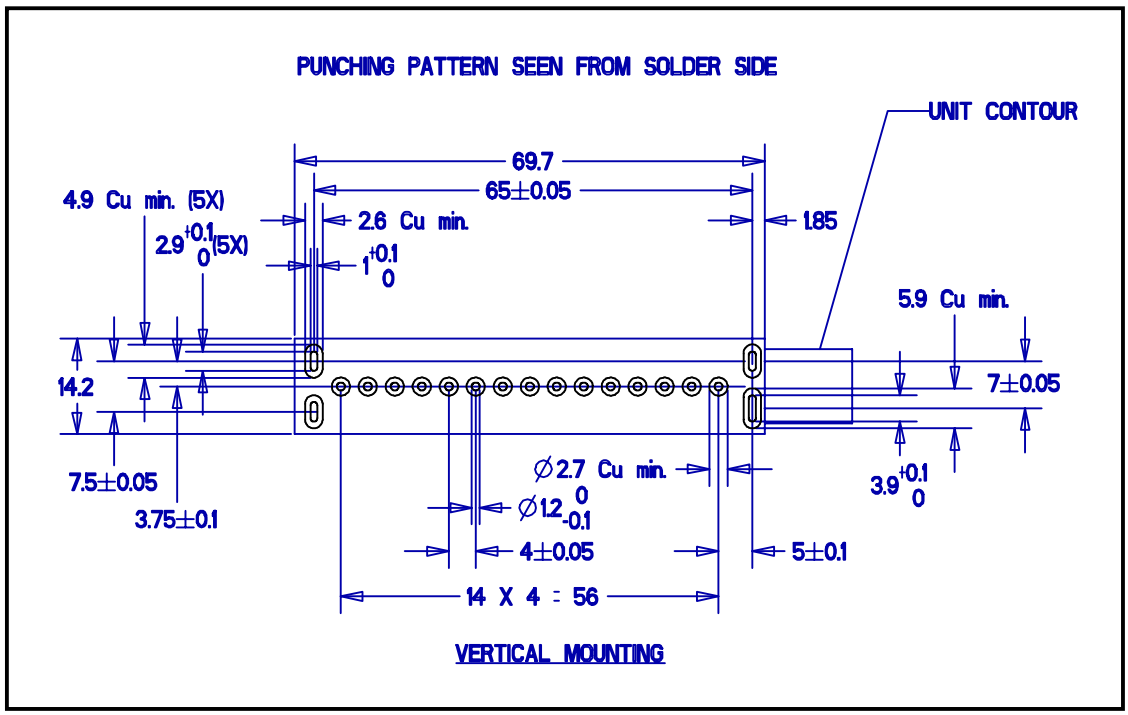
NOTE: CD1316L tuners are equipped with IEC connectors !
CD1336L tuners are equipped with F-connectors!



F-connector dimensions



IEC-connectors dimensions



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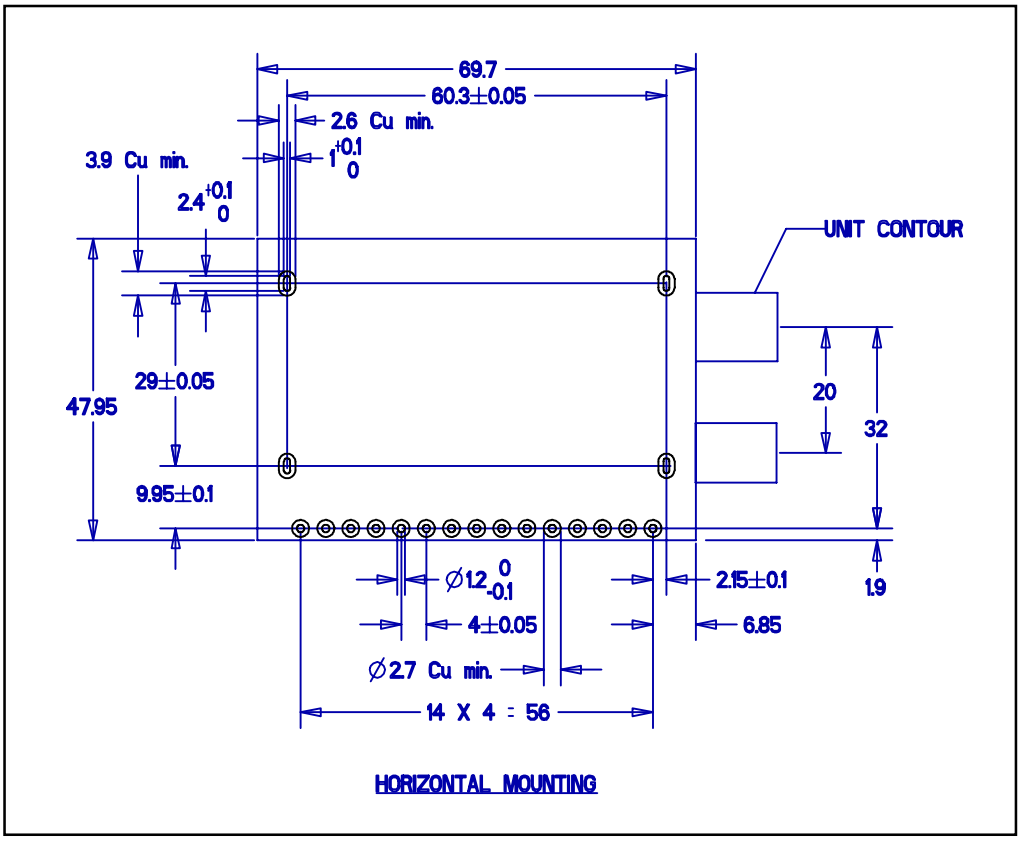
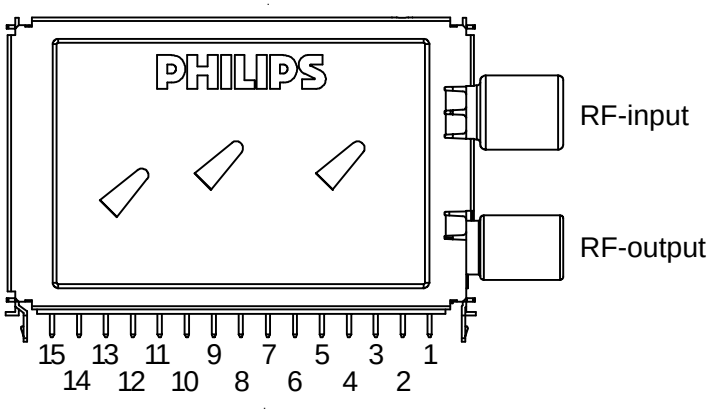

69.7
60.3±0.05
2.6 Cu min.
3.9 Cu min.
UNIT CONTOUR
47.95
29±0.05
9.95±0.1
20
32
1.9
2.15±0.1
6.85
4±0.05
Ø2.7 Cu min.
14 X 4 = 56
HORIZONTAL MOUNTING



6. Definition of Terminals / Supply Data

Terminal	Function	Remark
1	not connected	
2	+5V ± 5% splitter supply voltage	Max. current = 80mA
3	not connected	
4	not connected	
5	RF gain control voltage input (3.3V max. gain to 0.4V min.gain)	Max. current < 3uA
6	do not connect, leave terminal open	for testing only
7	Address select (I^2C / tuner)	See application note
8	SCL (I^2C / tuner)	
9	SDA (I^2C / tuner)	
10	4MHz crystal reference output	typ. 900mV_{p-p} into 500ohms
11	+5V ± 5% supply voltage tuner (V_{TU})	Max. current = 110mA
12	A-to-D converter input	See application note
13	do not connect, leave terminal open	for testing only
14	IF output	AC-coupled
15	IF output	AC-coupled

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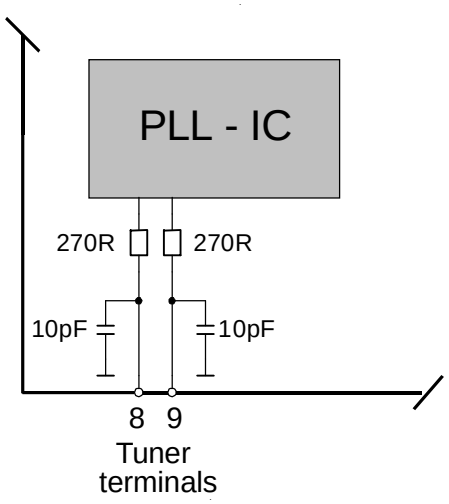
7. Application Notes

The tuner control (frequency selection and band switching) is done via the I^2C bus.
One address byte and four data bytes are need to fully program the tuner.
A PLL lock flag and the A to D converter data (depending on the voltage applied to terminal 12) can be read out from the tuner.
The PLL can respond on 4 adresses; which one is actually valid depends on the address select voltage that is connected to terminal 7.
The tuners are 5V- and 3.3V- I^2C bus compliant; the max. clock frequency is 400kHz.

Next sketch shows how the I^2C lines are loaded tuner internally.



I^2C-bus data format , 'write' mode (R/W-bit = 0):

NAME	BYTE	BITS								ACK
		MSB							LSB	
Address byte	ADB	1	1	0	0	0	CA1	CA0	R/W=0	A
Divider byte 1	DB1	0	N14	N13	N12	N11	N10	N9	N8	A
Divider byte 2	DB2	N7	N6	N5	N4	N3	N2	N1	N0	A
Control byte	CB	1	CP	0	T1	T0	1	1	0	A
Band-switch byte	BB	0	0	0	0	0	P2	P1	P0	A

Description of used symbols:

CA1, CA0: programmable chip address bits

CA1	CA0	*Voltage applied to terminal 7*
0	0	0V to $0.1xV_{TU}$
0	1	terminal open
1	0	$0.4xV_{TU}$ to $0.6xV_{TU}$
1	1	$0.9xV_{TU}$ to $1.0xV_{TU}$

N14 to N0: programmable divider bits

divider ratio: $N = N14x2^{14} + N13x2^{13} + ... + N1x2^{1} + N0$
min. step size: 62.5kHz

How to calculate the divider ratio N :

$$N = \frac{(f_{input} + f_{IF})}{f_{ref}}\left[\frac{Hz}{Hz}\right] \quad \text{whereby} \quad f_{ref} = \frac{4 \cdot 10^6}{64}[Hz] = 62.5kHz$$

Note: Do not set the divider ratio as such that the tuner is tuned into extreme conditions i.e. far below or far above the specified ranges.

CP: charge pump current CP = 0 = 60µA
CP = 1 = 280µA

Recommended PLL charge-pump setting:
to ensure fast tuning speed, for instance during search tuning, the charge pump current should be set to high condition; after channel acquisition the charge pump should set back to low current to ensure best phase noise performance.

T1, T0: programmable mode setting bits

T1	T0	*Mode settings*
0	0	normal mode
0	1	normal after power-on-reset

P2, P1, P0: programmable bandswitch-ports

P2	P1	P0	*Selected band*
0	0	1	low-band
0	1	0	mid-band
1	0	0	high-band

I^2C-bus data format , 'read' mode (R/W-bit = 1):

NAME	BYTE	BITS								ACK
		MSB(1)							LSB	
Address byte	ADB	1	1	0	0	0	CA1	CA0	R/W=1	A
Status byte	SB	POR(2)	FL(3)	1	1	0	AD2	AD1	AD0	-

1. MSB is transmitted first.
2. POR : power-on-reset flag; POR=1 at power-on.
3. FL : in-lock flag; FL=1 when loop is locked.
4. AD2,AD1,AD0 : digital output of 5-level A-to-D converter (see table)

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A-to-D converter levels

AD2	AD1	AD0	*Voltage applied to terminal 12*
1	0	0	0.60 x V_{TU} to 5.5V
0	1	1	0.45 x V_{TU} to 0.60 x V_{TU}
0	1	0	0.30 x V_{TU} to 0.45 x V_{TU}
0	0	1	0.15 x V_{TU} to 0.30 x V_{TU}
0	0	0	0 to 0.15 x V_{TU}

Note: Accuracy is ± 0.03 x V_{TU}

Default settings after Power-On-Reset (POR)

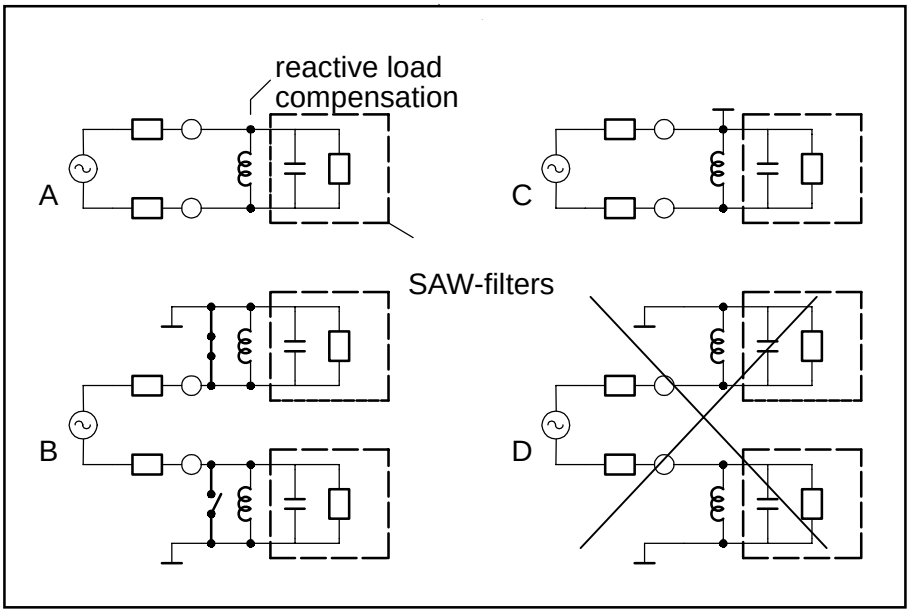
The power-on detection threshold voltage is at V_{TU}= 3.5V at room temperature (20deg. C). Below this threshold the tuner is reset to the power-on state.
At power-on state, the charge pump (CP) is set to 280µA, the tuning voltage is maximum, the mode-setting bits T1, T0 are set to '01'.
All bandswitching ports are set to '0' .

Max. Permissible IF-load and IF-output impedance:

The unbalanced load applied to the IF-output of the tuner should not exceed:
1.0kohms in parallel 26pF

The IF-output impedance (32MHz – 47MHz) is (Rs+jωLs):
Rs= 68ohms ; Ls= 24nH

How to load the IF-output of the tuners is demonstrated in below sketch:



For a better signal handling capability of the tuner it is advisable to compensate for the reactive (capacitive) load e.g. one or more SAW-filter(s) which is/are applied to the IF-output. This compensation is done by using an adequate inductance in parallel to the load (see sketch above).
Besides the standard balanced (symmetrical) loadability it is also possible to apply an unbalanced load to the tuner IF-output. In that case the unused IF-terminal **MUST** be connected to ground. In that sense example D of above sketch is not allowed.

Main board recommendations :

The tracks on the main board connected to the tuners' terminals should be kept as short as possible in order to avoid interferences because of immunty problems and/or to avoid problems with regard to radiation of the local oscillator.
The source impedance of the gain control voltage applied to terminal 5 should not exceed 5kohms.

8. Ordering Informations

Tuner Type	Mounting	RF-connector	Remarks	12 NC
CD1316L/IV	vertical	standard IEC female, male	pin10: 4MHz reference output	3112 297 12801
CD1316L/IH	horizontal	standard IEC female, male	pin10: 4MHz reference output	3112 297 12891
CD1335L/FH	Horizontal	standrard F	pin10: 4MHz reference output	3112 297 -----

9. Document revision history

Date	*Document status*	*Rev. no.*	*Revised by*	*Revision details*
01.08.00	objective spec.	1	T. Fenkes	12NC; separate splitter supply;
26.09.00	Objective spec.	2	T. Fenkes	Figures updated on: gain, phase noise, noise, image reject., tilt, RL; div. Ratio N described; IF-out impedance t.b.f.; introduction of balanced IF-output
19.10.00	Objective spec.	2.1	T. Fenkes	"horizontal drawing" and footprint added ; 12NC "horizontal" tuner added; gain figures adapted; typ. Error corr. "CA0";
02.03.2001	Objective spec.	3.0	T.Fenkes	CD1316L image rej. low-mid changed to 67dB; CD1336L data added!

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DEFINITIONS OF DOCUMENTATION

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

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