MICROTUNE™
broadband media access for the new century

FRONTEND 4049 FM5 3x8168; 3x8292

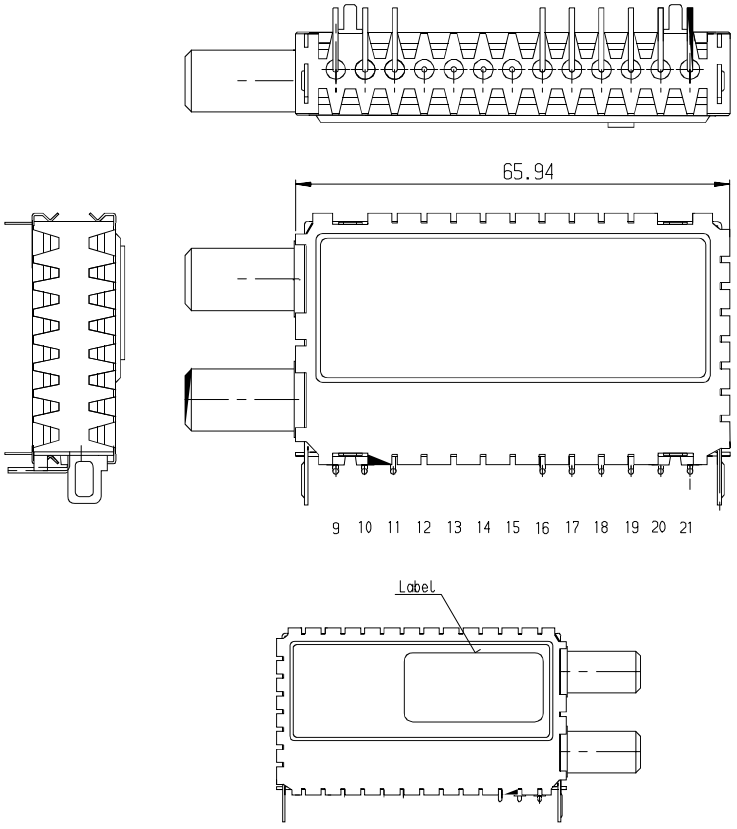
TARGET SPECIFICATION ELECTRICAL DATA

1. Description:

The frontend 4049 FM5 is specially designed for multimedia applications. It includes TV as well as FM reception possibility. TV reception standard are B/G; I, D/K, L, L`. The frontend includes a hyperband tuner which covers the frequency range from 45 to 865 MHz and an IF-part with SAW-filter, IF-amplifier, video- and sound demodulator. So the AF signal is available at the audio output terminal, the CVBS signal is available at the video output terminal. Also a 2nd IF output is provided, which allows external sound demodulation for stereo and NICAM reception. A video buffer is built in which makes a direct connection to 75 Ω inputs possible. The reception frequency range is divided in VHF low, VHF high and UHF.
VHFlow part of the tuner is used for FM reception also. Complete FM signal processing including demodulation and stereo decoding is built in. Baseband signals L (left) and R (right) as well as MPX (Baseband Multiplex signal) are on pins available.
Band, standard selection and tuning are done via I²C-bus, completely. Also a digital AFC-function can be realized, because the AFC-voltage generated by the IF-demodulator is fed to an analogue/digital converter which is integrated in the IF demodulator-IC and readable via I²C-bus.
A DC/DC converter is built in. Therefore supply voltage is 5V only.

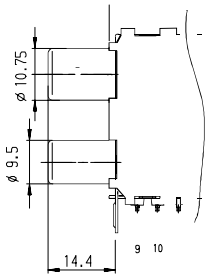
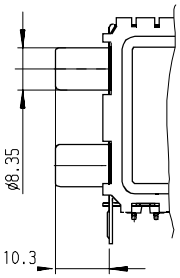
2. Mechanical Characteristics:

2.1. Dimensions: according drawing 3x8168GZ
2.2. Weight: appr. 52 g



PIN	
9	I²C bus signal SCL
10	I²C bus signal SDA
11	Address selection for I²C bus
12	
13	
14	
15	
16	FM sound output R
17	FM sound output L
18	2nd IF
19	Video output CVBS
20	Supply voltage V_{S1}
21	AF sound output / FM MPX

2.3. Types

Tunertype	3x8168	3x8292
Sockettype	IEC connectors	Phono sockets
		
Socketlength	14.4 mm	10.3 mm
Height	28.55/10.25 mm	28.55/10.25 mm

3. Working Data:

3.1. Reception Standard: B/G, I, D/K, L, L`

3. 2. Frequency Range:

VHF low	ch IA ...S6	45.75 MHz ... 140.25 MHz
VHF high	ch S7 ...S41	147.25 MHz ... 463.25 MHz
UHF	ch 21 ...69	471.25 MHz ... 855.25 MHz
FM		87.50 MHz … 108.10 MHz

Margin:

VHF low	ch IA ...	S6	+0.5 MHz/-0.25 MHz
VHF high	ch S7...	S41	+1 MHz/-6 MHz
UHF	ch 21 ...	69	+3 MHz/-6 MHz
FM			+/- 0.5 MHz

Recommened take over frequencies:

VHF low / VHF high	141 MHz
VHF high/ UHF	464 MHz

Frequency referred to picture carrier.

IF:

	B, G	I	L	L`	D/K
picture carrier	38.9	38.9	38.9	33.90	38.9
sound carrier 1	33.4	32.9	32.4	40.40	32.4
sound carrier 2	33.16				
NICAM sound carrier	33.05	32.348	33.05		33.05

all frequencies in MHz

Oscillator operates above received frequency.

3.3. Supply voltage:

Supply voltage V_{S1}	5 V +/- 5%	max. 230 mA

3.4. Input impedance:

VHF/UHF and FM	75 Ω, unbalanced

3.5. Temperature:

Operating temperature:	0 ... 60 °C
Storage temperature:	-25 ... 60 °C
(measured in slowly moved air)	

4. Test conditions:

If not otherwise noticed all data are hold under following conditions:

Measurement tolerance:	10 % or 1 dB
Ambient temperature:	25 °C +/- 3°
Supply voltage:	V_{S1} +/- 5%

5. TV Tuner Data:

5.1. VSWR:

	min.	typ.	max.	unit
VHF low			5.0	
VHF high			5.0	
UHF			5.0	

Referred to channel center frequency.

5.2. AGC-Range:

VHF low	40			dB
VHF high	40			dB
UHF	35			dB
FM	40			dB

5.3. IF-Rejection:

VHF low	50			dB
VHF high	60			dB
UHF	60			dB
FM	50			dB

5.4. Image-Rejection:

VHF low	60			dB
VHF high ch S7 .... ch S20	60			dB
VHF high ch S21 .... ch S41	55			dB
UHF	50			dB
FM	50			dB

6. TV Output parameter:

6.1. Video output:

		min.	typ.	max.	unit
Conditions:	Standard B/G; Ant. input level 66 dBµV				
CVBS - Output level (B/G, D/K, L/L`):			1		V_{pp}
(Standard I):			0.9		V_{pp}
Load impedance			75		Ω
Video S/N (unweighted):					
Flat Field					
VHF			46		dB
UHF			47		dB
Video sensitivity (Off Air Channels)			45		dBµV
Video S/N = 30 dB					
Frequency response:					
(sin x)/x Ref.: 0.2 MHz					
1 MHz		-1.5		2	dB
2 MHz		-2		3	dB
3 MHz		-4		3	dB
4 MHz		-4		4	dB
4.43 MHz		-5		3	dB
5 MHz			-12		dB
sound carrier rejection					
	B/G	30			dB
	I, D/K, L/L´	26			dB
Differential gain	modulated 5 step staircase		3		%pp
Differential phase	modulated 5 step staircase		5		°pp

6.2 TV Sound output:

Pin 21		min.	typ.	max.	unit
Load	DC	100			kΩ
	AC	10			kΩ
Output level:	DC		2.3		V

6.2.1 TV FM sound

Conditions:
Ant.input level 66 dBµV; Video signal: color bar
Audio signal 1kHz, 27 kHz deviation; 50 µs preemphasis
Measurements with 50 µs deemphasis:

AF - level:	400	540	680	mV_{rms}
THD:			0.5	%
S/N:		50		dB
Frequency response: 40 Hz ... 15 kHz (6 kHz deviation)	-1		1	dB

6.2.2 TV AM sound

input level 66 dBµV, video signal: color bar
audio signal 1kHz AM 54% modulation

AF - level:	400	500	600	mV_{rms}
THD:			1.0	%
S/N:		45		dB

6.3. 2nd IF output

AC level of SC_1 5.5, 6.0, 6.5 MHz: (PC/ sound carrier SC_1: 7, 10, 13 dB) (sound carrier SC_2 off)		400		mV_{pp}
AC level of SC_1 6.5 MHz: (PC/ sound carrier: 10 dB) (L standard, without modulation)		400		mV_{pp}
AC level of SC_2 5.74, 6.55 MHz: (PC/ sound carrier SC_1: 10 dB) (PC/ sound carrier SC_2: 20dB)		125		mV_{pp}
Load impedance	0.5			kΩ

7. FM part

7.1 FM output

		min.	typ.	max.	unit
7.1.1 Frequency range		87.5		108.1	MHz
7.1.2 Output levels					
AF = 1 kHz, 75 kHz deviation					
MPX	AC		810		mVrms
	DC		2.3		V
Load impedance			100		kΩ
L, R resp.	AC		255		mVrms
	DC		1.0		V
Load impedance			100		kΩ
7.1.3 Frequency response					
40 Hz to 15 kHz		-2		2	dB
7.1.4 Usable sensivity					
30 dB S/N			5		dBµV
50 dB S/N			15		dBµV
1 kHz 75 kHz deviation					
7.1.5 S/N at high input level			65		dB
Vin = 60 dBµV, Mod. = 1kHz					
75 kHz deviation					
measured at MPX output with 50 µs deemphasis					
7.1.6 Distortion at high input level			0.2		%
22.5 kHz deviation					
7.1.7 Stereo channel separation			30		dB
7.1.8 AM suppression			60		dB
Vin 60 dBµV 75 kHz dev. AM 30%					
7.1.9 Image rejection		53	80		dB
unwanted signal 66.6 MHz above wanted signal					
7.1.10 IF rejection		50			dB
referred to 33.3 MHz unwanted signal					

8. I²C bus

There are two different I²C bus used one **I²C Tuner** to control tuning and one **I²C IF** to control IF demodulation and baseband processing. With port P0 of control byte 2 the slave address of **I²C IF** can be controlled.

8.1 I²C Tuner

8.1.1 Write data format

	MSB							LSB	
Address byte	1	1	0	0	0	MA1	MA0	R/W	A
Divider byte 1	0	n14	n13	n12	n11	n10	n9	n8	A
Divider byte 2	n7	n6	n5	n4	n3	n2	n1	n0	A
Control byte 1	1	CP	T2	T1	T0	RSA	RSB	OS	A
Control byte 2	P7	P6	P5	P4	P3	P2	P1	P0	A

A = Acknowledge
R/W = 0 : Write mode
CP = 1 : charge pump current high
T2, T1, T0 = test bits, normal operation: T2 = 0, T1 = 0, T0 = 1
RSA, RSB bits for minimum step size, see 8.1.2
OS = tuning voltage switch, normal operation: OS = 0

8.1.2 Address selection

MA1	MA0	Address	Voltage at Pin 11
0	0	C0	(0 to 0.1) * V_{S1}
0	1	C2	(0.2 to 0.3) * V_{S1} or open
1	0	C4	(0.4 to 0.6) * V_{S1}
1	1	C6	(0.9 to 1) * V_{S1}

8.1.3 Oscillator frequency and divider byte calculation:

RSA	RSB	Reference divider	Min. tuning step [kHz]	f_{ref} [kHz]
1	1	512	62.5	7.8125
X	0	640	50.0	6.25
0	1	1024	31.25	3.90625

for FM recption we recommend 50 kHz minimum step size

$f_{OSC} = f_D + f_{IF}$
f_{IF} = 38.9 MHz at B/G, D/K, I, L
f_{IF} = 33.9 MHz at L'
f_{IF} = 33.3 MHz at FM

f_{OSC} : Local oscillator frequency
f_D : Desired frequency

$f_{OSC} = f_{REF} * 8 *$ **SF**
f_{REF} : Crystal reference frequency / 640 = 4 MHz / 640 = 6.25 kHz, (RSA =X, RSB = 0)
SF : Programmable scaling factor

Scaling factor
SF= 16384* n14 + 8192 * n13 * 4096 * n12 + 2048 * n11 + 1024 * n10 + 512 * n9 + 256* n8 + 128 * n7 + 64 * n6 + 32 * n5 + 16 * n4 + 8 * n3 + 4 * n2 + 2 * n1 + n0

8.1.4 Control byte 1 settings (default)

	MSB							LSB	
Control byte 1	1	0	0	0	1	X	0	0	A

8.1.5 Control byte 2 (Bandselection)

Band	Active port	P7	P6	P5	P4	P3	P2	P1	P0
VHF low	P7, P5	1	0	1	0	0	0	0	MAD
VHF high	P7,P4	1	0	0	1	0	0	0	MAD
UHF	P5,P4	0	0	1	1	0	0	0	MAD
FM	P7, P5, P2	1	0	1	0	0	1	MS	MAD

MAD: Programmable module address **I^2C IF**
0 = Slave address **I^2C IF** = 43[hex]
1 = Slave address **I^2C IF** = 42[hex]
MS: Forced Mono at FM mode:
0 = Stereo Mode with capability of stereo indication
1 = Forced Mono Mode

8.1.6 Read data format

	MSB							LSB	
Address byte	1	1	0	0	0	MA1	MA0	R/W	A
Status byte	POR	FL	I2	I1	I0	A2	A1	A0	A

R/W : 1 = Read mode
POR : Power on reset flag (POR =1 at power on)
FL : In lock flag (FL= 1 when PLL is locked)
I2, I1, I0: Digital levels for I/O ports P2, P1 and P0 respect.
In case of FM I1 = 1: Stereo indication
I2, I0 not defined
A2, A1, A0: FM-AFC or FM-AGC or SIF-AGC radio output detection

A2	A1	A0	SIF-AGC radio output *1)	FM-AGC radio output *2)	FM-AFC radio output *3)
1	0	0	not defined	not defined	-100 kHz
0	1	1	> 20dBµV	normal signal	-35 kHz
0	1	0	5dBµV … 20dBµV	weak signal	Correct tuning
0	0	1	<5dBµV	very weak signal	+35 kHz
0	0	0	not defined	not defined	+100 kHz

*1) typical values, peak level detection within a bandwith of appr. 2MHz
*2) only valid if FM-carrier exist and SIF-AGC radio output = (A2=0, A1=1, A0=1)
*3) typical values, only valid if CARRDET = high, see section 8.3.2

8.2. I²C IF

8.2.1. I²C-bus sequence write

Start	Slave addr.	R/W =0	Ack	subaddress	Ack	data	Ack	Stop

Start	start condition.
Slave addr	Slave address (7bit) = 42[hex] or 43[hex] in respect of MAD.
R/W	Read/Write bit: 0 = write to component; 1 = master reads from component.
Subaddress	byte which indicates register of component which the are data for.
	"switching register" 00[hex]
	"adjust register" 01[hex]
	"data register" 02[hex]
Ack	acknowledge generated by the component
Stop	stop condition

If more than one byte of data is transmitted, then auto-increment of subaddress is performed.
i.e. transmit 3 bytes starting with data for switch register

mode	**Slave addr + R/W =0**	**Subaddress**	**switch reg.**	**adjust reg.**	**data reg.**
	MAD=0 / MAD=1				
B/G	86 / 84	00	D4	70	09
I	86 / 84	00	D4	70	0A
D/K	86 / 84	00	D4	70	0B
L	86 / 84	00	C4	10	0B
L`	86 / 84	00	84	10	13
FM - AFC	86 / 84	00	DC	70	1D
FM - AGC	86 / 84	00	DC	70	9D
SIF - AGC	86 / 84	00	DC	70	81
FM - AFC stereo	86 / 84	00	DC	10	1D
FM - AGC stereo	86 / 84	00	DC	10	9D
SIF – AGC stereo	86 / 84	00	DC	10	81

all bytes in [hex]

8.2.2 switch register

acc. Chapter 8.2.1 switch register is addressed by subaddress **00** [hex]

switch register

B7	B6	B5	B4	B3	B2	B1	B0

Video mode

0	Sound bypass off
1	Sound bypass on

Audio mute FM

0	Inactive	
1	active	

Carrier mode

0	intercarrier
1	QSS

Modulation

0	0	Positive AM TV
1	0	Negative TV
x	1	FM Radio

Forced mute audio

0	off
1	on

Output port 1 (Audio-SAW switch)

0	L'
1	B/G, D/K, I, L

Output port 2 (not used)

0	Low ohmic active
1	High ohmic disabled

Recommended settings **switch** register

mode	B7	B6	B5	B4	B3	B2	B1	B0	=[hex]
B/G	1	1	0	1	0	1	0	0	**D4**
I	1	1	0	1	0	1	0	0	**D4**
D/K	1	1	0	1	0	1	0	0	**D4**
L	1	1	0	0	0	1	0	0	**C4**
L`	1	0	0	0	0	1	0	0	**84**
FM	1	1	0	1	1	1	0	0	**DC**

8.2.3 Adjust register

acc. Chapter 8.2.1 adjust register is addressed by subaddress **01** [hex]

Adjust register

C7	C6	C5	C4	C3	C2	C1	C0

AGC adjustment

1	0	0	0	0

Deemphasis

0	De-emphasis off
1	De-emphasis on

Value of de-emphasis

0	75 us
1	50 us

Audio gain

0	0 dB
1	-6 dB

Recommended settings **adjust** register

mode	C7	C6	C5	C4	C3	C2	C1	C0	=[hex]
B/G	0	1	1	1	0	0	0	0	**70**
I	0	1	1	1	0	0	0	0	**70**
D/K	0	1	1	1	0	0	0	0	**70**
L	0	0	0	1	0	0	0	0	**10**
L`	0	0	0	1	0	0	0	0	**10**
FM	0	1	1	1	0	0	0	0	**70**
FM stereo	0	0	0	1	0	0	0	0	**10**

8.2.3 data register

acc. Chapter 8.2.1 data register is addressed by subaddress **02** [hex]

data register

E7	E6	E5	E4	E3	E2	E1	E0	
						2nd IF		**MHz**
						0	0	4.5
						0	1	5.5
						1	0	6.0
						1	1	6.5

Video IF				
TV Mode: B3=0			**MHz**	
0	0	0	58.75	
0	0	1	45.75	
0	1	0	38.9	
0	1	1	38.0	
1	0	0	33.9	
1	0	1	33.4	
Radio Mode: B3=1				
0	0	0	44	SIF-AGC radio output
1	1	1	44	FM-AGC radio output

VIF, SIF, tuner gain	
0	Normal gain
1	Minimum gain

Gating (pos. AM)	
0	0 %
1	36 %

VIF AGC output – TV Mode: B3=0	
0	Normal port function (Output port2)
1	No port function
PIN 21 output – Radio Mode: B3=1	
0	FM-AFC radio output
1	FM-AGC or SIF-AGC radio output acc. E2…E4

Recommended settings **data** register

mode	E7	E6	E5	E4	E3	E2	E1	E0	=[hex]
B/G	0	0	0	0	1	0	0	1	**09**
I	0	0	0	0	1	0	1	0	**0A**
D/K	0	0	0	0	1	0	1	1	**0B**
L	0	0	0	0	1	0	1	1	**0B**
L`	0	0	0	1	0	0	1	1	**13**
FM-AFC	0	0	0	1	1	1	0	1	**1D**
FM-AGC	1	0	0	1	1	1	0	1	**9D**
SIF-AGC	1	0	0	0	0	0	0	1	**81**

8.3.1. I²C-bus sequence read

Start	Slave addr.	R/W =1	Ack	data	Ack not	Stop

Start	start condition.
Slave addr	Slave address = 43[hex].
R/W	Read/Write bit: 0 = write to component; 1 = master reads from component.
Ack	acknowledge, generated by the component
Ack not	acknowledge, generated by the master
Stop	stop condition

8.3.2 Read data format

Status register

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

Power on reset

0	Normal operation
1	Power on reset

AFC value

AFC4	AFC3	AFC2	AFC1

CARRDET – FM carrier detection

0	FM carrier not detected
1	FM carrier detected

VIFLEV - VIF level input

0	VIF low level
1	VIF high level

AFCWIN - AFC window (Note 1)

0	Tuning out of window (+/- 1.6 MHz)
1	Tuning in window (+/- 1.6 MHz)

Note1. If no IF input is applied, then bit AFCWIN = 1 due to the fact that the VCO is forced to the AFC window border for fast load-in behaviour.

Automatic Frequency Control f_{VIF} Versus f_0	**AFC4**	**AFC3**	**AFC2**	**AFC1**
$f_{VIF} \leq f_0$ – 187.5 kHz	0	1	1	1
$f_{VIF} = f_0$ – 162.5 kHz	0	1	1	0
$f_{VIF} = f_0$ – 137.5 kHz	0	1	0	1
$f_{VIF} = f_0$ – 112.5 kHz	0	1	0	0
$f_{VIF} = f_0$ – 87.5 kHz	0	0	1	1
$f_{VIF} = f_0$ – 62.5 kHz	0	0	1	0
$f_{VIF} = f_0$ – 37.5 kHz	0	0	0	1
$f_{VIF} = f_0$ – 12.5 kHz	0	0	0	0
$f_{VIF} = f_0$ + 12.5 kHz	1	1	1	1
$f_{VIF} = f_0$ + 37.5 kHz	1	1	1	0
$f_{VIF} = f_0$ + 62.5 kHz	1	1	0	1
$f_{VIF} = f_0$ + 87.5 kHz	1	1	0	0
$f_{VIF} = f_0$ + 112.5 kHz	1	0	1	1
$f_{VIF} = f_0$ + 137.5 kHz	1	0	1	0
$f_{VIF} = f_0$ + 162.5 kHz	1	0	0	1
$f_{VIF} \geq f_0$ + 187.5 kHz	1	0	0	0

9. ESD Protection

The frontend contains components that can be damaged by static discharge.
Observe these precautions: Ground yourself before handling the frontend.
Do not touch the frontend connector pins without ESD protection.

NAME	J. Kreil					
DATE	07.November 2002					
REV.:	01					
FÄM.- NO.						
DATE	07.11.2002					
NAME	J. Kreil					
SIGNATURE						