UHF ASK/FSK Transmitter

Description

The U2741B is a PLL transmitter IC which has been specially developed for the demands of RF low-cost data transmission systems at data rates up to 20 kBaud.

The transmitting frequency range is 300 MHz to 450 MHz. It can be used in both FSK and ASK systems.

Electrostatic sensitive device.
Observe precautions for handling.

Features

- One-chip solution with minimum external circuitry

- Lower cost than the usual discrete solutions using SAW and transistors

- Very small SSO16 package, pitch 0.635, 150 mil

- Supply voltage 2.0 V to 5.5 V
  in the temperature range –20°C to 70°C
  Supply voltage 2.2 V to 5.5 V
  in the temperature range –40°C to 85°C

- "Single-Ended Open-Collector" output (same antennas can be used as in discrete solutions, simpler adaptation of magnetic loop antennas)

- XTO output for clocking the µC, thereby together with M44C090 or M44C890 the optimum system cost-effectiveness

- Very large FSK frequency deviation achievable by ±100 ppm pulling of the reference crystal

- Very high transmitting frequency accuracy compared to SAW solutions. This enables receivers at lower bandwidth than is possible with SAW resonators.

- ESD protection according to MIL-STD.883 (4KV HBM) except Pins XTO1/ 2, ANT and LF
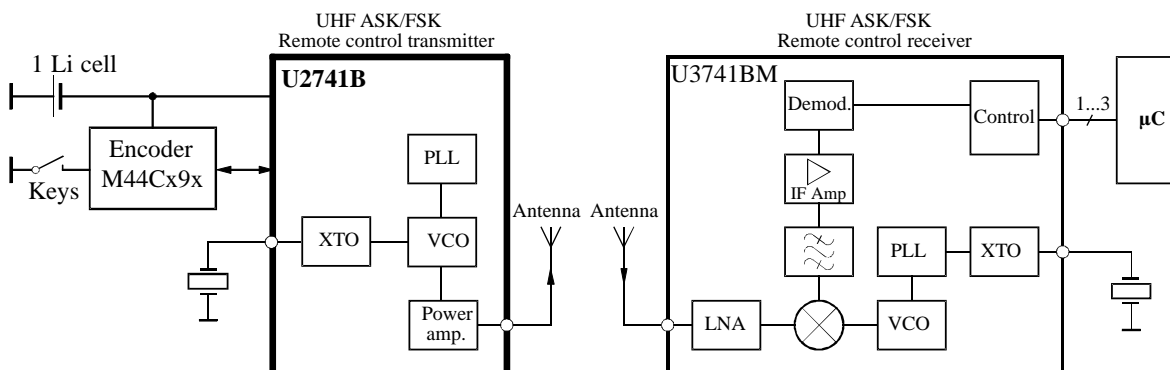
System Block Diagram

Figure 1. System block diagram

Order Information

Extended Type Number	Package	Remarks
U2741B-MFB	SSO16	Tube
U2741B-MFBG3	SSO16	Taped and reeled
U2741B-NFB	SSO16	Tube, optimized power-supply rejection, value of C_4 differs from M-version, enhanced XTO stability
U2741B-NFBG3	SSO16	Taped and reeled, see above

U2741B

Pin Description

Figure 2. Pinning SSO16
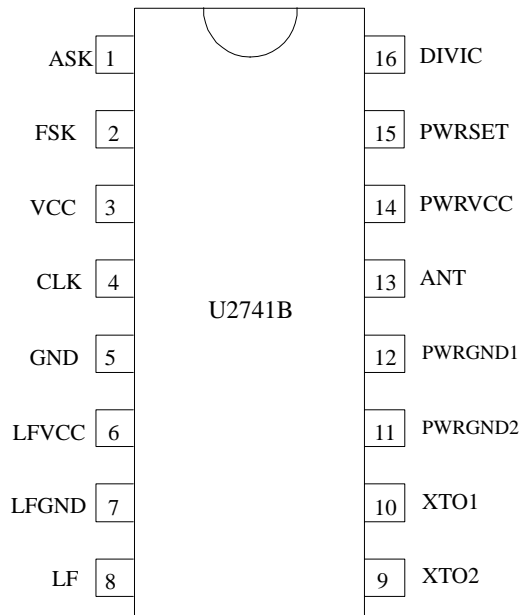
| Pin	Symbol	Function
1	ASK	Modulation input ASK
2	FSK	Modulation input FSK
3	VCC	Supply voltage
4	CLK	Clock output
5	GND	Ground
6	LFVCC	Supply voltage VCO
7	LFGND	VCO ground
8	LF	Circuit PLL loop
9	XTO2	FM modulation output
10	XTO1	Connection for crystal
11	PWRGND2	Power GND2
12	PWRGND1	Power GND1
13	ANT	RF output
14	PWRVCC	Supply voltage power amplifier
15	PWRSET	Applied to VCC
16	DIVIC	Pitch factor setting for crystal L: high crystal frequency; H: low crystal frequency
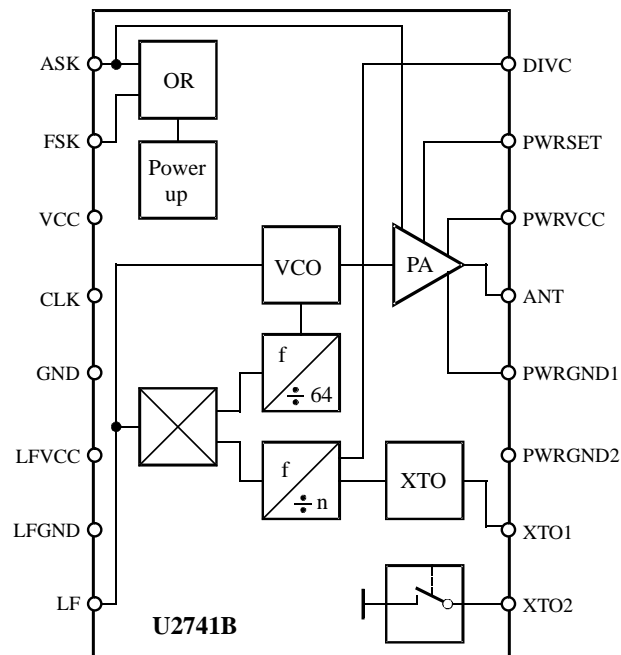
Block Diagram

Figure 3. Block diagram

General Description

The fully integrated VCO and the "single-ended open-collector" output allow particularly simple, low-cost RF miniature transmitters to be assembled. The single-ended output enables a considerably simplified adaptation of both a magnetic loop antenna of any form or a λ/4 antenna. This is because the load impedance must not be balanced as would be the case with a differential output.

The XTO's frequency can be selected at either 13.56 MHz (USA 9.844 MHz) or 6.78 MHz (USA 4.9219 MHz). Thus, it is possible to use not only exceptionally small SMD crystals at 13.56 MHz but also very low-cost 6.78-MHz crystals in a wired metal package (e.g. in the HC49S housing). The frequency is selected by connecting PIN16 (DIVC) to either GND or V_S.

At high frequencies, crystals have a very fast start-up time (< 1.5 ms at 13.56 MHz, < 3 ms at 6.78 MHz), whereby a wait time of 5 to 10 ms is required until the transmitter IC is locked. This means that the processor does not need to poll a lock detect output.

Functional Description

The IC can be switched on at both the FSK and the ASK input. The IC's ChipSelect is performed by the logical OR operation of ASK and FSK input. In the case of V_{FSK}, $V_{ASK} \leq 0.3$ V, the power-down supply current is $IS_{off} < 0.35$ μA. The ASK input activates the power amplifier and the PLL. The FSK input only activates the PLL and, if capacitor C3 is installed, pulls the crystal to the lower frequency, whereby the transmitter is FSK modulated. After switching on at FSK, the VCO locks onto the 32 or 64 times higher frequency of the crystal oscillator.

FSK Transmission

The U2741B is switched on by $V_{FSK} = V_S$. 5 ms later, V_S is applied to V_{ASK}. The output can then be modulated by means of Pin FSK. This is done by connecting capacitor C3 in parallel to the load capacitor C4.

ASK Transmission

The U2741B is activated by $V_{FSK} = V_S$. V_{ASK} remains 0 V for 5 ms, then the output power can be modulated by means of Pin ASK. In this case, V_{FSK} remains $= V_S$ during the message, the capacitor C3 is not mounted.

Take-Over of the Clock Pulse in the μC

The clock of the crystal oscillator can be used for clocking the μC. The M44C090 and M44C890 have the special feature of starting with an integrated RC oscillator to switch on the U2741B with $V_{FSK} = V_S$. 5 ms later, the 3.39-MHz clock frequency is present, so that the message can be sent with crystal accuracy.

Application Circuit

The following component values are recommendations for a typical application. C5, C6, C7 are block capacitors. The values of these capacitors depend on the board layout. C5 = 1 nF, C6 = 1 nF, C7 = 22 nF are typically used here. For C5, the impedance between f = 100 MHz and f = 1 GHz should be as low as possible.

C3 is not needed in ASK transmitter applications. In the case of FSK, C3 is selected in such a way that the desired transmission frequency deviation is achieved (typ. ± 30 kHz). The capacitance here depends upon the crystal's load capacity (C4) recommended by the manufacturer of the crystal. C2 = 3.9 nF, C1 = 15 nF, R4 = 220 Ω.

CLoop1, CLoop2 are selected so that the antenna oscillates in resonance and the adaptation to the appropriate impedance transformation is possible.

LFeed is an inductor for the antenna's DC current supply. A typical value is LFeed = 220 nH. LFeed can be either printed on the PC_Board or be a discrete component.

Further information regarding the application is provided in the description of the "RKE Design Kit (U2741B, U3741B)" in chapter 2.2.2. This chapter labeled "Application Hints U2741B" also describes the antenna design in more detail.

Output Power Measurement

The following output network (see figure 4) can be used for output power evaluation, the exact values of L10, C10 are dependent on the layout.

L10, C10 is the transformation network to adopt the output impedance of the IC to 50 Ω. The following table shows the values for an output power of 2 mW and an $R_{PWRSET} = 1.2$ kΩ.

f/ MHz	C10/ pF	L10/ nH	Z_{Load_opt}/ Ω
315	2.7	56	260 + j330
433.92	1.8	33	185 + j268
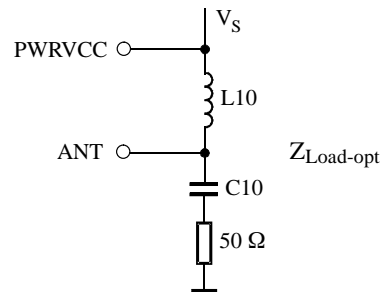
Figure 4. Measurement output network
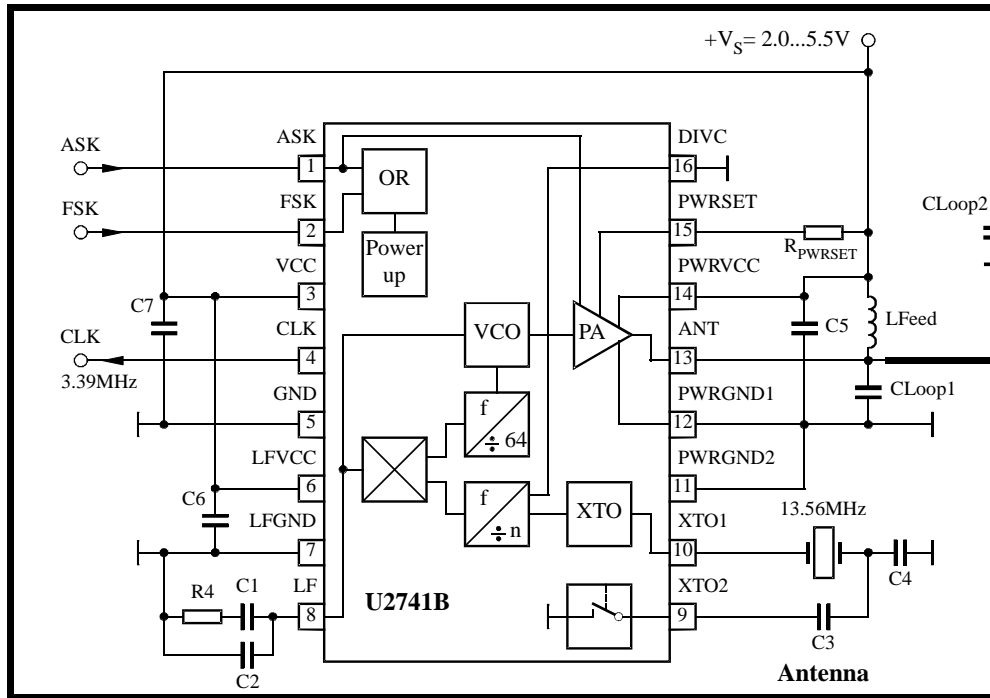
Figure 5. Application circuit

Absolute Maximum Ratings

Parameters	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_S			6	V
Power dissipation	P_{tot}			250	mW
Junction temperature	T_j			150	°C
Storage temperature	T_{stg}	–55		125	°C
Ambient temperature	T_{amb}	–40		105	°C

Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient	R_{thJA}	180	K/W

Electrical Characteristics

All parameters are refered to GND (Pin 5).

The possible operating ranges refer to different circuit conditions:

V_S = 2.0 V to 5.5 V @ T_{amb} = –20°C to +70°C, V_S = 2.2 V to 5.5 V @ T_{amb} = –40°C to +85°C (Typ. 25°C, 3 V)

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Supply current (power down)	V_{ASK}, V_{FSK} ≤ 0.3 V, V_S < 3.6 V	IS_{off}			0.35	μA
Supply current (power up, output OFF)	V_{ASK} = GND, V_{FSK} = V_S, V_s = 3 V	IS_{on}		4.7	6.2	mA
Supply current (power up, output ON)	V_{ASK} = V_S, V_S = 3 V, R_{PWRSET} = 1.2 kΩ	$IS_{transmit}$		10	12.5	mA
Output power	V_S = 3 V, T_{amb} = 25°C, f = 433.92 MHz, R_{PWRSET} = 1.2 kΩ, R_{PWRSET} = 1.8 kΩ	P_{Ref} P_{Ref}	1.5 –0.5	3 1	5 3	dBm dBm
Output power variation for the full temperature range	T_{amb} = –40°C to +85°C, f = 433.92 MHz, V_S = 3.0 V V_S = 2.4 V	ΔP_{Ref} ΔP_{Ref}			–1.5 –4.0	dB dB
	T_{amb} = –20°C to +85°C, f = 433.92 MHz, V_S = 2.0 V P_{out} = P_{Ref} + ΔP_{Ref}	ΔP_{Ref}			–5.5	dB
Output power variation for f = 315 MHz compared to f = 433.92 MHz	f = 315 MHz P_{out} = P_{Ref} + ΔP_{Ref}	ΔP_{Ref}		1.5		dB
Maximum peak output antenna voltage	@ P_{out} = 2.0 mW, The load impedance must be selected to meet the V_{out} maximum requirement. The supply current is not dependent on the load impedance tolerance.	V_{outmax}		V_S – 0.7 V		$V_{(peak)}$
Spurious emission	@ T_{amb} = 25°C f_o ± n × f_{PC} (f_{PC} = 6.78 MHz) Load capacitance at CLK ≤ 3 pF f = 230 MHz to 470 MHz f < 230 MHz, f > 470 MHz	Em Em			–40 –58	dBC dBC
Oscillator frequency XTO	M-version: @ T_{amb} = 25°C N-version: full temperature range (monitoring) Crystal frequency = 13.56 MHz	f_{XTO}	13.56 – 30 ppm	13.56	13.56 +30 ppm	MHz
	6.78 MHz load capacity of the crystal must be selected accordingly	f_{XTO}	6.78 –30 ppm	6.78	6.78 +30 ppm	MHz
Loop bandwidth	For best LO noise Loop filter components: C2 = 3.9 nF, C1 = 15 nF, R4 = 220 Ω	B_{Loop}		100		kHz
Phase noise PLL	Referring to the phase comparator f_{PC} = 6.78 MHz	PN_{PLL}		–111	–105	dBC/Hz
Phase noise VCO	@ 1 MHz @ 36 MHz	PN_{VCO} PN_{VCO}		–91 –123	–87 –119	dBC/Hz
Frequency range of the VCO		f_{VCO}	300		450	MHz
Clock output (CMOS μC compatible)		Clk_{out}		f_{out}/128		MHz

Electrical Characteristics (continued)

All parameters are refered to GND (Pin 5).

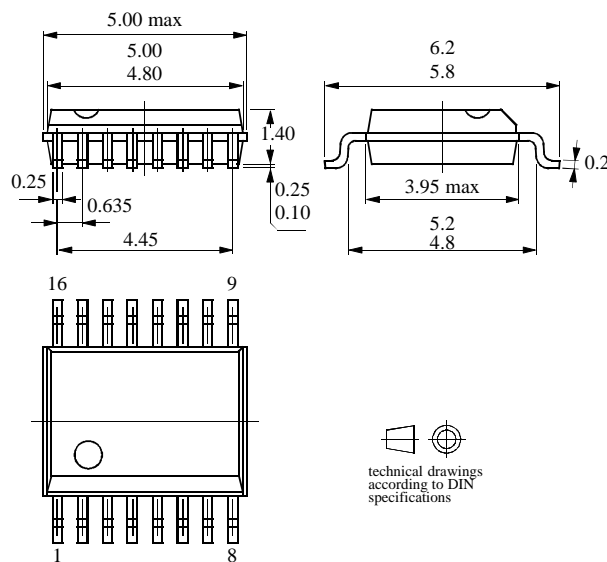The possible operating ranges refer to different circuit conditions:

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Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Load capacitance at CLK		C_{CLK}			10	pF
Series resonance R of the crystal	f_{XTO} = 13.56 MHz f_{XTO} = 9.84 MHz f_{XTO} = 6.78 MHz f_{XTO} = 4.90 MHz	Rs Rs Rs Rs			80 100 150 225	Ω
FSK modulation frequency rate	Duty cycle of the modulation signal = 50%	f_{modFSK}	0		20	kHz
ASK modulation frequency rate	Duty cycle of the modulation signal = 50%	f_{modASK}	0		20	kHz
CLK output – Output current Low – Output current Low – Output current High – Output current High	V_{CLK} = 0.2 × V_S V_{CLK} = 0.3 × V_S V_{CLK} = 0.8 × V_S V_{CLK} = 0.7 × V_S	I_{ol} I_{ol} I_{oh} I_{oh}	150 200 –150 –200		 100	μA μA μA μA
ASK input – Low level input voltage – High level input voltage – Input current High		V_{ASKl} V_{ASKh} I_{ASKh}	 1.7		0.3 140	V V μA
FSK input – Low level input voltage – High level input voltage – Input current High		V_{FSKl} V_{FSKh} I_{FSKh}	 1.7		0.3 140	V V μA

Package Information

Package SSO16
Dimensions in mm

technical drawings according to DIN specifications

13045

Ozone Depleting Substances Policy Statement

It is the policy of **Atmel Germany GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

Atmel Germany GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

Atmel Germany GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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Data sheets can also be retrieved from the Internet: http://www.atmel–wm.com

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