Features

- Superior FM Strong Signal Behavior by Using an RF AGC
- Soft Mute and HCC for Decreasing Interstation Noise in FM Mode
- Level Indicator (LED Drive) for AM and FM
- DC Mode Control: AM, FM and Tape
- Wide Supply-voltage Range and Low Quiescent Current
- High AF Output Power: 1 W
- Electronic Volume Control
- Electronic AF Bandwidth Control (Treble and High Cut)
- Output Stage for Headphone and Speaker Drive

Benefits

- Excellent AFC Performance (Level Controlled, Both Polarities Available)

Description

The U2510B is an integrated bipolar one-chip AM/FM radio circuit. It contains an FM front-end with preamplifier, FM IF and demodulator, a complete AM receiver, an AF amplifier and a mode switch for AM, FM and tape. This circuit is designed for clock radios and portable radio-cassette recorders.
Figure 1. Block Diagram

- **FM RF BPE**
- **AGC**
- **AM ant.**
- **AM osc. tank**
- **FM front end**
- **IF BPE**
- **AF preamp.**
- **Volume**
- **Mute**
- **HCC**
- **AM IF amp. and detect.**
- **Level indic.**
- **Power amp.**
- **FM antenna**
- **AF preamp.**
- **Volume**
- **Mute**
- **HCC**
- **VRef**
- **S2**
- **V_s**
- **LED**
- **FM osc. tank**
- **RF AGC**
- **AGC**
- **AM IF amp. and detect.**
- **Level indic.**
- **Power amp.**
- **FM RF BPE**
- **AGC**
- **AM ant.**
- **AM osc. tank**
- **FM front end**
- **IF BPE**
- **AF preamp.**
- **Volume**
- **Mute**
- **HCC**
- **VRef**
- **S2**
- **V_s**
- **LED**
Pin Configuration

Figure 2. Pinning SDIP28

```
1. MUTE
2. FM-DISCR
3. CF
4. VOL CTRL IN
5. AMOSC
6. FM-AFC
7. FMOSC
8. VREF
9. FMTANK
10. AMTANK
11. FM-AGC
12. FMIN
13. FE-GND
14. AM/FM IFOUT
15. MODE CTRL SWITCH
16. AM-IFIN
17. FM-IFIN
18. VTREBLE IN
19. LED DRIVE
20. IF-GND
21. AFC SWITCH
22. VAGC/AFC
23. AM/FM DETECT
24. AFIN
25. RIPPLE IN
26. VS
27. AFOUT
28. AF-GND
```
### Pin Description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mute</td>
<td>Mute voltage output. The time constant ( (C_{23}) ), mute depth and threshold are adjustable by load resistance ( (R_3) )</td>
</tr>
<tr>
<td>2</td>
<td>FM-DISCR</td>
<td>FM discriminator filter connection, ceramic resonator or equivalent LC-circuit</td>
</tr>
<tr>
<td>3</td>
<td>CF</td>
<td>Audio negative feedback input. The blocking capacitor ( (C_8) ) determines the audio amplifiers low-end cut-off frequency</td>
</tr>
<tr>
<td>4</td>
<td>VOL CTRL IN</td>
<td>Input for volume control voltage</td>
</tr>
<tr>
<td>5</td>
<td>AMOSC</td>
<td>AM oscillator tank circuit input. The recommended load impedance is approximately 2.5 kΩ</td>
</tr>
<tr>
<td>6</td>
<td>FM-AFC</td>
<td>AFC diode connection. The coupling capacitor ( (C_{19}) ) determines the AFC characteristic (holding range and slope)</td>
</tr>
<tr>
<td>7</td>
<td>FOSC</td>
<td>FM oscillator tank circuit input. The recommended load impedance is approximately 3 kΩ</td>
</tr>
<tr>
<td>8</td>
<td>VREF</td>
<td>Regulated voltage output (2.4 V)</td>
</tr>
<tr>
<td>9</td>
<td>FMTANK</td>
<td>FM RF tank circuit connection. The recommended load impedance is approximately 3 kΩ</td>
</tr>
<tr>
<td>10</td>
<td>AMTANK</td>
<td>AM RF tank circuit connection. The recommended load impedance is approximately 20 kΩ</td>
</tr>
<tr>
<td>11</td>
<td>FM-AGC</td>
<td>FM AGC voltage output, time constant ( (C_{20}) ). Loading this pin by a resistor (to GND) will increase the FM AGC threshold, grounding this pin will switch off the FM AGC function</td>
</tr>
<tr>
<td>12</td>
<td>FMin</td>
<td>FM RF input (common-base preamplifier transistor). The recommended (RF) source impedance is approximately 100 Ω</td>
</tr>
<tr>
<td>13</td>
<td>FE-GND</td>
<td>FM front-end ground</td>
</tr>
<tr>
<td>14</td>
<td>AM/FM Ifout</td>
<td>AM/FM IF output (collector output of the IF preamplifier)</td>
</tr>
<tr>
<td>15</td>
<td>MODE CTRL SWITCH</td>
<td>Mode control input:</td>
</tr>
<tr>
<td></td>
<td>Pin</td>
<td>Function</td>
</tr>
<tr>
<td></td>
<td>open</td>
<td>FM</td>
</tr>
<tr>
<td></td>
<td>Ground</td>
<td>AM</td>
</tr>
<tr>
<td></td>
<td>( V_0 ) ( (R_4 = 10 \text{ kΩ}) )</td>
<td>Tape</td>
</tr>
<tr>
<td>16</td>
<td>AM-IFIN</td>
<td>AM IF input, input impedance = 3.1 kΩ</td>
</tr>
<tr>
<td>17</td>
<td>FM-IFIN</td>
<td>FM IF input, input impedance = 330 Ω</td>
</tr>
<tr>
<td>18</td>
<td>VTREBLE IN</td>
<td>Treble control voltage input</td>
</tr>
<tr>
<td>19</td>
<td>LED DRIVE</td>
<td>Level indicator output (open-collector output, LED drive)</td>
</tr>
<tr>
<td>20</td>
<td>IF-GND</td>
<td>IF ground</td>
</tr>
<tr>
<td>21</td>
<td>AFC SWITCH</td>
<td>AFC function control input:</td>
</tr>
<tr>
<td></td>
<td>Pin</td>
<td>Function</td>
</tr>
<tr>
<td></td>
<td>open</td>
<td>AFC off</td>
</tr>
<tr>
<td></td>
<td>Ground</td>
<td>( f_{\text{osc}} &gt; f_{\text{in}} )</td>
</tr>
<tr>
<td></td>
<td>( V_0 )</td>
<td>( f_{\text{osc}} &lt; f_{\text{in}} )</td>
</tr>
<tr>
<td>22</td>
<td>VAGC/AFC</td>
<td>AGC/AFC voltage, time constant adjust ( (C_{10}) ). The input impedance is approximately 42 kΩ</td>
</tr>
<tr>
<td>23</td>
<td>AM/FM DETECT</td>
<td>AM/FM detector output. The load capacitor ( (C_{11}) ) in conjunction with the detector output resistance ( (7.5 \text{ kΩ}) ) determines the (FM) de-emphasis as well as the (modulation) frequency response of the AM detector</td>
</tr>
<tr>
<td>24</td>
<td>AFIN</td>
<td>Audio amplifier input. The input resistance is approximately 100 kΩ, the coupling capacitor ( (C_9) ) determines the low frequency response</td>
</tr>
<tr>
<td>25</td>
<td>RIPPLE IN</td>
<td>Ripple filter connection. The load capacitance ( (C_{12}) ) determines the frequency response of the supply-voltage ripple rejection</td>
</tr>
</tbody>
</table>
## Pin Description (Continued)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Function</th>
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<tbody>
<tr>
<td>26</td>
<td>VS</td>
<td>Supply voltage input</td>
</tr>
<tr>
<td>27</td>
<td>AFOUT</td>
<td>Audio amplifier output</td>
</tr>
<tr>
<td>28</td>
<td>AF-GND</td>
<td>Ground of the audio power stage</td>
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</tbody>
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## Terminal Voltages

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<tr>
<th>Pin</th>
<th>Function</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mute voltage ($R_3 = 0$)</td>
<td>$V_1$</td>
</tr>
<tr>
<td>2</td>
<td>FM discriminator</td>
<td>$V_2$</td>
</tr>
<tr>
<td>3</td>
<td>Negative feedback</td>
<td>$V_3$</td>
</tr>
<tr>
<td>4</td>
<td>Volume control input ($S_4 = A$)</td>
<td>$V_4$</td>
</tr>
<tr>
<td>5</td>
<td>AM oscillator</td>
<td>$V_5$</td>
</tr>
<tr>
<td>6</td>
<td>FM AFC</td>
<td>$V_6$</td>
</tr>
<tr>
<td>7</td>
<td>FM oscillator</td>
<td>$V_7$</td>
</tr>
<tr>
<td>8</td>
<td>$V_{Ref}$</td>
<td>$V_8$</td>
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<tr>
<td>9</td>
<td>FM RF tank</td>
<td>$V_9$</td>
</tr>
<tr>
<td>10</td>
<td>AM input</td>
<td>$V_{10}$</td>
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<tr>
<td>11</td>
<td>FM AGC</td>
<td>$V_{11}$</td>
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<tr>
<td>12</td>
<td>FM input</td>
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<tr>
<td>13</td>
<td>Front-end ground</td>
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<tr>
<td>14</td>
<td>AM/FM IF output</td>
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<tr>
<td>15</td>
<td>Mode control switch</td>
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<tr>
<td>16</td>
<td>AM IF input</td>
<td>$V_{16}$</td>
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<tr>
<td>17</td>
<td>FM IF input</td>
<td>$V_{17}$</td>
</tr>
<tr>
<td>18</td>
<td>Treble control input ($S_5 = A$)</td>
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<td>19</td>
<td>LED</td>
<td>$V_{19}$</td>
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<tr>
<td>20</td>
<td>IF ground</td>
<td>$V_{20}$</td>
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<tr>
<td>21</td>
<td>AFC switch ($S_3 = off$)</td>
<td>$V_{21}$</td>
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<td>22</td>
<td>AGC (AM)/AFC (FM)</td>
<td>$V_{22}$</td>
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<tr>
<td>23</td>
<td>Detector output</td>
<td>$V_{23}$</td>
</tr>
<tr>
<td>24</td>
<td>AF input</td>
<td>$V_{24}$</td>
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<tr>
<td>25</td>
<td>Ripple filter</td>
<td>$V_{25}$</td>
</tr>
<tr>
<td>26</td>
<td>Supply voltage</td>
<td>$V_{26}$</td>
</tr>
<tr>
<td>27</td>
<td>AF output</td>
<td>$V_{27}$</td>
</tr>
<tr>
<td>28</td>
<td>AF ground</td>
<td>$V_{28}$</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Voltage/V</th>
<th>$V_S = 3\ V$</th>
<th>$V_S = 6\ V$</th>
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<tr>
<td></td>
<td>AM</td>
<td>FM</td>
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<td>1</td>
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<td>1.6</td>
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<tr>
<td>2</td>
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<td>4</td>
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<tr>
<td>7</td>
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<td>2.4</td>
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<td>12</td>
<td>1.4</td>
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</tr>
<tr>
<td>13</td>
<td>-</td>
<td>-</td>
</tr>
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<tr>
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<tr>
<td>21</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>22</td>
<td>1.5</td>
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<td>1.2</td>
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<tr>
<td>28</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_S</td>
<td>13</td>
<td>V</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>P_tot</td>
<td>900</td>
<td>mW</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>T_amb</td>
<td>-20 to +75</td>
<td>°C</td>
</tr>
</tbody>
</table>

Electrical Characteristics

\( V_S = 6 \, \text{V}, \, T_{\text{amb}} = 25 \, ^\circ\text{C} \), “Test Circuit” on page 12, unless otherwise specified

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Test Conditions</th>
<th>Pin</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage range</td>
<td></td>
<td>V_S</td>
<td>2.5</td>
<td>9(1)</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oscillator stop voltage</td>
<td></td>
<td>V_S</td>
<td>2.2</td>
<td></td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td></td>
<td>T</td>
<td>-20</td>
<td>+75</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply quiescent current</td>
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<td></td>
<td>I_S</td>
<td>4.0</td>
<td>mA</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>I_S</td>
<td>6.5</td>
<td>mA</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>I_S</td>
<td>2.2</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulated voltage</td>
<td></td>
<td>8</td>
<td>V_{\text{Ref}}</td>
<td>2.4</td>
<td>V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Audio Amplifier** \( V_{\text{L}} \) (pin 24), test point: \( V_o \) (pin 27) \( f = 1 \, \text{kHz} \)

- AF measuring range: 30 Hz to 20 kHz, \( S_2 = \text{Tape}, \, S_4 = A, \, S_5 = A \)
- Input resistance: \( 24 \, \text{k}\Omega \)
- Closed loop voltage gain: \( G_{\text{Vaf1}} = 20 \, \log (V_o/V_{\text{L}}) \)
- Output voltage: \( V_o = 100 \, \text{mV}, \, S_4 = B \)
- High-end cut-off frequency: \( f_c \)
- Supply-voltage rejection ratio: \( SVRR = 20 \, \log (V_{\text{hum}}/V_o) \)
- Noise voltage: \( S_4 = B, \, V_o = 0 \)
- AF output power: \( \text{THD} = 10\%, \, R_L = 8 \, \Omega \)
- Distortion: \( P_o = 50 \, \text{mW}, \, R_L = 8 \, \Omega \)

**FM Section**, \( V_{\text{L}} = 60 \, \text{dBm}, \, f_o = 98 \, \text{MHz}, \, f_m = 1 \, \text{kHz}, \, \text{deviation} = \pm 22.5 \, \text{kHz}, \, f_{\text{IF}} = 10.7 \, \text{MHz}, \)

- AF measuring range: 300 Hz to 20 kHz, \( S_2 = \text{FM}, \, S_4 = A, \, S_5 = B, \, \text{test point: } V_{\text{D}} \) (pin 23)

- FM front-end voltage gain: \( G_{V_{\text{FM}}} = 20 \, \log (V_{\text{Q}}/V_{\text{L}}) \)
- Recovered audio voltage: \( 23 \, \text{dB} \)
- Detector output resistance: \( 23 \, \text{k}\Omega \)

Note: 1. U2510B-M_T: maximum 6 V
## Electrical Characteristics (Continued)

\( V_S = 6 \text{ V}, T_{\text{amb}} = 25^\circ \text{C}, \) “Test Circuit” on page 12, unless otherwise specified

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Test Conditions</th>
<th>Pin</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector output distortion</td>
<td>( \text{dev.} = \pm 75 \text{ kHz} )</td>
<td>THD</td>
<td>THD</td>
<td>0.5</td>
<td>0.8</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>( V_{\text{ip}} = 60 \text{ dBµV} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_{\text{ip}} = 105 \text{ dBµV} )</td>
<td>THD</td>
<td>THD</td>
<td></td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>AM rejection ratio</td>
<td>( m = 30% )</td>
<td>AM_{\text{BR}}</td>
<td>25</td>
<td></td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>RF sensitivity</td>
<td>( (S+N)/N = 26 \text{ dB} )</td>
<td>( V_{\text{ip}} )</td>
<td>9</td>
<td></td>
<td>22</td>
<td>dBµV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( (S+N)/N = 46 \text{ dB} )</td>
<td>( V_{\text{ip}} )</td>
<td>105 dBµV</td>
<td>26</td>
<td>22</td>
<td>dBµV</td>
<td></td>
</tr>
<tr>
<td>Limiting threshold (-3 dB)</td>
<td>( V_{\text{ip}} )</td>
<td>3</td>
<td></td>
<td>3 dBµV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mute voltage</td>
<td>Test point: Mute</td>
<td>( V_{\text{mute}} )</td>
<td>1.8</td>
<td></td>
<td>0.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_{\text{ip}} = 0 )</td>
<td>( V_{\text{mute}} )</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Mute depth</td>
<td>Referred to ( V_0 ) at ( V_{\text{ip}} = 0 )</td>
<td>MD</td>
<td>( V_{\text{mute}} )</td>
<td>26</td>
<td></td>
<td>20</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>( S_6 = A )</td>
<td>MD</td>
<td>( V_{\text{mute}} )</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>( S_6 = C )</td>
<td>MD</td>
<td>( V_{\text{mute}} )</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>AFC holding range</td>
<td>( f_{\text{osc }}&gt; f_{\text{in}}, S_3 = A, S_6 = A )</td>
<td>FHR</td>
<td>FHR</td>
<td>no AFC</td>
<td>±180</td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_{\text{ip}} \leq 10 \text{ dBµV} )</td>
<td>FHR</td>
<td>FHR</td>
<td></td>
<td>±220</td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_{\text{ip}} = 20 \text{ dBµV} )</td>
<td>FHR</td>
<td>FHR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_{\text{ip}} = 80 \text{ dBµV} )</td>
<td>FHR</td>
<td>FHR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED current</td>
<td></td>
<td>( i_{\text{LED}} )</td>
<td>5.5</td>
<td></td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Oscillator voltage</td>
<td>( eZ_{\text{load}} = 2.5 \text{ kΩ} )</td>
<td>7</td>
<td>( V_{\text{OSC}} )</td>
<td>180</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
</tbody>
</table>

**AM Section** \( V_{\text{ip}} = 60 \text{ dBµV}, f_{\text{in}} = 1.6 \text{ MHz}, f_{\text{in}} = 1 \text{ kHz}, m = 30\%, f_{\text{IF}} = 455 \text{ kHz}, \) AF measuring range: 300 Hz to 20 kHz, \( (S_2 = \text{AM}, S_1 = B, \text{test point: } V_{\text{ip}}) \)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Test Conditions</th>
<th>Pin</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM front-end voltage gain</td>
<td>( GV_{\text{AM}} = 20 \log \left( \frac{V_{\text{IF}}}{V_{\text{ip}}} \right) )</td>
<td>( V_{\text{IF}} ) = 20 dBµV, ( S_1 = A )</td>
<td>GV_{\text{AM}}</td>
<td>25</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Recovered audio voltage</td>
<td>( V_{\text{DAF}} )</td>
<td>( V_{\text{DAF}} )</td>
<td>70</td>
<td></td>
<td></td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Detector output resistance</td>
<td>( 23 )</td>
<td>( R_{\text{Do}} )</td>
<td>7.5</td>
<td></td>
<td></td>
<td>kΩ</td>
<td></td>
</tr>
<tr>
<td>Detector output distortion</td>
<td>( V_{\text{ip}} = 60 \text{ dBµV} )</td>
<td>THD</td>
<td>THD</td>
<td>1</td>
<td></td>
<td>3</td>
<td>%</td>
</tr>
<tr>
<td>RF sensitivity</td>
<td>( (S+N)/N = 10 \text{ dB} )</td>
<td>( V_{\text{ip}} )</td>
<td>0</td>
<td></td>
<td>16</td>
<td>dBµV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( (S+N)/N = 26 \text{ dB} )</td>
<td>( V_{\text{ip}} )</td>
<td>35</td>
<td></td>
<td></td>
<td>dBµV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( (S+N)/N = 46 \text{ dB} )</td>
<td>( V_{\text{ip}} )</td>
<td>70</td>
<td></td>
<td></td>
<td>dBµV</td>
<td></td>
</tr>
<tr>
<td>AGC figure of merit referred to ( V_{\text{DAF}} )</td>
<td>( V_{\text{ip}} = 105 \text{ dBµV, voltage drop (} V_{\text{DAF}} ) = -10 dB)</td>
<td>( FOM )</td>
<td>100</td>
<td></td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>IF input resistance</td>
<td>( 16 )</td>
<td>( Z_{\text{i}} )</td>
<td>3.1</td>
<td></td>
<td></td>
<td>kΩ</td>
<td></td>
</tr>
<tr>
<td>LED current</td>
<td>( i_{\text{LED}} )</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Oscillator voltage</td>
<td>( 5 )</td>
<td>( V_{\text{OSC}} )</td>
<td>160</td>
<td></td>
<td></td>
<td>mV</td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. U2510B-M_T: maximum 6 V
Figure 3. Quiescent Current

Figure 4. AF Section

Figure 5. AF Section: Distortion
Figure 6. AF Section: Maximum Output Power

![AF Section: Maximum Output Power](image1)

Figure 7. AF Section: Supply-voltage Rejection Ratio

![AF Section: Supply-voltage Rejection Ratio](image2)

Figure 8. FM Section: Mute Voltage

![FM Section: Mute Voltage](image3)
Figure 9. AM Section: Demodulator Output Level

Figure 10. Volume Control Range Characteristics

Figure 11. AM/FM Level Indicator Current
Figure 12. AM Section: AGC Voltage (at Pin 22)

Figure 13. FM Section: Demodulator Output Level

Figure 14. FM Section: Audio Output Level
Figure 15. AM Section: Audio Output Level

\[ P_0 = 50 \text{ mW at} \]
\[ V_{i1} = 60 \text{ dBµV} \]
\[ R_L = 8 \Omega \]
\[ f_1 = 98 \text{ MHz} \]
\[ f_{AF} = 1 \text{ kHz} \]
\[ m = 80\% \]
\[ T_{amb} = 25°C \]

Figure 16. Test Circuit
Application

General

The U2510B is a bipolar monolithic IC for use in radio sets such as headphone receivers, radio recorders and clock radios. The IC contains all AM, FM, AF and switching function blocks necessary to design these kinds of radio receivers using only few components around the IC. In the design, special efforts were made to get good performance for all AM bands (short and long wave).

The implementation of enhanced functions (options) makes it possible to improve the radio’s performance and to produce radios with interesting features. In this case few (external) parts have to be changed or added. By using all or some of the options offered by the U2510B different types or classes of radios can be designed to the customer's requirements with the same IC.

One of the main advantages of the U2510B is that all receiver functions (including the options) are integrated and tested on a system level. This allows cost savings due to:

1. Shorter development time
2. Higher reproducibility and low reject level in the set production line

Another advantage is the wide operating voltage range, especially the upper limit (13 V). This feature allows the use of a soft power supply for line powered radios which can also reduce the set's total cost.

Circuit Example

Figure 17 on page 15 shows a circuit diagram for low-end AM/AF radios using the U2510B. Figure 18 on page 16 shows a circuit diagram of an AM/AF radio for higher class designs using all possible options of the U2510B. The layout of the PC board, shown in Figure 19 on page 16, is suitable for both the circuit example shown in Figure 17 on page 15 and the circuit example shown in Figure 18 on page 16. The associated coil, varicon and filter specifications are listed in the table: “Coil Data and Components” on page 17. The circuit diagram in Figure 18 on page 16, has the following options compared to the circuit diagram in Figure 17 on page 15 (the additional parts, which have to be provided, are listed in parentheses):

a) Soft mute and high cut control in FM mode (1 capacitor)
b) Electronic treble control in AM, FM and TAPE mode (1 pot.)
c) On-chip mode control for TAPE application
d) RF AGC in FM mode (1 capacitor)
e) AFC, adjustable to the correct polarity and slope (1 capacitor)
f) Tuning indication using a LED as an indicator (1 LED, 1 capacitor)

Option a) reduces the interstation noise by the two functions: soft mute and HCC. Both are controlled by the mute voltage (pin 1). The soft mute reduces the loudness only, while the HCC reduces the high-end audio cut-off frequency of the audio preamplifier, when the signal level falls below a given threshold. This signal level threshold as well as the mute depth can be reduced by adding a resistor (R3) or by increasing the FM frontend gain.

Option b) allows the treble control for all operating modes without the need of an additional capacitor. This concept leads to a smooth and correct treble control behavior which is an improvement compared to the controlled RC network normally used.
Option c) is very useful for applications in radio cassette-recorders, for instance. In TAPE mode, the AM/FM receiver blocks are completely switched off and the signal from the tape recorder can be fed to the audio amplifier's input directly. This saves quiescent current and makes the TAPE switching easy. However, to minimize switching noise by the mode switch, the following switch sequence should be chosen: AM, FM, TAPE.

Option d) improves the strong signal behavior by protecting the FM mixer against over-load. This is provided by the integrated broad-band-width RF AGC. If necessary, the AGC threshold can be decreased by a resistor, loading pin 11 to GND (not shown).

Option e) improves the tuning behavior substantially. The special design of the on-chip AFC function means that common disadvantages such as asymmetrical slope, (chip-) temperature effects and unlimited holding range are avoided. As mentioned in the “Pin Description” on page 4, the AFC slope has to be inverted when the local oscillator (LO) frequency has to be below the receiving frequency. This can be achieved by connecting pin 21 to the potential of pin 8. In addition to the options described above, the following proposals are implemented in the circuit diagram (Figure 18 on page 16), too:

- An FM IFT is applied. This improves the channel selectivity and minimizes substantially the spurious responses caused by the FM ceramic filter (CF2). With the choice of the winding ratio of this IFT, the FM front-end gain can be matched to other values if necessary.
- In the FM RF input section, the low cost antenna filter (L5, C15) is replaced by a special band-pass filter (PFWE8). Such a BPF protects the FM front-end against the out-off-band interference signals (TV channels, etc.) which could disturb the FM reception.

Design Hints

The value of the power supply blocking capacitor C13 should not be below 470 µF. In addition, this capacitor should be placed near pin 26. This will help to avoid unacceptable noise generated by noise-radiation from the audio amplifier via the bar-antenna. In designs where the supply voltage goes below 2.5 V, the value of the blocking capacitor (C2) should be chosen as 47 µF or even higher. To achieve a high rejection of short wave reception in medium wave operation, the LO amplitude at pin 5 should not exceed approximately 200 mV. This LO amplitude depends on the LO transformer’s Q and its turns ratio. For the LO transformer type described in the Table “Coil Data and Components” on page 17, a resistor R4 (2.2 kΩ for example) in parallel to the secondary side of the AM LO transformer T2 is recommended. To minimize feedback effects in the RF/IF part in FM mode, the capacitor C6 should be placed as near to pins 8 and 20 as possible.

As shown in the application circuit diagrams (Figure 17 on page 15 and Figure 18 on page 16), in FM mode ceramic filter devices are used for channel selection (CF2) while for FM, demodulation in LC-discriminator circuit (T4, C24, C25) is used instead of a ceramic discriminator device.

Such an LC discriminator circuit can be easily matched to the FM IF selectivity block by its alignment. The zero-crossing of the discriminator can be detected at the demodulator output (pin 23). The zero-crossing voltage is equal to half of the regulated voltage at pin 8.

The alignment of the LC-discriminator circuit should be done with little or no effect on the AFC function. This can be realized by:

- switching pin 21 to an open-circuit
- connecting pin 1 to a voltage source of 2 V
- using a low signal level for alignment
In principle, ceramic discriminator devices can also be used. In this case, the effect of unavoidable spreads in the frequency characteristics of these case ceramic devices have to be considered. For example, mismatches of the characteristics between selectivity block and FM discriminator will lead to an increased signal-to-noise ratio at low signal levels as well as to a higher demodulation distortion level or to an asymmetrical AFC.

Application Circuits

Figure 17. Application Circuit for Low-cost Applications
Figure 18. Application Circuit (Upgraded), $R_2$ Only if $V_S > 8$ V

Figure 19. PC Board
# Coil Data and Components

<table>
<thead>
<tr>
<th>Part</th>
<th>Stage</th>
<th>L or C₀</th>
<th>Wire Diameter/mm Terminal Number</th>
<th>Type</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>AM IFT</td>
<td>180 pF 1 to 3</td>
<td>0.07 1 to 2 111</td>
<td>0.07 2 to 3</td>
<td>0.07 4 to 6 7</td>
</tr>
<tr>
<td>T₂</td>
<td>AM OSC</td>
<td>270 mH 1 to 3</td>
<td>0.06 1 to 3 107</td>
<td>0.06 4 to 6</td>
<td>0.09 4 to 6 2</td>
</tr>
<tr>
<td>T₃</td>
<td>FM IFT (optional)</td>
<td>100 pF 1 to 3</td>
<td>0.09 1 to 2 3</td>
<td>0.09 2 to 3</td>
<td>0.09 4 to 6 2</td>
</tr>
<tr>
<td>T₄</td>
<td>FM discriminator</td>
<td>100 pF 1 to 3</td>
<td>0.09 1 to 3 10</td>
<td>0.09 4 to 6</td>
<td>0.09 4 to 6 2</td>
</tr>
<tr>
<td>L₁</td>
<td>FM RF air coil 4 mm diameter</td>
<td></td>
<td>0.62</td>
<td>3.75</td>
<td></td>
</tr>
<tr>
<td>L₂</td>
<td>FM OSC air coil 4 mm diameter</td>
<td></td>
<td>0.62</td>
<td>3.75</td>
<td></td>
</tr>
<tr>
<td>L₄</td>
<td>FM antenna air coil 4 mm diameter</td>
<td></td>
<td>0.62</td>
<td>4.75</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part</th>
<th>Stage</th>
<th>Type</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>L₃</td>
<td>AM bar antenna</td>
<td>L: 630 µH total turns : 96 tap: 19</td>
<td>Soshin Electric Co.</td>
</tr>
<tr>
<td>BPF1</td>
<td>(optional)</td>
<td>PFWEB8 (88 to 108 MHz)</td>
<td>Murata® Toko</td>
</tr>
<tr>
<td>CF₁</td>
<td></td>
<td>SFU-455B BFCFL-455</td>
<td>Murata® Toko</td>
</tr>
<tr>
<td>CF₂</td>
<td></td>
<td>SFE10.7MA5 CFSK 107M1</td>
<td>Murata® Toko</td>
</tr>
<tr>
<td>CF₃</td>
<td>(optional)</td>
<td>CDA10.7MC1</td>
<td>Murata®</td>
</tr>
<tr>
<td>C₁</td>
<td>Variable capacitor</td>
<td>HD22124 AM/FM</td>
<td>Toko</td>
</tr>
</tbody>
</table>

Figure 20. Figure of Wirewound Components

Coil, bottom view

Air coil

AM bar antenna
Ordering Information

<table>
<thead>
<tr>
<th>Extended Type Number</th>
<th>Package</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>U2510B-M</td>
<td>SDIP28</td>
<td>–</td>
</tr>
</tbody>
</table>

Package Information

Package SDIP28

Dimensions in mm

27.5
27.1
27.5
27.1
27.3
27.1
0.9
4.8
4.2
3.3
1.778
0.53
0.43
1.1
0.9
23.114
0.35
0.25
12.2
11.0
10.26
10.06
8.7
8.5

technical drawings
according to DIN
specifications