Ordering number : EN5689A

Monolithic Linear IC

LA7790M

QPSK Transmitter for Cable TV

Overview

The LA7790M is a QPSK data transmitter for digital cable TV applications. By integrating the I/Q quadrature modulator, RF amplifier, electronic volume control, mute control, and other functions onto a single chip, parts count is reduced and set size is miniaturized.

Features

- Maximum RF amplifier output level of +10 dBm (75Ω terminator), suitable for directly driving the cable.
- RF output frequency range of 5 to 70 MHz. Frequency range selection function permits broadband designs.
- Electronic volume control for direct-current control of RF output level.
- Muting ensures ample attenuation during periods with no transmission.
- Support for both internal and external bias for I/Q modulation inputs.
- Support for I/Q modulation frequencies up to 10 MHz. (typ: 500 mVp-p)

Functions

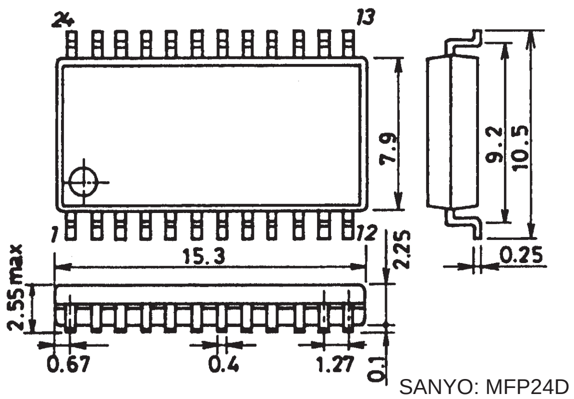
- I/Q quadrature modulator
- I/Q input bias power supply
- RF amplifier
- Varactor diode-based VCO
- Muting
- Electronic volume control
- Power-saving modes
- Switchable output frequency range
- Power supply voltage of 5 V (4.5 to 5.5 V)

Package Dimensions

unit: mm

3108-MFP24D

[LA7790M]



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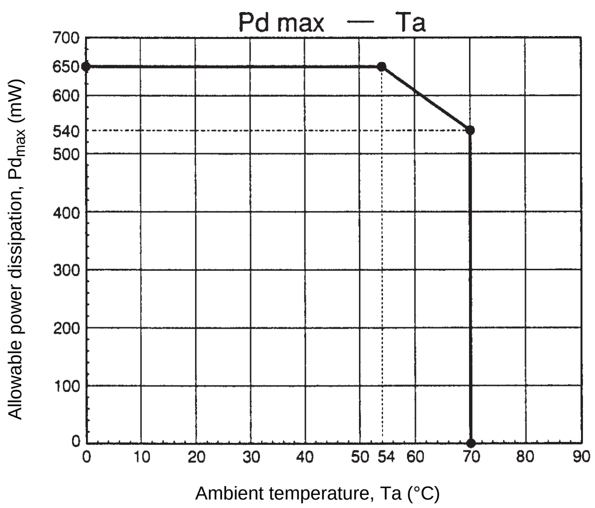

Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum power supply voltage	V_{CC} max	Pins 1, 10, and 24	7	V
Circuit voltage	Vmax	Pins 1, 12, 17, 20, 21, and 23	V_{CC}	V
Circuit current	I_{11}	Output lead-in current	1	mA
	I_{19}		2	mA
Allowable power dissipation	Pd max	Ta ≤ 54°C	650	mW
Operating ambient temperature	Topr		–20 to +70	°C
Storage temperature	Tstg		–55 to +150	°C

Recommended Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Operating power supply voltage	V_{CC} op	Pins 1, 10, and 24	4.5 to 5.5	V

Operating Characteristics at Ta = 25°C, V_{CC} = 5.0 V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Current drain						
Circuit current 1	I_1	With no signal, pin 1	26	33	44	mA
Circuit current 2	$I_{24} + I_{10}$	With no signal, pins 24 and 10	44	55	73	mA
Modulator fo: f(V19) = 25 MHz						
Output frequency range	$f_{(V19)}$		5		70	MHz
Output signal level	$V_{19(DSB)}$	Note 1: $V_{20} = V_{23}$ = GND, $V_{12} = V_{17} = V_{21} = V_{CC}$, S1 = A	–7	–4	–2	dBm
Output harmonic distortion	$V_{19(HD2)}$	Note 2: $V_{20} = V_{23}$ = GND,	40			dB
	$V_{19(HD3)}$	$V_{12} = V_{17} = V_{21} = V_{CC}$, S1 = A	35			dB
Output secondary harmonic distortion	$V_{19(2fo)}$	Note 3: $V_{20} = V_{23}$ = GND, $V_{12} = V_{17} = V_{21} = V_{CC}$, S1 = A	20			dB
Output tertiary harmonic distortion	$V_{19(3fo)}$	Note 3: $V_{20} = V_{23}$ = GND, $V_{12} = V_{17} = V_{21} = V_{CC}$, S1 = A	8			dB
Carrier suppression ratio	$V_{19(fo)}$	Note 4: $V_{20} = V_{23}$ = GND, $V_{12} = V_{17} = V_{21} = V_{CC}$, S1 = A	30			dB
Sideband suppression ratio	$V_{19(SSB)}$	Note 5: $V_{20} = V_{23}$ = GND, $V_{12} = V_{17} = V_{21} = V_{CC}$, S1 = A	30			dB
I input level	$V_{4.5}$	$V_{4.5} = \|V_4 — V_5\|$		500		mVp-p
Q input level	$V_{8.9}$	$V_{8.9} = \|V_8 — V_9\|$		500		mVp-p
I input DC voltage	$V_{4,5}$	External DC bias voltage	1.9	2.1	2.3	V
Q input DC voltage	$V_{8,9}$	External DC bias voltage	1.9	2.1	2.3	V
Reference voltage	V_6	Internal DC bias voltage	1.9	2.1	2.3	V
Variable attenuator						
Minimum gain control voltage	V_{21}	$V_{12} = V_{17} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A	0		0.5	V
Gain range	$V_{19(GR)}$	Note 6: $V_{20} = V_{23}$ = GND, $V_{12} = V_{17} = V_{CC}$, S1 = A, $V_{21} = V_{CC} \rightarrow 0.5$ V	45			dB
Modulator output impedance	R_{19}	$V_{12} = V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A	80	120	160	Ω
VCO						
Oscillator frequency range	$f_{(osc)}$	$V_{12} = V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A	20		280	MHz
VCO output level	$V_{11(fo)}$	$V_{12} = V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A	500	700	900	mVp-p
VCO output impedance	R_{11}	$V_{12} = V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A	200	300	400	Ω
Band switch						
Band switch 1 “H” level f(V19) = 25 MHz	V_{17H}	Note 7: $V_{12} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A	4			V
Band switch 1 “L” level f(V19) = 12.5 MHz	V_{17L}	Note 7: $V_{12} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A			1	V

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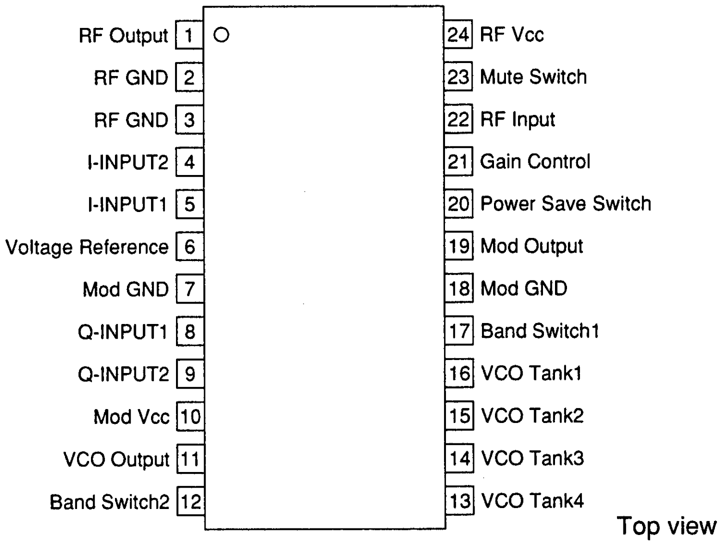
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Band switch 2 “H” level $f(V_{11})$ = 25 MHz	V_{12H}	Note 7: $V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A	4			V
Band switch 2 “L” level $f(V_{11})$ = 12.5 MHz	V_{12L}	Note 7: $V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, S1 = A			1	V
RF output amplifier						
Maximum output level	V_1 max	Note 8: $V_{12} = V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, SG3 = –6 dBm, S1 = A	7	10	13	dBm
Maximum output distortion	$V_{1(HD2)}$	Note 8: $V_{12} = V_{17} = V_{21} = V_{CC}$, $V_{20} = V_{23}$ = GND, SG3 = –6 dBm, S1 = A	40			dBc
	$V_{1(HD3)}$		40			dBc
Muting						
Muting on voltage	V_{23H}	$V_{12} = V_{17} = V_{21} = V_{CC}$, V_{20} = GND, S1 = B	4			V
Muting off voltage	V_{23L}	$V_{12} = V_{17} = V_{21} = V_{CC}$, V_{20} = GND, S1 = B			1	V
Muting attenuation	$V_{1(mute)}$	Note 9: V_{23} = 1 V → 4 V $V_{12} = V_{17} = V_{21} = V_{CC}$, V_{20} = GND, S1 = B	70			dB
Power save function						
Power save on voltage	V_{20H}		4			V
Power save off voltage	V_{20L}				1	V
Power save current	I_1	Note 10: V_{20} = 4 V	0		0.1	mA

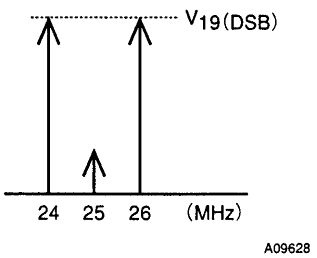
Pin Assignment



Note 1

Input: SG1 =1 MHz CW, 500 mVp-p, SG2 = No Signal or
SG2 = 1 MHz CW, 500 mVp-p, SG1 = No Signal

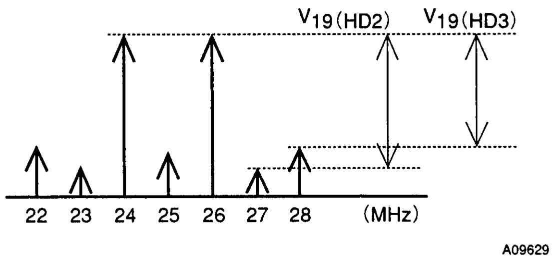
Output:



Note 2

Input: Same as Note 1

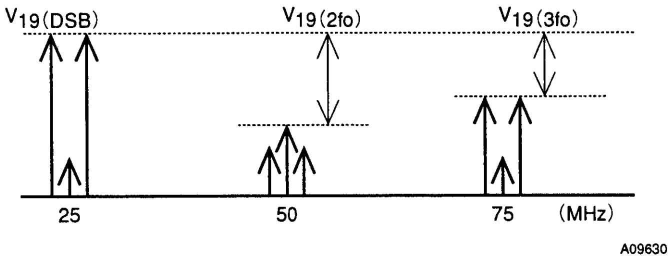
Output:



Note 3

Input: Same as Note 1

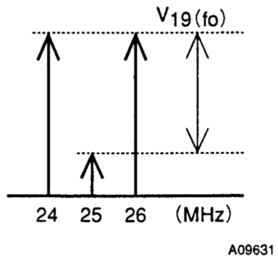
Output:



Note 4

Input: SG1 = SG2 = 1 MHz CW, 500 mVp-p

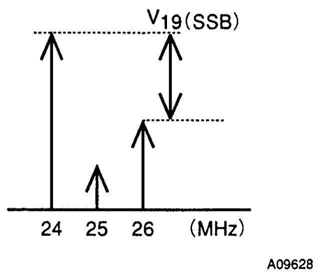
Output:



Note 5

Input: SG1 = 1 MHz CW, 500 mVp-p, 0deg
SG1 = 1 MHz CW, 500 mVp-p, 90deg

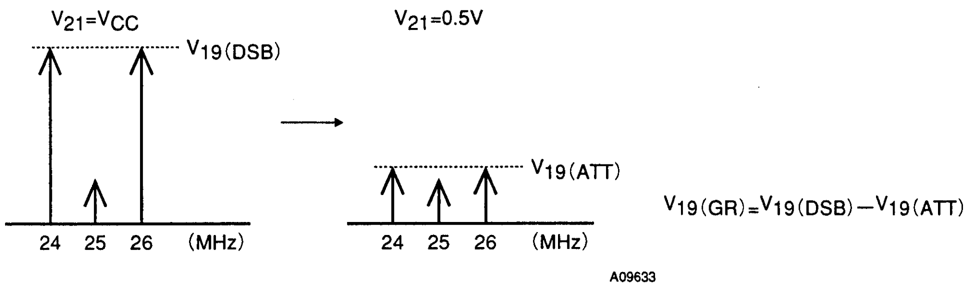
Output:



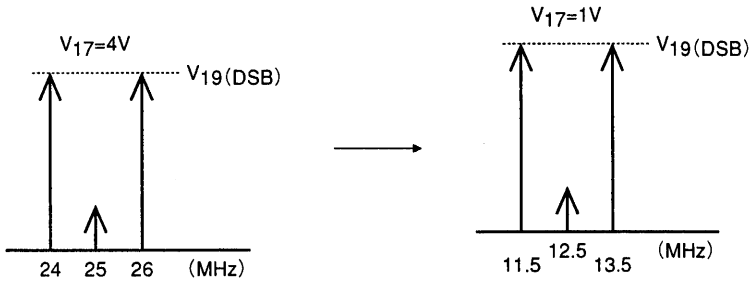
Note 6

Input: SG1 = 1 MHz CW, 500 mVp-p

Output:



Note 7
Input: SG1 = 1 MHz CW, 500 mVp-p
Output:



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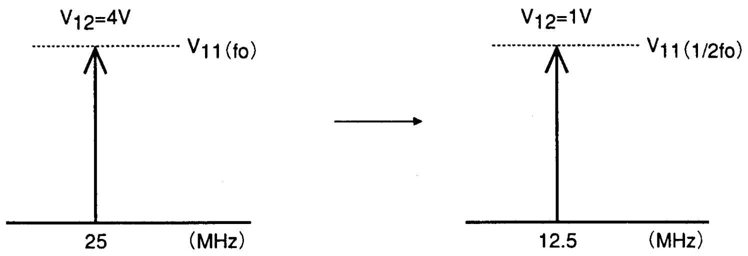

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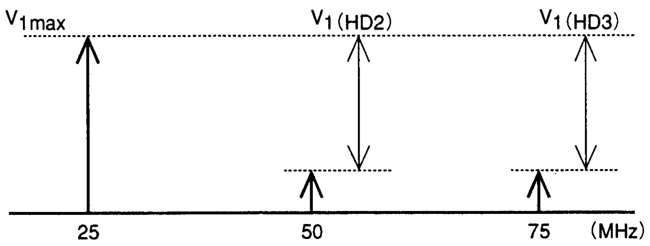
Note 8
Input: SG3 = 25 MHz CW, –6 dBm
Output:



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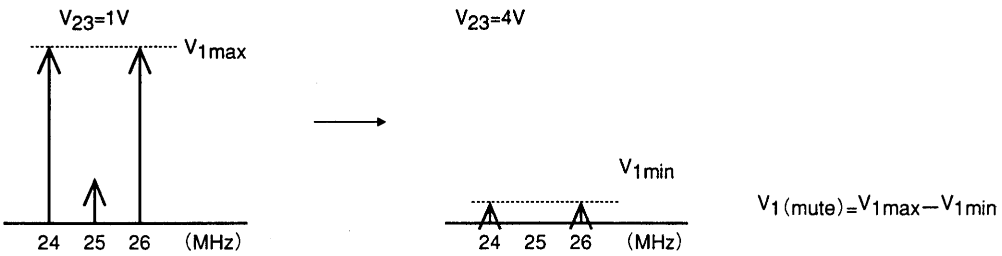
Note 9
Input: SG1 = 1 MHz CW, 500 mVp-p
Output:



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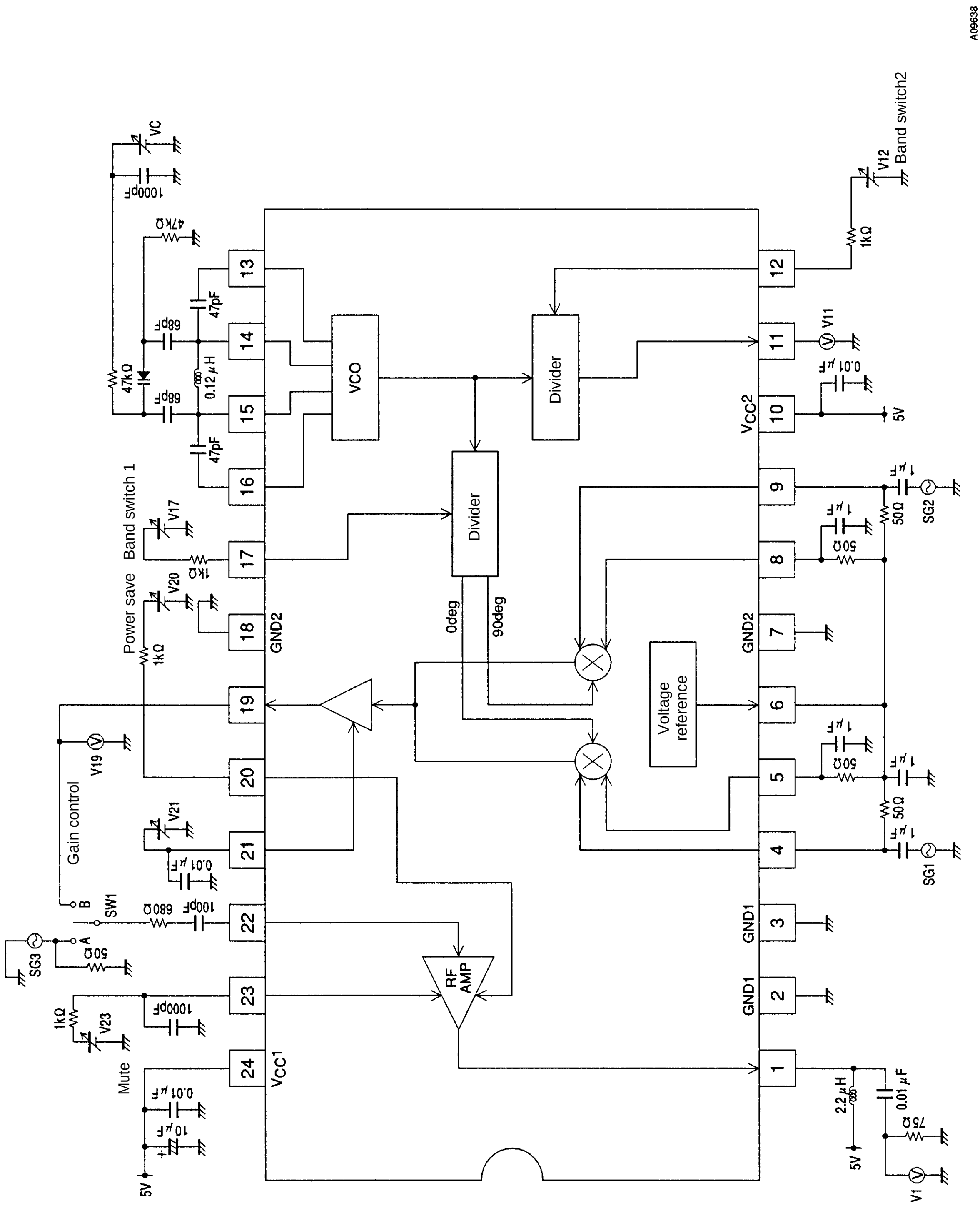
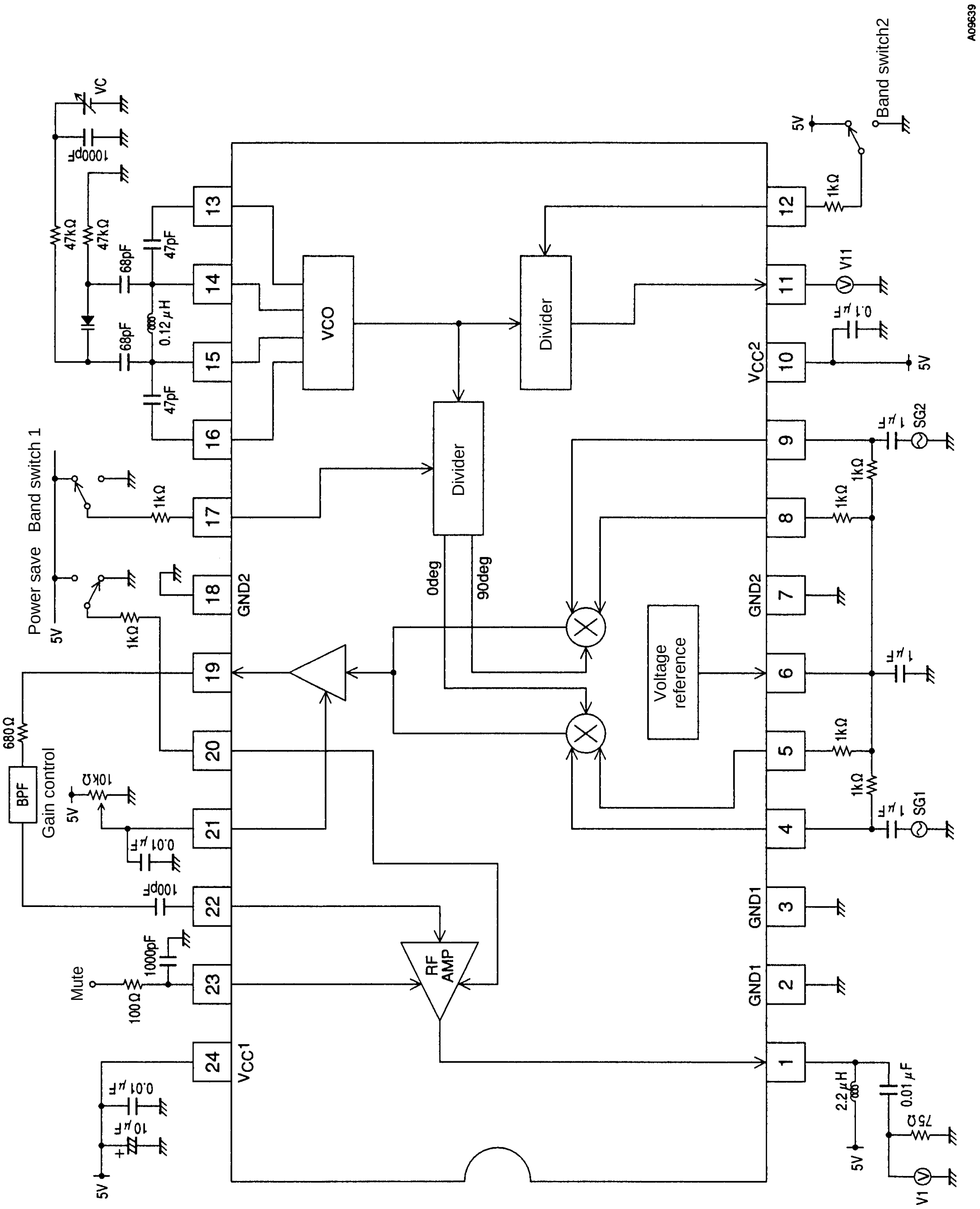
Note 10
I_1 = pin 1 current when V20 = 4 V (power save on).

Measurement Circuit

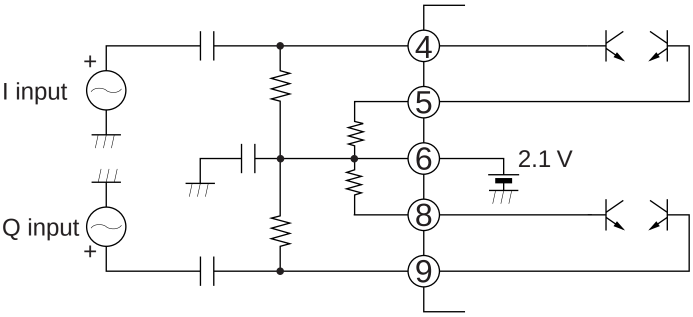


Sample Application Circuit

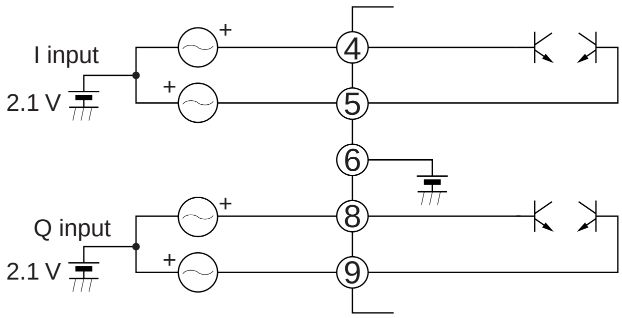


1. Modulator
   The modulator consists of two identical multiplier circuits, creating I and Q channels. Pins 4 & 5 and pins 8 & 9 are I and Q channel inputs, respectively. These pins must be biased at 2.1 ± 0.2 V. Pin 6 is an internal 2.1 V bias. This internal bias can be used if the I & Q data inputs are AC coupled, but an external bias must be used in the case of DC coupled data inputs. Carrier suppression is improved if the offset voltages between pins 4 & 5 and pins 8 & 9 are small.

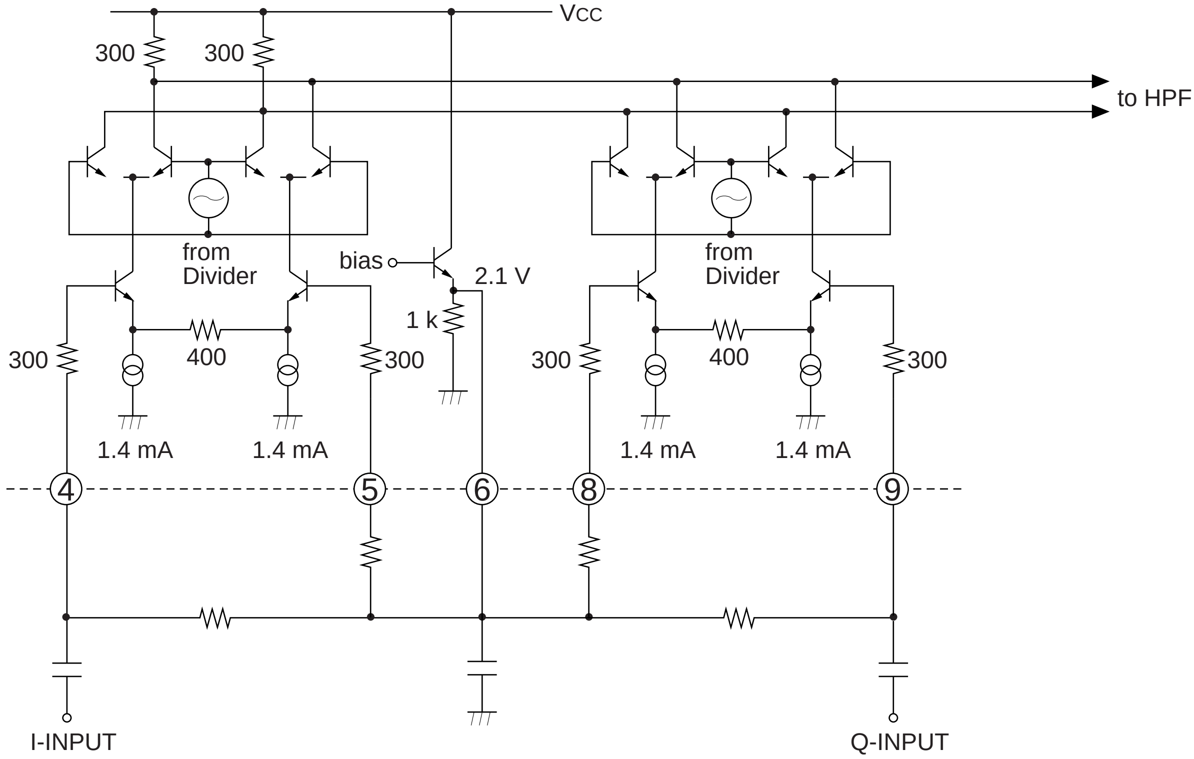
(1) AC coupled application



(2) DC coupled application



Equivalent circuit of modulator block



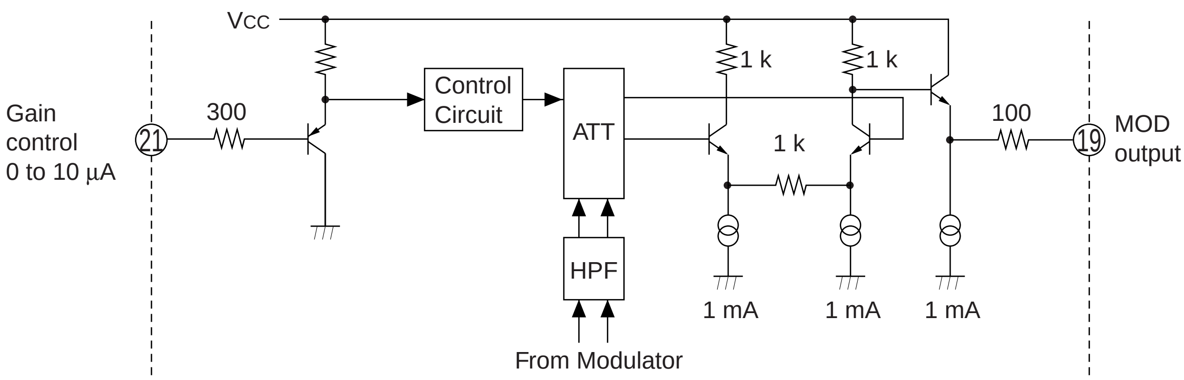
Unit (resistance : Ω)

2. Attenuator

The attenuator input signal comes from the modulator output via a high pass filter (f_C = 2 MHz). The modulator output is pin 19. Pin 19 is connected to the emitter of an NPN emitter follower through a 100 Ω resistor. The emitter sink current is about 1 mA, but can be increased by the addition of an external resistor between pin 19 and ground. The minimum value for the external resistor is 1.5 kΩ.

The output level of pin 19 can be adjusted using pin 21. Pin 21 is connected to the base of a PNP emitter follower through a 300 Ω resistor. When pin 21 = 0 V, the base current is about 10 µA.

Equivalent circuit of attenuator block



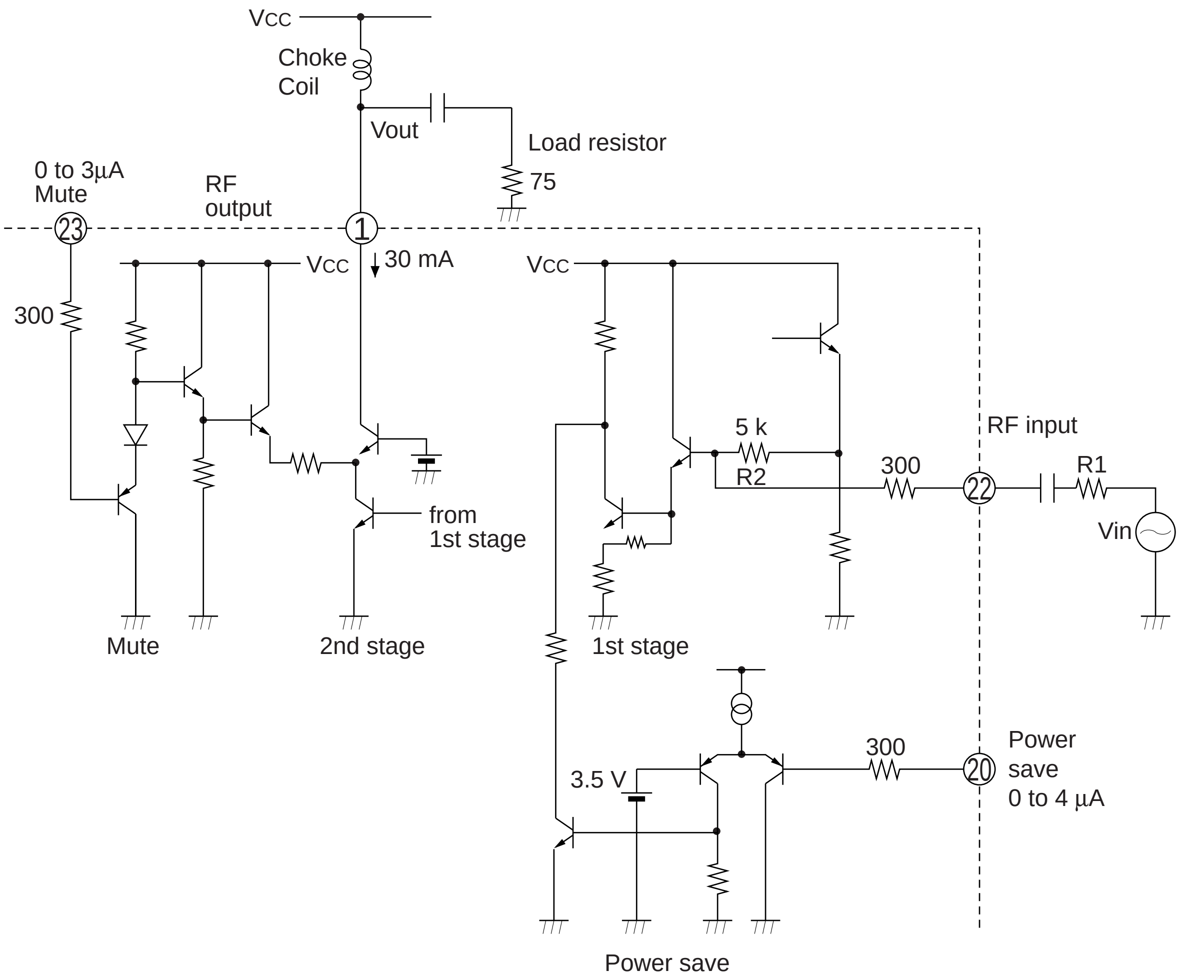
Unit (resistance : Ω)

3. RF Amplifier

The RF amplifier input signal comes from the attenuator output after the harmonics are removed by the LPF. The RF amplifier is composed of a two-stage amplifier and includes mute and power save functions.

The gain of the RF amplifier can be adjusted using the external input resistor connected to pin 22 and the external load resistor connected to pin 1. The input of pin 22 must be AC coupled. The output of pin 1 must be connected to V_{CC} via a choke coil. Pin 23 (mute control) and pin 20 (power save control) are both high impedance inputs (base current less than 10 µA). For normal operation, the voltage at pins 20 and 23 must be less than 1 V. For Mute and Power Save operation, the voltage at pins 20 are 23 must be between V_{CC}–1 and V_{CC}.

Equivalent circuit of RF amplifier block



$$\text{RF Amplifier Gain} \doteqdot \frac{R1 + R2 + 300}{R1 + 300}$$ R1 : Input Resistor

The gain of RF amplifier can be adjusted by changing the value R1.

Unit (resistance : Ω)

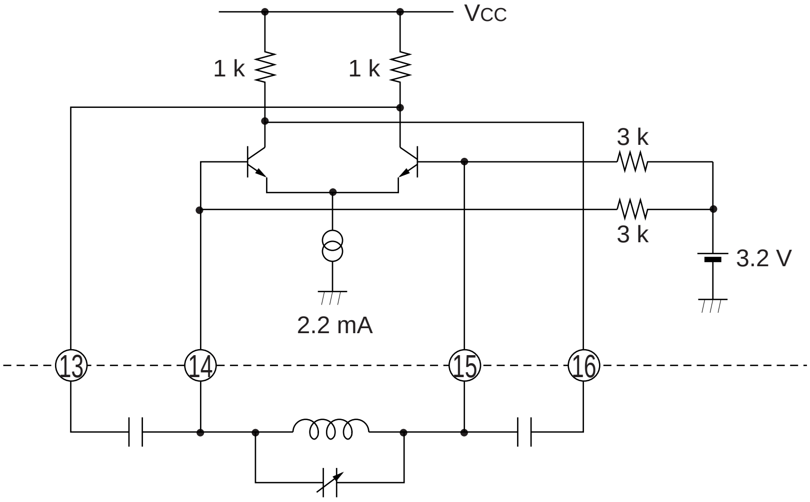
4. Oscillator
The oscillator signal is divided by either 4 or 8, and supplied to the modulator as 0° and 90° switching signals. The division mode can be selected using Band Switch 1 (pin 17).

Pin 17 = High → Modulation frequency = 1/4 oscillator frequency

Pin 17 = Low → Modulation frequency = 1/8 oscillator frequency

The oscillator requires an external coil and capacitors. Pins 14 & 15 should be DC coupled using a coil. A coil with Qu of 30 or greater is required and the impedance between pins 14 and 15 is 6 kΩ. The value of the coupling capacitors between pins 13 & 14 and pins 15 & 16 must be large enough so that the signal phase rotation is small.

Equivalent circuit of oscillator block



Unit (resistance : Ω)

5. Oscillator Output
   The output frequency of the oscillator is equal to or half of the output frequency of the modulator. The mode is set using Band Switch 2 (pin 12).

   Pin 12 = High → Oscillator output frequency = modulator frequency

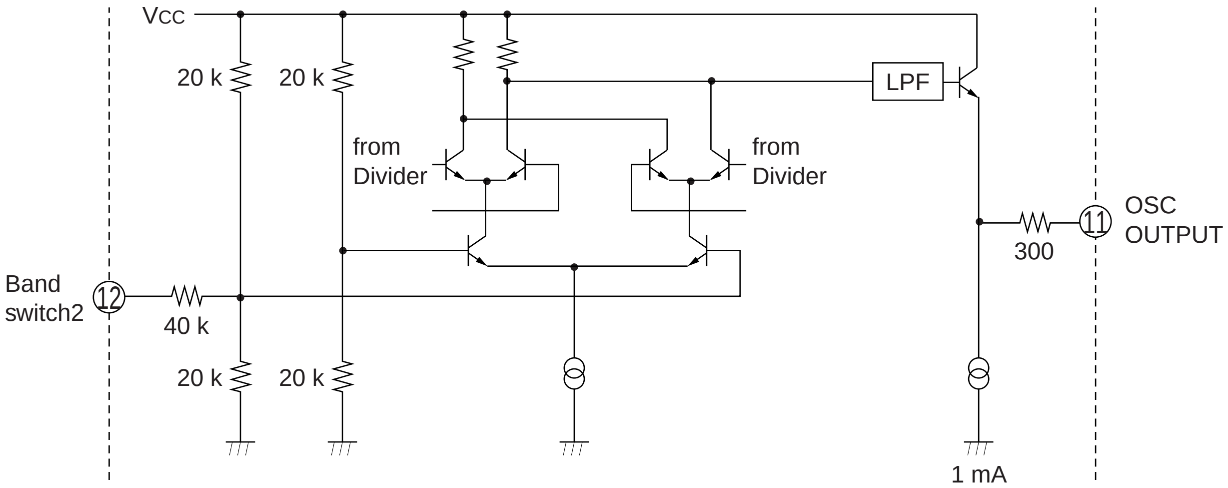
   Pin 12 = Low → Oscillator output frequency = 1/2 modulator frequency

6. Band Swtich
   The input circuitry of Band Switch 1 (pin 17) and Band Switch 2 (pin 12) are the same. A low setting requires a voltage of less than 1 V at the pin. A high setting requires a voltage between V_{CC}–1 and V_{CC} at the pin. Settings of low or high generate currents of ±50 µA at pins 12 and 17.

   Pin 12, 17 = High → Sink current = 50 µA

   Pin 12, 17 = Low → Source current = 50 µA

Equivalent circuit of osc output and band switch blocks



The input circuitry of band switch 1 is same.

Unit (resistance : Ω)

7. Digital ECL Circuit

To get the correct 0°/90° phase switching signal for the modulator, a divide-by-four dual flip-flop is employed as shown in the following figure.

Band Switch 1 can be usded to expand the range of the modulation frequency. Band Switch 2 can be used to select the frequency to output to an external PLL.