## Features

- **On-chip Control Functions are Available for System Gain Adjust (dB Linear versus DC Current)**
- **Low Noise LO Design**
- **ESD Protected**

## Benefits

- **All Front-end Functions of a High-performance FM Receiver Except the RF Preamplifier are Integrated**
- **Improved Dynamic Range by High Current Double-balanced Mixer Design and a New AGC Conception with 3 Loops On-chip**
- **Improved Blocking and Intermod Behavior Due to a Unique “Interference” Sensor Controlling the AGC**
- **Easy Cascading of 3 IF Filters (Ceramic) Enabled by Two On-chip IF Preamplifiers**

## Description

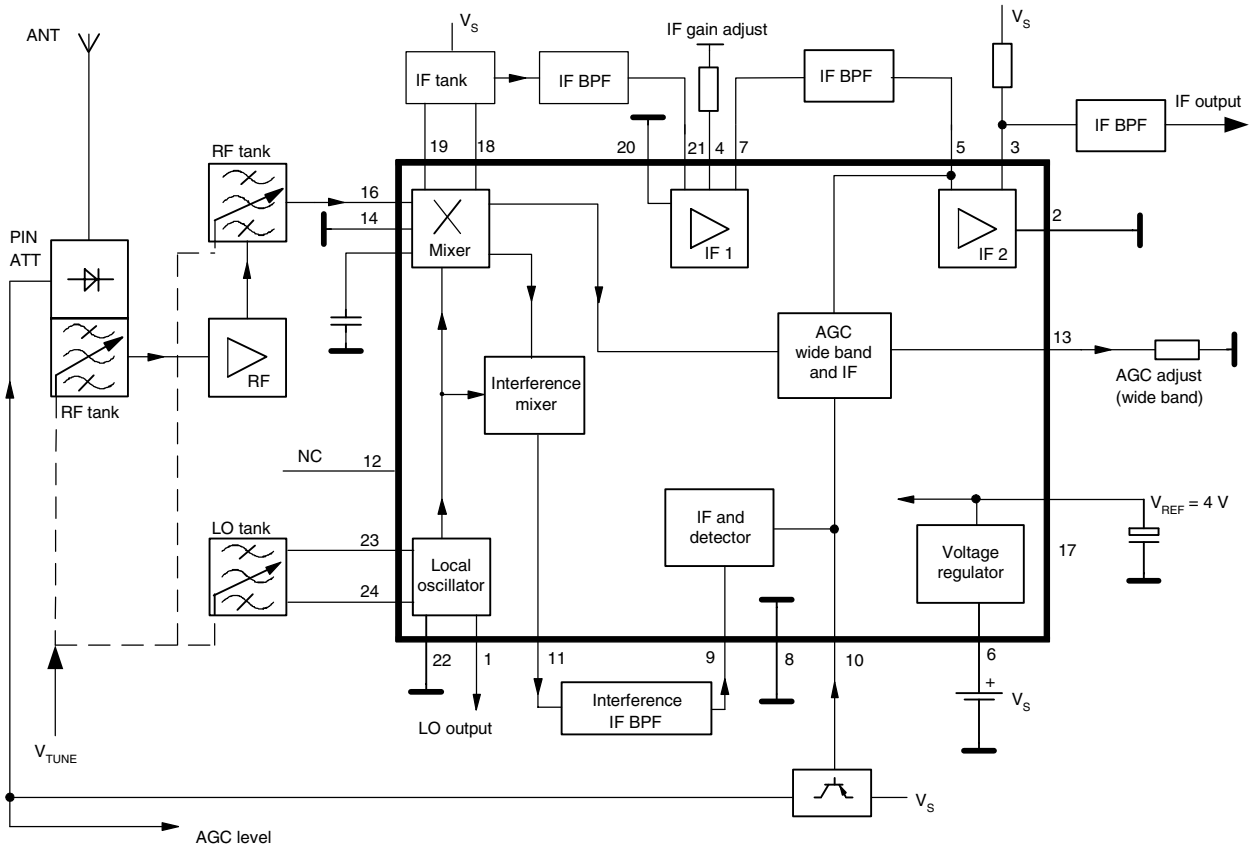
The IC U4065B is a bipolar integrated FM front-end circuit. It contains a mixer, an oscillator, two IF preamplifiers and an unique interference sensor. The device is designed for high-performance car radio and home receiver applications.

# FM Receiver IC

# U4065B

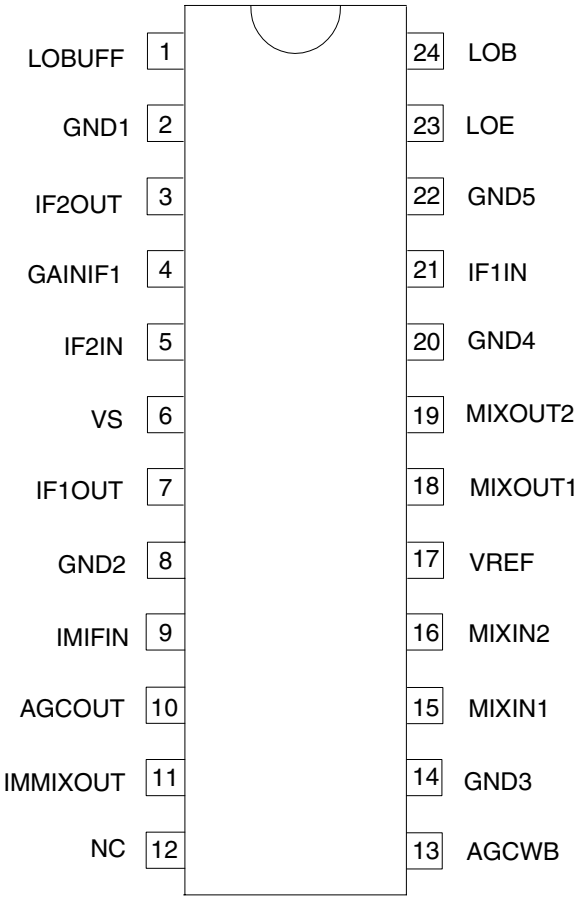
Rev. 4807A–AUDR–05/04

**Figure 1.** Block Diagram



## Pin Configuration

**Figure 2.** Pinning SO24

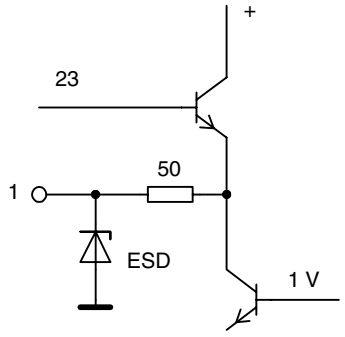


## Pin Description

| Pin | Symbol | Function |
|---|---|---|
| 1 | LOBUFF | Buffered local oscillator output |
| 2 | GND1 | Ground of the second IF amplifier |
| 3 | IF2OUT | Output of the second IF amplifier |
| 4 | GAINIF1 | Gain control of the first IF amplifier |
| 5 | IF2IN | Input of the second IF amplifier |
| 6 | VS | Supply voltage |
| 7 | IF1OUT | Output of the first IF amplifier |
| 8 | GND2 | Ground |
| 9 | IMIFIN | Input of the amplifier for the IM sensor |
| 10 | AGCOUT | Output of the automatic gain control |
| 11 | IMMIXOUT | Output of the intermodulation mixer |
| 12 | NC | Not connected |
| 13 | AGCWB | Threshold adjustment of the wideband AGC |
| 14 | GND3 | Mixer ground |
| 15 | MIXIN1 | Input 1 of the double-balanced mixer |
| 16 | MIXIN2 | Input 2 of the double-balanced mixer |
| 17 | VREF | Reference voltage output |
| 18 | MIXOUT1 | Mixer output 1 |
| 19 | MIXOUT2 | Mixer output 2 |
| 20 | GND4 | Ground of the first IF amplifier |
| 21 | IF1IN | Input of the first IF amplifier |
| 22 | GND5 | Oscillator ground |
| 23 | LOE | Local oscillator (emitter) |
| 24 | LOB | Local oscillator (base) |

## LOBUFF

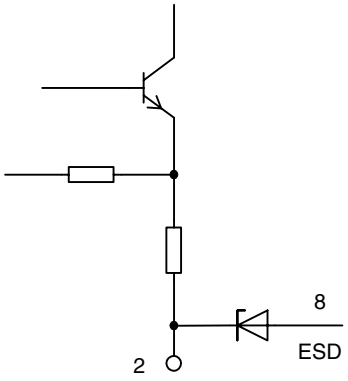
**Figure 3.** Buffered Local Oscillator Output




The buffered local oscillator used for output, drives the FM input of the PLL circuit (for example, U428xBM family). The typical parallel output resistance at 100 MHz is 70 Ω, the parallel output capacitance is about 10 pF. When using an external load of 500 Ω/10 pF, the oscillator swing is about 100 mV. The second harmonic of the oscillator frequency is less than -15 dBc.

## GND1

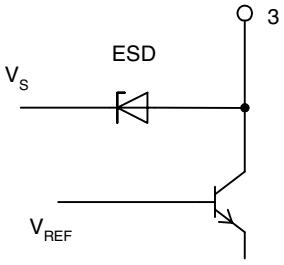
**Figure 4.** Ground of the Second IF Amplifier




There is no internal connection to the other ground pins.

## IF2OUT

**Figure 5.** Output of the Second IF Amplifier

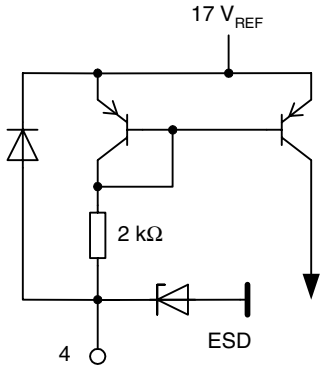



The parallel output capacitance to ground is about 7 pF. The external load resistance must be connected to $V_S$. The DC current into the pin is typically 3 mA.

Note: The supply voltage $V_S$ has to be protected against IF distortion.

## GAINIF1

**Figure 6.** Gain Control of the First IF Amplifier



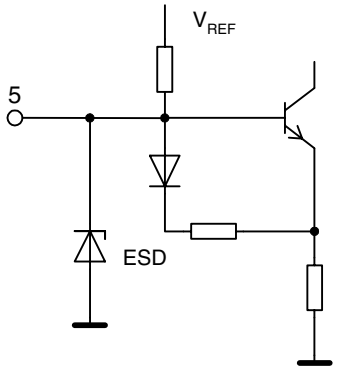

The gain of the first IF amplifier can be adjusted by a resistor to ground. This is useful, for example, to compensate for the insertion loss tolerances of the ceramic BPFs. It must be ensured that the output current of the pin does not exceed 150 µA in any case. Linear increasing in the current out of GAINIF1 results in a linear dB increase of the gain (0.15 dB/µA).

$I_4$ = 0, thus, G = $G_{min}$ = 2 dB

$I_4$ = 140 µA, thus, G = $G_{max}$ = 22 dB

## IF2IN

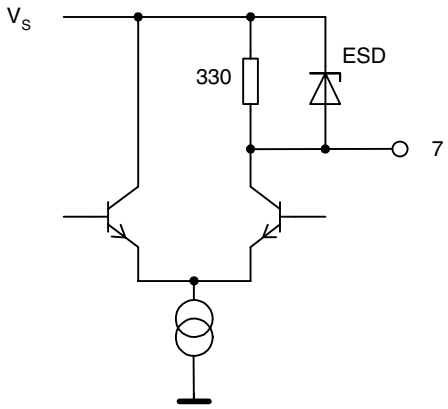
**Figure 7.** Input of the Second IF Amplifier




The parallel input resistance is 330 Ω. The parallel input capacitance is about 12 pF. No DC current is allowed. To avoid overload of this stage, an internal detector watches the input level and causes current at the AGCOUT pin.

## IF1OUT

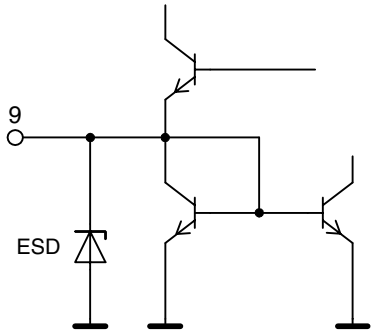
**Figure 8.** Output of the First IF Amplifier




The parallel output resistance is 330 Ω which allows the use of standard ceramic BPF. The parallel output capacitance is about 7 pF. The DC voltage at the pin is 0.5 V less than $V_S$.

## IMIFIN

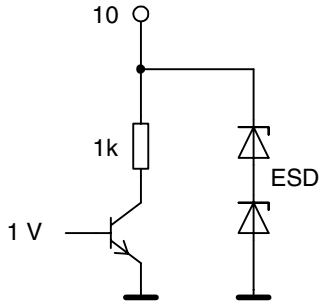
**Figure 9.** Input of the IF Amplifier for the IM Sensor




The parallel input resistance is 330 Ω. The amplifier is extremely sensitive to AC signals. An IF signal with a few hundred µV at this pin will cause current at the AGC output. Therefore, attention needs to be paid when connecting the standard ceramic filter between IMOUT and this pin. The reference point of the filter has to be free of any AC signal, no DC current shall appear at this pin.

## AGCOUT

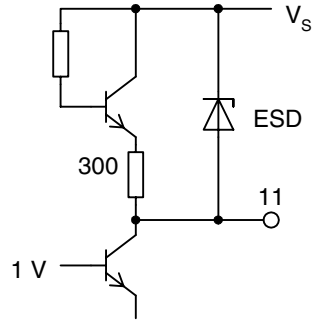
**Figure 10.** Output of the Automatic Gain Control




The AGC output is an open collector output. The current of the pin diode is this current multiplied by the current gain of the external PNP transistor. The DC voltage at the pin may vary from 2 V to $V_S$, therefore, this pin can easily be used as an indicator of the AGC regulation state.

## IMMIXOUT

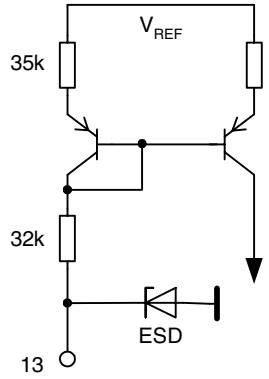
**Figure 11.** Output of the Intermodulation Mixer




The parallel output resistance is 330 Ω which allows the use of standard ceramic BPF without any further matching network. It must be ensured that the ground pin of the filter is free of AC signals.

## AGCWB

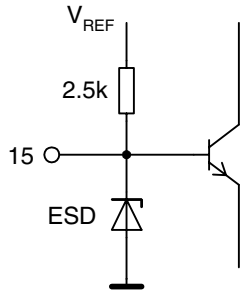
**Figure 12.** Threshold Adjustment of the Wideband AGC




The threshold of the wideband AGC can be adjusted by an external resistor to ground. The setting range is 10 dB. For minimum blocking, this pin is connected to ground. To set the threshold to lower levels, the resistance should have a value of up to a few hundred kΩ.

## MIXIN1

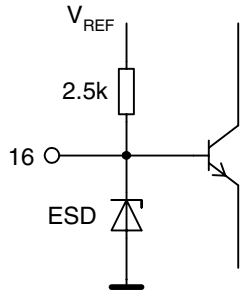
**Figure 13.** Input 1 of the Double-balanced Mixer




The parallel input resistance is 1.2 kΩ. The parallel input capacitance is about 9 pF. When using the mixer in an unbalanced way, this pin needs to be grounded for RF signals by an external capacitance of a few nF. DC current is not allowed.

## MIXIN2

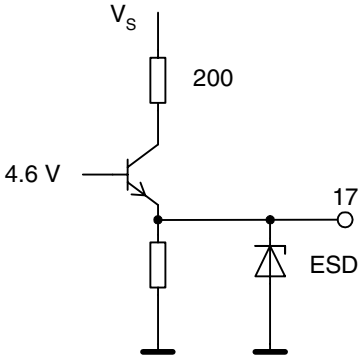
**Figure 14.** Input 2 of the Double-balanced Mixer




The parallel input resistance is 1.6 kΩ. The parallel input capacitance is about 7 pF. The double sideband noise figure of the unbalanced mixer is about 7 dB. If using the mixer in balanced mode, the noise figure will be reduced by about 0.8 dB.

## VREF

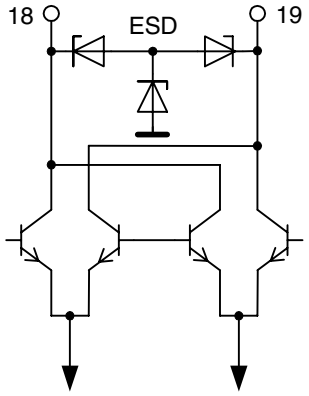
**Figure 15.** Reference Voltage Output




The internal temperature-compensated reference voltage is 3.9 V and it is used as bias voltage for most blocks. Therefore, the electrical characteristics of the U4065B are mainly independent of the supply voltage. The internal output resistance of the reference voltage is less than 10 Ω. To avoid internal coupling across this pin, external capacitors are required. The maximum output current is $I_{REF}$ = 5 mA.

## MIXOUT1, MIXOUT2

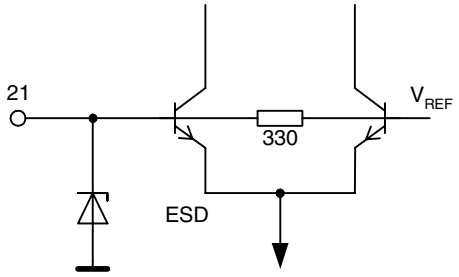
**Figure 16.** Mixer Output 1, 2




The mixer output is an open collector of a bipolar transistor. The minimum voltage at these pins is 5 V ($V_S$ - voltage swing). The DC current into these pins is typically 9 mA. Good LO and RF suppression at the mixer output can be achieved by symmetrical load conditions at the pins MIXOUT1 and MIXOUT2.

## IF1IN

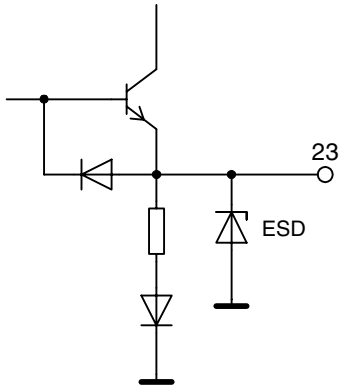
**Figure 17.** Input of the First IF Amplifier




The typical input resistance is 330 Ω. The DC voltage is almost identical to the reference voltage. DC current must be avoided at this pin.

## LOE

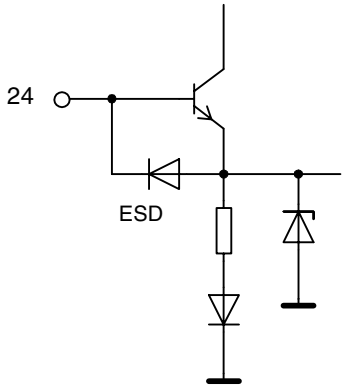
**Figure 18.** Emitter of the Local Oscillator




An external capacitor is connected between LOE and ground. The ground pin of this capacitor must be connected to pin GND5, the chip-internal ground of the local oscillator.

## LOB

**Figure 19.** Base of the Local Oscillator




The tank of the local oscillator is connected at pin LOB. The ground pin of this tank needs to be connected to pin GND5, the chip-internal ground of the local oscillator's pin 24. The resonant resistance of the tank should be about 250 Ω Minimum Q of the unloaded tank is 50.

## Functional Description

The U4065B FM-frontend IC is the dedicated solution for high-end car radios. A new design philosophy enables to build up tuners with superior behavior. This philosophy is based on the fact that the sensitivity of state of the art designs is at the physical border and cannot be enhanced any more. On the other hand, the spectral power density in the FM-band increases. An improvement of reception can only be achieved by increasing the dynamic range of the receiver. This description is to give the designer an introduction to get familiar with this new product and its philosophy.

### The Signal Path

The U4065B offers the complete signal path of an FM-frontend IC including a highly linear mixer and two IF preamplifiers. The mixer is a double-balanced, high-current Gilbert Cell. A high transit frequency of the internal transistors enables the use of the emitter grounded circuit with its favorable noise behavior. The full balanced output offers LO carrier reduction.

The first IF preamplifier has a dB-linear gain adjustment by DC means. Thus, different ceramic filter losses can be compensated and the overall tuner gain can be adapted to the individual requirements. The low noise design suppresses post stage noise in the signal path. Input and output resistance is 330 Ω to support standard ceramic filters. This is achieved without feedback, which would cause different input impedances when varying the output impedance.

The second IF preamplifier enables the use of three ceramic filters with real 330 Ω input- and output termination. Feedthrough of signals is kept low. The high level of output compression is necessary to keep up a high dynamic range.

Beneath the signal path the local oscillator part and the AGC signal generation can be found on chip. The local oscillator uses the collector grounded colpitts type. A low phase noise is achieved with this access. A mutual coupling in the oscillator coil is not necessary.

### The AGC Concept

Special care was taken to design a unique AGC concept. It offers 3 AGC loops for different kinds of reception conditions. The most important loop is the interference sensor part.

In today's high-end car radios, the FM AGC is state of the art. It is necessary to reduce the influence of 3rd and higher order intermodulation to sustain reception in the presence of strong signals in the band. On one hand, it makes sense to reduce the desired signal level by AGC as few as possible to keep up stereo reception, on the other hand two or more strong out-of-channel signals may interfere and generate an intermodulation signal on the desired frequency. By introducing input attenuation, the level of the intermod signal decreases by a higher order, whereas the level of the desired signal shows only a linear dependency on the input attenuation. Therefore, input attenuation by pin diodes may keep up reception in the presence of strong signals.

The standard solution to generate the pin diode current is to pick up the RF-signal in front of the mixer. Because the bandwidth at that point is about 1.5 MHz, this is called wideband AGC. The threshold of AGC start is a critical parameter. A low threshold does not allow any intermodulation but has the disadvantage of blocking if there is only one strong station on the band or if the intermod signals do not cover the desired channel. A higher AGC threshold may tolerate a certain ground floor of intermodulation. This avoids blocking, but it has the disadvantage, that no reception is possible, if the interfering signals generate an intermod signal inside the desired channel. This contradiction could not be overcome in the past.

With the new U4065B IC, there is a unique access to this problem. This product has an interference sensor on chip. Thus, an input signal attenuation is only performed if the interfering signals do generate an intermod signal inside the desired channel. If they do not, the existing wideband AGC is active but up to 20 dB higher levels. The optimum AGC state is always generated.

The Figure 20 to Figure 23 on page 14 illustrate the situation. In Figure 20 the AGC threshold of a standard tuner is high to avoid blocking. But then the intermod signal suppresses the desired signal. The interference sensor of the U4065B ensures that the AGC threshold is kept low as illustrated in Figure 21 on page 14.

In Figure 22 on page 14 the situation is reversed. The AGC threshold of a standard tuner is kept low to avoid intermod problems. But then blocking makes the desired signal level drop below the necessary stereo level. In this case, the higher wideband AGC level of the U4065B enables perfect stereo reception.

By principle, this interference sensor is an element with a third order characteristic. For input levels of zero, the output level is zero, too. With increasing input level, the output level is increased with the power of three, thus preferring intermod signals compared to linear signals. At the same time, a down conversion to the IF level of 10.7 MHz is performed. If a corresponding 10.7 MHz IF filter selects the intermod signals, only an output is generated, if an intermod signal inside the 10.7 MHz channel is present.

The circuit blocks interference sensor and IF, and detector build up a second IF chain. In an FM system, the maximum deviation of a 3rd order intermod signal is the triple max deviation of the desired signal. Therefore, the ceramic IF BPF between pin 11 and pin 9 may be a large bandwidth type. This is all that is needed for this unique feature.

A further narrow band AGC avoids overriding the second IF amplifier. The amplitude information of the channel is not compressed in order to maintain multipath detection in the IF part of the receiver.

**Figure 20.** A High AGC Threshold Causes the Intermod Signal to Suppress the Desired Signal

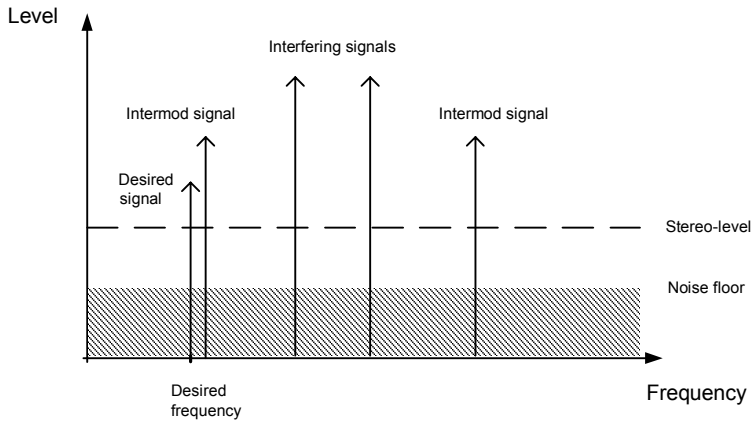


**Figure 21.** AGC Threshold Settings

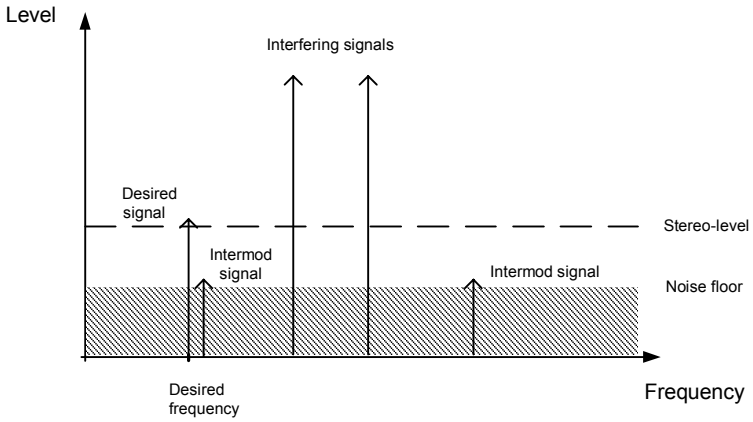



**Figure 22.** A Low AGC Threshold Causes the Blocking Signal to Suppress the Desired Signal

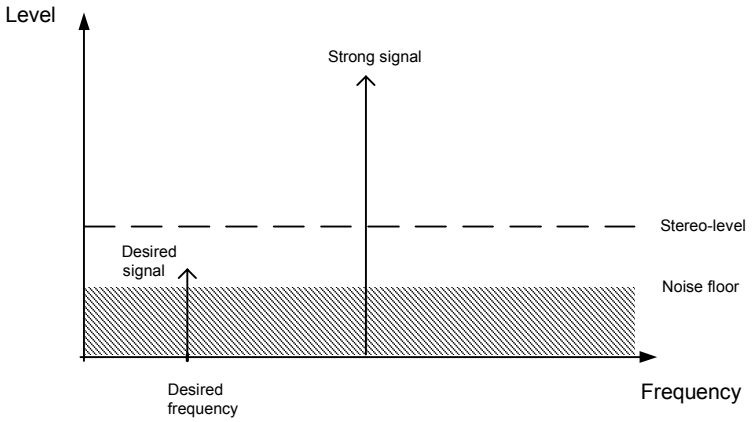
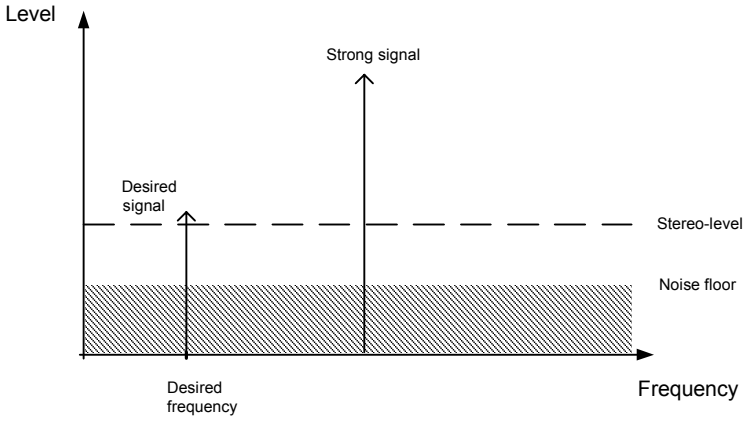



**Figure 23.** The Correct AGC Threshold Enables Optimum Reception



## 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.

Reference point is ground (pins 2, 8, 14, 20 and 22)

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Supply voltage | $V_S$ | 10 | V |
| Power dissipation at $T_{amb}$ = 85°C | $P_{tot}$ | 470 | mW |
| Junction temperature | $T_j$ | 125 | °C |
| Ambient temperature range | $T_{amb}$ | -30 to +85 | °C |
| Storage temperature range | $T_{stg}$ | -50 to +125 | °C |
| Electrostatic handling: Human body model (HBM), all I/O pins tested against the supply pins | ± $V_{ESD}$ | 2000 | V |

## Thermal Resistance

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance | $R_{thJA}$ | 90 | K/W |

## Electrical Characteristics

$V_S$ = 8.0 V, $f_{RF}$ = 98 MHz, $f_{OSC} \cong$ 108.7 MHz, $f_{IF} = f_{OSC} - f_{RF}$ = 10.7 MHz
Reference point is ground (pins 2, 8, 14, 20, and 22),$T_{amb}$ = 25°C, unless otherwise specified.

| Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Supply voltage | | 3, 6, 10, 18, 19 | $V_S$ | 7 | 8 | 10 | V |
| Supply current | | 3, 6, 10, 18, 19 | $I_{tot}$ | | 37 | 47 | mA |
| **Oscillator (GND5 Has to be Connected to External Oscillator Components)** | | | | | | | |
| Oscillator voltage | $R_{G24}$ = 220 Ω, unloaded Q of $L_{OSC}$ = 70, $R_{L1}$ = 520 Ω | 24<br>23<br>1 | $V_{LOB}$<br>$V_{LOE}$<br>$V_{LOBUFF}$ | <br><br>70 | 160<br>100<br>90 | <br><br>220 | mV |
| Harmonics | | 1 | | | | -15 | dBc |
| Output resistance | | 1 | $R_{LO}$ | | 70 | | Ω |
| Voltage gain | | Between 1 and 23 | | | 0.9 | | |
| **Mixer (GND3 Has to be Separated from GND1, GND2 and GND4)** | | | | | | | |
| Conversion power gain | Source impedance: $R_{G15,16}$ = 200 Ω Load impedance: $R_{L18,19}$ = 200 Ω | | $G_C$ | 5 | 7 | 10 | dB |
| 3rd-order input intercept | | | $IP_3$ | 4 | 6 | 14 | dBm |
| Conversion transconductance | | | $g_C$ | | 8 | | mA/V |
| Noise figure | | | $NF_{DSB}$ | | 7 | | dB |
| Input resistance to ground | f = 100 MHz | 15 | $R_{ignd15}$ | | 1.2 | | kΩ |
| Input capacitance to ground | f = 100 MHz | 15 | $C_{ignd15}$ | | 9 | | pF |
| Input resistance to ground | f = 100 MHz | 16 | $R_{ignd16}$ | | 1.6 | | kΩ |
| Input capacitance to ground | f = 100 MHz | 16 | $C_{ignd16}$ | | 7 | | pF |
| Input-input resistance | | Between 15 and 16 | $R_{ii15,16}$ | | 1.6 | | kΩ |
| Input-input capacitance | | Between 15 and 16 | $C_{ii15,16}$ | | 5 | | pF |
| Output capacitance to GND | | 18 and 19 | $C_{ignd18,19}$ | | 9 | | pF |

## Electrical Characteristics (Continued)

$V_S$ = 8.0 V, $f_{RF}$ = 98 MHz, $f_{OSC} \cong$ 108.7 MHz, $f_{IF} = f_{OSC} - f_{RF}$ = 10.7 MHz
Reference point is ground (pins 2, 8, 14, 20, and 22),$T_{amb}$ = 25°C, unless otherwise specified.

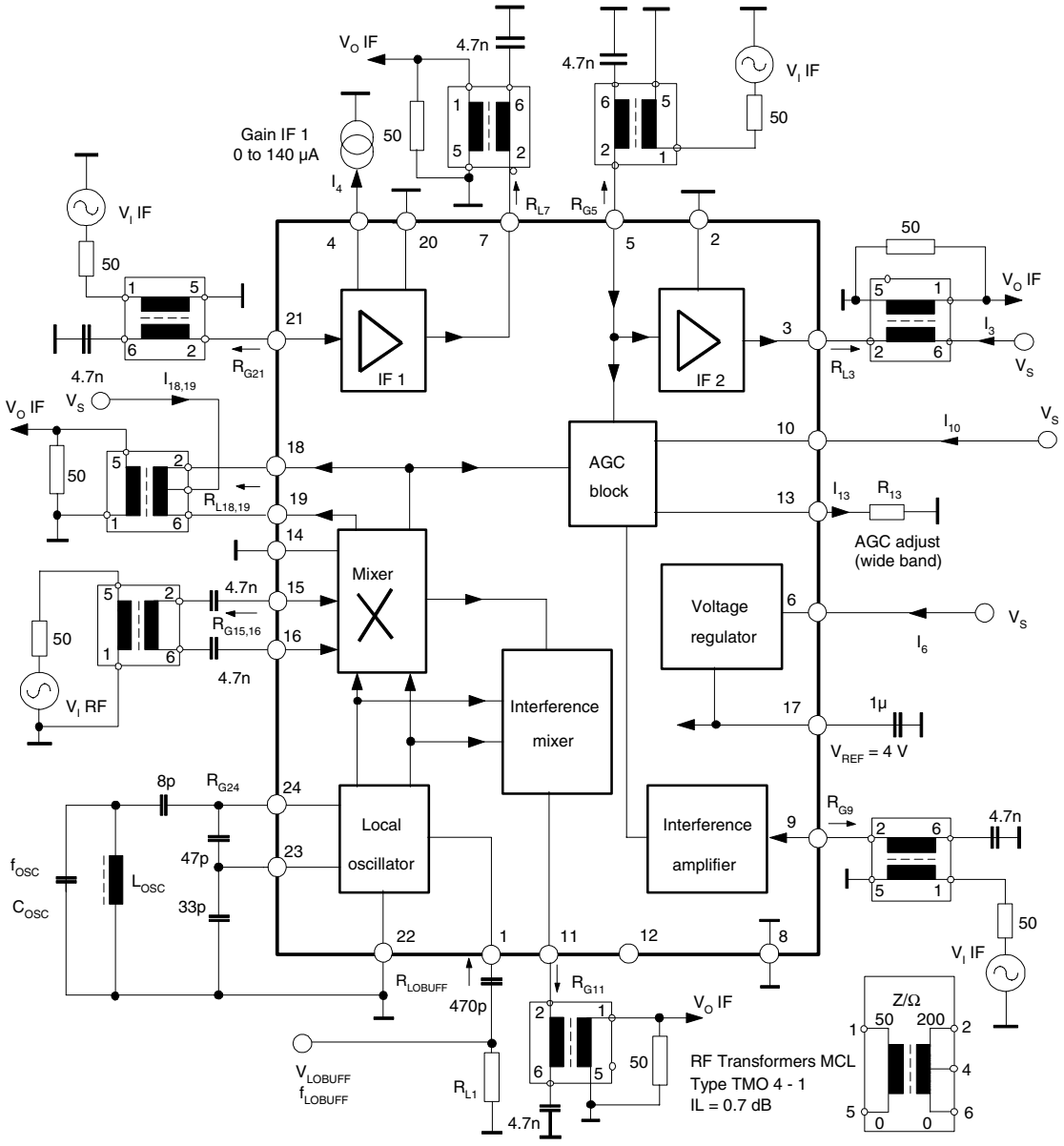
| Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **First IF Preamplifier (IF 1)** | | | | | | | |
| Gain control deviation by $I_4$ | | 4 | | 17 | 20 | 24 | dB |
| Gain control slope | | 4 | $dG_{IF1}/dI_4$ | | 0.15 | | dB/µA |
| External control current to ground<br>At $G_{min}$<br>At $G_{nom}$<br>At $G_{max}$ | | | <br>$I_{4min}$<br>$I_{4nom}$<br>$I_{4max}$ | | <br>0<br>70<br>140 | | µA |
| Power gain<br>At $I_{4min}$<br>At $I_{4nom}$<br>At $I_{4max}$ | Source impedance:<br>$R_{G21}$ = 200 Ω,<br>Load impedance:<br>$R_{L7}$ = 200 Ω | Between 21 and 7 | <br>$G_{min}$<br>$G_{nom}$<br>$G_{max}$ | <br>-2.5<br>11<br>19 | <br>2<br>12<br>22 | <br>2.5<br>16<br>28 | dB |
| Noise figure<br>At $G_{max}$<br>At $G_{nom}$<br>At $G_{min}$ | | Between 21 and 7 | <br>$NF_{min}$<br>$NF_{nom}$<br>$NF_{max}$ | | <br>7<br>9<br>15 | | dB |
| Temperature coefficient of the gain at $G_{nom}$ | | | TKnom | | +0.045 | | dB/K |
| 1 dB compression at $G_{nom}$ | | 7 | $V_{cnom}$ | | 70 | | mV |
| -3 dB cut-off frequency at $G_{nom}$ | | 7 | $f_{cnom}$ | | 50 | | MHz |
| Input resistance | f = 10 MHz | 21 | $R_{iIF1}$ | 270 | 330 | 400 | Ω |
| Input capacitance | f = 10 MHz | 21 | $C_{iIF1}$ | | 5 | | pF |
| Output resistance | f = 10 MHz | 7 | $R_{oIF1}$ | 270 | 330 | 400 | Ω |
| Output capacitance | f = 10 MHz | 7 | $C_{oIF1}$ | | 7 | | pF |
| **Second IF Preamplifier (IF 2)** | | | | | | | |
| Power gain | Source impedance:<br>$R_{G5}$ = 200 Ω<br>Load impedance:<br>$R_{L3}$ = 200 Ω | Between 5 and 3 | $G_{IF2}$ | 15 | 18 | 19 | dB |
| Noise figure | | | $NF_{IF2}$ | | 7 | | dB |
| 1 dB compression | | 3 | $V_{comp}$ | | 500 | | mV |
| -3 dB cutoff frequency | | 3 | $f_c$ | | 50 | | MHz |
| Parallel input resistance | f = 10 MHz | 5 | $R_{iIF2}$ | 270 | 330 | 400 | Ω |
| Parallel input capacitance | f = 10 MHz | 5 | $C_{iIF2}$ | | 12 | | pF |
| Parallel output resistance | f = 10 MHz | 3 | $R_{oIF2}$ | | 50 | | kΩ |
| Parallel output capacitance | f = 10 MHz | 3 | $C_{oIF2}$ | | 7 | | pF |
| **Voltage Regulator** | | | | | | | |
| Regulated voltage | | 17 | $V_{ref}$ | 3.7 | 3.9 | 4.9 | V |
| Maximum output current | | 17 | $I_{ref}$ | 5 | | | mA |
| Internal differential resistance, $dc_{17}/di_{17}$ when $I_{17}$ = 0 | | 17 | $r_{d17}$ | | 7 | 50 | Ω |
| Power supply suppression | f = 50 Hz | 17 | psrr | 36 | 50 | | dB |

## Electrical Characteristics (Continued)

$V_S$ = 8.0 V, $f_{RF}$ = 98 MHz, $f_{OSC} \cong$ 108.7 MHz, $f_{IF} = f_{OSC} - f_{RF}$ = 10.7 MHz
Reference point is ground (pins 2, 8, 14, 20, and 22), $T_{amb}$ = 25°C, unless otherwise specified.

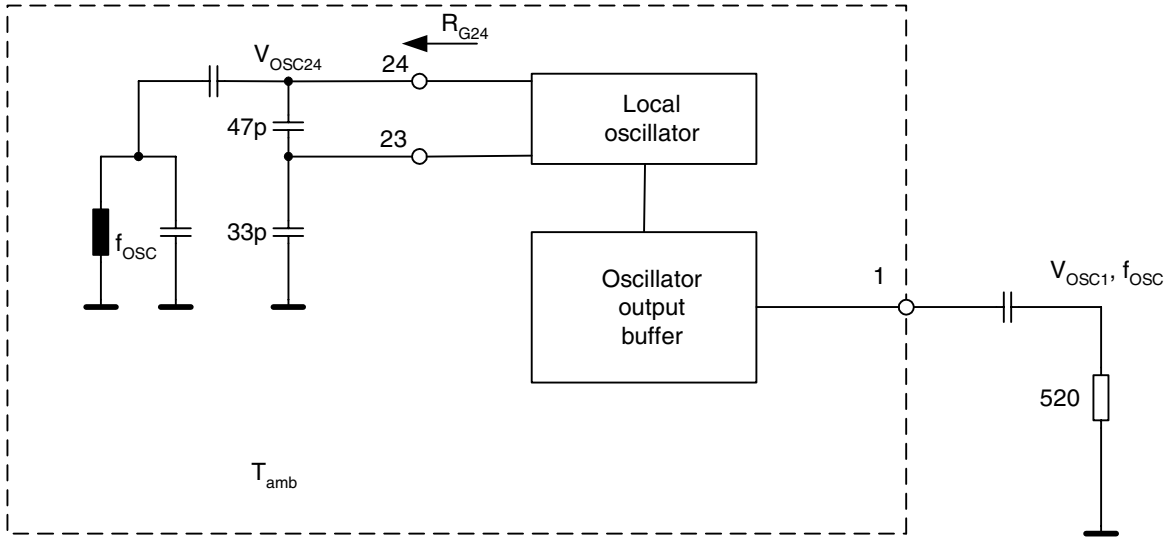
| Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **AGC Input Voltage Thresholds (AGC Threshold Current is 10 µA at Pin 10)** | | | | | | | |
| IF2 input | | 5 | $V_{thIF2}$ | 85 | 86 | 92 | dBµV |
| IF and detector | | 9 | $V_{thIFD}$ | 42 | 43 | 48 | dBµV |
| Mixer input level of wideband sensor | $f_{iRF}$ = 100 MHz<br>V at pin 13 = 0 V<br>I through pin 13 = 0 A | Between 15 and 16 | $V_{thWB1}$<br>$V_{thWB2}$ | 95<br>85 | 98<br>87 | 100<br>90 | dBµV<br>dBµV |

**Figure 24.** Test Circuit



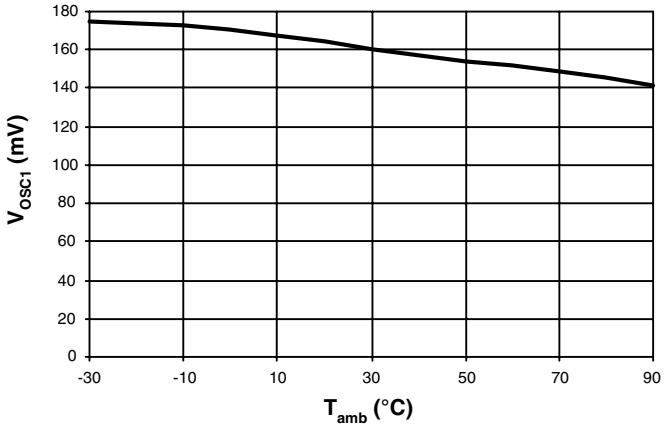
## Local Oscillator

**Figure 25.** LO Principle Application




Free running oscillator frequency $f_{OSC} \approx 110$ MHz, $V_{OSC24} = 160$ mV, $R_{G24} = 220\ \Omega$, $Q_L = 70$

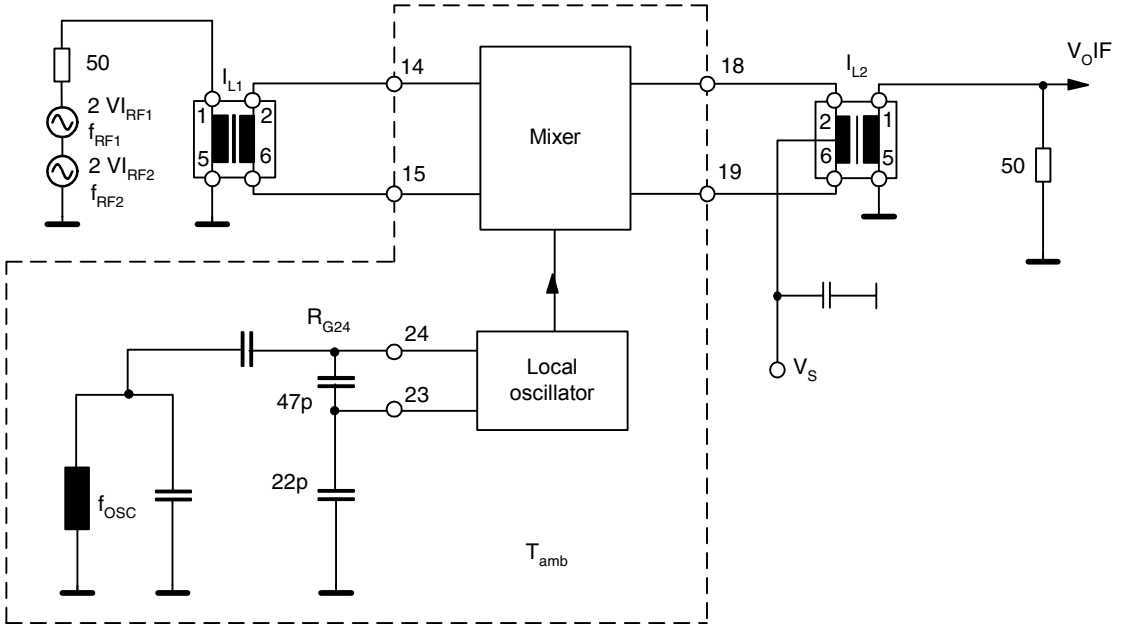
**Figure 26.** Oscillator Swing versus Temperature



## Mixer

$f_{OSC}$ = 110.7 MHz, $V_{OSC24} \cong$ 160 mV, $f_{IF}$ = 10.7 MHz

**Figure 27.** Mixer Principle Application




Conversion power gain $G_C$ = 20 log ($V_O$IF/$V_I$RF) + $I_{L1}$ (dB) + $I_{L2}$ (dB)

$I_{L1}$, $I_{L2}$ insertion loss of the RF transformers

**Figure 28.** Mixer Characteristic

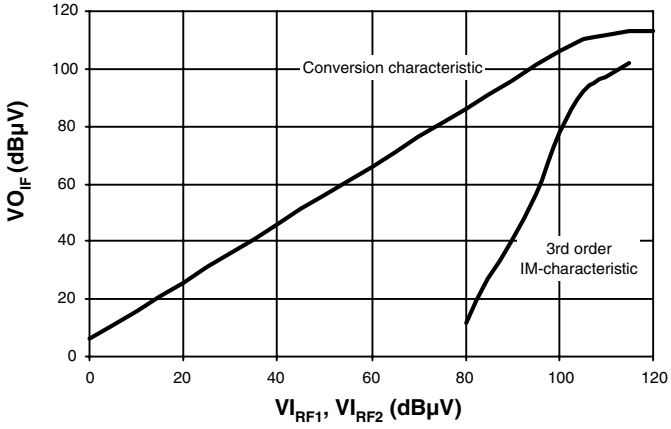


**Figure 29.** Conversion Power Gain of the Mixer Stage versus Temperature

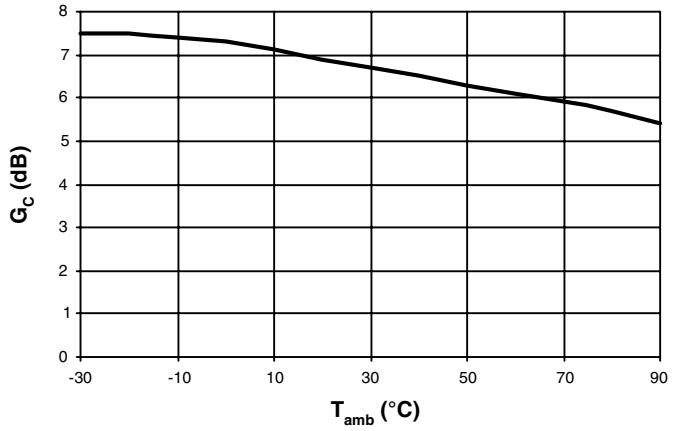
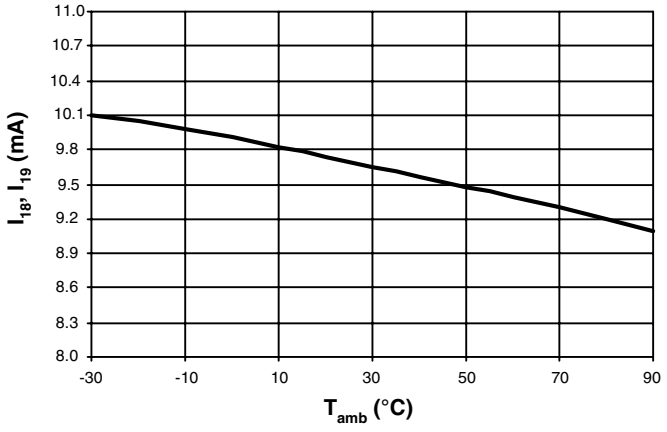
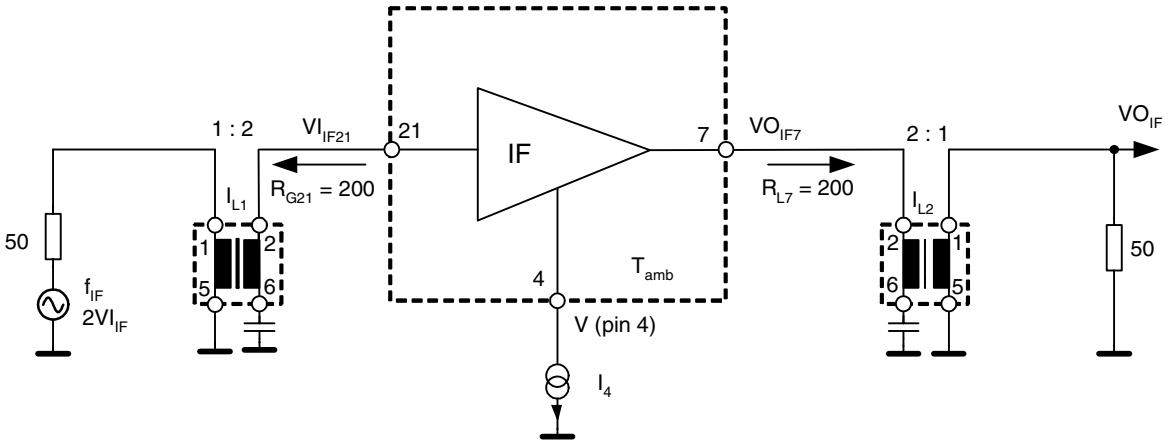



**Figure 30.** Current of the Mixer Stage versus Temperature



## First IF Preamplifier

**Figure 31.** First IF Preamplifier Principle Application




Power gain $G_{IF}$ = 20 log ($VO_{IF}/VI_{IF}$) + $I_{L1}$ (dB) + $I_{L2}$ (dB)

$I_{L1}$, $I_{L2}$ = insertion loss of the RF transformers

**Figure 32.** Power Gain of the First IF Amplifier versus $I_4$

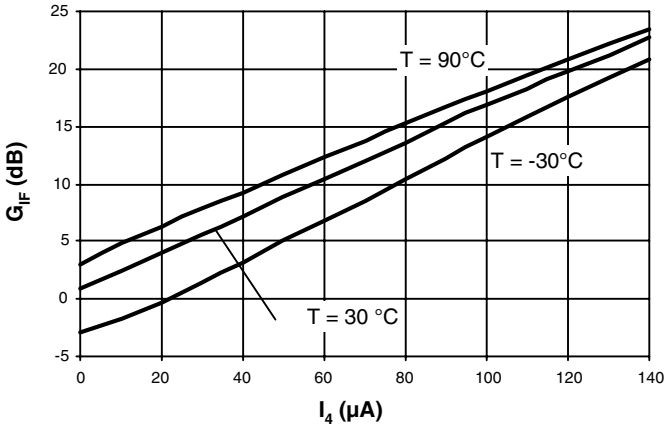


**Figure 33.** Power Gain of the First IF Amplifier versus Frequency

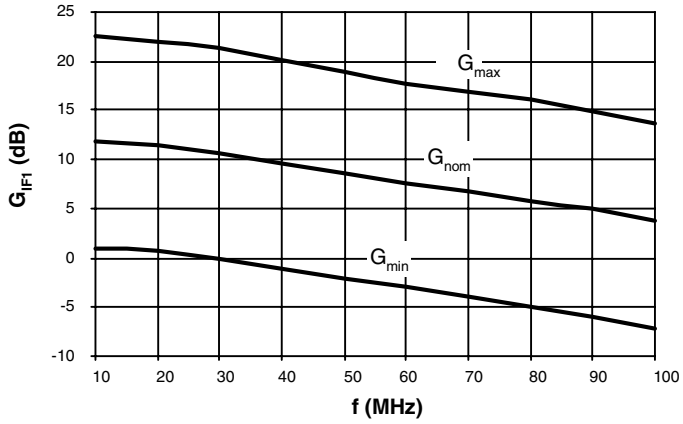
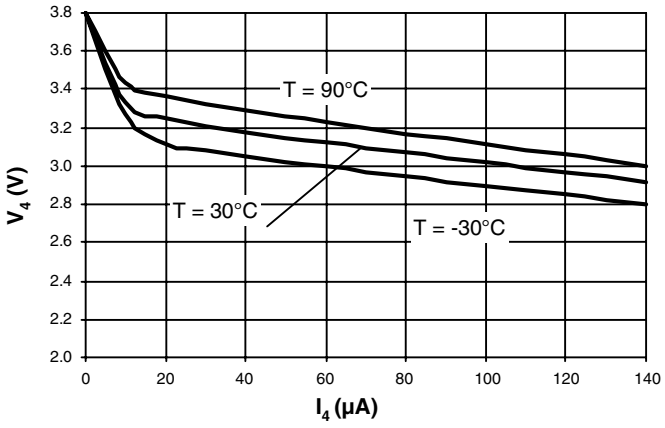
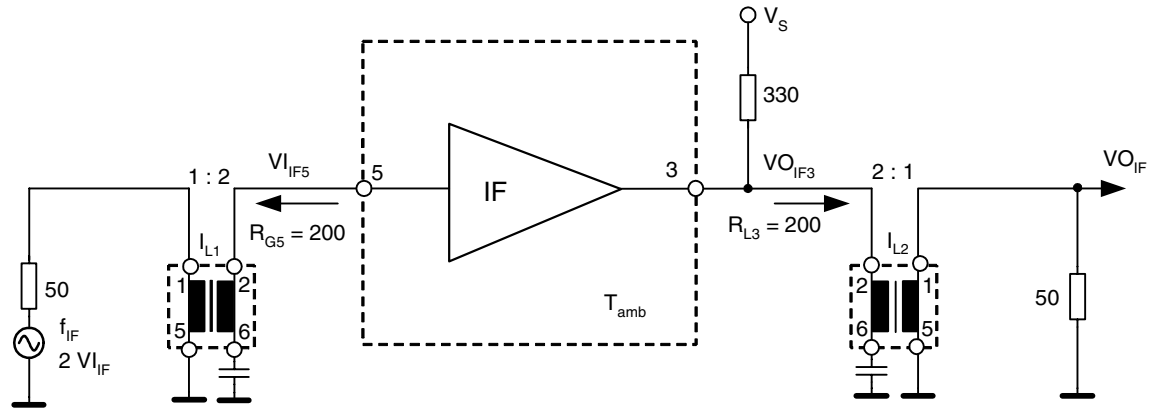



**Figure 34.** V (Pin 4) versus $I_4$



## Second IF Preamplifier

**Figure 35.** Second IF Preamplifier Principle Application




Power gain $G_{IF} = 20 \log (VO_{IF}/VI_{IF}) + I_{L1}$ (dB) + $I_{L2}$ (dB)

$I_{L1}$; $I_{L2}$ = insertion loss of the RF transformers

**Figure 36.** Power Gain of the Second IF Amplifier versus Temperature

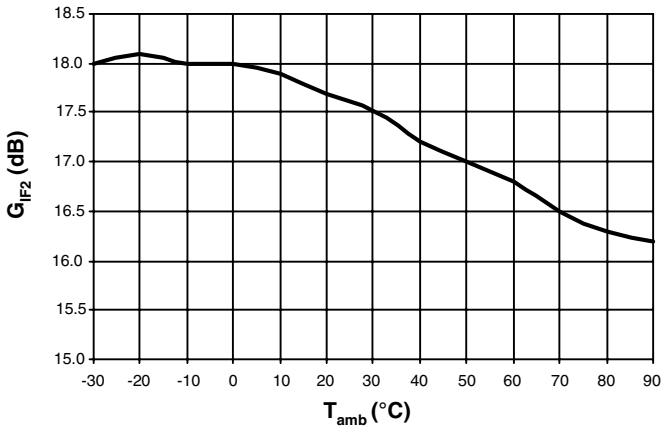


**Figure 37.** Power Gain of the Second IF Amplifier versus Frequency

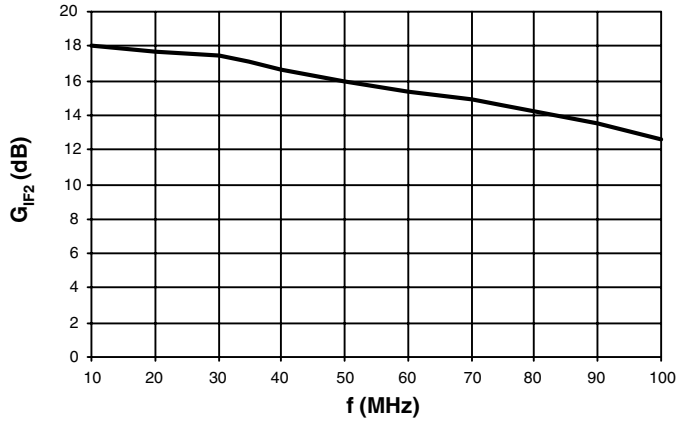



**Figure 38.** AGC Threshold (110 = 1 µA) of the Second IF Amplifier versus Temperature

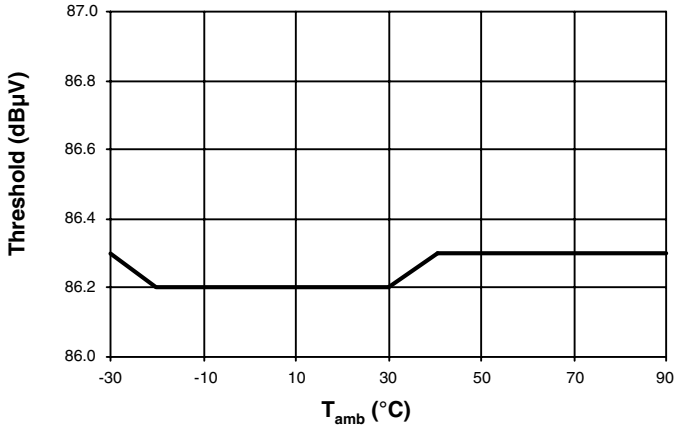
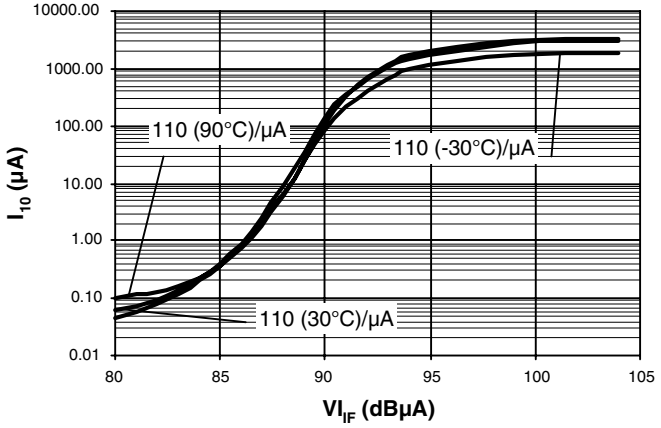
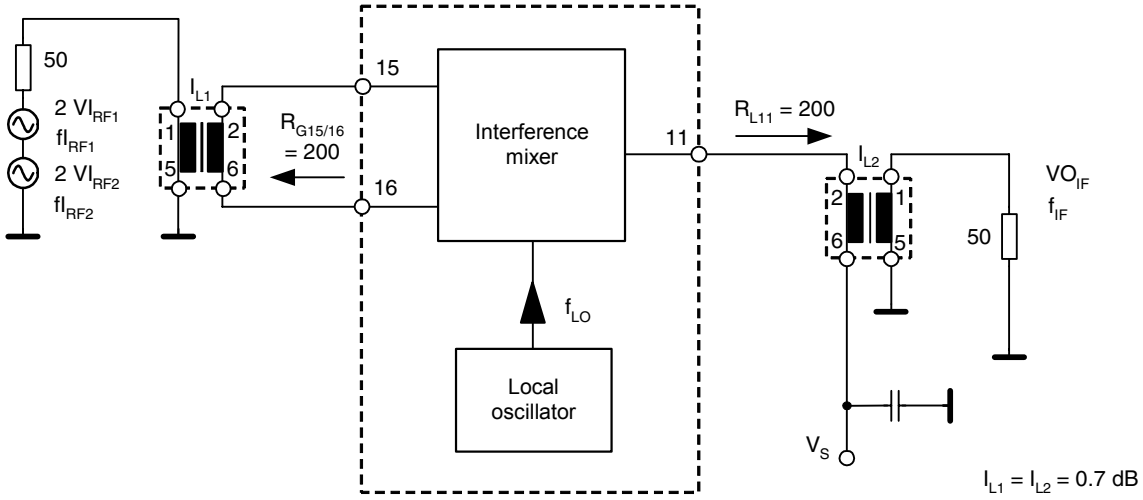



**Figure 39.** AGC Characteristic of the Second IF Amplifier Input



## Interference Sensor (Mixer)

**Figure 40.** Interference Sensor Principle Application




Test conditions for characteristic $VO_{IF}$ versus $VI_{RF1}$:
$f_{LO}$ = 100 MHz, $f_{RF1}$ = 89.3 MHz, $VI_{RF2}$ = 0, $f_{IF} = f_{LO} - f_{RF1}$ = 10.7 MHz

Test conditions for 3rd order IM-characteristic $VO_{IF}$ versus $VI_{RF1}$, $VI_{RF2}$:
$f_{LO}$ = 100 MHz, $f_{RF1}$ = 89.4 MHz, $f_{RF2}$ = 89.5 MHz, $f_{IF} = f_{LO} - (2\ f_{RF1} - 1\ f_{RF2})$ = 10.7 MHz
$I_{L1}$, $I_{L2}$ = insertion loss of the RF transformer

**Figure 41.** Characteristics of the Interference Sensor (Mixer)

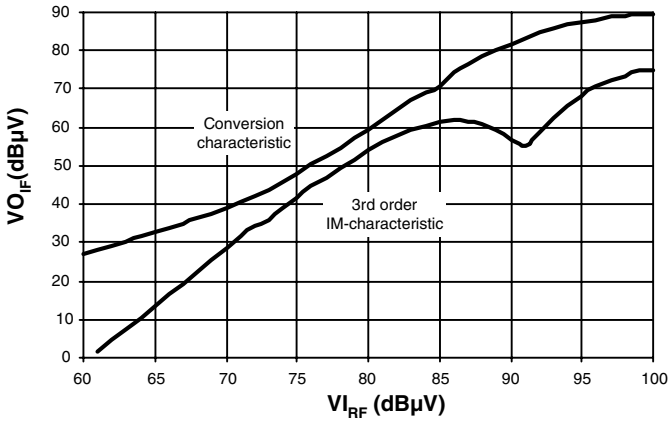


**Figure 42.** Conversion Characteristic of the Interference Sensor (Mixer)

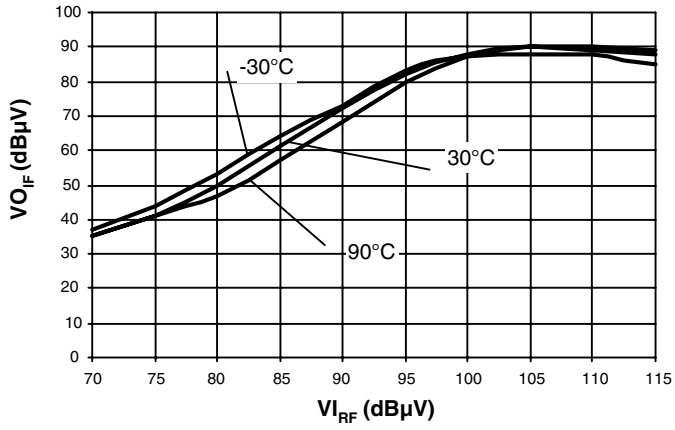
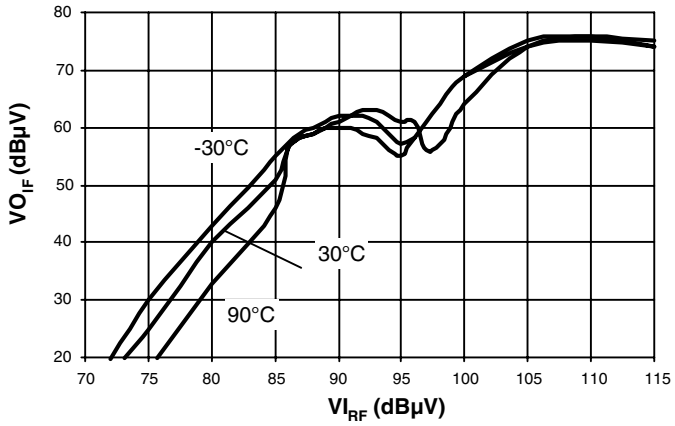
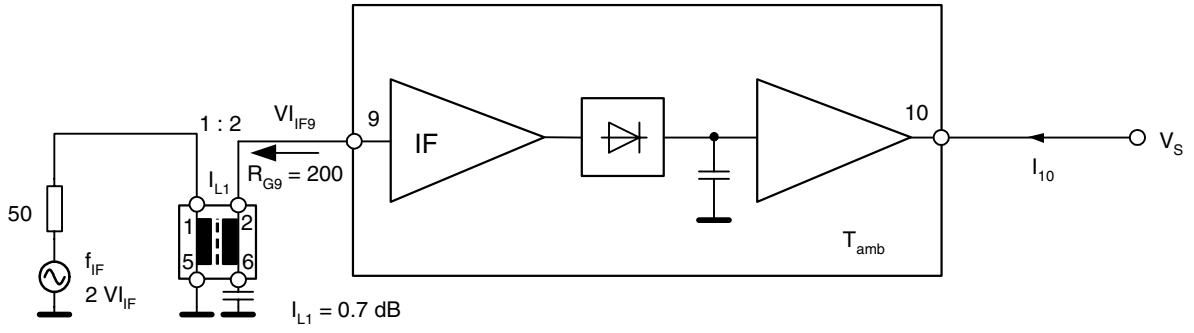



**Figure 43.** Third-order Interference Characteristic of the Interference Sensor (Mixer)



## Interference Sensor (Amplifier)

**Figure 44.** Interference Sensor Principle Application




### AGC Thresholds

**Figure 45.** AGC Threshold of the Interference IF Amplifier versus Temperature

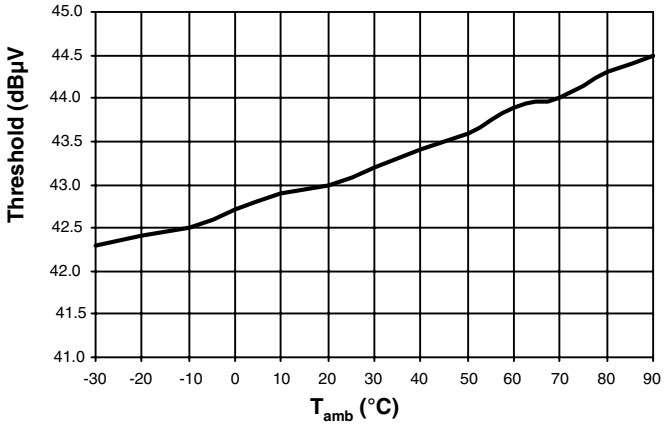



**Figure 46.** Wideband AGC Threshold ($I_{10}$ = 1 µA) versus $I_{13}$

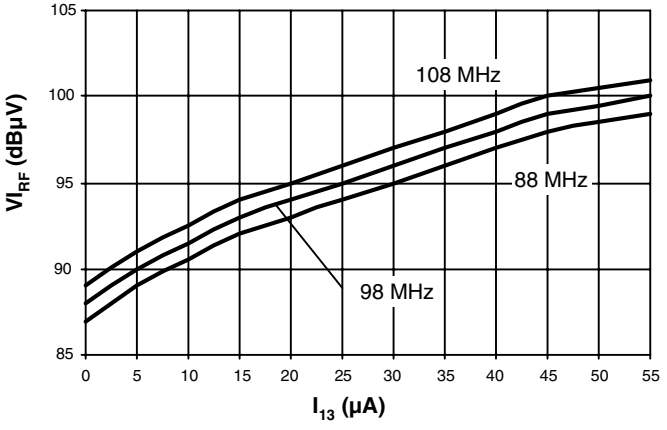
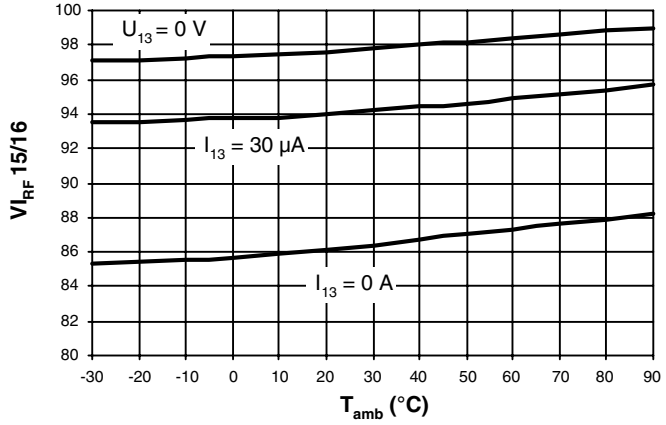


**Figure 47.** Wideband AGC Threshold ($I_{10}$ = 1 µA) versus Temperature




## AGC Characteristics

**Figure 48.** AGC Characteristic of the Interference IF and Detector Block

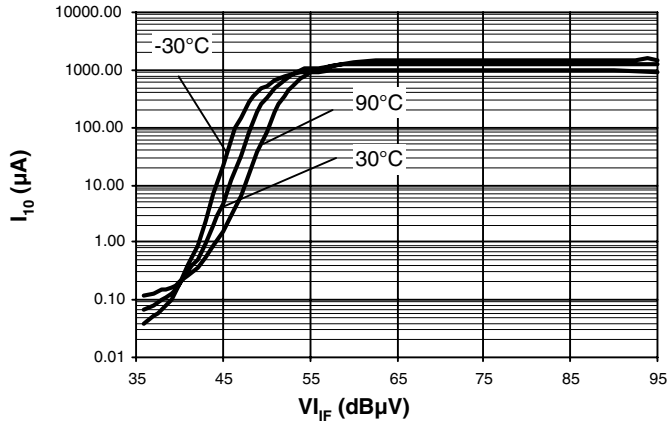



**Figure 49.** Characteristic of the Wideband AGC ($I_{13}$ = 0 V)

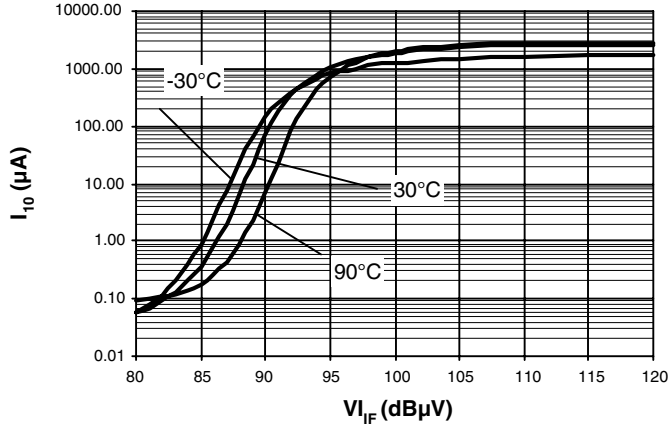
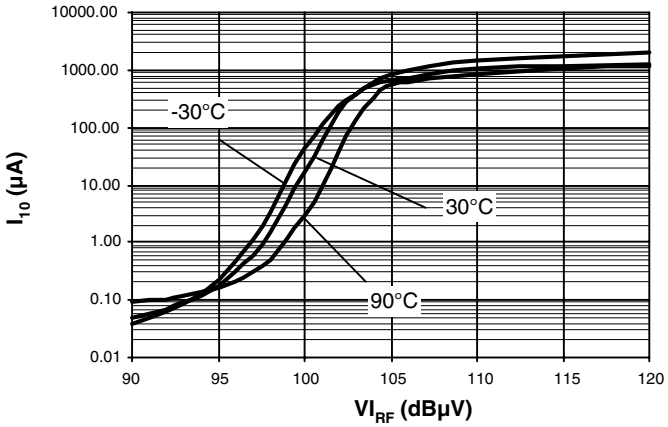


**Figure 50.** Characteristic of the Wideband AGC ($V_{13}$ = 0 V)




## DC Characteristics

**Figure 51.** Supply Current versus Supply Voltage

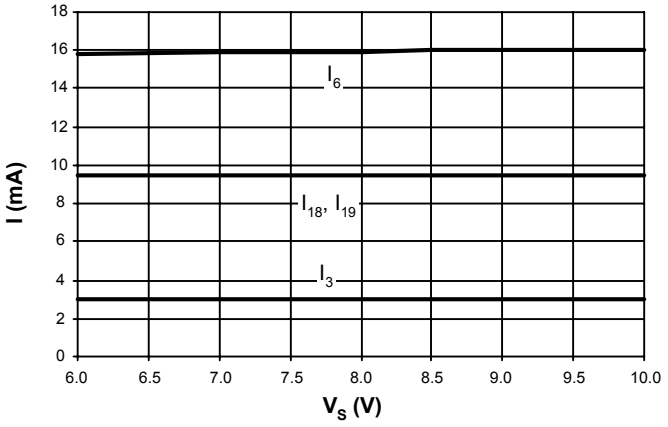



**Figure 52.** Reference Voltage versus Temperature

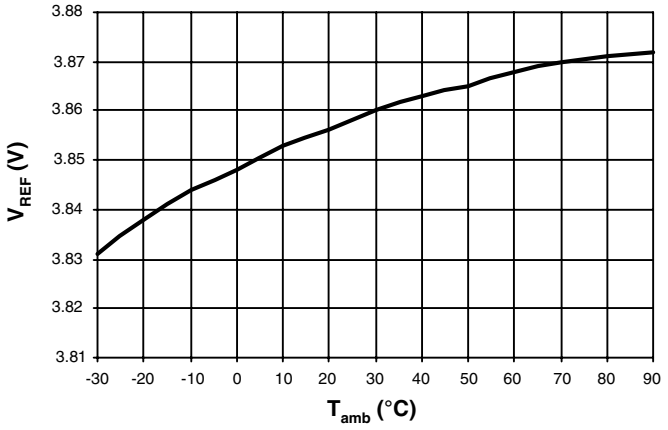


**Figure 53.** Supply Current versus Temperature

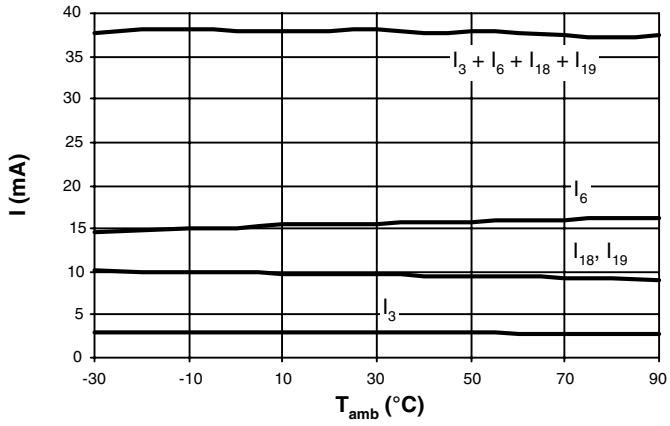



**Figure 54.** Reference Voltage versus $I_{17}$

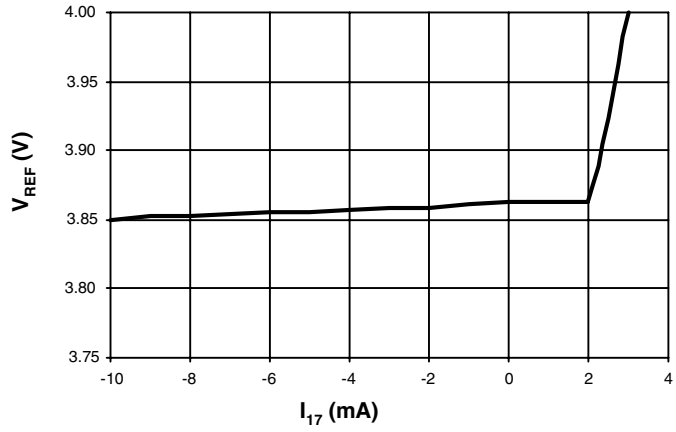
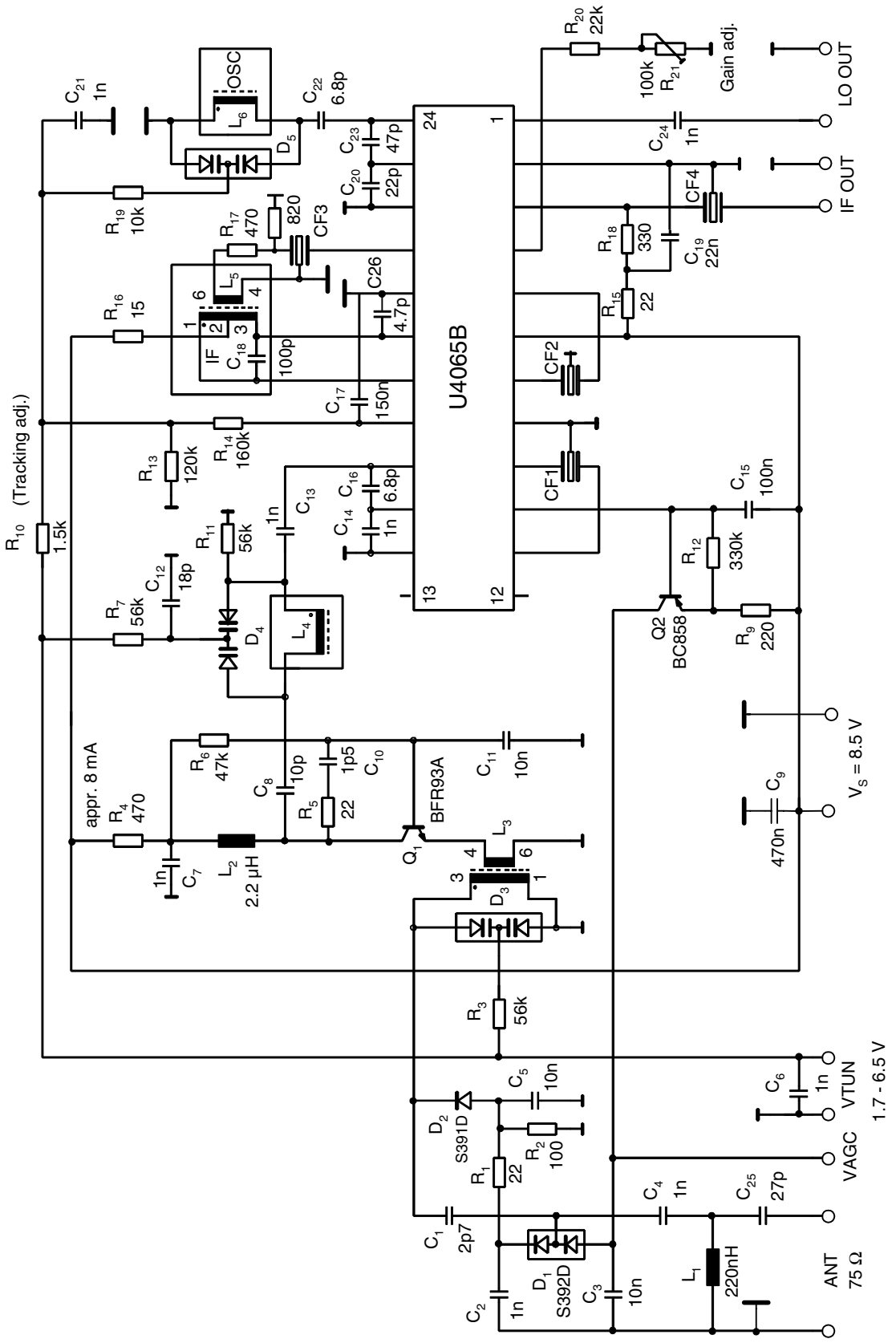


**Figure 55.** Application Diagram



## Part List

| Item | Description |
|---|---|
| Q1 | BFR93AR (BFR93A) |
| Q2 | BC858 |
| D1 | S392D |
| D2 | S391D |
| D3, D4, D5 | BB804 |
| L1 | 11 turns, 0.35 mm wire, 3 mm diameter (approximately 220 nH) |
| L2 | 2.2 mH (high Q type) |
| L3 | TOKO® 7KL-type, # 600ENF-7251x |
| L4 | TOKO 7KL-type, # 291ENS 2341IB |
| L5 | TOKO 7KL-type, # M600BCS-1397N |
| L6 | TOKO 7KL-type, # 291ENS 2054IB |
| CF1 | TOKO type SKM 2 (230 KHZ) |
| CF2, CF3, CF4 | TOKO type SKM 3 (180 KHZ) |

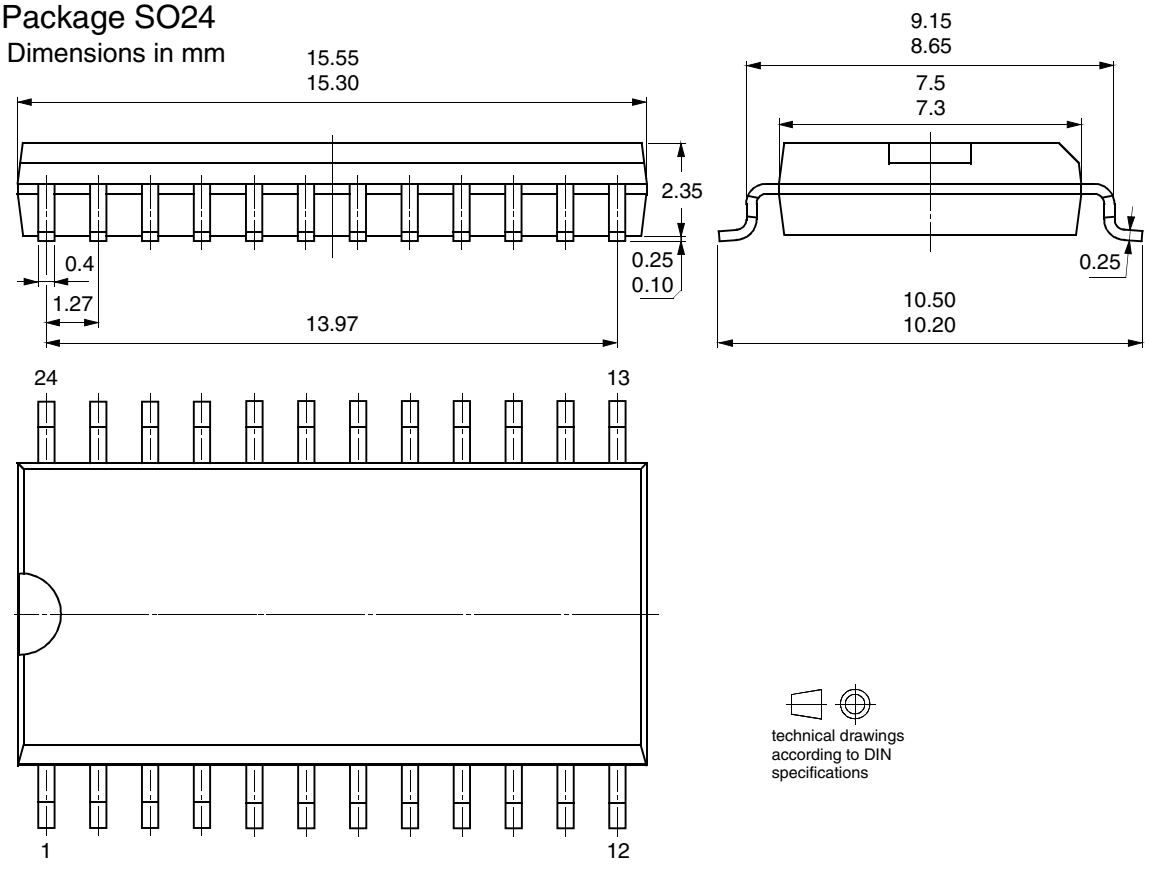
## Ordering Information

| Extended Type Number | Package | Remarks |
|---|---|---|
| U4065B-AFL | SO24 plastic | – |
| U4065B-AFL3 | SO24 plastic | Taping according to ICE-286-3 |

## Package Information

Package SO24

Dimensions in mm



## Atmel Corporation

2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 487-2600

## Regional Headquarters

*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 Tsimshatsui
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, USA
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

*Microcontrollers*
2325 Orchard Parkway
San Jose, CA 95131, USA
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, USA
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, USA
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


*Literature Requests*
www.atmel.com/literature




4807A–AUDR–05/04