TELEFUNKEN electronic
Creative Technologien

U 2505 B · U 2506 B – FP

IR REMOTE CONTROL FRONTEND AMPLIFIER

Technology: Bipolar

Features:

- 400 kHz carrier frequency
- Low power consumption (typ. 2 mA)
- On-chip bandgap-voltage reference
- AGC stage
- Few external components
- µC-compatible demodulated output signal

Case:

14-pin dual inline plastic (U 2505 B)
16-pin SO plastic (U 2506 B-FP)

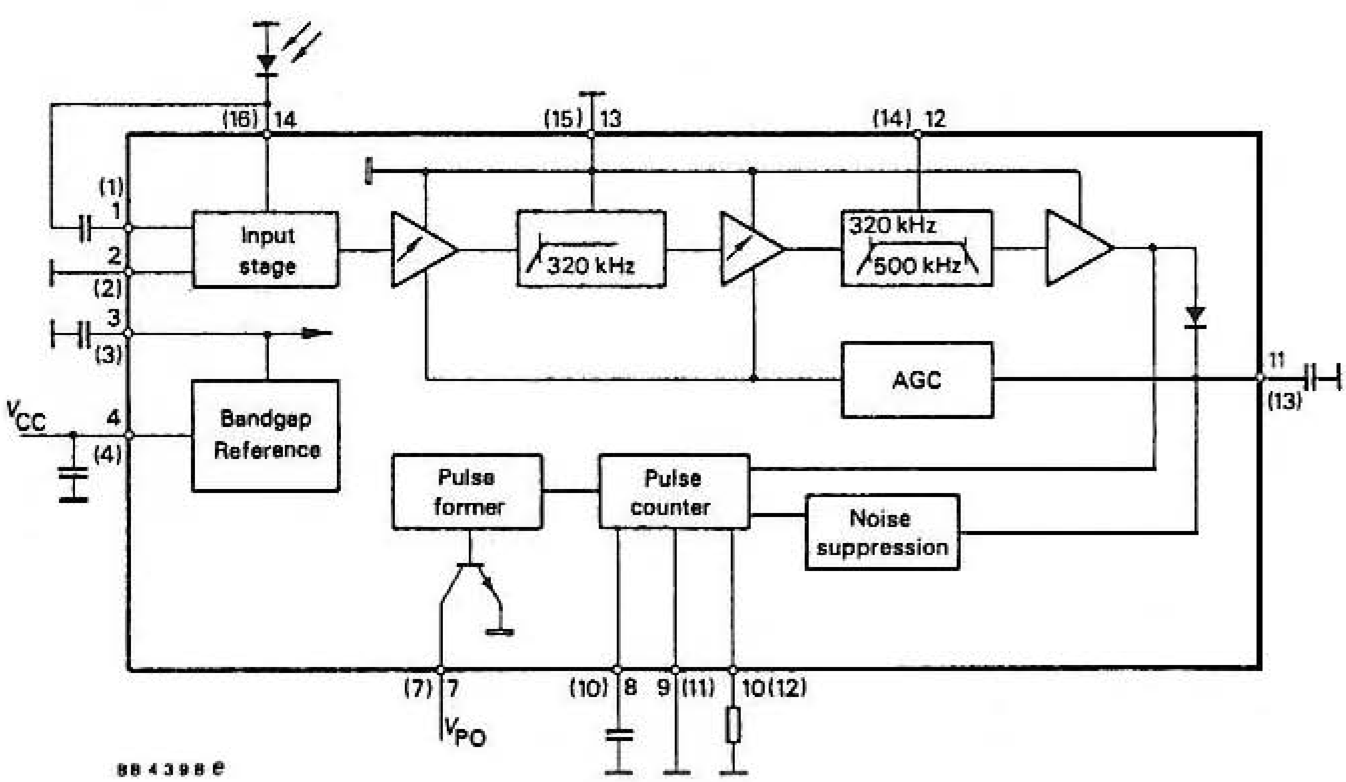

Fig. 1 Block diagram (pin connections for SO 16 case in bracket)

Absolute maximum ratings

Reference point pin 2, unless otherwise specified

Supply voltage range	Pin 4	V_{CC}	-0.3 ... +7	V
Input voltage	Pin 8,10,11,12,14	V_I	-0.3 ... +6	V
Input current	Pin 1	I_I	1	mA
Output current	Pin 7	$\pm I_O$	6	mA
	Pin 3	$\pm I_O$	0.5	mA
Junction temperature		T_j	130	°C
Storage temperature range		T_{stg}	- 40 ... +130	°C
Ambient temperature range		T_{amb}	0 ... +100	°C

Maximum thermal resistance

Junction ambient	DIP 14	R_{thJA}	90	K/W
	SO 16	R_{thJA}	160	K/W

400 kHz-amplifier and active filter

In order to obtain a correct pulse answer of 8 pulses at 400 kHz, a receiver bandwidth of about 100 kHz is necessary.
Considering the tolerances of integrated capacitors and resistors, the necessary filter components can be realized or chip.
To achiev a good suppression of the low frequencies and the corresponding disturbances, a butterwoth-high-pass filter of 5th or with a -3 dB frequency of 320 kHz is provided.
Normally, disturbances greater than 400 kHz are not present. From the noise point of view, a butterworth-low-pass filter of 3rd order with a -3 dB frequency of 500 kHz improves the performances (larger possible distance between transmitter and receiver).
All filters are realized with Sallen-key structures connected in series.
Since the received signal on the photo-diode is relatively small, an over all amplification of 90 dB is necessary.

Pin connections

Pin	Symbol	Function
1(1)	V_{I1}	Input voltage from IR-diode
2(2)	V_G	Ground
3(3)	V_{STAB}	Bandgap-reference output
4(4)	V_{CC}	Supply voltage
5(5)		Not connected
6(6)	V_G	Ground
7(7)	V_{PO}	Pulse former output
8(10)	V_{CO}	Pulse counter output
9(11)	V_G	Ground
10(12)	I_{NS}	Noise suppression current input
11(13)	V_{AGC}	AGC-output
12(14)	V_{TI}	Test input
13(15)	V_G	Ground
14(16)	V_{I2}	Input voltage from the IR-diode

Pin connections for SO 16 in bracket

Functional description

Input stage, V_{I1}, V_{I2}, Pin 1, Pin 14

A detailed block diagram of the input stage is shown in Fig. 2

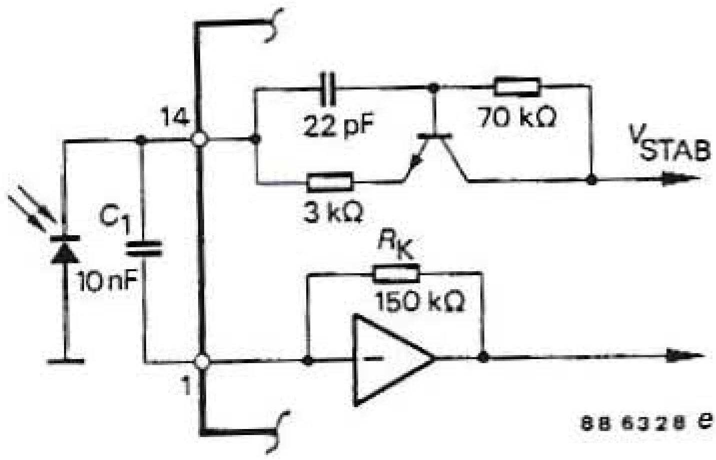

Fig. 2 Block diagram of the input stage and the external components

This infrared receiver front end includes a photodiode which is sensitive to infrared radiation and which provides an electrical current, in response to irradiation. The resistor R_k in the feedback loop of the input amplifier is responsible for a low input impedance at pin 1. Thus the parasitic capacity of the photodiode has no effect on the gain. The capacitor C_1 suppresses the DC and low frequency-part of the input signal. The circuitry on pin 14 is responsible for a high AC-impedance and improves the noise behaviour of the input stage.

Ground, Pin 2, Pin 6, Pin 9, Pin 13

Pin 2, Pin 6, Pin 9 and Pin 13 must be externally connected to ground.

Bandgap voltage reference V_{STAB}, Pin 3.

The IC incorporates a bandgap reference to bias the 400 kHz-amplifier and filter stages.

An external connected electrolytic capacitor on pin 3 is used to suppress any noise at the internal supply voltage.

Supply voltage V_{CC}, Pin 4

Unregulated supply voltage 4.5 V ... 6 V.

Output-pulse former with open collector output, Pin 7

In order to drive a microprocessor, an internal realized mono-stable circuit serves for an output pulse of 40 µs. The time-constant is realized internally and has a spread of ± 30 %. The output of this monoflop drives the open collector output transistor. This transistor is saturated during the pulse-duration (40 µs) and is open for the remaining time.
The output transistor is protected against positive pulses by means of a 7.5 V Zener-diode..

Pulse counter circuitry and noise suppression, Pin 8, Pin 10

A more detailled block diagram of the pulse counter circuitry is shown in fig. 3. The function of the pulse-counter circuitry can easily be understood regarding the timing diagram of fig. 4.

When the 400 kHz signal (burst or noise) overgoes the threshold voltage V_{THA} (≧ 20 mV) the internal realized capacitor C_1 is discharged (see signal V_B). Only a connected series of some pulses held signal C at a low voltage and T2 opens for the whole pulse sequence. During this time, the external capacitor C_2 can be charged up to the threshold voltage of 2 V (see signal V_D in fig.4). and on output pulse V_E is generated.
Smaller pulses or noise are also able to open T2 but the voltage on C_2 (V_D) doesn't reach the threshold voltage of 2 V and cannot generate an output pulse.
Thus only a connected series of 7 and more pulses generates an output pulse on point E.
The noise suppression part works in a very simple way. Each negative pulse on point C charges the AGC-capacitor on pin 11 with a current of ~ 10 µA.
If only transmitter pulses are received, the average value of this charge current is smaller than the internal realized discharging current (decay-time).
Thus, this additional charging current has no influence.
If the noise or other disturbation are large enough to overcome the threshold voltage V_{THA}, the number of chargeimpulses increases and these pulses load the AGC-capacitor until a certain number of pulse on point C is present (i.e. until the average value of the charging pulses are equal to the discharging current).

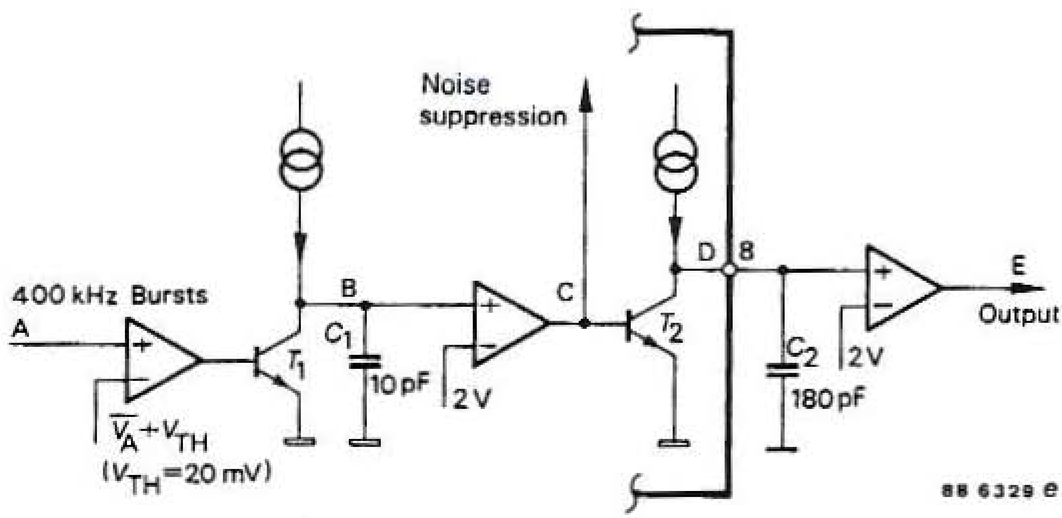

Fig. 3 Detailed block diagram of the pulse-counter circuitry

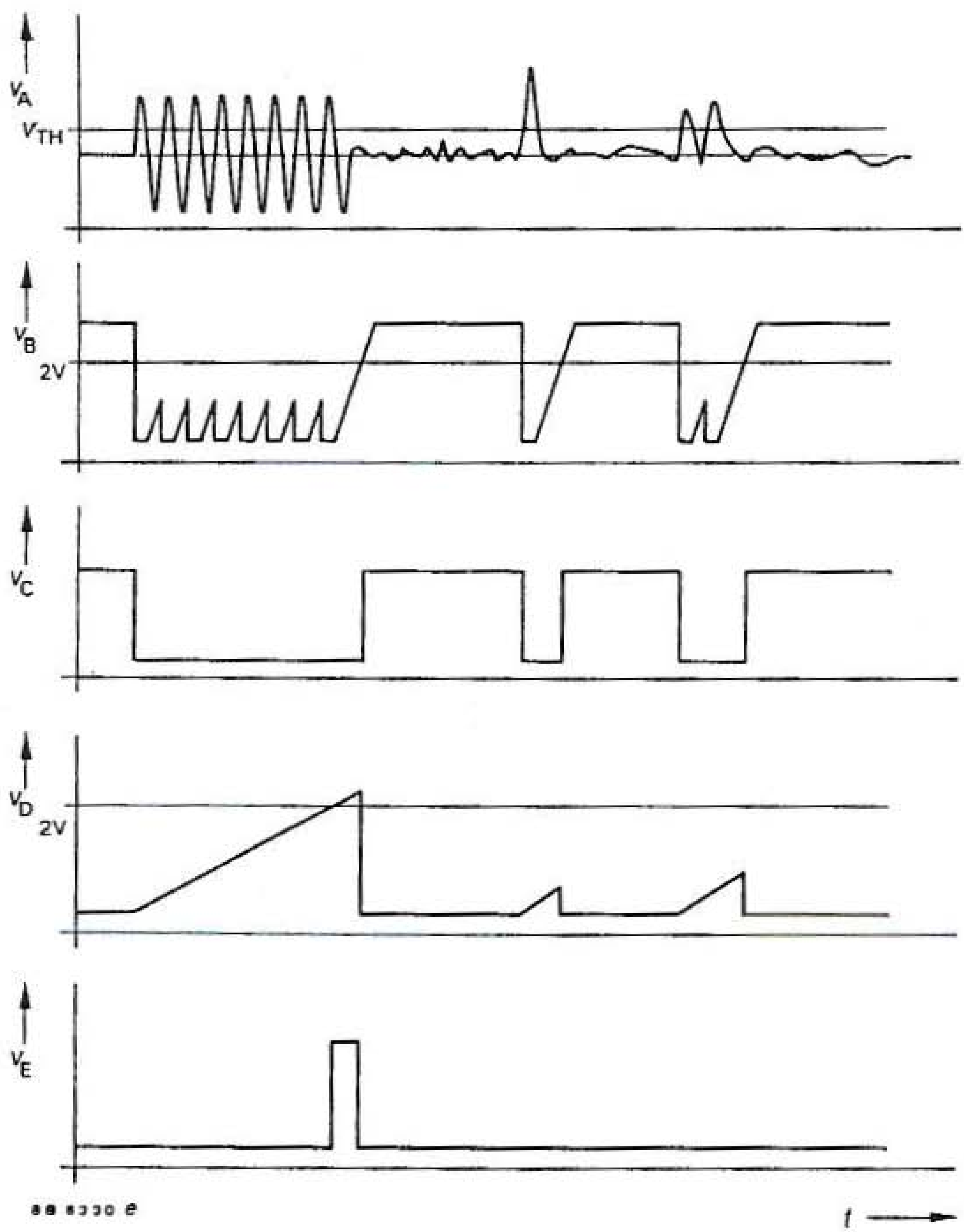

Fig. 4 Timing diagram of the signals in the pulse-counter block

Thus the noise level on the amplifier-output (point A) will be held on a nearly constant level.
This noise suppression system works in the same way for carriers with a constant amplitude e.g. the 250 kHz carrier of the infrared-wireless ear-phone system.
From the noise suppression circuitry point of view it is evident, that this IC can only receive small bursts of a 400 kHz carrier. All other kinds of signals are suppressed and are processed in the same way as noise signals.

AGC-stage, Pin 11

The amplifier output is connected via diode with the AGC-capacitor. If the voltage on the AGC-capacitor reaches the threshold voltage of about 1.2 V the voltage current converter reduces the total gain of the amplifier-filter-chain.
Thus, the 400 kHz output voltage after the last amplifier remains nearly constant (~0.5 V_{eff} during the 400 kHz burst pulses).
Since the charge current for the AGC-capacitor is several mA and the dis-charge current is only some 100 nA, a very fast attack-time (~5 µsec) and a comparable long recovery time from the transmitter have nearly the same amplitude and any over-driving of the amplifiers can be avoided.
Furthermore, this AGC-circuitry is used for noise suppresseion.

Test input, Pin 12

This input is used to test the characteristics of the internal band pass filter. By connecting an external LC or ceramic parallel resonator the band-width can be reduced. To compensate for this, the number of pulses which trigger the output has to be increased.

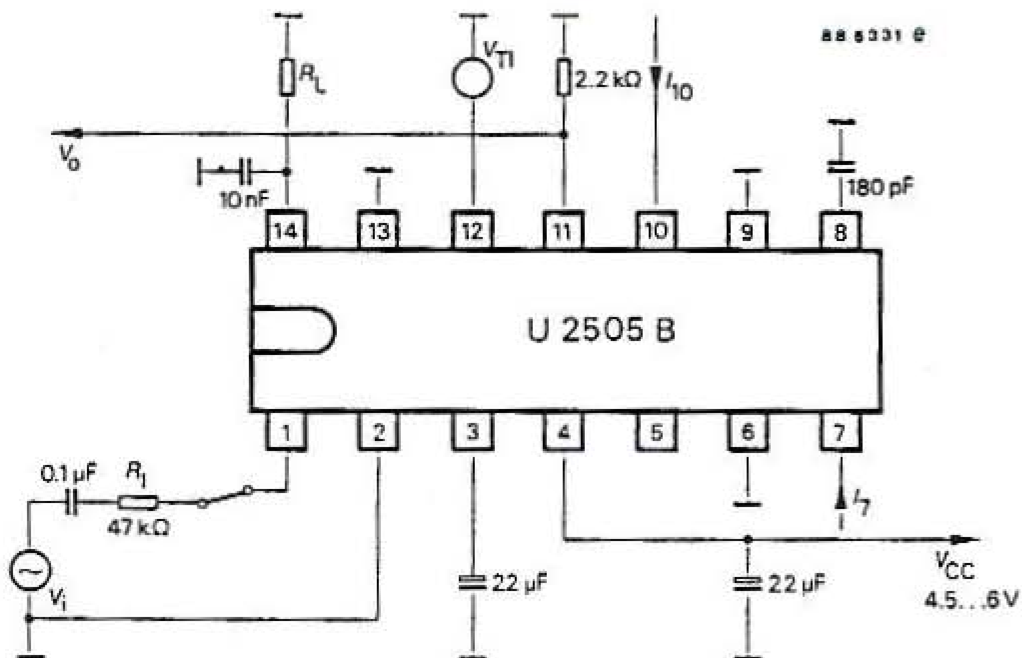

Fig. 5 Test circuit

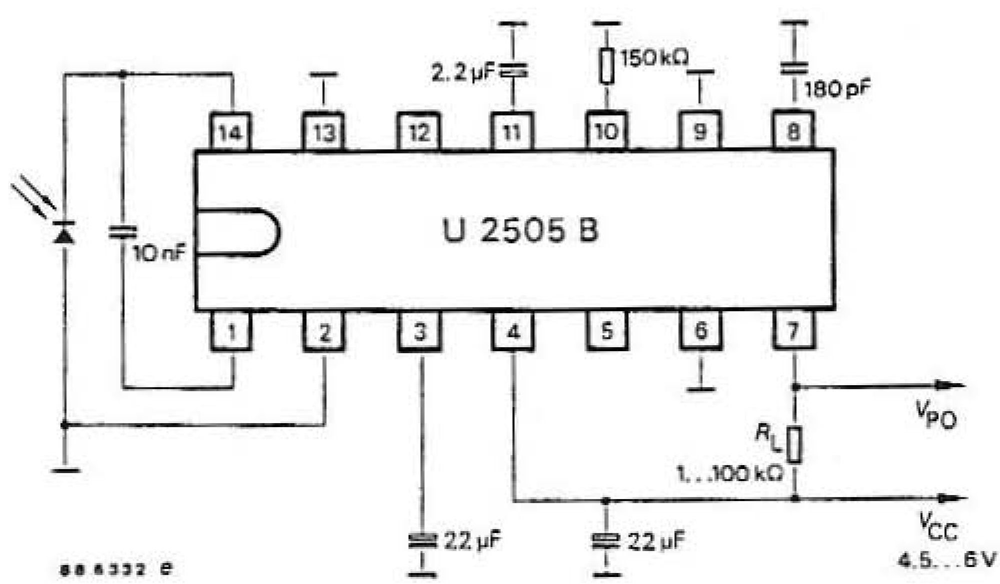

Fig. 6 Typical application for the amplifier

Electrical characteristics

V_{CC} = 5 V, T_{amb} = 25 °C, V_i = 0 V,
reference point pin 2,
unless otherwise specified, test circuit fig. 5

			Min.	Typ.	Max.	
Supply voltage	Pin 4	V_{CC}	4.5	5	6	V
Supply current V_{CC} = 4.5 ... 6 V	Pin 4	I_{CC}		2	3.1	mA
Bandgapreference voltage V_{CC} = 4.5 ... 6 V no ext. load	Pin 3	V_{STAB}	3.55	3.9	4.35	V
IR-diode interface						
Output voltage	Pin 1	V_{O1}	0.5		0.8	V
Output voltage R_L = 100 kΩ	Pin 14	V_O	2.95		3.45	V
R_L = 1 kΩ	Pin 14	V_O	0.6		1.2	V
Pulse former output	Pin 7					
Zener voltage I_7 = 0.2 mA		V_{OZ}	7.1		7.8	V
Output low-voltage I_7 = 5 mA		V_{OL}			0.5	V
Input pulses at V_{TI} = 70 mV_{pp} f_{12} = 400 kHz square wave pulse width 0 µs					4	Imp
pulse width 30 - 70 µs				7		
Pulse counter output	Pin 8					
Output voltage V_{CC} ≧ 3.5 V		V_O			0.25	V
Noise suppression current	Pin 10					
Output voltage I_{10} = 0.2 A		V_O	V_{OZ}+1.6		V_{OZ}+2.4	V

			Min.	Typ.	Max.	
AGC-output	Pin 11					
Output voltage		V_0	0.4		0.8	V
AC output voltage V_i = 1.414 mV_{pp} f_1 = 400 kHz sine wave		V_{oA}	60		170	mV
Test input	Pin 12					
Output voltage		V_0	3.1		3.7	V
Internal bandpass						
Output voltage at pin 11 f_c = 250 kHz ... 500 kHz					1.6 V_{oA}	mV
Upper cut-off frequency (-3 dB)		f_a			1.5 f_c	kHz
Lower cut-off frequency (-3 dB)		f_b	0.67 f_c			kHz
Noise voltage 0 - 1 MHz V_{IN1} open Pin 1 connected to pin 14 by C = 10 nF		V_N			50	mV