



## Features

- Few External Components
- Low Power Consumption
- Microcomputer Compatible
- Insensitive to Ambient Light and Other Continuous Interferences

## Applications

- Keyless Entry Systems
- Remote Control
- Wireless Data Transfer up to 4 kbit/s

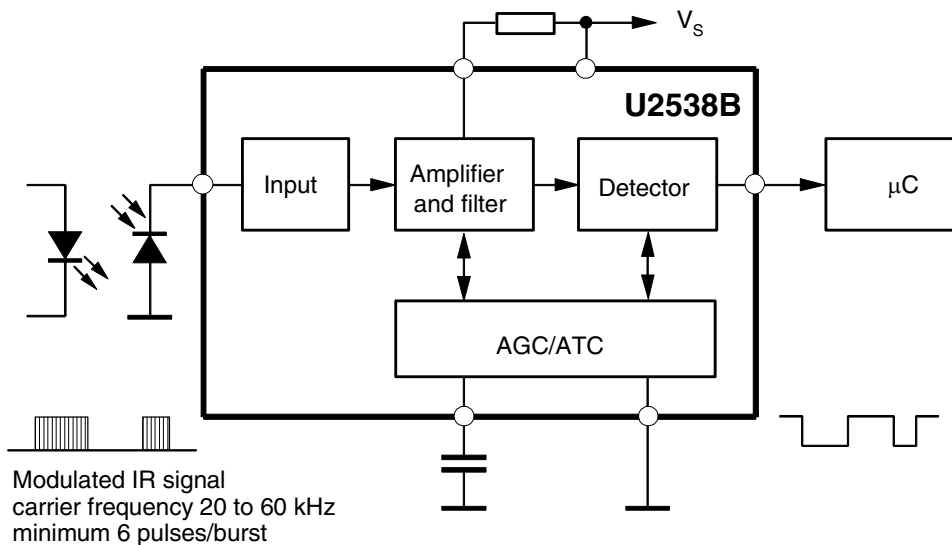
## Description

The IC U2538B is a complete IR receiver for data communication. The useful input signals are separated by a special input circuit and amplified by a gain-controlled amplifier. The bandpass filter suppresses the off-band signals. The signal detector, consisting of a demodulator, an integrator and a Schmitt trigger, forms the input signal into an output pulse that can be interfaced to a microcomputer. The AGC and the ATC circuit control the receiver's sensitivity, making it insensitive to ambient light sources.

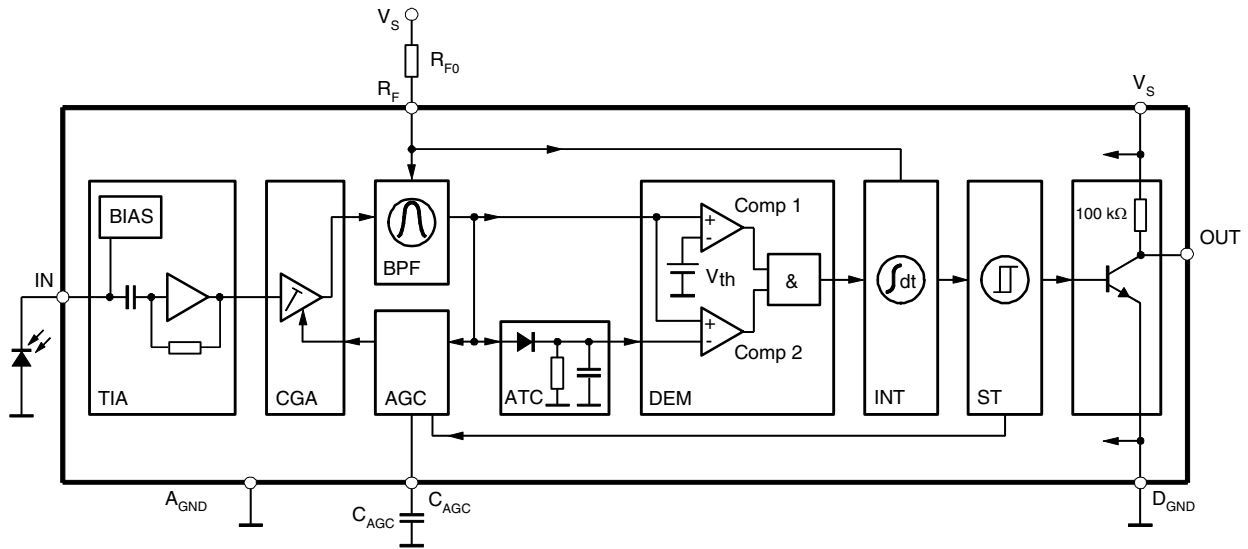
## IR Receiver for Data Communication

### U2538B

**Figure 1.** Block Diagram with Typical Circuit



## Block Diagram

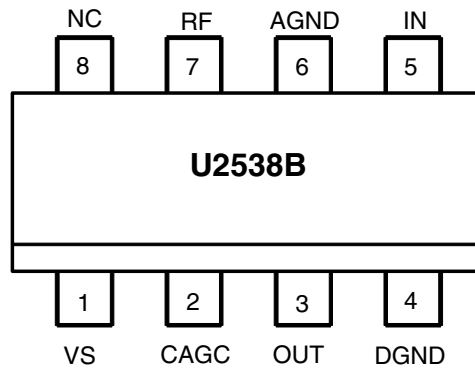


**TIA** Transimpedance amplifier  
**CGA** Controlled gain amplifier  
**BPF** Bandpass filter  
**AGC** Automatic gain control

**ATC** Automatic threshold control  
**DEM** Demodulator  
**INT** Integrator  
**ST** Schmitt trigger

## Pin Configuration

Figure 2. Pinning SO8



## Pin Description

Pin	Symbol	Function
1	VS	Supply voltage
2	CAGC	AGC capacitor
3	OUT	Data output
4	DGND	GND - DEM/INT/ST
5	IN	Input pin diode
6	AGND	GND amplifier
7	RF	Frequency determination
8	NC	Not connected

## Functional Description

### Input Stage (TIA)

The input stage provides the necessary bias voltage for the photo diode and ensures decoupling of the useful signal. This involves processing the DC and AC portions in separate parts of the circuit: the bias voltage (BIAS) and the transimpedance amplifier circuit (TIA). The bias voltage circuit operates like a load resistor with respect to the photo diode, the value of which is low for DC and low-frequency signals (3 to 100 kΩ), but as high as possible for the operating frequency (100 kHz to 1 MHz) depending on the input current). The ac portion of the input signal feeds an inverted amplifier with a sufficiently low input resistance ( $Z_i < 10 \text{ k}\Omega$ ). If the input resistance is too high, the useful signal will be lost due to the junction capacitance of the photodiode.

### Controlled Gain Amplifier (CGA)

The controlled gain amplifier accounts for the greatest part of the voltage gain and can be controlled via the voltage at CAGC (Pin 2). Gain control is needed to support the interference suppression of the detector. High-pass behaviour results from the capacitive coupling of the individual stages. The cut-off frequency is approximately 20 kHz.

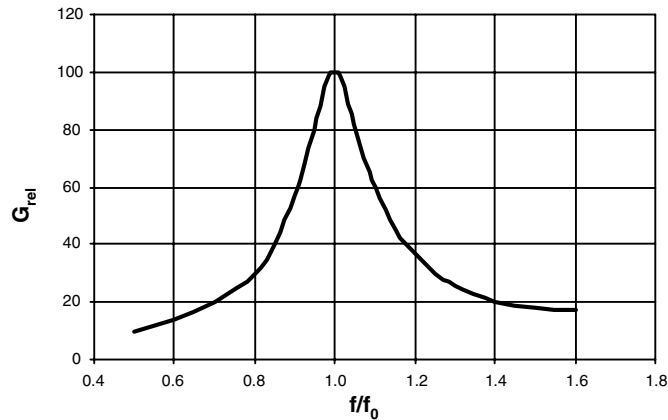
### Bandpass Filter (BPF)

The bandpass filter basically consists of integrated components. An external resistor determines the mid-frequency. The filter quality is about 7 and is practically independent of the selected mid-frequency (see Figure 3). The following formula can be used for calculating the resistor,  $R_{f0}$ :

$$R_{f0}(\text{k}\Omega) = \frac{8855}{f_0(\text{kHz})} - 13$$

where:  $20 \text{ kHz} < f_0 < 60 \text{ kHz}$

**Figure 3.** Characteristic of the Bandpass Filter



**Automatic Threshold Control (ATC)**

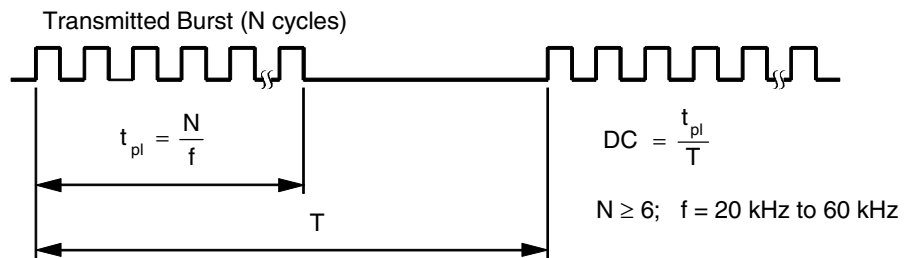
During the reception of an incoming telegram, the ATC reduces the sensitivity of the demodulator to establish the highest possible signal-to-noise ratio according to the signal strength. This prevents interferences which may arise during transmission from affecting the output. The advantage of the circuit is achieved if its output voltage exceeds  $V_{Th}$  (Comp 1). That is the case when the input signal strength is more than twice as much as the minimum detectable signal intensity.

**Automatic Gain Control (AGC)**

The automatic gaincontrol improves the circuit's resistance to interference by adapting the amplification of the gain-controlled amplifier to the relevant existing interference level. In order to prevent the circuit from responding to transmitted data signals, it gradually reduces the sensitivity, but only if the duty cycle exceeds a specific value (see Figure 4). When using telegrams with higher duty cycles than this value, the capacitor,  $C_{AGC}$ , maintains the sensitivity for a certain time period. A higher capacitance enables a longer transmission time. A capacitance of  $C_1 = 22$  nF is adequate for most known telegrams. A typical value for the maximum duty cycle (DC) can be calculated by the following formula:

$$DC_{max} = \frac{N}{14.2 + 1.1 \times N}$$

**Figure 4.** Duty Cycle



**Detector**

The output signal of the bandpass filter is compared to a fixed reference (Comp 1) and to a reference generated by the ATC circuit (Comp 2). The output of the comparator with the higher threshold voltage controls the integrator. Using the integrator keeps the output free of short-time interference.

The integrator drives the output stage after being processed through a Schmitt trigger. The internal pull-up resistor can replace an external resistor in some applications.

## Absolute Maximum Ratings

Parameters		Symbol	Value	Unit
Supply voltage	Pin 1	$V_S$	-0.3 to +6.0	V
Input voltages	Pin 2, 3, and 5 Pin 7	$V_{IN}$	-0.3 to $V_S$ -0.3 to +1.5	V
Input current	Pin 7	$I_{IN}$	0 to 0.1	mA
Power dissipation $T_{amb} = 105^\circ\text{C}$		$P_{tot}$	110	mW
Junction temperature		$T_j$	125	$^\circ\text{C}$
Ambient temperature		$T_{amb}$	-40 to +105	$^\circ\text{C}$
Storage temperature		$T_{stg}$	-40 to +125	$^\circ\text{C}$

## Thermal Resistance

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

## Electrical Characteristics

$T_{amb} = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Pin 1	$V_S$	4.5		5.5	V
Supply current	Pin 1	$I_S$	0.35		0.65	mA
Maximum input current $V_{IN} = 0$	Pin 5	$I_{IN}$	0.6			mA
Output voltage low: $I_{OL} = 2\text{ mA}$	Pin 3	$V_{OL}$			0.2	V
Internal pull-up resistor	Pin 3	$R_L$	75	100	125	$k\Omega$
Center frequency of bandpass $RF = 240\text{ k}$		$f_0$	33.3	35	36.7	kHz
Q factor		Q		7		
Frequency range		f	20		60	kHz
AGC current source sink	Pin 2		90 70	120 100	155 140	nA nA
AGC slope	Pin 2			20		dB/V
Number of pulses required			6			
Sensitivity	Pin 5				0.7	nA(rms)
Switch-on delay, $i_{IN} = 0.7\text{ nA (rms)}$	Pin 3, see Figure 5	$t_{don}$	3		7.5	Period
Switch-off delay, $i_{IN} = 0.7\text{ nA (rms)}$	Pin 3, see Figure 5	$t_{doff}$	5		10	Period
Pulse width, $i_{IN} = 0.7\text{ nA (rms)}$ , 6 pulse bursts	Pin 3, see Figure 5	$t_{po}$	4.5		10	Period

$$R_{f0}(k\Omega) = \frac{8855}{f_0(\text{kHz})} - 13\text{ k}\Omega$$

Figure 5. Switch On/Off Delay

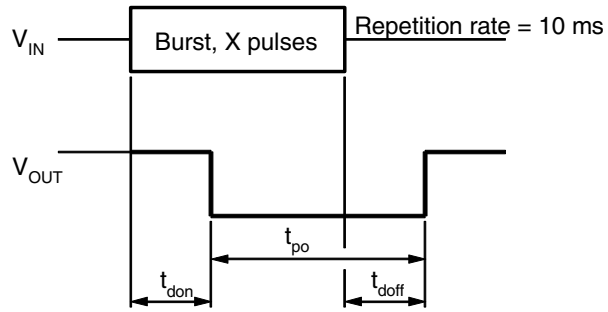
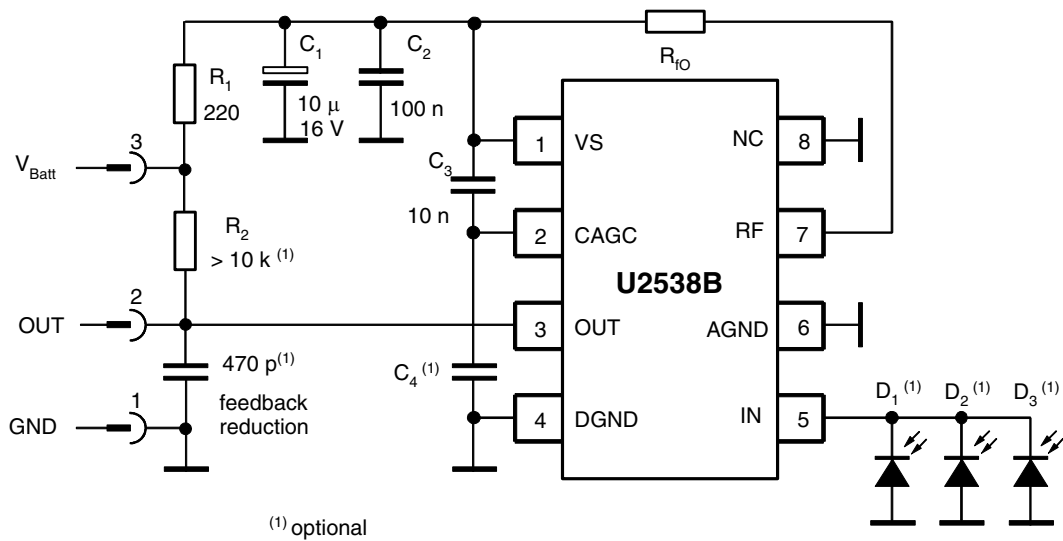


Figure 6. Application Circuit



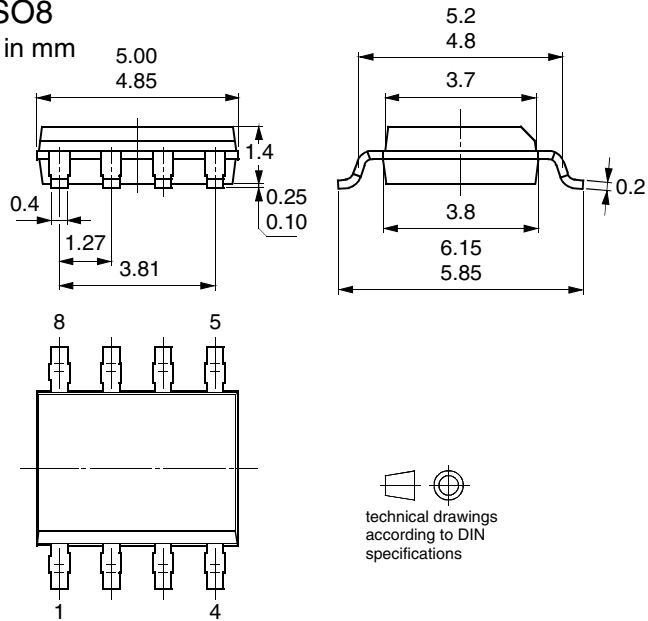
## Ordering Information

Extended Type Number	Package	Remarks
U2538B-MFP	SO8	Tube
U2538B-MFPG3	SO8	Taped and reeled

## Package Information

### Package SO8

Dimensions in mm







## Atmel Headquarters

### *Corporate Headquarters*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 487-2600

### *Europe*

Atmel Sarl  
Route des Arsenaux 41  
Case Postale 80  
CH-1705 Fribourg  
Switzerland  
TEL (41) 26-426-5555  
FAX (41) 26-426-5500

### *Asia*

Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimhatsui  
East Kowloon  
Hong Kong  
TEL (852) 2721-9778  
FAX (852) 2722-1369

### *Japan*

9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
TEL (81) 3-3523-3551  
FAX (81) 3-3523-7581

## Atmel Operations

### *Memory*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 436-4314

### *Microcontrollers*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 436-4314

La Chantrerie  
BP 70602  
44306 Nantes Cedex 3, France  
TEL (33) 2-40-18-18-18  
FAX (33) 2-40-18-19-60

### *ASIC/ASSP/Smart Cards*

Zone Industrielle  
13106 Rousset Cedex, France  
TEL (33) 4-42-53-60-00  
FAX (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
TEL 1(719) 576-3300  
FAX 1(719) 540-1759

Scottish Enterprise Technology Park  
Maxwell Building  
East Kilbride G75 0QR, Scotland  
TEL (44) 1355-803-000  
FAX (44) 1355-242-743

### *RF/Automotive*

Theresienstrasse 2  
Postfach 3535  
74025 Heilbronn, Germany  
TEL (49) 71-31-67-0  
FAX (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
TEL 1(719) 576-3300  
FAX 1(719) 540-1759

### *Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom*

Avenue de Rochepleine  
BP 123  
38521 Saint-Egreve Cedex, France  
TEL (33) 4-76-58-30-00  
FAX (33) 4-76-58-34-80

---

### *e-mail*

literature@atmel.com

### *Web Site*

<http://www.atmel.com>

### © Atmel Corporation 2003.

Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty which is detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by the Company in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

Atmel® is the registered trademark of Atmel.

Other terms and product names may be the trademarks of others.



Printed on recycled paper.