Diamond DA40-180

The gee meter

Garmin G1000 stars in Diamond DA40-180

BY THOMAS B. HAINES

A theory: The reason the new all-glass integrated flight deck in the DA40-180 Diamond Star is called the Garmin *G1000* is because the average general aviation pilot will say, "Gee!" a thousand times during the demo flight.

Postulation perhaps, but given that many GA pilots have never flown behind even a horizontal situation indicator (HSI), the idea of an affordable all-electronic cockpit in a light airplane is revolutionary.

Actually, Garmin prefers to think of it as evolutionary, given that company founders Gary Burrell and Min Kao (the *Gar* and *Min* in *Garmin*) have envisioned the G1000 since before they produced their first product in 1989. From the beginning, Garmin planned that components of the GNS 430 and 530 first developed in the mid-1990s would grow into an integrated cockpit system. Now, with thousands of units delivered and many thousands of hours of flight time, these components bring a level of maturity to the new G1000 flight deck.

Diamond Aircraft, as innovative in its own right as Garmin, jumped at the chance to be the first to offer this new technology. The G1000, with its two 10.4-inch high-resolution displays, further expands the model offerings from Diamond. The airframer builds multiple versions of its two-place aircraft, from motorglider to military trainer. The four-place DA40-180 comes with conventional instruments and either Honeywell Bendix/King or Garmin avionics. Or you can upgrade to the Avidyne glass cockpit with Garmin avionics. Or finally, there's the latest variant with the G1000 integrated cockpit.

PHOTOGRAPHY BY MIKE FIZER


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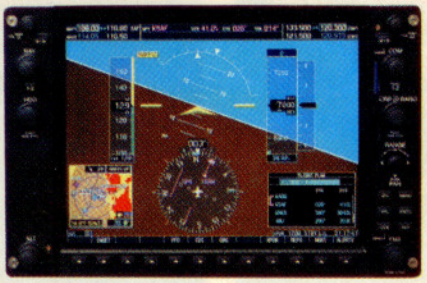
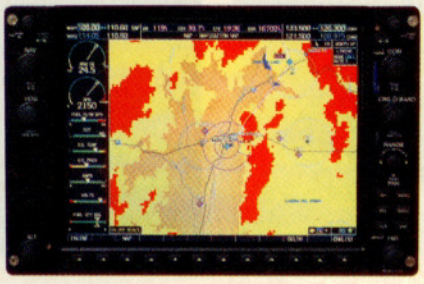
LIGHTS
INSTRUMENT
FLOOD
LANDING
TAXI
POSITION
STROBE
EMERGENCY
ALTERNATE AIR





The Garmin G1000 PFD (top) includes the ability to show thumbnails of the moving map and flight-plan route. The MFD stacks engine instruments down the left side. The MFD can be configured to show terrain and terrain warnings (second from top). The airport info page (second from bottom) includes approach overviews. Above, the MFD shows both traffic and conventional moving-map information.

You want to go simple? Diamond recently introduced a lower-cost variant that replaces the 180-horsepower fuel-injected Lycoming IO-360 with a carbureted O-360 and swaps the constant-speed propeller for a fixed-pitch prop. The $10,000 price reduction makes the DA40-180FP a more affordable acquisition for flight schools and lowers ongoing maintenance costs. It also simplifies things for primary flight students.

Base price for DA40-180FP is estimated to be under $175,000. Final pricing will be set before the first one ships this summer. The DA40-180 with conventional instruments and Bendix/King avionics starts at $186,900; a Garmin panel adds $2,000. The G1000-equipped DA40-180 comes in at $224,900. A DA40 with a pair of Avidyne displays and a stack of Garmin avionics costs $228,800. First deliveries of the G1000 models are scheduled for this quarter.

Not much 100LL in your neighborhood? Diamond has delivered more than 30 Stars powered by the Thielert Centurion 1.7 turbocharged engine developing 135 hp. At this point, the diesel version is available only in Europe; Diamond isn't saying whether it will develop a North American version.

Innovation extraordinaire

The latest variant of the DA40-180 is no diamond in the rough. With customer feedback from more than 200 DA40s already delivered, Diamond implemented a number of enhance-

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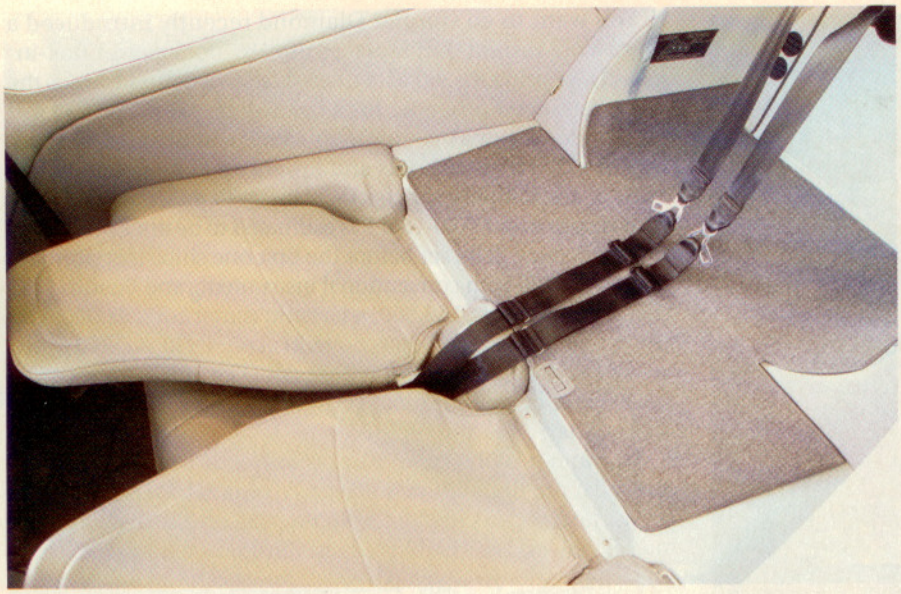
ments to the latest models. Among the improvements is a speed kit that incorporates redesigned main landing gear struts with low-profile tires, fully enclosed main wheel fairings, a new nose landing gear strut fairing, and a low-drag nose wheel fairing. According to John Gauch, Diamond's vice president of sales and marketing, the change adds 2 to 3 knots, giving the Diamond Star a cruise of about 145 knots while burning just nine gallons of 100LL per hour.

Inside, a new premium interior, an extra $4,900, incorporates more than a dozen upgrades, from concealed rudder cables along the sidewalls to leather seats and side panels, padded glareshield, and additional cup holders and storage compartments throughout. The changes move the DA40's comfortably sized interior from utilitarian to luxurious.

The most significant interior change is in the back. The open ski tube has been replaced by an aft storage area with a hinged door. With the door folded down flat, the compartment can hold two sets of golf bags plus baggage. Fold one or both of the rear seat backs forward, and the compartment can take longer items, such as skis or snowboards. Finally lift up the floor of the main compartment to find storage for the towbar and other flat items, such as computer cases or a few quarts of oil.

The air vents in the aft section accommodate the fans cooling the G1000 line-replaceable units (LRUs)—the black boxes—stowed underneath the compartment (more about LRUs in a minute).

With its long fiberglass and carbon fiber wing, unusual forward-opening canopy, and upward-swinging aft door, the DA40 probably looks nothing like most airplanes you've flown. Many say it looks small and kitelike. It isn't. Sit inside and fly it,



The latest DA40s have an improved baggage compartment. Backseats fold flat, and flat items can be stowed beneath the floor (above). The door in the extreme aft opens to more storage.

and any pretense of this being a "toy" airplane is quickly banished. The stick makes it a joy to fly. The controls are well balanced and harmonized, with all flight controls except the rudder actuated by pushrods; the rudder is cable-powered. The seats do not adjust, but the rudder pedals do, giving most pilots both adequate headroom and a comfortable sitting position. The panel is tall. Those of us who are rather height-challenged will do well to use a cushion or at least to climb at something less than the V_Y of 73 knots indicated airspeed.

The airplane climbs well, given 180 hp and a large cabin—650 to 800 fpm depending on load and conditions. In level flight, it quickly speeds up to a comfortable speed of between 140 and 145 knots, again, depending upon power setting and conditions.

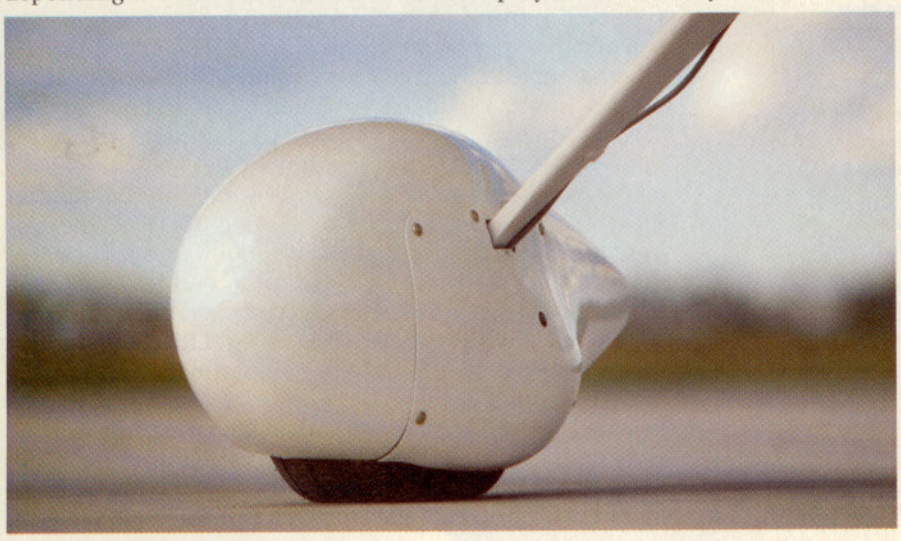
Land it like a Mooney and you'll get pleasing arrivals every time. How's that? Nail the approach speed and don't flare until the airplane is just inches above the surface. Arrive too fast or flare too high and that long wing will float you right down the runway.

Look outside!

Now here's the hard part: Take your eyes off that sexy Garmin display and enjoy Mother Nature's WYSIWYG moving map through the expanse of wraparound plexiglass. Up, down, and all around, visibility out of the Diamond Star is Imax-theaterlike. But come an instrument day, you'll appreciate those big Garmin displays with long horizon lines. The extra-long horizon line on the primary flight display (PFD) allows you to catch the slightest straying from straight and level, even out of the corner of your eye.

Garmin built the G1000 to be flexible enough for installation in everything from light singles all the way up to jets. In fact, the Cessna Mustang jet will come with a three-tube G1000 set up: two 10.4-inch PFDs and a 15-inch multifunction display (MFD) in the middle. Diamond chose two 10.4-inch displays—a PFD and an MFD—for the DA40.

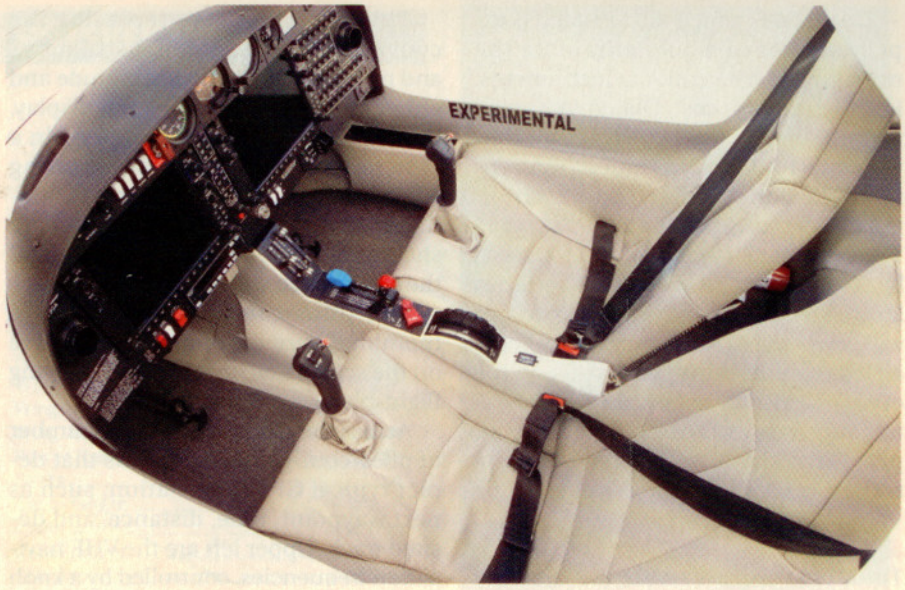
Details on how the displays work in a minute, but first it's important to understand that the G1000 is much more than just a couple of big, colorful screens. The G1000 is a *system* in the true sense of the word. Its many components in the panel and elsewhere in the airplane work together to help the pilot manage loads of information. In addition to the displays, the system consists of an audio panel (or two)—intended to be mounted vertically between the displays, but it can be mounted horizontally. The panel does all of the things you expect an audio panel to do, except in this case all of the sound is digital. A voice synthesizer alerts the pilot to system anomalies and, depending on the setup, can warn of traffic alerts and minimum altitudes, and provide other messages.



A new speed kit includes smaller tires, more tightly enclosed wheels, and streamlined struts.

Another component may be an alphanumeric keyboard for entering data. The Mustang may get the keyboard; the Diamond does not.

That's it for the pilot interface. Elsewhere in the airplane is a rack of LRUs. The rack can be mounted anywhere.



G1000 LRUs are stashed below the baggage compartment (above left). Control sticks highlight the DA40's cockpit (above right).

The displays are shallow enough that the rack can be mounted forward of the displays if desired—in the space normally occupied by panel-mount radios. Diamond elected to put the rack under the aft baggage compartment because it needed to move some weight back there for balance purposes. Each of the LRUs is a self-contained component—a nav radio, a com radio, a GPS sensor, a transponder, or an engine control unit. If any component fails, it's a simple matter to pull out the LRU and stick in another one (*line-replaceable unit* literally means it can be replaced while the airplane is still on the line—without taking it out of service). Every component in the system shares information with every other component through an Ethernet network. Ethernet is a high-speed data bus that basically allows one wire or one bundle of wires to connect all of the devices. It's digital so information can flow in both directions. Chances are your office computer network or that high-speed connection you get at your hotel is Ethernet. It's an industry standard in the computer world.

As a result, there's no need for panel-mount radios or transponders. Because the system is all digital, the remotely mounted radios can be controlled from anywhere.

In fact (here's the cool part), it doesn't even matter what model of airplane you put a display or LRU in. In the future, if you're flying a DA40 and a display goes out, you can land at an avionics shop and technicians there can grab a display off the shelf and stick it in your Diamond. A config.sys file in the airplane tells the display that it's in a Diamond and voilá it's ready to go. Meanwhile, your old display can be repaired, and if a Mustang rolls in with a bad display, your repaired one can go in the jet. Remarkably, even the engine data units (EDUs) are completely interchangeable—turbine or piston. The EDU is what gathers all of the engine data and displays it for the pilot on the MFD. The EDU on your jet goes bad? Borrow one from your Diamond. The G1000 doesn't care.

Fault monitoring in the G1000 tracks any problems and alerts maintenance crews. In flight, the system uses master warning and caution lights to tip off the crew to problems.

The heart of the G1000 is its attitude and heading reference system (AHRS). An AHRS is basically a solid-state gyro system. Conventional spinning gyros have a life of about 500 to 1,000 hours, depending upon whom you ask. Mean time between failures for a solid-state AHRS—about 10,000 hours.

Recognizing that it would take four to five years to develop its own AHRS, Garmin went shopping for technology and found Sequoia Instruments in November 2001. Sequoia had already developed much of the technology for an AHRS. Unlike expensive ring laser gyros costing more than $100,000 in business jets, Sequoia uses three-dimensional GPS, 3-D magnetometry (measurement of changes in the Earth's magnetic field), and 3-D air data information to compute the aircraft's attitude. All three components are combined to compute the attitude, but only two are necessary for determining attitude. If one input fails, the system soldiers on. As a result of the way it computes attitude information, the Garmin AHRS does not need to remain stationary for three minutes during start-up to configure itself. Other systems showing up in light airplanes require you to sit still for three minutes. The Garmin system can figure out where it is and what attitude it is in under about any circumstances. According to Bill Stone, Garmin's avionics product manager, it can be shut down while in flight even during a sustained bank. Turn it on and within 45 seconds it will tell you which way is up. Not even the systems on airliners or business jets can do that, Stone says. Of course, if you're in the clouds at night when that happens, those could be 45 long seconds.

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Dual AHRS, which the Mustang is expected to have, could eliminate the need for any conventional instruments. However, to save cost, Diamond elected to use a single AHRS. Its backup is a conventional attitude indicator at top center of the panel, along with a conventional airspeed indicator and altimeter. The AI with its mechanical gyros has a backup battery pack of 28 AA batteries located behind the panel. The batteries will power the AI for 40 minutes after the alternator and ship's battery die. In the event of a display failure, the system automatically reverts to the other display, providing the pilot with everything needed to continue flying safely.

Show time

The G1000 displays utilize the latest active-matrix (or *thin film transistor*—TFT) liquid-crystal display technology to bring 16 million colors and extremely wide viewing angles to the cockpit. If you're an IT person, you'll be interested to know that each XGA-quality 1,024-by-768-pixel display is powered by an X-scale microprocessor and features a high-performance graphics accelerator for superior 3-D rendering. Stone said that. Here's what I said when I first saw them: "Gee!"

According to Stone, the displays are purchased from the commercial market, but carry a great deal of customization by Garmin, including Garmin backlighting. They are only 2 inches deep and weigh about 6.5 pounds each.

Think of the PFD as replacing the conventional six-pack of instruments and more. Besides showing attitude and either an HSI or arc navigation display, the screen also depicts airspeed in a tape format with trend lines showing where you will be in a few seconds. Similarly, altitude and vertical speed are shown via tapes down the right side of the screen, also with trend lines.

The pilot can choose to show a thumbnail-size moving map elsewhere on the screen and/or a window showing flight-plan waypoints.

Across the extreme top are a number of pilot-configurable windows that depict typical GPS information, such as next waypoint, time, distance, and desired track. Upper left are the VHF navigation frequencies, controlled by a knob on that side. Below that knob is a control for the heading bug; a push syncs the bug to the current heading. Lower left is the altitude knob for setting altitude bugs. Upper right are the communications frequencies and their control knobs. Much of the communication and navigation frequency knob interface and the flight-planning interface will be familiar to anyone who has used a GNS 430 or 530. Below the com control knob is the control for setting barometric pressure and the course indicator. Next is the joystick for moving the cursor around the moving map. Below that is a series of buttons familiar to 430/530 users for setting up flight plans, instrument approaches, and other day-to-day navigation chores. An FMS knob works in tandem with the nav buttons. Soft keys across the bottom do a variety of things, from bringing up the transponder functions to clearing cautions and warnings, to configuring the display. They are called *soft keys* not because they feel soft, but because their functions are not hard-wired. In other words, the keys perform different functions depending on what you are attempting to do. Small menu choices appear or change above the buttons depending on the choices available in that setting. Conveniently, a Back button is usually available to back out of the menus.

The MFD will look surprisingly familiar because it is exactly the same display—same buttons, same labels. In fact, you can even use knobs on the MFD to perform functions on the PFD and vice versa. A change to a com frequency on one display, for example, is repeated on the other display—again, thanks to the Ethernet bus that allows every component to talk to every other component.

The MFD is where you can get creative with the setup. You can set the moving map any way you want—terrain off or on, obstruction and terrain warnings off or on, airspace, airports, navaids—you decide what you want.

In the Diamond, the engine instrument depictions occupy a strip down the left side of the MFD. Among the presentations are: manifold pressure; rpm; cylinder head temperature; fuel flow and

quantity; oil temp and pressure; amps; and voltage. The individual displays provide cryptic information, but certainly all that you need for most flying. If any item exceeds established parameters, the G1000 alerts the pilot. A touch of the Engine soft key brings up a larger display that shows cylinder head and exhaust gas temperatures for each cylinder and allows for managing fuel inputs. There's also a system to assist in leaning. The manifold pressure and rpm displays show both an arc with a pointer and an exact digital reading, but do not show any numerics along the arc. I found myself wanting to know where on the arc I could find, say, 24 inches of manifold pressure. Garmin representatives said they felt the extra digits would clutter the display. I had only a short flight in the DA40. I'm sure with a little practice it's easy enough to quickly nail a power setting.

Diamond is equipping the DA40 with the G1000 Mode S transponder and traffic information service (TIS) to depict traffic in terminal areas. Buyers can opt to install a terrain warning system and a weather datalink. The G1000 uses an XM Satellite Radio-delivered datalink that includes a host of weather products in the cockpit and 101 channels of entertainment.

Garmin is also developing a flight control system that will be integrated into the G1000. Since that component won't be available until later this year, Diamond has installed the Bendix/King KAP 140 two-axis autopilot.

Like the rest of the G1000 components, the flight control system will be fully integrated. There will be no main autopilot computer. Instead, each servo will be its own computer, feeding information back to the AHRS and other components for processing and use. Garmin is also developing an airborne weather radar system, positioning itself to sell the G1000 to aircraft even larger and higher flying than the Mustang.

The G1000 is already set to debut on the Diamond D-Jet. With Diamond's ability to turn out new models faster than just about any GA manufacturer and Garmin's avionics innovation, we undoubtedly haven't heard the last "Gee!" from this pair. AOPA

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i Links to additional information about Diamond Aircraft and Garmin may be found on AOPA Online (www.aopa.org/pilot/links.shtml). Keyword search: Diamond, Garmin.

SPECSHEET

Diamond DA40-180

Base price: $186,900
Price as tested with Garmin G1000: $258,763

Specifications

Powerplant	180-hp Lycoming IO-360 M1-A
Recommended TBO	2,200 hr
Propeller	2-blade Hartzell, 74 in dia
(Optional)	3-blade MT Propeller, 71 in dia
Length	26 ft 3 in
Height	6 ft 6 in
Wingspan	39 ft 2 in
Wing area	145.7 sq ft
Wing loading	17.4 lb/sq ft
Power loading	14.1 lb/hp
Seats	4
Cabin length	8 ft 6 in
Cabin width	3 ft 9 in
Cabin height	3 ft 8 in
Standard empty weight	1,620 lb
Empty weight, as tested	1,711 lb
Max gross weight	2,535 lb
Max useful load	915 lb
Max useful load, as tested	824 lb
Max payload w/full fuel	660 lb
Max payload w/full fuel, as tested	584 lb
Max takeoff weight	2,535 lb
Fuel capacity, std	41 gal (40 gal usable) 246 lb (240 lb usable)
Baggage capacity	100 lb, 24.7 cu ft

Performance

Takeoff distance, ground roll	800 ft
Takeoff distance over 50-ft obstacle	1,150 ft
Max demonstrated crosswind component	20 kt
Rate of climb, sea level	1,070 fpm
Cruise speed/endurance w/45-min rsv, std fuel (fuel consumption) @ 75% power, best economy, 4,000 ft	145 kt/3.1 hr (63 pph/10.5 gph)
@ 50% power, best economy (fuel consumption), 10,000 ft	120 kt/5.4 hr (40.2 pph/6.7 gph)
Service ceiling	14,000 ft
Landing distance over 50-ft obstacle	2,093 ft
Landing distance, ground roll	1,155 ft

Limiting and Recommended Airspeeds

V_R (rotation)	59 KIAS
V_X (best angle of climb)	66 KIAS
V_Y (best rate of climb)	73 KIAS
V_A (design maneuvering)	108 KIAS
V_{NO} (max structural cruising)	129 KIAS
V_{NE} (never exceed)	178 KIAS
V_{FE} (max flap extended)	91 KIAS
V_{S1} (stall, clean)	52 KIAS
V_{SO} (stall, in landing configuration)	49 KIAS

For more information, contact Diamond Aircraft, 1560 Crumlin Sideroad, London, Ontario, Canada N5V 1S2; telephone 888/359-3220 or 519/457-4000; fax 519/457-4021; or visit the Web site (www.diamondair.com).

All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, sea level, gross weight conditions unless otherwise noted.