



LA7780M

QPSK Downconverter for CATV Systems

Overview

The LA7780M is a downconverter for QPSK data demodulation for digital CATV transmission. This IC integrates a preamplifier, an AGC amplifier, a mixer, an oscillator, a post-amplifier, and other circuits in a single chip, and provides all the functions required from cable signal input through output to the A/D converter.

Features

- Since a preamplifier is built in, the LA7780M has adequate sensitivity to handle the input signal from the cable directly.
(Input signal level: -30 to +30 dBm)
- Both internal and external AGC are supported as the AGC amplifier drive technique.
- The output amplitude of the post amplifier used to drive the A/D converter is 2 V_{p-p} (typical).
- Applications can be designed to use either a crystal or an inductor oscillator.

Specifications

Maximum Ratings at T_a = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|---------------------|--------------------------|-----------------|------|
| Maximum supply voltage | V _{CC max} | Pins 5, 6, and 17 | 7.0 | V |
| Circuit voltage | V max | Pins 4, 12, and 24 | V _{CC} | V |
| Circuit current | I ₄ | The pin 4 output current | 30 | mA |
| | I ₁₃ | The pin 13 sink current | 2 | mA |
| | I ₁₆ | The pin 16 sink current | 2 | mA |
| Allowable power dissipation | P _{d max} | T _a ≤ 70°C | 540 | mW |
| Operating temperature | T _{opr} | | -20 to +70 | °C |
| Storage temperature | T _{stg} | | -55 to +150 | °C |

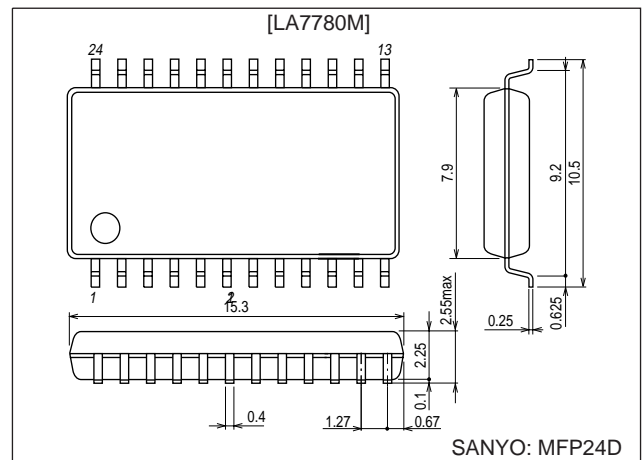
Functions

- Preamplifier
- AGC amplifier
- Mixer
- Oscillator
- Post amplifier
- IF AGC (internal/external)
- AGC detector

Package Dimensions

unit: mm

3108-MFP24D



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Operating Conditions at $T_a = 25^\circ\text{C}$

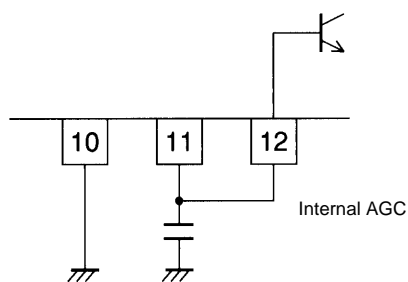
| Parameter | Symbol | Conditions | Ratings | Unit |
|--------------------------------|--------------------|-------------------|------------|------|
| Recommended supply voltage | V_{CC} | Pins 5, 6, and 17 | 5.0 | V |
| Operating supply voltage range | $V_{CC\text{ op}}$ | Pins 5, 6, and 17 | 4.5 to 5.5 | V |

AC Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC} = 5.0\text{ V}$, internal AGC mode, Pin 24 is left open.

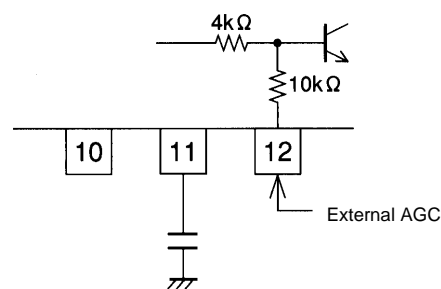
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|-----------------------------------|---------------------------|---|---------|-----|------|-------|
| | | | min | typ | max | |
| Circuit current | I_{total} | Pins 4, 5, 6, and 17: no signal | 64 | 80 | 95 | mA |
| RF input frequency range | $f_{(\text{in})}$ | Pins 1, 8, and 9 | 30 | | 150 | MHz |
| IF output level | $V_{O(\text{IF})}$ | Pin 13: *1 | 1.6 | 2.0 | 2.5 | Vp-p |
| IF output IM3 | $V_{O(\text{IM3})}$ | Pin 13: *2 | 40 | | | dB |
| IF output frequency bandwidth | BW | Pin 13: *3 | 15 | | | MHz |
| Local oscillator frequency range | $f_{(\text{LO})}$ | Pins 18, 19, 20, and 21 | 30 | | 200 | MHz |
| AGC amplifier input sensitivity | $V_{\text{in(RF2)}}$ | Pins 8 and 9: *4 | -25 | -21 | -17 | dBmV |
| AGC range | GR | Pin 13: IF output level $< \pm 1\text{ dB}$ | 60 | 80 | | dB |
| AGC flatness | $\Delta V_{O(\text{IF})}$ | Pin 13: Compare with the state when $V_{\text{in(RF2)}} = 30\text{ dBmV}$ | -1 | 0 | +1 | dB |
| Preamplifier gain | $G_{(\text{RF1})}$ | Pin 4: *5 | 17 | 19 | 21 | dB |
| Maximum preamplifier output level | $V_{O\text{max}}$ | Pin 4: *6 | 50 | | | dBmV |
| Oscillator output level | $V_{O(\text{OSC})}$ | Pin 23: The pin 23 frequency is 1/2 that of the local oscillator | 500 | 800 | 1000 | mVp-p |

Operating Modes

| Mode | Pin 10 | Pin 11 | Pin 12 |
|--|-------------------------------|--|--|
| Internal AGC | GND | With a capacitor between pin 11 and ground | Connected to pin 11 |
| External AGC (Narrow control range: 3 to 5 V) | GND (AGC divider inactive) | With a capacitor between pin 11 and ground | External AGC voltage supply Pin 12 = high impedance |
| External AGC (Wide control range: 0 to 5 V) | Open (AGC divider active) | With a capacitor between pin 11 and ground | External AGC voltage supply Pin 12 = low impedance (14 k Ω) |



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Note: In internal AGC mode, the IF output level can be adjusted by varying the pin 24 DC voltage.

Caution:

Note 1.

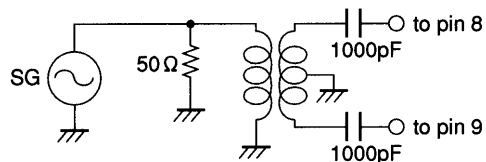
Input: SG = 69.55 MHz, 20 dBm V

Other conditions:

Internal AGC mode

Pin 24 left open.

Output: The post amplifier output (pin 13) at 5 MHz

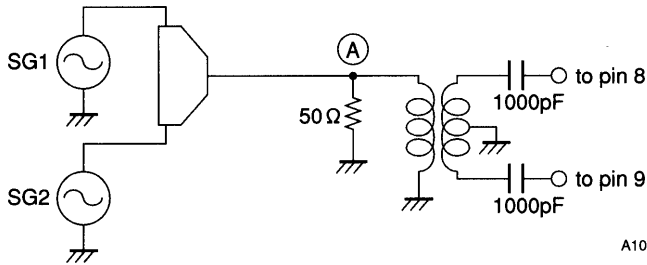


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Transfer ratio = 1 : 1

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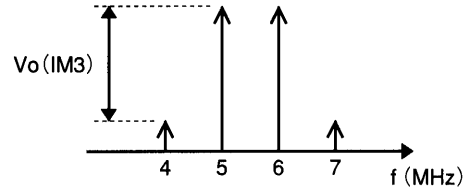
Note 2.
Input: SG1 = 69.55 MHz, SG2 = 70.55 MHz



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Point (A) = 20 dBmV (69.55 MHz) + 20 dBmV (70.55 MHz)

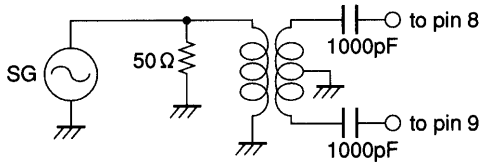
Other conditions:
Internal AGC mode
Pin 24 left open.
Output: The post amplifier output (pin 13)



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Note 3.
Post amplifier output level = -3 dB
Remove the low-pass filter between pins 14 and 16.
(Short the coil of 27 μ H and remove the capacitors of 27 pF and 15 pF.)

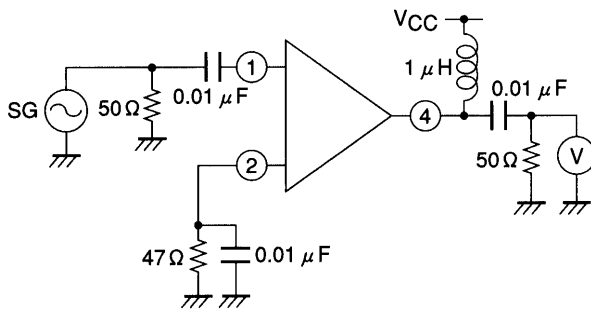
Note 4.
Input: SG1 = 69.55 MHz



A10611

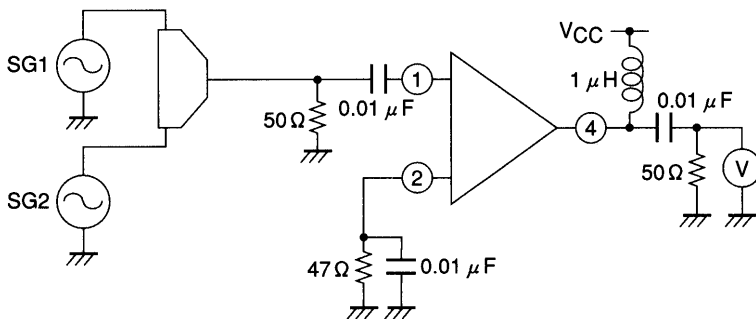
Other conditions:
Internal AGC mode
Pin 24 left open.
Output: The signal level such that the post amplifier output (pin 13) falls by -3 dB.

Note 5.
SG = 75 MHz, 20 dBm V



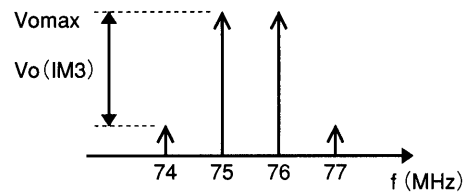
A10612

Note 6.
SG1 = 75 MHz, SG2 = 76 MHz,
Adjust the pin 1 level until the IM3 in the pin 4 output is 40 dB.



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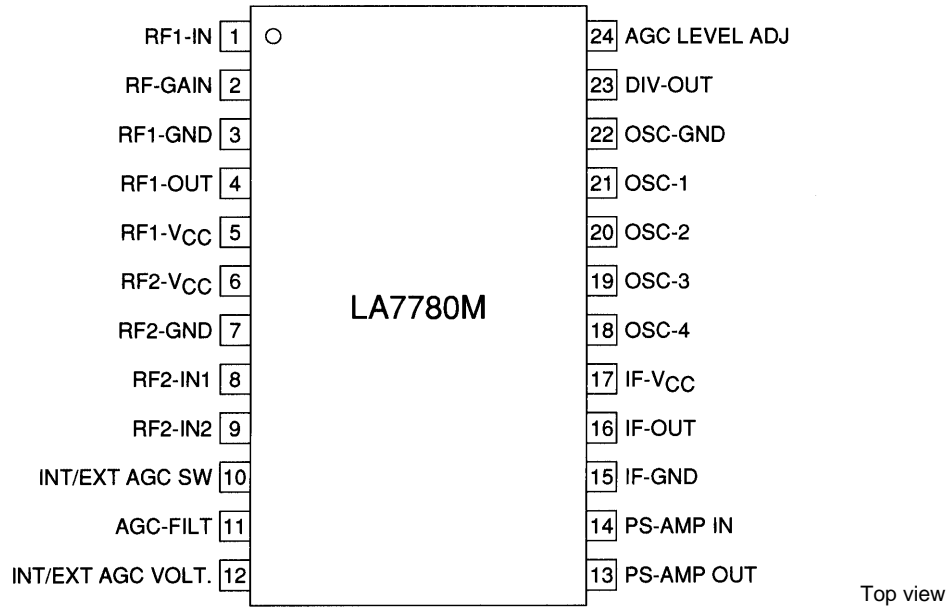
Output: RF1-OUT (pin 4)
 $V_{O(IM3)} = 40$ dB



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Pin Assignment

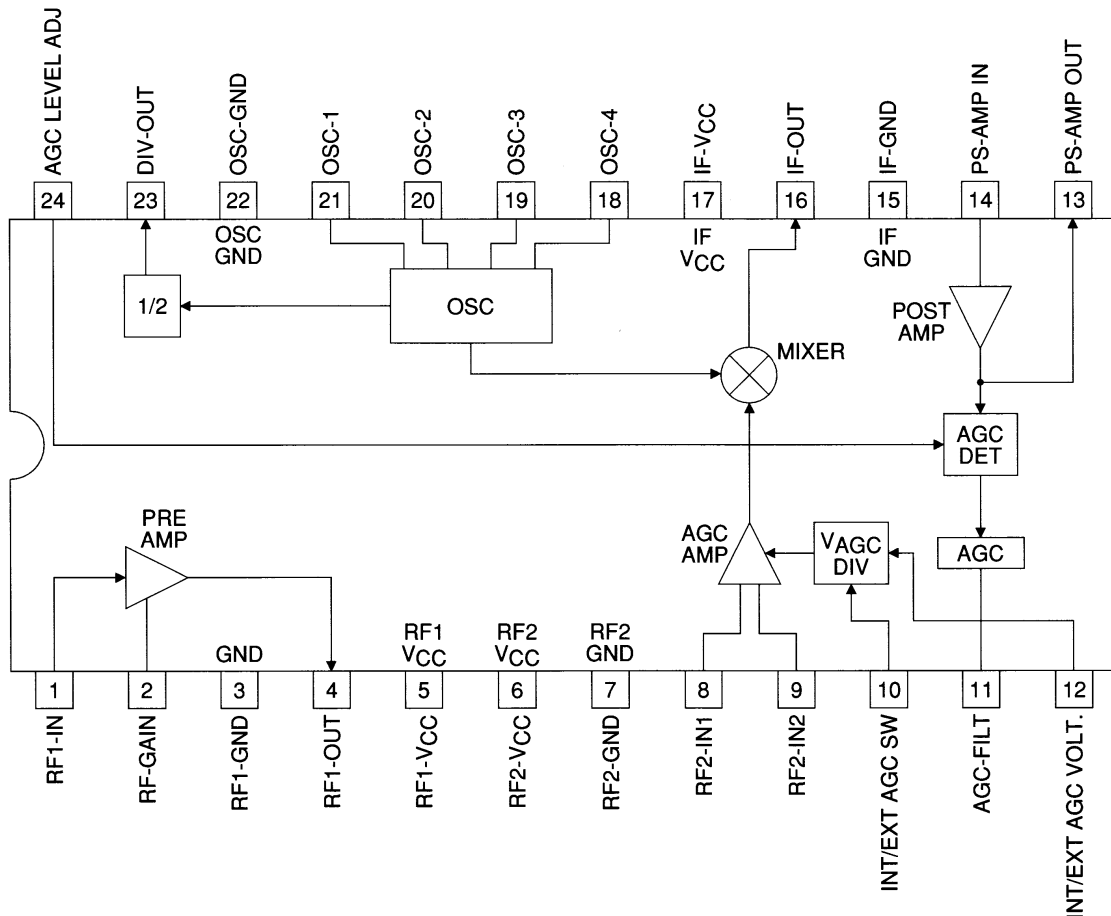


A10604

Usage Notes

- The oscillator may stop if the power supply rise time is extremely short. To prevent this problem, insert a 500 kΩ resistor between pin 18 and ground or between pin 21 and ground. (This applies when a crystal oscillator is used.)
- This IC should be used with the pin 13 output level between 1 V_{p-p} and 2 V_{p-p}.
- Use a low-pass filter with a 6-dB attenuation between pins 14 and 16.
- Since the high-frequency process is adopted, care must be taken to prevent the influence of static electricity.

Block Diagram



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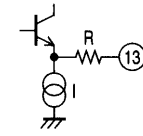
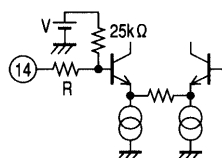
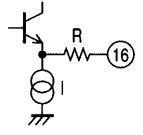
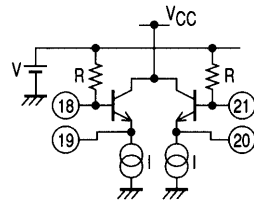
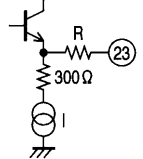
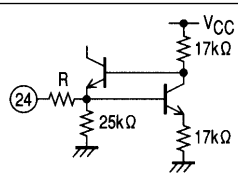
Pin Descriptions

| Pin No. | Function | Pin voltage (V) | Note | Equivalent circuit |
|---------|------------------------------|--|--|--|
| 1 | RF1 input | 2.8 | | <p style="text-align: right;">A10615</p> |
| 2 | RF gain | 1.3 | Impedance connected to pin 2 must be > 45 Ω | <p style="text-align: right;">A10616</p> |
| 3 | GND | 0 | | |
| 4 | RF1 output | Open collector | | <p style="text-align: right;">A10617</p> |
| 5 | V _{CC} | 5.0 | | |
| 6 | V _{CC} | 5.0 | | |
| 7 | GND | 0 | | |
| 8 | RF2 input (1) | 2.5 | V = 2.5 V | <p style="text-align: right;">A10618</p> |
| 9 | RF2 input (2) | 2.5 | R = 1 kΩ | |
| 10 | Internal/external AGC switch | 0 (GND) 1.0 (open) | Pin 10 → GND : Internal or external AGC (narrow control range) Pin 10 → open : External AGC (wide control range) | <p style="text-align: right;">A10619</p> |
| 11 | AGC filter 2 | Open collector Open base (Pin 10 → GND) 4.0 (Pin 10 open) | I ₁ = 20 μA I ₂ = 100 μA I ₃ , I ₄ & Q ₁ are switched on and off by pin 10. | <p style="text-align: right;">A10620</p> |
| 12 | AGC filter 1 | | | |

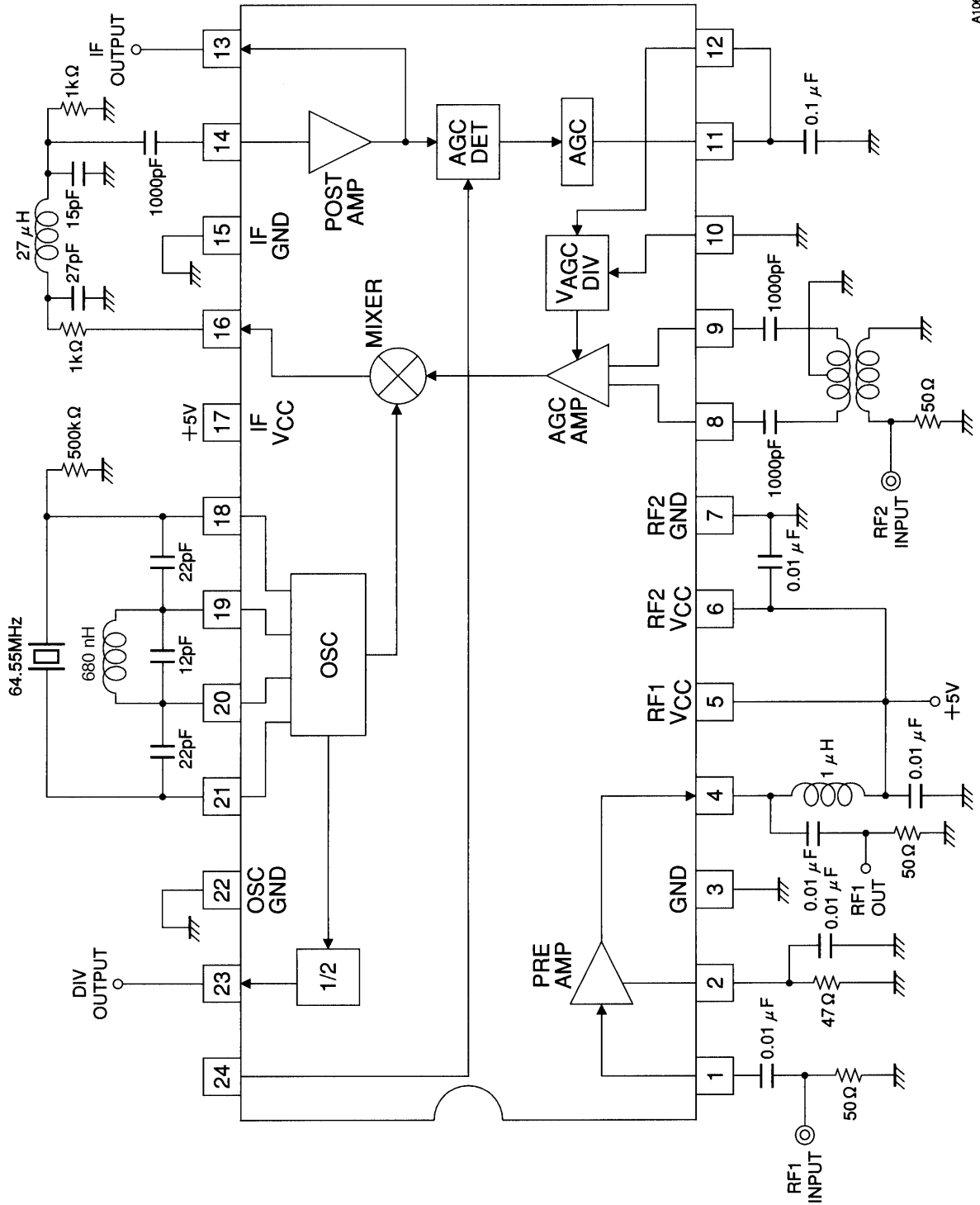
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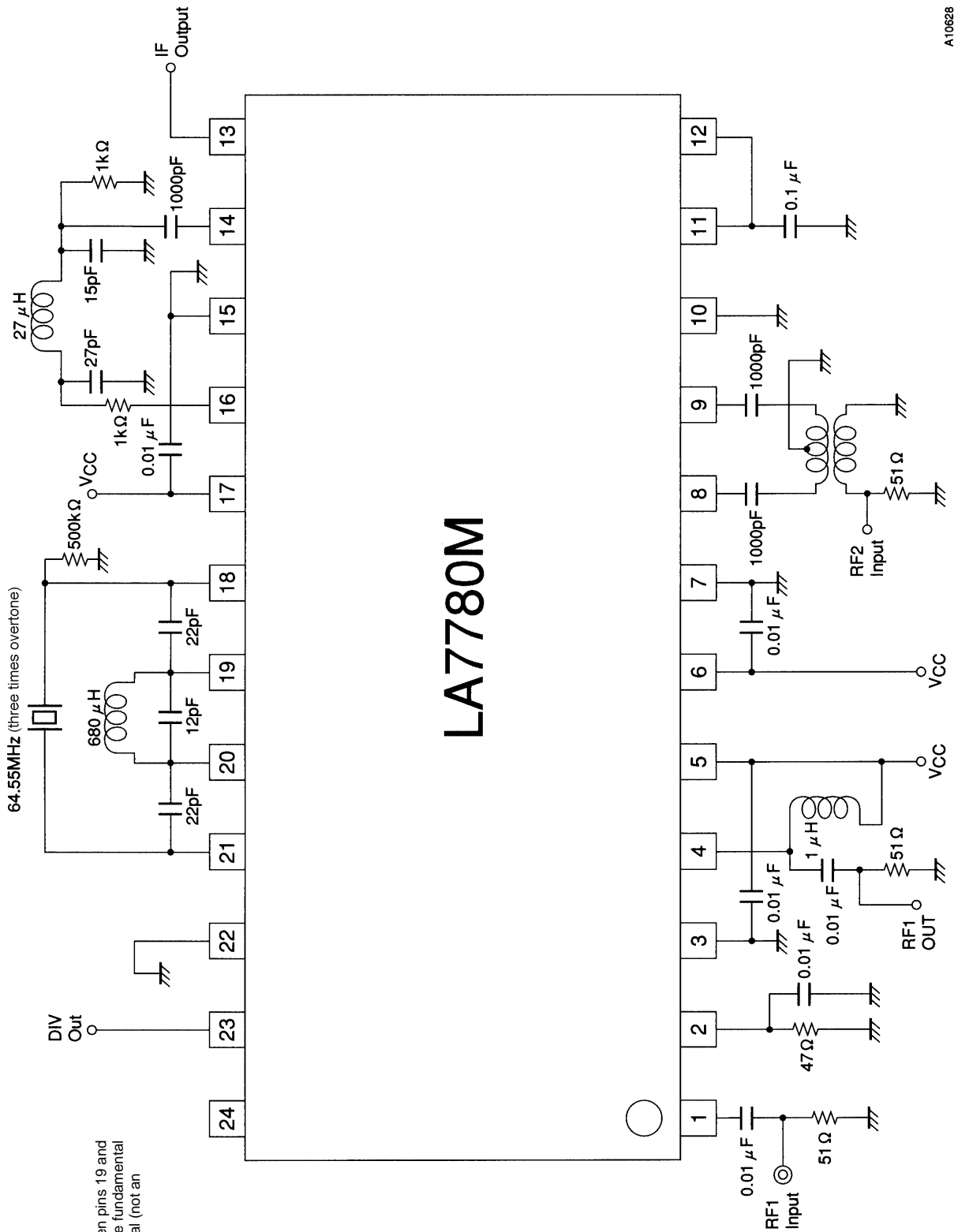
| Pin No. | Function | Pin voltage (V) | Note | Equivalent circuit |
|----------------------|--|-----------------|--|--|
| 13 | Post-amp output | 2, 3 | $R = 30 \Omega$ $I = 7 \text{ mA}$ |  <p style="text-align: right;">A10621</p> |
| 14 | Post-amp input | 2.0 | $V = 2.1 \text{ V}$ $R = 300 \Omega$ |  <p style="text-align: right;">A10622</p> |
| 15 | GND | 0 | | |
| 16 | IF output | 1.7 | $R = 100 \Omega$ $I = 3.5 \text{ mA}$ |  <p style="text-align: right;">A10623</p> |
| 17 | V_{CC} | 5.0 | | |
| 18 19 20 21 | Oscillator input 4 Oscillator input 3 Oscillator input 2 Oscillator input 1 | 3.0 3.0 | $V = 3.0 \text{ V}$ $R = 5 \text{ k}\Omega$ $I = 1 \text{ mA}$ |  <p style="text-align: right;">A10624</p> |
| 22 | GND | 0 | | |
| 23 | Divider output | 3.3 | $R = 100 \Omega$ $I = 1 \text{ mA}$ |  <p style="text-align: right;">A10625</p> |
| 24 | Output level adjustment | 2.5 | $R = 25 \text{ k}\Omega$ |  <p style="text-align: right;">A10626</p> |

Test Circuit



A10627

Sample Application Circuit



*: The choke coil between pins 19 and 20 is not required if the fundamental frequency of the crystal (not an overtone) is used.

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