## Features

- **High Dynamic Range for AM and FM**
- **Integrated AGC for FM**
- **High Intercept Point 3rd-order for FM**
- **FM Amplifier Adjustable to Various Cable Impedances**
- **High Intercept Point 2nd-order for AM**
- **Low-noise Output Voltage**
- **Low-power Consumption**

Electrostatic sensitive device.
Observe precautions for handling.

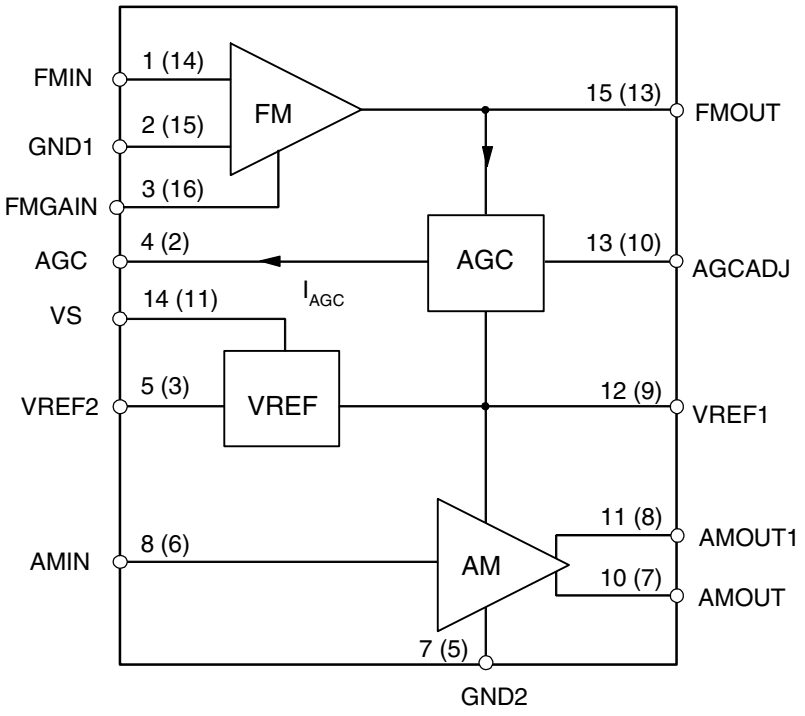
# Low-noise AM/FM Antenna Impedance Matching IC

# U4254BM-M

## Description

The U4254BM-M is an integrated low-noise AM/FM antenna impedance matching circuit in BiCMOS technology. The device is designed specifically for car applications and is suitable for windshield and roof antennas.

**Figure 1.** Block Diagram




() Pin numbers in brackets = QFN 4 × 4 package

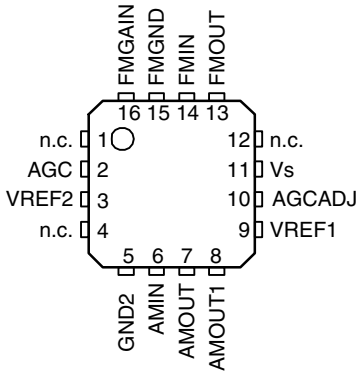
Rev. 4772C–AUDR–08/04

## Pin Configuration

**Figure 2.** Pinning SO16




**Figure 3.** Pinning QFN16 4 × 4




## Pin Description

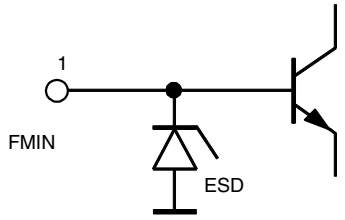
| Pin SSO16 | Pin QFN16 | Symbol | Function |
|---|---|---|---|
| 1 | 14 | FMIN | FM input |
| 2 | 15 | GND1 | Ground for FM part |
| 3 | 16 | FMGAIN | FM gain adjustment |
| 4 | 2 | AGC | AGC output |
| 5 | 3 | VREF2 | Reference voltage 2 output |
| 6 | 1 | NC | Not connected |
| 7 | 5 | GND2 | Ground for AM part |
| 8 | 6 | AMIN | AM input |
| 9 | 4 | NC | Not connected |
| 10 | 7 | AMOUT | AM output |
| 11 | 8 | AMOUT1 | AM output |
| 12 | 9 | VREF1 | Reference voltage 1 output |
| 13 | 10 | AGCADJ | Adjustment FM wide-band AGC threshold |
| 14 | 11 | VS | Supply voltage |
| 15 | 13 | FMOUT | FM output |
| 16 | 12 | NC | Not connected |

## Pin Description

### FMIN

FMIN, a bipolar transitor's base is the input of the FM amplifier. A resistor or a coil is connected between FMIN and VREF2. If a coil is used, the noise performance is excellent.

**Figure 4.** Internal Circuit at Pin FMIN



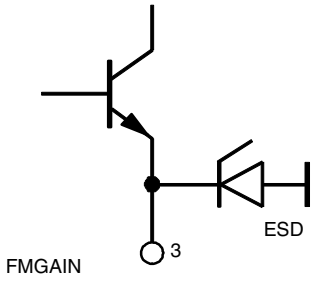

### GND1

To avoid cross-talk between AM and FM signals, the circuit has two separate ground pins. GND1 is the ground for the FM part.

### FMGAIN

The DC current of the FM amplifier transistor is adjusted by an external resistor which is connected between FMGAIN and GND1. To influence the AC gain of the amplifier, a resistor is connected in series to a capacitor between FMGAIN and GND1. The capacitor has to shorten frequencies of 100 MHz.

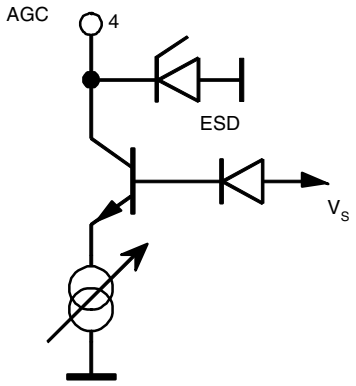
**Figure 5.** Internal Circuit at pin FMGAIN




### AGC

DC current flows into the AGC pin at high FM antenna input signals. This current has to be amplified via the current gain of an external PNP transistor that feeds a PIN diode. This diode dampens the antenna's input signal and protects the amplifier input against overload. The maximum current which flows in the AGC pin is approximately 1 mA. In low-end applications, the AGC function is not necessary and the external components can therefore be omitted.

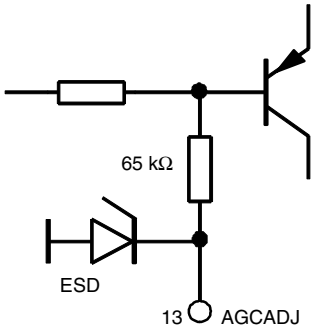
**Figure 6.** Internal Circuit at Pin AGC




## AGCADJ

The threshold of the AGC can be adjusted by varying the DC current at pin AGCADJ. If pin AGCADJ is connected directly to GND1, the threshold is set to 96 dBµV at the FM amplifier output. If a resistor is connected between AGCADJ and GND1, the threshold is shifted to higher values with increasing resistances. If AGCADJ is open, the threshold is set to 106 dBµV.

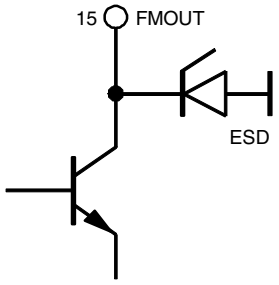
**Figure 7.** Internal Circuit at Pin AGCADJ




## FMOUT

The FM amplifier output is an open collector of a bipolar RF transistor. It should be connected to $V_S$ via a coil.

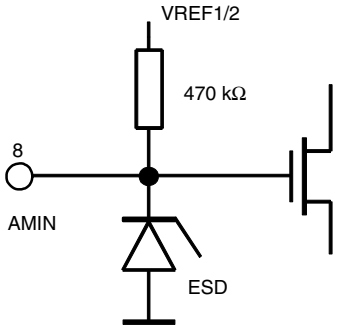
**Figure 8.** Internal Circuit at Pin FMOUT



## AMIN

The AM input has an internal bias voltage. The DC voltage at this pin is $V_{Ref1/2}$. The input resistance is about 470 kΩ. The input capacitance is less than 10 pF.

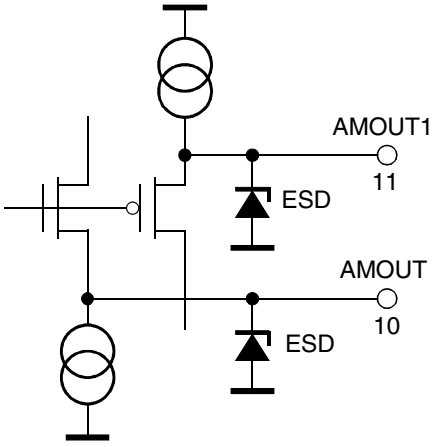
**Figure 9.** Internal Circuit at Pin AMIN




## AMOUT, AMOUT1

The buffered AM amplifier consists of a complementary pair of CMOS source followers. The transistor gates are connected to AMIN. The pin AMOUT is the NMOS transistor's source, pin AMOUT1 is the PMOS transistor's source. Due to the two different DC levels of these pins, they have to be connected together via an external capacitor of about 100 nF. By means of this technique an excellent dynamic range can be achieved.

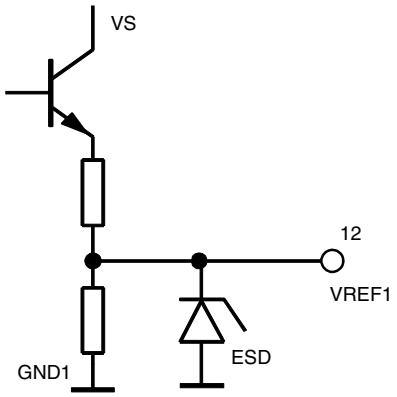
**Figure 10.** Internal Circuit at Pins AMOUT1 and AMOUT




## VREF1

VREF1 is the stabilized voltage for the AM amplifier and the AGC block. To achieve excellent noise performance at LW frequencies, it is recommended that this pin be connected to ground via an external capacitor of about 1 µF.

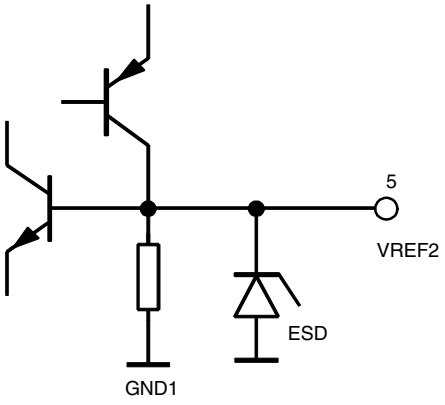
**Figure 11.** Internal Circuit at Pin VREF1




## VREF2

For the DC biasing of the FM amplifier, a second voltage reference circuit is integrated. Since the collector current is temperature independent, the output voltage has a negative temperature coefficient of about -1 mV/K. To stabilize this voltage, an external capacitor to ground of a few nF is recommended.

**Figure 12.** Internal Circuit at Pin VREF2




## GND2

GND2 is the ground for the AM amplifier.

## Functional Description

The U4254BM-M is an integrated AM/FM antenna impedance matching circuit. It compensates cable losses between the antenna (for example windshield, roof or bumper antennas) and the car radio which is usually placed far away from the antenna.

The FM amplifier provides excellent noise performance. External components are used to adjust the gain and the input-output matching impedance. Therefore, it is possible to adjust the amplifier to various cable impedances (usually 50, 75 or 150 Ω). To protect the amplifier against input overload, an Automatic Gain Control (AGC) is included on the chip. The AGC observes the AC voltage at the FM amplifier output, rectifies this signal, and delivers DC current to dampen the input antenna signal via an external PIN diode. The threshold for the AGC is adjustable. Simple and temperature-compensated biasing is possible due to the integrated voltage reference $V_{Ref2}$.

The AM part consists of a buffer amplifier. The voltage gain of this stage is approximately one. The input resistance is 470 kΩ, the input capacitance less than 10 pF. The output resistance is 125 Ω. An excellent dynamic range is achieved due to the complementary CMOS source follower stage.

## 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 and 7)

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Supply voltage | $V_S$ | 8.8 | V |
| Power dissipation, $P_{tot}$ at $T_{amb}$ = 85° C | $P_{tot}$ | 460 | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Ambient temperature | $T_{amb}$ | -40 to +85 | °C |
| Storage temperature | $T_{stg}$ | -50 to +150 | °C |
| Electrostatic handling (HBM at ESD S.5.1) | $\pm V_{ESD}$ | ±1000 | V |

## Thermal Resistance

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Junction ambient | $R_{thJA}$ | 140 | K/W |

## Electrical Characteristics

$V_S$ = 8 V, $T_{amb}$ = 25° C, unless otherwise specified (see Figure 13 on page 9).

| Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Supply voltage | | 14 | $V_S$ | 7.2 | 8 | 8.8 | V |
| Supply currents | | 14 | $I_S$ | 3.5 | 4.8 | 5.6 | mA |
| Reference voltage 1 output ($I_{12}$ = 0) | | 12 | $V_{Ref1}$ | 5.1 | 5.4 | 5.7 | V |
| Reference voltage 2 output ($I_5$ = 0) | | 5 | $V_{Ref2}$ | 2.3 | 2.6 | 2.8 | V |
| Temperature dependence of VREF2 | | 5 | $V_{Ref2}/\Delta T$ | | -1 | | mV/K |
| **AM Amplifier** | | | | | | | |
| Input resistance | | 8 | $R_{AMIN}$ | | 470 | | kΩ |
| Input capacitance | | 8 | $C_{AMIN}$ | | | 10 | pF |
| Output resistance | | 10 | $R_{OUT}$ | | 125 | | Ω |
| Voltage gain | | 8, 10 | a | | 0.85 | | |
| Output noise voltage (rms value) | S1 switched to 2<br>B = 6 kHz<br>150 kHz to 300 kHz<br>500 kHz to 6.5 kHz | 10 | <br><br>$V_{N1}$<br>$V_{N2}$ | | <br><br>-2<br>-6 | | <br><br>dBµV<br>dBµV |
| 2nd harmonic | S2 switched to 1<br>$f_{AMIN}$ = 500 kHz<br>Output voltage = 110 dBµV | 10 | | | -65 | | dBc |
| **FM Amplifier** | | | | | | | |
| Supply current limit | $I_{AGC}$, $I_{AGCADJ}$ = 0 A | 15 | $I_{15}$ | | 33 | 35 | mA |
| Input resistance | f = 100 MHz | 1 | $R_{FMIN}$ | | 50 | | Ω |
| Output resistance | f = 100 MHz | 15 | $R_{FMOUT}$ | | 50 | | Ω |
| Power gain | f = 100 MHz | 1, 15 | G | | 5 | | dB |
| Output noise voltage | f = 100 MHz<br>B = 120 kHz | 15 | $V_N$ | | 0 | | dBµV |
| 3rd-order output intercept | f = 100 MHz | 15 | | | 132 | | dBµV |
| **AGC** | | | | | | | |
| AGC input voltage threshold | f = 100 MHz<br>S2 switched to 1;<br>AGC threshold DC current is 10 µA at pin 4 | 15 | $V_{th1}$ | | 96 | | dBµV |
| AGC input voltage threshold | f = 100 MHz,<br>S2 switched to 2;<br>AGC threshold DC current is 10 µA at pin 4 | 15 | $V_{th2}$ | | 106 | | dBµV |
| AGC output current | AGC active | | $I_{AGC}$ | | | 1.2 | mA |

**Figure 13.** Test Circuit

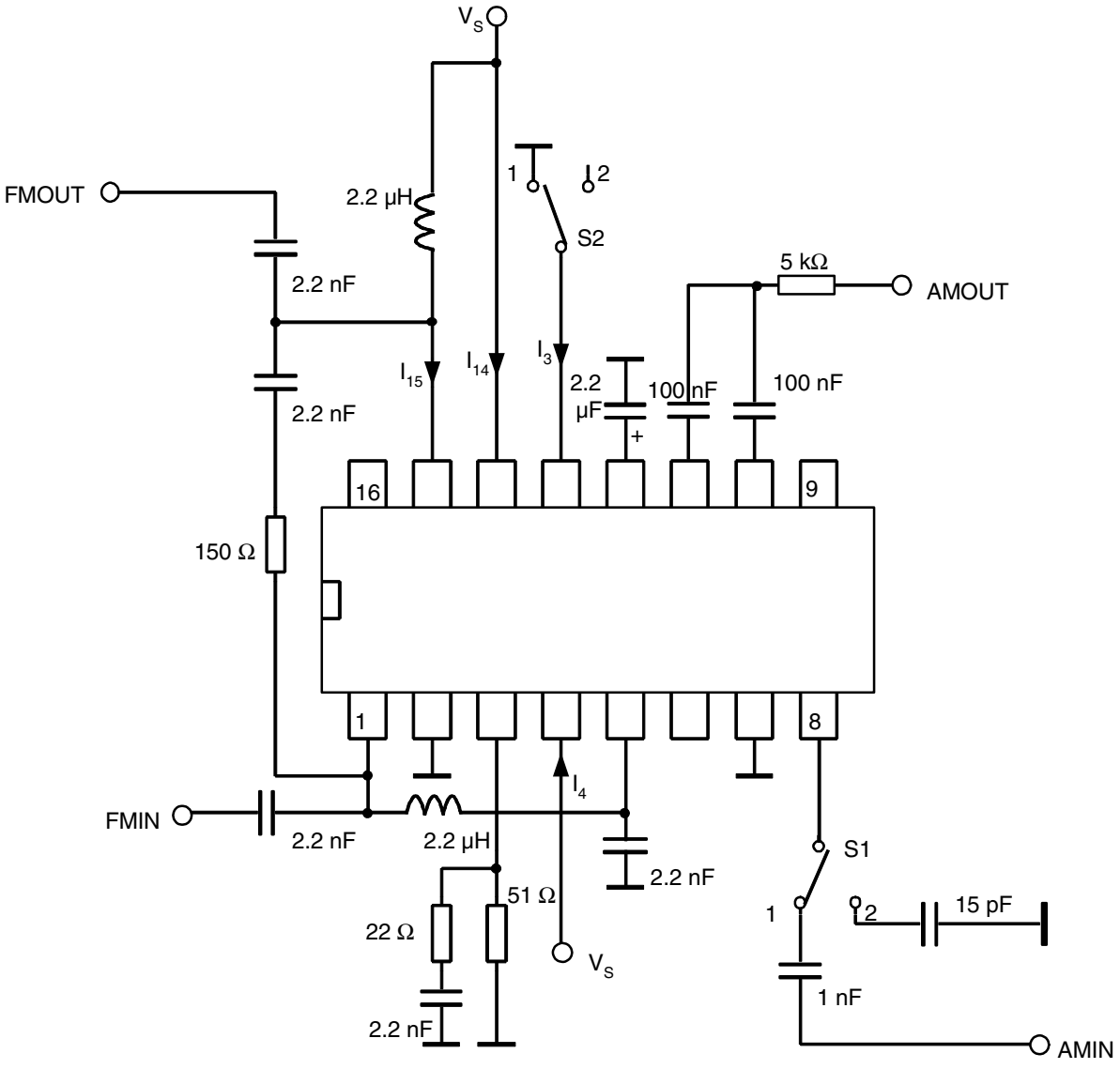


**Figure 14.** FM Intermodulation Distortion

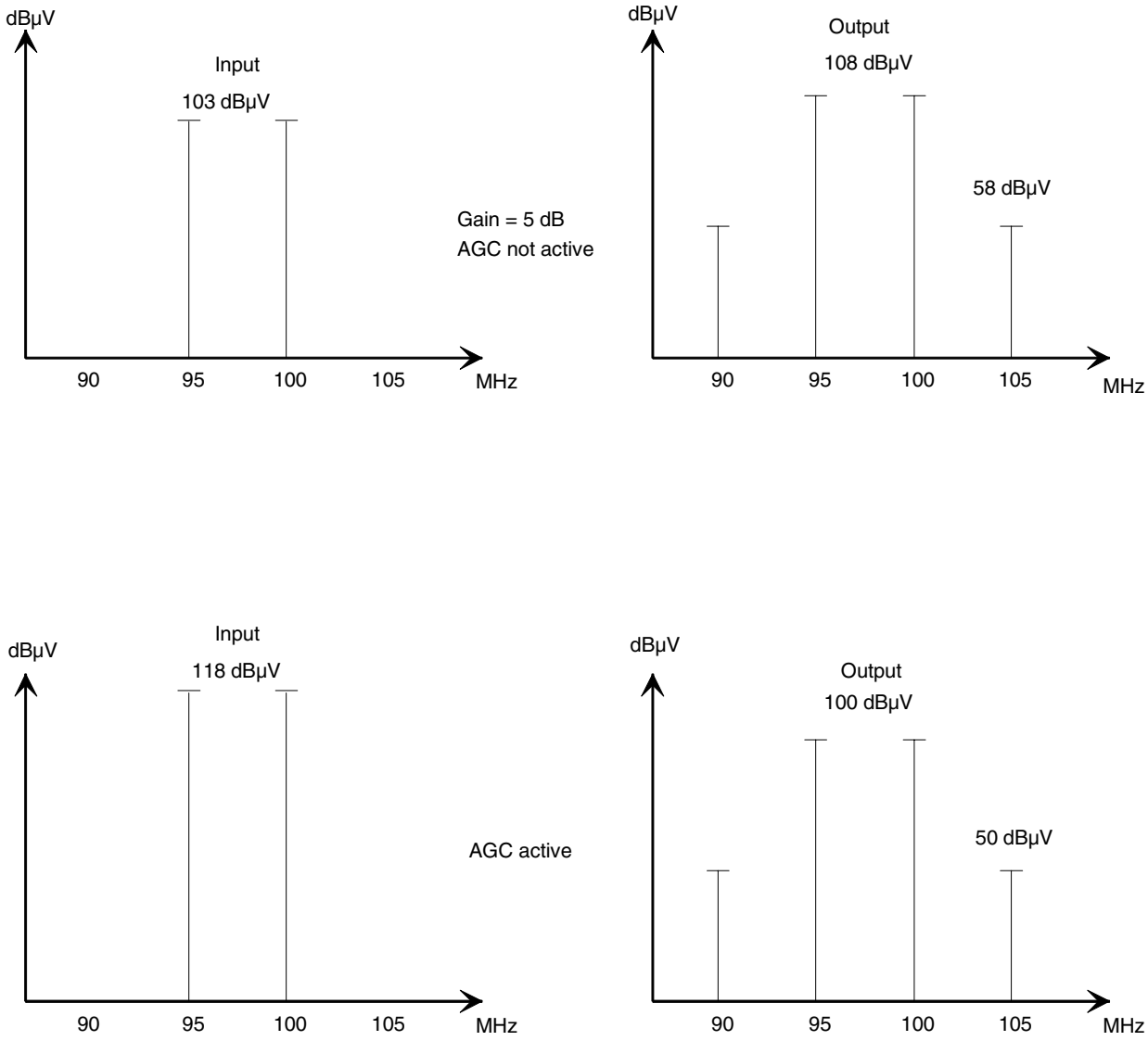


**Figure 15.** Test Circuit for AM Large Signal Behavior

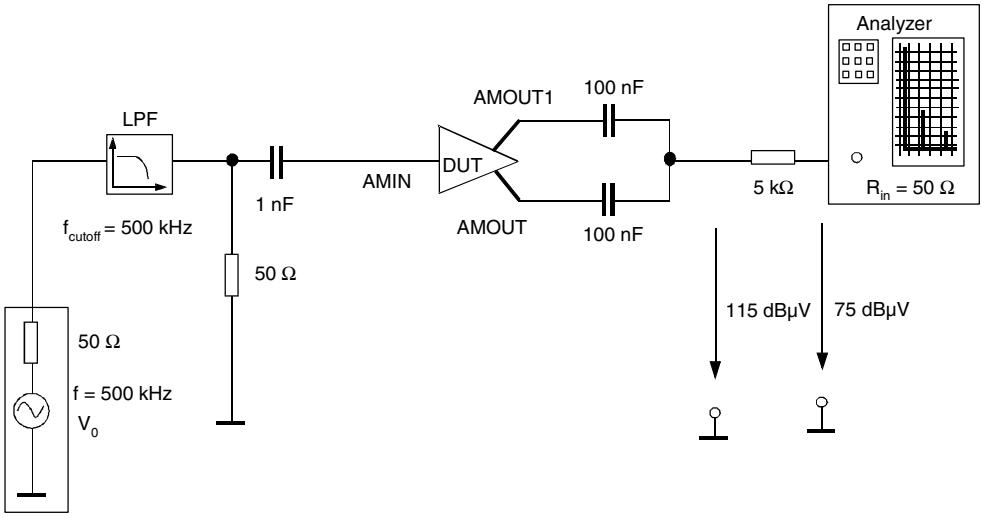



**Figure 16.** AM Harmonic Distortion

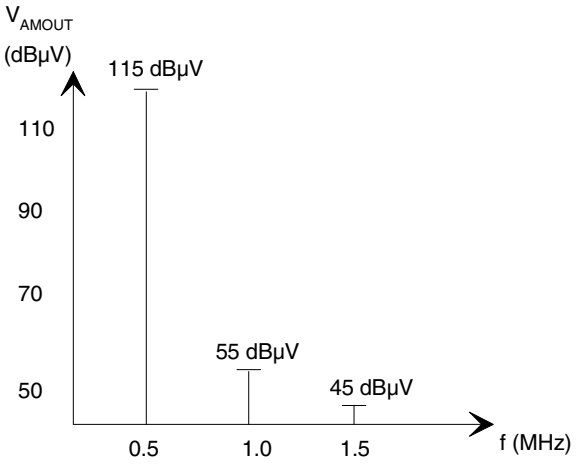
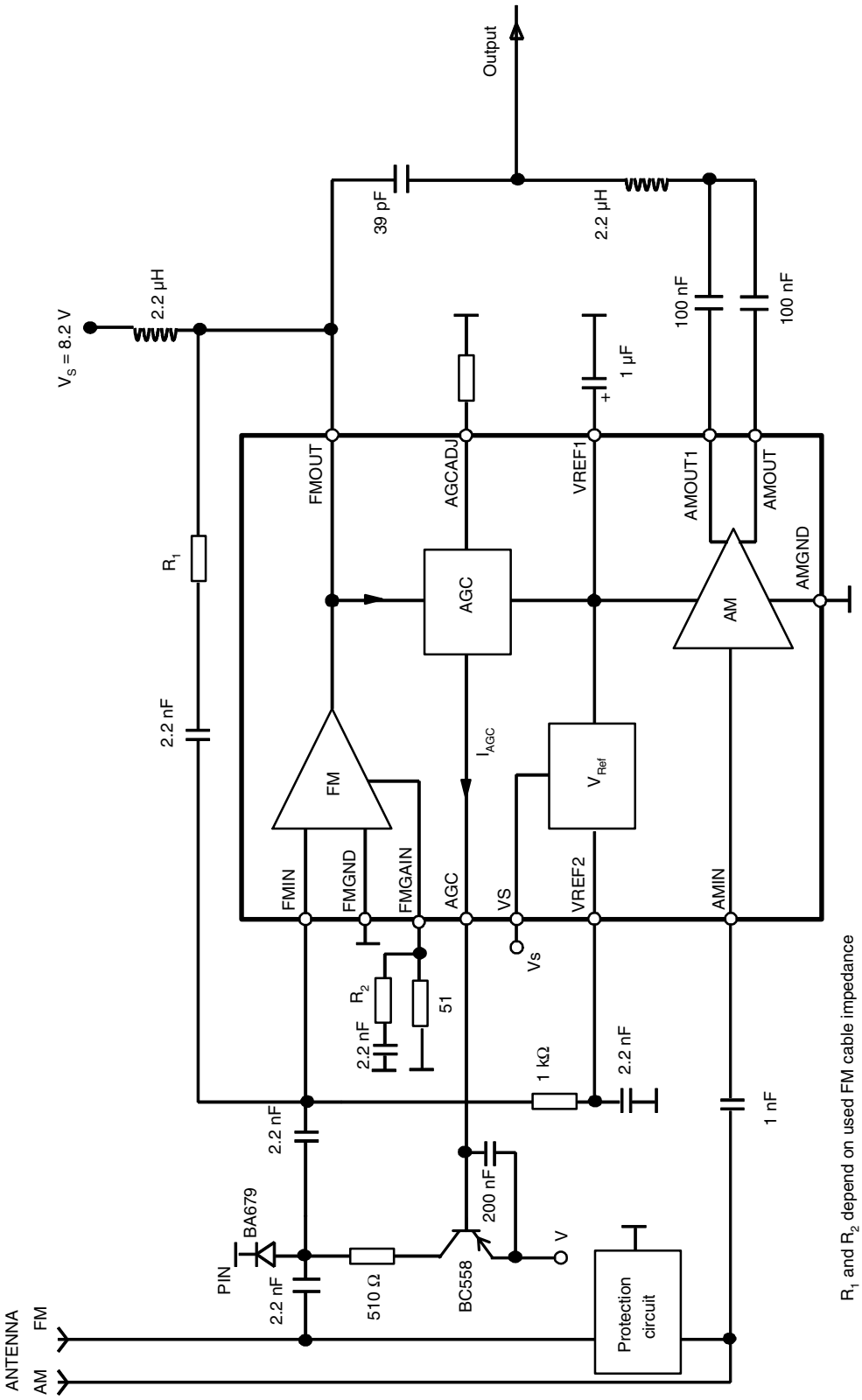


**Figure 17.** Application Circuit




$R_1$ and $R_2$ depend on used FM cable impedance

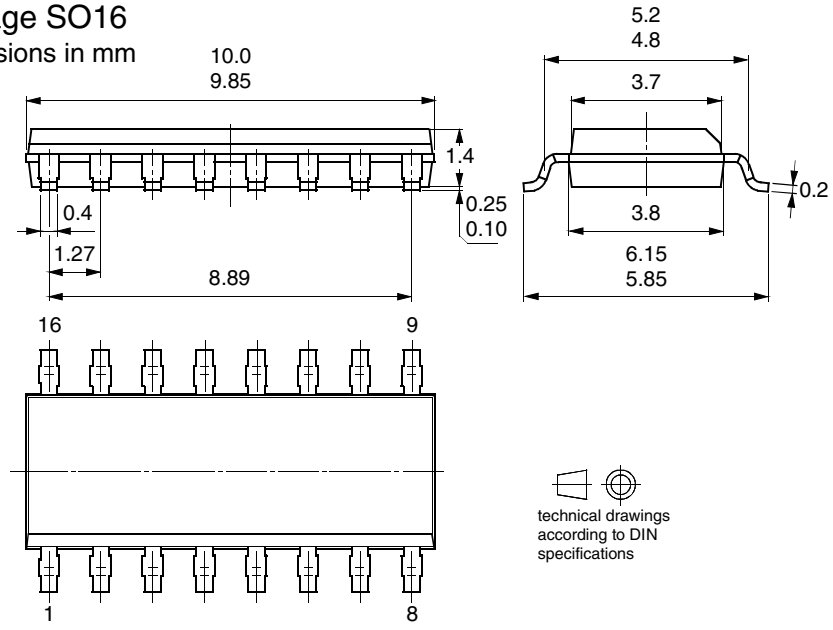
| FM cable impedance | $R_1$ (Ω) | $R_2$ (Ω) |
|---|---|---|
| 50 | 150 | 22 |
| 75 | 270 | 33 |
| 100 | 390 | 51 |
| 125 | 470 | 86 |
| 150 | 620 | 160 |

## Ordering Information

| Extended Type Number | Package | Remarks |
|---|---|---|
| U4254BM-MFP | SO16 | – |
| U4254BM-MPG3 | SO16 | Taping corresponding, ICE-286-3 |
| U4254BM-MPH | QFN16 | – |
| U4254BM-MPG3H | QFN16 | Taping corresponding, ICE-286-3 |

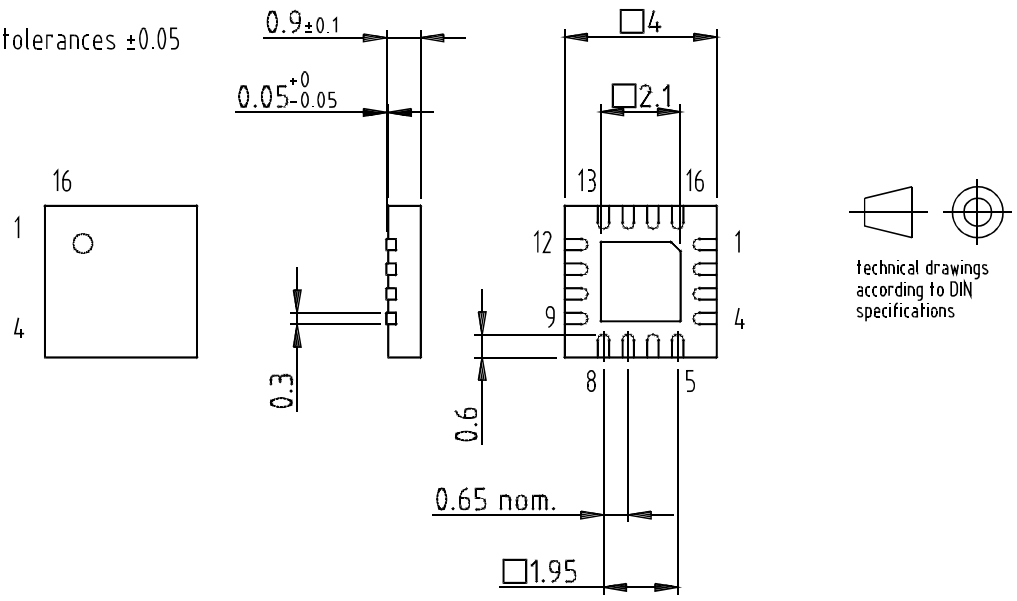
## Package Information

Package SO16
Dimensions in mm



Package: QFN 16 - 4x4
Exposed pad 2.1x2.1
(acc. JEDEC OUTLINE No. MO-220)
Dimensions in mm

Not indicated tolerances ±0.05




Drawing-No.: 6.543-5090.01-4
Issue: 2; 24.01.03

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