

DATA SHEET

UAA3220TS Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

Product specification
Supersedes data of 1998 April 10
File under Integrated Circuits, IC01

1999 Jan 22

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

UAA3220TS

FEATURES

- Low cost single-chip ASK or FSK receiver
- Superheterodyne architecture with high integration level
- Few external low cost components and crystal required
- Wide supply voltage range
- Low power consumption
- Wide frequency range, 250 to 920 MHz
- High sensitivity
- IF bandwidth determined by application
- High selectivity
- Automotive temperature range
- SSOP24 package.

Applications

- Keyless entry systems
- Car alarm systems
- Remote control systems
- Security systems
- Telemetry systems
- Wireless data transmission
- Domestic appliance.

GENERAL DESCRIPTION

The UAA3220TS is a fully integrated single-chip receiver, primarily intended for use in VHF and UHF systems. It supports both Amplitude Shift Keying (ASK) and Frequency Shift Keying (FSK) demodulation. By connecting DEMO1 (pin 10) to ground during realisation of the receiver module the UAA3220TS works as an ASK receiver (see Fig.10). By connecting pin 10 as shown in Fig.9 the UAA3220TS works as an FSK receiver. The UAA3220TS incorporates a crystal stabilized local oscillator, frequency multiplier, balanced mixer, post mixer amplifier, limiter, Received Signal Strength Indicator (RSSI), FSK demodulator, data filter, data slicer and power down circuit.

QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-------------------|----------------------------|-----------------------------------------------------------------------------|------|------|------|---------|
| V_{CC} | supply voltage | | 2.7 | – | 5.5 | V |
| I_{CC} | supply current | $f_{i(RF)} = 433.92$ MHz; FSK mode operating mode on; $V_{PWD} = 0$ V | 2.8 | 4.3 | 5.8 | mA |
| | | operating mode off; $V_{PWD} = V_{CC}$ | – | 3 | 30 | μ A |
| ASK mode | | | | | | |
| $P_{i(max)(ASK)}$ | maximum input power | BER \leq 3% | –22 | –16 | –10 | dBm |
| $\Phi_{i(ASK)}$ | sensitivity into pin MIXIN | $f_{i(RF)} = 433.92$ MHz; BER \leq 3% | – | –119 | –113 | dBm |
| FSK mode | | | | | | |
| $P_{i(max)(FSK)}$ | maximum input power | BER \leq 3% | –6 | 0 | +1 | dBm |
| $\Phi_{i(FSK)}$ | sensitivity into pin MIXIN | $f_{i(RF)} = 433.92$ MHz; BER \leq 3% | – | –103 | –100 | dBm |

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ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|-------------|---------|-------------------------------------------------------------------|----------|
| | NAME | DESCRIPTION | VERSION |
| UAA3220TS | SSOP24 | plastic shrink small outline package; 24 leads; body width 5.3 mm | SOT340-1 |

BLOCK DIAGRAM

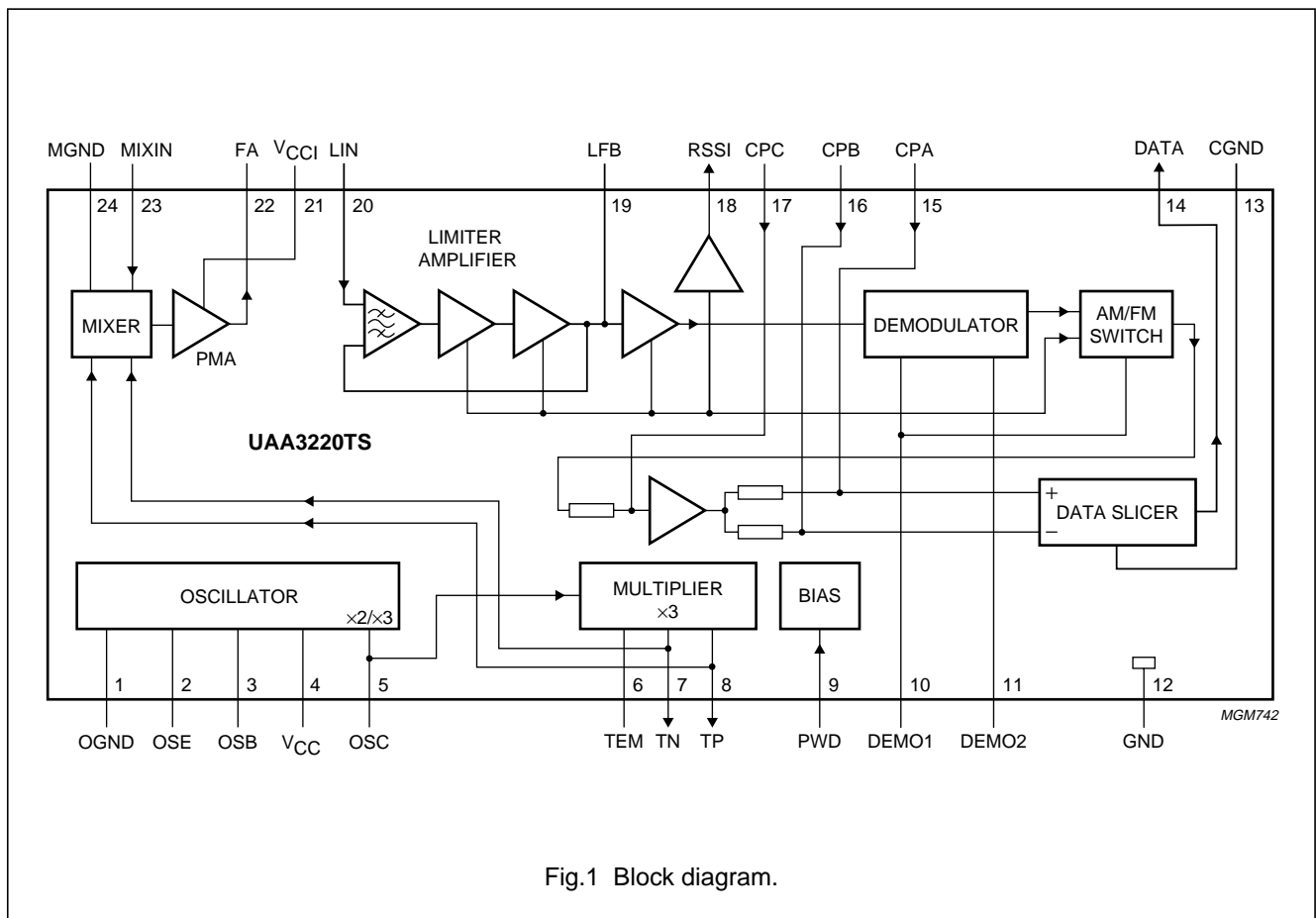


Fig.1 Block diagram.

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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PINNING

| SYMBOL | PIN | DESCRIPTION |
|------------------|-----|---------------------------------------|
| OGND | 1 | oscillator ground |
| OSE | 2 | oscillator emitter |
| OSB | 3 | oscillator base |
| V _{CC} | 4 | positive supply voltage |
| OSC | 5 | oscillator collector |
| TEM | 6 | frequency multiplier emitter resistor |
| TN | 7 | frequency multiplier negative output |
| TP | 8 | frequency multiplier positive output |
| PWD | 9 | power down control input |
| DEMO1 | 10 | FM demodulator 1, ASK/FSK switch |
| DEMO2 | 11 | FM demodulator 2 |
| GND | 12 | general ground |
| CGND | 13 | comparator ground |
| DATA | 14 | data output |
| CPA | 15 | comparator input A |
| CPB | 16 | comparator input B |
| CPC | 17 | comparator input C |
| RSSI | 18 | RSSI output |
| LFB | 19 | limiter feedback |
| LIN | 20 | limiter input |
| V _{CCI} | 21 | IF amplifier positive supply voltage |
| FA | 22 | IF amplifier output |
| MIXIN | 23 | mixer input |
| MGND | 24 | mixer ground |

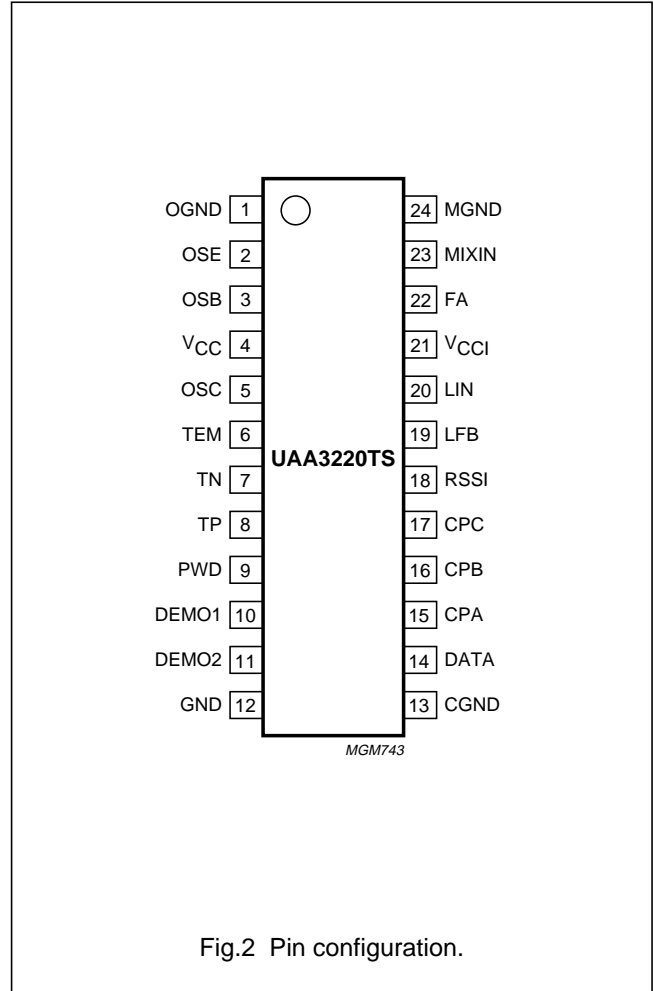


Fig.2 Pin configuration.

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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FUNCTIONAL DESCRIPTION

Mixer

The mixer is a single-balanced emitter-coupled mixer with internal biasing. Matching of the RF source impedance to the mixer input requires an external matching network.

Oscillator

The oscillator is based on a transistor connected in common collector configuration followed by a cascode stage driving a tuned circuit. The voltage at this tuned circuit drives the frequency multiplier. The bias current of the oscillator is set by an off-chip resistor (R40 in the application diagram of Fig.9) to a typical value of 260 μ A at 433.92 MHz (R40 = 1.8 k Ω). The oscillator frequency is controlled by an off-chip overtone crystal (X40). Off-chip capacitors between base and emitter (C42) and ground (C41) make the oscillator transistor appear as having negative resistance at small signal levels. This causes the oscillator to start. A parallel resonance circuit (L40 and C41) connected to the emitter of the oscillator transistor prevents oscillation at the fundamental frequency of the crystal. The LC tank circuit at the output of the oscillator is used to select either the fundamental, the second or the third harmonic of the oscillator frequency.

Frequency multiplier

The frequency multiplier is an emitter-coupled transistor pair driving an off-chip balanced tuned circuit. The bias current of this emitter coupled pair is set by an off-chip resistor (R50) to a typical value of 350 μ A at 433.92 MHz (R50 = 1.2 k Ω). The oscillator output signal is AC-coupled to one of the inputs of the emitter-coupled pair. The other input is connected to ground via an on-chip capacitor. The output voltage of the frequency multiplier drives the switching stage of the mixer. The bias voltage at this point is set by an off-chip resistor (R51) to allow sufficient voltage swing at the mixer outputs.

Post mixer amplifier

The Post Mixer Amplifier (PMA) is a differential input, single-ended output amplifier. Amplifier gain is provided in order to reduce the influence of the limiter noise figure on the total noise figure.

Limiter

The limiter is a single-ended input multiple stage amplifier with high total gain. Amplifier stability is achieved by means of an external DC feedback capacitor (C21), which is also used to determine the lower limiter cut-off frequency. An RSSI signal proportional to the limiter input signal is provided. Figure 3 shows the DC voltage at pin 18 (RSSI) as a function of the input voltage (RMS value) at pin 20 (LIN). It also gives the typical IF of 10.7 MHz. The lower knee of the level curve (see Fig.3) is determined by the effective noise bandwidth and is, consequently, slightly higher.

IF filter

IF filtering with high selectivity is realized by means of an external ceramic filter (X20), which feeds the IF from the PMA to the limiter.

FM demodulator

Coming from the limiter the FSK signal is fed differential to the input of the FM demodulator. After buffering the signal is fed to a phase detector. The phase shift is generated by an external LC combination connected to DEMO1 (pin 10) and DEMO2 (pin 11). The baseband signal is coupled out single ended via an output buffer and is fed to the FSK input of the ASK/FSK switch.

ASK/FSK switch

The selection of either ASK or FSK reception will be done by the DEMO1 (pin 10). Grounding this pin to 0 V will switch the IC to ASK mode. Additionally the FM demodulator and parts of the data slicer will be switched off. In FSK mode DEMO1 (pin 10) is connected to DEMO2 (pin 11) via a LC combination (see Fig.9).

Data filters

After demodulation a two-stage data filtering circuit is provided in order to suppress unwanted frequency components. Two RC low-pass filters with on-chip resistors are provided which are separated by a buffer stage.

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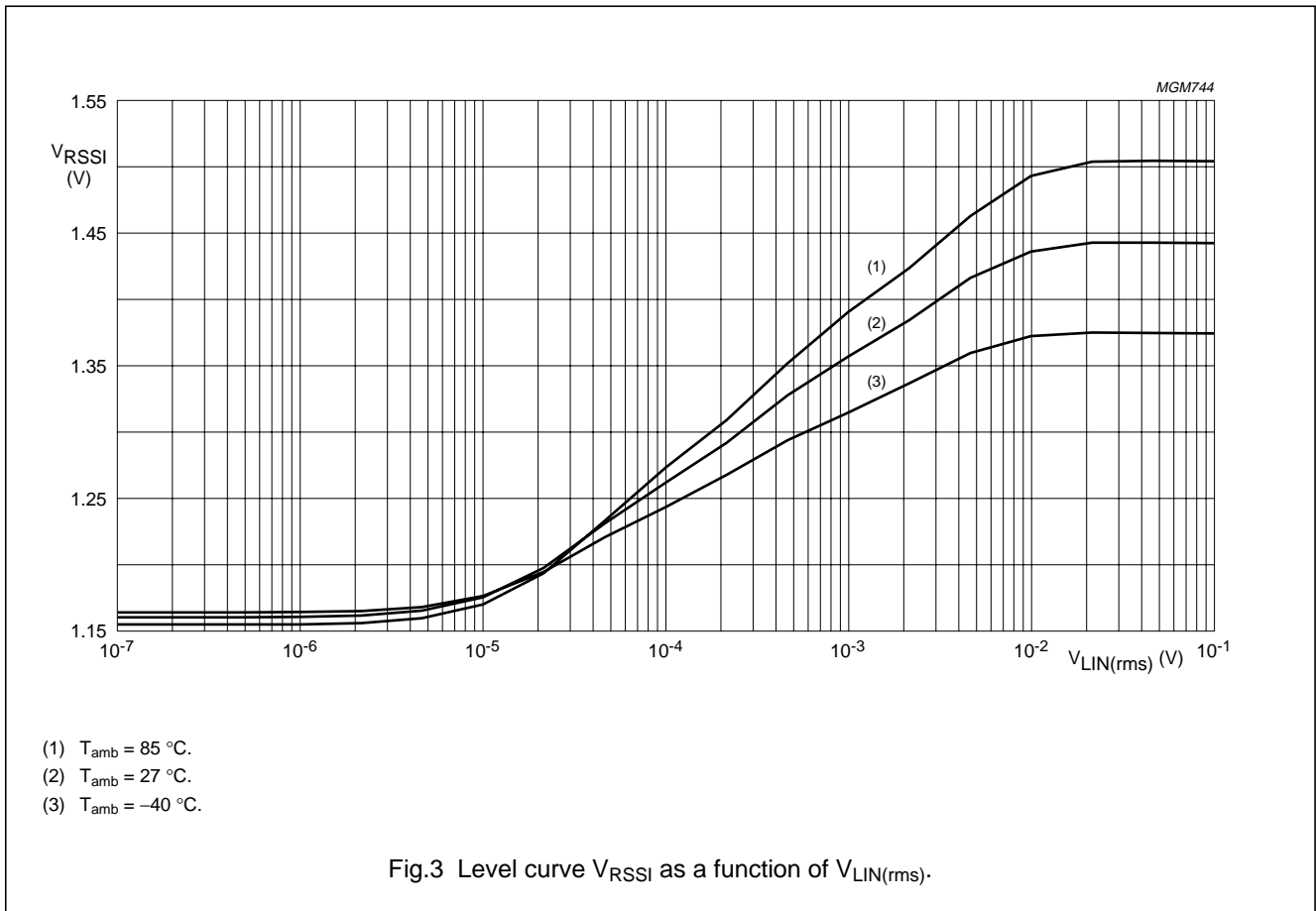
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Data slicer

Data detection is provided by means of a level comparator with adaptive slice reference. After the first data filter stage the pre-filtered data is split into two paths. One passes the second data filter stage and is fed to the positive comparator input. The other path is fed to an integration circuit with a large time constant in order to derive the average value (DC component) as an adaptive slice reference which is presented to the negative comparator input. The internal buffer provides 13 dB AC voltage gain. The adaptive reference allows to detect the received data over a large range of noise floor levels. The integration circuit consists of a simple RC low-pass filter with on-chip resistors. The data slicer output is designed with internal pull-up.

RSSI buffer

The RSSI buffer is an amplifier with a voltage gain of 0 dB. At FSK receive mode the RSSI output provides a field strength indication. It has an output impedance of 10 kΩ. Figure 3 shows the level curve (RSSI curve) as a function of the limiter input voltage (RMS value).



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LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|--------------|-------------------------------|------------|------|------|------|
| V_{CC} | supply voltage | | -0.3 | +8.0 | V |
| $P_{i(max)}$ | absolute maximum input power | | - | 3 | dBm |
| T_{amb} | operating ambient temperature | | -40 | +85 | °C |
| T_{stg} | storage temperature | | -55 | +125 | °C |
| V_{es} | electrostatic handling | note 1 | | | |
| | pins 3 and 6 | | -50 | +50 | V |
| | pin 2 | | -100 | +100 | V |
| | pin 5 | | -250 | +150 | V |
| | pin 23 | | -200 | +250 | V |
| | all other pins | | -250 | +250 | V |

Note

- Machine model: $C = 200 \text{ pF}$, $R = 0 \text{ } \Omega$ and $L = 0.75 \text{ } \mu\text{H}$; pins are connected to GND and V_{CC} .

THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---------------|---------------------------------------------|-------------|-------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | 125 | K/W |

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DC CHARACTERISTICS

$V_{CC} = 2.7\text{ V}$; $T_{amb} = 25\text{ °C}$; for application diagram see Figs 9 and 10; crystal disconnected; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-----------------------------|----------------------------|------------------------------------------------------------------|----------------|------|----------|---------------|
| Supplies | | | | | | |
| V_{CC} | supply voltage | | 2.7 | – | 5.5 | V |
| I_{CC} | supply current | operating mode on; $V_{PWD} = 0\text{ V}$; notes 1 and 2 | | | | |
| | | FSK demodulation; note 3 | 2.8 | 4.3 | 5.8 | mA |
| | | ASK demodulation; note 4 | 2.5 | 3.7 | 4.9 | mA |
| | | operating mode off; $V_{PWD} = V_{CC}$ | – | 3 | 30 | μA |
| V_{PWD} | voltage on pin PWD | operating mode on (receiving mode) | 0 | – | 300 | mV |
| | | operating mode off (sleep mode) | $V_{CC} - 0.3$ | – | V_{CC} | V |
| I_{PWD} | current into pin PWD | operating mode on (receiving mode); $V_{PWD} = 0\text{ V}$ | –30 | –10 | –3 | μA |
| | | operating mode off (sleep mode); $V_{PWD} = V_{CC}$ | – | 2 | 15 | μA |
| Oscillator | | | | | | |
| V_{OSE} | DC voltage at pin 2 | independent of oscillator | 0.33 | 0.38 | 0.43 | V |
| V_{OSB} | DC voltage at pin 3 | independent of oscillator | 1.05 | 1.15 | 1.25 | V |
| Multiplier | | | | | | |
| V_{TEM} | DC voltage at pin 6 | independent of oscillator | 0.33 | 0.39 | 0.45 | V |
| $V_{TN,TP}$ | DC voltage at pins 7 and 8 | independent of oscillator | 2.01 | 2.21 | 2.41 | V |
| Mixer | | | | | | |
| V_{MIXIN} | DC voltage at pin 23 | independent of oscillator | 0.68 | 0.78 | 0.88 | V |
| Post mixer amplifier | | | | | | |
| V_{FA} | DC voltage at pin 22 | independent of oscillator | 1.10 | 1.25 | 1.40 | V |
| Limiter | | | | | | |
| V_{LIN} | DC voltage at pin 20 | independent of oscillator | 1.85 | 1.95 | 2.05 | V |
| V_{LFB} | DC voltage at pin 19 | independent of oscillator | 1.85 | 1.95 | 2.05 | V |
| V_{RSSI} | DC voltage at pin 18 | independent of oscillator | 1.00 | 1.16 | 1.32 | V |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-------------------------------|--------------------------------------------|-------------------------------------|-----------------------|------|-----------------|------|
| Demodulator | | | | | | |
| $V_{\text{DEMO1,2}}$ | DC voltage at pins 10 and 11 | independent of oscillator; note 5 | 2.00 | 2.24 | 2.48 | V |
| $V_{\text{DEMO1(ASK)}}$ | DC voltage at pin 10 to switch in ASK mode | | 0 | – | 300 | mV |
| Data filter and slicer | | | | | | |
| $V_{\text{CPA,CPB,CPC}}$ | DC voltage at pins 15, 16 and 17 | ASK mode | 1.27 | 1.42 | 1.57 | V |
| | | FSK mode; note 6 | 1.81 | 2.01 | 2.21 | V |
| $V_{\text{OH(DATA)}}$ | HIGH-level output voltage at pin 14 | $I_{\text{DATA}} = -10 \mu\text{A}$ | $V_{\text{CC}} - 0.5$ | – | V_{CC} | V |
| $V_{\text{OL(DATA)}}$ | LOW-level output voltage at pin 14 | $I_{\text{DATA}} = 200 \mu\text{A}$ | 0 | – | 0.6 | V |

Notes

1. For $f_{i(\text{RF})} = 868.35 \text{ MHz}$ all values + 0.6 mA.
2. Crystal connected; oscillator and multiplier active.
3. Pin DEMO1 connected to pin DEMO2 via tank circuit.
4. Pin DEMO1 short circuited to ground.
5. The given values are applicable for FSK reception mode. In ASK mode pin 10 is short circuited to ground.
6. No modulation and $f_{\text{F}} = 10.7 \text{ MHz}$.

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AC CHARACTERISTICS

$V_{CC} = 2.7\text{ V}$; $T_{amb} = 25\text{ °C}$; for application diagram see Figs 9 and 10; $f_{i(RF)} = 433.92\text{ MHz}$ (see Table 4) and $f_{i(RF)} = 868.35\text{ MHz}$ (see Table 5); $f_{mod} = 1\text{ kHz}$ square wave; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---------------------------------------|-------------------------------------------|----------------------------------------|-------|------|-------|------------------|
| System performance | | | | | | |
| $f_{i(RF)}$ | RF input frequency | | 250 | – | 920 | MHz |
| f_{IF} | IF frequency | | 10.56 | 10.7 | 10.84 | MHz |
| $P_{i(max)}$ | maximum input power | | – | – | 3 | dBm |
| | | ASK mode; BER \leq 3%; notes 1 and 2 | –22 | –16 | –10 | dBm |
| | | FSK mode; BER \leq 3%; notes 2 and 3 | –6 | 0 | +1 | dBm |
| P_{SPUR} | spurious radiation | note 4 | – | – | –57 | dBm |
| f_{DATA} | data frequency | note 5 | – | 1 | – | kHz |
| $t_{on(RX)}$ | receiver turn-on time | notes 6 and 7 | – | – | – | – |
| | | $f_{i(RF)} = 433.92\text{ MHz}$ | – | 6 | 10 | ms |
| | | $f_{i(RF)} = 868.35\text{ MHz}$ | – | 3 | 7 | ms |
| V_{RSSI} | RSSI voltage | | 1.1 | – | 1.6 | V |
| ASK mode | | | | | | |
| $\Phi_{i(ASK)}$ | input sensitivity directly into pin MIXIN | BER \leq 3%; notes 1 and 2 | – | –119 | –113 | dBm |
| | | $f_{i(RF)} = 433.92\text{ MHz}$ | – | –116 | –110 | dBm |
| | | $f_{i(RF)} = 868.35\text{ MHz}$ | – | – | – | – |
| FSK mode | | | | | | |
| $\Phi_{i(FSK)}$ | input sensitivity directly into pin MIXIN | BER \leq 3%; notes 2 and 3 | – | –103 | –100 | dBm |
| Δf | frequency deviation (peak value) | | 4 | 10 | 75 | kHz |
| $\Delta\Phi_{(FSK)(max)}$ | maximum sensitivity degradation | $\Delta f = 4\text{ kHz}$ | – | – | 3 | dB |
| G_{dem} | demodulator gain | note 8 | 0.75 | 1.0 | 1.25 | $\frac{mV}{kHz}$ |
| Mixer and post mixer amplifier | | | | | | |
| Z_i | input impedance of mixer | $f_{i(RF)} = 433.92\text{ MHz}$ | – | 600 | – | Ω |
| | | $f_{i(RF)} = 868.35\text{ MHz}$ | – | 300 | – | Ω |
| $IP3_{PMA}$ | interception point (mixer + PMA) | | –38 | –30 | – | dBm |
| G_{PMA} | gain (mixer + PMA) | note 9 | 40 | 42 | 50 | dB |
| $Z_{o(IF)}$ | output impedance of IF amplifier | | 280 | 330 | 380 | Ω |

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|------------------------------------------------------|-------------------------------------------------|------------|------|------|------|-----------|
| Limiter | | | | | | |
| $R_{i(LIN)}$ | limiter input resistance | | 40 | 48 | 56 | $k\Omega$ |
| Buffer | | | | | | |
| R_{CPC} | data buffer output resistance at pin 17 | | 24 | 30 | 36 | $k\Omega$ |
| G_{buffer} | data buffer AC gain | | 12 | 13 | 14 | dB |
| $R_{CPA,CPB}$ | data buffer output resistance at pins 15 and 16 | | 120 | 150 | 180 | $k\Omega$ |
| Data slicer; see Chapter "DC characteristics" | | | | | | |
| B_{ds} | internal data slicer bandwidth | | 50 | – | 100 | kHz |

Notes

- 100% AM modulation (ASK); available power from generator into a 50 Ω load.
- With external matching network, to transform the impedance to 50 Ω .
- $\Delta f = 10$ kHz; available power from generator into a 50 Ω load.
- Measured at the RF input connector of the test board into a 50 Ω load; $f_{i(RF)} = 25$ MHz to 1 GHz.
- The data frequency range can be varied by changing C30 to C32 (see Figs 9 and 10) to match other bit rates. Data frequency determined by data slicer application.
- $t_{on} = 50$ ms; $t_{off} = 138$ ms; $P = P_{sens} + 3$ dB.
- The given turn-on time is only valid during strobing by pin PWD; if the IC is strobed on and off by the supply voltage the turn-on time will be longer.
- LC tank circuit (L60, C60) tuned to maximum phase slope.
- G_{PMA} is typically 6 dB lower when measured in the application, because of the load of the ceramic filter.

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INTERNAL CIRCUITRY

Table 1 Equivalent pin circuits and pin voltages for rough test of printed-circuit board; $V_{CC} = 2.7\text{ V}$; no input signal

| PIN NO. | PIN SYMBOL | DC VOLTAGE (V) | EQUIVALENT CIRCUIT |
|---------|------------|----------------|--------------------|
| 1 | OGND | 0 | |
| 2 | OSE | 0.38 | |
| 3 | OSB | 1.15 | |
| 5 | OSC | 2.7 | |
| 4 | V_{CC} | 2.7 | |
| 6 | TEM | 0.39 | |
| 7 | TN | 2.21 | |
| 8 | TP | 2.21 | |
| 9 | PWD | - | |
| 10 | DEMO1 | 2.24 | |
| 11 | DEMO2 | 2.24 | |
| 12 | GND | 0 | |

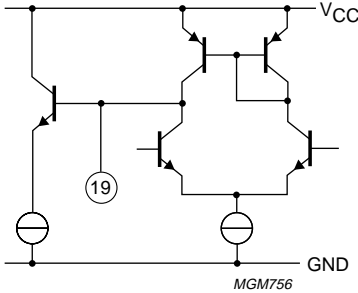
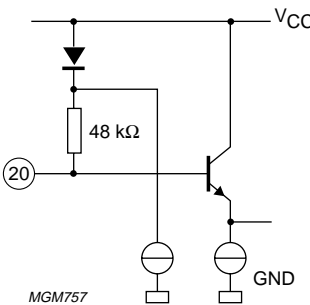
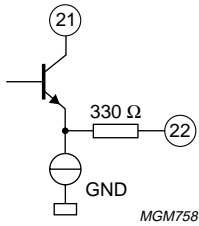
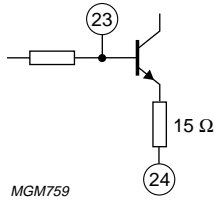
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| PIN NO. | PIN SYMBOL | DC VOLTAGE (V) | EQUIVALENT CIRCUIT |
|---------|------------|----------------|--------------------|
| 13 | CGND | 0 | <p>MGM753</p> |
| 15 | CPA | 1.95 | |
| 16 | CPB | 1.95 | |
| 14 | DATA | – | <p>MGM754</p> |
| 17 | CPC | 1.95 | <p>MGM755</p> |
| 18 | RSSI | 1.16 | <p>MGM752</p> |

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| PIN NO. | PIN SYMBOL | DC VOLTAGE (V) | EQUIVALENT CIRCUIT |
|---------|------------|----------------|--------------------------------------------------------------------------------------|
| 19 | LFB | 1.95 |  |
| 20 | LIN | 1.95 |  |
| 21 | V_{CCI} | 2.7 |  |
| 22 | FA | 1.25 | |
| 23 | MIXIN | 0.78 |  |
| 24 | MGND | 0 | |

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TEST INFORMATION

Tuning procedures

TUNING PROCEDURE FOR AC TESTS

1. Turn on the signal generator ($f_{i(RF)} = 433.92$ or 868.35 MHz; no modulation; RF input level = -50 dBm).
2. Tune first C50 (multiplier tank circuit), second C11 (RF stage input) to obtain a peak IF voltage at pin FA.

TUNING PROCEDURE FOR ASK RECEPTION

1. Make sure that pin DEMO1 is short circuited to ground.
2. Turn on ASK modulation and check that data is appearing on the DATA output pin and proceed with the AC tests.

TUNING PROCEDURE FOR FSK RECEPTION

1. Make sure that pins DEMO1 and DEMO2 are connected by the LC tank circuit.
2. Turn on FSK modulation ($\Delta f = 10$ kHz; RF input level = -103 dBm).
3. Tune C61 (or L60) (phase shifter LC tank circuit) to obtain a peak LF voltage at pin CPC.
4. Check that data is appearing on pin DATA and proceed with the AC tests.

AC test conditions

Table 2 Test signals

The reference signal level P_{ref} for the following tests is defined as the minimum input level in dBm to give a $BER \leq 3 \times 10^{-2}$ (e.g. 60 bit errors per second for 2000 bits/s). All test signal levels refer to 50Ω load condition.

| TEST SIGNAL | FREQUENCY (MHz) | DATA SIGNAL | MODULATION | MODULATION INDEX | FREQUENCY DEVIATION |
|-------------|-----------------|----------------------|---------------|------------------|---------------------|
| 1 | 433.92/868.35 | 1 000 Hz square wave | AM (ASK) | 100% | – |
| 2 | 433.92/868.35 | 1 000 Hz square wave | FM (FSK) | – | 10 kHz |
| 3 | 433.92/868.35 | – | no modulation | – | – |
| 4 | 433.82/868.35 | – | no modulation | – | – |

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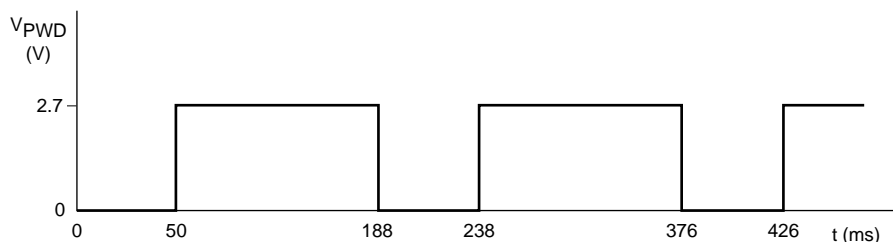
Table 3 Tests and results

P_1 is the maximum available power from signal generator 1 at the input of the test board; P_2 is the maximum available power from signal generator 2 at the input of the test board.

| TEST | GENERATOR | | RESULT |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| | 1 | 2 | |
| ASK sensitivity into pin MIXIN (see Fig.5) | modulated test signal 1; $P_1 \leq -113$ dBm for $f_{i(RF)} = 433.92$ MHz; $P_1 \leq -110$ dBm for $f_{i(RF)} = 868.35$ MHz | – | $BER \leq 3 \times 10^{-2}$ (e.g. 60 bit errors per second for 2000 bits/s) |
| FSK sensitivity into pin MIXIN (see Fig.5) | modulated test signal 2; $P_1 \leq -100$ dBm | – | $BER \leq 3 \times 10^{-2}$ (e.g. 60 bit errors per second for 2000 bits/s) |
| Maximum input power for ASK (see Fig.5) | modulated test signal 1; $P_1 \geq -22$ dBm | – | $BER \leq 3 \times 10^{-2}$ (e.g. 60 bit errors per second for 2000 bits/s) |
| Maximum input power for FSK (see Fig.5) | modulated test signal 2; $P_1 \geq -6$ dBm | – | $BER \leq 3 \times 10^{-2}$ (e.g. 60 bit errors per second for 2000 bits/s) |
| Receiver turn-on time; see note 1 and Fig.4 | modulated test signal 1 or 2; $P_1 = P_{ref} + 3$ dB | – | check that the first 10 bits are correct; error counting is started 10 ms after power down is switched into operating mode on |
| Interception point (mixer + PMA) see note 2 and Fig.6 | test signal 3; $P_1 = -40$ dBm | test signal 4; $P_2 = P_1$ | measure with high impedance probe at pin FA $IP3_{PMA} = P_1 + \frac{IM3}{2}$ dBm (for IM3 see Fig.6) |
| Spurious radiation; see note 3 and Fig.7 | – | – | no spurious signals (25 MHz to 1 GHz) with level higher than maximum P_{SPUR} |

Notes

1. The voltage at pin PWD of the test circuit alternates between operating mode: on (50 ms; 0 V) and off (138 ms; V_{CC}); see Fig.4.
2. Probe of spectrum analyzer connected to pin FA (pin 22).
3. Spectrum analyzer connected to the input of the test board.

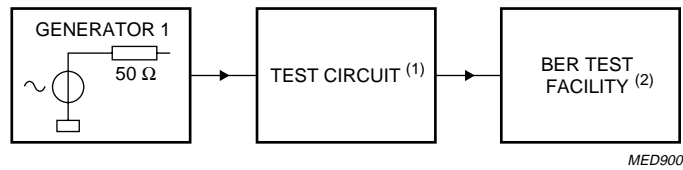


MGM745

Fig.4 Timing diagram for pulsed power down voltage.

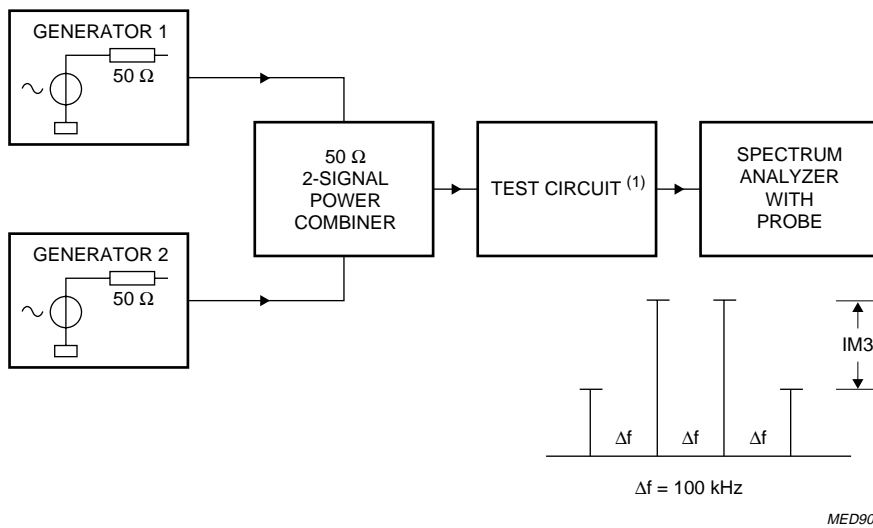
Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

UAA3220TS



- (1) For test circuit see Fig.9.
- (2) For BER test facility see Fig.8.

Fig.5 Test configuration A (single generator).

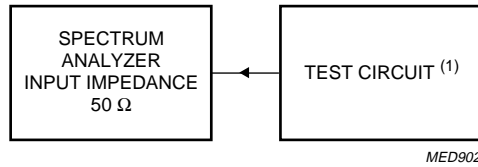


- (1) For test circuit see Fig.9.

Fig.6 Test configuration C (IP3).

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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(1) For test circuit see Fig.9.

Fig.7 Test configuration D (spurious radiation).

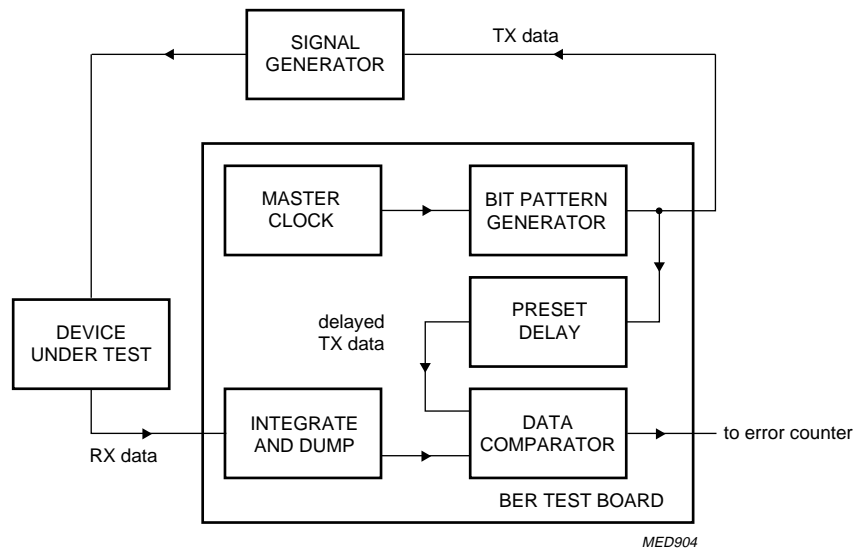


Fig.8 BER test facility.

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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APPLICATION INFORMATION

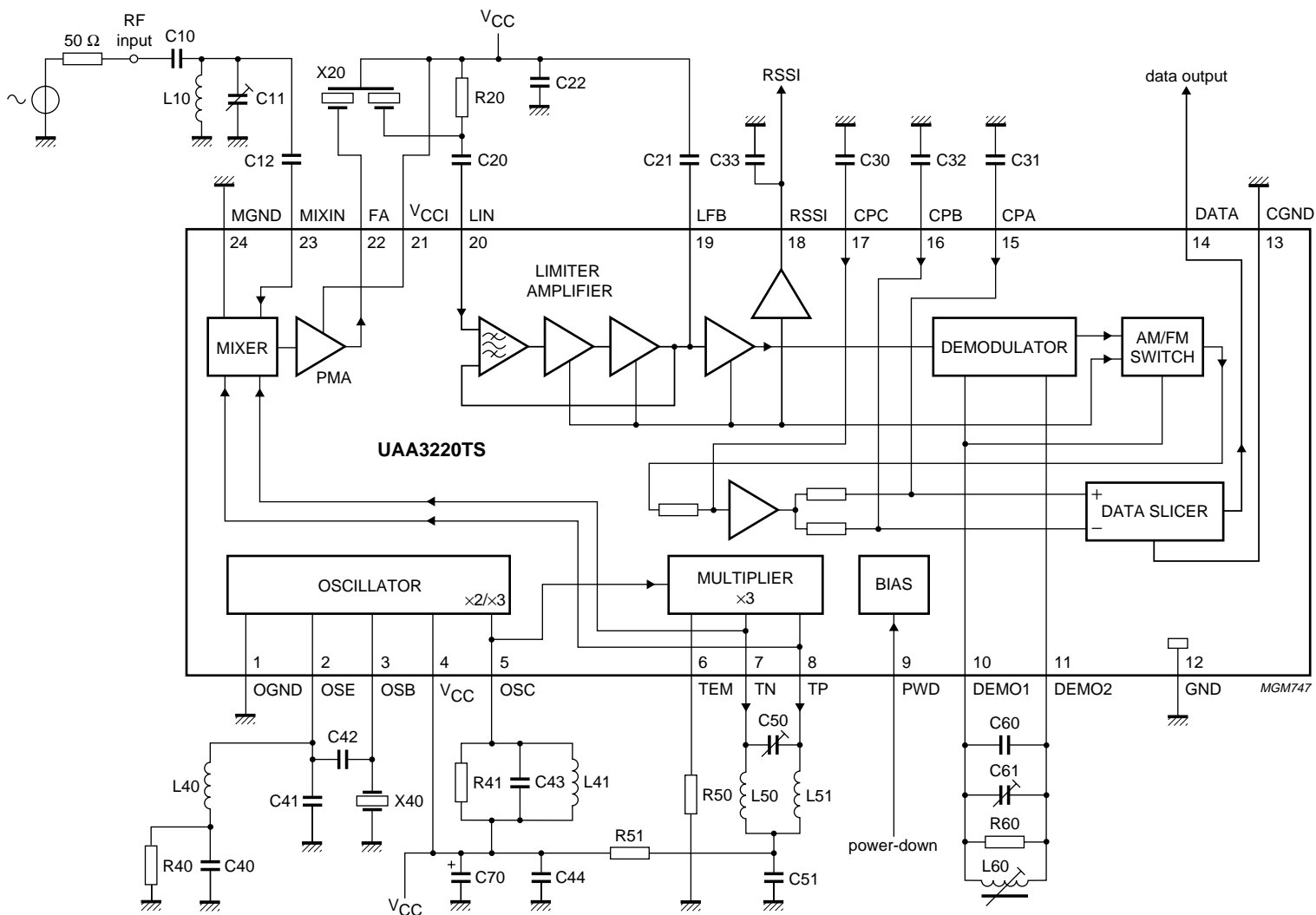


Fig.9 Application diagram (FSK reception).

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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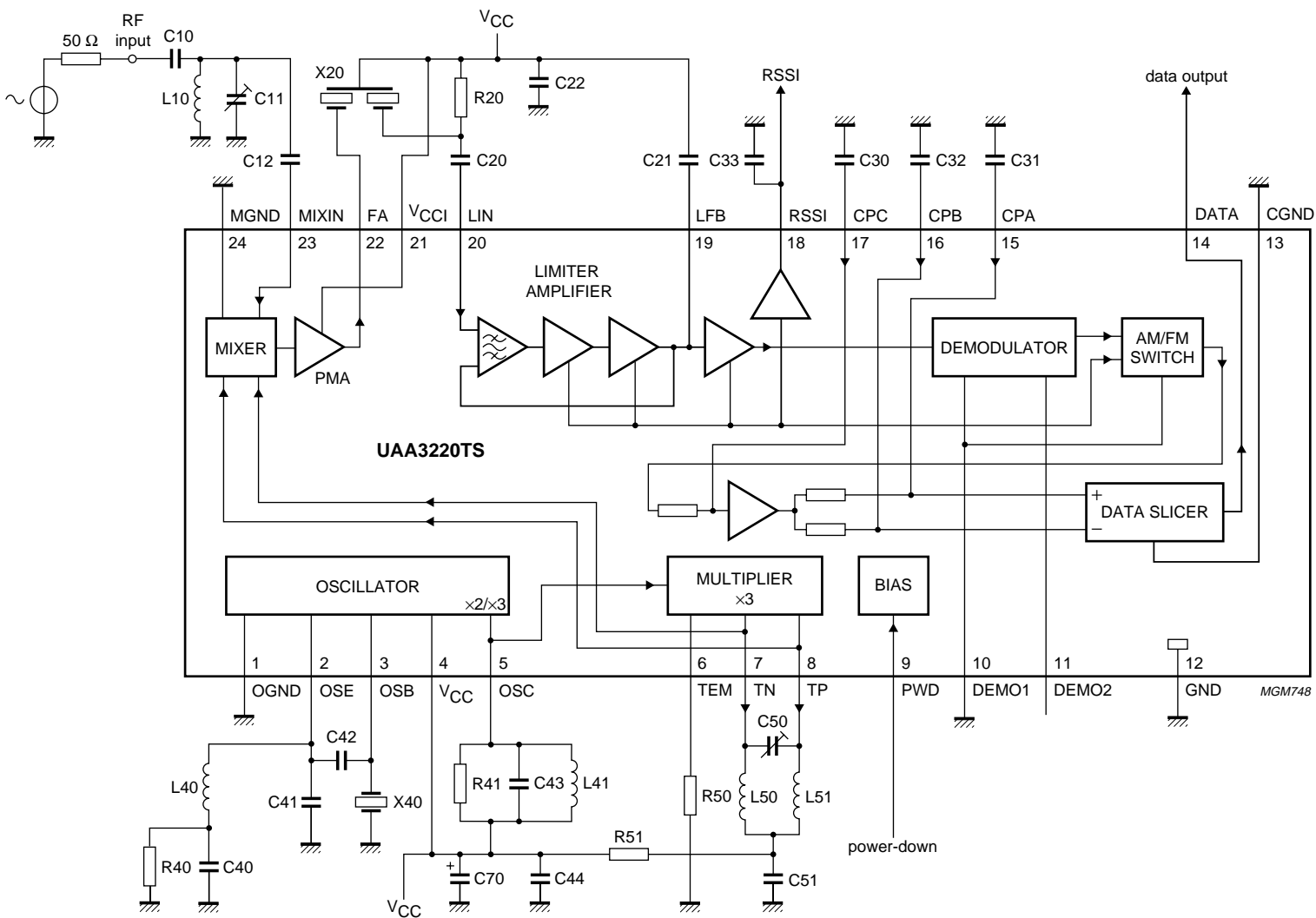


Fig.10 Application diagram (ASK reception).

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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Table 4 Component list for Figs 9 and 10; $f_{i(RF)} = 433.92$ MHz

| COMPONENT | COMPONENT CHARACTERISTICS | | | | | |
|--------------------|----------------------------------------------------|------------|---------------------------------|--------------------------------------|-----------------------|--------------------------|
| | VALUE | TOLERANCE | TEMPERATURE COEFFICIENT (ppm/K) | LOSS FACTOR AT 1 MHz | QUALITY FACTOR | SELF RESONANCE FREQUENCY |
| R20 | 330 Ω | $\pm 2\%$ | +50 | – | – | – |
| R40 | 1.8 k Ω | $\pm 2\%$ | +50 | – | – | – |
| R41 | not placed | – | – | – | – | – |
| R50 | 1.2 k Ω | $\pm 2\%$ | +50 | – | – | – |
| R51 | 1.5 k Ω | $\pm 2\%$ | +50 | – | – | – |
| R60 | 4.7 k Ω | $\pm 2\%$ | +50 | – | – | – |
| C10 ⁽¹⁾ | 2.7 pF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C11 | 3 to 10 pF | – | 0 ± 300 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C12 | 100 pF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C20 | 1 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C21 | 47 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C22 | 1 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C30 | 2.7 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C31 | 470 pF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C32 | 47 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C33 | 10 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C40 | 1 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C41 ⁽¹⁾ | 15 pF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C42 | 15 pF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C43 ⁽¹⁾ | 8.2 pF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C44 | 1 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C50 | 3 to 10 pF | – | 0 ± 300 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C51 | 1 nF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C60 ⁽²⁾ | 82 pF | $\pm 10\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C61 ⁽²⁾ | 5 to 30 pF | – | 0 ± 300 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C70 | not placed | – | – | – | – | – |
| L10 ⁽³⁾ | 8 nH | $\pm 5\%$ | +25 to +125 | – | ≥ 140 at 150 MHz | ≥ 3 GHz |
| L40 | 560 nH | $\pm 10\%$ | +25 to +125 | – | ≥ 45 at 100 MHz | ≥ 400 MHz |
| L41 | 100 nH | $\pm 10\%$ | +25 to +125 | – | ≥ 60 at 350 MHz | ≥ 1 GHz |
| L50 ⁽³⁾ | 8 nH | $\pm 5\%$ | +25 to +125 | – | ≥ 140 at 150 MHz | ≥ 3 GHz |
| L51 ⁽³⁾ | 8 nH | $\pm 5\%$ | +25 to +125 | – | ≥ 140 at 150 MHz | ≥ 3 GHz |
| L60 ⁽²⁾ | 2.2 μ H | $\pm 10\%$ | +25 to +125 | – | ≥ 37 at 7.9 MHz | ≥ 150 MHz |
| X20 | ceramic filter, Murata SFE 10.7 MA 5 A; see note 4 | | | | | |
| X40 | 3rd overtone crystal, 70.5367 MHz; see note 5 | | | | | |

**Frequency Shift Keying (FSK)/Amplitude
Shift Keying (ASK) receiver**

UAA3220TS**Notes**

1. C10, C41 and C43 can be placed as tuning capacitors on the PCB.
2. C60, C61 and L60 can be substituted by an LC tank.
3. L10, L50 and L51 are 3 turn air coils.
4. 3 dB bandwidth: 280 ± 50 kHz; insertion loss: 4 dB typical and 6 dB maximum; spurious: 30 dB minimum at 8 to 12 MHz; input and output impedance: 330Ω .
5. Motional resistance: $R_m \leq 20 \Omega$; static capacitance: $C_0 \leq 6$ pF; load capacitance: $C_L = 6$ pF; loaded parallel resonance frequency: 70.5367 MHz; drive level dependency: $R_m \leq 20 \Omega$ ($1 \text{ nW} \leq P \leq 1 \text{ mW}$).

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

UAA3220TS

Table 5 Component list for Figs 9 and 10; $f_{i(RF)} = 868.35$ MHz

| COMPONENT | COMPONENT CHARACTERISTICS | | | | | |
|--------------------|---------------------------------------------------|---------------|---------------------------------|---------------------------------------|----------------------|--------------------------|
| | VALUE | TOLERANCE | TEMPERATURE COEFFICIENT (ppm/K) | LOSS FACTOR AT 1 MHz | QUALITY FACTOR | SELF RESONANCE FREQUENCY |
| R20 | 330 Ω | $\pm 5\%$ | $\leq \pm 100$ | – | – | – |
| R40 | 1.5 k Ω | $\pm 5\%$ | $\leq \pm 100$ | – | – | – |
| R41 | not placed | – | – | – | – | – |
| R50 | 390 Ω | $\pm 5\%$ | $\leq \pm 100$ | – | – | – |
| R51 | 330 Ω | $\pm 5\%$ | $\leq \pm 100$ | – | – | – |
| R60 | 4.7 k Ω | $\pm 5\%$ | $\leq \pm 100$ | – | – | – |
| C10 | 27 pF | $\pm 5\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C11 | 1.7 to 3 pF | – | 0 ± 300 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C12 | 27 pF | $\pm 5\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C20 | 1 nF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C21 | 47 nF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C22 | 1 nF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C30 | 3.3 nF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C31 | 680 pF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C32 | 10 nF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C33 | 10 nF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C40 | 1 nF | $\pm 10\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 2.5\%$ | – | – |
| C41 | 12 pF | $\pm 5\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C42 | 12 pF | $\pm 5\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C43 | 4 pF | ± 0.25 pF | 0 ± 30 | $\tan \delta \leq 15 \times 10^{-4}$ | – | – |
| C44 | 47 pF | $\pm 5\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C50 | 2.5 to 6 pF | – | 0 ± 300 | $\tan \delta \leq 20 \times 10^{-4}$ | – | – |
| C51 | 47 pF | $\pm 5\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C60 ⁽²⁾ | 82 pF | $\pm 5\%$ | 0 ± 30 | $\tan \delta \leq 10 \times 10^{-4}$ | – | – |
| C61 ⁽²⁾ | 5 to 30 pF | – | 0 ± 300 | $\tan \delta \leq 3.4 \times 10^{-4}$ | – | – |
| C70 | 4.7 μ F | $\pm 20\%$ | $\pm 15\%^{(1)}$ | $\tan \delta \leq 0.06$ | – | – |
| L10 ⁽³⁾ | – | – | – | – | – | – |
| L40 | 560 nH | $\pm 10\%$ | +25 to +125 | – | ≥ 30 at 25 MHz | ≥ 415 MHz |
| L41 | 39 nH | $\pm 10\%$ | +25 to +125 | – | ≥ 50 at 50 MHz | ≥ 1.5 GHz |
| L50 ⁽³⁾ | – | – | – | – | – | – |
| L51 ⁽³⁾ | – | – | – | – | – | – |
| L60 ⁽²⁾ | 2.2 μ H | $\pm 10\%$ | +25 to +125 | – | ≥ 20 at 7.9 MHz | ≥ 140 MHz |
| X20 | ceramic filter, Murata SFE 107 MA 5 A; see note 4 | | | | | |
| X40 | 3rd overtone crystal, 95.2944 MHz; see note 5 | | | | | |

**Frequency Shift Keying (FSK)/Amplitude
Shift Keying (ASK) receiver**

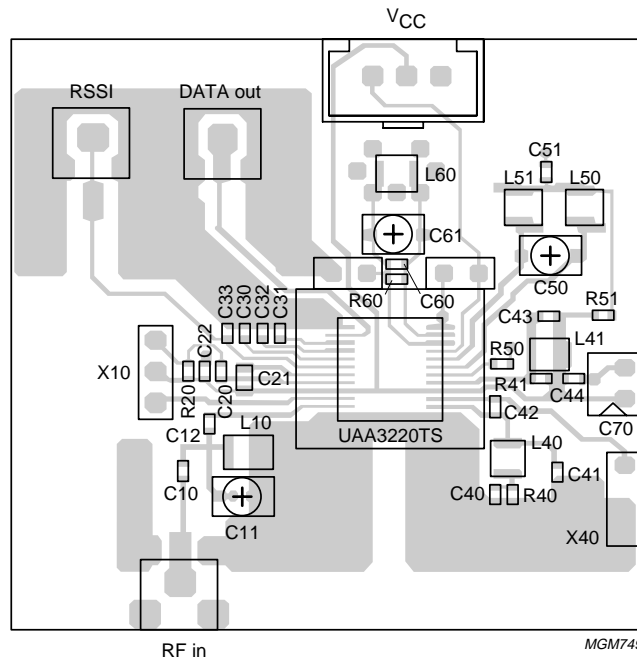
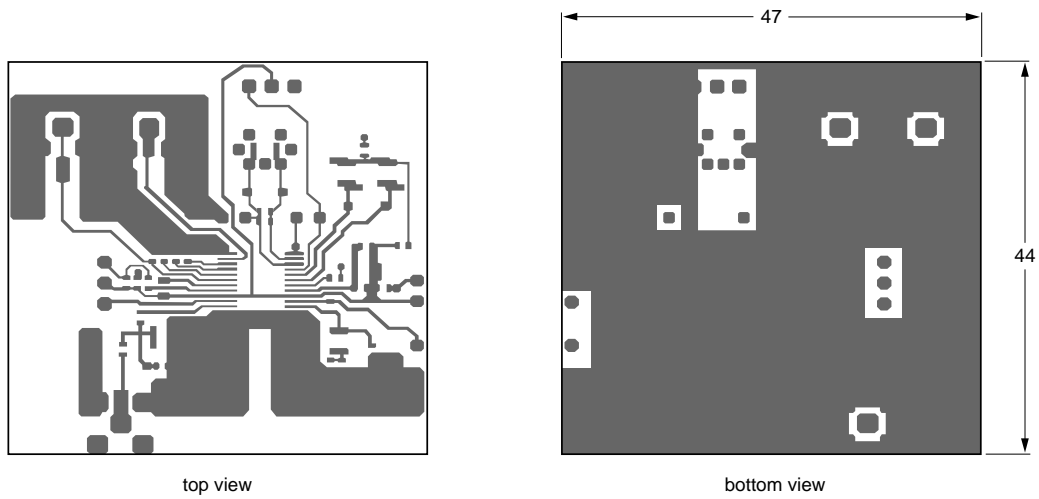
UAA3220TS

Notes

1. Temperature coefficient given as maximum $\Delta C/C$ over temperature range.
2. C60, C61 and L60 can be substituted by an LC tank.
3. Realized as microstrip line; see Fig.12.
4. 3 dB bandwidth: 280 ± 50 kHz; insertion loss: 4 dB typical and 6 dB maximum; spurious: 30 dB minimum at 8 to 12 MHz; input and output impedance: 330Ω .
5. Motional resistance: $R_m \leq 20 \Omega$; static capacitance: $C_0 \leq 6$ pF; load capacitance: $C_L = 6$ pF; loaded parallel resonance frequency: 95.2944 MHz; drive level dependency: $R_m \leq 20 \Omega$ ($1 \text{ nW} \leq P \leq 1 \text{ mW}$).

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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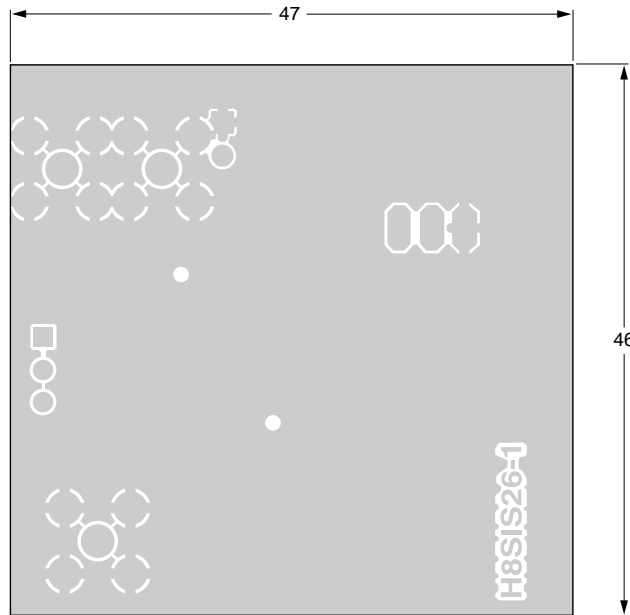


Dimensions in mm.

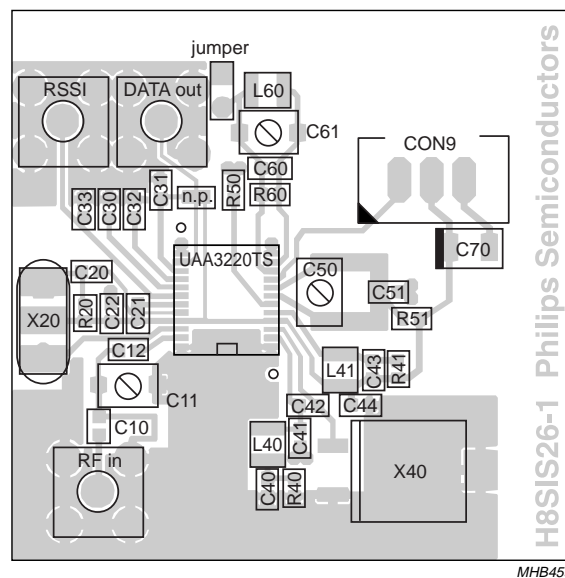
Fig.11 Printed-circuit board layout for $f_{i(RF)} = 433.92$ MHz.

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

UAA3220TS



bottom view



MHB459

Dimensions in mm.

Fig.12 Printed-circuit board layout for $f_{i(RF)} = 868.35$ MHz.

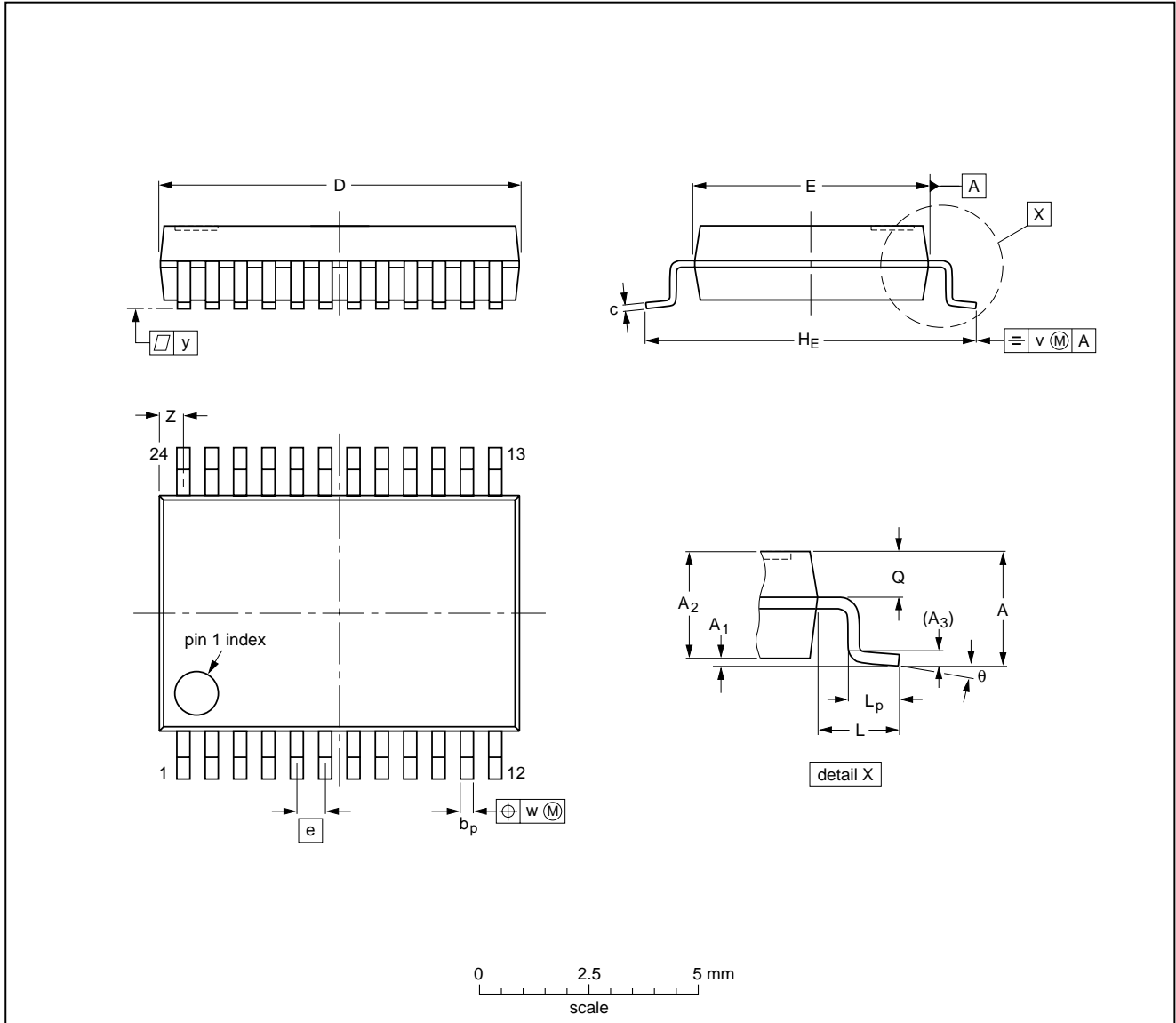
Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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PACKAGE OUTLINE

SSOP24: plastic shrink small outline package; 24 leads; body width 5.3 mm

SOT340-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | Z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|------|----------------|------------|-----|------|-----|------------------|----------|
| mm | 2.0 | 0.21 0.05 | 1.80 1.65 | 0.25 | 0.38 0.25 | 0.20 0.09 | 8.4 8.0 | 5.4 5.2 | 0.65 | 7.9 7.6 | 1.25 | 1.03 0.63 | 0.9 0.7 | 0.2 | 0.13 | 0.1 | 0.8 0.4 | 8° 0° |

Note

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT340-1 | | MO-150AG | | | | 93-09-08 95-02-04 |

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "Data Handbook IC26; Integrated Circuit Packages" (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

Frequency Shift Keying (FSK)/Amplitude Shift Keying (ASK) receiver

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Suitability of surface mount IC packages for wave and reflow soldering methods

| PACKAGE | SOLDERING METHOD | |
|---------------------------------|-----------------------------------|-----------------------|
| | WAVE | REFLOW ⁽¹⁾ |
| BGA, SQFP | not suitable | suitable |
| HLQFP, HSQFP, HSOP, HTSSOP, SMS | not suitable ⁽²⁾ | suitable |
| PLCC ⁽³⁾ , SO, SOJ | suitable | suitable |
| LQFP, QFP, TQFP | not recommended ⁽³⁾⁽⁴⁾ | suitable |
| SSOP, TSSOP, VSO | not recommended ⁽⁵⁾ | suitable |

Notes

- All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the "Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods".
- These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
- If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
- Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

DEFINITIONS

| Data sheet status | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| Limiting values | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| Application information | |
| Where application information is given, it is advisory and does not form part of the specification. | |

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NOTES

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