Hand held 20 MHz digital frequency/period meter features liquid crystal display

This project features a 4½-digit liquid crystal display and is completely portable as it's battery powered. It counts to 20 MHz in four ranges (2 kHz, 20 kHz, 2 MHz, and 20 MHz) and measures period from 200 ms to 200 us (full scale).

Part 1
Geoff Nicholls

NO MATTER HOW you're involved with electronics, there's always a need to measure various quantities — voltage, current, resistance, frequency, etc. What you want to do is put a *number* to that quantity and the best way to do that is to employ a digital display.

Digital displays, based on neon-filled vacuum tubes called 'Dekatrons' first appeared in the late '50s-early '60s. With the advent of seven-segment LED displays, digital measuring instruments rapidly became commonplace. With the introduction of liquid crystal displays, which require virtually no power to operate, battery-operated portable measuring instruments burgeoned.

Portable instruments can be used almost anywhere — right where you want to make the measurement. It's not always possible or convenient to take the equipment to the workshop. The majority of multimeters are portable, handheld devices and we thought, "why shouldn't a frequency meter be the same?"

There are so many occasions in electronics today (. . . err, pardon the pun) where you need to measure frequency. In times past, it was almost the exclusive reserve of 'the RF man'. These days even those involved in audio and computing need to have frequency measuring facilities.

Just being able to measure frequency is great, but what sort of accuracy is generally required? I asked around and, for the great range of applications, it seems six-figure accuracy, while seemingly desirable, is not really necessary.

Take a computer modem for example. These use two audio tones to signal the 'high' and 'low' bits of the digital information transmitted through them. The accuracy required is a few Hertz in several thousand Hertz — about 0.1%.

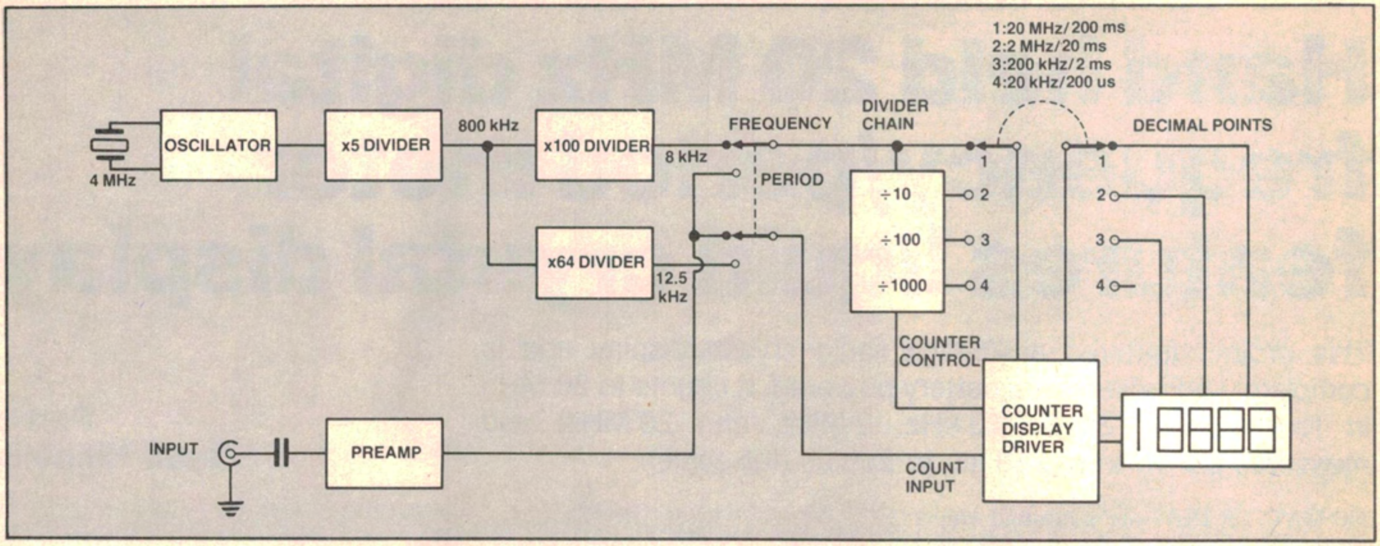
The accuracy and temperature stability of your 'off-the-shelf' quartz crystal is 100 parts per million (ppm) and 20 ppm/°C, respectively. Put another way — 100 Hz per megahertz accuracy, 200 Hz per megahertz for a 10°C temperature range.

All that adds up to this — a 4½-digit display has all the accuracy you need for the greater range of applications. (The left-most digit on a 4½-digit display will only read '1', while the other four will read 1 to 9).

That's when I went searching for a 4½-digit counter-display driver as 4½-digit liquid crystal displays are readily available.

I turned up Intersil's ICM7224IPL, which is perfect for the job, and what's more, it's capable of counting to 20 MHz! A portable, battery-operated digital frequency meter was a distinct possibility, so I obtained several samples from R&D Electronics, the Intersil agents, through All Electronic Components in Melbourne.

Many months before we tackled this design, a representative from Mayer Krieg & Co had called in and left us a range of sample 'Unimes' cases, amongst which was a small handheld case just made for the application. It was palm-sized and featured a 'sculpted' front with a window just the right size for a liquid crystal display. It also had a battery compartment to take a ▶



standard No 216 9 V battery. It was all too easy!

The electronic design was a 'snack' but it was obvious that fitting the components on a pc board and into that case was going to require some pretty fancy juggling. Right here, Murphy stepped in. After considerable effort with the mechanical design, it was abandoned and another case sought. But Mayer Krieg came to our rescue with a somewhat larger handheld case with all the features we wanted. Known as the Unimes 2, it measures 180 mm long by 100 mm wide and from 35 to 44 mm deep. It has a battery compartment in the rear to take 4 x AA cells, plus a wire tilting bail so that the case can be either laid flat or stood up on a flat surface. There is a recessed window in the front, up top, for a display and a recessed, sloping section for a front panel label.

Design

Frequency counter designs may be classified according to the type of range switching employed. In low-cost designs there are only two common types, the *switched gate period* type and the *input divider* type. The latter divides the input signal down by various ratios, according to the range selected, while keeping a fixed gate period, typically one second. This allows the actual counter to operate at a low frequency while counting a high input frequency but requires high speed dividers for one or two stages. I decided to take advantage of the excellent high frequency counting ability of the Intersil ICM7224IPL and use a switched gate period. The block diagram here shows the overall arrangement of the instrument.

The count input of the Intersil device has a Schmitt trigger first stage with a typical hysteresis of 0.5 V, centred on 2.0 V. When operating in the frequency mode, the preamplifier output is fed to the COUNT input while the 8 kHz reference is divided to select gate times of 1 ms, 10 ms, 100 ms or one second, corresponding to ranges of 20 MHz, 2 MHz, 200 kHz and 20 kHz. The actual gate time is eight cycles of the frequency sent to the divider chain.

In period mode, the count input of the ICM7224IPL is switched to a fixed 12.5 kHz reference, while the input signal from the preamplifier goes to the divider chain. Once again, the gate period is eight cycles, so the counter ends up counting at the rate of 12.5 kHz for eight input periods. This produces a 'true' decimal period readout in microseconds or milliseconds.

Next month I'll reveal the circuit and describe the construction.●