M54821P

FREQUENCY COUNTER WITH 5-DIGIT LED DRIVER

T-45-23-29

DESCRIPTION

The M54821P is an I^2L semiconductor integrated circuit consisting of a 5-digit LED driven for 7-segment LED display elements.

FEATURES

- Direct drive of a 5-digit common-cathode type 7-segment LED display
- Presettable IF frequencies, 5 for AM and 2 for FM
- Adjustable LED brightness
- Built-in zero suppression circuit
- Low power dissipation (I_{CC} = 28mA for V_{CC} = 5V)

APPLICATION

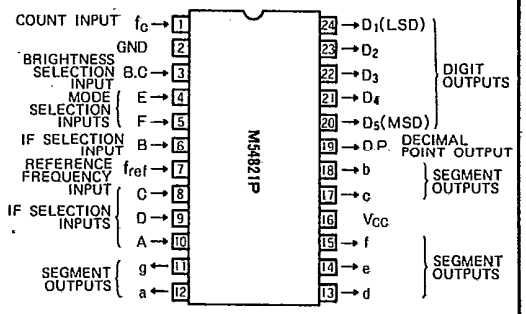
Display of received frequency in radio receivers, instrumentation frequency counters.

FUNCTION

The M54821P is designed to serve as the received frequency display for radio receivers, counting the local oscillator frequency to enable display of frequency with 1kHz resolution (AM mode) or 0.1MHz (FM mode).

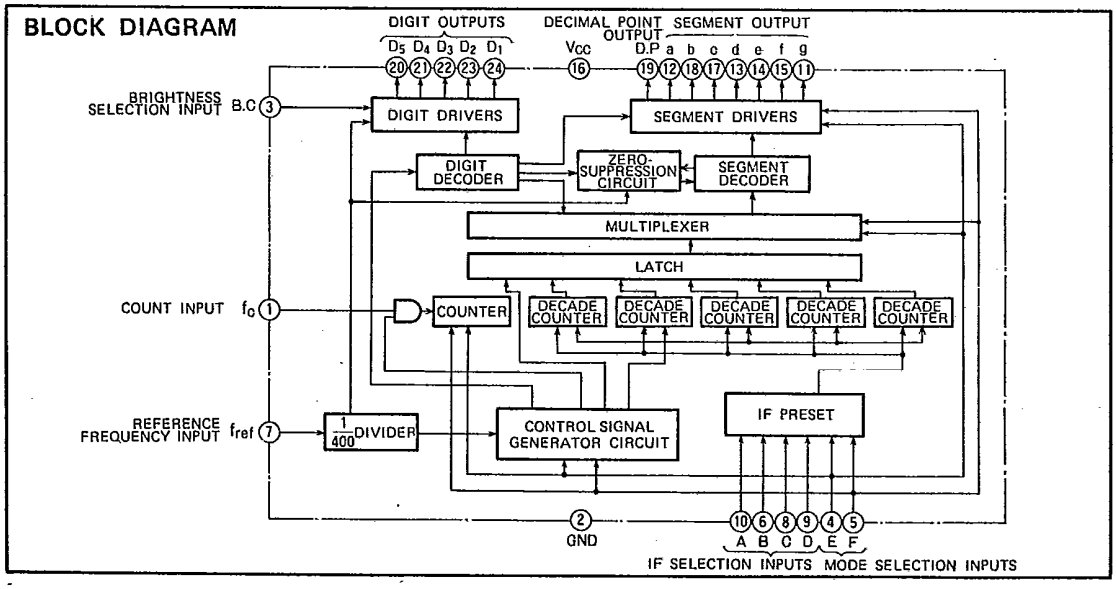
It is also usable as a conventional frequency counter circuit.

PIN CONFIGURATION (TOP VIEW)



Package Outline 24P4

BLOCK DIAGRAM



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DESCRIPTION OF OPERATION

The functions of the M54821P are described below.

- **Maximum Operating Frequency**

With the count input (f_c) as the measured frequency, for the AM mode a maximum of 1.6MHz and for the FM mode a maximum of 2.5MHz can be input. By prescaling the input either 1/32 or 1/80, using an external circuit, counting can be done up to 50MHz with 1kHz resolution or 200MHz with 0.1MHz resolution respectively.

However, as the input frequency approaches the maximum, the input signal must be a rectangular waveform of duty cycle of 50%.

- **Reference Frequency (f_{ref})**

A reference frequency of 1.25MHz, rectangular waveform with a duty cycle of 50±20% is required. This signal is divided to provide the control signals for the rest of the circuit.

Counting accuracy is determined by the accuracy of the reference frequency. This is normally provided by a quartz oscillator circuit to ensure stable, highly accurate operation.

For example, by use of a 1/32 external prescaler, when we count a 50MHz signal to limit the error to within 1kHz, it is necessary that the reference frequency be 1.25MHz ±25Hz.

The count and reference frequency inputs and both TTL compatible.

- **Gate Time**

The count input signal is counted only while the gate is open. The counted value is temporarily latched into memory and held until the next count cycle is completed.

The gate times for the AM and FM modes are indicated in Table 1.

Table 1. Gate times

Mode	Gate time	Inactive time	Repetition frequency
AM	128ms	32ms	6.25Hz
FM	12.8ms	3.2ms	62.5Hz

- **Intermediate Frequency (IF)**

As indicated in Table 2, the IF selection inputs (A, B, C, and D) are used to select one of six AM mode IF frequencies or one of two FM mode IF frequencies. If the IF value is chosen as zero, the counter operates as a conventional frequency counter.

- **Display Mode**

As shown in Table 3, the selection of the AM and FM modes is done using the mode selection inputs (E and F), the frequency resolution being 1kHz for the AM mode, with three types of display sub-modes selectable. For the FM mode the resolution is 0.1MHz.

Table 2. IF selection inputs and IF values

IF	IF selection inputs				Mode
	A	B	C	D	
262kHz	X (Note 1)	H	L	L	AM
450kHz	X	L	H	L	
455kHz	X	H	H	L	
460kHz	X	L	L	H	
470kHz	X	H	L	H	
0kHz (Note 2)	X	H	H	H	
10.7MHz	L	X	X	X	FM
−10.7MHz (Note 3)	H	X	X	X	

Note 1. X: Don't care
H: Open
L: Ground
2. For use as a conventional frequency counting circuit
3. For local oscillator frequency below the received frequency

Table 3. Display modes

Mode	Mode selection inputs		Display
	E	F	
AM	H	H	Y Y Y Y 0 kHz (Note 4)
	H	L	Y Y Y Y Y kHz
	L	H	Y Y. Y Y Y MHz
FM	L	L	Y Y Y Y. Y MHz

Note 4. For 262kHz and 455kHz IF frequencies, the last digit (kHz) is rounded so that the resolution is actually 10kHz. For other IF frequencies, the last digit is discarded so that it reads zero.

For the AM mode (E high, F low) if the local oscillator frequency is 1820kHz and the IF frequency is 455kHz, the received frequency is expressed by the relationship.

Received frequency = local oscillator frequency − IF.

For the example cited, the received frequency would be displayed as 1365kHz.

- **LED Drive**

The LED drive is a dynamic-type drive with a repetition frequency of 625Hz.

A built-in zero suppression circuit blanks unwanted upper digits. In addition, the decimal counter makes use of rounding so that the least significant digit does not vary widly.

The M54821P is intended for use with common-cathode type display elements.

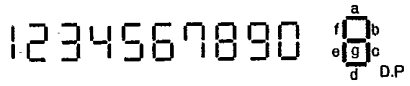


Fig. 1 Display element configuration

- **Segment, Digit Outputs and Decimal Point Output**

The segment and digit outputs are current source-type outputs capable of sinking 20mA and 5mA currents, peak, respectively.

The decimal point is placed at the second digit for the AM mode and the fourth digit for the FM mode, the LED drive current being a peak value of 8mA.

Both output circuits have built-in current limiting resistors making the use of external resistors unnecessary.

- **Brightness Control**

LED brightness control is achieved by using the brightness selection input (BC), controlling the brightness in two steps (bright for low-level and dark for high-level input).

FREQUENCY COUNTER CONFIGURATION

The following external circuits and components are required for configuring a counter using the M54821P.

1. 1.25MHz rectangular wave generator circuit (reference frequency signal)
2. Digit drive NPN transistor
3. 1/32 divider (for AM mode)
4. 1/80 divider (for FM mode)
5. Common-cathode type LED

These are the only components required; segment driver and current limiting resistors are not required.

The above external circuits can be implemented by using an M54408P to provide function 1 and 3 (crystal oscillator circuit and 1/32, 1/8 divider circuits), an M54450L divider with ECL input and TTL output capable of operating at 150MHz (1/10 division ratio), an M54451P divider (1/32, 1/80 division ratio) and an M54521P 5-element transistor array. These circuit components make such a circuit design extremely simple.

For a reference frequency of 1MHz, the above 1/32 and 1/80 dividers can be changed to 1/40 and 1/100 divider circuits respectively.

APPLICATION EXAMPLE

Fig. 2 shows a frequency counter circuit using the M54821P, while Fig. 3 shows the block diagram of a circuit using this device to display a radio receiver received frequency.

The input signals for the M54408P must be TTL level.

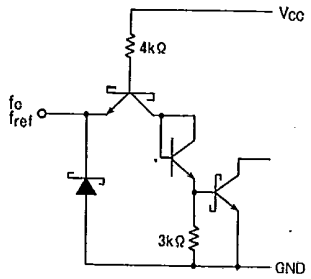
PRECAUTIONS FOR USE

1. Careful consideration should be given to noise since the M54821P dynamic drive can generate noise.
2. To program the IF selection input (A, B, C, and D), the mode selection inputs (E and F) and the brightness selection input (BC) to a high-level, these pins may be left open.

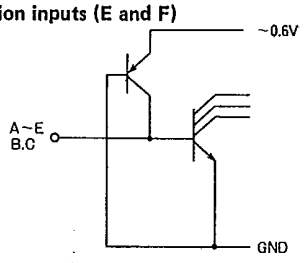
Care should be taken not to apply excessive voltage directly to the IC as this can cause damage to the device.

INPUT/OUTPUT CIRCUITS

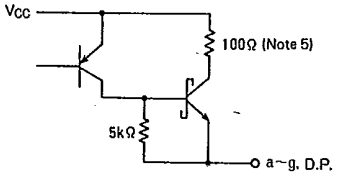
f_o and f_{ref} inputs



IF selection inputs (A, B, C and D), brightness selection input (B, C) and mode selection inputs (E and F)

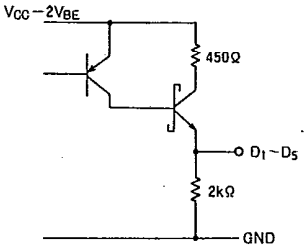


Segment and decimal point outputs



Note 5. 220Ω for the decimal point output circuit

Digit outputs



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ABSOLUTE MAXIMUM RATINGS (T_a = −10 ~ +65℃, unless otherwise noted)

Symbol	Parameter		Conditions	Limits	Unit
V_{CC}	Supply voltage			−0.5 ~ +6.5	V
V_I	Input voltage	f_C, f_{ref} inputs		−1.2 ~ +5.5	V
		A~F, B.C. inputs		−0.5 ~ +1	V
Pd	Power dissipation			600	mW
Topr	Operating temperature			−10 ~ +65	℃
Tstg	Storage temperature			−55 ~ +125	℃

RECOMMENDED OPERATING CONDITIONS (T_a = −10 ~ +65℃, unless otherwise noted)

Symbol	Parameter		Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.5	5	5.5	V
f_C	Count frequency	AM mode	0		1.6	MHz
		FM mode	0		2.5	MHz
f_{ref}	Reference oscillation frequency		1.0	1.25	1.5	MHz
Duty	Duty cycle input duty cycle (f_C, f_{ref} inputs)		45	50	55	%

ELECTRICAL CHARACTERISTICS (T_a = −10 ~ +65℃, unless otherwise noted)

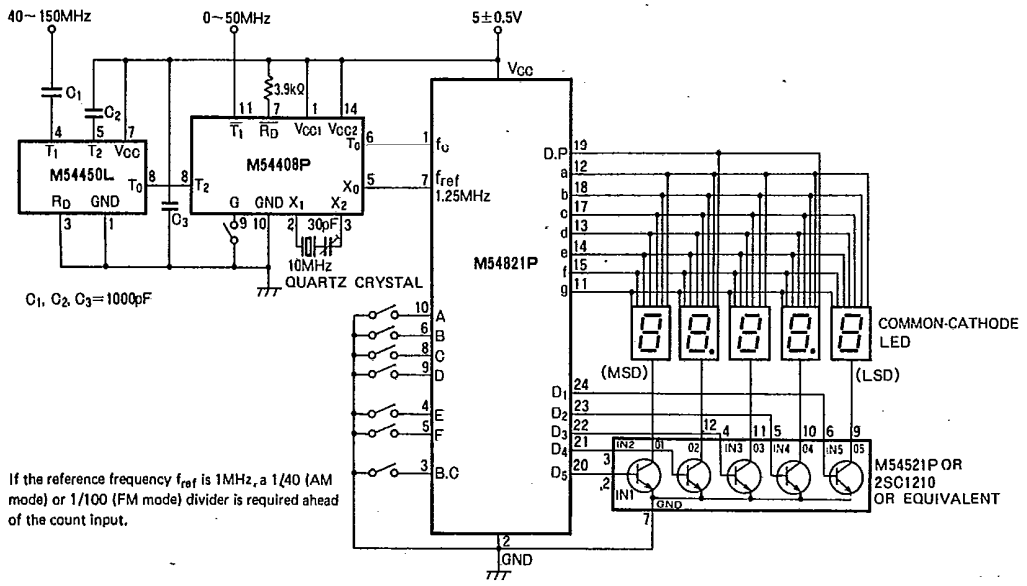
Symbol	Parameter		Test conditions	Limits			Unit
				Min	Typ *	Max	
V_{IH}	High-level input voltage	f_C, f_{ref} inputs		2			V
		A~F, B.C inputs (Note 6)					V
V_{IL}	Low-level input voltage	f_C, f_{ref} inputs				0.7	V
		A~F, B.C. inputs				0.2	V
V_{IC}	Input clamp voltage		V_{CC}=4.5V, I_{IC}=−10mA			−1.2	V
I_{IH}	High-level input current	f_C, f_{ref} inputs	V_{CC}=5.5V, V_I=2.4V			500	μA
I_{IL}	Low-level input current	f_C, f_{ref} inputs	V_{CC}=5.5V, V_I=0.4V			−1.6	mA
		A, B, C, D, B.C. inputs	V_{CC}=5.5V, V_I=0.1V			−100	μA
		E, F inputs				−300	μA
Iseg	Segment current	a~g outputs	V_{CC}=4.5V, V_O=2.5V	10	20		mA
		D.P. output		5	8		mA
Idig	Digit current		V_{CC}=4.5V, V_O=0.8V	3	5		mA
I_{CC}	Circuit current		V_{CC}=5.5V		28	45	mA

* : The typical values are at V_{CC}=5V, T_a=25℃

Note 6. Inputs A~F and BC are set at high-level by leaving them open.

APPLICATION EXAMPLES

(1) Frequency counter circuit



Note: If the reference frequency f_{ref} is 1MHz, a 1/40 (AM mode) or 1/100 (FM mode) divider is required ahead of the count input.

(2) Radio receiver application