

## 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



# IR Receiver for Data Communication

## U2538B

## 1. 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 to 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.

Figure 1-1. Block Diagram with Typical Circuit

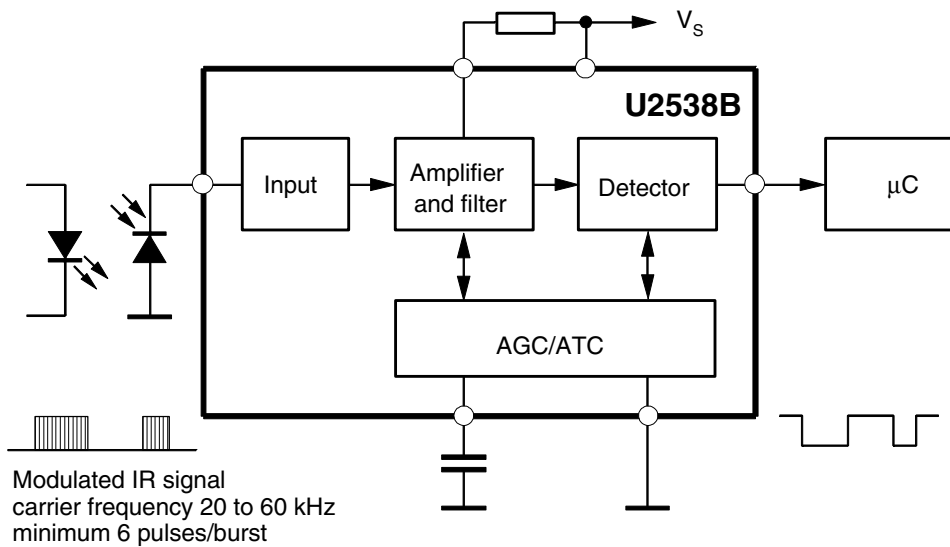
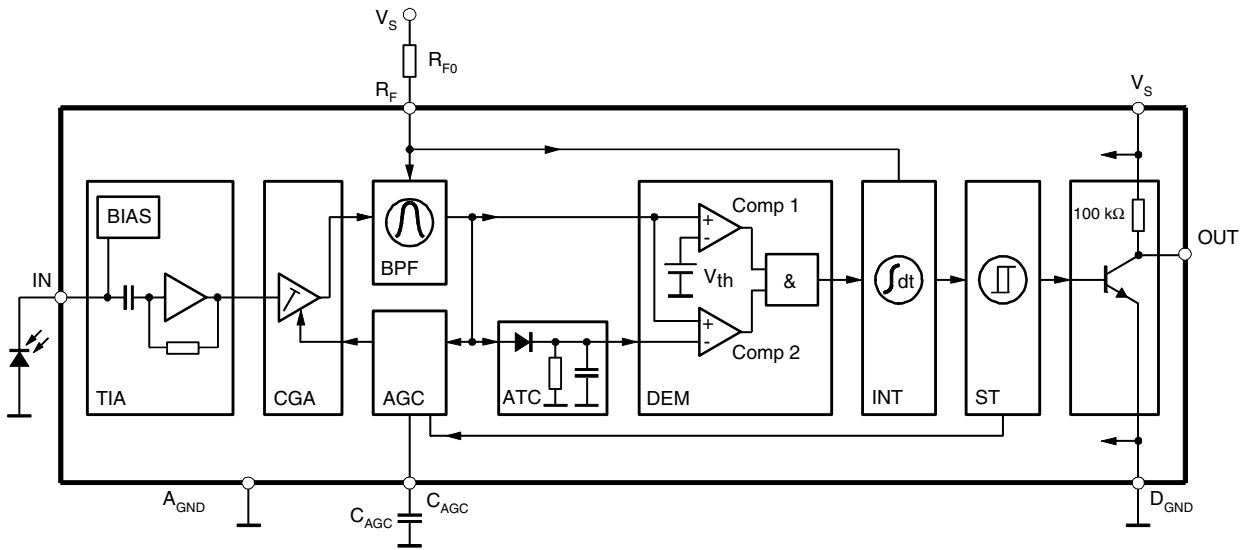


Figure 1-2. Block Diagram

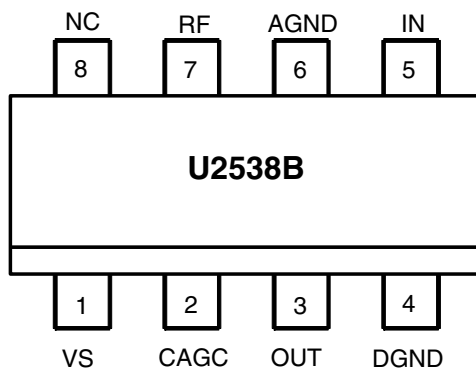


TIA Transimpedance amplifier  
 CGA Controlled gain amplifier  
 BPF Bandpass filter  
 AGC Automatic gain control

ATC Automatic threshold control  
 DEM Demodulator  
 INT Integrator  
 ST Schmitt trigger

## 2. Pin Configuration

**Figure 2-1.** Pinning SO8



**Table 2-1.** 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

### 3. Functional Description

#### 3.1 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.

#### 3.2 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 behavior results from the capacitive coupling of the individual stages. The cut-off frequency is approximately 20 kHz.

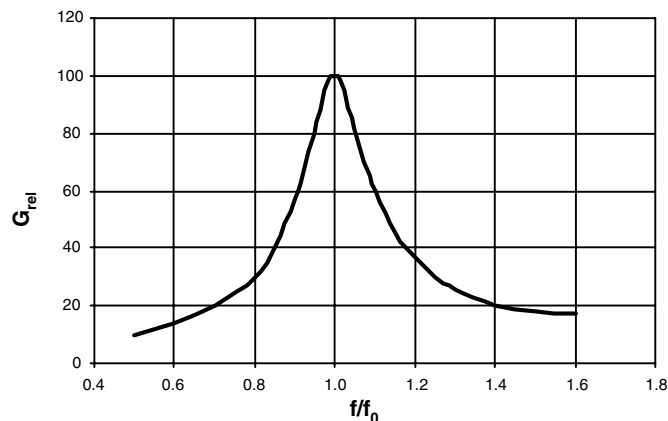
#### 3.3 Bandpass Filter (BPF)

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 3-1](#)). 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 3-1.** Characteristic of the Bandpass Filter



### 3.4 Automatic Threshold Control (ATC)

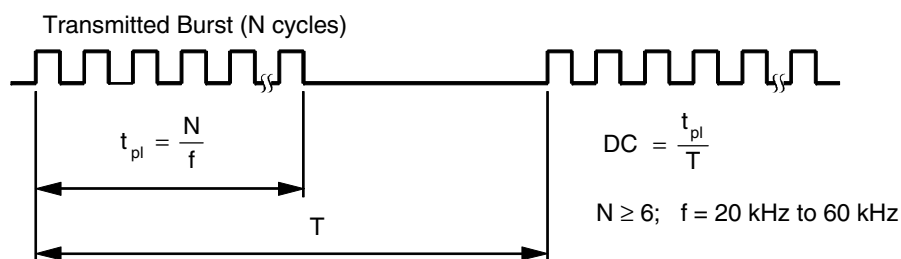
During the reception of an incoming telegram, the ATC reduces the sensitivity of the demodulator to establish the highest possible signal-to-noise ratio according to the signal strength. This prevents interferences which may arise during transmission from affecting the output. The advantage of the circuit 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.

### 3.5 Automatic Gain Control (AGC)

The automatic gain control 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 3-2). 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  $C_1 = 22 \text{ nF}$  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 3-2. Duty Cycle



### 3.6 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.

## 4. Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Parameters	Symbol	Value	Unit
Supply voltage, pin 1	$V_S$	-0.3 to +6.0	V
Input voltages Pins 2, 3, and 5 Pin 7	$V_{IN}$ $V_{IN}$	-0.3 to $V_S$ -0.3 to +1.5	V 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	$^\circ\text{C}$

## 5. Thermal Resistance

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

## 6. 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 $RF = 240k$		$f_0$	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 <a href="#">Figure 6-1</a>	$t_{don}$	3		7.5	Period
Switch-off delay, $i_{IN} = 0.7\text{ nA (rms)}$	Pin 3, see <a href="#">Figure 6-1</a>	$t_{doff}$	5		10	Period
Pulse width, $i_{IN} = 0.7\text{ nA (rms)}$ , 6 pulse bursts	Pin 3, see <a href="#">Figure 6-1</a>	$t_{po}$	4.5		10	Period

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

Figure 6-1. Switch On/Off Delay

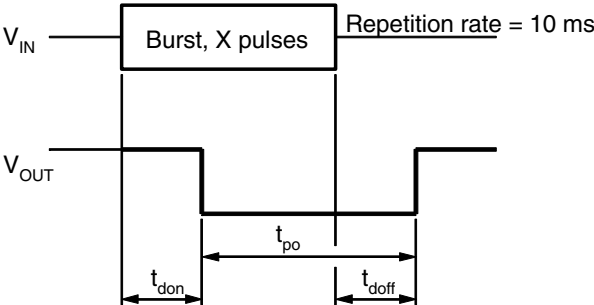
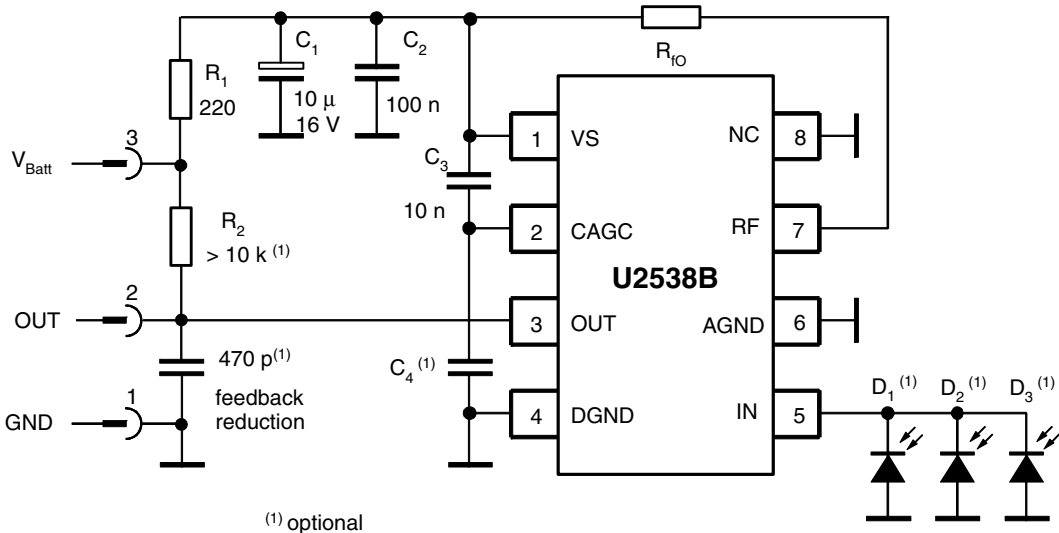


Figure 6-2. Application Circuit



(1) optional

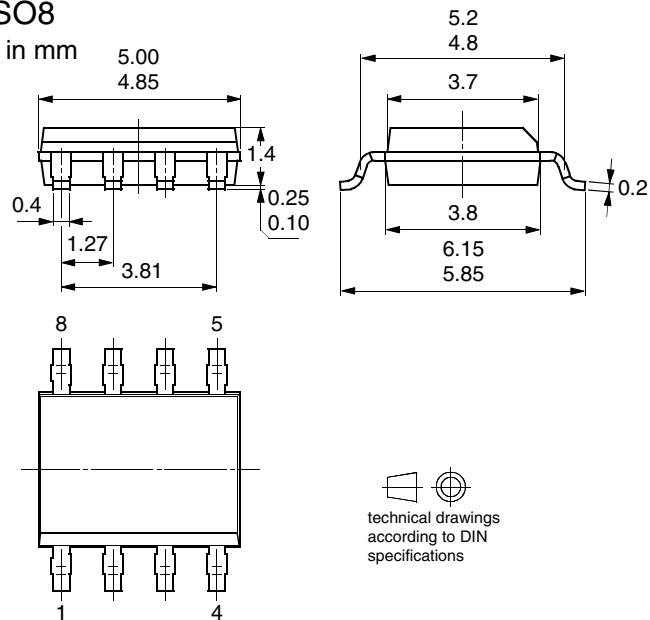
## 7. Ordering Information

Extended Type Number	Package	Remarks
U2538B-MFPY	SO8	Tube, Pb-free
U2538B-MFPG3Y	SO8	Taped and reeled, Pb-free

## 8. Package Information

### Package SO8

Dimensions in mm



## 9. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

Revision No.	History
4717B-IRRC-09/05	<ul style="list-style-type: none"> <li>Put datasheet in a new template</li> <li>Pb-free Logo on page 1 added</li> <li>Heading Rows on Table "Absolute Maximum Ratings" on page 6 added</li> <li>Ordering Information on page 8 changed</li> </ul>





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