

Build RE's Digital Printing Computer

Don't leave f-stop thinking outside the darkroom. This photo timer has f-stop settings for the ultimate in timing prints and enlargements

by DON LANCASTER and LEON SCHOENFELD

THE RADIO-ELECTRONIC'S DIGITAL PRINTING Computer (DPC) is a specialized timer for the photo buff who does his own black and white or color printing. It has several brand new circuit features not found on *any* commercially available device, even those costing many times its price. Unlike any ordinary photo timer, the Digital Printing Computer works directly in quarter stop increments of time. This means it thinks in exactly the same manner that photo paper does. There's now no more guesswork or fancy math involved any more—the computer does it for you. If your prints turn out a half a stop too light, just advance the computer two quarter stop clicks for a perfect print. If you decide to retard your enlarger a stop or two, just click the exposure computer just as much the opposite way, and you're right back where you started—with no guesswork and no math.

The instrument uses all integrated circuits and a very simple switching system that gives permanent calibration and unbeatable long-term accuracy. Both these features are picked up by counting cycles of the stable 60-hertz power-line instead of relying on traditional resistor-capacitor timing schemes that have to be calibrated and drift with age.

You get a range of 29 quarter-stop increments, ranging from 0.5 to 64 seconds, set and read by two overlapping, easy-to-read, red backlit dials. In addition to its "by stops" unique operation, you get all the other features normally found on high-quality timers, including

a safety isolated remote control for foot switches, three-wire inputs, outputs and safety ground, dual-complementary ENLARGER-SAFELIGHT outputs, focus override and an emergency stop panic button.

About stops

Photographic papers work on a logarithmic rather than on a linear basis. This means you *double* the light every time you want to go one stop darker. Thus, going from 1 second to 2 seconds exposure time will make a one stop darker exposure. But, going from 31 seconds to 32 seconds will have practically no effect. It's not the time difference that counts, but how much time or light you add as a percentage of what you already have. If a 1 *f*-stop difference is a 2:1 time or light ratio, a one-half stop difference would be a 1.41 time or light ratio, and a quarter stop difference would be only a 1.2 time or light ratio. Incidentally, a quarter-stop is cutting things pretty fine—few photo experts could spot a quarter stop change even in critical color work. Table I shows the actual time values you get for each quarter-stop increment.

The DPC is a real digital computer that you program as a frequency synthesizer. It generates the needed times to very high accuracy and in the required log scale quarter-stop increments. Figure 1 shows the block diagram.

The 60-Hz power-line frequency is divided down by six to get a train of 0.1-second reference pulses. These are

counted by two cascaded counters, called the F-STOP counter and the BASELINE counter. The *f*-stop counter divides the 0.1-second reference pulses to switch selectable basic output times of 0.5, 0.6, 0.7, 0.8, 1, 1.2, 1.4, 1.6, and 2.0 seconds, giving either an exact or extremely accurate approximation to a -1 stop, -3/4 stop, -1/2 stop, -1/4 stop,

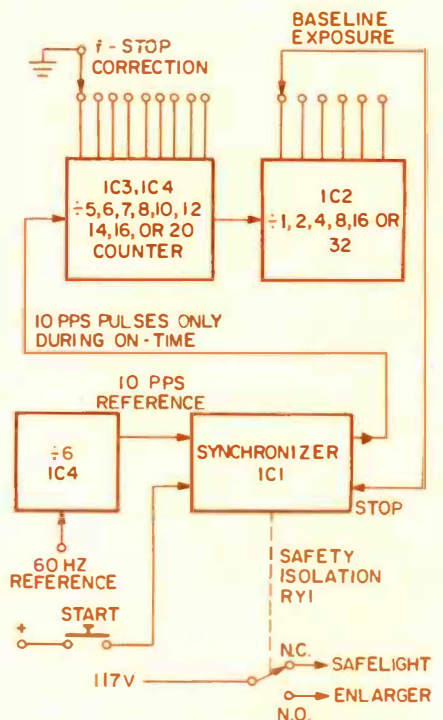
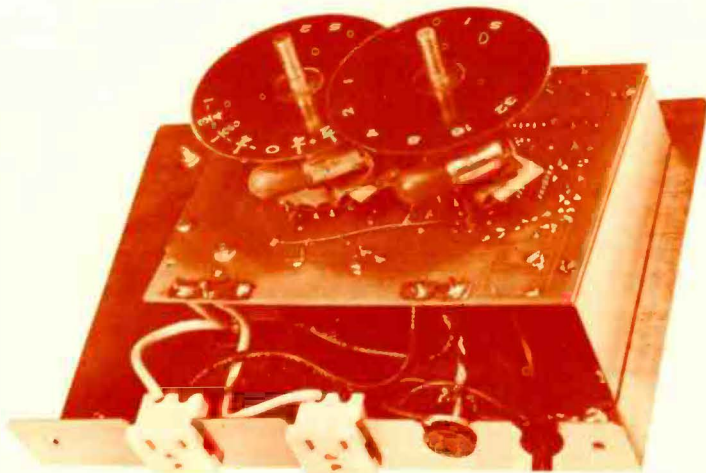


FIG. 1 FUNCTIONAL BLOCK DIAGRAM of the digital printing computer. Four IC's and a printed-circuit board simplify its construction.



baseline exposure. +1/4 stop, +1/2 stop. +3 +4 stop. or +1 stop exposure value. The baseline counter extends the *f*-stop counter's range to 1, 2, 4, 8, 16, or 32 seconds. Together the two give you a continuous range of 0.5 to 64 seconds in

quarter-stop increments. Considerable overlap is provided by the two counters for ease of operation.

The computer acts independently each time as a one-shot counter. Every time the START switch is depressed, a special synchronizer locks the counter to the power-line, loads the proper division ratio into the *f*-stop counter, resets the baseline counter, and starts the

count process. When the count is finished the synchronizer goes back to its initial or WAIT state. During the counting time, a signal is routed to a safety isolating relay that turns the safelight off and the enlarger on for the timing duration.

The remaining switching is omitted in Fig. 1 for simplicity. The other circuitry lets you bypass the timer for focus-

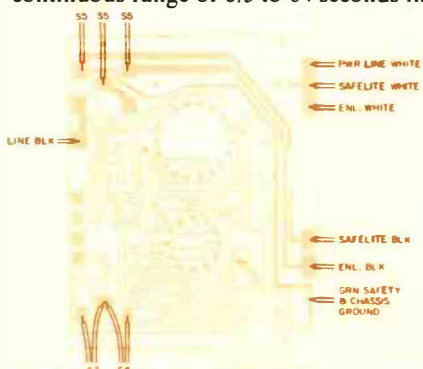


FIG. 2—EXTERNAL COMPONENTS connect to the circuit board as shown in this diagram.



FIG. 3—PC BOARD MECHANICAL DETAILS. Drill as Indicated then install the jumpers.

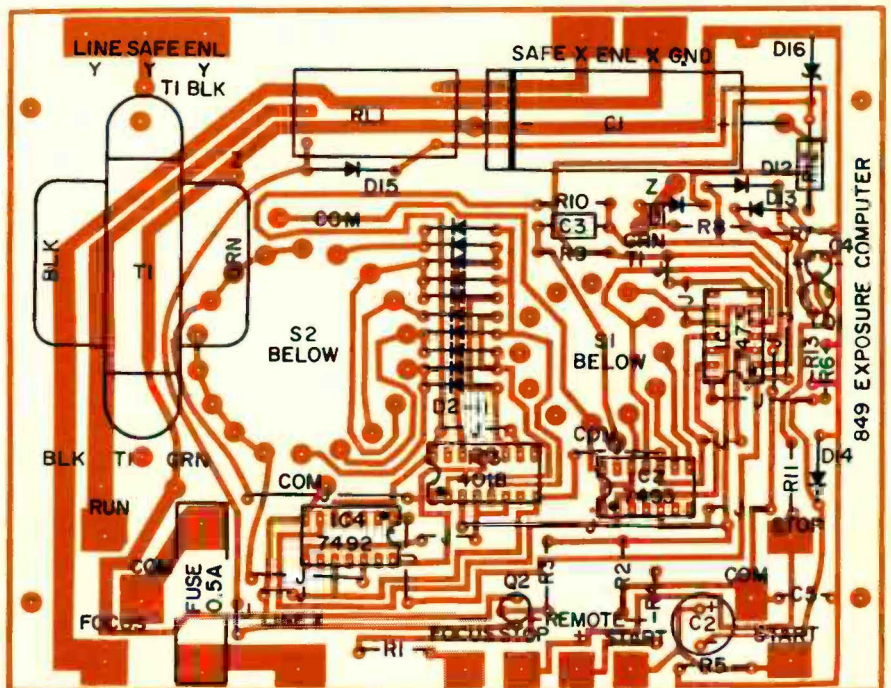


FIG. 4—COMPONENT SIDE OF THE BOARD showing the external connections and the location of major components. Be sure to observe polarity of the diodes and electrolytics.

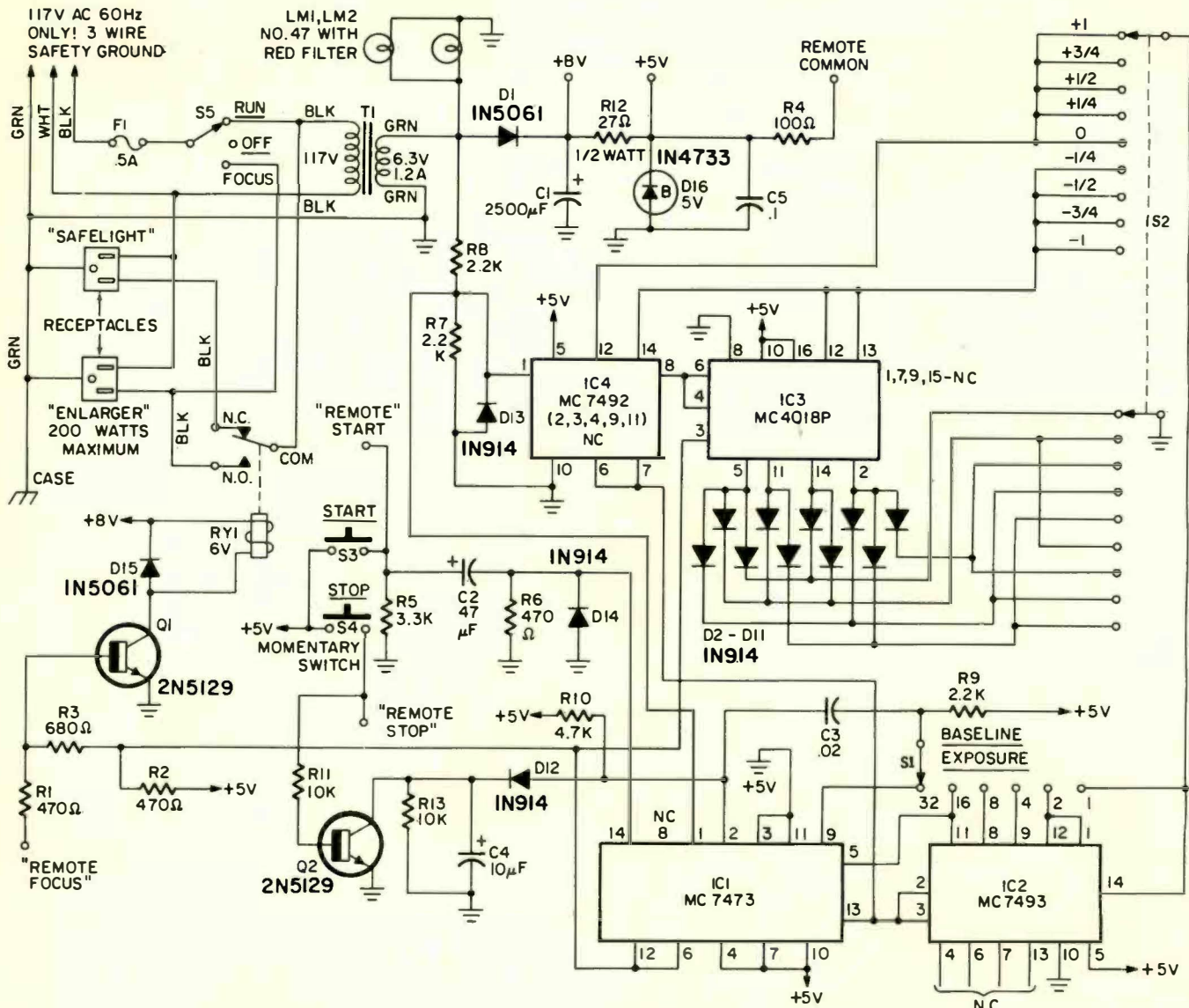


FIG. 5—SCHEMATIC OF THE DPC. The selector switches are mounted directly on the PC board to minimize point-to-point wiring. The IC frequency dividers are clocked by the powerline.

PARTS LIST

Resistors

R1, R2, R6—470-ohm, 1/4-watt carbon
 R3—680-ohm, 1/4-watt carbon
 R4—100-ohm, 1/4-watt carbon
 R5—3300-ohm, 1/4-watt carbon
 R7-9—2200-ohm, 1/4-watt carbon
 R10—4700-ohm, 1/4-watt carbon
 R11, 13—10,000-ohm, 1/4-watt carbon
 R12—27-ohm, 1/2-watt carbon

Capacitors

C1—2500 μ F, 10-volt electrolytic
 C2—47 or 50 μ F, 15-volt electrolytic
 C3—0.02 μ F, 50-volt Mylar
 C4—10 μ F, 15-volt electrolytic
 C5—0.1 μ F, 10-volt disc ceramic

Semiconductors

D1, 15—1-amp, 50 pIV silicon power diode, 1N5061 or equiv.
 D2-14—Silicon computer diode, 1N914 or equivalent
 D16—5.1-volt, 1-watt Zener diode, 1N4733 or equiv.

IC1—MC7473P or SN7473N TTL dual flip-flop
 IC2—MC7493P or SN7493N TTL divide-by-sixteen counter
 IC3—MC4018P programmable binary divider, TTL
 IC4—MC7492P or SN7492N TTL divide-by-twelve counter
 Q1, Q2—2N5129 transistor

Miscellaneous

RY1—6-volt spdt relay, 300-ohm coil, 2-amp contacts
 S1—1-pole, 6-position non-shorting selector switch
 Mallory 3226J, Do not substitute.
 S2—2-pole, 9-position non-shorting selector switch
 Mallory 3229J, Do not substitute.
 S3, S4—sps momentary pushbutton
 S5—1-pole, 3-position, rotary selector switch, 2-amp 110 V contacts, non-shorting
 T1—6.3-volt, 1.2-ampere filament transformer, Triad F-14X, Stancor P6134, or equal
 F1—0.5 amp, 3AG fuse and PC mounting clips

LM1, LM2—No. 47 pilot lamp, 6.3 volts, 150 mA.

MISC: 4 1/4" x 6" PC board (See text and Fig. 3, 4 and 5), case, bottom plate, end brackets (2); switch hardware; 1 1/4" push-on knobs; dial assemblies including 3/4" knob (2), (See Fig. 6 and 7); mounting bracket and red filter (APM 1813-27-R5) and socket for pilot lamps (2); 3 prong ac safety outlets (2); PC board mounting brackets (2); Line cord and strain relief; feet (4); 6-32 hardware; jumpers, sleeving, wire, solder, ground lug, remote control plug and socket, etc. . . .

Note: The following are available from Southwest Technical Products, 217 West Rhapsody, San Antonio, Texas, 78216: PC Board, etched and drilled #ET-1 \$6.25. Complete kit of all parts, except case. ETC-1, \$34.25. Any and all individual parts also available.

TABLE 1
AVAILABLE QUARTER STOP TIME INCREMENTS

		F-STOP CORRECTION FACTOR SETTING (S2)								
		-1	-3/4	-1/2	-1/4	0	+1/4	+1/2	+3/4	+1
BASELINE EXPOSURE SETTING (S1)	1	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	2.0
	2	1.0	1.2	1.4	1.6	2.0	2.4	2.8	3.2	4.0
	4	2.0	2.4	2.8	3.2	4.0	4.8	5.6	6.4	8.0
	8	4.0	4.8	5.6	6.4	8.0	9.6	11.2	12.8	16.0
	16	8.0	9.6	11.2	12.8	16.0	19.2	22.4	25.6	32.0
	32	16.0	19.2	22.4	25.6	32.0	38.4	44.8	51.2	64.0

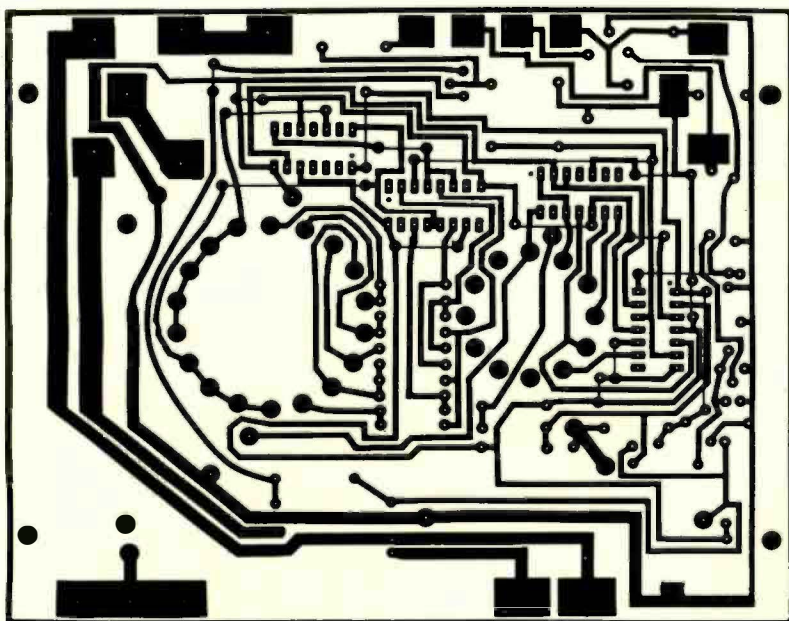


FIG. 6—PATTERN FOR THE PC BOARD. It is 6 inches wide and 4 1/4 inches high overall. Use it to make photographic copy for your board.

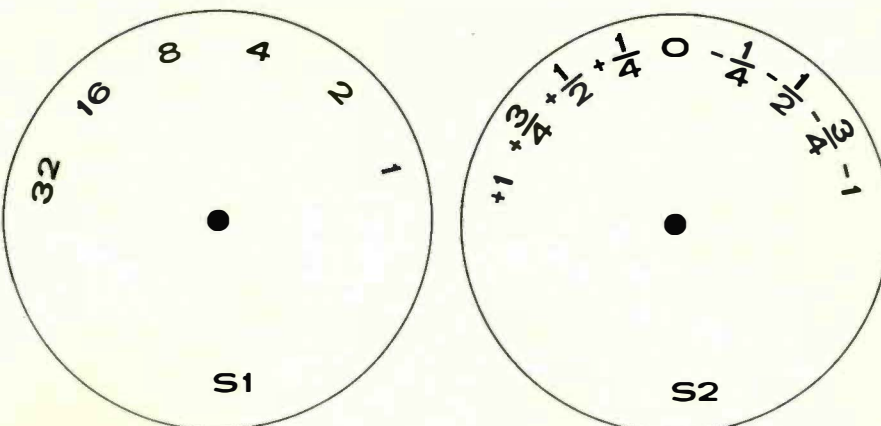


FIG. 7—PATTERNS FOR THE SELECTOR DIALS. The 3-inch circles—as photo negatives—can be mounted on or laminated to thicker plastic.

ing, stop in the middle of a time cycle if you make a mistake, or remotely control any of the functions with a foot switch or two.

The complete schematic and parts list appear in Fig. 5. Note that the two single deck rotary switches do all the time switching. These mount directly on the PC board for very low cost and minimum external wiring.

Construction

A printed-circuit board is a must for this project and may be obtained commercially or the pattern in Fig. 6 may be used. Drilling and layout details are given in Figs. 2 and 3. Fig. 4 shows component and wiring locations.

PC assembly is begun with the sixteen jumpers. These are mounted on the component side exactly where shown. Sleeving should be used on the two longest jumpers. The IC's are mounted next, noting carefully the alignment dot and notch. IC numbering is counterclockwise from the notch when viewed from the top, starting with pin 1. Use a small iron and fine solder for the IC's, and follow up with a close inspection with a magnifying glass.

The remainder of the components are then mounted on the component side *except* for the large switches. Note particularly the type and orientation of the diodes, as well as the + and - terminals on the capacitors. Start with the smaller components and finish up with the transformer, large electrolytic, and relay.

The board may then be flipped over and the switches may be mounted. Half of each switch terminal is cut away so the switch terminals may be freely passed through the holes in the PC board. The switches mount on the *foil side*. The common terminal is wired to a small jumper and then terminated on its foil pad. Be sure the common switch terminal goes "straight through" the other terminals to reach its common pad; otherwise the switch will be jumped one position and the unit will

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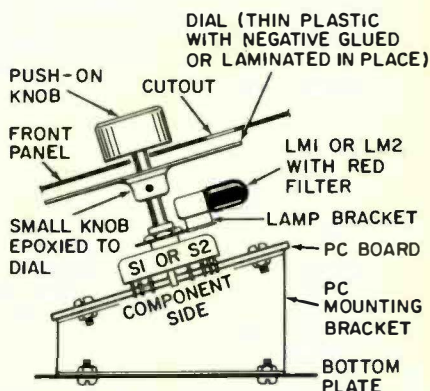


FIG. 8—CONSTRUCTION AND MOUNTING DETAILS for selector switches, dials and PC board.

DIGITAL PRINTING COMPUTER

(continued from page 53)

not work. Also be sure the common terminal and its jumper do not short any foil on the board or other switch terminals. After the switch commons are wired and soldered and the switch is seated, the terminals may be clinched on the component side. Finally, the remaining terminals may be soldered in place.

Dial replicas appear in Fig. 7. Figure 8 shows how these $+ \frac{3}{4}$ mounted to the switch shafts. Pilot lamps and red filters are bracket mounted between the PC board and the dials.

Final assembly

An antique brass and walnut-finished case assembly was used on the prototype, although any suitable enclosure should do the job. It has to be large enough to hold the PC board, the three-wire outlets, and has to have a front panel with two cutouts for the dial display. The additional START, STOP, and SELECT switches are mounted on the front panel, while the line cord, output sockets, and the remote control jack mount on the rear panel. The green safety ground from the three-wire line cord goes both to the case and the two output sockets.

The PC board mounts to the bottom of the units via two brackets. Be very careful to align these brackets so the dials, knobs, pilot lamps, and front panel holes line up. When properly aligned, you should see a red numeral on a black background, properly centered and corresponding to the right switch settings. Push-on knobs complete the front assembly.

The unit may be initially tested with 15-watt red and white lamps in the safelight and enlarger sockets. Use an oscilloscope, a kitchen clock, or a stopwatch to verify that each switch setting is correct. As there are no adjustments or calibration needed, this should be all the checkout required. If you are going to use an enlarger lamp greater than 200 watts, add a suitable high-current relay or triac to the output.

Normally, you start off with a nominal baseline exposure, say eight seconds for a normal black and white print to be dodged and burned on a single pass. You also set the CORRECTION FACTOR dial to ZERO, and run a test strip or a test exposure. If you want a small correction after running these tests, advance or retard the correction factor dial as needed. If you ever get to +1 or -1 on the correction factor dial, simply snap to one higher or one lower baseline exposure position and reset the correction factor dial to zero. This way you get a continuous exposure range. R-E

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