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A technical review of the J3400 slate computer manufactured by Motion Computing

METADATA	
Title	A technical review of the J3400 slate computer manufactured by Motion Computing
Series	Technology Blog
Workflow Process	Data Collection
Description	The J3400 is a rugged Tablet PC / slate designed to use in a variety of outside conditions. This article documents a number of observations made by the author on the operation of the unit over a 1-year period while using the unit intensively to collect ecological data.
Hardware	J3400 by Motion Computing

What are Botanicus Australia's Technology Blogs: These are articles on a range of technological issues I have encountered, investigated, compiled data on and/or value added to for use in my company. They are provided 'as is' for others to help facilitate the use of these technologies, especially in the Natural Resource Management Industry.

Introduction

It has been a long time coming but I think computers have become powerful enough and functional enough to provide field workers with an interactive platform similar to those they would be familiar with in the office. Certainly PDA's and data logging hardware has been around for several years but they do not run Windows programs natively or have enough screen "real estate" to accommodate the variety of programs utilized by workers in the field.

Over the last few years I have been watching the development of Tablet PCs but have been put off by their fragility and inability to operate for very long away from a power source. [Panasonic Toughbooks](#) have been the only products occupying this niche - although their products are actually convertible



notebooks (i.e. the screen swivels around and covers the keyboard), which means you are carrying extra dead weight while operating in tablet mode.

In a recent review of mobile technology that I conducted to evaluate available technologies to address my need to collect, review and complete vegetation sampling in the field, I uncovered a new Tablet PC that looked extremely promising – the [J3400](#) Rugged Tablet PC by Motion Computing. These guys have been on the market for a while but their main outside product, the [LE1700](#), was not a rugged PC, which posed some problems for some one like me that might get caught in the rain, scrambles around the bush a lot or could accidentally drop the unit.

After consideration I actually purchased a unit and have been using it for about a year. During this time I have kept track of any problems I have encountered and collected some base data on battery life under normal use, rather than in a laboratory with everything set to minimum. Consequently, this article is not really a review, rather a catalog of observations made and issues encountered by me as I used the unit to collect scientific data in the field. My comments are provided primarily so others can ascertain the suitability of this or other computers for their needs.



To clarify, my needs aren't focused on the need for wireless communication (e.g. email or web access in the field), electronic note taking in meetings or client management (although these needs are addressed for by the unit), rather the need for a data entry unit powerful and functional enough to display and record flora and fauna data, including Geographic Information, in the field.

General Impression, Observation and Use

I purchased the unit because of the relatively light weight, the ease of holding it in the field, the large screen, the ease of reading the screen regardless of the weather conditions and general ruggedness of the unit. A year on, I find the unit still works well and has greatly improved my ability to conduct my work.

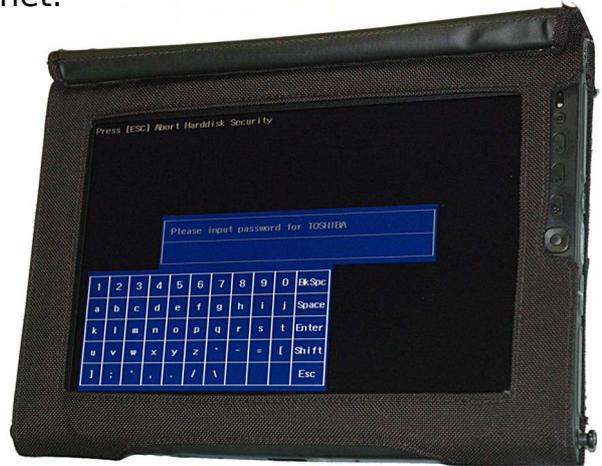
First, it is worth discussing ruggedness as this is one of the main marketing points for the unit. The unit is essentially dust proof, shower-proof and able to be dropped. It is not indestructible and if the unit fell in water it would most likely short.

I have however used the unit in light rain and apart from having to dry the screen regularly it continued to work without any major problems. I have not dropped the unit but the videos on Motion's Website are impressive.



I thought it would be worth running through my daily routine when using the unit so I can discuss its operation and a number of issues that are not mentioned or explained in the manual or on the Internet.

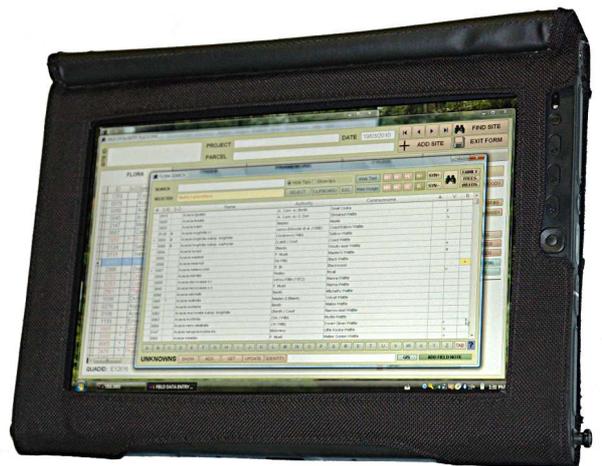
Being a remote computer security is an important issue. I have a BIOS lock on my hard disk to prevent someone from accessing the unit if it is stolen. On starting the unit you are presented with a relatively clunky password entry screen. It is essential to enter your password slowly as it is not unusual that a letter or number is not read by the computer. Look to see if an asterisk appears when you type in a letter.



The next step is to access Windows Vista. For speed, I have set up the fingerprint scanner (arrow). It is just a matter of swiping my finger along the side of the unit to gain access. On cold days this can take several attempts. The angle you swipe your finger is also important - remember to record your fingerprints in all the various positions you would hold the unit.



Once in Windows, I can open 'typical' windows packages without any problems. If it can be controlled by a mouse it can be readily controlled by the pen. Here you can see an in-house software package developed in Visual Foxpro used to collect, analyze and prepare reports on flora and fauna. This program was only slightly modified to ensure all functions could be selected using a mouse. Pick-lists allow quick data entry.



Other windows packages such as Word, Excel, Outlook, etc are all run without any changes. I regularly use Microsoft Journal to take notes at meetings and draw all over imported aerial photographs or maps.



I regularly use GIS to document the location of sites. Here you can see a surveyor's AutoCAD file superimposed on georeferenced aerial photographs. I can readily draw the extent of my sites on this background using obvious features seen on the photographs. All data collected can be directly read by the same program on my desktop computer once I return to the office and synchronize this computer with my desktop computer.

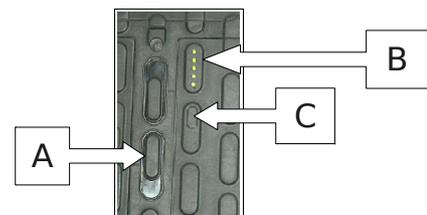


As explained below the following sequence is followed to conserve battery power. Data entry and GIS work have different power plans. GIS work needs the screen to be brighter to ensure you can distinguish features on screen. When I am not entering data I shut off the screen (not put the computer to sleep!) by pressing one of the buttons on the right. The screen is reactivated by tapping the screen with the pen. When you lift the unit to continue working, the hard disk works furiously as seen by the rapid flashing 'M' on the icon toolbar at the bottom right of the screen. Once this indicator stops flashing, which usually takes 1-2 seconds, I start adding data again. If you begin work without waiting for the hard disk to settle, Windows can become destabilized, or programs crash. Since delaying work by this 1-2 seconds I have not had a problem with the unit.

The J3400 is good in that you can hot swap the batteries. This means you do not have to stop what you are doing (although I make sure I save my work just in case). You can see the battery power remaining on the windows task bar - running your pen over the power icon results in a pop up box appearing that tells you how much battery is left.



Batteries readily pop out of the unit by sliding the lock (A). The power remaining in the battery is shown on the light display (B) if you press the button (C). It is relatively easy to tell which battery needs changing because the bottom indicator light in the light display (B) flashes.





Miscellaneous Issues

Screen Maintenance

The screen can be readily cleaned with clean water and dried with untreated tissues. Fluff can then be removed by using a micro-fibre cleaning cloth similar to what comes with the unit. I purchased a cleaning cloth from the local supermarket and it worked just as well as the expensive small cloth sold by Motion Computing. While in the field, smudges and dust are removed with the above-mentioned micro-fibre cloth.

Sunscreens, Sweat and Fly Sprays

This actually concerned me a lot. I have purchased wet weather stationary before and found they lose their waterproof qualities if they come in contact with sunscreens and fly sprays. These chemicals however are commonly used by fieldworkers and I was unable to find any documentation on what would happen to the screen, if anything, if it came in contact with these chemicals.

Over the last year I have used a variety of sunscreens and insect repellents and found none stained, melted or damaged the screen in any way. Smudges caused by these chemicals present on your hands can be readily be removed with water and tissues or a micro-fibre cloth as explained above.

Sweat however – consisting of salt, water, oils, fly repellents and sunscreen combined together – is very difficult to clean off the screen. On extremely hot days, when I have sweat a lot, beads of sweat roll off my Acubra and land on the screen. The best way of handling a drop of sweat is to dab dry the drop with a dry cloth then vigorously wipe away the oils with a micro-fibre cloth. If you wipe the sweat drop away with your micro-fibre cloth, it smears across the screen and is very difficult to remove. I usually remove any persistent smudges at lunch with water and tissues.

Screen Responsiveness

Although the specification sheets indicate that the unit will operate between +5°C and +45°C, I found the screen responsiveness to the pen noticeably slows on days <10°C.

Screen Blistering

Small blisters are apparent on the screen in cold weather (<15°C). These blisters can be rubbed out with your finger and then the oil from your fingers removed with a cloth. This issue can be quite a distraction when many small blisters cover a particular area. When the screen is at 100% brightness these blisters are not apparent, but at lower brightness levels and when in the sun they can become apparent.

GPS Capability

Although the unit came with a quite expensive GPS enabled Sierra HSDPA



Wireless Chip, GPS capability is only possible when you are able to connect to a mobile telephone tower (i.e. it is tower assisted). Consequently it is of no use in rural or outback areas.

Broadband-only Plans

Reasonable broadband-only plans are very scarce in Australia, and those that exist are monthly plans with fixed downloads that can not be rolled over. Consequently unless you are using the unit to manage you email or Internet the Sierra HSDPA Wireless Modem is pretty much useless.

Camera

The unit I purchased came with a 2 mega-pixel [camera](#). This camera is of limited use as the auto-focus and auto-exposure does not work in the field unless you are within 1 metre of your subject and in perfect lighting conditions. Landscape or close up photos of any value are out of the question.



Air-vent Position

One issue I noted while working in the field was that in order to counter balance the unit while in the Work Anywhere harness it is necessary to hold the top left corner of the tablet (since I am right handed). The problem though, is that your hand can block the fan vent causing the unit to heat up.

BIOS and hard disk problems

When I first got the unit I tried to set up the hard disk password from within the BIOS to prevent data being available to a thief if the unit was stolen. When the password was set then removed (so I could install the software without having to type in a password on every reboot), the BIOS locked me out of the computer, resulting in me having to wait several days for the technicians in Motion to get the unlock codes from the hard disk manufacturer.

Work Anywhere Kit

The screen protection flap is difficult to tuck under the unit. Although magnets are used to keep the cover protecting the screen, they don't work in reverse and you soon have to become adept at holding it still with your fingers, particularly in windy weather. Magnets on both sides would be useful, so the flap can be restrained when the screen is being accessed.

Note that the flap actually obscures the camera when the screen is being used. This is a problem as you need to access the camera software to take a picture. Again the only solution is to hold the flap on the top of the tablet while steadying the unit and trying to manipulate the software. Ahhh!

Care needs to be taken when fitting the Work Anywhere Kit, particularly the knobs that are screwed into the unit that the strap hangs off. I had thought I had securely connected these knobs but was on one occasion lucky to catch



the unit mid-air when getting it out of the car (while parked on bitumen). Although the unit would have survived I would prefer not to take chances, and would have been upset if the screen was scratched, unit's exterior damaged or data lost. Motion Computing has now published a detailed [tutorial](#) on how to correctly seat the knobs attached to the side of the unit that the strap attaches.



Nearly a year down the track, I was also surprised to note serious deterioration of the strap, the photo shows how the elastic rubber has separated from the cloth strap used to connect to the tablet. Happily, since the unit was still in warranty, on notification of the damage, the supplier couriered a replacement the next day.

Unit not particularly easy to manipulate with gloves

I have found that the pen is difficult to grab and manipulate with gloves.

Turning off the screen greatly increases battery life. Although buttons can be programmed to do this task, these buttons are almost impossible to press when wearing gloves. See how the Work Anywhere Kit partially obscures the buttons! I find the only solution is to use the back of the pen to press the button but as mentioned it is difficult to manipulate this pen with gloves on.



You will also note in this photograph that the left side of the large navigation pad is obscured (the perimeter ring replicates the left, right, up and down arrow keys, and the centre button replicates the enter key). This navigation pad can not be used with the Work Anywhere Kit attached (even without gloves). In this situation, it is necessary to use the on-screen keyboard to achieve these actions.

In my opinion, the unit needs a screen-off button that can be readily triggered while wearing gloves, or a software option provided where, for example, a part of the screen can be clicked to achieve the same result. I have experimented with using the standard Windows API calls but the Wacom Screen does not behave as expected when using standard programming calls.

Use in rain and in windy conditions

The unit works well in wind. I noted no obvious issues when using the unit in winds of up to 70km/h. I have used the unit in light rain and found that if the screen is regularly dried that data entry can continue. In cold situations, as mentioned, screen responsiveness to the pen can be reduced.

Computer Crashes

Although not common, the tablet can crash so care needs to be taken to regularly backup data to disk. Working on the assumption that disk failure is



unlikely, I created a program that backed up all 'newly created' raw data to date-time stamped directories after every site is assessed. This means no more than an hour's data would be lost if the computer crashed. Daily backups to the server was also done once back at the office, meaning if there was a catastrophic disk failure I would only lose one day's project data.

Investigation of the cause of these crashes identified the following issues.

- Windows Vista does not always come out of the sleep mode elegantly (at least on this unit), resulting in all open programs hanging. When this occurs, although the screen is able to be turned on and off, it is not possible to reenter sleep in an attempt to get the programs to respond. Thankfully, the unit readily reboots to start a new session. This problem still occurs.
- I have noted that Windows Media Player can destabilize this system. I can be running GIS, Data Logging Software and have a range of PDF files open for reference and be using these for several hours, but open Windows Media Player to listen to a frog or bird call and the system crashes. When this happens data loss was common, as all the data in the cache was lost, but rebooting generally allows you to start a new session. I ditched this software and use [Media Player Classic](#) instead and have not encountered the problem again.
- The only other situation where the system crashed, and this as happened about 3 times in a year, appears to happen when Windows Vista swaps between battery #1 and battery #2. These crashes are catastrophic and has resulted in data loss and database corruption. The first time this happened the fieldwork needed to be abandoned and the software data reinstalled from the previous days backup. Although little information is available about the cause of this issue as no error logs are retained on the system, it seems likely that it maybe caused by a faulty battery or the battery and Windows Vista not talking nicely. This issue occurs so intermittently that despite trying to consistently reproduce/document the error I have not been able.

The Primary Limitation – Power

Battery Charging

When I originally purchased the unit batteries could only be charged while they are in the unit, making the ability to charge spare batteries in the office while roaming around outside, impossible. This essentially tied the unit to a power source for at least 2-3 hours per set of batteries in any one day in order to have a completely charge set of batteries for the following day.

Recently, Motion Computer has released a [battery charger](#) but it only allows one battery to be charged at a time. This is alright if you have 3 batteries and you charge both the batteries in the unit and the spare at the same time.

If you have 4 or more batteries, like I do, this solution is not satisfactory. You find yourself having to check on and rotate batteries in the evenings to ensure



adequate numbers are available for the following day. What is required is a stand alone charger that is capable of charging multiple batteries simultaneously.

Trial 1 – Battery life during 'Intensive File Manipulation'

Objective

To estimate how long a J3400 will work in the field doing 'typical' data entry and file manipulation.

Setup

- Screen set to 'Power Saver Plan' (Display Brightness 41%, Maximum CPU Usage 50%). Although screen set to never turn off and computer never to go to sleep, which is a bit unrealistic, this was necessary to ensure continuous recording. I expect with fieldwork that 40 minutes of work would be interjected with 10 minutes of travel and setup – therefore a more realistic potential usage time can be weighted by multiplying the time taken to reach the critical battery threshold by 25% (50 actual time / 40 computer working).
- Two batteries used: fully charged then discharged four times prior to test.
- Motion Dashboard settings: dynamic display, dim display never, camera disabled, broadband disabled.
- LAN cable disconnected as well as power cord (obviously) during test.
- J3400 (Vista Business, 4GB RAM). Windows Standard desktop with no fancy effects. See Appendix 1 for complete hardware specifications of the system.

Actual Test

- Working with 87 tables/memo/indexes combinations, 174 files, average file size 4.6 MB, total amount of files copied in each iteration 806 MB.
- Each table is opened, copied to a new location, packed, reindexed and deleted using Microsoft Visual Foxpro, version 9.
- The time (seconds from midnight) and the remaining battery life is recorded in a text file after all 87 files are processed. During the test the screen is updated with various progress indicators.
- This sequence is then followed by a 10 second pause, then repeated until the critical battery threshold (set at 5%) is reached.
- The data was imported into a Microsoft® Excel Spreadsheet as a comma delimited file and presented in Figure 1.
- The system power was obtained from Windows Vista™ directly using standard API functions.

Results

- It took, on average 41.51 seconds to complete the assigned file manipulations (including the 10 second pause).
- The computer took 4 hours and 26 minutes to go from 100% to 5% battery power. At reaching the critical threshold the computer went to hibernation



mode without warning. All programs resumed once the system was rebooted following the reconnection of the power cord. It took 11 minutes between receiving the 10 minute low battery warning and system shutdown.

- Figure 1 shows the power consumption during this test.
- The power loss exhibits a polynomial form. Trend-line analysis shows a very strong correlation ($R^2=0.9997$) with the equation

$$\text{Power Remaining} = -1.0139 \text{ hours}^2 - 16.539 \text{ hours} + 99.338.$$

- It is estimated that with breaks in work flow that the two batteries would last for 5 hours 32 minutes.

Trial 2 – Battery life during 'Intensive File Manipulation' and reduced luminescence

Setup

- As mentioned, the initial test used the Window's Classic Desktop Theme. Simple with minimal effects, but still bright. In order to reduce power going to the screen to illuminate areas not actually being used, the computer's theme was changed to "High Contrast - Black" - a not unpleasant theme where the window's background is black. I also adjusted the desktop so it was black and moved all the icons to menus so that the desktop was clear. The objective here was to reduce the battery drain due to illuminating the screen. In order to improve contrast the screen brightness was increased to 70%.

Result

- The results of this test is shown in Figure 1. The effect of minimizing screen luminescence does not significantly improve battery life. In fact, the increase in brightness slightly decreased the time to reach the critical battery threshold. The effective working time was decreased by 9 minutes.
- This suggests that power consumption of the screen is independent of the luminescence of the screen. Putting it another way, battery life can be extended, by minimizing the time the screen is on.

Trial 3 – Battery life while actually using the tablet in the field

Objective

To monitor the discharge of the batteries while conducting normal work.

Setup

- Testing so far has indicated that battery drain is strongly correlated to whether the screen is on or off, so whenever the unit was not being used the screen was turned off. This was achieved by remapping the 'escape button' so that pressing it turned the screen off. Tapping the screen with the pen



turned the screen on automatically. This was a behavioural change that became quite instinctive.

- Two custom power settings were used, GIS Data Plan and Data Entry Plan, and these were switched between as required. The basic difference between the plans was that the Data Entry Plan had display brightness of 40%, while the GIS Data Plan had a display brightness 100%. The extra brightness was required for the GIS Data Plan to clearly see variation in aerial photographs used in the fieldwork. While in the field all time segments were allocated to a particular activity.
- Camera, bluetooth and broadband disabled from the Motions Dashboard.
- The system power was obtained from Windows Vista™ directly using standard API functions.
- Time blocks were tagged based on what tasks were being conducted.

Results

- Battery logs were recorded over several months of use in the field.
- The discharge profile for 3-days have been provided to illustrate the variation in discharge due to behavioural and configurational changes.
- Using the computer setup to use the GIS Data Plan resulted in a very similar discharge profile to that noted in Trial 1 and 2 (Profile 'T3 N', Figure 1). If the screen is switched off immediately after the data has been entered this increases the battery life by about 1-hour (Profile 'T3 SM', Figure 1). If the power plan is changed to one with a lower screen brightness the battery life can be extended by another hour or so (Profile 'T3 SM+PS', Figure 1).
- Battery discharge is primarily dependent on whether the screen is on and on its brightness. These parameters are influenced by what is being run on the computer.
- These trials showed that two fully charged batteries typically allow an user to spend between 4 and 6 hours in the field. When the computer is required to have the screen on full brightness and visible for extended periods of time the battery discharges in just over 4 hours. If the screen brightness is reduced and screen shutdown as often as practical the effective battery life can be extended to about 6½ hours. I have on occasion extended the battery to over 7½ hours (excluding breaks) by manipulating these parameters (e.g. screen brightness reduced further on dull days).
- So, the upshot - it is imperative that users have at least 3 fully charged batteries available at the start of a day to ensure they have enough power to get through a typical 8-10 hour field day.



Appendix 1 – Hardware Specification of the J3400 Tested

Operating System

OS Name Microsoft® Windows Vista™ Business
Version 6.0.6002 Service Pack 2 Build 6002

Computer

System Manufacturer Motion Computing
System Model J3400
System Type X86-based PC
Processor Intel(R) Core(TM)2 Duo CPU
U9300 @ 1.20GHz, 1201 MHz, 2 Core(s),
2 Logical Processor(s)
BIOS Version/Date Motion Computing - J3400 A.01, 3/03/2009
SMBIOS Version 2.4
RAM 4.00 GB

Sound

Name IDT High Definition Audio CODEC
Manufacturer IDT

Display

Name 12.1" WXGA ViewAnywhere LCD
Resolution 1280 x 800 x 60 hertz

Disks

Model TOSHIBA MK1216GSG ATA Device
Size 111.79 GB (120,031,511,040 bytes)

Only those components relevant to the test have been listed. The unit also had 802.11 WiFi, Intel Gigabit LAN, Bluetooth, SmartCard & ExpressCard Reader, USB Camera and Fingerprint Reader. The WiFi, Bluetooth and Broadband capabilities were disabled using the Motion Dashboard.



Figure 1: Power consumption over time for a J3400 Motion Computing Tablet PC under various conditions. **T1** = disk intensive file manipulation tests with the screen at normal luminescence. **T2** = disk intensive file manipulation tests with the screen darkened to reduce luminescence. **T3 N** = Data logging without any behavioural changes and using the GIS Data Plan. **T3 SM** = Data logging with screen being turned off immediately after data entered and using the GIS Data Plan. **T3 SM+PS** = Data logging with screen being turned off immediately after data entered and using the Data Entry Plan.

