DATA SHEET

FQ916 - family (MK2)

VHF/UHF television front ends

Preliminary specification
File under Display Components, DC03

November 1998

PHILIPS

FQ916 - family
UHF/VHF Television Front Ends

- FULL BAND Tuner Section: derived from UV916M tuner
- Mono/Multistandard IF- demodulation section
- Systems B/G,I,L,L',M,D2MAC
- Superior performance, high CENELEC/BZT reserve.
- PLL controlled tuning and demodulation via I^2C-bus
- AFC status read-out via I^2C-bus
- Internal AGC
- Second sound output provides (modulated) NICAM signal

Channel coverage

BAND	FREQUENCY RANGE (MHz)	OFF-AIR CHANNELS (MHz)	CABLE CHANNELS (MHz)
Low	46.25 - 170.00	E2 - C (48.25 - 82.25)	S01 - S10 (69.25 - 168.25)
Mid	170.00 - 450.00	E5 - E12 (175.25 - 224.25)	S11 - S39 (231.25 - 447.25)
High	450.00 - 860.25	E21 - E69 (471.25 - 855.25)	S40 - S41 (455.25 - 463.25)

Derived types

type number	optimal system	secondary system	aerial connector	ordering code
FQ916/LIF	B/G		IEC - long	3112 297 11601
FQ916ME/LIF	B/G	L, M	IEC - long	3122 237 10911
FQ916MF/LIF	L, L'	B/G, I	IEC - long	3122 237 11921
FQ916MR/PH	B/G, D/K	M	Phono	3112 297 11421
FV916MG/PH	B/G, D/K, I, M		Phono	3112 297 11251

Intermediate frequencies

SYSTEM	B/G	D/K	I	L	L'	M
picture	38.90	38.9	38.90	38.90	33.95	38.90
sound 1	33.40	32.4	32.90	32.40	40.45	34.4
sound 2	33.158	-	-	-	-	-
nicam	33.05	-	32.348	33.05	39.8	-
band edge	-	-	-	-	-	-

Note: The oscillator frequency is above the input signal frequency.

DESCRIPTION

The frontends consist of a tuner-section and an IF-section, which are designed on separate PWB's.

The tuner and IF section are assembled in a metal housing made of a rectangular tin plated steel frame with front and rear covers, in which the tuner and IF-parts are interconnected via one or two four-fold connection bridges.
The rear and front cover have soldered contacts to the frame.

A 9.5 mm IEC (long) aerial input socket or phono socket is mounted at the antenna side of the frame . All other connections are made via pins at the bottom.

The tuner part is equipped with 3 tuned RF mosfet input stages, with a 3-band mixer-oscillator IC, containing the oscillators, mixers and IF amplifier.
Tuning and band switching in the tuner-section is done with a digital programmable PLL tuning system.
This enables tuning with a 62.5 kHz pitch with crystal accuracy.

In the IF part the vision carrier is fixed at 38.9 MHz with exception for system L' (fixed at 33.95 MHz, in FQ916MF types only).
All frontends use a true-synchronous vision IF demodulator (PLL) with a vision SAW filter in front of it. For the FQ916MF (system L') a double Nyquist SAW filter is used.
The vision IF demodulator used, is suitable for positive and negative modulation.
Systems B/G, I, L, L' and D/K are split sound, system M is intercarrier.
The IF sound demodulation is done by means of PLL FM demodulators for systems B/G, D/K, M and I. It has also the features of a system switch and an automute in case of mono transmission or AM-sound (system L/L').
The AM detector takes care of the AM sound demodulation for the L/L' system.

The frontends have a 2nd IF sound output which provides digital sound (NICAM) and FM 2nd sound (FV916MG only).

The system switching is done internally via the I^2C bus. The analog AFC voltage is kept internally. This voltage is fed to the A/D converter, present in the PLL tuning IC, offering the feature that the AFC status can be read via the I^2C bus.

The FQ916 front ends comply with the requirements of radiation, signal handling capability and immunity according to the standards listed below:

	FQ916	FQ916ME FQ916MR	FQ916MF	FV916MG
CISPR13 (1990)	X	X	X	X
Amtsblatt 15 (1992) and DIN VDE 0872	X	X		X
European standards EN55013 (radiation) EN55020 (immunity)	X	X	X	X

Terminals

TERMINAL		DESCRIPTION
5	AGC	test purpose
6	B+	supply voltage tuner section (+12 V)
11	V_T	tuning supply voltage (+33 V via 22 kΩ)
12	V_{PLL}	PLL supply voltage (+5 V)
13	SCL	I^2C serial clock
14	SDA	I^2C serial data
15	AS	address select input
16	IF	IF output for test purpose
17	IF	IF output for test purpose
22		2nd IF sound out (for Nicam)
23	CVBS	video output
24	V_{IF}	supply voltage IF section (+5 V)
25	AF1/AM	AF sound out (for both 2 CS and L/L' sound)
27	AF2	AF sound out (for 2CS) note: not on FQ944 types
M1,M2	GROUND	mounting tags

RATINGS

Limiting values

PARAMETER	MIN.	TYP.	MAX.	UNIT
Under non-operational conditions				
Ambient temperature	-25	-	85	°C
Relative humidity	-	-	100	%
Bump acceleration	-	-	245	m/s^2
Shock acceleration	-	-	490	m/s^2
Vibration amplitude (10 to 55 Hz)	-	-	0.35	mm
Under operational conditions				
Ambient temperature	-10	-	60	°C
Relative humidity	-	-	95	%
IF section supply voltage	-	-	5.75	V
B+ supply voltage	-	-	12.6	V
AGC voltage	-	-	13.2	V
PLL supply voltage	-	-	5.75	V
Tuning voltage supply (via series resistor of 22 kΩ)	-	-	35	V
Bus input voltage SDA	-0.3	-	6	V
Bus input voltage SCL	-0.3	-	6	V
Bus current SDA (open collector)	-1	-	5	mA
Address select input voltage	-	-	13.2	V
Video output load impedance d.c. a.c.	 1.0 0.5	 - -	 - -	 kΩ kΩ
AF1/AF2 sound output load impedance d.c. a.c.	 1.0 0.6	 - -	 - -	 kΩ kΩ
2nd IF sound output load impedance d.c. a.c.	 0.5 0.5	 - -	 - -	 kΩ kΩ

OPERATIONAL CONDITIONS AND SUPPLY DATA

The front end can be guaranteed to function properly under the following conditions:

PARAMETER	MIN.	TYP.	MAX.	UNIT
Environmental				
Ambient temperature	-10	-	60	°C
Relative humidity	-	-	95	%
Supply voltage				
B+ supply voltage (terminal 6)	10.8	12	12.6	V
B+ current	-	80	110	mA
B+ permissable ripple	-	-	50	mV(p-p)
V_{IF} supply voltage IF section (terminal 24)				
V_{IF} supply voltage	4.6	5.0	5.5	V
relevant current			160	mA
permissable ripple			50	mV(p-p)
V_{PLL} PLL supply voltage				
V_{PLL} Supply voltage	4.5	5.0	5.5	V
Relevant current for PLL	-	-	55	mA
Permissable ripple voltage	-	-	50	mV(p-p)
V_T Tuning voltage supply (note 1)				
V_T Tuning voltage supply	30	33	35	V
Relevant current	-	-	1.7	mA
permissable ripple	-	-	50	mV(p-p)

Video output				
Load impedance	1.0	-	-	kΩ
Load time constant			100	ns
2nd IF sound output				
Load impedance	0.5			kΩ
AF1/AF2 sound outputs				
Load impedance	1.0			kΩ
Band & System switching				
Refer to the APPLICATION INFORMATION section.				

note 1: An external pull-up resistor of 22 kΩ ±5% must be connected between the tuning supply voltag and terminal 11. See also an alternative solution in the **APPLICATION INFORMATION** section of this datasheet.

ELECTRICAL DATA

Unless otherwise specified, all electrical values apply at the following levels:

Ambient temperature:	25±5°C
Rel. humidity:	60±15%
Supply voltage tuner section:	12±0.3 V
Supply voltage IF section:	5±0.2 V
AGC voltage:	9.2±0.2 V
Aerial source impedance:	75Ω unbalanced
PLL supply voltage:	5±0.2 V
Tuning supply voltage:	33±0.5 V (via 22 kΩ resistor)
2nd IF sound output load:	0.5 kΩ

2nd if sound output characteristics.

Output impedance.
Specification valid for: all frontend types.
Output impedance at terminal 22 75 Ω nom.

CVBS output characteristics.

Output impedance.
Output impedance at terminal 23 10 Ω max.

Gain limited sensitivity.
Specification valid for: all frontend types however
not valid for FQ916ME and FQ916MR in M mode
not valid for FQ916ME and FQ916MF in L mode
not valid for FV916MG
Carrier level of test signal 25 dB(μV) max.

Specification valid for: - FQ916ME in M mode
- FQ916MR in M mode
Carrier level of test signal 25 dB(μV) max.

Specification valid for: - FQ916ME and FQ916MF in L mode
Carrier level of test signal 30 dB(μV) max.

Maximum usable input signal.

Specification valid for: all frontend types
All channels except UHF 100 dB(μV) min.
UHF channels 90 dB(μV) min.

Image rejection.
Specification valid for: all frontend types
Image rejection for test signal level 60 to 70 dB(μV)
(Nom. gain to 10 dB gain reduction):

Low-Mid band	< 300 MHz	70 dB min.	77 dB	typ.
	> 300 MHz	66 dB min.	73 dB	typ.
High band	< 470 MHz	60 dB min.	64 dB	typ.
	> 470 MHz	53 dB min.	64 dB	typ.

IF rejection.
Specification valid for: all frontend types
IF rejection for test signal level 60 dB(μV):

Channel E2	50 dB	min.
Other channels	60 dB	min.

½IF susceptibility.

Specification valid for: all frontend types
Level of unwanted test signal:

Low-Mid band	< 300 MHz	80 dB(μV) min.	85 dB(μV) typ.
Mid band	> 300 MHz	75 dB(μV) min.	77 dB(μV) typ.
High band		70 dB(μV) min.	77 dB(μV)	typ.

Cross modulation.

Specification valid for: all types

IN-BAND: Level of V_{unw} for	N ± 2 Low band	95 dB(μV) typ. 86 dB(μV) min.
	N ± 3 Mid band	95 dB(μV) typ. 86 dB(μV) min.
	N ± 5 Hgh band	100 dB(μV) typ. 94 dB(μV) min.
OUT OF BAND: Level of V_{unw}		100 dB(μV) typ.

CVBS output level.
Specification valid for: all frontend types
Amplitude video signal at terminal 23: nom. 2.0 Vpp
min. 1.7 Vpp max. 2.3 Vpp
DC level of sync. pulse at terminal 23 between: 1.0 V and 1.5 V

Microphony.

For sound signals in the audio frequency range 100 Hz to 10 kHz and sound pressure levels up to 105 dB (20μPa) the CVBS-signal to sound-interference ratio will be more than 40 dB.

Audio output characteristics.

Output impedance.
Specification valid for: all frontend types

Output impedance at terminals 25 (AF1/AM) and 27 (AF2)	100 Ω	nom.

Oscillator voltage at the terminals

Supply and control terminals:	60 dBμV max.
CVBS, 2nd IF sound and AF output terminals:	60 dBμV max.

APPLICATION INFORMATION

For information regarding general aspects of I²C-bus control, See Philips Semiconductors "The I²C-bus and how to use it (including specifications) 1995" (ordering code: 9398 393 40011, release 12/94) or the publications in one of the Philips Handbooks.

WRITE MODE

	MSB							LSB
Address byte	1	1	0	0	0	MA1	MA0	0 (1)
Prog.div. byte1 (Dr1)	0	n14	n13	n12	n11	n10	n9	n8
Prog.div. byte2 (Dr2)	n7	n6	n5	n4	n3	n2	n1	n0
Control word byte1 (Cw1)	1	CP	T1	T0	1	1	1	OS
Control word byte2 (Cw2)	p7	p6	p5	p4	p3	p2	p1	p0

note (1): R/_,W bit =0 for WRITE mode.

Address selection

MA1	MA0	Address	VOLTAGE AT TERMINAL 15
0	0	C0	0 to 0.1 V_{PLL}
0	1	C2	don't care (note 1)
1	0	C4	0.4 to 0.6 V_{PLL}
1	1	C6	0.9 to 1.1 V_{PLL}

Note 1: This general address is always valid for all tuner types of this group. It is recommended not to use this address in applications where a further tuner becomes necessary, e.g. television sets with an option for picture-in-picture or satellite reception.

PROGRAMMABLE DIVIDER SETTING (Dr1, Dr2)

Divider ratio:
$N = 16x(F_{rf,pc} + F_{if,pc})$
$F_{osc} = N/16$

where:
$F_{rf,pc}$ = wanted channel frequency at picture carrier (MHz)
$F_{if,pc}$ = intermediate frequency at picture carrier (MHz)
F_{osc} = internal oscillator frequency (MHz)

$N = (16384xn14) + (8192xn13) + (4096xn12) + (2048xn11) + (1024xn10) + (512xn9) + (256xn8) + (128xn7) + (64xn6) + (32xn5) + (16xn4) + (8xn3) + (4xn2) + (2xn1) + n0$

Note: $F_{if,pc}$ = 38.9 MHz, except for FQ916MF types in L' mode. In that case this frequency is: 33.95 M

CONTROL WORD BYTE 1 (Cw1)

Charge pump setting CP = 0 for all bands. Faster tuning is achieved by CP = 1 for all frequencies higher than channel:
S5 at low band
S29 at mid band
E47 at high band

Testmode setting T1 = T0 = 0 for normal operation.

Op amp output OS = 0 for normal operation.

CONTROL WORD BYTE 2 (Cw2)

BANDSWITCHING

BAND SWITCHING	P7	P6	P5	P4	P3
Low band	1	0	1	0	0
Mid band	1	0	0	1	0
High band	0	0	1	1	0

SYSTEM SWITCHING

Setting for FQ916ME:

	P2	P1	P0
B/G mode	X	0	1
L mode	X	1	1
M mode	X	0	0

X = don't care

Settings for FQ916MF:

	P2	P1	P0
L mode	1	1	1
L' mode	0	1	1
B/G mode	1	0	1
I mode	1	0	0

Settings for FQ916MR:

	P2	P1	P0
B/G	1	0	1
D/K	1	0	1
M	1	0	1

X = don't care

Settings for FV916MG:

	P2	P1	P0
B/G	1	0	1
D/K/I	0	0	1
M	0	0	0
Search mode	1	1	1

TELEGRAM EXAMPLES:

Start-Adr-Dr1-Dr2-Cw1-Cw2-Stop
Start-Adr-Dr1-Dr2-Dr1-Stop
Start-Adr-Dr1-Dr2-Stop
Start-Adr-Cw1-Cw2-Stop
Start-Adr-Cw1-Cw2-Dr1-Stop

where:

Start = start condition
Adr = address byte
Dr1 = divider ratio byte 1
Dr2 = divider ratio byte 2
Cw1 = control word byte 1
Cw2 = control word byte 2
Stop = stop condition

For channel selection involving bandswitching, and to ensure smooth tuning to the desired channel without causing unnecessary charge-pump action, it is recommended to consider the following:
1. Compare wanted channel frequency (fw) to the current channel frequency (fc).
2. If fw > fc, use telegram as: Start-Adr-Dr1-Dr2-Cw1-Cw2-Stop
3. If fw < fc, use telegram as: Start-Adr-Cw1-Cw2-Dr1-Dr2-Stop

Note: Unnecessary charge-pump action will result in very low tuning voltage ($V_t = 0$ V), which may drive the oscillator to extreme condition.

READ MODE

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

Address and Status bytes:

	MSB							**LSB**
Address byte	1	1	0	0	0	MA1	MA0	R/
Status byte	0	FL	X	X	X	A2	A1	A0

X = don't care

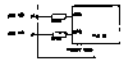
Status byte explanation

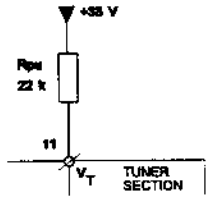
FL — Phase Lock detect Flag:
1 = device is phase locked
0 = device is unlocked

A2,A1,A0 — ADC word (see under 'Tuning characteristics')

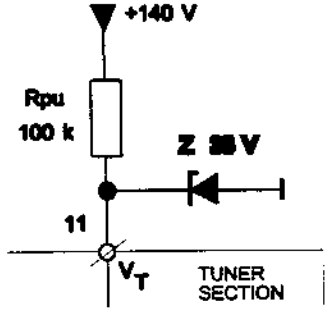
TUNING VOLTAGE SUPPLY

1) A tuning supply voltage of typical 33 V (max. 35 V and min. 30 V) has to be connected via a pull-up resistor of 22 kΩ to terminal 11.





2) Instead of this a constant current of 1 ... 1.5 mA can also be supplied.
The figure beside shows an alternative supply from a 140 V source.
The zener diode prevents the tuning voltage at pin 11 to exceed 33 V.

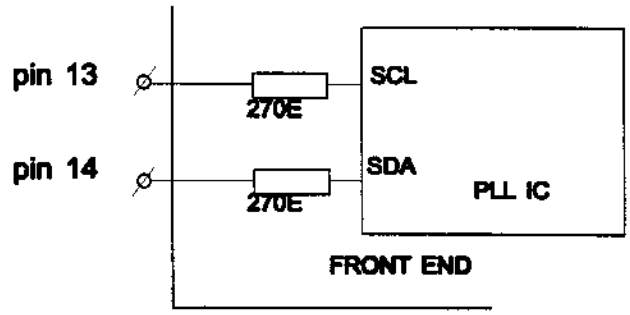


5V SUPPLY VOLTAGE

In the application of the frontend it is advised to connect terminal 12 (5V supply of PLL circuit) and terminal 24 (5V supply of IF section) to the same 5V source. Use adequate decoupling.

Application information regarding I^2C-bus terminals

In the figure below the serial resistors in the clock and data lines of the I^2C-bus interface are shown:



Mounting the unit on a printed wiring board (PWB)

The tuner must be mounted without clearance between the tuner supporting surface and the printed wiring board. When mounted in this way, the tuner must be soldered to the printed wiring board.

This can be achieved by:

a. Bending the connection pins

b. Pressing the unit vertically on the PWB during soldering

c. Supporting the unit with its aerial connector in the right position

d. Twisting the ground tags.

If the tuner is soldered to the PWB on a wave solder machine, the solder joints should be reinforced afterwards.

In order to prevent any stress to the PWB it is recommended that the unit is supported at its aerial connector