PATHFINDER

An informal newsletter published for the GPS user community by PM GPS. Information presented is based on published and submitted news items of interest to the general user. Widest dissemination and reproduction is encouraged. Newsworthy items are solicited for inclusion. Editor Mr. Don Mulligan at PM GPS, PM NAV SYS, Ft Monmouth NJ DSN 992-6137 or (732) 532-6137 or email: Donald.Mulligan@iews.monmouth.army.mil

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Next-Generation Embeddable GPS Receiver !

PM's Corner

As discussed elsewhere in this issue, components of the GPS system range from very large to very small! Shown above is the most recent launch of a GPS satellite, a massive display of night-time rocket power. (*photo courtesy of COL Billy Welch)*

I am pleased to report volume production of the Ground-Based GPS Receiver Applications Module (GB-GRAM) will begin in 2004!

GB-GRAM is a lightweight circuit card measuring about 3X5 inches and incorporating all of the essential functions of the state-of-the-art DAGR handheld receiver. This newsletter carries the full technical description of the GB GRAM and an overview of how it will be used.

GB-GRAM will be embedded in communication, navigation, weapon, vehicular and other systems to provide next-generation military-rated GPS capabilities for America's war-fighters. An embeddable GPS receiver makes GPS a seamless part of weapon systems operation and reduces the logistics burden by eliminating the separate PLGR or DAGR receiver.

In the years to come, GB-GRAM will spread across the Army as existing weapons systems are upgraded and new ones introduced. GB-GRAM will also be used by other services and Allied Nations. The first GB-GRAM cards are already undergoing integration and testing as reported elsewhere in this issue. The Army Land Warrior and Movement Tracking System are leading the pack with plans to start buying and installing GB-GRAM now. If you have any questions, contact me or my staff.

Skip Harborth, LTC, SC

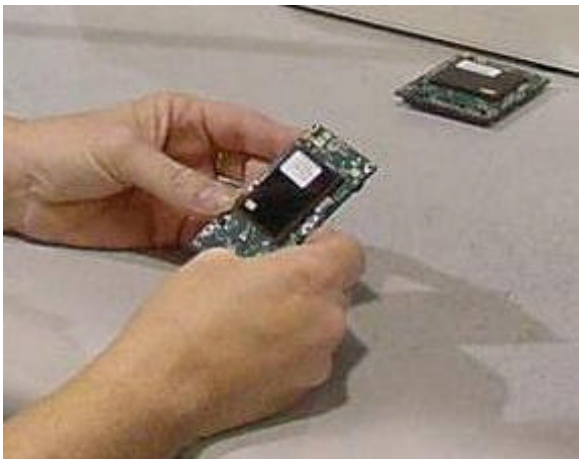
Product Manager, GPS

GPS Receiver Design Evolves to GB GRAM

Ground-Based GPS Receiver Applications Module (GB GRAM)

Smaller, lighter, more capable.

Over the past decade, this newsletter has reported on the evolution of military GPS receivers. At the onset of Operation Desert Storm in 1990, the Army had a few AN/PSN-8 "backpack" sized GPS receivers. To get more equipment quickly, PM GPS turned to commercial products, purchasing over 7,000 Small Lightweight GPS Receivers (SLGR). Although some were bought from other manufacturers, most SLGR were variations of the Trimble TRIMPACK which the Army designated the AN/PSN-10. Many soldiers will remember the SLGR. It weighed only 4 lbs (compared to the 17 lbs "backpack") and the operator held the SLGR almost like binoculars to read the coordinate grid display. As a pure commercial item, SLGR could only access the Standard Positioning Service (SPS) signal unlike the Precise Positioning Service (PPS) capable military designs. At the time GPS was a new technology and there was no hostile attempt to disrupt the signal so SLGR was a great aid to navigation. Experts agree that future conflicts will be subjected to much more electronic interference which makes the use of PPS-rated equipment very important (See box about SPS and PPS).



The powerful GB GRAM circuit card is a GPS receiver without a body measuring 2.4 " by 3.4 "

Time moved on and in 1994, PM GPS began fielding the Precision Lightweight GPS Receiver (PLGR) AN/PSN-11 to replace the TRIMPACK. Eventually over 100,000 PLGR were fielded to military users world-wide with the majority going to the Army. The PLGR brought about a further reduction in size and weight from SLGR. PLGR was a modified Non-Developmental Item (NDI) which means it was based on a commercial design with the very important modification that it was capable of using the military-only PPS signal.

The PLGR has been around for a decade now. It does not have the user-friendly features or graphic displays found in SPS receivers available to the general public nevertheless, the PLGR soldiers on with the KEY ADVANTAGE of PPS. As many PATHFINDER readers know, PM GPS is preparing to field the PLGR's replacement, the Defense Advanced GPS Receiver (DAGR) beginning late in 2004. The DAGR is a PPS-rated receiver that incorporates SAASM technology (a further advancement in communication security feature for improved signal protections). DAGR will become the dominant military handheld GPS receiver. And as with each new design, the DAGR will weigh less than its predecessor. DAGR weighs in at just under 1 lb and will fit in a BDU utility pocket. For a while there will be a mixture of PLGR and DAGR in service until the PLGR is retired from service.

The last chapter in this report on GPS receiver evolution brings us to the GB-GRAM which is the focus of this newsletter. As described elsewhere in this issue, the GB-GRAM is a circuit card, not a free-standing receiver (see photo above). It will have essentially the same internal components and advanced technology as DAGR but with no separate display screen or keypad!

That's because GB-GRAM has been designed from the "get-go" to be embedded inside communication, navigation, weapon, vehicular and

SPS and PPS? The most important distinction in GPS receivers is SPS versus PPS. PPS stands for Precise Positioning Service, the military-only signal that provides greater positional accuracy and protection from jamming or spoofing signals. Commercial receivers are limited to the Standard Positioning Service (SPS) signal which does not afford those signal protections. The Secretary of Defense has mandated the use of PPS rated GPS for all combat and combat support operations.

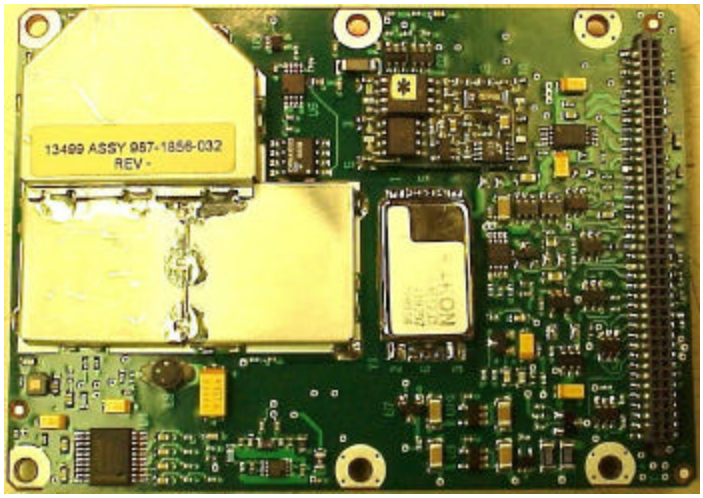
other systems to provide seamless full-time GPS data. The host system will command the GB-GRAM and the operator will interact with GB GRAM for GPS data through the host platforms display screen and controls/keypads. As an internal "spare part" the GB-GRAM can evolve and be replaced over time to keep up with advances in computer component design. The combination of the DAGR and the GB-GRAM will meet virtually all hand-held and ground-mobile host platform requirements for GPS in the foreseeable future.

A TECHNICAL ANSWER: WHAT IS GB-GRAM?

For the engineers among you, here is a technical description of GB-GRAM:

GB-GRAM is formally defined as a standardized compact low power highly integrated Small Serial Interface (SSI) card form factor, multi-channel dual frequency continuous tracking Precise Positioning Service (PPS) capable embeddable GPS receiver. It measures 2.45 " X 3.40" and weighs about 4 ounces. GB-GRAM fulfills the GPS Tactical Receiver (GTR) Operational Requirements Document (ORD) for next-generation embeddable GPS receivers (The ORD is the "Army Authorization" that makes GB-GRAM a required part of a weapons system).

The front and back of the GB GRAM card are shown above and below at approximately actual size of 2.45 inches W by 3.4 inches L by .6 inches H.



For the non-engineer readers, GB-GRAM is a circuit card containing a next-generation PPS-rated GPS receiver. The typical user won't see GB-GRAM because it will be installed inside a component of the larger host platform, such as the radio or the navigation box.

The adjacent photos show the front and rear of the GB-GRAM at approximate actual size.

GB-GRAM is first in a family of standardized receiver designs configured for aircraft, tactical vehicles, munitions and communications systems. GB-GRAM improves interoperability because it uses the same design thresholds as the handheld DAGR so either device will generate essentially the same quality of GPS data to field users

The most practical thing about GB-GRAM for the typical user is that it eliminates the need for a separate external GPS receiver, reducing overall dimensions and weight of the weapons system.

Host platform managers can procure the GB-GRAM through a central Army-managed contract and supply them to the vendor building their weapons system. Over its service life, the GB GRAM will be treated as a "spare part" not a separate GPS receiver although due to the sensitivity of the SAASM component, anyone in the repair cycle will have to observe accountability procedures to keep track of the GB-GRAM from first installation to turn-in for disposal by an authorized depot.

CAPT Daniel Vore at JPO, DSN 833-5885

Mike Dash at JPO, DSN 833-6505

From 1,000,000 lbs to 4 ounces!

With 1,000,000 lbs boost, a Delta II rocket lifts the newest GPS satellite from Cape Canaveral FL.

The components of the GPS system range from very large to the very small. Although the typical ground user may not think about the satellites very often, without them your GPS receiver will not function.

The core of GPS are the satellites orbiting the earth, each beaming a signal used by your receiver to calculate a position location and time using the principal of triangulation. As seen at left, satellites start their journey into space onboard Delta II rockets. This most recent launch was photographed in December 2003 by COL Billy Welch, the Project Manager for Navigation Systems, parent organization of Army PM GPS.

It takes a lot of power to lift a GPS satellite weighing over 2 tons. In fact, the Delta II rockets expand about 1,000,000 pounds of thrust between the first and second stage booster rockets to get the typical GPS satellite into orbit. Maintaining a minimum constellation of 24 satellites is the full-time job of personnel assigned to the Space Segment, based at Schriever AFB, Colorado. This effort requires the launch of several replacement satellites each year. The current version of GPS satellites have a minimum operating life of 10 years.

Although satellites make GPS possible, the typical user back on planet earth thinks of GPS in terms of the handheld GPS receiver that provides a visual or numeric display of position location.

The technology of GPS receivers, or User Equipment (UE) continues to evolve. UE is the acronym used to describe the entire family of GPS receivers, from handheld to integrated. Although handheld GPS receivers such as the PLGR are the most common UE today, embedded GPS receivers are the wave of the future and in time they will probably outnumber handheld GPS receivers.

A good example of embedded GPS technology today is the automotive navigation system, i.e. On-Star ™ where the GPS receiver resides within the computer, requiring no direct operator interface. That's the goal for Army applications using the GB-GRAM, to make GPS an "automatic and integral" part of the overall operation of the host system.

In addition to the Ground Based GRAM highlighted in this newsletter, other GRAM variations are in development tailored for aircraft and munitions. Where the GB-GRAM is tuned to the "dynamics" of soldier-portable and vehicle-mounted systems, other formats are being developed for aircraft (high G effects) and munitions (a very quick signal acquisition time!). Contact the Product Management Office for more information concerning other GRAM formats.

The UE weight reduction from PLGR (3 lbs) to GB-GRAM (4 ounces) is critical to applications like the Land Warrior program where every ounce counts since the soldier carries the equipment. It is interesting to note that the 4 ounce GB-GRAM relies on those 2 ton satellites circling the globe and the one million pounds of thrust that it took to get each of them there!

The GB-GRAM module measures 2.4 X 3.4 inches! Deb Imhoff inspects and tags new units at Rockwell-Collins.

It's also ironic to think that the GB-GRAM, like those satellites, are pretty much 'invisible' to the average user. Whether hidden inside a radio or circling overhead at 15,000 nautical miles, the GB-GRAM and the GPS satellites are essential, even if unseen, components to the remarkable GPS system serving America's war-fighter.

Who is Using GB GRAM?

This issue of PATHFINDER has described the GB-GRAM and how it represents future integrated GPS solutions for Army weapons systems. So is it worth the effort to upgrade to GB-GRAM?

Yes, and here's why: GB-GRAM brings an affordable, state-of-the-art, multi-channel, dual-frequency, SAASM-based GPS receiver capability to the host weapon system. That technology gives you the best GPS accuracy and security bang-for-the-buck at the lowest power drain and with the smallest package ever available before. You can eliminate the separate GPS receiver and those pesky power and data cables.

Okay, GB-GRAM is definitely a step forward, so who's first? Four Army platforms are already integrating GB-GRAM and have committed to production purchases: They are Land Warrior (LW), Movement Tracking System (MTS), Abrams Modernization and the Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T). Joint-service programs evaluating GB-GRAM include Dragon Eye, Pointer, Raven and the Airborne Command and Control System. All of these platforms are working to make GB-GRAM an integral part of their system.

For LW, the GB-GRAM is installed to the belt-mounted navigation box carried by the individuals soldier. In MTS the GB-GRAM is installed in the transceiver that is mounted outside the vehicle. In the Abrams Modernization it is included in the upgrade of the navigation system and in the SMART-T program it replaces the existing cable-connected PLGR.

Land Warrior (left) and Movement Tracking System (right) are very different applications –using the same GB GRAM card to provide GPS position and timing data to the soldier carried LW and the vehicle mounted MTS devices.

The GPS Joint Program Office (JPO) oversees GPS integrations. Army platforms using GB-GRAM are getting hands-on engineering expertise from the CECOM CERDEC Command and Control Platforms Division (CERDEC C2D) at Fort Monmouth NJ. The Position, Navigation and Timing Branch develops, demonstrates, integrates and applies new technologies and concepts in positioning and navigation for Army platforms. The JPO publishes the GPS Interface Control Document (ICD) that defines the technical interface and CECOM implements the ICD working with host platform engineers, test agencies and supporting contractors to provides Position, Velocity and or Timing data when and where its needed.

As more Army weapons systems sign up to use GB-GRAM when their systems are due for overhaul or upgrade, they will benefit from the experience of the CERDEC engineering team to make GB-GRAM integration as smooth and efficient as possible.

Mike Dash at JPO, DSN 833-6505

Brian Mitchell at CERDEC, DSN 987-4076.

The Abrams tank and the SMART-T Terminal will use GB GRAM for GPS data for positional data and to synchronize communications systems.

The "Home Front" GB -GRAM Team

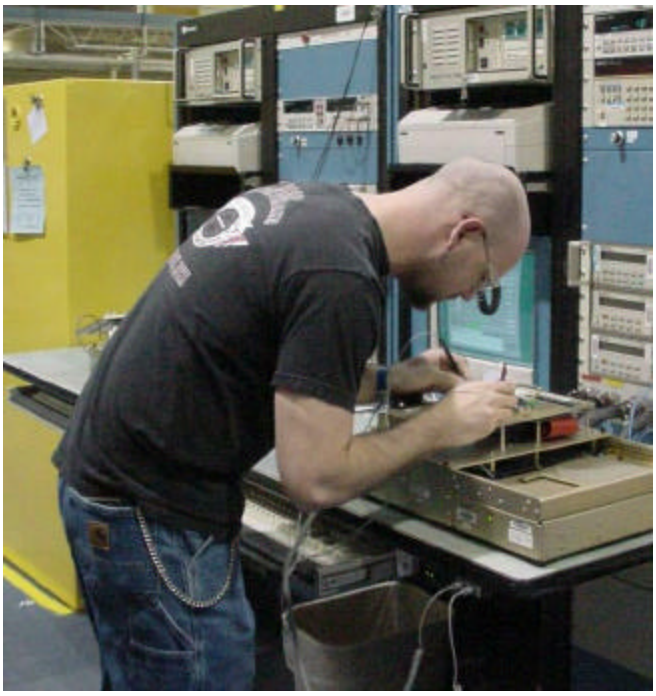
The Home Front GB-GRAM team includes 175 employees at Rockwell-Collins facilities in Iowa where the GB-GRAM is built, inspected, tested and packed for shipment.

Although a computer-controlled assembly machine mounts most of the components to precise locations on the GB-GRAM circuit card, the human touch is an essential part of the process, particularly for the visual inspection and testing that you see being performed here. From circuit continuity checks to software verification, the GB-GRAM team works to ensure that each card going out the door is 100% ready for service.

Photos pages 6 and 7 courtesy of Rockwell-Collins

Dani Smith is conducting operational checks on 4 GB GRAM units returned from the Key Loading Facility where security software was installed.

Carolyn Wenndt builds a GB-Gram at her workstation.



(Left) Deb Imhoff and Neil Wolford are discussing GB-Gram units during the final audit process as Sandy Phelps builds a PLGR in the background. (Right) John Sullivan is testing and troubleshooting a GB-GRAM at the test station.

BJ Wilkerson is packaging GB-Gram at Rockwell-Collins for delivery to customers.

"Loggies" Working PLGR Repair and Return

Another "GPS Team" consists of the folks supporting the current handheld system, AN/PSN-11 PLGR, including the Monmouth Field Office, the Georgia Field Office, the Joint Service Support Management Office (JSSMO) in Warner Robins GA, the PLGR repair depot at Rockwell-Collins in Iowa and logisticians at numerous sites between the field and the depot.

The members of this team support units called to Active Duty as well as those already deployed. Working with Regional Support Centers, this team has pursued a common objective, "To repair and return PLGR to those who need them". During the past 12 months, PM GPS released over 1,000 PLGR from Deferred Maintenance and fielded over 14,000 additional PLGR to support deployment requirements. During this same period, over 9,000 PLGR have been received at the Iowa depot, repaired and returned to owning units!

NOTE! Some PLGR are returned without full identification of the owning unit which challenges the team to identify the rightful owner! Help us by following the return procedures posted by your deployed organization or the standard return procedures posted at our website. As an absolute minimum, always include your DODAAC and a good "ship-to" return address so we can expedite the repair, return or replacement process!

Randy Robinson at DSN 992-6140

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Who to Call?

For GPS integration and new products, call the PMO.

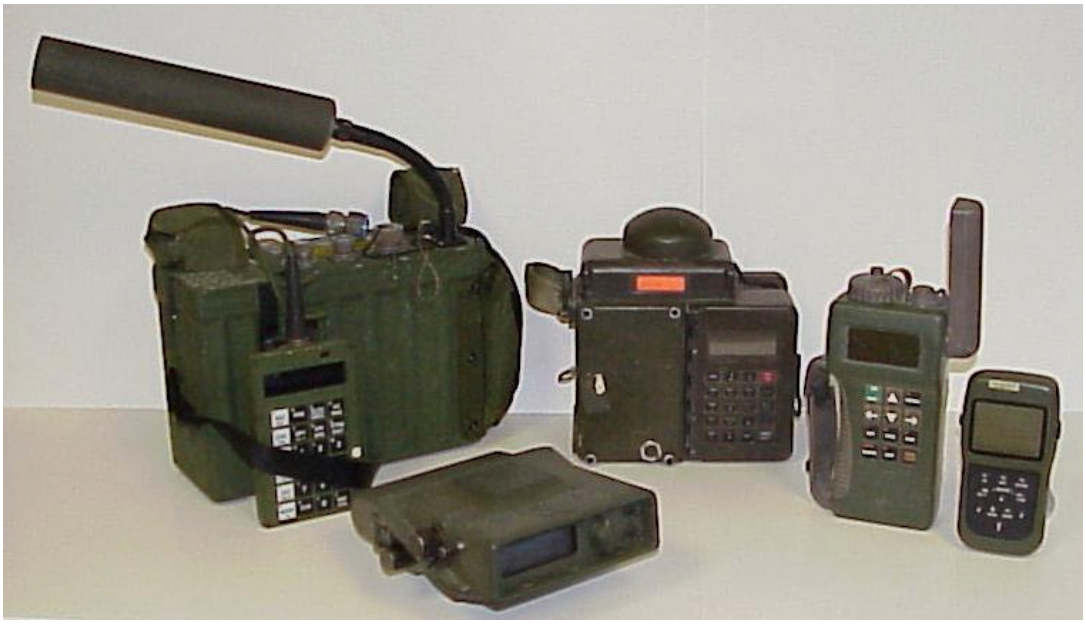
For equipment authorizations, Deferred Maintenance, fielding, host vehicle installations and New Equipment Training, call the MFO.

For sustainment support including software, supply, technical publications and accessories, call the GFO.

Or visit the WEBSITE: http://Army-gps.robins.af.mil

If you need further assistance, contact the newsletter editor at address on page one and we'll put you in contact with the right office.

The Evolution of Hand-held Military-rated GPS Receivers Equipped for Precise Positioning Service (PPS) Mode



From the left, the 17lb AN/PSN-8 backpack @ $34,000, the 10lb AN/PSN-9 portable @ $20,000, at front left is the 4 lb AN/PSN-10 @ $3,800 (PPS version was the AN/ASN-169),and on the right are the 3 lb AN/PSN-11(V) PLGR @ $1,058, and the 1 lb DAGR, nomenclature pending.

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