

### Features

- Fully integrated, PLL-stabilized VCO
- Flexible frequency range from 310 MHz to 450 MHz
- ASK achieved by on/off keying of internal power amplifier
- FM possible with external varactor
- Wide power supply range from 2.2 V to 5.5 V
- High over-all frequency accuracy
- Very low standby current
- Adjustable output power range from -12 dBm to +2 dBm
- Adjustable current consumption from 4.8 mA to 11.5 mA
- Differential output well-suited for loop antenna
- Conforms to EN 300 220 and similar standard

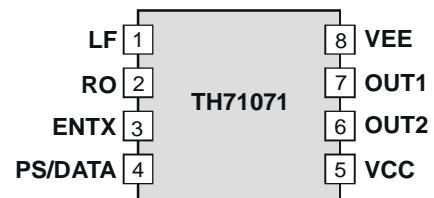
### Ordering Information

Part No.	Temperature Range	Package
TH71071	-40 C° to 85 °C	SOIC8

### Application Examples

- Keyless car and central locking
- Low-power telemetry
- Alarm and security systems
- General digital data transmission
- General analog audio signal transmission
- Local oscillator signal generation

### Pin Description



## General Description

The TH71071 ASK transmitter IC is designed for applications in the European 433MHz industrial-scientific-medical (ISM) band, according to the EN 300 220 telecommunications standard. It can also be used for any other system with carrier frequencies ranging from 310 MHz to 450 MHz (e.g. for applications in the US 315MHz ISM band).

The transmitter's carrier frequency  $f_c$  is determined by the frequency of the reference crystal  $f_{ref}$  that is used. The integrated PLL synthesizer ensures that each RF value, ranging from 310 MHz to 450 MHz, can be achieved by using a crystal with reference frequency according to:  $f_{ref} = f_c/N$ , where  $N = 32$  is the PLL feedback divider ratio.

## Theory of Operation

### General

As depicted in Fig.1, the TH71071 transmitter consists of a fully integrated voltage-controlled oscillator (VCO), a divide-by-32 divider (div32), a phase-frequency detector (PFD) and a charge pump. An external loop filter at pin LF determines the dynamic behaviour of the PLL and suppresses reference spurious signals.

The VCO's output signal feeds the power amplifier (PA). RF signal power  $P_o$  can be adjusted in six steps from  $P_o = -12$  dBm to  $+2$  dBm either by changing the value of resistor  $R_1$  or by varying the voltage  $V_{PS}$  at pin PS/DATA. The open-collector differential output (OUT1, OUT2) can be used to either directly drive a loop antenna or to be converted to a single-ended impedance by means of a balanced-to-unbalanced (balun) transformer. For maximum available output power, the differential output should be matched to a load of approx. 1 k $\Omega$ .

Bandgap biasing ensures stable operation of the IC at a power supply range of 2.2 V to 5.5 V.

### ASK Modulation

The TH71071 can be ASK-modulated by applying data directly at pin PS. This turns the PA on and off and therefore leads to an ASK signal at the output.

### LO Source

Many applications require a stable RF source. For this purpose, the TH71071 can be used without modulation as an easy-to-use, PLL-stabilized, continuous wave (CW) generator.

### Frequency Modulation (FM)

For FM operation an external varactor is required. It simply acts as a pulling capacitor connected in series to the crystal. Then the analog modulation signal, applied through a series resistor, directly modulates the XOSC.

### Mode Control Logic

The mode control logic allows two different modes of operation as listed in the following table. The mode control pin ENTX is pulled-down internally. This guarantees that the whole circuit is shut down if this pin is left floating.

ENTX	Mode	Description
0	TX disabled	whole circuit in standby
1	TX enable	TX active

Table 1: Modes of operation

Block Diagram

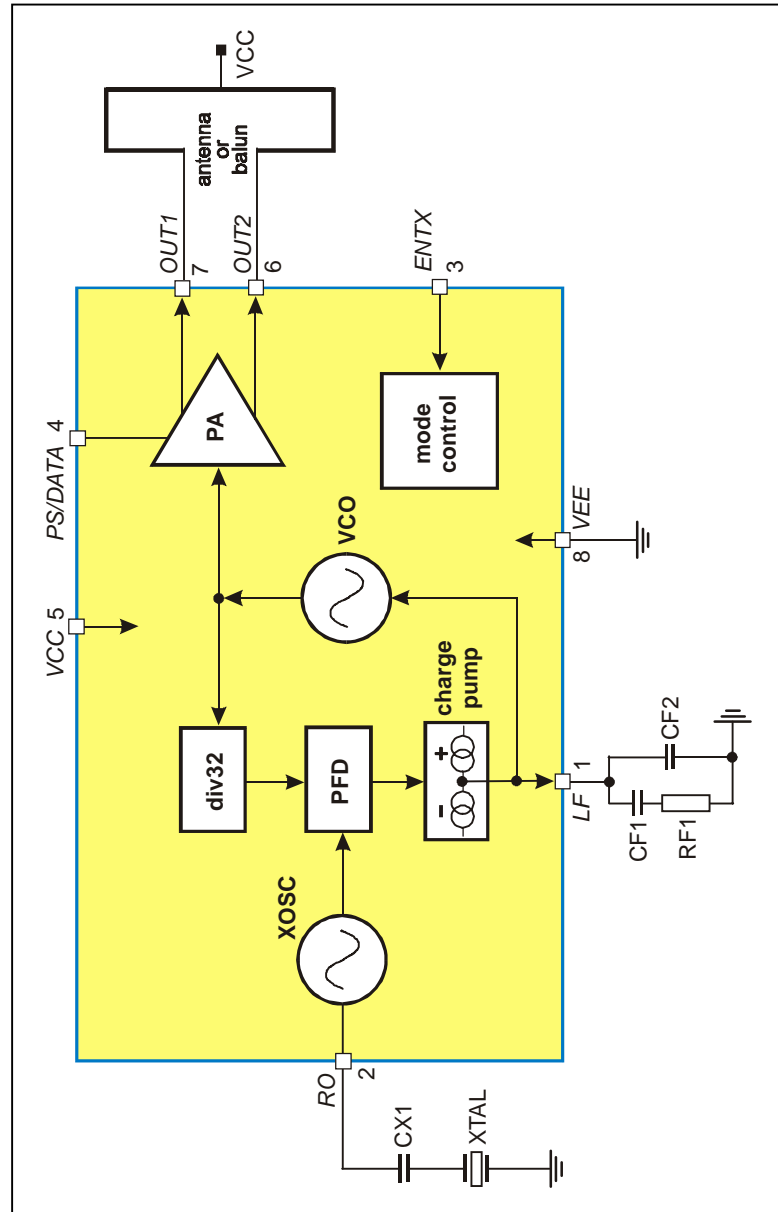
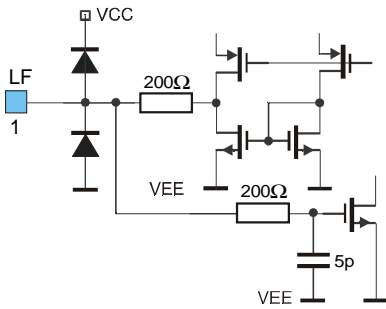
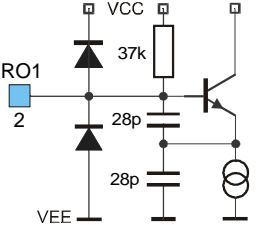
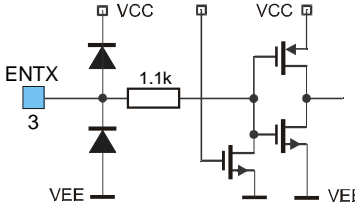
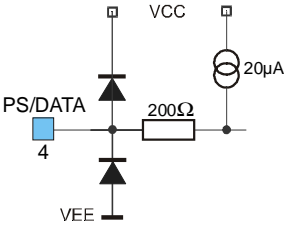
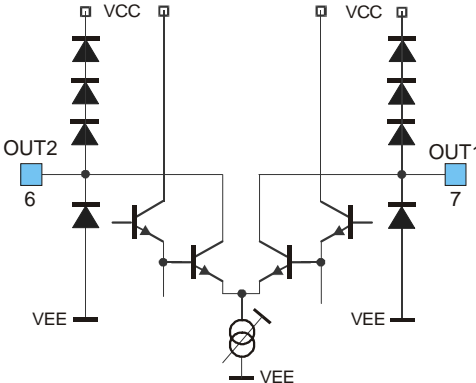


Fig. 1: TH71071 block diagram with external components

### Pin Definition and Description

Pin No.	Name	I/O Type	Functional Schematic	Description
1	LF	analog I/O		connection to loop filter, charge pump output, VCO tuning input
2	RO	analog I/O		XOSC connection to XTAL, Colpitts type crystal oscillator
3	ENTX	input		mode control input, CMOS-compatible with internal pull-down
4	PS/DATA	analog I/O		power-select and ASK input, high-impedance comparator logic
5	VCC	supply		positive power supply
6	OUT2	output		differential power amplifier output, open collector
7	OUT1	output		differential power amplifier output, open collector
8	VEE	ground		negative power supply

## Technical Data

### Absolute Maximum Ratings

Parameter	Symbol	Condition	Min	Max	Unit
Supply voltage	$V_{cc}$		-0.3	7.0	V
Input voltage	$V_{in}$	ENTX pin	-0.3	$V_{CC}+0.3$	V
Input current	$I_{in}$	ENTX pin	-1.0	1.0	mA
Storage temperature	$T_{STG}$		-40	150	°C
Electrostatic discharge	$V_{ESD}$	human body model, MIL STD 833D method 3015.7	-1.0	+1.0	kV

### Normal Operating Conditions

Parameter	Symbol	Condition	Min	Max	Unit
Supply voltage	$V_{cc}$		2.2	5.5	V
Operating temperature	$T_a$		-40	85	°C
XOSC frequency	$f_{ref}$	set by the crystal	9.69	14	MHz
VCO frequency	$f_c$	$f_c = 32 \cdot f_{ref}$	310	450	MHz

### DC Characteristics

all parameters under normal operating conditions, unless otherwise stated;  
typical values at  $T_a = 23\text{ °C}$  and  $V_{cc} = 3\text{ V}$

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Standby current	$I_{SBY}$	ENTX=0		0.05	0.1	$\mu\text{A}$
Operating current	$I_{cc}$	ENTX=1, $V_{PS}=1.1\text{V}$	7	9	10	mA
Input HIGH voltage	$V_{HIGH}$	ENTX pin	$0.7 \cdot V_{cc}$		$V_{cc}+0.3$	V
Input LOW voltage	$V_{LOW}$	ENTX pin	-0.3		$0.3 \cdot V_{cc}$	V
Input current	$I_{in}$	ENTX=0	-1		1	$\mu\text{A}$
Pull down current	$I_{pd}$	ENTX=1	2	8	15	$\mu\text{A}$

## AC Characteristics

all parameters under normal operating conditions, unless otherwise stated;  
typical values at  $T_a = 23\text{ }^\circ\text{C}$  and  $V_{cc} = 3\text{ V}$ ;  
ENTX = 1,  $V_{PS} = 1.1\text{ V}$ ,  $f_c = 433.6\text{ MHz}$ , test circuit shown in Fig. 2

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output power	$P_o$			-1		dBm
FM deviation	$\Delta f_{FM}$	adjustable with varactor and $V_{FM}$		$\pm 6$		kHz
Modulation frequency FM	$f_{mod}$			5		kHz
Data rate ASK	$R_{ASK}$	NRZ		40		kbit/s
Reference spurs	$P_{ref}$	@ $f_c \pm f_{ref}$		-44		dBm
Harmonic content	$P_{harm}$	@ $2f_c, 3f_c, 4f_c$		-40		dBm
Spurious output signal	$P_{off}$	$V_{PS} \leq 0.1\text{ V}$		-60		dBm
Phase noise	PN	@ $f_c \pm 500\text{ kHz}$		-87		dBc/Hz
VCO gain	$K_{VCO}$			200		MHz/V
Charge pump current	$I_{CP}$			$\pm 260$		$\mu\text{A}$
Start-up time	$t_{on}$	from "all OFF" to any other mode			0.9	ms

## Output Power Selection

typical values at  $T_a = 23\text{ }^\circ\text{C}$  and  $V_{cc} = 3\text{ V}$ ;  
ENTX = 1,  $f_c = 433.6\text{ MHz}$ , test circuit shown in Fig. 2

R1 / k $\Omega$	0	7.5	11	15	24	43
R2 / k $\Omega$	$\infty$	4.7	4.7	4.7	4.7	4.7
$V_{PS}$ / V	$\geq 2$	1.1	0.9	0.7	0.5	0.3
$I_{cc}$ / mA	11.5	8.6	7.3	6.2	5.3	4.8
$P_o$ / dBm	2	-1	-4	-7	-10	-12
$P_{harm}$ / dBm	$\leq -40$	$\leq -40$	$\leq -40$	$\leq -45$	$\leq -45$	$\leq -50$

If the transmitter is operated at any supply voltage  $V_{cc}$ ,  
the values for  $R_1$  and  $R_2$  can be calculated as follows:

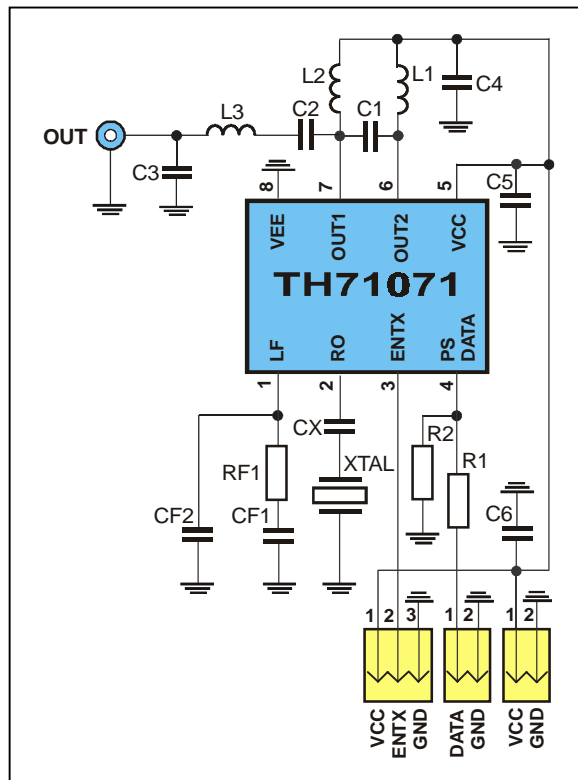
$$R_1 = R_2 \cdot \left( \frac{V_{cc}}{V_{PS}} - 1 \right)$$

## Crystal Parameter

Parameter	Symbol	Condition	Min	Max	Unit
Crystal frequency	$f_{crystal}$	fundamental mode, AT	9.69	14	MHz
Load capacitance	$C_{load}$		10	15	pF
Static capacitance	$C_0$			7	pF
Resonance resistance	$R_m$			60	$\Omega$
Spurious response	$a_{spur}$			-10	dB

### Test Circuit

Fig. 2: Test circuit for ASK with 50Ω matching network



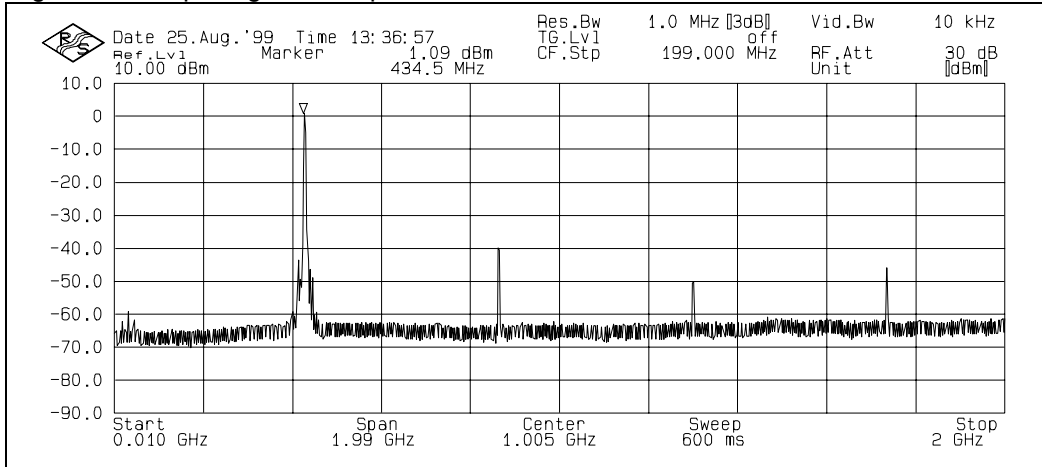
Test circuit component list to Fig. 2

Part	Size	Value	Tolerance	Description
CF1	0603	10 nF	±10%	loop filter capacitor
CF2	0603	56 pF	±10%	loop filter capacitor
CX	0603	68 pF	±10%	XOSC capacitor
C1	0603	2.7 pF	±5%	impedance matching capacitor
C2	0805	100 pF	±5%	impedance matching capacitor
C3	0805	3.9 pF	±5%	impedance matching capacitor
C4	0603	330 pF	±10%	blocking capacitor
C5	0603	330 pF	±10%	blocking capacitor
C6	0805	33 nF	±10%	blocking capacitor
L1	0603	22 nH	±5%	impedance matching inductor
L2	0603	27 nH	±5%	impedance matching inductor
L3	0603	33 nH	±5%	impedance matching inductor
RF1	0603	1.5 kΩ	±10%	loop filter resistor
R1	0603	See output power selection table	±10%	ASK power-select resistor, not requirement at CW mode
R2	0603	See output power selection table	±10%	ASK or CW mode power-select resistor
XTAL	HC49/S	13.55 MHz fundamental wave	±30ppm calibration ±30ppm temp.	crystal, C <sub>load</sub> = 12 pF to 15 pF, C <sub>0, max</sub> = 7 pF, R <sub>m, max</sub> = 60 Ω

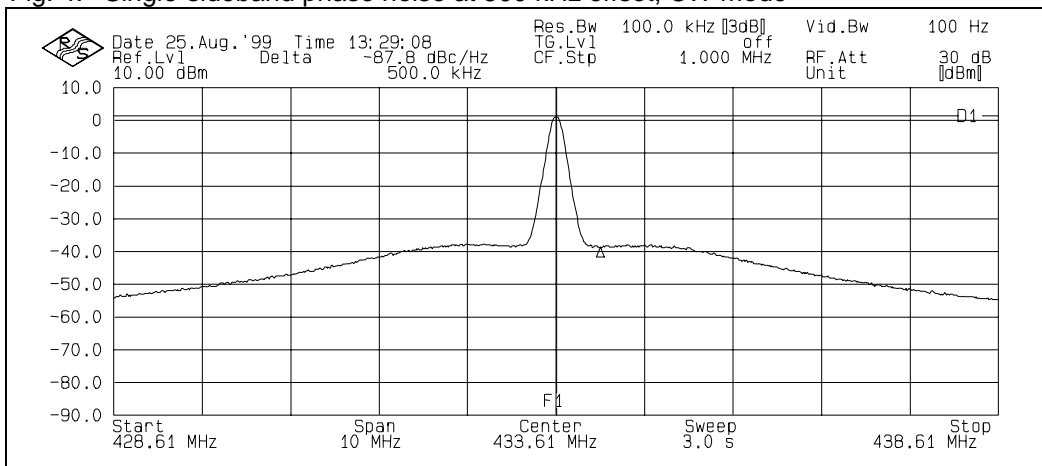
### Spectrum Plots

All plots depict TH71071's typical performance at  $V_{CC} = 3.0\text{ V}$  and  $T_a = 23\text{ }^\circ\text{C}$ , derived with the test circuit shown in Fig. 2.

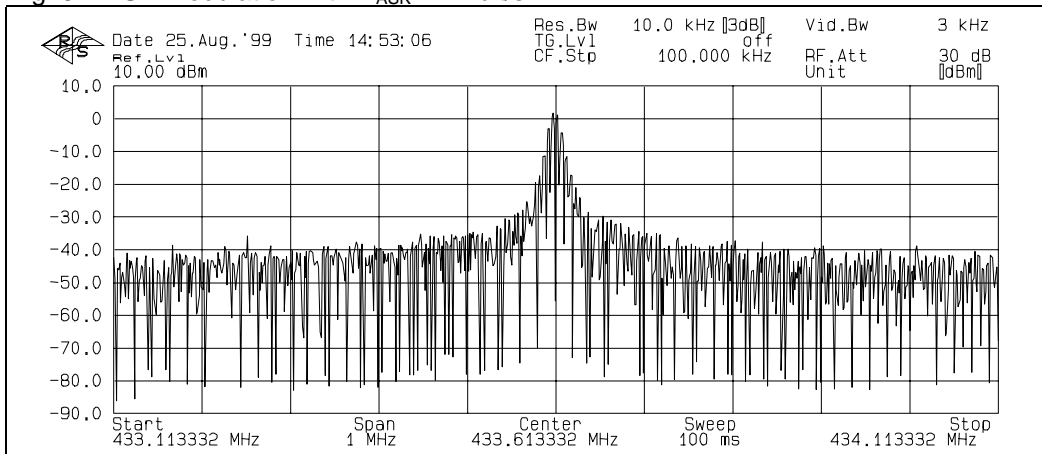
**Fig. 3: RF output signal and spurious emissions, CW mode**



**Fig. 4: Single-sideband phase noise at 500 kHz offset, CW mode**



**Fig. 5: ASK modulation with  $R_{ASK} = 4\text{ kbit/s NRZ}$**





Package Information

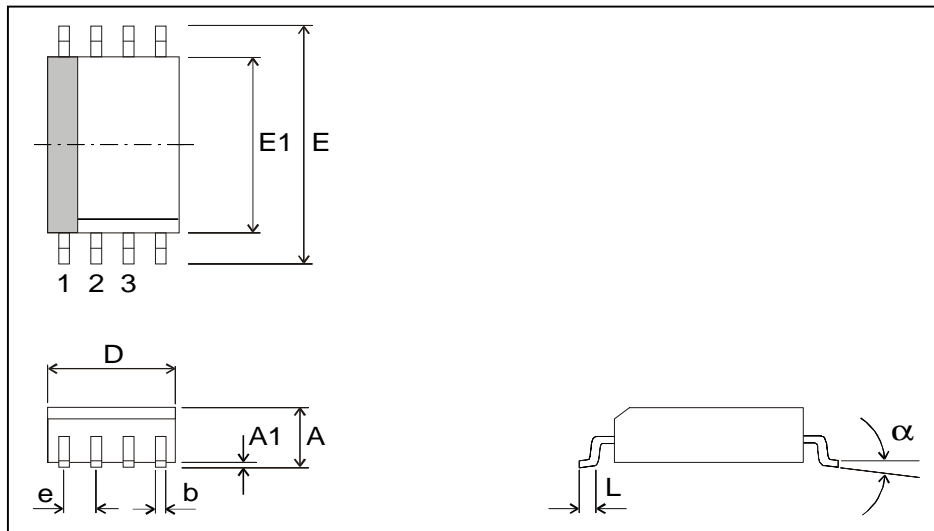


Fig. 6: SOIC8 (Small Outline Package)

all Dimension in mm, coplanarity < 0.1mm									
	D	E1	E	A	A1	e	b	L	α
min	4.80	3.81	5.80	1.32	0.10	1.27	0.36	0.41	0°
max	4.98	3.99	6.20	1.72	0.25		0.46	1.27	8°
all Dimension in inch, coplanarity < 0.004"									
min	0.189	0.150	0.2284	0.060	0.0040	0.05	0.014	0.016	0°
max	0.196	0.157	0.2440	0.068	0.0098		0.018	0.050	8°

*Your Notes*

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