MaxQData, LLC

Windows Desktop and Windows Mobile Software

END USER LICENSE AGREEMENT

NOTICE: THIS IS A LEGAL AGREEMENT BETWEEN YOU AND MAXQDATA, LLC. YOU MUST READ AND ACCEPT ALL OF THE TERMS OF THIS END USER LICENSE AGREEMENT IN ORDER TO BE LICENSED TO USE THE ACCOMPANYING SOFTWARE. USAGE OF ANY COMPONENT OF THE ACCOMPANYING SOFTWARE, OR INSTALLATION OF THE ACCOMPANYING SOFTWARE ON A COMPUTER, OR DOWNLOADING THE SOFTWARE INDICATES YOUR ACCEPTANCE OF AND BINDS YOU TO ALL THE TERMS OF THIS AGREEMENT. READ THIS AGREEMENT CAREFULLY. IF YOU ARE NOT WILLING TO ACCEPT THE TERMS OF THIS AGREEMENT, DO NOT DOWNLOAD OR INSTALL OR USE THE SOFTWARE.

This MaxQData, LLC ("MaxQData") End User License Agreement ("EULA") covers the accompanying software products and related written materials and images, including but not limited to Chart, Flight, gCal, Setup, Codes, MQGPS-TraQr Manager, sensor drivers, related .DLLs, and other related software and documentation (collectively, "Software"), designed to work with related MaxQData hardware products or compatible products from third parties ("Hardware"). This End User License Agreement also covers upgrades, patches, bug fixes, or documentation or utility software, related to said software product or written materials or images, that are distributed without an accompanying EULA. You must agree to use any Hardware according to all terms and conditions in this EULA in order be licensed to use the Software.

1. Intellectual Property

MaxQData owns intellectual property rights in the Software and Hardware, including but not limited to Copyright, Patent, Look and Feel, Trade Dress, Trademark, and Trade Secret rights. These rights are protected by U.S. and international laws and treaties. You agree not to violate these intellectual property rights. You agree not to copy the Software except as explicitly allowed herein. You agree not to reverse engineer the Software or Hardware, including data file formats and APIs.

2. Terms and Fees

You are not licensed until you have accepted all the terms and conditions of this EULA and paid the appropriate license and/or purchase fees for the Software and/or Hardware to MaxQData or its authorized distributor or reseller.

3. Installation

In the absence of a separate specific license agreement superseding this section, you are permitted to install the Software on an unlimited number of computers, as long as you own, lease, or rent each computer. You may be required to purchase unlock or registration codes for each separate installation. You are not permitted to install the Software on computers you do not own, lease, or rent, except when you are acting as an agent of the owner and the owner is licensed under this EULA. You must remove the Software before the computer on which it is installed passes from your control.

4. Use

You are permitted to use the Software and Hardware so long as your use of the Software and Hardware does not violate any laws, including but not limited to traffic laws and noise ordinances. You are permitted to use the Software and Hardware only when exercising due caution, when using appropriate safety equipment, and under circumstances that present no unusual or unexpected risk to life, limb, or property.

5. Third Party Use

You agree that third-party use of any Software licensed to you shall be on a short-term basis (e.g. for a racing event; for a demonstration; for instructional purposes; where the scope of use is limited in duration to a racing event or less and the Software returns to your possession and control afterwards) and only when you are present and aware of that party's actions. Refer to section "Indemnification" for other relevant terms and conditions.

6. Suggestions

You grant MaxQData a fully-paid-up, perpetual, unrestricted, transferrable, irrevocable license to any recommendations, improvements, new product ideas, designs, copyrighted material, or patentable methods you transmit to MaxQData or post on any forum or Wiki owned or managed by MaxQData, whether solicited or unsolicited, for use in its present or future products, services, or business methods.

7. Data

You grant MaxQData a fully-paid-up, perpetual, unrestricted, transferrable, irrevocable license to any flight recordings, data files, telemetry data, images, video, or debug logs (collectively "Data"), related to or deriving from your use of the Software or Hardware, which you transmit to MaxQData, or post on any forum or Wiki owned or managed by MaxQData, whether solicited or unsolicited.

8. Indemnification

You agree to indemnify and hold harmless MaxQData for any claim against it regarding all: a) injuries or damages occurring during your use of the Hardware and/or the Software, and b) injuries or damages occurring during third party use of Hardware owned by you and/or Software licensed to you. You agree this indemnification shall hold under any circumstances and in any place including but not limited to injuries or damages occurring while racing, while on public or private roads or property, while on a body of water or while airborne, and even when such injuries or damages are claimed or proven to have resulted from correct, incorrect, unexpected, distracting, or erroneous operation or inoperation of the Software or Hardware, and even when such injuries or damages were foreseeable or not foreseeable by you or by MaxQData, and even when an agent of MaxQData was present at the time of the injuries or damages, and even when an agent of MaxQData was in control of or co-driving the vehicle used at the time of the injuries or damages. You agree to indemnify and hold harmless MaxQData for any claim against it by you or by third parties for intellectual property you transmitted to MaxQData covered by section "Suggestions" or section "Data".

9. Disclaimer of Warranties

MaxQData provides the Software and Hardware AS IS AND WITH ALL FAULTS. MAXQDATA MAKES NO WARRANTIES, EXPRESS OR IMPLIED OR STATUTORY, AS TO NONINFRINGEMENT OF THIRD PARTY RIGHTS, MERCHANTABILITY, ACCURACY, SAFETY, LACK OF NEGLIGENCE, LACK OF WORKMANLIKE EFFORT, OR FITNESS FOR ANY PARTICULAR PURPOSE. IN NO EVENT WILL MAXQDATA BE LIABLE TO YOU FOR ANY CONSEQUENTIAL, INCIDENTAL OR SPECIAL DAMAGES, INCLUDING ANY LOST PROFITS OR LOST SAVINGS, TOWING CHARGES, RACING DAMAGES, EMISSIONS-RELATED FAILURES OR VIOLATIONS, OR TRAFFIC TICKETS, EVEN IF A MAXQDATA REPRESENTATIVE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR THE POSSIBILITY OF SUCH DAMAGES WAS FORESEEABLE BY MAXQDATA, OR FOR ANY CLAIM BY ANY THIRD PARTY. THE ENTIRE RISK AS TO THE QUALITY OF THE SOFTWARE, ITS PERFORMANCE, SIDE EFFECTS, AND FORSEEN OR UNFORSEEN CONSEQUENCES OF USE, REMAINS WITH YOU. Some states or jurisdictions do not allow the exclusion or limitation of incidental, consequential or special damages, or the exclusion of implied warranties or limitations on how long an implied warranty may last, so the above limitations may not apply to you. To the extent permissible, any implied warranties are limited to ninety (90) days.

10. Termination

Termination is automatic at the time you violate any of the provisions in this EULA. MaxQData may terminate this EULA at any time with or without cause, and with or without refunding any license fees. You may terminate this EULA at any time, with or without cause, by destroying all copies of the Software and notifying MaxQData. In the event of termination, you agree to destroy all copies of the Software. The provisions of section "Intellectual Property", section "Suggestions", section "Data", section "Indemnification", section "Disclaimer of Warranties", and section "Governing Law" shall survive termination.

11. Governing Law

This EULA is governed by the laws of the State of Washington.

12. Version, Supersession

This EULA is version 4, revised April 21, 2008, and supersedes all previous EULAs upon installation or download of any accompanying Software.

MQ200™ User Manual

<u>MQ200 Quickstart Guide</u>

Thank you for purchasing a MaxQData™ MQ200™ system. If you have any problems getting started, you can send email to Info@MaxQData.com or call 800-589-7305.

This quickstart guide assumes you are using an MQ200 with a Pocket PC. If you are using a laptop in the car to do the actual data collection, the steps are similar, but please refer to your laptop's documentation for instructions on setting up a Bluetooth Serial Port Profile connection to the MQ200, as the exact steps can vary between different computers. If you are using an MQ200 with an RS-232 connection, the steps are the same except of course that you do not need to set up Bluetooth.

NOTE: The "X" in the upper right corner of the Pocket PC screen does not close an application. It minimizes it. Always use File > Exit to truly exit from any MaxQData application.

IF YOU ORDERED YOUR MQ200 WITH A POCKET PC, YOU DO NOT NEED TO PAIR IT. ALL SOFTWARE HAS BEEN LOADED AND CONFIGURED FOR YOU. TO OPERATE:

IF YOU PURCHASE THE MQ200 BY ITSELF, YOU WILL NEED TO PAIR IT WITH YOUR POCKET PC OR LAPTOP AND SET UP THE SOFTWARE ACCORDING TO THE INSTRUCTIONS BELOW.

<u>Mounting</u>

MQ200 data acquisition unit: The MQ200 needs to be mounted <u>flat</u> and <u>level</u> for the internal accelerometers to work properly. Try the floor or the trunk. Check the installation location with a bubble level before attaching the unit with fasteners. The unit must also be mounted either lengthwise/parallel to the centerline of the vehicle or widthwise/perpendicular to the centerline. Mount the system in a dry, clean location where it is not exposed to heat, water, fluids, or excessive dirt. The recommended attachment method for most applications is high-strength adhesive Velcro strips.

Pocket PC: Mount the Pocket PC securely in a dry, clean location. You can mount the Pocket PC with the Velcro, but be careful when dismounting the Pocket PC as excessive force can pull off the battery cover.

<u>Wiring</u>

> **WARNING: Work carefully around airbag wiring. These wires are usually yellow. Never make a connection to an airbag wire. Always stay clear of airbag deployment areas when working on an airbag-equipped vehicle. DO NOT MOUNT ANYTHING IN FRONT OF AN AIRBAG.**
>
> **CAUTION: Do not tap sensors used in ABS, Stability Control, or other safety-critical systems.**

CAUTION: Make wiring connections only with power disconnected and the car turned "off". Check for short circuits before applying power. Protect wires from cuts and abrasion.

Pocket PC: Connect the Bluetooth adapter (or RS-232 cable) to the connector on "Side 3" of the MQ200. If you need to, you can use a DB9 M-F "straight-through" extension cable to provide additional length. If you are using an RS-232 cable to connect a standard male PC-type serial port, you need a M-F "straight-through" cable.

GPS only: Plug into the "GPS/OBD-II" port on "Side 1" of the MQ200. The GPS module is powered directly from the port.

OBD-II with GPS: Your OBD-II module came with a Y-cable. Plug the "MQ200" end into the "GPS/OBD-II" port. Plug the GPS module into the "GPS" end. Plug the OBD-II module into the "OBD-II" end. Plug the OBD-II cable into the other end of the OBD-II module. Plug the OBD-II cable into the OBD-II port on the car

Direct sensor inputs: You may wish to tap into the vehicle's wiring harness to read sensors directly. You will need to identify which wires to tap with the help of a service manual wiring diagram. You can use "tap-in squeeze connectors" (e.g. Radio Shack 64-3053) to make the connection. Be sure to protect the tap connection from moisture and corrosion by wrapping it with silicone tape or by using a sealant. On cars with OBD-II systems, do not leave the MQ200 unpowered while the car is "on" if you have tapped into existing sensor wiring, as this can trip fault codes.

+12V Power: If you are not using OBD-II, you connect power to the MQ200 through the "BAT+" and "BAT-" screw terminals.

Calibration

The internal 3-axis accelerometer (and angular rate sensors, if equipped) were tested at the factory and the calibration constants stored in the file a factory calibration file. This file is emailed to you from MaxQData and is named with the serial number of your MQ200. You must load this file for proper operation of the internal sensors, as described later. Do not lose this file.

Step 1 - Partnering your Pocket PC with Windows 2000 or Windows XP

Before you can connect your Pocket PC to your laptop or desktop PC, you must first download and install the "ActiveSync" application from Microsoft. You may also have ActiveSync on the CD-ROM that came with your Pocket PC, but it is recommended to download the latest version from the Microsoft website. You can find this quickly by going to www.microsoft.com and searching for "ActiveSync". Install ActiveSync, then follow the on-screen instructions for connecting to and setting up a partnership with your Pocket PC. From then on, ActiveSync will run automatically when you connect your Pocket PC.

You can transfer files by clicking the "Explore" button in the ActiveSync window. The initial file explorer window shows the "\My Documents" folder on the Pocket PC, which is where you will find all your data files unless you change the location later.

Step 1 - Partnering your Pocket PC with Windows Vista

Setting up a Pocket PC is automatic under Windows Vista. Do not install ActiveSync. Instead, you need to use "Windows Mobile Device Center". First, be sure that your PC is connected to the Internet. Then connect your Pocket PC to your PC using the USB cable that came with it. Windows Vista will recognize the device and automatically download and install Windows Mobile Device Center from Microsoft. Follow the on-screen instructions for setting up a partnership with your Pocket PC. From then on, Windows Mobile Device Center will run automatically when you connect your Pocket PC. You can also access it from the Control Panel.

You can transfer files by clicking "Browse the contents of your device" under "File Management". The initial file explorer window shows the root folder "\" and may also show a Storage Card folder. Double-click on "\", then double click on "\My Documents". This is the folder where you will find all your data files unless you change the location later.

Step 2 - Software Download and Installation – Pocket PC

Download the latest software from the MaxQData website. You will need the file specifically for Pocket PC. The name of the file will be similar to "MaxQData 28c PPC Software.exe". Transfer this file to the \My Documents folder on your Pocket PC using ActiveSync or Windows Mobile Device Center as explained above. Then on the Pocket PC, tap Start > Programs > File Explorer (it may also be found on the Start menu). You should see the \My Documents folder; if not, navigate to that folder. Locate the installation file and tap its name to install the MaxQData software. This will install the Chart, Flight, and Setup applications, and optionally the Codes utility. Chart is for data analysis, Flight is for collecting the data, and Setup is for setup and calibration. Codes is a simple OBD-II code scanning utility. After installing the software, delete the install file from the Pocket PC.

In addition to the installation file, be sure to transfer the factory calibration file you got from MaxQData to the Pocket PC. You will use it later.

Step 3 – Software Download and Installation – Laptop/Desktop

Again, download the latest software from the MaxQData website. You will need the file labeled as "PC Chart". The name of the file will be similar to "MaxQData 28c PC Chart.exe". Download the file to your laptop and double-click on it to run it. This will install only the Chart software on your PC, which is what you will need to do data analysis.

Step 4 – Bluetooth Pairing with a Windows Mobile 2003 Pocket PC

- Power on the MQ200.
- Tap the Bluetooth icon at the lower right of the Today screen and turn on Bluetooth.
- Run the Bluetooth Manager from the Bluetooth icon.

- Tap “New”, and then “Explore a Bluetooth Device”. The Pocket PC will search for new Bluetooth devices. An icon should appear for “Aircable xxxxx” or similar. The number “xxxxx” identifies your module. Tap this icon.
- Select “Serial Port” and “Next”. A shortcut will be created.
- Go back to the Today screen and select “Bluetooth Settings” from the Bluetooth icon.
- Tap the “Services” tab.
- Tap “Serial Port”. Check “Enable service”. Uncheck the other checkboxes.
- Tap “Advanced” and make a note of the “Outbound COM Port”.
- Tap “OK” and “OK” again to get out of the Bluetooth Settings applet.
- Run MaxQData Setup and go to Settings > Serial Port Settings. For “GPS Port”, enter “COMx”, where “x” is the number of the Outbound COM Port. Select “Is Bluetooth” under “GPS Port”. Continue with the remaining setup as described below under “MQ200 Setup”.
- If you are ever asked for a passkey for the Aircable, it is either 1234 or the module ID number.

Step 4 – Bluetooth Pairing with an HP iPAQ rx4200 Pocket PC and certain others

- A few Pocket PCs based on Windows Mobile 2005 use the same pairing process as the one above for Windows Mobile 2003 devices.

Step 4 – Bluetooth Pairing with most other Windows Mobile 2005 Pocket PCs – Dell Axim X51, etc.

- Turn on the MQ200
- Tap the Bluetooth icon at the lower right of the Today screen.
- Check “Turn on Bluetooth”. You can either check or uncheck “Make this device discoverable”
- Go to the “Devices” tab and tap “New Partnership...”. The Pocket PC will scan for Bluetooth devices. An entry for “Aircable xxxxx” or similar will appear. The number “xxxxx” identifies your GPS module. Tap this entry and then “Next”.
- Enter the passkey for the Aircable and tap “Next”. The passkey is either 1234 or the module ID number.
- Check the “Serial Port” box and tap “Finish”.
- Go to the “COM Ports” tab.
- Tap “New Outgoing Port”
- Select your Socket BT GPS module and tap “Next”.
- Choose a COM port to use for the connection. “COM7” is recommended if available. Uncheck “Secure Connection”. Tap “Finish”. Note: on a Pocket PC Phone Edition device, your choice of COM port may interfere with the “Wireless Modem” function. If you find that you are unable to use the PPCPE as a wireless data modem after pairing the MQ200, delete the Outgoing Port and try a different COM port number.
- Run MaxQData Setup and go to Settings > Serial Port Settings. For “GPS Port”, enter “COMx”, where “x” is the number of the Outbound COM Port. Select “Is Bluetooth” under “GPS Port”.

Step 5 - Setup

After installing the software and pairing the MQ200 with your Pocket PC, run MaxQData Setup and check the following settings.

Settings > Serial Port Settings:

- "MQ Port" must be the outgoing COM port that you set up earlier during pairing.
- "Is Bluetooth" under "MQ Port" should be checked.
- "MQ Baud Rate" should be 115200
- "Delay Bluetooth Init" should be checked.
- "GPS Port" must blank (no spaces or any other characters).
- "Is Bluetooth" under "GPS Port" should be unchecked.
- "GPS Baud Rate" should be "38400".
- "Enable $GPRGH" must be checked.
- "GPS Hz" should be "Default"

Settings > MQ Module Configuration:

- "System type" must be "MQ200". Check "Pro" if you are using either an MQ200-PRO or MQ200-MAX
- For an MQ200-RT, check the following boxes: A0-A3, A12-A15, P0, and P5
- For an MQ200-PRO, check the following boxes: A0-A3, A4-A7, A8-A11, A12-A15, P0, P1, P2, P3, P4, and P5.
- For an MQ200-MAX, check the following boxes: A0-A3, A4-A7, A8-A11, A12-A15, A16-A19, A20-A23, A24-A27, A28-A31, P0, P1, P2, P3, P4, and P5.
- If you have any of the optional internal roll, pitch, or yaw rate sensors, check "A32-A37". Also check "Roll", "Pitch", and/or "Yaw" appropriately.
- Check "GPS" if you are using a GPS module
- Check "OBD2" if you are using an OBD-II module.
- Check "PWM" if you intend to use the PWM outputs of the MQ200-MAX.

Settings > Advanced:

- You do not need an unlock code for the MQ200. Simply leave this number "0".
- "Racing type" should be set to the kind of racing you expect to be doing most often.
- "Log type 1 records only" may be checked if you like. This will reduce the size of flight recordings by removing certain data that may be redundant. This is only really necessary for long recordings many hours in length.
- "Open before trigger" should be checked (but see later for details on how to use this option when hot-swapping data cards during pit stops).
- "Max lap count" prepares each flight recording to hold enough beacons for the specified number of laps. The default of 100 laps works for most users. Do not change this to an unnecessarily high value, as this will make the flight recordings unnecessarily large.
- If you are using OBD-II and you know your car's OBD-II bus type, set "OBD2 Bus" accordingly. This will speed bus initialization. You can also choose "Autosense". Otherwise, for systems without OBD-II, choose "None".
- Leave the ISO init timeout unless you are directed otherwise by MaxQData.

- Check ISO 14230 if your car has an ISO 14230 OBD-II bus (e.g. Subaru WRX STi)
- MQ ticks/s must be 1000.
- "Debug mode" and "Log serial" should be unchecked unless directed otherwise by MaxQData.

Next, use "File > Load Calibration Backup" to load the factory calibration file. Then expand "Sensors Requiring Calibration" and "Internal LatG". You must set "Orientation" under "Internal LatG" to match the orientation of the MQ200 as installed in the vehicle; see the on-screen tip or the sensor reference at the end of this manual for more information.

<u>Step 6 – Verify Operation</u>

Turn on the MQ200. From within MaxQData Setup, choose "Settings > Get firmware version". You may be prompted to select a Bluetooth device; if so, check the "Always use the selected device" box if it appears, then tap the icon for the Aircable. After a short wait, you should be presented with a message box that displays a firmware code which ends in the serial number for your MQ200. Exit from MaxQData Setup. Do not use the "X" button, which only hides the application on a Pocket PC instead of closing it. Use File > Exit instead. Make sure the GPS module has a good view of the sky. Run MaxQData Flight. Go into Configure > Sensors, select "Standard", and click "OK". Make sure the MQ200 is flat and level. Pick "Internal LatG" from one of the two drop-down selection boxes on the main screen. Verify that it is reading very close to 0.00g. Check "Internal LongG" as well to verify it is also very close to 0.00g. Pick "Satellite Count" from one of the two drop-down selection boxes on the main screen and verify that the GPS module is picking up a satellite count greater than 3.

<u>Step 8 – Trial Run</u>

With the MQ200 turned on and the Pocket PC running Flight, do a test run. Be sure to reach a speed above 20 MPH in order to trigger a flight recording. After your run, come to a stop, then run MaxQData Chart and load the file you just created, which should be named "Run000". Tap Map > Full GPS Map" if necessary to see your complete GPS trackmap. Your car is at the "+" sign. Tap one of the fields which reads "Select..." and choose "GPS Vehicle speed". This will bring up a vehicle speed data trace on the screen in the crosshair plot area. To move the data forward in time, tap and drag the plot area to the left. As you move the data forward in time, you will see the "+" sign move around the trackmap.

<u>Step 9 – View Flight Recording on PC</u>

Reconnect your Pocket PC to your PC. Using ActiveSync or Windows Mobile Device Center, open the \My Documents folder on the Pocket PC. You should see the "Run000.mqd" flight recording file. Drag and drop this file to your desktop, then double-click on it. MaxQData Chart will launch and automatically load the file. Be sure to select the correct racing type under "File > Racing type...". You may need to exit and restart Chart for this to take effect.

MQ200 Datasheet

General System capabilities

- Autocrossing: track mapping, segment timing, acceleration/ braking/ cornering/ MPH; immediate review of data without leaving your car
- Road racing: real-time lap time display, track mapping, lap and segment times calculated from GPS position, lap count, “continuous” lap time measurement (Time since last here), acceleration/ braking/ cornering/ MPH, etc.
- Strip/Street: full “magazine test” performance calculations, including:
    - Time to speed (e.g. 0-60, 5-60, 50-70, 0-100, ...)
    - Time to distance (60’, 330’, 1/8 mile, 1000’, ¼ mile), speed at distance, deceleration
    - Lateral acceleration
- 3-axis internal accelerometer
- Analog and Pulse inputs for direct sensor connections
- Optional OBD-II
- Optional 5 Hz high performance GPS
- Horsepower
- Altitude
- GPS UTC time (synchronized among all vehicles)
- Automatic start and stop of flight recordings based on vehicle speed
- Color graphic real-time display featuring four display modes: bar graph, strip chart, X vs. Y, and numeric; touch-screen operation
- Recording time limited only by available memory. 32 MB can hold more than 20 hours of data.
- Color graphic timeslip images, Excel spreadsheets, web page result summaries
- Analysis software for both Pocket PC and PC, including data file overlays, lap/segment time lists with min/max/average, manual and automatic beacon placement, GPS track map full/zoom, export to Excel™ and text files, timeslip generation
- Automatic emailing of data files; automatic text messaging of lap and segment times in real time (requires Phone Edition device and a data plan from your wireless provider).
- Automatic start and stop of flight recordings based on vehicle speed

MQ200-PRO system capabilities

- 6g, 3-axis accelerometer
- 12 analog and 6 pulse input channels
- 100 Hz sampling
- Optional internal Roll, Pitch, and Yaw rate sensors

MQ200-MAX system capabilities

- 6g, 3-axis accelerometer
- 28 analog and 6 pulse input channels
- 2 relay or pulse-width modulated outputs

- 100 Hz sampling
- Up to 500 Hz sampling on selected channels (recommended for shock velocity measurements)
- Optional internal Roll, Pitch, and Yaw rate sensors

GPS Module Technical specifications

- 32 channel GPS receiver
- 1 second hot start, 39 seconds cold start
- -158 dBm sensitivity
- 5 Hz sample rate

Mounting

The most important considerations for mounting are:

- The MQ200 must be both flat and level when mounted in the vehicle so the accelerometers read accurately.
- It must be aligned with the centerline of the vehicle, though it does not have to be directly on the centerline. Either the major or minor axis of the MQ200 must be parallel with the centerline of the vehicle. Locating the MQ200 near the center of gravity is not critical. Eyeballing the centerline alignment is generally OK.
- Typical good mounting locations are in the passenger footwell, under the passenger's seat, behind the driver's seat, in the trunk, or under the rear parcel shelf. As long as the MQ200 is flat and level, pretty much anywhere will do.
- Do not mount the MQ200 in the engine compartment, or where it will be exposed to intense heat, or where it will be exposed to water spray.

The recommended mounting mechanism for most installations is high-strengthVelcro™ or a similar product. Here are some of the more common scenarios:

- Production car carpeting
  This usually works very well if Velcro will stick to your carpet. Apply the "hook" side of the Velcro to the box and discard the "loop" (fuzzy) side.
- Race car floorpan
  You'll want to find a flat and level smooth metal or plastic surface that isn't exposed to heat, fluids, water, or excessive dirt. You can apply Velcro to hold it in place.
- Hard mount
  You can fabricate a strap that will hold it in place on a flat surface. Alternatively, you can drill through the housing of the box and insert your own hardware. You need to take apart the MQ200 enclosure to do this, and you need to clean out all the aluminum chips from any drilling or cutting that you do. Send email to Info@MaxQData.com for details.

Pocket PC

There are numerous mounting solutions available for mounting Pocket PCs in cars. Check with a vendor such as www.mobileplanet.com or www.ram-mount.com to see if there is anything that suits your needs.

At MaxQData, our favorite approach is to fasten the Pocket PC to the dashboard with Velcro™. A few judiciously applied strips on the back of the device and on the dashboard are usually enough to hold under hard driving. Be careful when removing the Pocket PC so as not to pop off the battery door on the back of the Pocket PC.

If you have Flight set up to trigger a flight recording automatically, then you can put the Pocket PC in a glove box, center console, or otherwise hidden out of sight. Be sure to flip the screen lock switch or close the screen cover to prevent the screen from being touched while operating.

Protect your Pocket PC from water, heat sources, and dirt. Use a protective case where necessary.

Laptop

If you are using a laptop for data collection, it will require a secure mounting solution. For temporary use, it is sometimes possible to use the seat belt of the passenger seat to hold the laptop. Other applications may require the installation of a permanent hardmount. Keep in mind that the hard drives in laptops may become damaged from excessive shock and vibration. Companies like www.ram-mount.com provide vehicle mounting solutions for laptops.

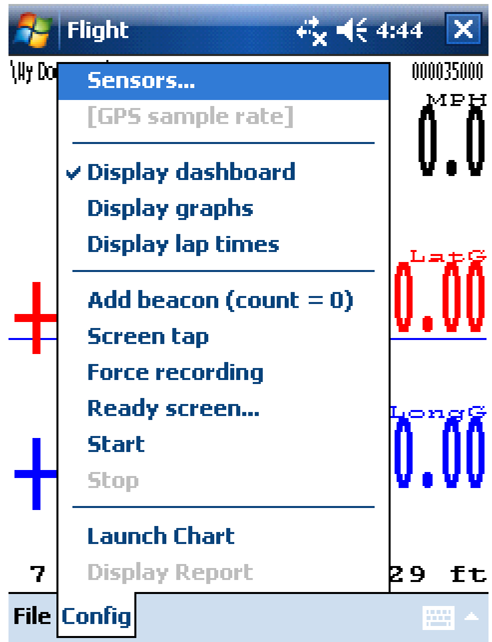
Using Flight

Flight is the application that records your data, displays data in real time, and shows lap and segment times. You can start Flight either before or after you turn on your MQ200. You can even assign it to a button on the Pocket PC using "Start > Settings > Personal > Buttons".

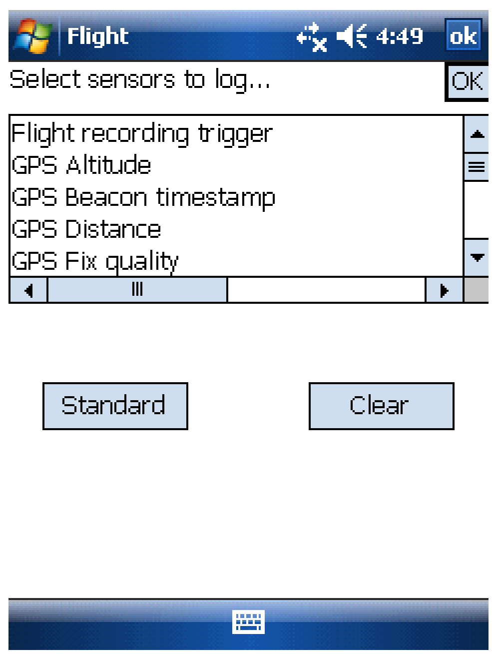
Initial Configuration

Turn on your MQ200 and run Flight. The first time you do this, you will see:

Tap "Config" and a menu pops up:



Now tap "Sensors..." and you'll be presented with a list of sensors that you can flight record. To begin with, tap the "Standard" button. This will enable the most commonly-used sensors. Later, you can add other sensors by clicking on them. Flight will remember the sensors you pick and will automatically select them each time you restart Flight.

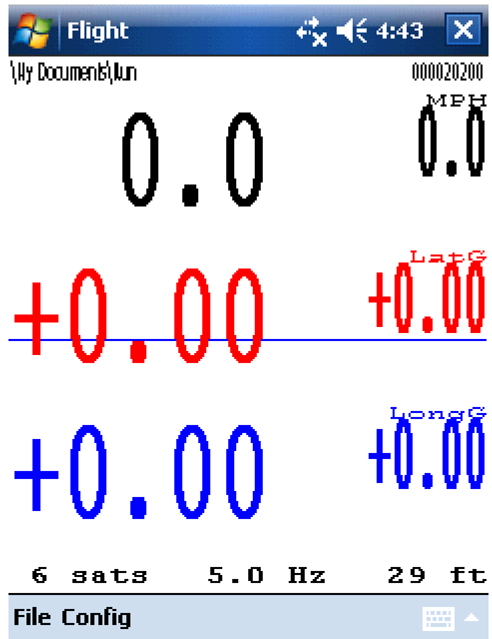


The Standard sensor configuration does not enable lap and segment timing. You first need to set up beacons using the Chart application. See the "Working with Beacons" section later in this manual for complete details.

The Standard sensor configuration enables automatic flight recording based on vehicle speed. The default configuration causes a flight recording to start when the vehicle exceeds 20 MPH, then stop when the speed drops below 15 MPH for more than 5 seconds. Flight stores 25 seconds of data (12.5 seconds at 10 Hz) from the time before the vehicle hits 20 MPH to ensure that you do not lose data from the launch.

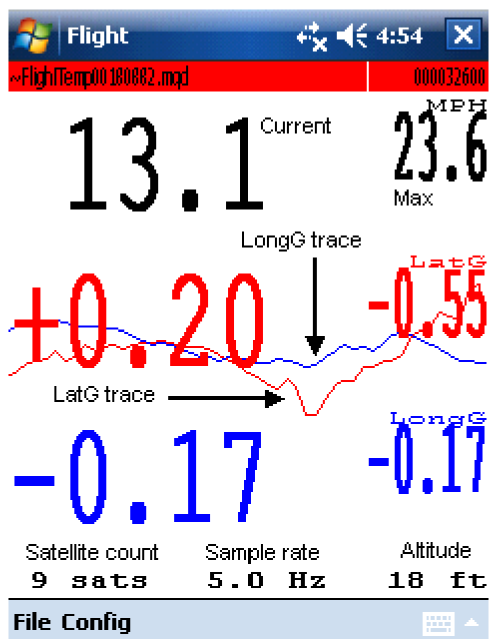
Display Dashboard

Tap "OK" and you will return to the main screen. This is the default "Display Dashboard" mode, accessible with Config > Display Dashboard. If the MQ200 is connected, the number in the upper right corner ("000020200" in this case) will be counting up. If the MQ200 is not connected, it will read "[time code]".



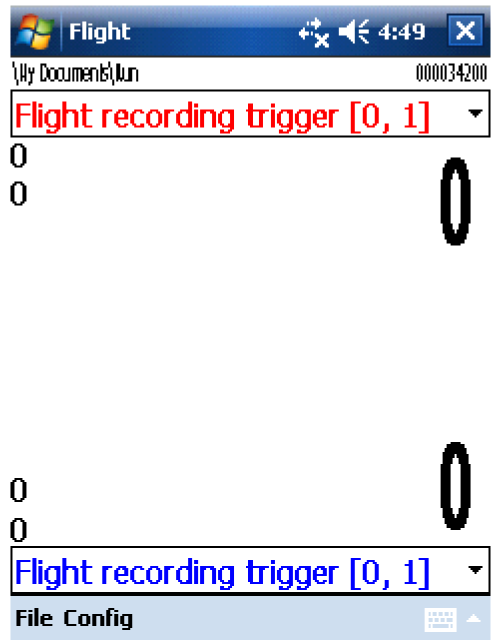
Also note the "\My Documents\Run" in the upper left corner. This is telling you that any flight recordings you log will go in the "\My Documents" folder on the Pocket PC, and they will begin with the word "Run".

This image explains the elements of the dashboard display. The larger numbers are the current values of MPH, LatG, and LongG. The smaller numbers along the right side are the maximum values of each over the past 10 seconds. LatG and LongG are also plotted as red and blue traces in the background. At the bottom of the screen are the current satellite count, the average sample rate over the past 10 seconds, and the altitude above sea level.

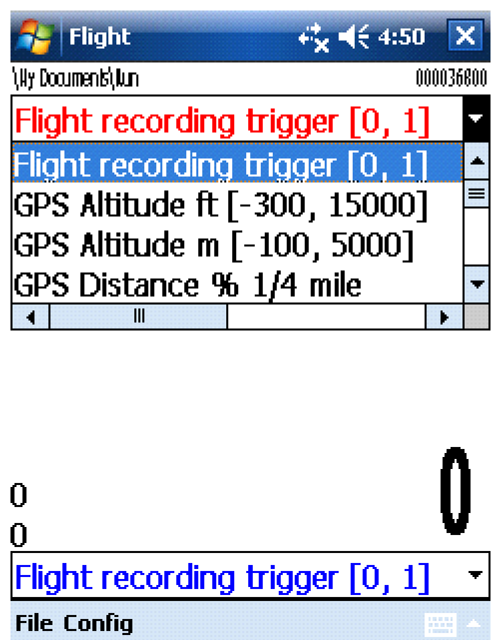


Display Graphs

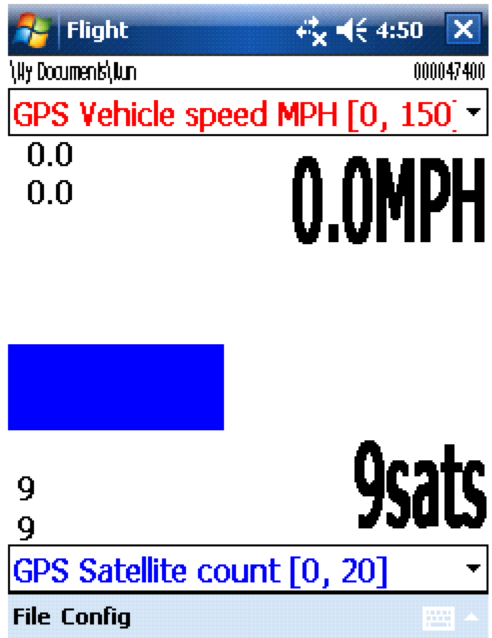
You can also use the user-configurable "graphs" display mode. Tap Config > Display Graphs. Initially, you will see this screen:



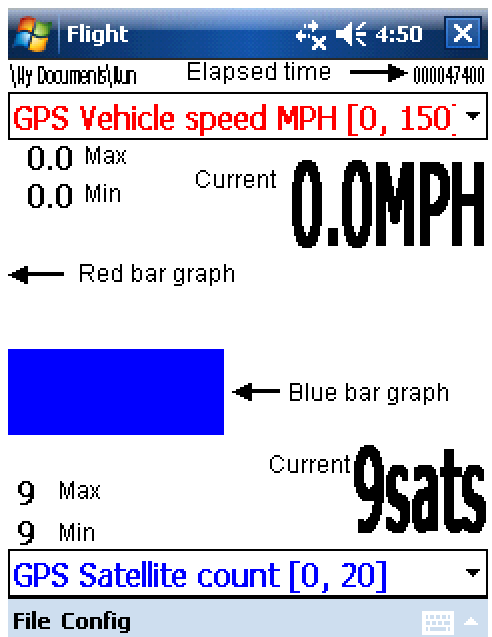
To the right of "Flight recording trigger [0, 1]" there is a small down-arrow. Tap one and a list of values will appear:



You can scroll through the list to select a value to view. In this screen, we have chosen “GPS Vehicle speed MPH [0, 150]” for the top (red) value, and “GPS Satellite count [0, 20]” for the bottom (blue) value. It is useful to check “GPS Satellite count” before each run to ensure that the GPS module is tracking at least four satellites.

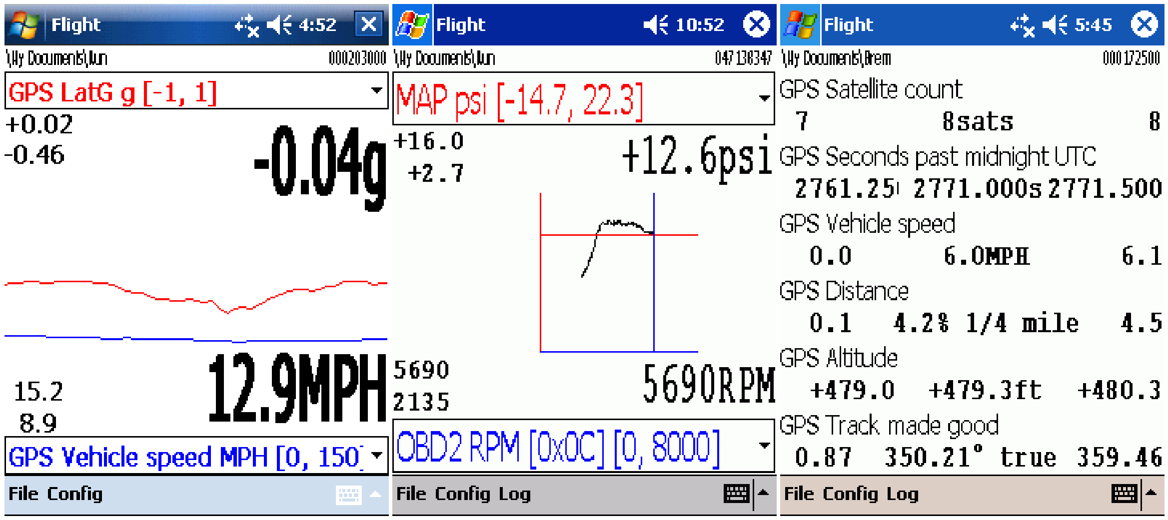


Here is an explanation of what you see on the screen. The "Max" and "Min" numbers are the maximum and minimum values seen in the last few seconds (either 10 or 20 seconds, depending on the Config > MinMax window setting). The “Current” numbers are the values “right now”. “Elapsed time” is a number that basically tells you if the connection to the MQ200 is operational. As long as this number keeps counting up, you are connected.



There are two bar graphs in this image. The red one is MPH, and the blue one is Satellite count. The length of the bar graph corresponds to the current value, with a range that corresponds to the numbers in brackets. For MPH, the range is 0 to 150 MPH. In this example, the car is not moving, so MPH is 0 and the red bar graph has a zero length. The range on satellite count is 0 to 20 satellites. We are currently seeing 10 satellites, which is half of 20, so the bar graph extends halfway across the screen.

The Config > Display Graphs option actually gives you a total of eight configurable screens for viewing data in real time. There are eight data views you can watch. There are two bar chart screens, two strip chart screens, two X vs. Y screens, and two numeric summary screens. To cycle between the screens, you use the left/right buttons on the front of your Pocket PC. You can also bring up the soft keyboard (tap the little keyboard at the bottom) and use the left or right arrows. Here are examples of the strip chart, X vs. Y, and Numeric Summary screens:



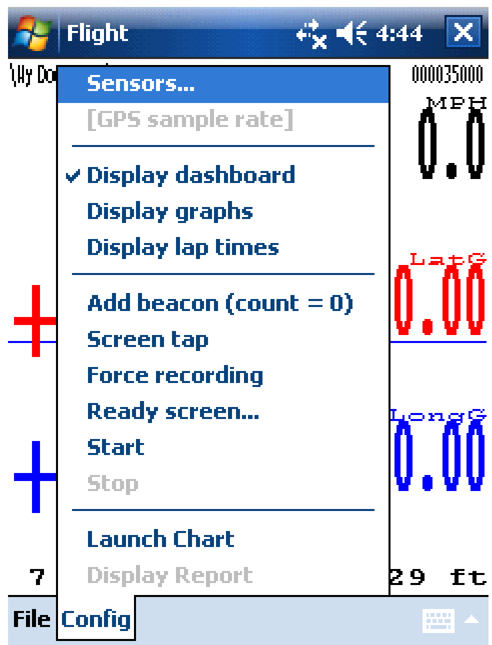
The two numeric text summary screens (Numeric A and Numeric B). summarize the min, current, and max values from the other bar graph, strip chart, and X vs. Y graphic screens. Numeric A summarizes the “A” screens and Numeric B summarizes the “B” screens. To see the numeric data you want on the numeric summary screens, you need to set up the previous six screens appropriately.

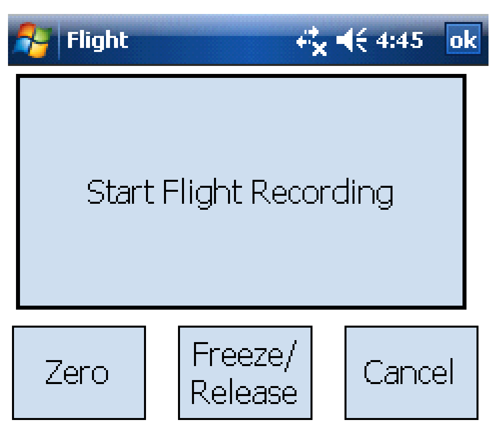
Starting a Flight Recording – Automatic Flight Recording Trigger

You must trigger a flight recording in order to cause data to be saved to memory. You can cause a flight recording to trigger automatically based on vehicle speed, which is the easiest method. Just ensure that you have "Flight recording trigger" in the list of sensors you have configured to record. It is automatically selected when you pick the "Standard" sensor configuration. This is the default setting when the software is first installed. The "Flight recording trigger" works for road racing as well as autocrossing a drag racing. In the default configuration, it will start recording when the vehicle is above 20 MPH, and then it will stop when the vehicle speed drops below 15 MPH for more than 5 seconds. This is a good all-purpose setting, because it filters out driving around the paddock at slow speeds. It works for autocrossing and drag racing because it will still capture 25 seconds (12.5 seconds at 10 Hz) of data before the trigger speed is hit, allowing you to see your burnout and launch.

Starting a Flight Recording – Screen Tap

The next most common way to start a flight recording is to use "Screen tap". Tap "Config", then tap on "Screen tap" to check it (we recommend leaving it unchecked when using the automatic Flight recording trigger to help prevent accidental triggering).





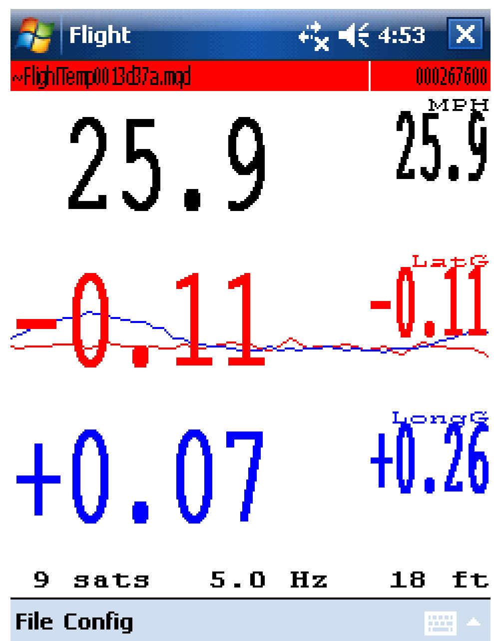
Now, to manually trigger a flight recording, tap anywhere in the middle of the screen and this will come up:

The big "Start Flight Recording" button is what starts the flight recording. The "Zero" button, which is rarely used,

resets certain values. “Freeze/Release” allows you to freeze the values on the screen and then release them. “Cancel” gets you out of this screen without creating a flight recording.

Tap “Start Flight Recording” and you will be back at the main display screen, only this time you will be recording data. When recording data, the top line will be colored red. In the upper left corner you will see the name of the temporary file used to hold the data.

To stop the recording, tap the center of the screen again. After a short delay (during which time Flight is flushing its data buffers and closing the flight recording file), you will hear a double beep and the red highlighting of the top line text will go away.

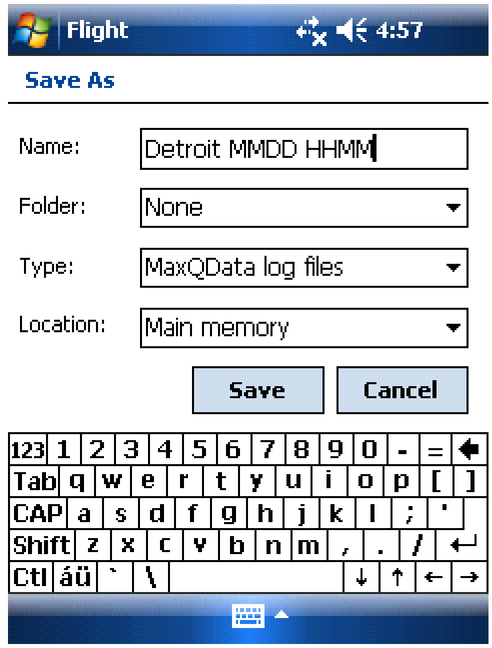


Starting a Flight Recording – Other Methods

The “Log” menu also gives you two more methods to start and stop a flight recording. The “Log > Start” and “Log > Stop” menu options start and stop a flight recording without using “Screen tap”. The “Log > Force recording” option causes a flight recording to start immediately as soon as you launch Flight and it doesn’t stop until you exit Flight. We do not recommend using Force Recording except in special circumstances.

Changing the Default Filename Prefix

The default filename begins with “Run”. You can change this, for example to give a different name to flight recordings taken on different days or at different tracks. In order to do this, chose “File > Set name prefix...” from the main menu. Enter a new filename prefix.

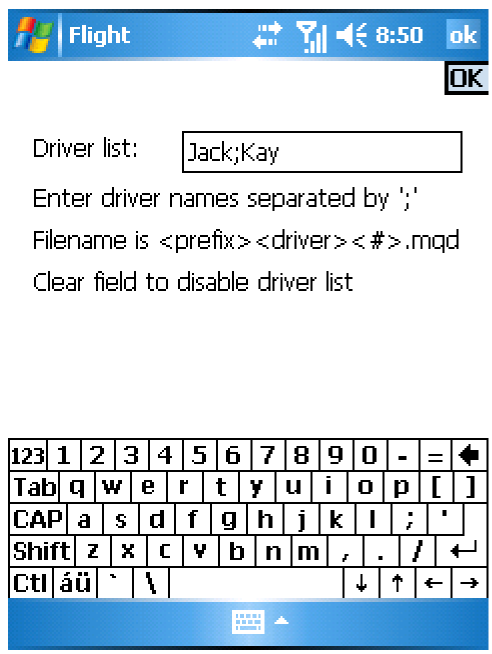


You can use the special codes “MMDD” and “HHMM” in the filename prefix. Flight will replace these codes with the month, day, hour, and minute, respectively. For example, “Detroit MMDD HHMM” will generate filenames with the month, day, hour, and minute in the filename. This is very convenient for determining which flight recording corresponds to which run or session. When using MMDD/HHMM, Flight will not use the three-digit numeric suffix.

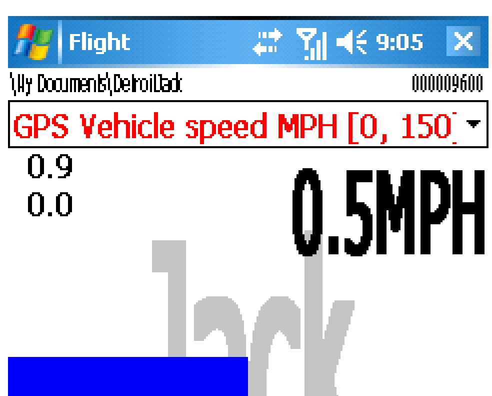
By specifying a different folder other than “My Documents”, you can have Flight automatically save to another location, such as a removable Storage Card.

Mulitple Driver Support

The menu option “File > Set driver list...” allows you to further modify the filenames used for flight recordings in order to better organize the data you collect from multiple drivers. Enter driver names separated by semicolons as shown here:



You must switch manually between drivers. To do this, you use the “up/down” control on your Pocket PC. The



name of the current driver will be shown in grey in the background of the main screen, like this:

Using the example of "Detroit" for the filename prefix (i.e. the event name) and "Jack;Kay" for the driver list, and with manually switching drivers between runs, then your data files will be named:

DetroitJack000.mqd
DetroitKay000.mqd
DetroitJack001.mqd
DetroitKay001.mqd
...

If you have multiple drivers driving multiple courses (as in a ProSolo event), you can also enter, for example, "JackLeft;KayLeft;JackRight;KayRight" for your driver list.

Preopened Flight Recording File

In order to reduce the time it takes to start a flight recording after pressing "Start Flight Recording", Flight by default will preopen a flight recording file. While Flight is running, if you look in the "My Documents" directory, you will see a flight recording with a numeric name that begins with the character '~'. If a flight recording is started, the data is stored in this file, and the file is closed and renamed when the flight recording is stopped. If a flight recording is never started, this file goes away when you exit from Flight. If Flight is abnormally terminated (e.g. by a system reset or some error), this temporary file will not be deleted automatically. You can delete it manually; however, if it contains important data, you may want to send it to MaxQData for recovery.

The Preopened Flight Recording File and Pit Stops

Some users save their flight recordings to a storage card so that the card can be swapped during a pit stop in order to analyze data just collected. This is typical in an endurance event. The preopened flight recording file is a problem in this case, because the preopened file resides on the storage card. Removing the storage card while there is a preopened file on it can cause Flight to lock up.

If you need to swap cards during a pit stop (while Flight is running), follow these recommendations:

First, enable the automatic Flight Recording Trigger to both start and stop the flight recording automatically. Ensure that the "Stop Speed" and "Off Delay" are set so that the flight recording is closed before the car stops in the pit. For example, if the pit speed limit is 35MPH and the slowest point on the track is 50MPH, a good choice for "Stop Speed" would be 40MPH, and for "Off Delay" would be 5 seconds. If you were to choose 30MPH for the "Stop Speed", then the flight recording wouldn't begin to close until the car is pulling into its pit. Since it takes several seconds to close (even of Off Delay is 0), the flight recording might still be active when the storage card is removed. A good choice for "Start Speed" in this case would be 45 MPH.

Second, turn off the "Open before trigger" option in MaxQData Setup. This is found under "Settings >Advanced..." When this box is unchecked, Flight will no longer preopen a new flight recording immediately after closing an old one. Instead, it will only open a new flight recording when triggered.

With this setup, Flight will stay running when the car is stopped but will not be recording data and will have no open file. Then you can eject the Storage Card and insert a second Storage Card without problems.

Timeslips

When Racing Type is set to Drag Race (in Setup), the "Timeslip" option will appear in the "Config" menu. When enabled, a ¼ mile timeslip will be automatically generated at the end of your run.

Launch Chart at End of Run

When Racing Type is set to something other than Drag Race, the "Timeslip" option will be replaced with "Launch Chart". If this option is enabled, Chart will be launched at the end of your run and the flight recording you just collected will be displayed, allowing for immediate access to your data.

Display Report

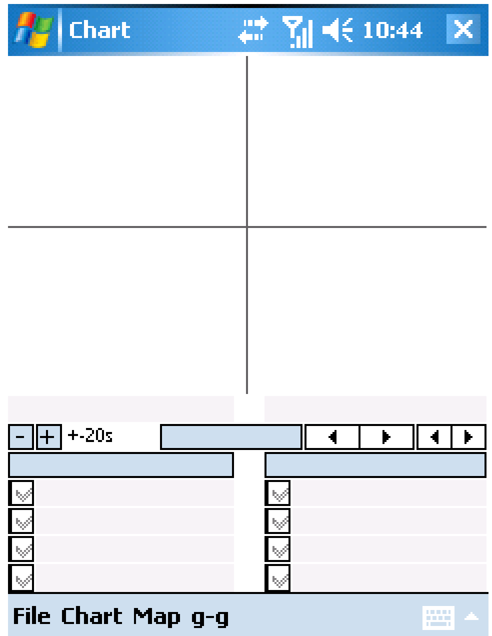
The "Display Report" option in the "Config" menu affects the "Timeslip" and "Launch Chart" options. If "Display Report" is unchecked, then after generating the timeslip or loading the last flight recording in Chart, you will automatically returned to Flight after a few seconds. But if checked, then the timeslip or Chart will remain in the foreground. Flight, however, is still running in the background while the Timeslip or Chart is displayed. You can continue to record data assuming you have the Flight Recording Trigger enabled.

Course Walk Beacons

Under the "Config" menu you will find "Add beacon". Use this while walking the course to add beacons to the flight recording during the course walk. There are two main reasons for this feature: 1) to mark individual cones on an autocross course so you can see orange cone marks when you load flight recordings into Chart, and 2) to mark the finish line and other desirable beacon locations around the course. Most MQ200 users will not be able to walk the course while carrying the MQ200. This feature is primarily for MQGPS users. See the MQGPS User's Manual for more information.

Using Chart

Chart is the app you use to review flight recordings that have been generated by Flight. Chart lets you load several files at once and view them either individually or two at a time, overlaid.

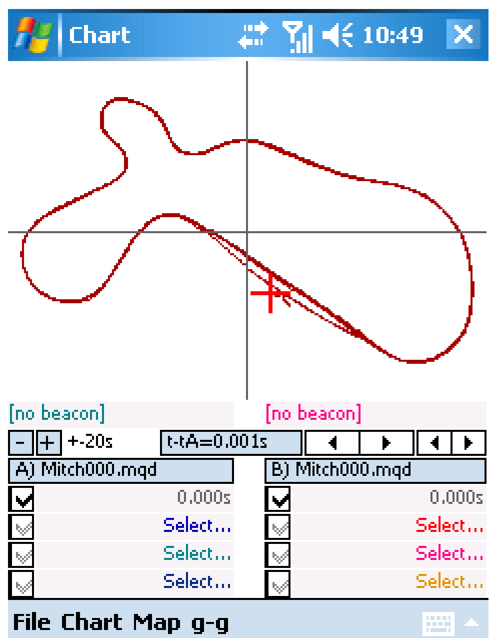


This section uses screenshots primarily from Chart running on a Pocket PC. You can also run Chart on a desktop or laptop PC. The functionality is the same, with just a few minor differences in the user interface which will be discussed later.

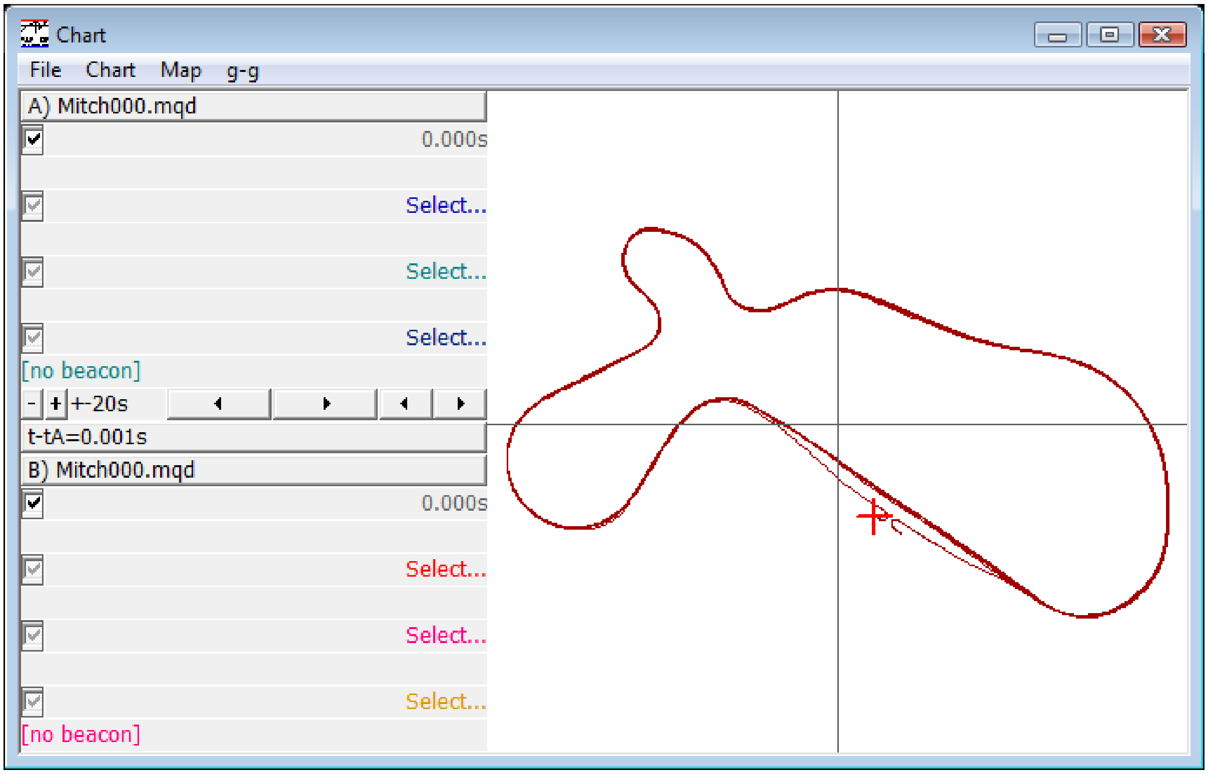
The data shown here is the file “Mitch000.mqd”, which is downloadable from the MaxQData website. You can follow along with the examples by transferring it to your Pocket PC or using it on your PC.

Run Chart. You do not need to have Flight running. You will see this screen. To ensure consistency with this example, you should tap “File > Racing type...” and make sure that “Road race” is selected. If not, change it to “Road race”, then “File > Exit” from Chart and restart to make the change take effect.

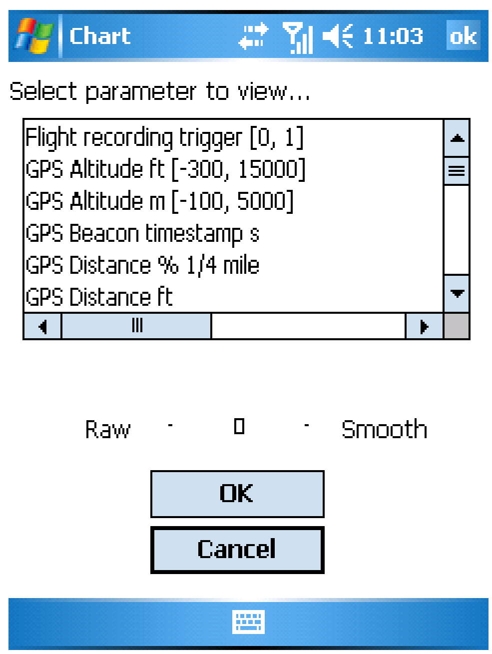
Now tap “File > Load...” and select the file “Mitch000.mqd”. The trackmap will be displayed in the plot area of the screen. In this view (“Full GPS map”), North is always at the top of the screen.



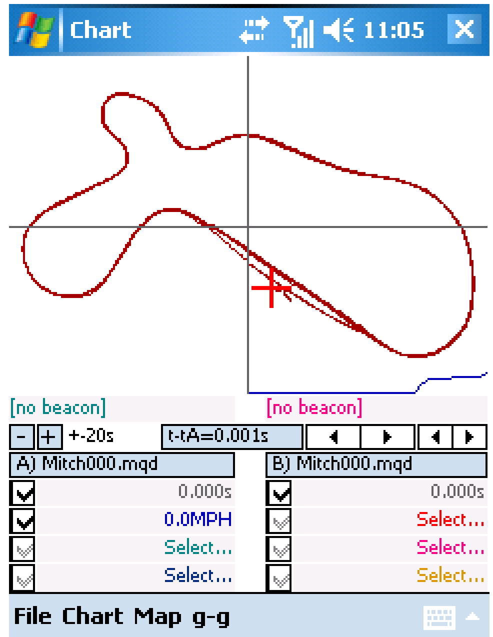
On a PC, it will look like this:



Tap the blue "Select..." field and you will see this:

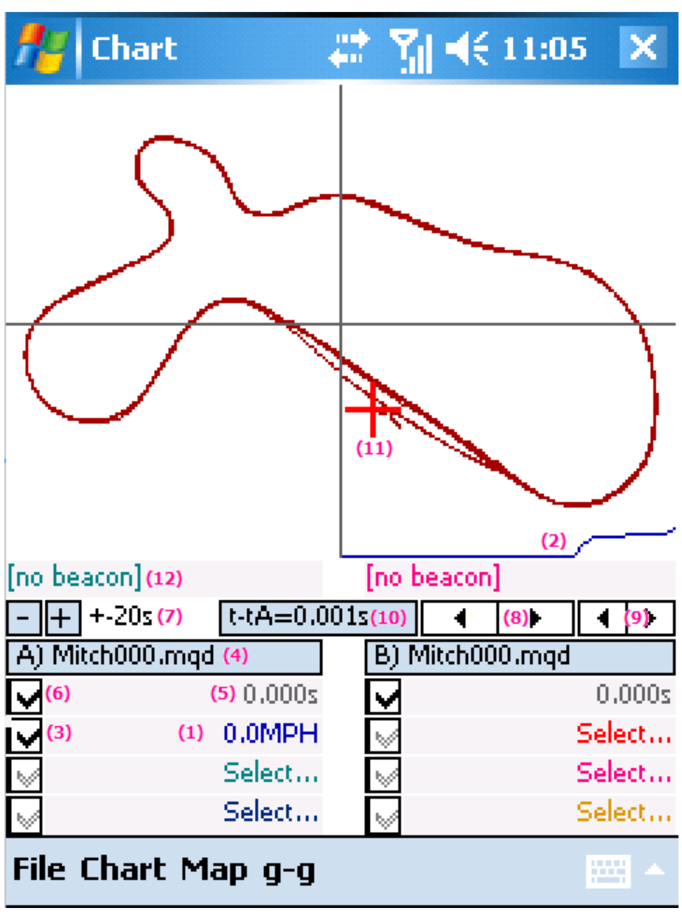


Scroll down to "GPS Vehicle speed MPH [0, 150]", select it, and tap "OK". Now you get this:



User Interface

This is a good time to describe the user interface. Here we have expanded the screenshot and numbered the various areas of the screen you need to learn about:

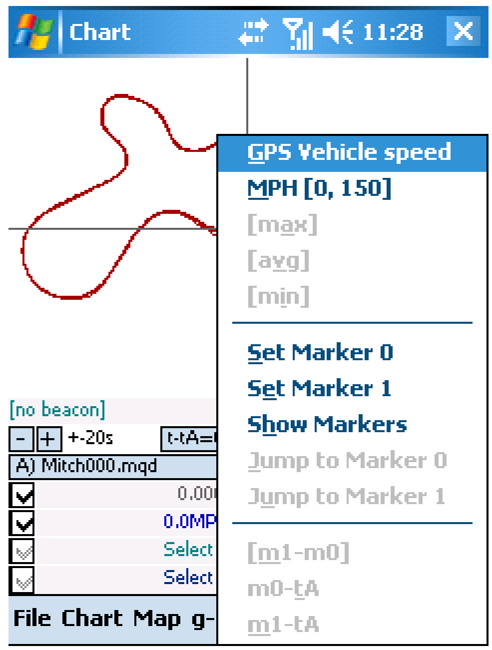


In order to get the most out of the small screen on a Pocket PC, we made the display elements respond to screen taps in order to access related functionality. You are encouraged to try these out to learn how to access all of the features of the software.

The Pocket PC takes advantage of the "tap and hold" feature from the Pocket PC user interface. "Tap and hold" means to hold the stylus down for a couple of seconds. A ring of colored dots will circle around the tap point, and then something happens, either a menu pops up or a value underneath the stylus changes. On a desktop or laptop PC, you would use a right button click to do the same thing.

"(1)" As you just learned, tapping this field brings up a screen that allows you to select from a list of sensor values to view. The current value is displayed here.

Tap and hold on this area to bring up a context menu as shown in this screenshot. On a PC, you would right-click to get the menu.



The top line of the menu indicates the sensor value that is being displayed. The next line shows the range, in this case 0 to 150 MPH. That means that the bottom of the plot area is 0 MPH and the top is 150 MPH.

You can set two marker positions specifically for this data trace using the Set Marker 0 and Set Marker 1 menu options. This is used for calculating minimum, maximum, and average values over a given time period, or for calculating time deltas. You would do this by scrolling through the data to the first time position (e.g. the entry to a particular corner), setting marker 0, then scrolling to the second time position (e.g. the exit of that corner) and setting marker 1. Finally, when you bring up this context menu after setting the two markers, you pull up this menu again to read the values. The maximum, average, and minimum values for that sensor reading over the time between the two markers will be in the "[max]", "[avg]", and "[min]" positions. The time between the two markers will be in the "[m1-m0]" position. "m0-tA" and "m1-tA" are used for calculating time deltas to the tA marker which will be discussed later. "Jump to Marker" allows you to instantly shift the data to the specified marker point.

"(2)" This is the MPH data trace corresponding to the sensor value we enabled earlier. Note that it is color coded to match the numeric value. In this example, you can see that the car is initially stopped, and then after about 13 seconds the vehicle starts moving and the MPH trace rises.

"(3)" This checkbox turns on and off the corresponding data trace. This is useful when you get so many data traces on the screen that you can't easily make them out. Turn off the ones you don't need to unclutter the screen.

“(4)” This is the “A” file selector. It shows the name of the file loaded on the “A” side. You can load many files, but you can only view two files at once. You select the files you want to view by tapping on either the “A” or “B” file selectors. Notice how the values are color coded. “A” side files use bluish colors, while “B” side files use reddish colors. In this case, we have the same file loaded on the “A” and “B” sides, which is what you need to do in order to compare different laps within the same data file.

Tapping on this field brings up a screen that lets you choose which of the loaded files you want to view.

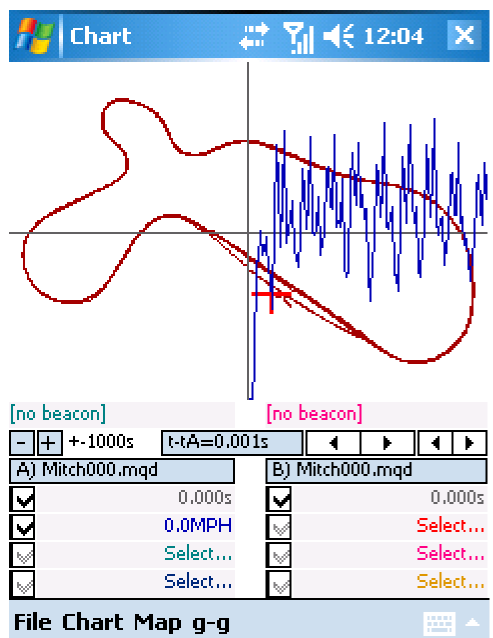
“(5)” This is the current file time “t” for the “A” file, corresponding to the vertical crosshair. To scroll the data forward in time, you drag the plot area to the left of the screen with your stylus (or with your mouse on a PC). To scroll backward, you drag the plot area to the right.

You can also scroll the data in specific time increments using the large arrow buttons “(8)” or the small arrow buttons “(9)”.

“(6)” This checkbox, when unchecked, locks the data traces for the “A” file. They are frozen in time, allowing you to scroll the “B” file independently with your stylus. This is useful for comparing laps. The “B” file also has a lock checkbox so that you can hold it in place and move the “A” file independently.

“(7)” This is the time scale for the data traces. In this example, it is initially set to plus or minus twenty seconds. That means that the right edge of the plot area is twenty seconds in the future, and the left edge is twenty seconds in the past. The middle of the plot area is the “current” time, designated “t”, which corresponds to the numeric values.

To change the time scale, use the “+” and “-“ buttons on the left. This is how you zoom in or out on the data traces. Here we have zoomed out to +- 1000 seconds:



To switch to plot-by-distance mode, you tap and hold (or right click) on this field. In plot-by-distance mode, both data files scroll the same distance, keeping them aligned according to track position. You will then see (for example) “+-500’” instead of “+-20s”. This means the right edge of the plot area is 500 feet ahead and the left edge is 500 feet behind. The “+” and “-“ buttons also change the distance scaling in this mode.

To switch back to plot-by-time mode, tap and hold again on this field.

“(8)” The large arrow buttons scroll the data forward or backward in increments of one-tenth of the time scale (or the distance scale).

“(9)” The small arrow buttons scroll the data in increments of one-hundredth of the time scale (or the distance scale).

“(10)” This is the time delta display. As described later, you can set a time marker for the “A” file and the “B” file. The time delta between “t” (the current time) and either the “tA” or “tB” mark is shown here. To switch from “t-tA” to “t-tB”, tap on this field.

“(11)” The big red “+” sign is where the car is at the current time. If you scroll the data forward, you will see the car move around the track.

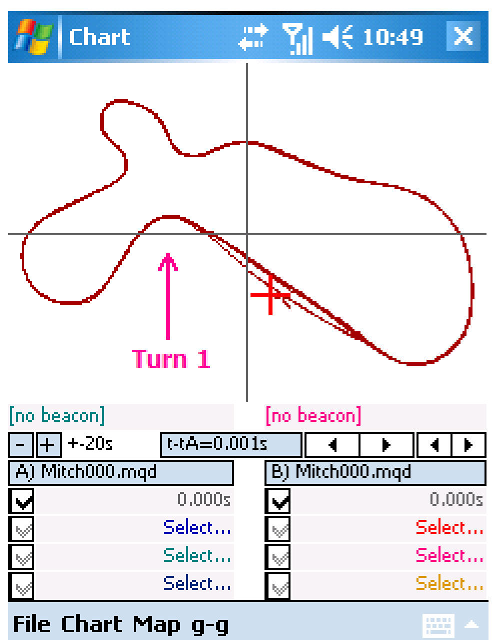
“(12)” The grey box where it reads “[no beacon]” is called the “beacon counter field”. It displays the timestamp of the most recent beacon before the current car position, if any. Also, if you tap and hold or right-click on this box, you will get the beacon context menu. Please read the section on setting up beacons for more information.

Viewing Data – Simple Corner Analysis

Here we will walk through the steps to determine the following values in Turn 1:

- Top speed before the turn
- Entry and exit speed
- Elapsed time from entry to exit
- Mid-corner average and peak lateral acceleration

Turn 1 is shown in this screenshot.



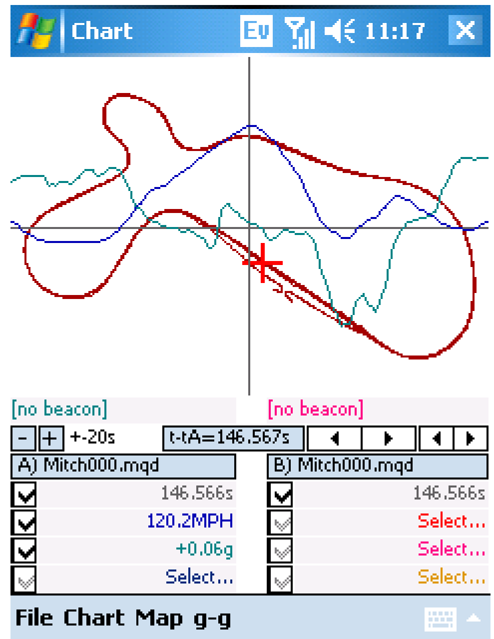
Step 1: Tap the blue “Select...” field and select “GPS Vehicle speed MPH [0, 150]”.

Step 2: Tap the green “Select...” field and select “GPS LatG [-2, 2]”.

Step 3: Drag the plot area to the left to start the car moving around the track. We don’t want to see the very first time that the car enters Turn 1, because it is only just leaving the pits and is not up to speed. So continue to advance the data until the car goes all the way around the track and comes back onto the front straightaway.

Step 4: Look at the blue MPH trace and find the peak MPH. Drag the data traces so that the MPH peak is under the vertical crosshair.

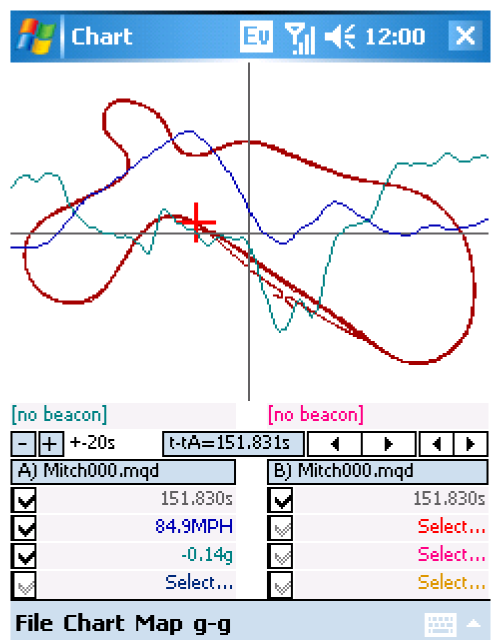
At this point, your screen should look like this:



You can read off the top speed directly, which is 120.2 MPH.

To determine the entry speed for Turn 1, we first need to figure out where the corner begins. We will say that the corner begins when the car turns in and the lateral acceleration builds. In this case, the car is entering a left-hand turn and the lateral acceleration will go negative. You can see this in the green trace just a few seconds to the right of the vertical crosshair. So, drag the data traces to the left until the vertical crosshair is over the point where LatG starts to go steeply negative (e.g. where LatG goes below -0.10 g).

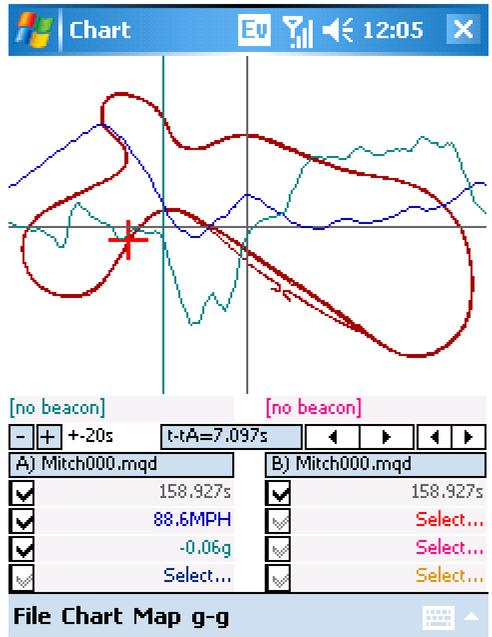
Here is the new screenshot. The data is aligned to the corner entry, signified by the first point where the LatG trace goes below -0.10 g (it is -0.14 g in this image). You can read off the corner entry speed, which is 84.9 MPH.



Now we will set several markers:

- tap Chart > Set tA
- tap and hold on “84.9MPH” and select “Set Marker 0”
- tap and hold on “-0.14g” and select “Set Marker 0”

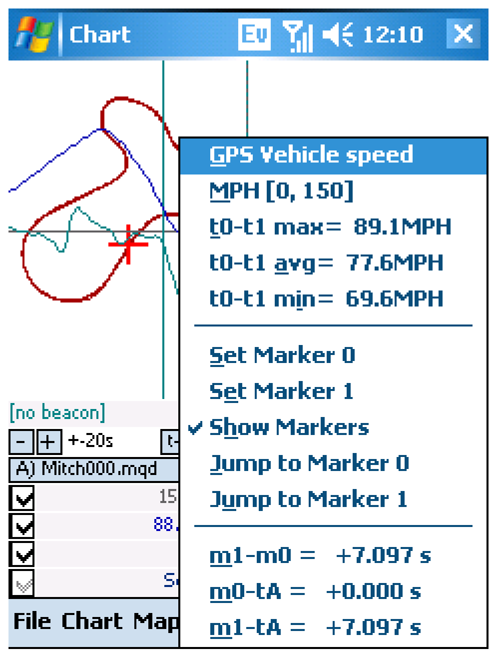
Next, we will scroll forward in the data until we find the corner exit. We will define the corner exit as the point where LatG comes back above -0.10 g. Here is the new screenshot.



Note the vertical green line in the left half of the plot area. This line is the "tA" mark which we placed at the corner entry point. You can read the elapsed time through the corner where it reads "t-tA", which is 7.097 seconds. You can also read the corner exit speed, which is 88.6 MPH.

Now, tap and hold on "88.6MPH" and select "Set marker 1". Do the same for "-0.06g".

After setting marker 0 and marker 1 for a given sensor value, you can get min/max/average information by doing another tap-and-hold (or right click) on the value. For example, if we tap-and-hold on the MPH value, we get this display where we can read off these values. Through Turn 1, our maximum speed was 89.1 MPH, our minimum speed was 69.6 MPH, and our average speed was 77.6 MPH.

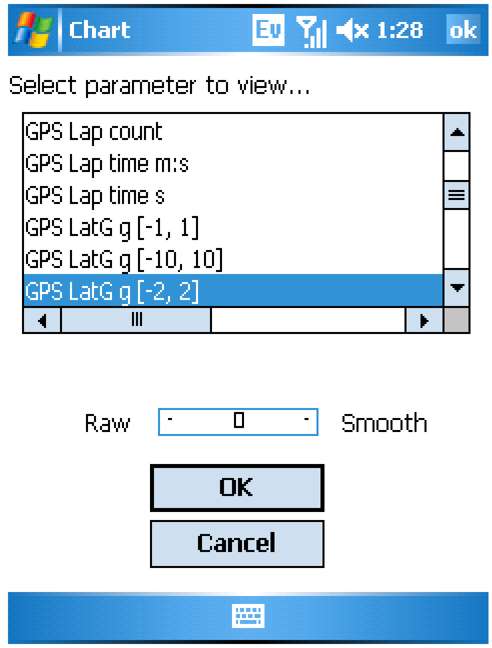


Similarly, we find that our maximum LatG was -1.21g, our minimum LatG was -0.06g, and our average LatG through the turn was -0.76g.

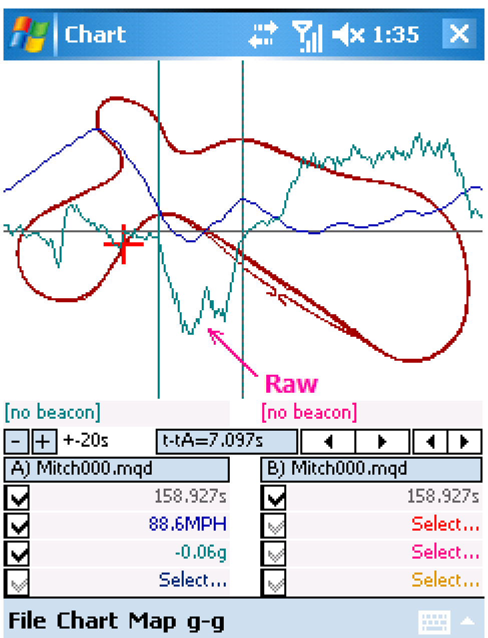
Data Smoothing

All data is noisy. "Noise", meaning random transient fluctuations in the value of the data, makes data analysis difficult and misleading. It would be wrong, for example, to conclude that your car has amazing cornering potential if you see a 1.5g spike on a corner where it otherwise only averages 1.0g. That spike is unlikely to be "real" – it might have resulted from hitting a berm, or from a GPS signal glitch, or from something bumping the accelerometer, or for any number of other reasons.

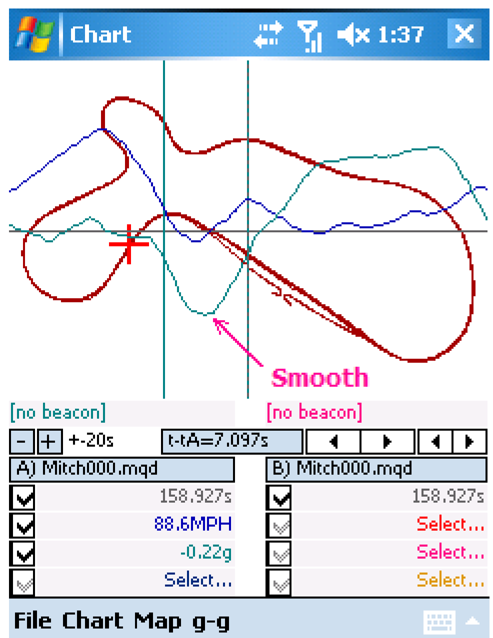
By default, Chart smooths the data in the graphs somewhat to reduce noise and make the graphs less misleading. You can control the amount of smoothing on each data trace. When you select a data trace, you are presented with a parameter selection screen. On this screen (as shown here), there is a slider for controlling the smoothing of the data. Moving the slider all the way to the "Raw" position disables smoothing. Moving it to "Smooth" smooths it out considerably. The default setting, in the middle, has proven to be a good all-around setting. The smoothing factor is separate for each data trace plotted.



The data in the previous examples was all shown using the middle setting. Take a look at how the LatG (green) data trace varies from the Raw setting to the Smooth setting:



Raw

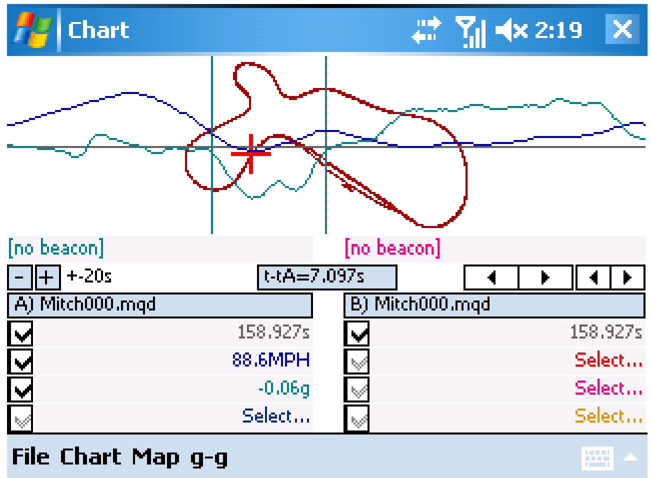


Smooth

You can see the minute instantaneous variations all along the LatG trace in the "Raw" plot. These small fluctuations are meaningless. In the "Smooth" plot, you can see that these fluctuations are gone, but the excessive smoothing erased evidence of a mid-corner correction right where the arrow is pointing. Still, this amount of smoothing is sometimes helpful. Notice that in the right half of the plot, where LatG goes to about +1.0 g (corresponding to the right-hand Turn 2), smoothing makes it immediately clear that the driver gradually increased his lateral acceleration through the turn, as if feeling for the limit. This is less obvious in the "Raw" plot due to the noise.

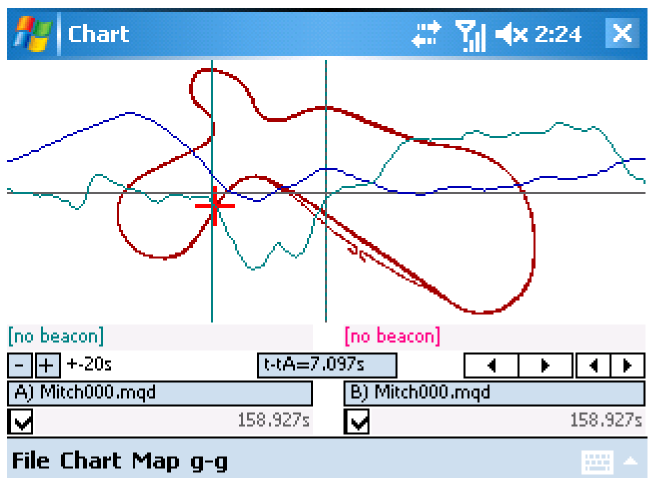
Landscape Mode User Interface

Pocket PCs based on Windows Mobile 5.0 and later are able to rotate the screen into either portrait or landscape mode. Here is an example of landscape mode:



In landscape mode, in order for the numeric values to still be readable, it is necessary to maintain the font height of the numeric values and squeeze the plot area. Unfortunately, this makes the trackmap much smaller and the data traces shorter.

You can turn off the bottom three lines (the ones containing the numeric data values) by unchecking "Chart > Show numerics". Then the display will look like this:



This makes the trackmap and data traces easier to view. The feature also works in portrait mode and can be useful when the track is tall North-South and skinny East-West. This feature is not enabled (and is not necessary) on the PC version of Chart.

Using GPS Beacons

GPS "beacons" allow you to get lap and segment times without having to set up trackside optical beacons. They can also be set up to give you real-time lap and segment times while driving. They are far more convenient than optical beacons. It is expensive and time consuming to set up three or four optical beacons around a typical racetrack, whereas you can set up ten GPS beacons with just a few screen taps.

(GPS Beacons are also used for marking cones during a course walk; see the section "Marking Cones" later in this chapter.)

The accuracy of GPS beacon lap timing is about as good as a handheld stopwatch, or better (typically down to a few hundredths of a second).

You place beacons by <u>starting with at least one full lap of data</u>, which you load into Chart, then you scroll through the data <u>until the car is at the position on the track where you want a beacon</u>, then you mark that position with either the "Add beacon" or "Add beacon each lap" function, explained shortly. You do not need to download a trackmap from anywhere, since you make your own trackmaps. You can place up to ten beacons. The course can be open-ended or closed. You can use a flight recording generated by driving or by walking the course.

There are a few rules of thumb for successful GPS beacon placement:

In general, try to place beacons on straightaways shortly before the braking zone. This is not always practical, but it gives the most consistent results.

Do not place too many beacons. GPS beacons are not a reliable way to measure elapsed time over short distances (use the time markers explained earlier). Also, it is hard to analyze data when segments are short. Place your beacons to get the "big picture". For example, many courses naturally break down into one fast and two slow sections, or two fast and two slow sections. That should be your guide for beacon placement.

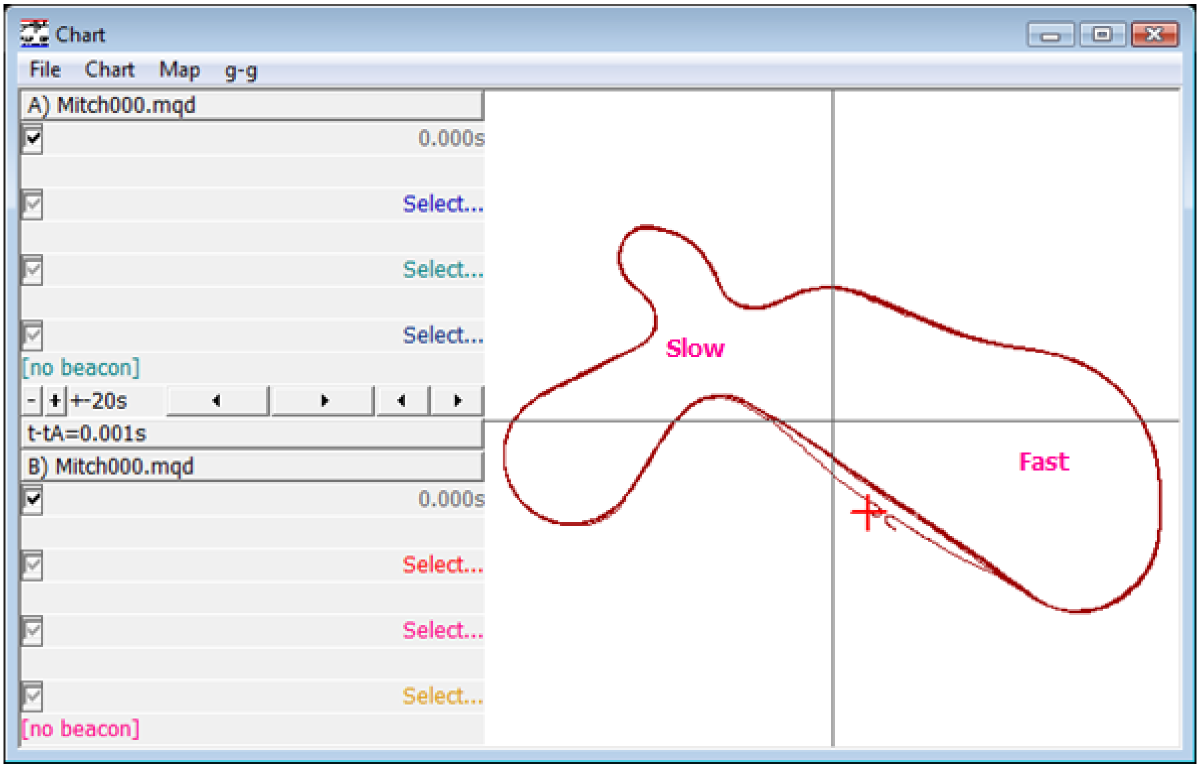
Avoid placing beacons where the track folds back on itself tightly. You might get erroneous triggers if the track folds back too close to a beacon position.

GPS beacons work by remembering the Latitude and Longitude of the beacon position and the direction the car was traveling, then finding the point where the car comes back closest to that position and is still heading in the same general direction. If the car is too far away, the beacon will be ignored. However, the software makes generous assumptions about track width, so you do not have to worry about triggering a beacon if you happen to be way off line as you pass it.

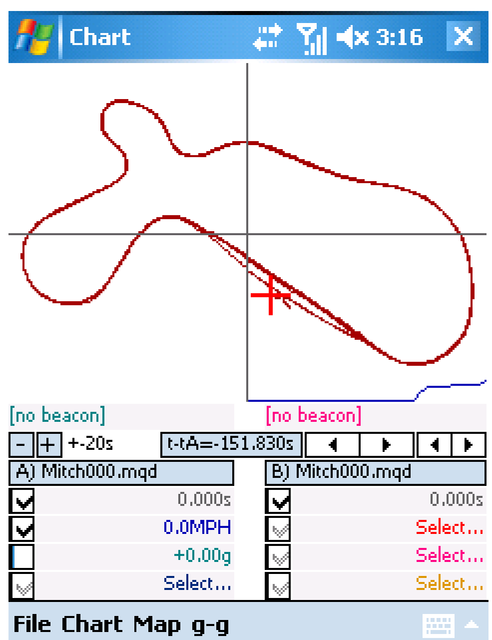
Technical note: When adding a beacon manually to a flight recording, the beacon is actually marked by the time of the current sample, therefore segment times for this file will be multiples of the base sample frequency (e.g. 0.200 second for 5 Hz sampling). This does not mean that the segment times are only accurate to the nearest 0.200 second. The segment time is exact. In effect, it means that the beacon position you requested is adjusted slightly so that the segment time is precisely a multiple of 0.200. When exporting the beacon to a file, the beacon Latitude and Longitude are taken from this sample and placed in the beacon file. When this beacon is imported into a new file, the Latitude/Longitude samples will be slightly different from the Latitude/Longitude samples as recorded for the first file. So the beacon times are interpolated based on the closest that the car comes to the original beacon Latitude/Longitude, in order to preserve 0.001 second precision. This is why the segment times for the new file are not multiples of 0.200.

Example – Placing Beacons

Now we will walk through the procedure for placing beacons. Take another look at the trackmap we have been using. The track naturally breaks down into slow and fast sections:



We'll place two beacons. Segment 1 will be the "slow" section of the course, and segment 2 will be the "fast" section. We will show screenshots from the Pocket PC version of Chart, but you can do the exact same process on a PC.

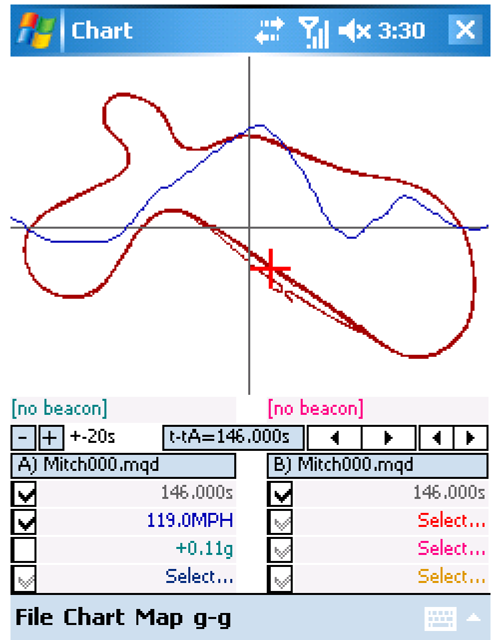


Start by moving back to the beginning of the run (use "Chart > Align to start of run"). Bring up a GPS Vehicle speed data trace. You see here that we are staring with the car just about to come out of the paddock onto pit lane:

Just to emphasize, you do not place beacons by tapping on the trackmap where you want the beacon to be placed. This is imprecise. Instead, you must move the data until the "+" symbol is at the location where you want a beacon, then add a beacon at that point.

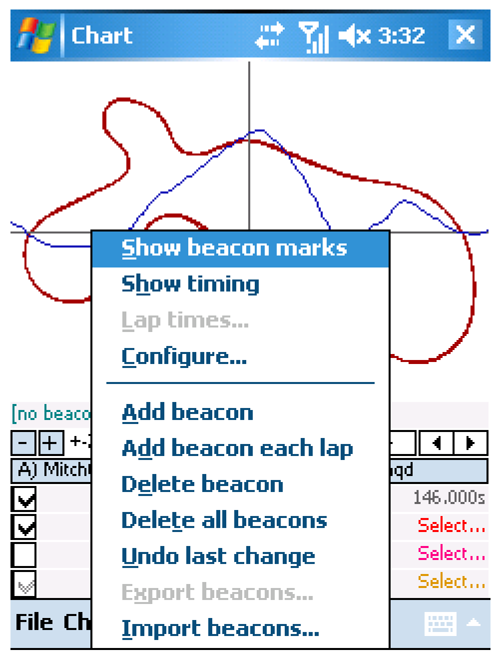
Drag the data forward in time (slide it to the left with your stylus or mouse). Continue until the car is on its first hot lap. This makes it easier to see braking points and place beacons relative to them. The lap times on warmup laps are unimportant.

In this example, you can see the driver is up to speed by the time he comes around for his first full lap (notice that the car in this screenshot is on the front straight, not pit lane). We're going to pick t = 146.000s as the location for the first beacon, because it is shortly before the braking zone going into Turn 1.



Adding Beacons

To place a beacon, you tap-and-hold (or right click) on the field which reads "[no beacon]". Do it on the "A" side for this example. You will see the beacon context menu pop up as in this screenshot.

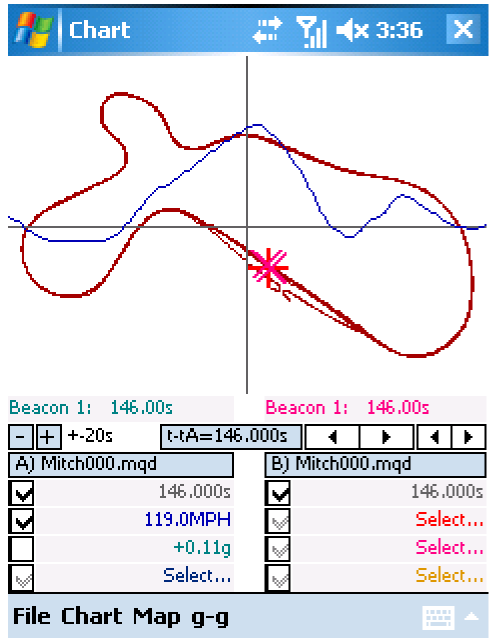


You have two options:

1. "Add beacon" This places a single beacon at this point. It does not change the "beacons per lap" count.
2. "Add beacon each lap" This places beacons on every successive lap starting at the current file time (but not earlier). It also increments the "beacons per lap" count.

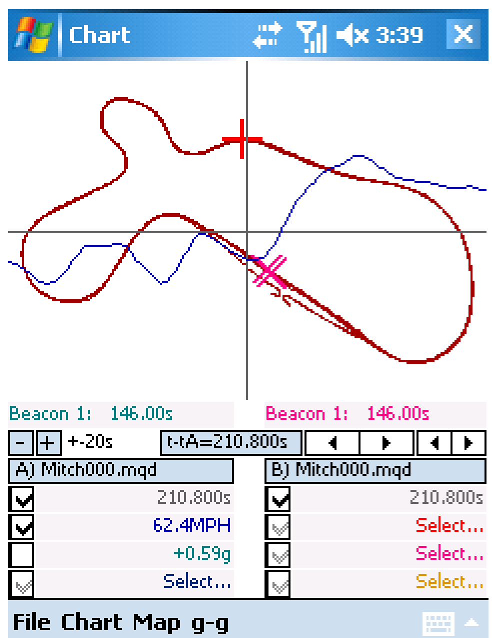
Typically, you would use "Add beacon each lap". However, you might use "Add beacon" for specialized timing or if you are adding in a missing beacon.

In this case, choose "Add beacon each lap". You will now see several "X" symbols appear right around the point where you added the beacon. These symbols are beacon markers, one for each lap. They do not always lie exactly on top of one another due to GPS drift, but they should be close.



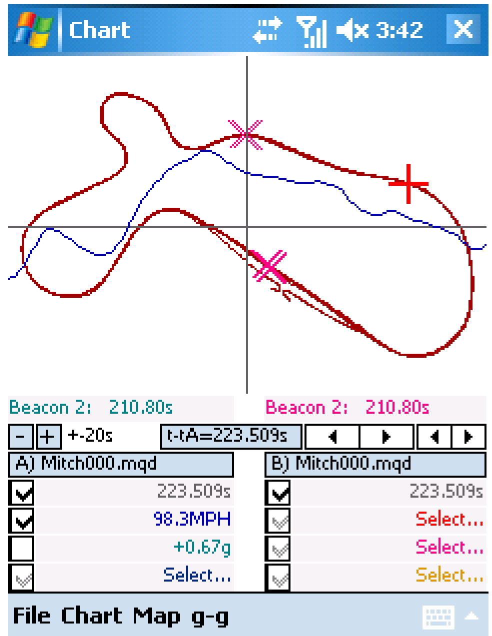
The first beacon you place determines the start of lap 1. Note that your lap times will not correspond to official timing if you do not put your first beacon at the start/finish line. However, for analysis it is sometimes better to choose your own beacon position rather than try to align it with start/finish.

Now, scroll the data forward until the car is at the location shown here. Although it is not on a straightaway, the beacon location is good because speed is not changing rapidly at this point and it is not a sharp turn. As before, "Add beacon each lap".



Here we have moved car forward on the track so you can see the beacon marks.

Notice that the beacon counter fields now show "Beacon 2: 210.80s" instead of "[no beacon]". The beacon counter fields show the beacon number and timestamp of the most recent beacon position relative to the current position of the car.

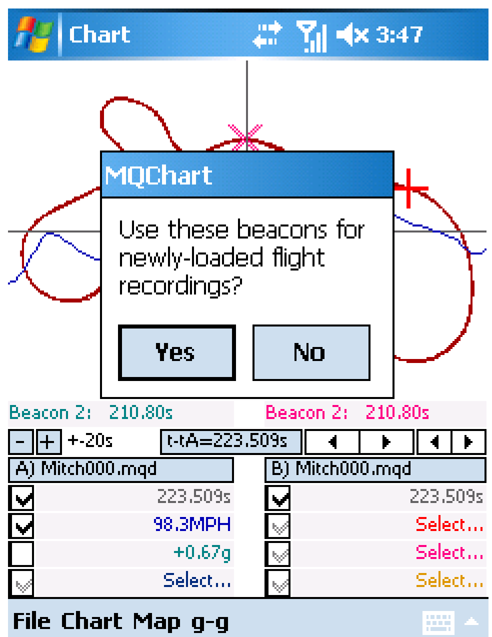


Exporting Beacons

Before going further, export your beacon positions to a file so you can use them again in other flight recordings. From the beacon submenu, choose "Export beacons...", assign a filename, and save it.

You will then be prompted with the question: "Use these beacons for newly-loaded flight recordings?"

Answering "Yes" will cause an automatic import of this beacon file for each new flight recording you load into Chart. This will continue until you exit Chart. The next time you run Chart, if you want to import beacons, you will have to import them manually.



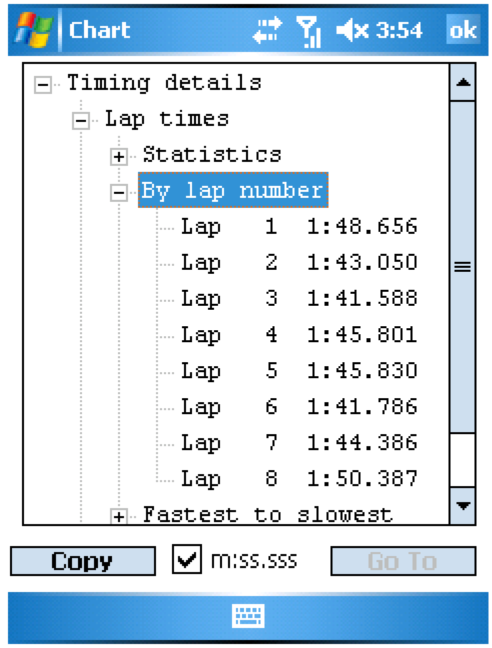
Importing Beacons

If we had previously saved a beacon file, or if we had copied one from a racing buddy, rather than placing beacons we could have simply chosen the "Import beacons..." option from the beacon context menu as shown earlier.

Please remember that the GPS beacons are "directional" in order to reduce false triggering. The direction the car is traveling when it passes a beacon position is a factor in determining if a beacon point has been crossed.

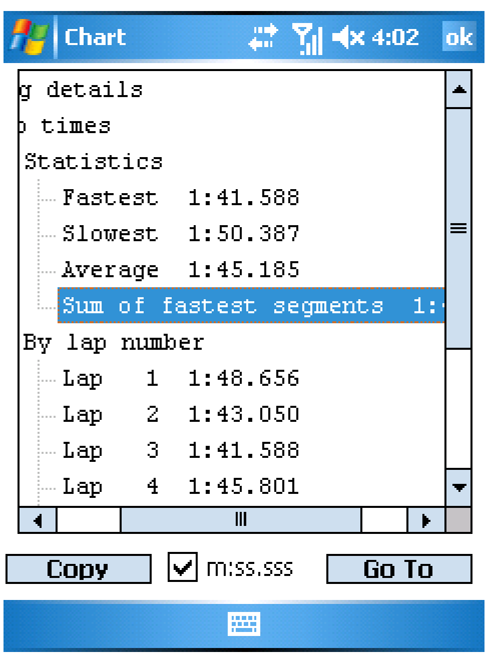
Viewing the List of Lap and Segment Times

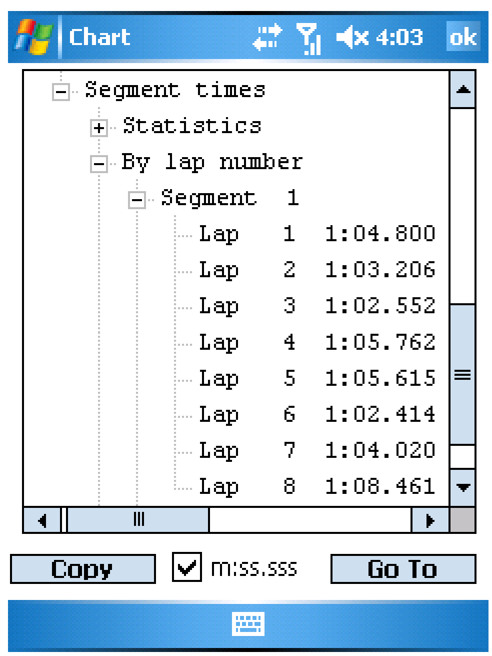
On the beacon context menu you may have noticed the "Lap times..." option. In this example, the "Lap times..." option brings up the following screen.

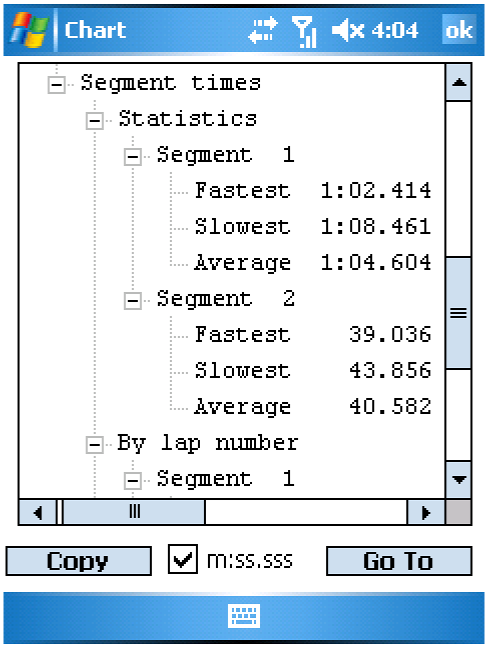


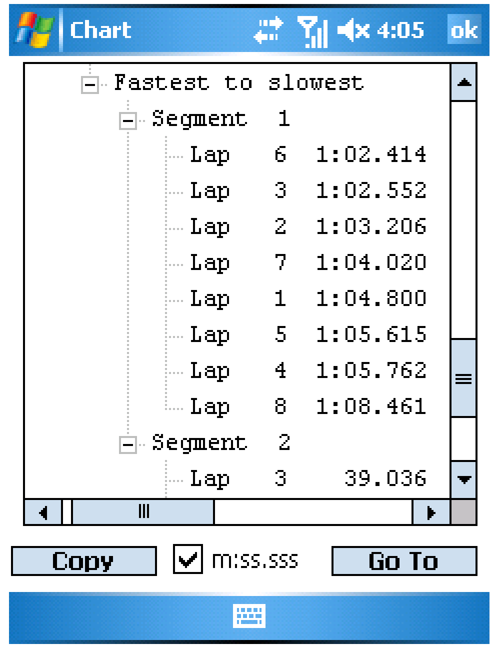
The MQGPS system samples GPS Latitude and Longitude in intervals of 0.200 s. But the actual lap timing accuracy is better than that. Chart uses interpolation to estimate lap times down to a typical accuracy of a few hundredths of a second. This is about the same as or better than a handheld stopwatch. Optical beacons will do even better.

By expanding the different areas of this tree view (tap the "+" signs), you can see other interesting information as shown in the following screenshots. In some cases the information is off the right edge of the screen and it is necessary to scroll over to see it. For example, the "Sum of fastest segments" figure, which indicates a theoretical fastest lap time, scrolls off to the right. Also, the segment times include "MPH at beacon" and "Max segment MPH" information.









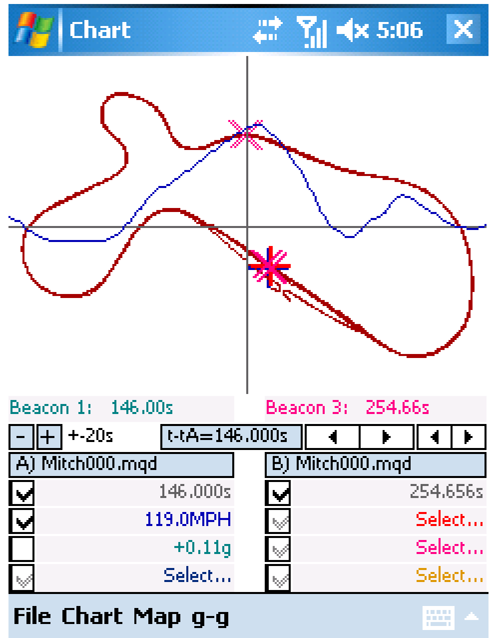
Unchecking the "m:ss.sss" checkbox will give you timings in seconds rather than minutes and seconds. The "Copy" button allows you to copy the data out and paste it into another application. For example, you can select an element of this tree view, such as "Segment 1" under "Fastest to slowest", then tap "Copy", then run Excel and paste all the Segment 1 times into a spreadsheet. The "Go To" button jumps you to the selected location. For example, you can tap "Lap 3" under "Segment 2", then "Go To" and Char t will go back to the main view with the flight recording positioned at the beginning of Segment 2 on Lap 3.

Comparing Two Laps

In order to overlay data for the purpose of comparing laps (out of the same flight recording, or from different flight recordings), it is important to understand the meaning of the "A" and "B" sections of the display.

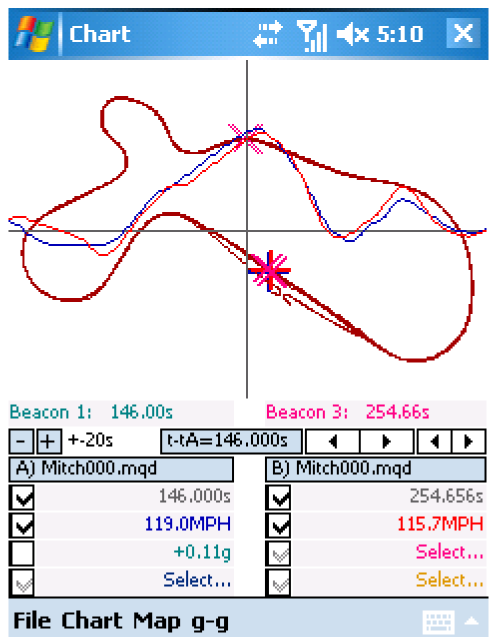
In all the screenshots used so far, you see that "Mitch000.mqd" is listed in both the "A" and "B" sections of the display. This means that you are viewing the same file twice. The important thing to note is that you can view the same file from two different time positions.

We'll compare lap 1 to lap 2. Start by bringing up the beacon context menu. Tap and hold on the beacon counter field on the left side of the screen; it will read either "[no beacon]" or "Beacon" followed by a number and a time. Then choose "Lap times..." Tap on "Lap 1" and tap the "Go To" button. Now, tap and hold on the beacon counter field on the right side of the screen. Again choose "Lap times..." Tap on "Lap 2" and tap "Go To". The screen will look like this:

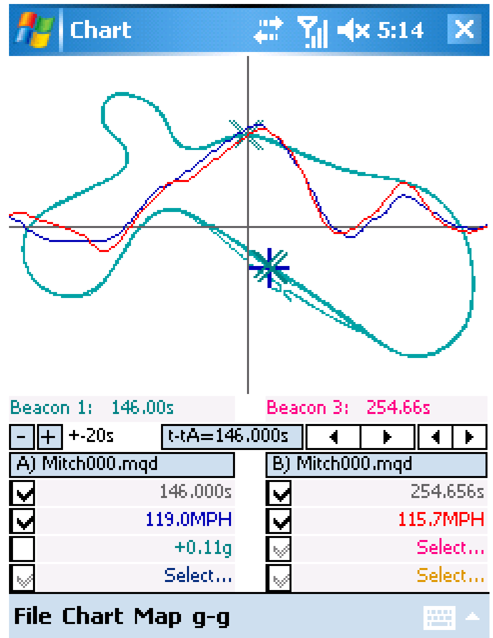


You are now viewing the same file from two different time positions. File A is at 146.000 seconds, the beginning of lap 1, and file B is at 254.656 seconds, the beginning of lap 2.

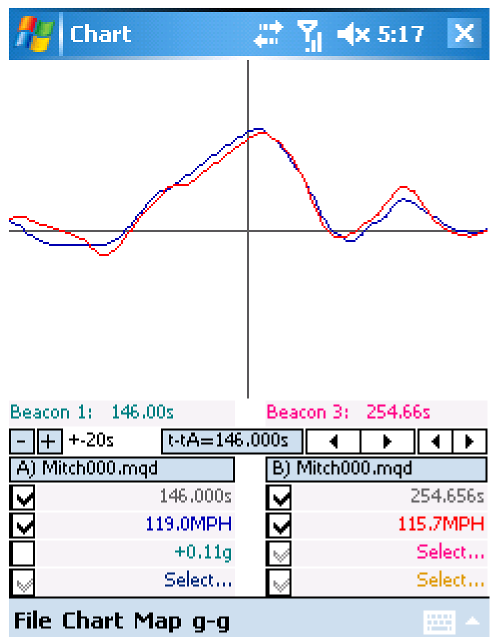
A good place to start when comparing laps is vehicle speed. Tap the red "Select..." field (just under "254.656") and select "GPS Vehicle speed MPH". You are now seeing the MPH trace in blue from lap 1 and the MPH trace in red from lap 2 at the same time. You can immediately see some differences; for example, on lap 2 the driver reached a significantly higher speed between turns 1 and 2 than he did on the first lap. Let's zoom into that to get a closer look.



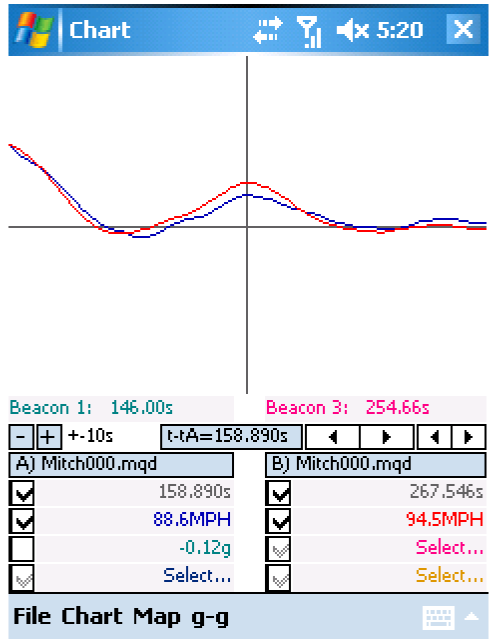
First, to unclutter the screen, turn off the track maps. Tap "Map" and then uncheck "Show GPS map B". You will notice the trackmap is now displayed in aqua rather than red. That is because you only turned off the trackmap for the "B" file, which is colored red. The trackmap for the "A" file is still displayed. Showing two trackmaps is useful when there might be significant differences between the trackmaps of two different flight recordings.



Tap "Map" and then uncheck "Show GPS map A" to turn off the "A" trackmap. You will be left with just the MPH traces as shown here.

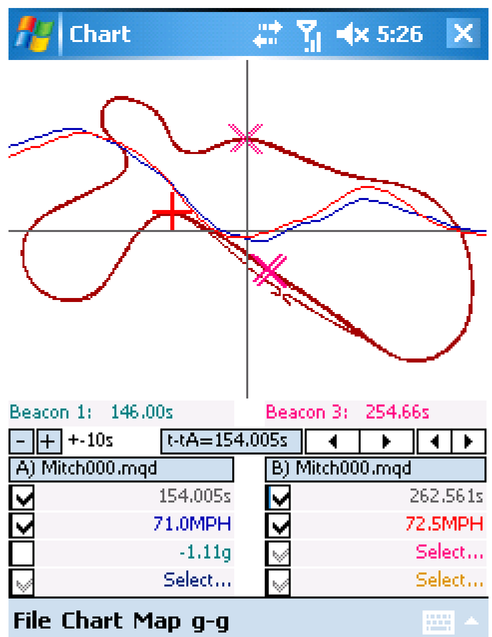


We'd like to see just how much of a difference there was in speed between turns 1 and 2. To do this, first slide the data over until the smaller peaks on the right are centered in the plot. Then tap the "-" next to "+-20s" to zoom into the +-10s range. You can see that the peak speed on lap 1 at this point was only 88.6 MPH, while on lap 2 it was 94.5 MPH.

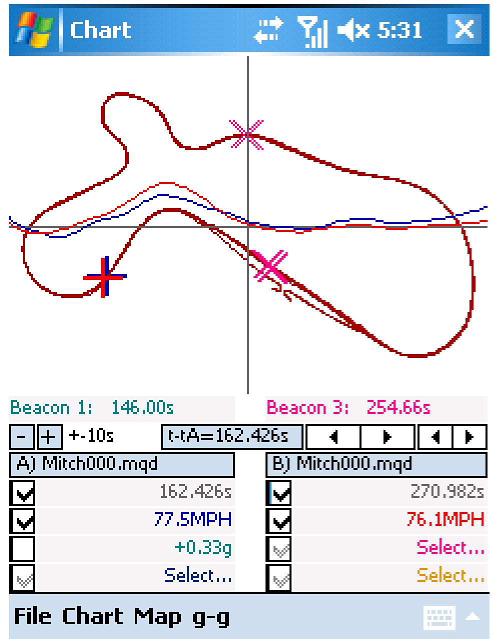


Determining Time Lost/Gained

How much time did the driver gain in this short section due to his higher speed? First, turn the A and B trackmaps on. Now, move both cars to the apex of turn 1. Do this by dragging the data traces back until the red car is at the apex of turn 1. The blue car will be slightly displaced from the red car. Uncheck the B file time counter (the checkbox directly under the "B)", which will freeze the location of the red car. Then, by tapping the small left/right arrow buttons, move the blue car until it is directly under the red car. Then put a check back in the B file time counter so the red car can move again.

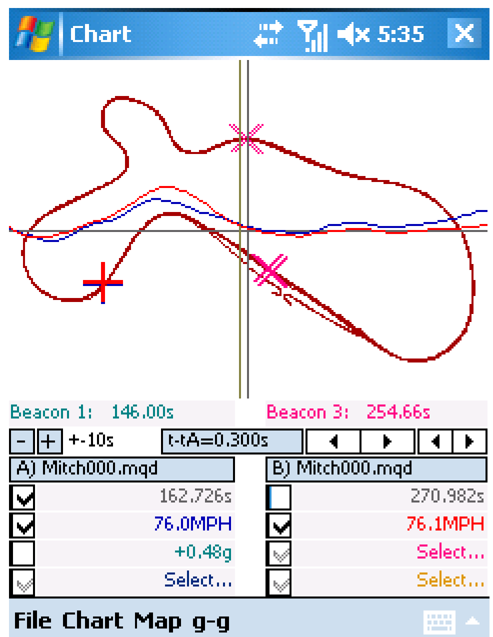


Scroll the data forward in time until the red car reaches the entry of turn 2. You will notice in that the red car is now slightly ahead of the blue car. Uncheck the B file time counter to freeze the location of the red car. Now tap "Chart > Set tA" to set a time marker for the blue car.



Finally, using the small arrow buttons, advance the blue car until it is directly under the red car (or as close as possible). You can then read the time difference from the "t-tA" display. In this case, the red car gained 0.300 seconds in this short section due to the higher speed. This is not an exact measurement, but it is a reasonable estimate.

Put a check back in the B file time counter checkbox to continue with this example.

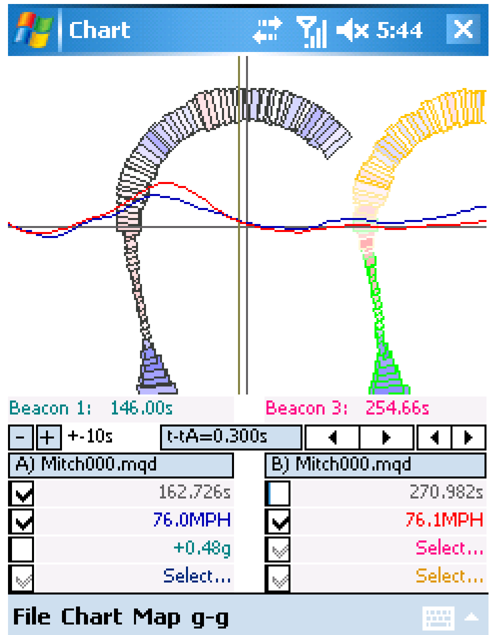


Comparing Two Laps with Qview™

Qview™ is an innovative way to visualize the performance of a car as it drives around the track. It combines lateral acceleration, longitudinal acceleration, and speed differences into a single graphic that is easy to grasp.

QView™ requires the following values to be in the flight recording:

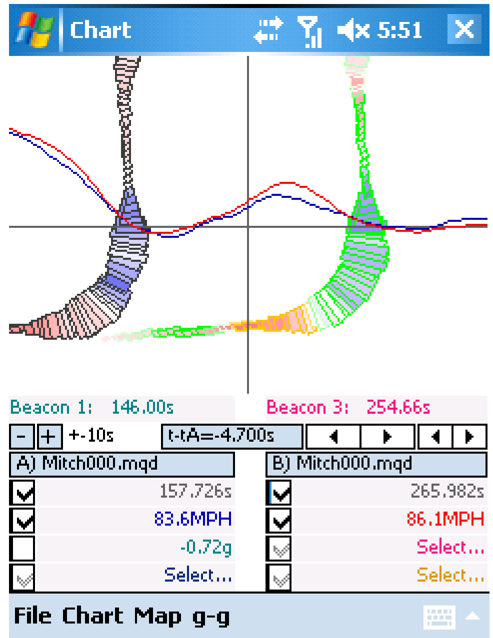
- GPS Latitude
- GPS Longitude
- GPS LatG
- GPS LongG
- GPS Track Made Good



Tap "Map > Zoom GPS map". Also tap "Map" and make sure "Qview (tm) in Zoom is checked. Finally, tap "Map" and make sure "Overlay" is unchecked to be consistent with this example.

Immediately, you can see where lap 2 was faster than lap 1. It is outlined in green. You can also see that the upcoming turn (turn 2) was actually slower on lap 2 than on lap 1, because it is outlined in orange.

Notice that we have switched to a view directly over the car, as if you are a helicopter flying and turning with it. As you scroll forward in time, the track will pass underneath you. The top of the display is the forward direction of the car.



As before, to move forward in time you either drag the plot area to the left with the stylus, or you use the arrow buttons. Here, we have gone backwards exactly five seconds to show turn 1.

Qview™ works like this:

The width of each block is proportional to lateral acceleration

The length (in the direction of travel) of each block is proportional to longitudinal acceleration

The inside color is red for braking, blue for accelerating. Intense red is hard braking, intense blue hard acceleration. White means you are neither braking nor accelerating

Blocks are 0.2 seconds apart

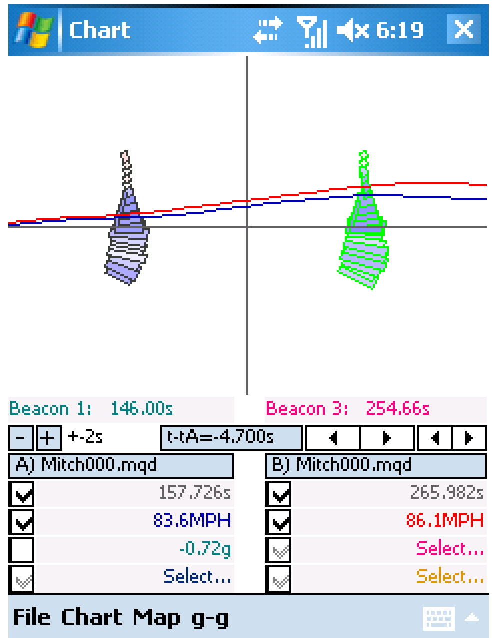
The green outline indicates where the "B" file is faster than the "A" file, orange where it is slower. This coloring only appears when the "A" and "B" files are synced to approximately the same point on the track. The blocks on left-hand side for the "A" file are only outlined in grey because they are the "reference" data.

There is a minimum block size even if LatG and LongG are near zero.

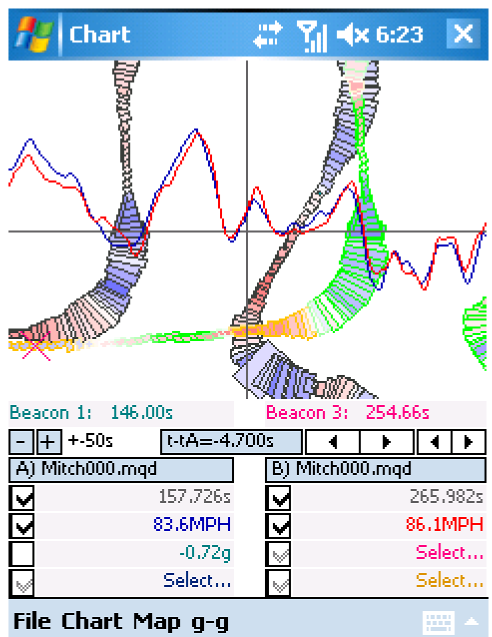
There are a few things that are immediately apparent from the Qview™ plot. Remember earlier we pointed out a mid-course correction in turn 1 from the LatG trace. That is obvious in the Qview™ plot, in the middle of the corner where there is a small blue block. Second, just by looking at the overall greater width of the plot for the "B" file, it is easy to see that the driver maintained high lateral acceleration through the turn on lap 2, with no mid-corner correction. You can see that the driver was faster on lap 2 from early in turn 1 all the way to the entry of turn 2. Finally, you can see that the driver actually lost a little time on lap 2 in the braking zone before turn 1 (it is outlined in orange).

Zooming in on Qview™

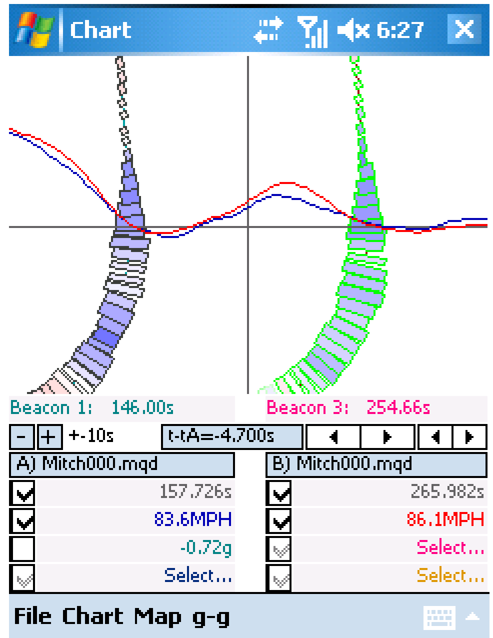
The time zoom factor ("+-10s") determines how much data will be plotted in Qview™ mode. Here is what you see if you zoom in to "+-2s":



And here is what you see if you zoom out to "+-50s". This is perhaps a bit too much. Chart tries to plot +-50 seconds of track starting at the current position, which means that the track plot goes off the screen and comes back on.



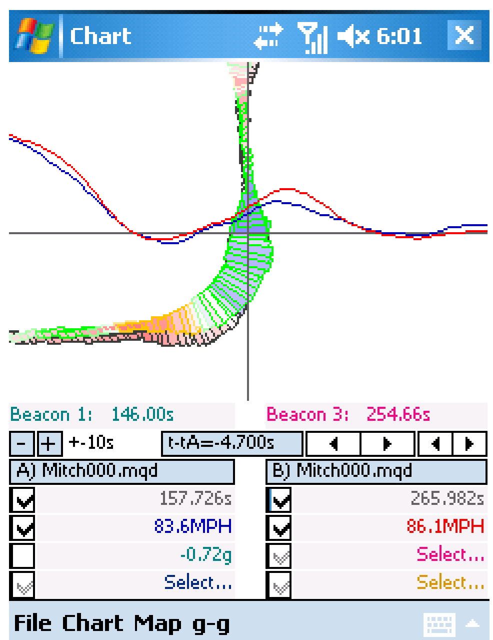
Under the "Map" menu, you will see several distance zoom factors. The plots so far have been at 200 yards. This means that, in zoom mode, the distance from the center of the plot area to the top of the plot area is 200 yards. Here is 100 yards, +-10 s.



Comparing Lines

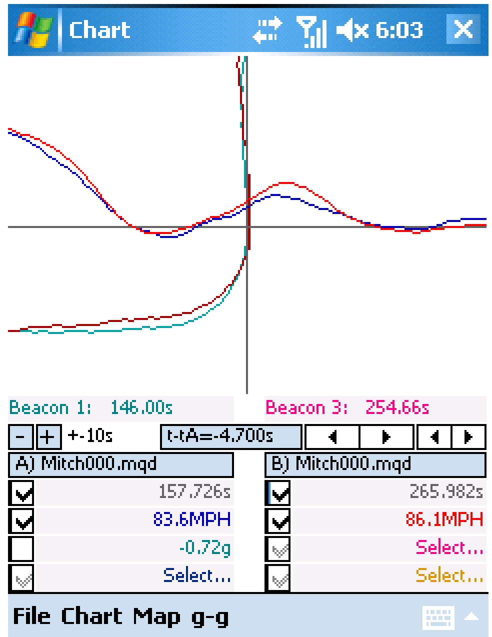
Zooming back out to 200 yards, here is what you get when you check "Map > Overlay":

The "B" file is plotted on top of the "A" file. This obscures the "A" file but tends to make differences in line more obvious. In this case, it looks like the driver turned in earlier on lap 2.



This becomes even more obvious if you turn off "Qview (tm) in Zoom". Notice how the green trace stays wide on the entry to turn 1, while the red trace takes an inside line.

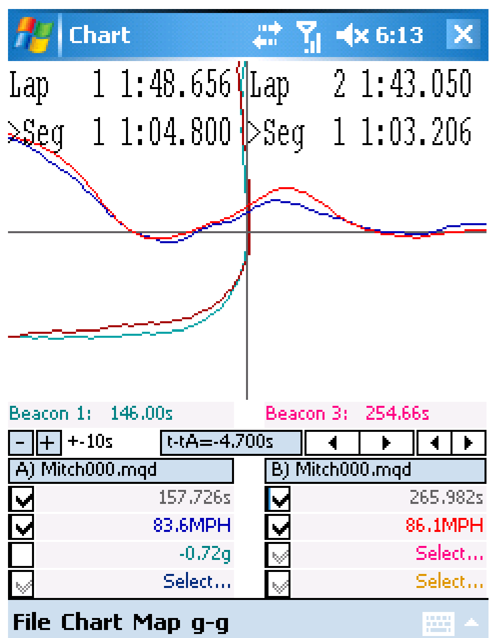
You should use this information cautiously. GPS is frequently not accurate enough to show differences in line. You need to have 8 satellites or more with GPS HDOP below 1.20 throughout a given section of track to get trackmaps this accurate (and even then the accuracy cannot be guaranteed).



Showing Lap and Segment Timing

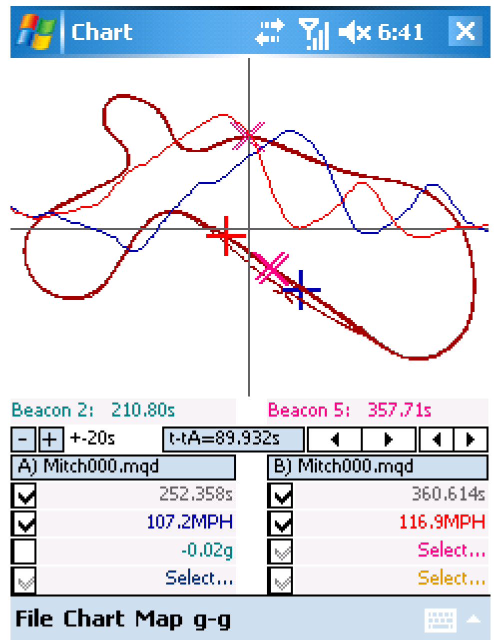
You can also view the current lap and segment time in the plot area if you pull up the beacon context menu and tap "Show timing...". You can do this for the "A" and "B" files separately.

We see here that, at this point on the track, the blue car was on lap 1, segment 1 and the red car was on lap 2, segment 1.



Plot by Time vs. Plot by Distance

In the previous examples, we were using the "Plot by Time" mode. This means that the data on the screen was plotted where the horizontal axis was measured in time. "+-20s" means that the right edge of the screen is 20 seconds into the future, and the left edge is 20 seconds into the past.



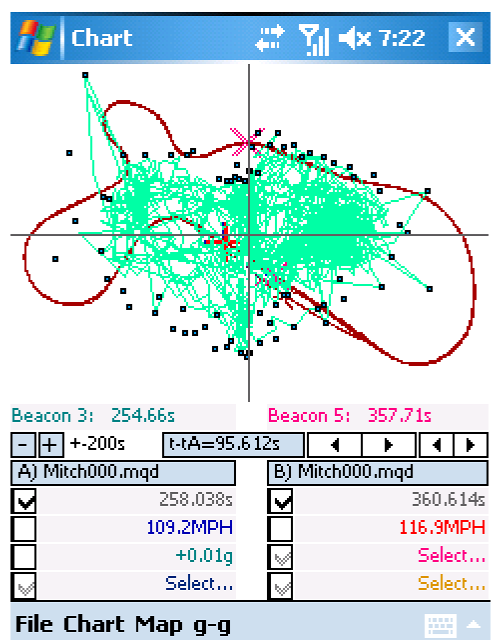
The problem with Plot by Time mode is that, as you scroll forward in time, the "A" and "B" data traces will get out of sync as one car moves faster than the other, shown here. To correct this, you would uncheck one of the file time counter checkboxes, scroll the other file until it is realigned, and then recheck the time counter checkbox.

Alternatively, you can use Plot by Distance mode. You need to have "GPS Distance" recorded in your file for this to work. To access this mode, tap and hold (or right click) on the time zoom factor ("+-20s"). It will change to a distance range, e.g. ("+-500'"). Now as you scroll the data, both cars move the same distance down the track.

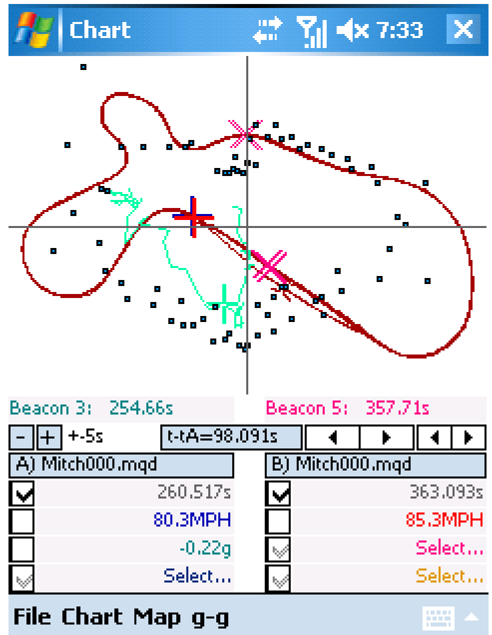
Plot by Time is more commonly used than Plot by Distance. We feel that it's easier to see where one car falls behind or moves ahead. Having to resync the data traces from time to time is a minor inconvenience. But occasionally Plot by Distance turns out to be useful.

g-g Plot

The "g-g" plot, otherwise (somewhat erroneously) known as a "friction circle" plot, is a way to gauge the overall performance of the car and driver. Here is the g-g plot for the "Mitch000.mqd" file. You can access it from the "g-g" menu. Here we have turned on "g-g A" and selected the "1.5g" scale. In this mode, the top of the screen represents 1.5g acceleration, and the bottom of the screen represents 1.5g deceleration. The left edge of the screen is 1.5g left turn, and the right edge is 1.5g right turn (actually, since the plot area is a bit wider than it is tall, the left and right edges are somewhat more than 1.5g).



You can see two major features with the g-g plot. The first is the "point cloud" of small square symbols in roughly an ellipse shape. These points represent the performance envelope of the car as measured by actual on-track acceleration, braking, and cornering. The idea is that the fastest way around a racetrack is to always be on the edge of this ellipse, or to transition across it quickly. The bigger this ellipse, the higher the all-around capabilities of the car (and the more the driver has extracted from it). The second major feature is the mess of green lines in the center. This is a trace of lateral and longitudinal acceleration based on the current zoom factor, which in this case is +-200s, so the green lines cover the 200 seconds of data before and after the current file time. The sharp peak in the upper-left corner is most likely caused by noise in the data.

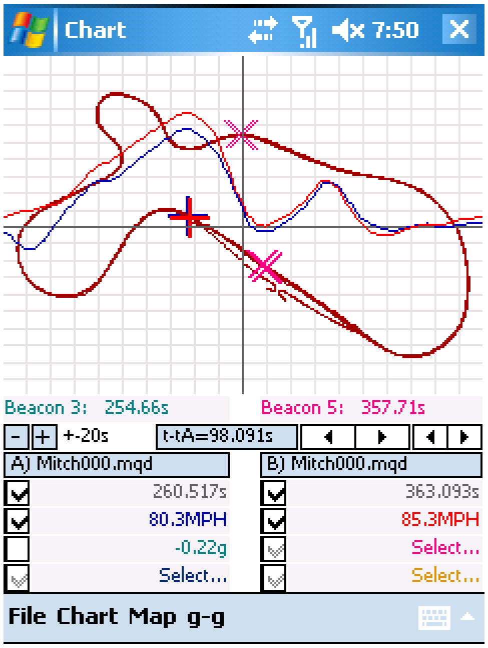


Zooming in to +-5 seconds gives this plot. You can see from the red and blue "+" symbols that the car is entering turn 1. The light green trace also has a "+" symbol on it, which indicates where the car is inside the performance envelope at the current time. See how the green trace descends from the center of the plot to the bottom of the point cloud. That corresponds to the braking zone before turn one. Then see how the green trace goes back up and over to the left. That corresponds to the entry into turn 1. In this case, we can see that the driver did not reach maximum braking going into turn 1. Also, the green trace did not track around the edge of the point cloud going into turn 1. That means that the driver did not do as good a job of trail braking as perhaps he could have.

You need to interpret the g-g plot with care. The actual performance envelope of the car varies from corner to corner. The fact that the car did not reach the edge of the envelope in a particular corner may be due to that corner being off-camber, for example. It may also be due to the driver simply not having enough skill. Braking can be excellent in some areas and compromised in others by a rough or slick surface. The g-g plot is a "big picture" guide to the performance of the car and driver.

Show Grid

The “Chart > Show grid” feature turns on a light grey grid that makes it easier to estimate the value of the data traces by eye. The grid divides the plot area into tenths above and below the horizontal crosshair, and to the left and right of the vertical crosshair.



Align to Start of Run

The “Chart > Align to start of run” moves the A and B files back to the beginning. When the data file is short, however, Chart assumes it is an autocross or drag race file. In this case, it tries to find the actual beginning of the run by starting at the top speed in the file and moving backwards until GPS Distance = 0. It also does a “Set zero time”, described next.

Set zero time

The “Chart > Set zero time” feature simply resets the current file times to zero. Data before this point becomes negative time. This is helpful so you can align two files to the same start point and then have that point be t=0.000 for both files.

Play

The “Chart > Play” feature sets the data in motion, like a play button on a tape recorder, according to the time factor selected. “Play 1x” will play the data back in real time. “Play 2x” will play the data back in double time, etc. To stop the playback, simply tap the plot area.

Show Yaw Path, Show g Path

These options create a high-fidelity plot of the path the car took based on yaw rate and/or lateral acceleration.

Copy [t..tA] and Copy [t..tB]

If you have set tA (or tB) time markers as described earlier, this function, found under "Chart", will copy the three numeric data values currently selected across the [t..tA] (or [t..tB]) time range to the Windows clipboard. You can then paste this data into another application, such as Excel.

Manual Beacon Editing in Chart

If you do not have GPS Latitude and Longitude information, if you need to add a missing beacon, or if you wish to add or remove beacons at irregular locations, use the beacon context menu.

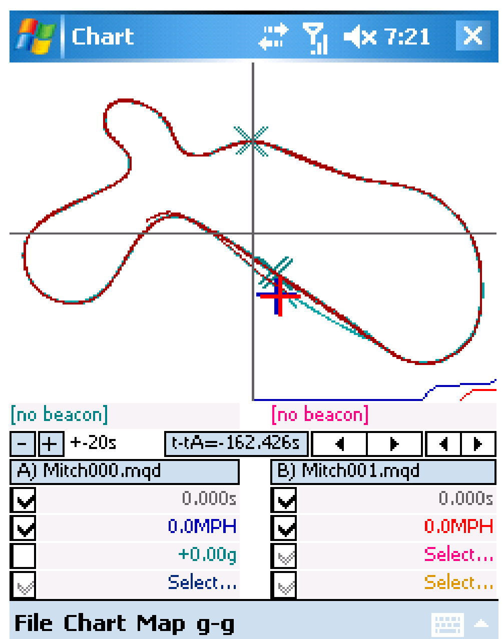
To add a beacon, position the flight recording at the point where you want a beacon and select "Add beacon" from the Beacon Context Menu.

After adding all your beacons, select "Configure..." from the Beacon Context Menu and enter the number of beacons per lap. If this number is not correct, your lap and segment times will be incorrect.

To remove a beacon, position the flight recording just past the beacon that you want to remove and select "Delete beacon". This deletes the last beacon encountered before the current position in the flight recording.

If you make a mistake, select "Undo last change" from the Beacon Context Menu.

Comparing Laps from Different Files



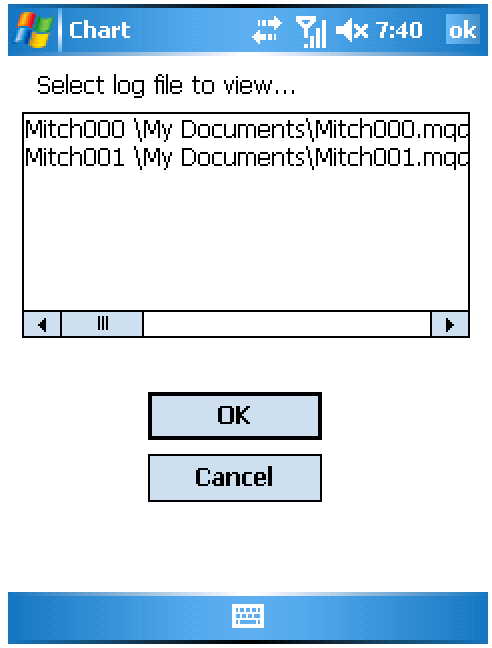
Everything just discussed applies when you want to compare laps from different files. In this screenshot, we did a "Chart > Align to start of run" to bring the "A" file ("Mitch000.mqd") back to the beginning of the session, and then a "File > Load" to load "Mitch001.mqd". The second file loaded is automatically placed into the "B" section.

There are a couple of things to notice:

The red "X" symbols are gone. That is because Mitch001.mqd does not have any beacons yet. Remember, the trackmap for the "A" file is plotted in light blue and the trackmap for "B" is plotted in dark red.

There are a few small differences in the trackmap compared to Mitch000.mqd. There is a short tail coming off of turn 1 because the flight recording ended when the driver had a minor off at that point. For the same reason, there is no red trace coming back into the pits.

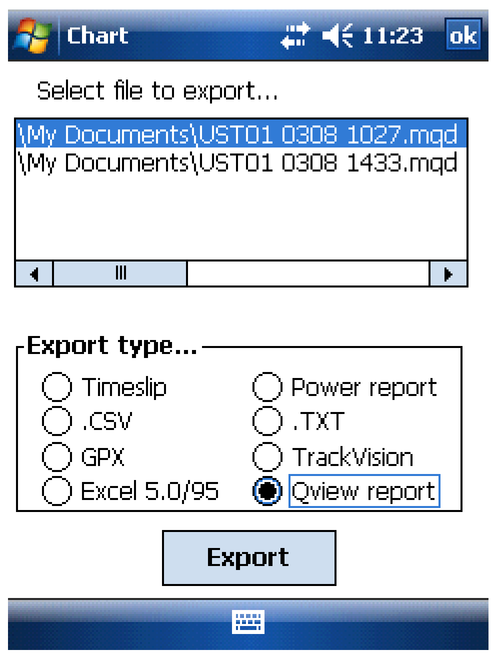
The first thing to do is to import the beacon file saved previously. This time, tap and hold (or right click) on the "B" side beacon counter field, where it reads "[no beacon]" in pink. Tap "Import beacons...", and then select the beacon file saved previously. Now you can access lap and segment times for "Mitch001.mqd" as you did before.



If you would rather have "Mitch001.mqd" displayed as the "A" file, simply tap the "A" file selector. This screen will appear. Tap "Mitch001 \My Documents\Mitch001.mqd" and then "OK". Now Mitch001 will be displayed on both the "A" side as well as the "B" side.

You can load up to 100 files at a time, memory permitting. To unload a file (e.g. to make room for other files), use the "File > Unload" feature.

Exporting Data



There is an "Export..." option under the "File" menu which gives you several options for generating files that are compatible with other applications or for generating reports of various types. To perform an export, you first tap on the filename of the file you wish to export (this is the list of files currently loaded), then select the export type, then tap the "Export" button. The export types are:

Timeslip: This is for straight-line testing and drag racing and is more fully described in a later chapter.

.CSV: "Comma-Separated-Variable" is one of the most universal data formats for spreadsheet and mathematical analysis software. Exporting to CSV creates a file with all of the data organized as one column per sensor value, one row per sample interval. If the resulting file would be more than 65000 rows, it will give you the option of splitting it into several successive files for compatibility with some applications.

GPX: This is a standardized XML format for GPS information. It encodes Latitude, Longitude, Altitude, Time, Course Made Good, Speed, Satellite Count, and HDOP into a .XML file. You can use this file in various third party applications. A later chapter will describe how to create a Google Earth plot of your data using the GPX Export feature.

Excel 5.0/95: This creates an .XLS file from your data suitable for use in Excel (or Excel Mobile on your Pocket PC).

Power report: This is histogram data of the power output of the car as it drives around the course. It is a specialized report and requires manipulation in Excel to generate usable horsepower plots.

.TXT: This is the same as .CSV, except the data values are separated by tabs rather than commas.

TrackVision: TrackVision™ is third party software that will overlay a data display onto a digital video file collected from a video camera. Contact www.trackvision.net for details.

Qview: See next section.

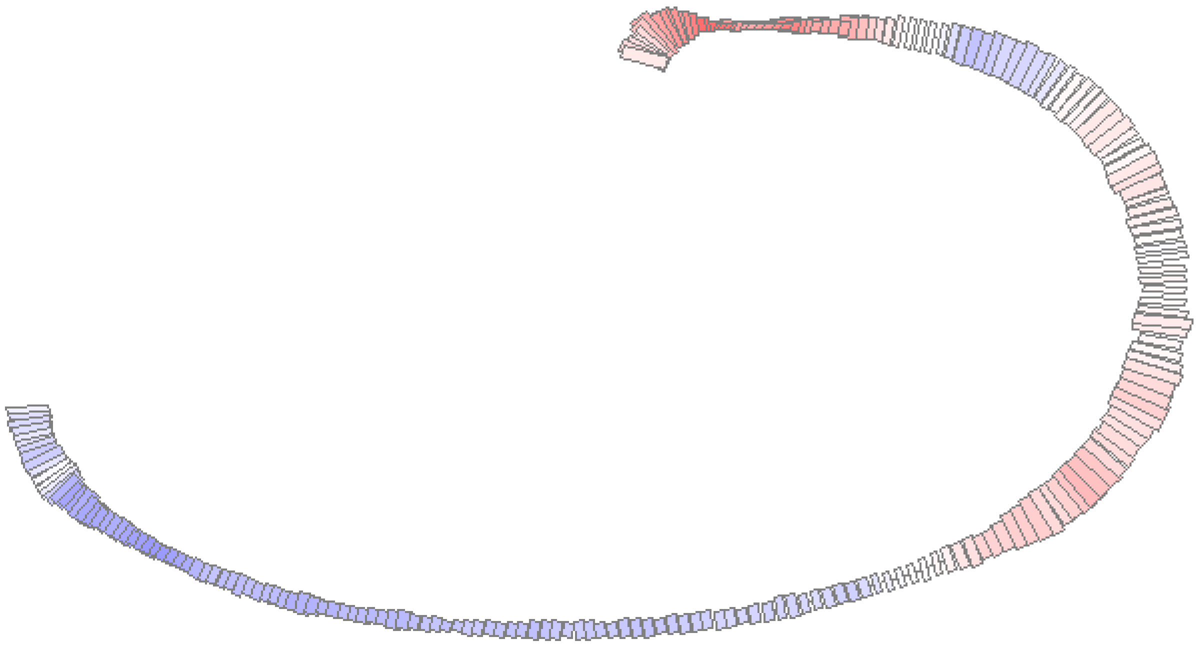
Qview Report

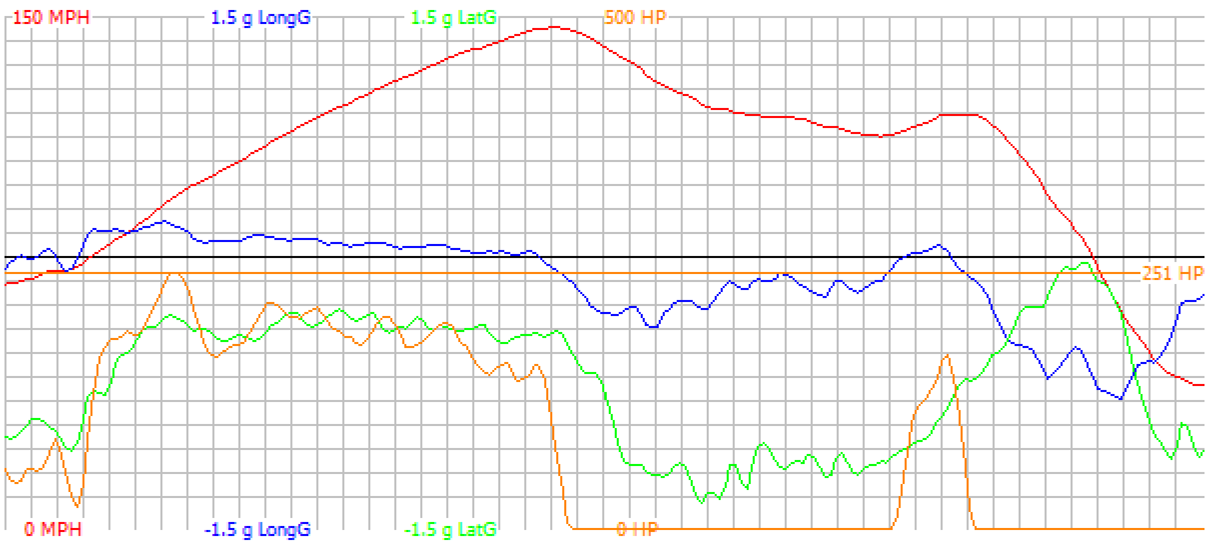
This Export option is a powerful tool for summarizing your lap-by-lap and segment-by-segment results, either within a given session or when comparing different sessions or drivers.

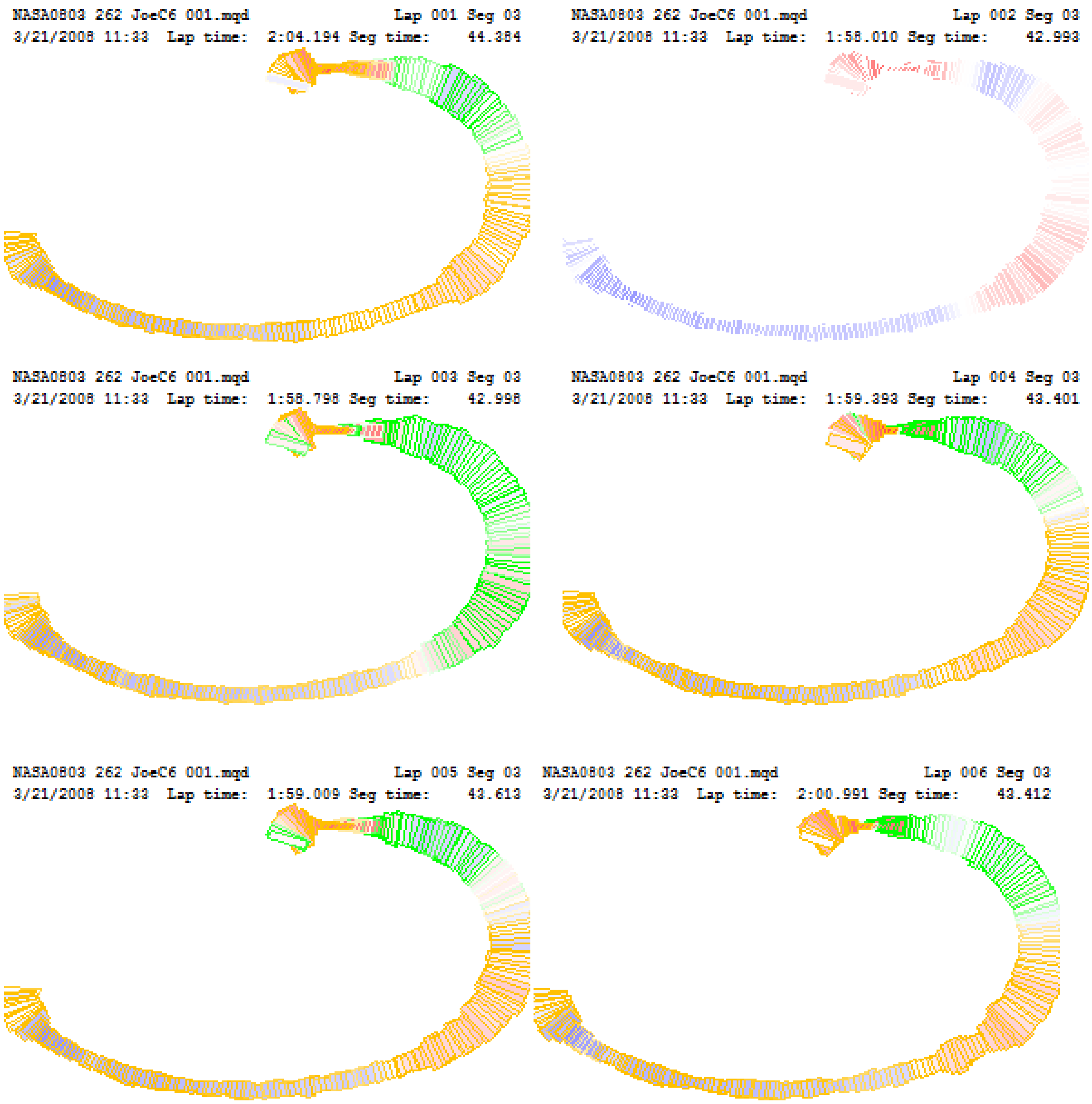
The Qview Report is shown on the following pages. A full Qview report is a series of HTML pages that are viewed in a web browser. Each report page is generated lap-by-lap and segment-by-segment. At the top of the report is a Qview plot of the trackmap for the given segment with lap and segment times calculated. Next is a time-series graph of several important data values, including speed and horsepower. Finally, individual Qview plots are generated comparing the given segment to the same segment in every other lap. This is perhaps the most powerful feature, since it gives the driver, at a glance, the ability to evaluate every segment of the course against any other segment to find differences in technique.

During the Qview export process, you are asked for two files to compare. You can compare the same file to itself, or you can compare two different files. In either case, all report pages are linked together so you can browse through them quickly to find the track segments you are most interested in.

MaxQData™ NASA0803 262 JoeC6 001.mqd Lap 002 Seg 03
3/21/2008 11:33 Lap time: 1:58.010 Seg time: 42.993







Gold means slower, green means faster – for example, the front straight is colored in gold for laps 1, 3, 4, 5, and 6, which means that the car went faster down the front straight on the reference lap (lap 2 in this example) than any other lap. Notice that the outline color for lap 2 is white, which is a result of comparing the reference lap to itself (white meaning no difference in speed).

Course Walk Beacons and Cones

In the chapter on Flight, the section "Course Walk Beacons" describes how to add beacons to a flight recording while walking the course for the purpose of marking cone locations. This creates an MQD flight recording file that contains GPS Beacons which are not used for timing, but rather for plotting orange cone marks so you can see your driving line relative to the cones. You must use the special "File > Load cones" menu choice in order to load a "cone file". If you simply use "File > Load", your cone file will load as a normal flight recording, and instead of seeing orange cone marks, you will simply see a trackmap with a lot of beacon marks.

When you load the cone file properly, orange cone markers will be placed in the background of all flight recordings you load with "File > Load". Please note that, due to errors inherent in the GPS system, your cone marks may not line up perfectly with your trackmap. GPS drift throughout the day can cause this to happen. The cone markers are more for orienting yourself to the layout of the course and remembering key course features than they are for doing line analysis.

Slide map B

The "Map > Slide map B" feature allows you to slide the B map around with the stylus to adjust for GPS drift when comparing files. The slide distance is not permanently recorded in the flight recording.

Using Setup

Setup is used to configure a number of things, including:

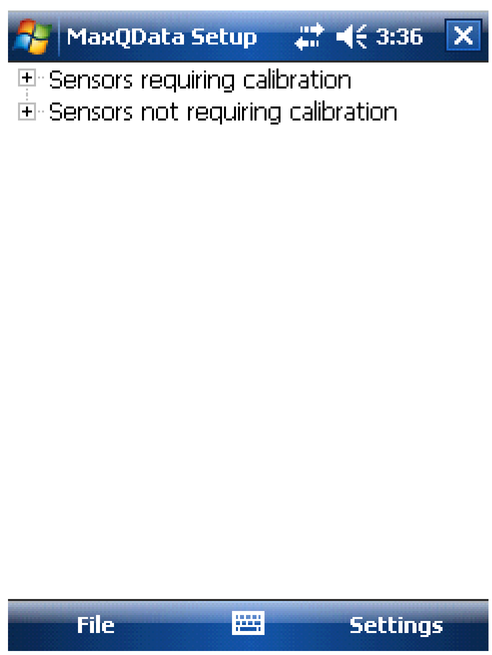
- Calibration values
- GPS Lap Time beacons
- Bluetooth and serial communications
- The unlock code
- MQ Module type and configuration
- Email and Text message telemetry
- Debug settings

Calibration and Sensors

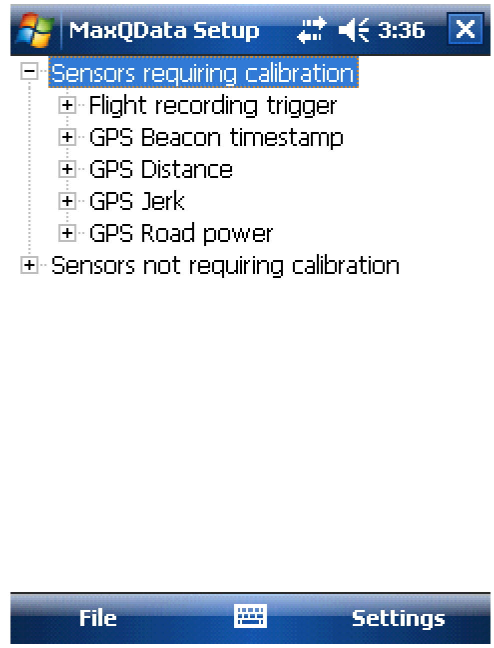
As you know from the explanation in the Flight chapter, the "Sensors" are responsible for measuring all the different values that can be recorded by the MaxQData system. For example, "GPS Altitude" is a "sensor" that measures the height above mean sea level. "GPS Altitude" computes its measurement directly from GPS data with no input from the user. But some sensors, such as "GPS Road power", require you to configure or "calibrate" them before they can produce the value you want. In the case of "GPS Road power", you need to enter the mass of the car. "Flight recording trigger" is another "sensor". It measures whether the car is going fast enough to warrant starting up a new flight recording. There are several calibration points that go along with the "Flight recording trigger": Start Speed, Stop Speed, Off Delay, and Max Record Time.

You can view a complete list of sensors using Setup. You can also edit the calibration points for those sensors that have them. Here is a sequence of screenshots showing how to access the "Flight recording trigger" calibration points.

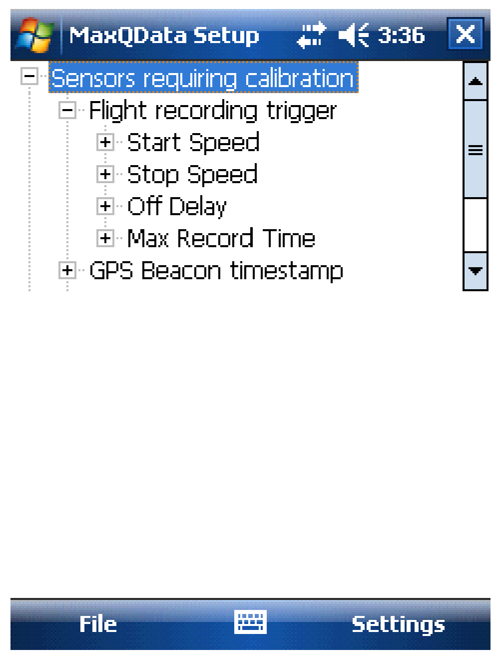
Here is the initial MaxQData Setup screen.



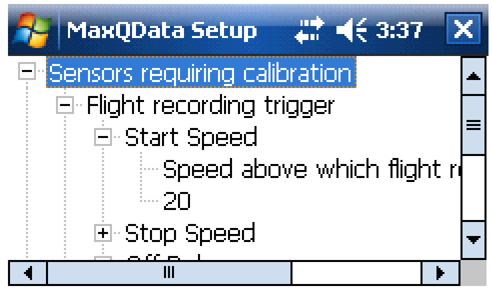
Tap on the "+" next to "Sensors requiring calibration" to expand the list.



Tap on the "+" next to "Flight recording trigger" to expand its calibration point list.



Tap the "+" next to "Start Speed" to expand it. Note that there is a brief explanation of the calibration value immediately above the value itself. At this point, you can edit the calibration value, in this case the number "20". On a Pocket PC, you need to tap it once to highlight it, wait two seconds, and then tap it a second time to open it for editing.



Lap Time Beacons

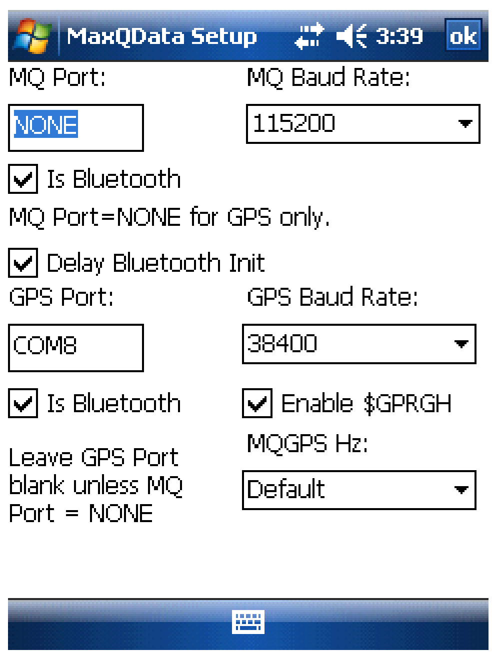
You use the same process for pulling in the beacons for displaying lap times while driving. Please refer to the section titles "Using the MQ200 for Road Racing", subsection "Showing Real-Time Lap and Segment Times", for a detailed explanation.

Saving the Calibration

Use the "File > Save calibration backup" command to save a copy of the calibration to a file in case you need to reinstall or upgrade the software. The calibration itself is saved in the system registry. A calibration backup file only stores calibration points. It does not save the unlock code or other Setup settings.

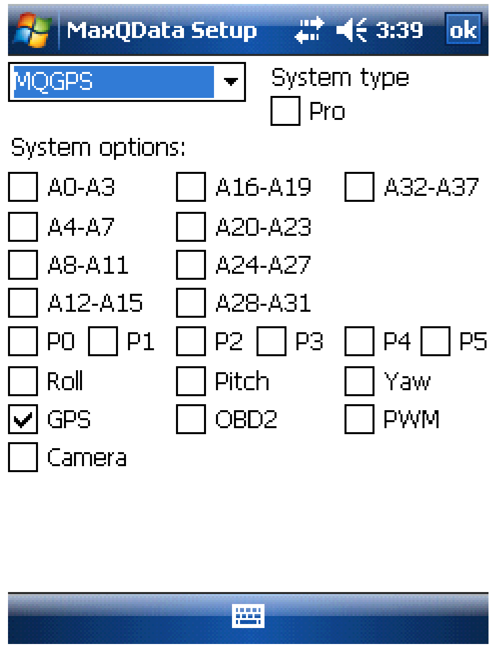
Serial Communications

The menu option "Settings > Serial Port Settings" reveals this screen.



- "MQ Port" is the COM port for communicating to an MQ200. Must be set to the name of the COM port to which the MQ200 is connected. If the COM port is COM10 or greater, you must add \\.\ to the beginning of the name, e.g. \\.\COM10.
- "MQ Baud Rate" must be 115200 for the MQ200.
- "Is Bluetooth" under MQ Port should be checked if a Bluetooth module is being used with the MQ200
- "Delay Bluetooth Init" should be checked on Pocket PCs. It delays opening the Bluetooth connection for a few seconds so that the Pocket PC has time to initialize the Bluetooth stack.
- "GPS Port" must be blank for MQ200 use.
- "GPS Baud Rate" must be 38400.
- "Enable $GPRGH" must be checked
- MQGPS Hz should be set to Default

MQ Module Configuration



The menu option "Settings > MQ Module Configuration" reveals a screen for specifying which MaxQData system is connected and which features are enabled. For MQ200 applications, "System type" must be "MQ200" and the "Pro" box must be checked for MQ200-PRO and MQ200-MAX systems.

The "A0" through "A37" checkboxes enable groups of analog input channels. The MQ200-PRO has channels A0-A3, A4-A7, A8-A11, and A12-A15. The MQ200-MAX has all channels through A31. If your system has the optional roll, pitch, and/or yaw sensors, then A32-A37 must be checked. You may uncheck any group of channels you are not using. However, do not uncheck A12-A15, as these channels are used for the internal accelerometer and battery voltage sensor.

P0 through P5 are the pulse input channels and should be checked unless you are not using any of these channels.

Roll, Pitch, and Yaw must be checked (in addition to A32-A37) if your system has the optional roll, pitch, and/or yaw sensors.

GPS must be checked unless you choose not to use the GPS channels.

OBD2 must be checked if you are using the optional OBD-II module.

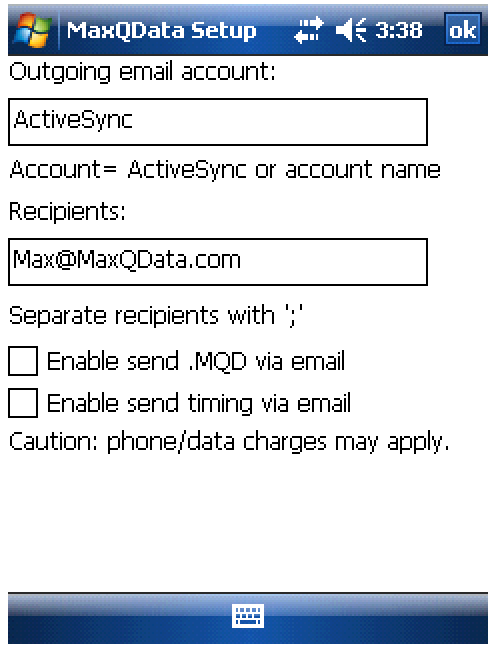
PWM only applies to the MQ200-MAX and should be checked if you are using the PWM output channels.

Camera is for future expansion.

Email and SMS Text Message Telemetry

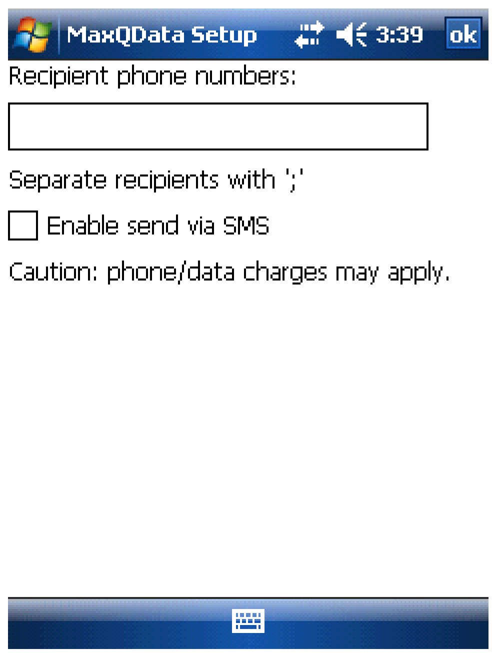
If you are running the software on a Windows Mobile Pocket PC Phone Edition or Smartphone, you can do basic telemetry using the phone's data capabilities.

You can email your data files while driving, and have your lap and segment times sent via email, too. If your email is handled by a Microsoft Exchange Server that supports Always Up To Date technology, the delivery of the email will be nearly instantaneous.

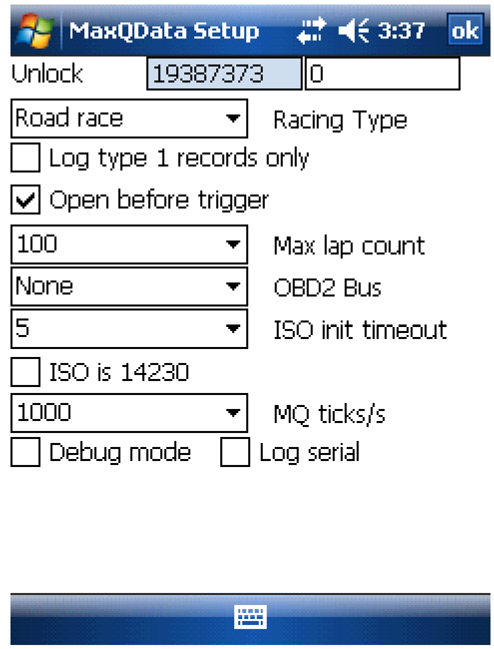


You can also use SMS to send lap and segment times.

Please read the chapter on Telemetry for more information about these capabilities.



Advanced Options



The "Settings > Advanced" menu option reveals a screen with several important options:

- "Unlock" is where you enter your unlock code. The number in the grey box is the "challenge" code. The number in the white box is your "response" code. You must provide the challenge code to MaxQData so that a unique response code can be generated. If you do not have a valid unlock code entered, you will be limited to 1 Hz sampling.
- "Racing Type" should be set to the type of racing you are doing. This adjusts a few internal values, such as the threshold distance for GPS beacons. Also, when set to "Autocross", it tells Chart to assume that courses are open-ended and that the start point should be calculated from acceleration, not a beacon point.
- "Log type 1 records only" is specific to the MQ200. It must be unchecked for MQGPS use. On the MQ200, checking this box does two things. First, it makes flight recording files somewhat smaller. Second, it ensures that the samples stored in the file have timestamps synchronized with the base sample rate you set in Flight. If you leave this unchecked, you will get asynchronous samples in addition to the base sample rate, depending on exactly when GPS and/or OBD-II samples arrive from their sources. Most users won't notice the difference, so we recommend leaving this box unchecked. Users who require a constant sample interval should check this box.
- "Open before trigger" should be unchecked if you are storing flight recordings on a memory card which will be hot-swapped while Flight is running.
- "Max lap count" should be set to a value above the maximum number of consecutive laps you expect to run
- "OBD2 Bus" should be set to the OBD-II bus of the car if you are using the optional OBD-II module. We strongly recommend setting this to the specific bus rather than using "Autosense".
- "ISO init timeout" should be 5 unless you are having trouble initializing an ISO 9141-2 interface.
- "ISO is 14230" must be checked if your vehicle bus is ISO 14230.
- "MQ ticks/s" is for backward compatibility with the MQ100/MQ125/MQ175. It should be 1000 for MQ200 systems.
- "Debug mode" and "Log serial" work together to generate special debug files while Flight is running. If you encounter a problem with the software, you may be asked to check both of these checkboxes and run a test in order to collect additional data about the problem. Be sure to leave these boxes unchecked if you have no need to collect debug data. The debug files can grow to become quite large, possibly affecting the operation of the Pocket PC, so you should only use debug mode when necessary.

Using the MQ200 for Road Racing

Road racers should go through the Flight and Chart walkthroughs earlier in this manual. The walkthroughs, which use road racing data as an example, show most of what a typical road racer would do with an MQ200 system. Here are some specific tips and comments.

Racing Type

Be sure to set the "Racing Type" to "Road race" in MaxQData Setup (under "Settings > Advanced"). In this configuration, laps are assumed to be closed-ended, and the first lap begins at the first beacon position. Certain other software settings, such as zoom factors and track widths, are automatically set for typical road racing courses.

Pocket PC Mounting

If your race car still has the factory interior, then consider mounting your Pocket PC with Velcro™ on your dashboard, or put it in your glove box or center console. Be sure that nothing will tap the screen while driving, since this could erroneously stop a flight recording in progress. Some Pocket PCs (e.g. Dell Axim X51) have a lock button on the side to lock out button presses and screen taps.

If your race car has been stripped of its interior, you can mount the Pocket PC to the floorpan or center tunnel. Putting it in a small plastic box or Pelican™ case is a good idea.

Do not mount the Pocket PC where it will get hot. Watch for excessive exhaust heat, and don't mount it in continuous direct sunlight on a hot day. Some Pocket PCs will shut themselves off if they get too hot. If the Pocket PC screen goes blank but comes on after you let it cool down for several minutes and press the power button, then it got too hot. A white sheet of paper covering the Pocket PC is often enough to keep it cool if sunlight is the problem.

Finding a Racing Buddy

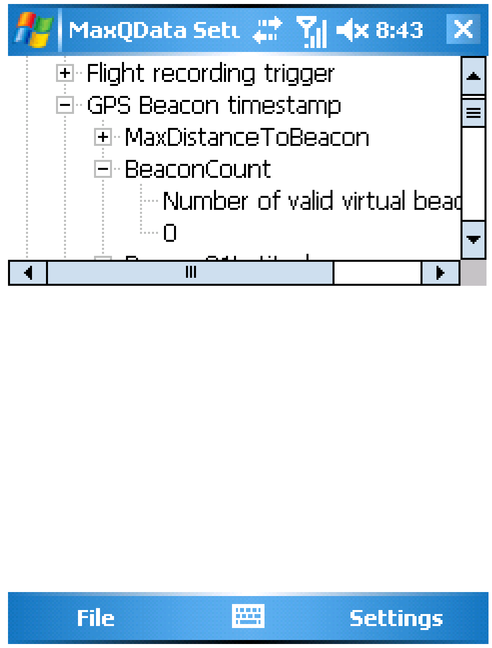
It is extremely helpful to be able to share and compare data files. The ideal situation is to get a better driver to drive your car and capture the data. But you can still lean a lot even if you are able to get the data from a driver in a different car, so long as that car is in the same class as yours.

Setting Beacons

Road racers will typically use the data from their first session to set their beacons. If you have beacons from a previous event on the same course, you can reuse them.

Showing Real-Time Lap and Segment Times

Flight can display real-time lap and segment times as you drive the course, provided you have properly set up the GPS beacons. It is important to remember that you need to export the beacons from Chart and then load them into MaxQData Setup before you can get real-time lap and segment times. Here are the steps you need to perform.



Collect at least one complete lap worth of data.

Load the flight recording into chart and set up your beacon locations according to the instructions in the Chart walkthrough.

Export the beacons to a file.

Run MaxQData Setup.

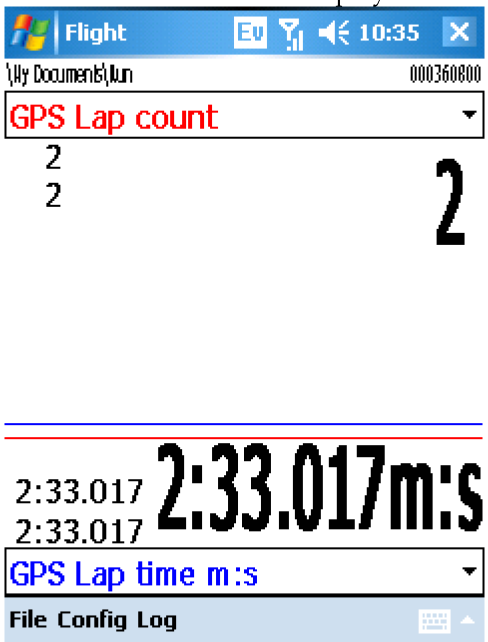
Expand "Sensors requiring calibration", then "GPS Beacon timestamp", then "BeaconCount".

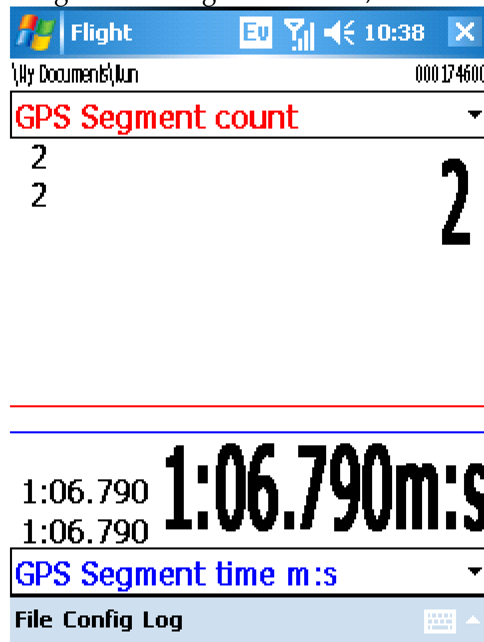
Tap the BeaconCount number ("0" in this screenshot) once to highlight it, wait a moment, then tap it again. You will be asked if you want to import beacons from a file. Tap "Yes" and then select the beacon file you exported earlier.

File > Exit from Flight. Your beacon positions are now locked and will be used until you again change them in Setup.

Run Flight, go into Config > Sensors, and make sure the following sensor values are highlighted in addition to the Standard sensors: GPS Beacon timestamp; GPS Lap count; GPS Lap time; GPS Segment count; GPS segment time

You can use the normal displays to show the lap and/or segment timing information, for example:





In the first display, you are currently on lap 2 and the lap time from lap 1 was 2:33.017. In the second display, you are currently in segment 2 and your segment time for segment 1 was 1:07.790.

Alternatively, you can pull up a pure lap time/count display using "Config > Display lap times". The numbers are large and easy to read. Again, this shows that you are currently on lap 2 and the lap time for lap 1 was 2:33.017.

Please note that the real time lap time calculation is the sum of the previous one lap of beacons, which means that the reported lap time may change at each beacon. This is a feature so that you can see earlier in your lap (at each beacon) whether you are gaining or losing ground. In contrast, lap times calculated in Chart are based off the location of the first beacon encountered and do not change at successive beacons.

This display mode will show "GPS Time Since Last Here" (described next) instead of "GPS Lap time" if it is present. If the display shows "N/A", then no lap time or lap count value is currently configured for recording and you will have to add them.

Showing Lap Time without using Beacons

Flight can also display "continuous" lap time without setting up any GPS beacons. This function is called "GPS Time since last here", abbreviated "TSLH". It has certain advantages over using GPS beacons. First, of course, is that you can use this value without going through any of the steps for setting up beacons. You just need to select "GPS Time since last here" in the "Config > Sensors" list. Second, it gives you a continuous measure of lap time as you drive around the track. You can see where you lose or gain time almost immediately.

TSLH works by maintaining a history of the exact time you passed each Latitude/Longitude point around your trackmap. As you are driving, the TSLH software searches backwards in the data for the most recent time that you passed the same point on the track where you are now. It then calculates the time delta and displays it. Every two-tenths of a second it performs this calculation again. In a sense, it is like having an infinite number of beacons around the track, and the lap time (meaning the time since exactly one lap ago at the same point) is updating every step of the way.

Assuming you are driving with excellent consistency, the TSLH value will always be the same. As soon as you make a mistake, though, the TSLH value will increase by the amount of the mistake. Similarly, the TSLH value will decrease if you make an improvement.

TSLH is especially effective for endurance racing where you are trying to maintain a consistent lap time target. You do not need to wait until you complete a lap to get a lap time. Just glance down whenever it is convenient to see how you are doing.

Pocket PC Power Usage

The Pocket PC battery life will depend on the Pocket PC type, battery age, and backlight setting. If you are not viewing data or lap times while driving, turn the backlight brightness down all the way to the "off" position (Start > Settings > System > Backlight > Brightness). If you are viewing data or lap times while driving, turn the brightness down to the minimum setting where it is still visible in daylight. Some Pocket PCs also have a processor speed setting for improved battery life. You can turn this down to the lowest setting without compromising software responsiveness.

With the backlight turned off, we typically see 4-6 hours of continuous use from a fully-charged Pocket PC. With the backlight turned on "high", this can cut the run time by about half.

You can try leaving your Pocket PC turned on, with Flight running, throughout the day. You will need to recharge it at night.

Alternatively, you can turn off the Pocket PC between sessions. With many Pocket PCs, especially newer ones, it is not even necessary to exit from Flight. Just push the power button. When you turn the Pocket PC back on, it may take 30 seconds or so for Flight to reconnect to the MQ200 and for the MQ200 to reacquire satellites. However, if you find that Flight does not reliably reconnect to the MQ200 after turning the power off, you will need to exit from Flight before turning the power off.

Some Pocket PCs have optional extended life batteries. If battery life is a concern, you can also use car charger cigarette lighter adapters for both the Pocket PC and the MQ200. This would be required for the longer endurance races.

Road Racing Data Analysis

The procedures for comparing two laps as described earlier in the Chart Walkthrough are the basis for doing data analysis. Here are some suggestions for zeroing in quickly on the important data:

Start by setting up your GPS beacons and getting your lap and segment times.

Decide which area of the track you want to focus on, and then check the segment times for that area. Start with comparing your best or second-best segments with your average segments. The worst segments are likely to be the result of either traffic or big mistakes you already know how to avoid.

Whenever possible, get data from a better driver for comparison.

Align the "A" file to the start of your best segment. Align the "B" file to the start of an average segment. Then use Qview™ mode to immediately see where you were faster or slower on your average segment. Pay attention to the acceleration information from Qview™. For example, you may find you braked earlier and not as hard in an area of the slower segment, or you didn't maintain the same LatG level through a turn.

Look carefully at your braking technique in the significant braking zones. A common issue with many drivers is that they simply do not go as deep into the brakes as the car is capable. Your average minivan can achieve 1.0 g braking, but we often see race cars only hitting 0.7-0.8g under braking. Of course, track conditions and traffic need to be taken into account.

Look at your cornering technique. If you are ragged through turns or pinching them, two common mistakes, this will be immediately evident in the Qview™ plot. Also, compare your technique to that of a better driver, especially through transients. You will probably learn something.

Pick the most significant one or two things you need to do better and work on those in the next session.

Most drivers, especially at the amateur level, will gain what they need to learn from these basic steps. Drivers with excellent consistency will need to look at increasing levels of detail in order to gain further improvements. At these more advanced levels, you will want to look closely at corner exit speeds and braking points.

<u>Using the MQ200 for Autocrossing</u>

Autocrossers should go through the walkthroughs for Flight and Chart. Although they are based on road racing examples, the walkthroughs are essential in order to learn the basics of capturing and comparing data.

The MaxQData software has features specifically for Autocrossing. Here are some tips and comments about using the system.

Racing Type

Be sure to set the "Racing Type" to "Autocross" in MaxQData Setup (under "Settings > Advanced"). In this configuration, laps are assumed to be open-ended. The "lap" (or run) does not begin at the first beacon position. Instead, Chart will find the beginning of the run by looking for the top speed in the file and then working backwards to find the point where the car started moving. This means that the segment time calculations will ignore any paddock driving, burnouts, or other motion before you get to the start line. The "Lap" count will either be 0 (all times before the start of the run) or 1 (when the car is making its run). Certain other software settings, such as zoom factors, are automatically set for typical autocross courses. When calculating segment times, Chart assumes a narrower track than with other racing types. When "Chart > Show timing" is enabled, Chart will show all of the segment times in the plot area, rather than just the time of the current segment.

Finding a Racing Buddy

Even more so than road racers, our autocross customers tend to pair up in order to share data. You can learn quite a bit from another driver, even if that driver is not necessarily faster than you are. Whenever possible, get an instructor to ride along with you and help you review the data.

Flight Recording Trigger

The default "Start Speed" is 20 MPH, the default "Stop Speed" is 15 MPH, and the default "Off delay" is 5 seconds. That means that a flight recording will be created if the car reaches 20 MPH, and it will be stopped once the car gets below 15 MPH for more than 5 seconds. This is fine for most autocross courses. However, if you happen to be at a course which is very tight in the beginning, preventing the car from exceeding 20 MPH until well into the course, then you will want to change the "Start Speed" and "Stop Speed" values. Run MaxQData Setup, expand "Sensors requiring calibration", expand "Flight recording trigger", and change the values as necessary.

<u>Please note</u>: the data that you capture does not begin at the 20 MPH point. That would mean that you lose the data covering your launch and run up to 20 MPH. Flight is smarter than that. While Flight is running, it fills a buffer with up to 25 seconds worth of data (12.5 seconds at 10 Hz). Once the car crosses 20 MPH, the first thing Flight does is write this buffer to the flight recording file, and then it continues with new data. You do not lose your launch, unless it takes a long time to get to 20 MPH.

Flight Recording Trigger vs Manual Trigger

The Flight Recording Trigger reduces the burden on the driver. Use it. It's "fire and forget" to ensure you get a flight recording on each run. The software comes preconfigured to use the Flight Recording Trigger. All you need to do is make sure "Flight Recording Trigger" is one of the sensors enabled under Flight > Config > Sensors.

Some drivers prefer to use a manual trigger mode to initiate a flight recording before they begin their run. This allows them to visually verify that data is being collected before they start. The downside of this technique is that, in the heat of battle, it is too easy to forget to do this.

Placing Beacons

Don't place beacon at the start line. The start line is determined by where the car starts moving for greater accuracy. The software determines where the run begins by reading through the recording to find the top speed, then working backwards from that point to find where the car was last stopped.

Do not place too many beacons or the information will become hard to analyze. Two or three beacons (creating three or four segments) generally are enough. Be sure to place a beacon at the finish line. Do not place beacons too close to one another, and do not place beacons where the track folds back on itself.

Back-to-Back Runs

In some autocross competitions, and especially in practice sessions, you may have the opportunity to do back-to-back runs. We encourage you to take advantage of the automatic Flight Recording Trigger. This will automatically create a new flight recording for each run without need to tap the screen or do any other manual intervention.

Stopping after your Run

This applies to the automatic Flight Recording Trigger. If you do not stop shortly after your run, or at least if you do not drop below the "Stop Speed" specified in the Flight Recording Trigger calibration, then you will continue to collect data beyond the last beacon, which might include your complete trip back to the paddock, or out to get lunch, or whatever. Then, when you bring up your data, the trackmap plot will be huge and full of irrelevant driving. We recommend that you come to a stop for a few seconds as soon as reasonably possible after the finish line or at least slow down to below the "Stop Speed".

Obviously, if you exceed the "Start Speed" on the way from the paddock to the start line, you will start an unnecessary Flight recording.

Pocket PC Power Usage

See the comments in the Road Racing section. Autocrossers generally don't have much to worry about in terms of battery life during a 1-day event.

Real-time Segment Time Display

Although it is possible to use the "GPS Segment count" and "GPS Segment time" values while driving an autocross course, they really aren't set up for autocrossing and will probably not work well. At the very least, you will not get a time for your first segment (since there is no beacon at the start line). Watching segment times while driving an autocross course is probably too distracting anyways. Don't bother with it.

Autocrossing Data Analysis

First, enable "Log > Launch Chart" in MaxQData Flight so that each new run will be automatically loaded into Chart.

Second, get in the habit of reviewing your data immediately after each run while the run is fresh in your mind.

Here are three techniques for analyzing your autocross flight recordings that have proven useful to the best people in the sport.

Use Qview™. Qview™ gives us the best information in the least amount of time. Compare each new flight recording to one of the best earlier flight recordings on the same course, or (even better) to a reference flight recording from someone who is faster. With the new file loaded as the "B" file and the reference file loaded as the "A" file in Chart, simply tap "Play 1x" to scroll through the data and observe the outline coloring of QView™. Green is where you went faster, orange is where you went slower. This is often enough for you to figure out what you need to do on your next run. In addition, you can watch the shape and internal coloring of the Qview™ blocks to look for differences. If you only have five minutes to look at your data, use Qview™.

Use the full track map instead of Qview™. Use "Play 1x" to start the cars moving around the course. If the two runs are identical, the red "+" will stay on top of the blue "+". But where they start to diverge, tap the screen to stop playback, then look at the GPS Vehicle Speed, GPS LatG, and GPS LongG traces to determine what you did differently. Bring up "Map > Zoom GPS map" with Qview™ turned off and Overlay turned on to see if there were any significant differences in line (only valid with GPS HDOP below 1.2).

Use segment times. You need to set up beacons as described in the Chart walkthrough. Import the beacons into your first flight recording, and then allow Chart to use the same beacons for each new flight recording. Review the segment times shortly after each run in order to learn what went well and what didn't. When you see an improvement (or mistake), play through the data until you reach the segment in question, then use Qview™ or the data traces to figure out what you did differently.

Using the MQ200 for Drag Racing

You can use the MQ200 to generate highly accurate timeslip information as well as analyze your driving technique. Be sure to read the general walkthroughs for Flight and Chart.

Racing Type

Be sure to set the "Racing Type" to "Drag race" in MaxQData Setup (under "Settings > Advanced").

Log Options in Flight

Enable "Log > Timeslip". Optionally, enable "Log > Display Report" if you want to see your results immediately after your run.

Technically, you do not need to enable timeslips in Flight, since you can export to a Timeslip after your run from within Chart. However, enabling timeslips in Flight makes the timeslip generation automatic.

GPS Beacons

Do not set any GPS beacons for drag racing. The Timeslip data is calculated based on vehicle speed and distance traveled, not beacons.

Recording Your Run

We recommend using the automatic Flight recording trigger so that you will get one new flight recording per run without needing to interact with the Pocket PC. The default settings will work for most drag racers. See the autocrossing section for additional comments.

If you do a running burnout (as opposed to using line locks or not performing a burnout), you may exceed the Flight recording trigger "Start Speed" and create a flight recording of your burnout. This may or may not be desirable. You can adjust the "Start Speed" if necessary in the flight recording calibration in MaxQData Setup.

As mentioned earlier, your data does not begin when you exceed the "Start Speed". Your data actually includes up to 25 seconds (12.5 seconds at 10 Hz) before the "Start Speed" threshold, so you will not lose the beginning of your run.

Flight record at least the "GPS Vehicle speed" and "GPS Distance" sensors. You may also flight record "GPS LongG".

Do a clean run that begins with a standing start and accelerates "continuously" until the end of the run, then decelerate. You can also begin a run from a non-zero speed, but be sure to hold speed steady for a few seconds before beginning your acceleration.

Timeslip Information

The software generates a standing start timeslip by looking for the highest speed in the file, then looking backwards from that time to find the time when the vehicle was at a standstill. In a typical drag race scenario, it is recommended that you start the flight recording when you enter the burnout box, or even earlier. The movements of the car during the burnout and staging will not be counted in the final timeslip calculation.

Technical note: when generating timeslips, if GPS Jerk and GPS LongG are present and there is a rolling start, a standing start timeslip is calculated. The time to go from 0 to the rolling start speed is estimated based on the acceleration of the vehicle immediately after the initial Jerk spike. The total 0-to-whatever time is therefore the estimated 0-to-rolling start time plus the actual rolling start-to-whatever time. This is good for measuring boat acceleration (since it is hard to get a boat completely stopped on the water) and also car acceleration if there is some initial roll due to slope in the road at the start line or GPS speed drift. For most accurate results, keep the rolling start speed low, e.g. under 5-6 MPH for a boat, under 1-2 MPH for a car. (In a car, especially one with a clutch, the jerk phase of a rolling launch will not resemble that of a standing launch if the car is already rolling so fast that a drop-clutch engagement or sudden WOT produces little or no momentum transfer from the rotating mass of the engine to the forward momentum of the car.)

For a data file named “Run000.mqd”, the following files are created:

Run000-Timeslip.htm: web page with detailed performance information

Run000-TimeslipSummary.png: graphic timeslip image, suitable for emailing or posting to newsgroups (standard .png file format, similar to .gif)

Run000-TimeslipTimeGraph.png: larger graph of speed and acceleration vs. time

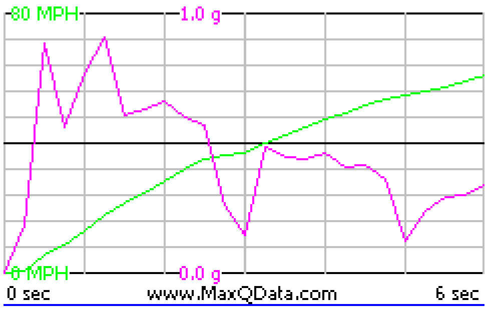
Run000-Timeslip.txt: text file of results

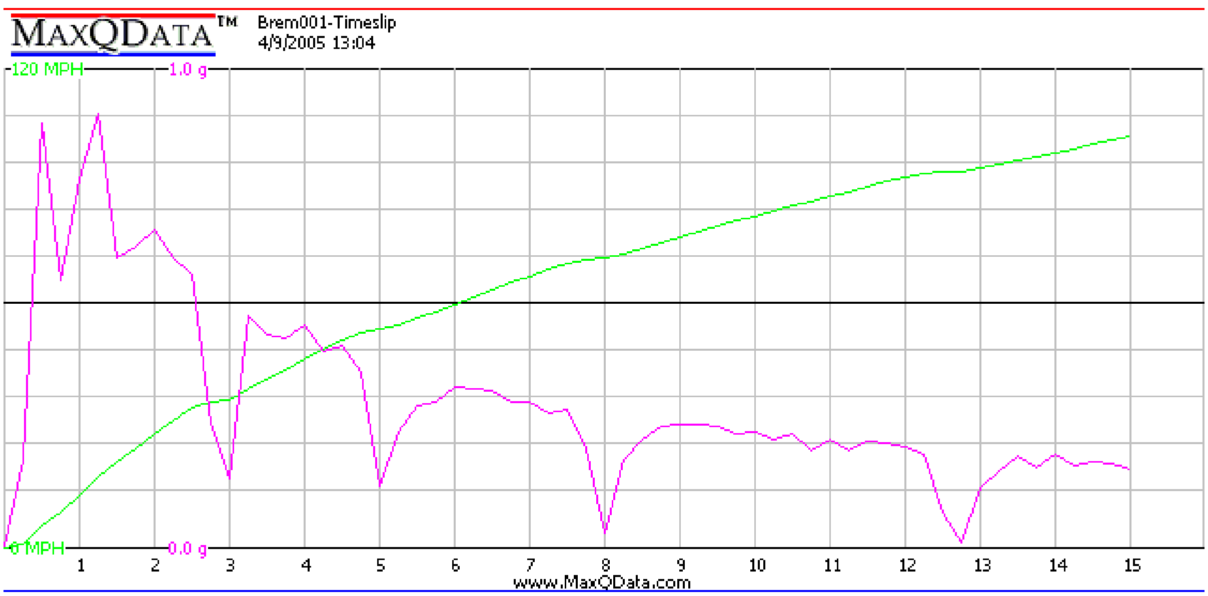
Run000-Timeslip.xls: spreadsheet of results

Here are some samples of the data you will get from Timeslip generation.

Brem001-Timeslip
4/9/2005 13:04
MaxQData™

			sec	MPH
0- 10	0.49			
0- 20	1.06	60'	1.99	32.8
0- 30	1.78	330'	5.74	61.8
0- 40	2.92	1/8mi	8.87	79.0
0- 50	3.95	1000'	11.55	92.5
0- 60	5.50	1/4mi	13.81	99.8
0- 70	6.95	Peak	Launch	Run
0- 80	9.05	MPH	59.5	103.2
0- 90	11.04	g	0.91	0.91
0-100	13.86			






```
Brem001-Timeslip
4/9/2005 13:04
Data acquisition by MaxQData, LLC

Minimum speed:   0.0 MPH
Maximum speed: 103.2 MPH

  0-  5        0.13
  5- 10        0.36
 10- 15        0.28
 15- 20        0.29
 20- 25        0.37
 25- 30        0.35
```

30- 35	0.39
35- 40	0.75
40- 45	0.51
45- 50	0.52
50- 55	0.76
55- 60	0.79
60- 65	0.68
65- 70	0.77
70- 75	1.22
75- 80	0.88
80- 85	0.95
85- 90	1.04
90- 95	1.52
95-100	1.30

MPH	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0	0.13	0.49	0.77	1.06	1.43	1.78	2.17	2.92	3.44	3.95	4.71	5.50	6.18	6.95	8.17	9.05	10.00	11.04	12.55	13.86
5		0.36	0.64	0.93	1.29	1.65	2.04	2.79	3.30	3.82	4.58	5.37	6.05	6.82	8.03	8.92	9.86	10.90	12.42	13.72
10			0.28	0.57	0.94	1.29	1.68	2.43	2.94	3.46	4.22	5.01	5.70	6.46	7.68	8.56	9.51	10.55	12.06	13.37
15				0.29	0.66	1.01	1.40	2.15	2.67	3.19	3.94	4.73	5.42	6.18	7.40	8.28	9.23	10.27	11.79	13.09
20					0.37	0.72	1.11	1.86	2.37	2.89	3.65	4.44	5.12	5.89	7.10	7.99	8.94	9.97	11.49	12.80
25						0.35	0.74	1.49	2.01	2.52	3.28	4.07	4.76	5.52	6.74	7.62	8.57	9.61	11.13	12.43
30							0.39	1.14	1.66	2.17	2.93	3.72	4.41	5.17	6.39	7.27	8.22	9.26	10.77	12.08
35								0.75	1.27	1.78	2.54	3.33	4.02	4.78	6.00	6.88	7.83	8.87	10.39	11.69
40									0.51	1.03	1.79	2.58	3.26	4.03	5.24	6.13	7.08	8.12	9.63	10.94
45										0.52	1.27	2.07	2.75	3.52	4.73	5.62	6.56	7.60	9.12	10.42
50											0.76	1.55	2.23	3.00	4.21	5.10	6.04	7.08	8.60	9.90
55												0.79	1.48	2.24	3.46	4.34	5.29	6.33	7.84	9.15
60													0.68	1.45	2.67	3.55	4.50	5.54	7.05	8.36
65														0.77	1.98	2.87	3.81	4.85	6.37	7.67
70															1.22	2.10	3.05	4.09	5.60	6.91
75																0.88	1.83	2.87	4.39	5.69
80																	0.95	1.99	3.50	4.81
85																		1.04	2.56	3.86
90																			1.52	2.82
95																				1.30

	sec	MPH
60':	1.99	32.79
330':	5.74	61.76
1/8 mi:	8.87	79.00
1000':	11.55	92.46
1/4 mi:	13.81	99.83

Peak:	Launch	Run
MPH	59.5	103.2
g	0.91	0.91

Time	g	MPH	ft	HP
0.000	+0.01	0.00	0.0	0.
0.250	+0.19	1.06	0.4	0.
0.500	+0.89	5.94	2.6	0.
0.750	+0.56	9.03	5.9	0.
1.000	+0.77	13.26	10.8	0.
1.250	+0.91	18.25	17.5	0.
1.500	+0.61	21.58	25.4	0.
1.750	+0.63	25.05	34.5	0.
2.000	+0.67	28.69	45.1	0.
2.250	+0.61	32.02	56.8	0.
2.500	+0.57	35.17	69.8	0.
2.750	+0.27	36.62	83.2	0.
3.000	+0.15	37.43	96.9	0.

3.250	+0.49	40.09	111.6	0.
3.500	+0.45	42.56	127.2	0.
3.750	+0.44	44.97	143.7	0.
4.000	+0.47	47.53	161.2	0.
4.250	+0.41	49.80	179.4	0.
4.500	+0.42	52.11	198.6	0.
4.750	+0.37	54.13	218.4	0.
5.000	+0.13	54.85	238.5	0.
5.250	+0.24	56.18	259.2	0.
5.500	+0.30	57.81	280.4	0.
5.750	+0.30	59.49	302.2	0.
6.000	+0.34	61.35	324.7	0.
6.250	+0.33	63.17	347.9	0.
6.500	+0.33	64.98	371.8	0.
6.750	+0.30	66.66	396.2	0.
7.000	+0.31	68.33	421.3	0.
7.250	+0.28	69.89	446.9	0.
7.500	+0.29	71.48	473.1	0.
7.750	+0.21	72.63	499.8	0.
8.000	+0.03	72.81	526.5	0.
8.250	+0.19	73.84	553.6	0.
8.500	+0.23	75.08	581.1	0.
8.750	+0.26	76.49	609.2	0.
9.000	+0.26	77.92	637.8	0.
9.250	+0.26	79.34	666.9	0.
9.500	+0.25	80.74	696.5	0.
9.750	+0.24	82.05	726.6	0.
10.000	+0.25	83.39	757.3	0.
10.250	+0.23	84.65	788.3	0.
10.500	+0.24	85.97	819.8	0.
10.750	+0.21	87.10	851.8	0.
11.000	+0.23	88.36	884.2	0.
11.250	+0.20	89.48	917.1	0.
11.500	+0.22	90.71	950.3	0.
11.750	+0.22	91.92	984.1	0.
12.000	+0.21	93.08	1018.2	0.
12.250	+0.20	94.17	1052.8	0.
12.500	+0.08	94.59	1087.5	0.
12.750	+0.01	94.67	1122.2	0.
13.000	+0.13	95.35	1157.2	0.
13.250	+0.16	96.25	1192.5	0.
13.500	+0.19	97.30	1228.2	0.
13.750	+0.17	98.24	1264.2	0.
14.000	+0.20	99.33	1300.7	0.
14.250	+0.17	100.28	1337.5	0.
14.500	+0.18	101.27	1374.6	0.
14.750	+0.18	102.25	1412.2	0.
15.000	+0.17	103.16	1450.0	0.

Accuracy

Statistical testing has shown the 60′, 330′, 1/8 mile, 1000′, and ¼ mile times to be generally within a few hundredths of a second of the official track timing system. The measurement with the largest error is typically the 60′ time. The MPH numbers at 1/8 and ¼ mile are slightly higher (e.g. 1%) than what the track timing system will report. This is because the MQ200 reports the instantaneous MPH, whereas the track timing system measures the average MPH over the preceding 66 feet. The timing information is insensitive to any slope in the road, although of course any slope in the road will have a real effect on the speed of the vehicle. Poor GPS reception, caused by trees or poor GPS module placement, can reduce this accuracy. Errors inherent in the GPS satellite system can reduce accuracy in rare conditions, for example if the GPS satellites are positioned poorly in the sky.

Telemetry

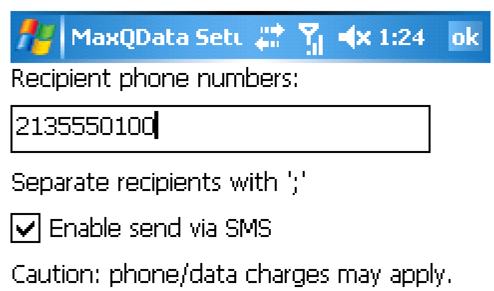
MaxQData is the first racing data acquisition company to bring telemetry down to the affordable end of the market by using smart cellular phone devices.

In order to use Telemetry, you need to have a "Pocket PC Phone Edition" PDA based on Windows Mobile 2003 or later, and preferably based on Windows Mobile 5.0 or later. Smartphone support is planned for a future release.

Our current telemetry capabilities include lap and segment times via SMS text messaging, and emailing of data files. You must have a text messaging component to your cell phone plan for SMS support, and a cellular data component for email support. Your cellular provider will probably charge you extra for them if you do not already have them as part of your plan.

SMS Text Messaging of Lap and Segment Times

First, you need to set up your beacons for GPS Lap Time and GPS Segment Time as described earlier. These beacons need to be imported into the "GPS Beacon timestamp" calibration. Then you need to ensure that "GPS Lap count" and "GPS Lap time", and optionally "GPS Segment count" and "GPS Segment time", are enabled in the configured list of sensors.



Next, you need to set up the "Settings > SMS..." option in MaxQData Setup. Enter the phone number(s) of the recipient(s), separated by semicolons. Then check "Enable send via SMS". Please note that SMS text messaging is generally not free for either the sender or the receiver. You would pay for these text messages as part of your regular plan with your cell phone provider (MaxQData does not bill you nor receive any revenue from this). Be cautions, as you can quickly overrun your text message limit on a long race.

A text message will be sent every time your lap count (or segment count) is incremented while logging data. The time delay between crossing a beacon position and a recipient receiving the text message is typically about 15-20 seconds, but can extend to a few minutes, and occasionally much longer than that. This is due to delays in the cellular text messaging system that MaxQData has no control over. In-order receipt is not guaranteed.

Assuming you have enabled lap time, lap count, segment time, and segment count, the text message will look like this:

"L 1 2:15.692 L 2 S 2 0:28.989"

The message is necessarily cryptic due to the limited size of text messages and the desire to be able to read the lap and segment times at a glance without having to open up the message.

Here's how to decipher it:

"L 1 2:15.692": The most recently completed lap was Lap 1. The lap time was 2:15.692.

"L2 S 2 0:28.989": The most recently completed segment was Segment 2 on Lap 2. The segment time was 0:28.989.

A sequence on a course with three beacons might look like this:

```
L 0 0:00.000 L 0 S 0 0:00.000    [this is the initial message sent when the car
passes the first beacon]
L 0 0:00.000 L 1 S 1 0:16.094
L 0 0:00.000 L 1 S 2 0:35.435
L 1 1:20.933 L 1 S 3 0:29.404
L 1 1:20.933 L 2 S 1 0:15.650
L 1 1:20.933 L 2 S 2 0:34.844
L 2 1:19.483 L 2 S 3 0:28.989
```

If you are not recording all four lap time/lap count/segment time/segment count values, you will get a somewhat different message, such as:

"On L 3 Prv L 2:14.030"

which means that the car is currently on Lap 2 and the lap time of the previous lap (lap 2) was 2:14.030.

Email of Flight Recording Files

The other form of telemetry currently supported is the ability to automatically email your flight recording file when it is closed. This is handy if you have racing buddies with whom you are sharing data (they will also need Pocket PC Phone Edition devices), or if you have a remote observer that is going to analyze your data for you.

Although this is not exactly "real-time" telemetry, you can send periodic flight recordings if you use the Flight Recording Trigger and set the "Max Record Time" calibration value to a value such as, for example, 600, which would send a new flight recording every 10 minutes. During an endurance race, this would allow a data analysis person to periodically check the data coming from the car and look for problems.

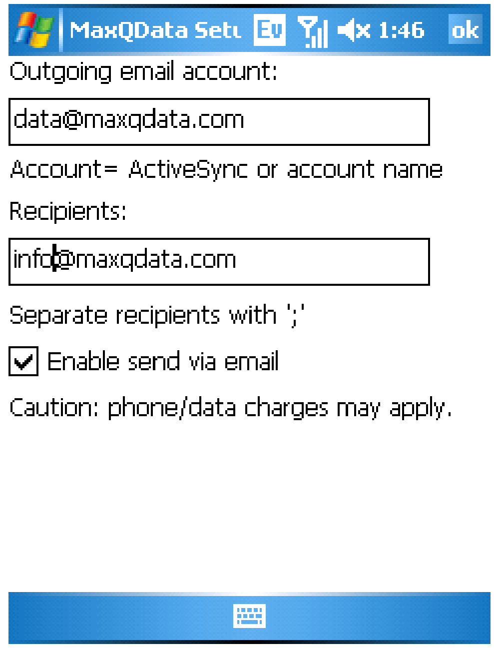
There are a few prerequisites for using this feature:

Data plan for your phone

Email account already set up (contact your cellular provider or ISP for instructions) and capable of sending email

The Flight recording trigger does not need to be enabled (the flight recording will email even on a manual trigger), but it is recommended.

To set up email, go into MaxQData Setup and select the "Settings > Email..." option. First, you need to type the name of the email account already set up on your phone you will use for sending email. If this is a POP3 account, type the name you assigned to it during setup (this is usually either "POP3" or the email address). If you are using an Exchange Server account (common for corporate email accounts), use "ActiveSync" instead.



Next, type in the recipient email addreses, separated by semicolons.

Finally, check the "Enable send via email" checkbox.

Each time a flight recording closes (either at the end of a session or as a result of the Max Record Time for the Flight Recording Trigger), an email message will be created, the flight recording will be attached, and it will be placed in the Outbox for the outgoing email account.

Assuming you have Windows Mobile 5.0 on your device, the email will be sent immediately (subject to cellular reception). The attachment will arrive as a normal .mqd file. The delay time between sending and receiving is a function of your cellular connectivity, file size, and server delays, but it can be as little as a few seconds. Exchange users will want to enable "Direct Push" on both the sender and receiver for best performance.

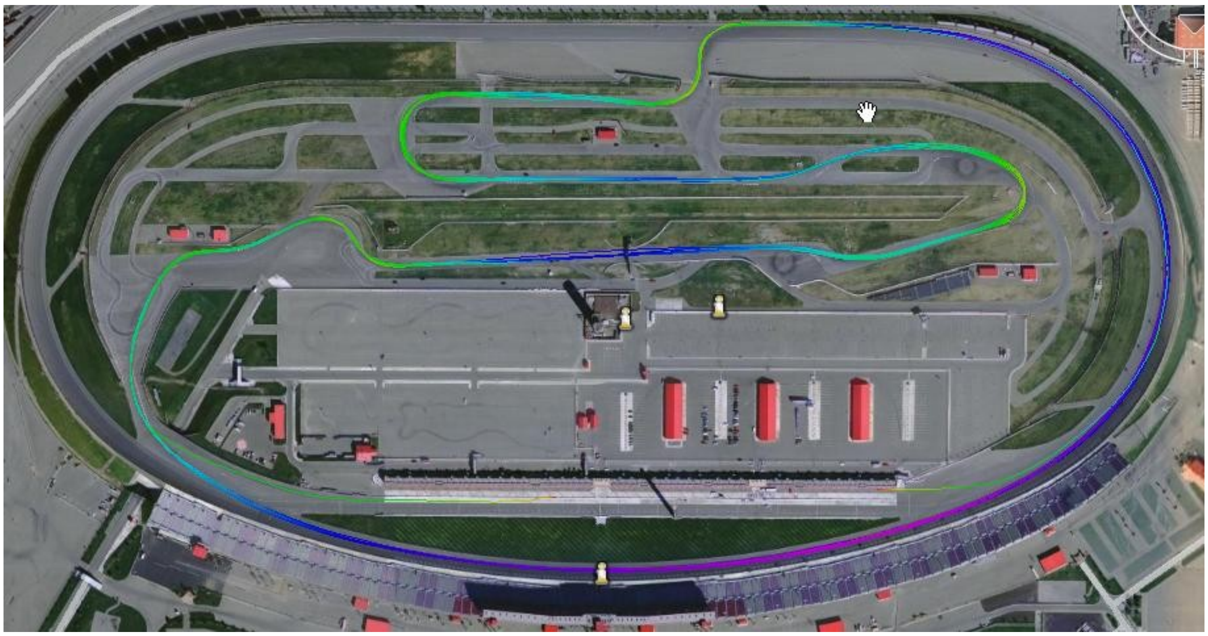
At the time of this writing, Windows Mobile 2003 devices are not recommended. Although the email is constructed and placed in the Outbox, the attachment is Base64 encoded into the body of the message and does not appear as an attachment, making it very awkward to extract. Also, there is no operating system function to force the message to be sent. Instead, you have to set up your Inbox application to do a periodic send/receive, which reduces battery life.

The maximum supported flight recording size for this feature is 2 megabytes, which is more than enough for most applications. Please note that some cellular data plans charge per kilobyte. We recommend using only an "all you can eat" data plan, otherwise you can quickly rack up some expensive phone bills.

Note that, once emailed, a copy of the email including the attachment will be saved in your "Sent mail" folder on the Pocket PC. Also, the original flight recording will still be saved in the usual location. This is good redundancy, but it eats up more memory.

Generating a Google Earth Satellite Plot

In a few simple steps, you can plot your track data on a satellite image, like this:



In this graphic, the color of the line is a function of vehicle speed. With Google Earth software, you can zoom in on the track and, given excellent satellite visibility and low HDOP, you can do line analysis against the actual course.

You will need a laptop or desktop PC with an active Internet connection. You must also have Google Earth installed on your PC.

Load the data file into Chart on your PC, and choose "File > Export". Select the file, choose the "GPX" option, and click the "Export" button. This will create a file with the same prefix but an ".XML" extension, e.g. "Run000.xml".

Bring up a web browser and go to www.gpsvisualizer.com . This is the service you will use to create a Google Earth file from your data. MaxQData is not associated with GPSVisualizer.com

Select the "Make a map: Google Earth KML" link. Most of the default parameters on the next page are correct. Make the following changes:

Click the "Browse..." button next to "File #1" and select the .xml file you just created.

Under “Track options”, select “Colorize by: Speed”.

Now click the “Create KML file” button. After a short delay, a new page will be displayed. There is a link on this page to your Google Earth KML file (actually a .KMZ file). Right click on this link, choose “Save target as...”, and put the file somewhere convenient.

Finally, run Google Earth and load your .KMZ file. You can use Google Earth to pan across and zoom in on your trackmap. If you zoom in close enough and if your satellite reception was good enough, you should be able to see lap-to-lap variations in your racing line.

Please note that we have seen instances where the GPS Latitude/Longitude data does not exactly match with the Google Earth satellite imagery, so the trackmap won’t line up with the satellite image. Also, Google Earth does not have high-resolution imagery of all areas. Tracks in remote locations will probably have fuzzy satellite images.

For off-road rallys, you can tilt the Google Earth map and see your trackmaps plotted against the terrain.

Sensor Reference

Following is a description of the sensor drivers supported by the MQ200.

A00..A37 voltage

These are raw analog voltage inputs. The input voltage must be between 0 and 5 volts. The raw resolution on channels A00-A15 is 10 bits, oversampled and averaged to 12 bits. The raw resolution on channels A16-A31 is 12 bits. The raw resolution on channels A32-A37 is 10 bits, oversampled and filtered to 12 bits. Channels that are not present (e.g. A16 on an MQ200-RT) will report undefined values. Some channels are used internally:

- A12 is used to measure supply voltage
- A13 is the X accelerometer axis (minor axis of the MQ200)
- A14 is the Y accelerometer axis (major axis of the MQ200)
- A15 is the Z accelerometer axis (vertical axis of the MQ200)
- A32 is the raw roll rate input
- A33 is the temperature sensor for roll rate
- A34 is the raw pitch rate input
- A35 is the temperature sensor for pitch rate
- A36 is the raw yaw rate input
- A37 is the temperature sensor for yaw rate, which is the same as "MQTemp"

Calibration values:

- None

Dependencies:

- These inputs do not depend on any other inputs. However, other sensors (such as MAP sensors or throttle position sensors) may depend on these inputs.

Beacon lap counter

Counts the number of laps completed when a beacon system is attached. A beacon system must have a compatible square wave output and be connected to one of the P0..P3 inputs.

Calibration values:

- None (depends on the calibration for "Beacon lap time")

Dependencies:

- Beacon lap time

Beacon lap time

Measures lap time when using an optical beacon system.

Calibration values:

- Channel
  Channel number [0..3] of the pulse channel where the beacon is attached.

- BeaconCount
  Number of beacons around the track.

Dependencies:

- None

Beacon segment time

Reports the elapsed time over the last segment when using a beacon system.
Calibration values:

- None (depends on the calibration for "Beacon lap time")

Dependencies:

- Beacon lap time

Beacon timestamp

This value is the timestamp recorded when the car passes a beacon when a beacon system is attached. One timestamp count is one millisecond.
Calibration values:

- None (depends on the calibration for "Beacon lap time")

Dependencies:

- Beacon lap time

Distance

Estimates distance traveled. Used for time-to-distance calculations and plotting by distance.
Calibration values:

- SpeedSignalSource
  0: "Speed"
  1: "OBD2 Vehicle speed"
  2: "TransSpeed"
  3: GPS. When using certain GPS modules in conjunction with the "Enable $GPRGH" setting in the MaxQData Setup serial port settings, Distance is calculated by Doppler shift. This is generally the most accurate way to measure distance. If $GPRGH is not enabled, then Distance is calculated from changes in Latitude and Longitude. This is the recommended setting.

Dependencies:

- Depends on the specified base sensor.

ECT (Engine Coolant Temp)

Measures engine coolant temperature based on a standard thermistor-based sensor. You should calibrate the sensor near its operating point. This is a very simple linear model which will be increasingly inaccurate as the temperature gets far away from the calibration points.
Calibration values:

- Channel
  Specifies the analog input channel used for the signal
- HighTempDegrees
  The high temperature calibration point in degrees C
- HighTempVoltage
  The voltage output from the sensor at HighTempDegrees
- LowTempDegrees
  The low temperature calibration point in degrees C
- LowTempVoltage
  The voltage output from the sensor at LowTempDegrees

Dependencies:

- None

Flight recording trigger

This "sensor" is used to start and stop the datalogging process in "Flight" automatically. Be sure to select "Flight recording trigger" along with the other sensors being recorded in "Flight", otherwise it will only respond to manual commands.

Calibration values:

- Start Speed
  When the vehicle speed exceeds this value, flight recording begins automatically.
- Stop Speed
  Once the flight recording has been started automatically, it continues until the vehicle speed comes down below the Stop Speed and stays there for more than the time specified by Off Delay. The Stop Speed must be less than the Start Speed.
- Off Delay
  This sets the delay before the flight recording is automatically turned off. The value is the number of seconds for the delay. Typically, this value would be set to 2-4 seconds. With such a delay, momentary brake lockup will not turn off a flight recording.
- Max Record Time
  For long sessions, it is sometimes desirable to break up the data file into chunks rather than save one huge file. If Maximum Record Time is 0, the flight recording will be one big file. Otherwise, the flight recording will be broken up into chunks N seconds long, where N is the Maximum Record Time. Note that there will be a gap in the data between one data file and the next, corresponding to the time it takes to close out the first file and open the second file. This feature can be combined with Email Telemetry to send data files from a moving car.

Dependencies:

- Depends on the "GPS Vehicle speed" sensor.

Fuel Consumed [Since Reset]

Total fuel consumed since the flight recording was started.
Calibration values:
- None

Dependencies:
- Uses Fuel Consumption Rate.

Fuel Consumption Rate

Estimates the fuel flow rate (in cc/min) based on injector pulse width.
Calibration values:
- MaxFlowRate
  Set this to the flow rate of one injector at 100% duty cycle.
- InjectorCount
  The number of injectors on the engine.

Dependencies:
- Uses the Channel setting for InjectorPulseWidth.

Gear Ratio

Estimates the gearbox ratio based on vehicle speed and RPM.
Calibration values:
- FinalDriveRatio
  Set this to the final (differential) drive ratio, e.g. 4.100.
- RevsPerMile
  Set this to the number of rolling revolutions per mile for the tire. This can usually be found in the tire manufacturer's specifications.

Dependencies:
- Depends on both the "RPM" sensor and the "Speed" sensor. Be sure to configure both of these sensors to get information from the appropriate sources.

Standard GPS values

GPS Latitude
Latitude. 0 degrees is the Equator, +90 degrees is the North Pole, -90 degrees is the South Pole.

GPS Longitude

Longitude. 0 degrees is the Prime Meridian through Greenwich, England. Negative values are west, positive are east of the Prime Meridian.

GPS Altitude
Height above mean sea level.

GPS Satellite count
Number of satellites used to compute the GPS position fix. Should be at least four. Eight or more satellites gives the best results.

GPS Seconds past midnight UTC
Based on global GPS time. Not adjusted for local time zone. Watch this value for a quick check to see if GPS is connected. Also a good way to check the exact time between different runs. If you have data files collected from two separate cars that drove at the same time, you can align them according to this value and you will see their exact locations on the course, relative to one another, throughout the session.

GPS Track made good
0 degrees is due North, 90 degrees is due East, etc. Note that this is the direction the vehicle actually traveled, not the direction it was pointing.

GPS Vehicle speed
The speed of the car in the direction of travel. This is calculated using a highly accurate Doppler shift measurement from the GPS satellites instead of the change in Latitude/Longitude.

GPS HDOP
This value ("Horizontal Dilution Of Precision") is a measure of the quality of the GPS fix. It is based on the position of the satellites used to generate the fix. Good HDOP values are below 1.2. If Satellite Count stays above 8 and HDOP stays above 1.2, the accuracy is typically good enough to do line analysis. HDOP varies with the positions of the satellites position in the sky (which are constantly changing), vehicle motion, and satellite visibility.

GPS Fix quality
This value is either 0, 1, or 2. 0 means no satellite fix, 1 means standard GPS fix, 2 means DGPS fix (only when using a DGPS-enabled unit). Flight will disregard GPS data points where this value is 0.

GPS Beacon timestamp

You can use GPS to simulate trackside beacons. See the "Chart" walkthrough for more details. You must first make a flight recording of a lap of the course, and then in Chart you must place beacons where you want them around the track. Then you export the beacons, which saves the first lap of beacon positions to a file. After that, go into the GPS Beacon Timestamp calibration and modify the setting for BeaconCount. This will bring up a dialog that will ask you if you want to import the beacons from a file. Answer "Yes" and then select the file you exported from Chart. This will populate the beacon count and locations automatically. You will have to change the beacon settings when you go to a new track, so save the beacon export files. Note: you do not need to use GPS Beacon Timestamp in order to place beacons in Chart, but it does save you from having to add them later, plus you get a lap time readout while driving the course.

Calibration values:

- MaxDistanceToBeacon
  This is the maximum allowable distance between the car and a beacon position, in meters (1 meter is approximately 1 yard), beyond which the beacon will not trigger. Adjust this value for tracks that are extremely wide or narrow, or that fold back onto themselves tightly.
- BeaconCount
  The number of virtual GPS beacons in one lap. (maximum 10).
- BeaconXXLatitude/BeaconXXLongitude
  The latitude and longitude of the specified beacon.

Dependencies:

- GPS Latitude
- GPS Longitude.

GPS Distance

This is measures distance traveled based on GPS Vehicle Speed. GPS Vehicle Speed is used instead of delta Latitude/Longitude because it is more accurate. This sensor value is important for many features of the MaxQData software.

Calibration values:

- GPSDistanceZero
  If set to 1, then the GPS Distance calculation is automatically reset to zero when the vehicle stops. This is required for some software features. Setting it to 0 is useful when calculating total distance traveled including stops

Dependencies:

- GPS Vehicle speed
- GPS Longitude.

GPS Lap count, Lap time, Segment Count, and Segment time

If you have set up the GPS virtual beacons as described under “GPS Beacon timestamp”, then you can view these values while driving to see your lap and segment times in real time.

Calibration values:

- None

Dependencies:

- Depends on GPS Latitude and GPS Longitude

GPS Time Since Last Here

This provides a way to compute lap time "on the fly" from GPS information only, without a trackside beacon. As the car drives around the track, the flight recorder constantly watches GPS position. It searches backwards in its recording to find the most recent time that the vehicle has been at the same spot on the track. Then it computes the time difference. If you look at this value every time you cross the start/finish line, you will have lap time. But it's a bit more powerful than that. If, for example, you lose a couple seconds in the middle of the track, you will see "Time Since Last Here" grow right away without having to wait until you hit a beacon. You do not need to flight record "GPS Time Since Last Here" in order to calculate lap and segment times in Chart. "GPS Time Since Last Here" does not generate virtual beacon timestamps.

Calibration values:

- None

Dependencies:

- GPS Latitude
- GPS Longitude
- GPS Vehicle speed
- GPS Track made good
- GPS HDOP

GPS LongG

Measures longitudinal acceleration by calculating the change in velocity over each sample period.

Calibration values:

- None

Dependencies:

- GPS Vehicle speed

GPS Jerk

Measures the rate of change of GPS LongG. Useful for identifying the exact point where the vehicle began to move, and also shift smoothness.

Calibration values:

- None

Dependencies:

- GPS LongG

GPS LatG

Lateral acceleration calculation based on speed and turning rate.

Calibration values:

- None

Dependencies:

- GPS Track made good
- GPS Vehicle speed

GPS Power ratio

Estimates instantaneous power-to-weight ratio (actually weight-to-power ratio, lb/hp or kg/kw) based on the weight of the vehicle, how fast it is going, and its acceleration. Note that this is net horsepower, which is considerably less than crankshaft horsepower because of losses due to wind resistance, transmission and tire losses, etc.

Calibration values:

- Mass
  Set this to the weight of the vehicle in pounds, including driver

Dependencies:

- GPS LongG
- GPS Vehicle speed

GPS Road power

Estimates horsepower output based on the weight of the vehicle, how fast it is going, and its acceleration. Note that this is net horsepower, which is considerably less than crankshaft horsepower because of losses due to wind resistance, transmission and tire losses, etc. You should therefore compare power numbers only within the same speed range.

Calibration values:

- Mass
  Set this to the weight of the vehicle in pounds.

Dependencies:

- GPS LongG
- GPS Vehicle speed

GPS Turn radius

Estimates the radius of the imaginary circle the car is traveling around as it goes through a corner. When the car is going straight or nearly so, this value gets very large and will flip from positive to negative as you turn slightly left or right.

Calibration values:

- None

Dependencies:

- GPS Vehicle speed
- GPS Track made good

Injector pulse width

Measures injector pulse width in milliseconds.
Calibration values:
- None

Dependencies:
- Depends on the calibration for "RPM (injector)"

Internal LatG

Measures lateral acceleration from the internal lateral accelerometer.
Calibration values:
- Orientation
  This value must be set according to the orientation of the MQ200 as it is installed in the car.

Side 0

Side 3

Side 1

Side 2

If side 0 is towards the front of the car, “Orientation” should be set to “0”. If side 1 is towards the front, “Orientation” should be set to “1”, and so forth.

- Other calibration values are determined at the factory and stored in a file shipped with the unit. Recalibration is not necessary. Contact Info@MaxQData.com if you believe your MQ200 needs to be recalibrated. Calibration values are shared with Internal LongG.

Dependencies:

- Based on A13 or A14, depending on orientation.

Internal LongG

Measures longitudinal acceleration from the internal accelerometer.
Calibration values:

- Internal LongG shares the same calibration values with Internal LatG.

Dependencies:

- Based on A13 or A14, depending on orientation.

Internal VertG

Measures vertical acceleration from the internal accelerometer.
Calibration values:

- Internal VertG shares the same calibration values with Internal LatG.

Dependencies:

- Based on A15

MAP

MAP stands for “Manifold Absolute Pressure”. You can add a MAP sensor as long as it has a 0 to 5V analog output. MAP is the best measurement of engine load. TPS (Throttle Position) tells you what the driver is commanding out of the engine, but MAP essentially tells you how hard the engine is actually working (meaning how much air is pumping through it).
Calibration values:

- Channel
  Set this to the channel number of the analog input where the MAP sensor is hooked up.
- OneHundredkPaVoltage
  Set this to the voltage representing “atmospheric” pressure. This is the pressure that the MAP sensor sees at sea level when the engine is not running. This value can either be looked up in the pressure sensor specifications or can be measured by looking at the raw analog voltage input when the engine is off.
- ZerokPaVoltage
  Set this to the voltage produced by the sensor in response to full vacuum. Normally, you have to either look up this voltage from the sensor specification. You can get a fairly good

estimate of this voltage if you flight record the sensor analog voltage output, rev the engine high, and then suddenly close the throttle.

Dependencies:

- Based on the underlying analog input, e.g. "A00"

MQTemp

Measures the temperature inside the MQ200.

Calibration values:

- Calibration values are determined at the factory and stored in a file shipped with the unit. Recalibration is not necessary. Contact Info@MaxQData.com if you believe your MQ200 needs to be recalibrated.

Dependencies:

- Based on A37

OBD2 values

The MQ200 connects to the OBD-II bus in late-model vehicles in order to acquire data from built-in sensors. It can communicate with ISO 9141-2 (most imports and many Chrysler vehicles), ISO 14230 (Subaru STi, Cadillac CTS, some other imports), VPW (mostly GM), and PWM (mostly Ford). Consult Web references to verify which bus your vehicle has. CAN is supported as a special option; contact MaxQData for details.

The sampling rate depends on the bus and is typically in the range of 5-10 samples per second. The more OBD-II values you flight record, the slower the sample rate on each.

Here are the standard OBD-II parameters supported:

- Calculated Load Value
- Coolant Temperature
- IAT (Intake Air Temperature)
- Long Term Fuel Trim Bank 1 / Bank2
- MAF (Mass Air Flow)
- MAP (Manifold Absolute Pressure)
- O2 Trim Bank 1 Sensor 1 through Bank 2 Sensor 4
- O2 Voltage Bank 1 Sensor 1 through Bank 2 Sensor 4
- RPM
- Short Term Fuel Trim Bank 1 / Bank 2
- Spark Advance
- TPS (Throttle Position)
- Vehicle Speed

Calibration values:

- None

Dependencies:

- None

OBD2 Generic PID

Allows reading of manufacturer-specific PIDs. You must know the PID number. PID numbers above 0xFF are requested using SAE J2190 protocol.
Calibration values:

- PID
  Set to the hexadecimal PID number.
- DataLength
  Set to the number of data bytes used in the response.

Dependencies:

- None

P0..P5 duty cycle

The pulse inputs are capable of measuring the duty cycle of a square wave signal. The duty cycle is the ratio of the "on" time of the signal to the "on+off" time of the signal.
Calibration values:

- Invert
  Set this to "1" if you'd like to measure the ratio of "off" time to "on+off" time.

Dependencies:

- Based on the underlying pulse input, e.g. "P0"

P0..P5 period

Measures the period (on time plus off time) of a square wave signal.
Calibration values:

- None

Dependencies:

- Other sensors may depend on these values

P0..P5 pulse count

Counts the number of pulses received on the input line during one sample period.
Calibration values:

- None

Dependencies:

- Other sensors may depend on these values

Pitch rate

This senses the rate of pitch in degrees/second. A car that is driving straight on a flat and smooth road will measure a Roll Rate of 0 degrees/second. When the driver suddenly brakes, the pitch rate will spike in one direction as the car noses down, then it will fall back down to zero. When the brake is released or the car stops, it will briefly spike the other way as the nose of the car comes back up. This can be used to tune sway bars and shocks.
Calibration values:

- Calibration values are determined at the factory and stored in a file shipped with the unit. Recalibration is not necessary. Contact Info@MaxQData.com if you believe your MQ200 needs to be recalibrated.

Dependencies:

- Based on A34 voltage with temperature correction from MQTemp.

PWM0 and PWM1 control

The MQ200-MAX has two "PWM" outputs ("PWM" stands for "Pulse Width Modulation"). The PWM outputs stay off until activated. When activated, they produce a square wave output. The "on" time and "off" time of the square wave is calibratable. The conditions that determine when the PWM outputs go active are also calibratable. There are many threshold values that can be set, such as RPM and Speed. The PWM output is active only while all threshold values are exceeded.
In the event that the serial connection to the MQ200 is broken, or if the Pocket PC fails, the MQ200 will automatically turn off the PWM outputs after a short time.
The PWM output feature is not designed to control delivery of flammable or inflammable substances (e.g. fuel or nitrous oxide) or to control critical components (e.g. electronic throttle). In any application, consider the effects of a PWM output getting "stuck" either on or off before deciding whether or not to use PWM control. While this failure mode is unlikely, the effects must be understood to make sure there is no possibility of damage or injury.
The state of the PWM outputs is updated at the sample rate set in Flight.
The value recorded in the flight recording is based on the OnTime, OffTime, and Timeout calibration values, plus the on/off state of the PWM output. When this value is above 1000000000, the PWM output is active. When it is below 1000000000, the PWM output is inactive.
Calibration values:

- OffTime
  Number of milliseconds per cycle that the output is "off" when the PWM output is active. Set this to 0 to get an output that stays on continuously while active.
- OnTime
  Number of milliseconds per cycle that the output is "on" when the PWM output is active.
- Timeout
  Number of periods to cycle before shutting off if no update is received from the Pocket PC. For most situations, the value of Timeout multiplied by the sum of OffTime plus OnTime should be greater than the sample period. For example, if Flight is set to sample at 10Hz, the sample period is 100 milliseconds. Then if OffTime is 5 milliseconds and OnTime is 10 milliseconds, the period of the PWM output square wave is 15 milliseconds. At a minimum, Timeout should therefore be set to 7, since (7 * 15 milliseconds) = 105 milliseconds. This keeps the PWM output active until the next update. To allow for software latencies, it is best to increase Timeout by a factor of at least two or three over the minimum. The maximum

value can be used by default (255); however, the user must consider whether or not it is acceptable to have such a long timeout period in the event that the connection to the Pocket PC is broken.

- A0Threshold, etc.
  These threshold values govern when the PWM output is active. A value of 0 for a threshold means that threshold is ignored. All non-zero thresholds must be exceeded before the PWM output goes active.

Dependencies:
- Depends on whatever sensors are used for thresholds.

Road Power

Estimates horsepower output based on the weight of the vehicle, how fast it is going, and its acceleration. Note that you will probably different values for "Road Power" based on the sources you choose for "Speed". "GPS Road Power" is recommended over "Road power" when using a high performance (4 Hz or faster) GPS module.
Calibration values:
- Mass
  Set this to the weight of the vehicle in pounds.

Dependencies:
- Internal LongG
- Speed

Roll rate

This senses the rate of roll in degrees/second. A car that is driving straight on a flat and smooth road will measure a Roll Rate of 0 degrees/second. When that car enters a corner, the roll rate will spike in one direction as the car turns into the corner and the body leans, then it will fall back down to zero. On exit, it will briefly spike the other way. This can be used to tune sway bars and shocks.
Calibration values:
- Calibration values are determined at the factory and stored in a file shipped with the unit. Recalibration is not necessary. Contact Info@MaxQData.com if you believe your MQ200 needs to be recalibrated.

Dependencies:
- Based on A32 voltage with temperature correction from MQTemp.

RPM

This sensor is used by other sensor drivers as the "generic" RPM value. You can measure RPM via several means (see the other RPM sensor drivers). "RPM" simply uses the one that you "trust" the most.

RPM is important because other sensors (such as "Gear ratio") depend on its value and do not use other RPM sources.
Calibration values:

- RPMSignalSource
  0: use "RPM (Pulse)"
  1: use "OBD2 RPM"
  2: use "RPM (injector)"

Dependencies:

- Depends on the specified base sensor

RPM (injector)

This sensor is used to measure RPM by tapping into an injector drive line. This works for normal saturated-circuit or peak-and-hold injector drives (not continuous flow or direct injection).
The injector drive line must be attached to "P4" or "P5" due to the nature of the electrical signal coming off of the injector. Do not connect the injector directly to a one of the "P0".."P3" inputs.
Calibration values:

- Channel
  Set this to the pulse input channel that the pulse conditioner circuitry is connected to.
- RevolutionsPerPulse
  Set this to the number of revolutions per pulse that your fuel injection system uses. "Sequential" systems are normally 2. "Double-fire" systems are normally 1.

Dependencies:

- Depends on the base pulse input channel.

RPM (pulse)

This sensor is used to measure RPM by using either a Hall effect or inductive crankshaft sensor or a "Clean Tach Out" output from an electronic ignition system. Make sure the signal output is a 0-5V or 0-12V pulse train (the trigger voltage is about 1V; do not exceed the battery supply voltage). Do not connect a pulse input to the secondary side of the ignition coil. Contact MaxQData for pulse conditioning advice if you need to make the connection to the primary side of the ignition coil.
Calibration values:

- Channel
  Set this to the pulse input channel that the pulse conditioner circuitry is connected to.
- PulsesPerRevolution
  Set this to the number of spark pulses per revolution sent by your ignition system. You can enter a negative value to signify "revolutions per pulse".

Dependencies:

- Depends on the base pulse input channel.

Speed

This is the general-purpose "Speed" sensor that is used by other sensors. "Speed" can be based on an actual speed sensor (e.g. "TransSpeed") or can be estimated from LongG.

Calibration values:

- SpeedSignalSource
  0: LongG (standing starts only)
  1: use "OBD2 Vehicle speed"
  2: use "TransSpeed"
  3: use "GPS Vehicle speed" < Recommended setting when using 5 Hz or faster GPS
  4: LongG, but uses GPS to reset vehicle speed when the car is not accelerating

Dependencies:

- Depends on the specified base sensor.

TPS

TPS stands for "Throttle Position Sensor". You can connect a TPS that has a 0-5V output to any of the analog input channels.

Calibration values:

- Channel
  Set this to the number of the analog channel where the sensor is connected.
- WOTVoltage
  Set this to the voltage output of the sensor when the throttle is wide open.
- ClosedThrottleVoltage
  Set this to the voltage output of the sensor when the throttle is fully closed.

Dependencies:

- Depends on the base analog channel.

TransSpeed

The MQ200 is capable of measuring vehicle speed from a transmission speed sensor that has a 0-5V (or 0-12V) pulse output, which is common on many production vehicles. The advantage of TransSpeed is that it updates faster than GPS or OBD-II. It is subject to errors due to tire slip.

Calibration values:

- Channel
  Set this to the number of the pulse channel where the sensor is connected.
- PulsesPerKilometer
  Set this to number of pulses per kilometer coming from the transmission speed sensor. You can usually look this up in a service manual for the vehicle. It is also possible to adjust this by starting with a good guess (say 2548, a common value), driving the car at a known speed, and then adjusting this value to bring "TransSpeed" in line with the known speed.

Dependencies:

- Depends on the base pulse channel.

Vbat

Measures the Vbat voltage (essentially the same as the supply voltage to the MQ200).
Calibration values:

- None

Dependencies:

- None

Yaw rate

This sensor is commonly used in OEM stability control systems to detect whether a car is understeering or oversteering (or spinning). The output tells you how fast the car is rotating around its vertical axis in degrees per second (clockwise is positive).
When a car is going dead straight, Yaw rate is zero. When a car is in a constant-radius turn at a constant speed and steering neutrally, Yaw rate will be a constant non-zero value (on the order of 20 degrees per second for a typical corner on a road course, and 50 degrees per second or more on hairpin autocross turns). If the car begins to understeer in that turn, Yaw rate will drop to a lower level, and will drop farther depending on the severity of the understeer. If the car begins to oversteer or spin in that turn, Yaw rate will suddenly increase.
Yaw rate is also used to compute path maps that are generally more accurate than path maps based on LatG, and with more detail than GPS track maps.
Calibration values:

- Calibration values are determined at the factory and stored in a file shipped with the unit. Recalibration is not necessary. Contact Info@MaxQData.com if you believe your MQ200 needs to be recalibrated.

Dependencies:

- Based on A36 voltage with temperature correction from MQTemp.

I/O Port Pinouts

The I/O boards are normally mounted on the MQ200. You can relocate them elsewhere in the vehicleif you use a standard DB-25 M-F extension cable. You can also create a custom wiring harness based on the pinouts below. Please note that the MQ200 I/O ports are not compatible with the older MQ125 / MQ175 Expansion Port pinout.

Standard I/O Port:

Pin #	Function
1	A00
2	A01
3	A02
4	A03
5	A04
6	A05
7	A06
8	A07
9	A08
10	A09
11	A10
12	A11
13	P0
14	P1
15	P2
16	P3
17	P4P
18	P4N
19	P5P
20	P5N
21	GND
22	+5V out
23	Vbat out
24	BAT+ in
25	BAT- in

Expansion I/O Port (MQ200-MAX only):

Pin #	Function
1	A16
2	A17
3	A18

4	A19
5	A20
6	A21
7	A22
8	A23
9	A24
10	A25
11	A26
12	A27
13	A28
14	A29
15	A30
16	A31
17	no connection
18	no connection
19	no connection
20	no connection
21	GND
22	+5V out
23	Vbat out
24	PWM0 output (open collector current sink)
25	PWM1 output (open collector current sink)

The pins are numbered on the connector. Look carefully into the connector for the number markings at each end. The top row is numbered 1 through 13 and the bottom row is numbered 14 through 25.

The most common retail source for the DB-25 female connector you need to make your own wiring harness that attaches to the expansion port is Radio Shack.

Voltage and Current Limits

The following voltage and current limits must be respected in order to avoid improper operation or damage to the MQ200 and/or damage to the attached devices. In each case, make sure to get the voltage polarity right when making connections.

BAT-/BAT+ power supply input: 10 to 15 volts DC. Power is normally supplied by an automotive 12V power connection. You can also use 8 AA batteries in series (lithium or NiMH recommended). You can also use a 9.6V RC car battery. Contact Info@MaxQData.com for information on operating at lower voltages if you have a special application.

The continuous current draw from the battery is about 110 mA for the MQ200-PRO, plus about 40mA for the optional Bluetooth adapter and about 70 mA for the GPS module. Additional current may be drawn by sensors. It is usually not a problem to leave everything powered on continuously in vehicles that have good batteries and are driven on a daily basis. However, if the vehicle is kept in storage for a significant period, it is recommended that the power be disconnected from the MQ200 to avoid discharging the battery.

Special note for OBD-II cars: It is not recommended that the car be driven with power disconnected from the MaxQData system if there are direct connections to any OEM sensors on an OBD-II car. When the power to the MQ200 is disconnected, there are tiny leakage paths through the MaxQData input circuitry which may be detected by some cars as a sensor failure. This is normally not harmful, but could set an erroneous trouble code.

A00-A31 inputs are limited to signals between 0 and +5 volts.

P0-P3 inputs are limited to signals between 0 and VBat. The trigger voltage for these pulse inputs is approximately 1 volt. DO NOT connect P0-P3 inputs to either the primary or secondary side of an ignition coil. Also, do not connect directly to injector drive lines as these can be subject to inductive voltage spikes (you can, however, connect an injector drive line if you use a diode clamp or transient suppression diode; contact Info@MaxQData.com for details). Use the “Clean Tach Out” signal available from the ECU on some cars instead.

P4P and P4N / P5P and P5N inputs: These inputs provide voltage conditioning that allows attachment of coil primaries or injector drive lines for RPM and Injector Pulse Width measurements. The “N” line should be connected to the negative side of the signal (usually ground) and “P” line should be connected to the positive side.

PWM Outputs (MQ200-MAX only): These can be used to drive LEDs, shift lights, solenoids, or relays as long as voltage and current limits are respected. PWM0 and PWM1 are “open collector” outputs. They can each sink up to 200 mA and can drive lights and small inductive loads (e.g. relay coils). The Expansion I/O module contains two relays, R0 and R1. Use a PWM output to drive the coil of a relay by connecting the “cl” terminal to one of the PWM outputs. The relays are double-throw, so the “in” terminal is connected to the “nc” (normally closed) terminal when the relay coil is off, and the “no” (normally open) terminal when the coil is energized. The current limit for the relay contacts is 2A.

+5V Out: This is a regulated 5V supply used for powering sensors. Current limit is 250mA.

Vbat Out: This is a switched line to the BAT+ In terminal. When BAT+ In/BAT- In are connected at the proper polarity, Vbat turns on. Current limit is 500 mA. You can track Vbat voltage using the "Vbat" sensor driver.

About MaxQData™

MaxQData is a leader in developing high value data acquisition solutions that bring advanced technology to amateur and professional racers. MaxQData is proud to be a technology leader and an early adopter of advanced technologies such as PDAs, GPS, OBD-II, solid state inertial sensors, and cellular data services.

Contact information:

MaxQData, LLC
2526 229TH PL NE
Sammamish, WA 98074
Info@MaxQData.com
800-589-7305
425-562-3423