Problems

6-1 Determine the ramp time required for the digital voltmeter in Figure 6-1 to register 1999 V if the clock generator frequency is 1 MHz. Also determine a suitable frequency for the ramp generator.

6-2 Recalculate the measured voltage for the DVM in Problem 6-1 if the clock frequency drifts by −5%.

6-3 The DVM in Figure 6-2 has a 200 kHz clock, and the integrator control waveform frequency is 45 Hz. Calculate the number of clock pulses that occur during t_1, and determine a suitable time duration for t_2 when the input is 1 V. Recalculate t_1, t_2, and the measured voltage if the clock frequency drifts by −5%.

6-4 Calculate the maximum measurement error for a digital voltmeter with an accuracy of ±(0.1% rdg + 1d),when indicating 1.490V.

6-5 Determine the possible maximum and minimum measured voltage when the instrument in Problem 6-4 indicates 1.255 V.

6-6 A digital frequency meter uses a time base consisting of a 1 MHz clock generator frequency-divided by six decade counters. Determine the meter indication (a) when the input frequency is 5 kHz and the time base output is selected at the sixth decade counter and (b) when the input frequency is 2.9 kHz and the time base output is at the fifth decade counters.

6-7 A frequency meter with an accuracy of ±1 LSD $\pm(1 \times 10^{-5})$ is used to measure frequencies of 30 Hz, 30 MHz, and 300 MHz. Calculate the percentage error for each measurement.

6-8 The frequency meter in Problem 6-6 is rearranged for reciprocal counting. Determine the error that can occur when a 30 Hz frequency is measured on this system.

6-9 A frequency meter with a 1 MHz clock source is used for measuring the time period of an input wave.

(a) Determine the measured time period when 1560 pulses are registered on the display.

(b) Determine the new display reading for the same input wave if the clock generator is replaced with a 1.5 MHz source.

6-10 A frequency meter measuring the ratio of two frequencies displays 1133 when the pulses of the unknown frequency (f_2) are counted over 1000 cycles of the known frequency (f_1). If f_1 is 33 kHz, determine f_2.

6-11 Determine the accuracy of measurement for each of the two instruments discussed in Section 6-7 when measuring 750 kHz.

Review Questions

6-1 Sketch the block diagram and system waveforms for a DVM using an analog-to-digital converter. Show the system waveforms, and explain its operation.

6-2 Define dual-slope integrator and zero-crossing detector. Sketch the block diagram and system waveforms for a digital voltmeter that uses a dual-slope integrator. Explain how it operates, and discuss the advantages of the dual-slope system.

6-3 Sketch a range-changing circuit for a DVM, and explain how it operates.

6-4 Draw the front panels of two typical digital multimeters, showing the terminals and controls. Explain terminal connections, function selection, range selection, and meter readings.

6-5 State typical digital instrument accuracy specifications. Compare the accuracy of digital and analog multimeters.

6-6 Draw the basic block diagram of a digital frequency meter, sketch the system waveforms, and carefully explain its operation.

6-7 Sketch a switching arrangement for changing the measured frequency range and displayed measurement for a digital frequency meter. Explain.

6-8 Discuss the errors that occur in digital frequency meters, and explain the method of specifying measurement accuracy.

6-9 Define reciprocal counting. Draw the basic block diagram of the digital frequency meter rearranged for reciprocal counting. Explain its operation, and show why reciprocal counting is sometimes used in preference to the straight counting method.

6-10 Draw waveforms to show how time period, pulse width, and frequency ratio may be measured on a digital frequency meter. Explain each case.

6-11 Discuss the need for input attenuation and amplification with a digital frequency meter. Draw waveforms to illustrate the errors that can be produced by noisy waveforms, and the method of dealing with them.

6-12 Discuss the frequency range, accuracy, and sensitivity of typical basic and high-performance frequency counters. Also, list the various measurements that can be made on a high-performance instrument.