Productivity Plus
Option / Upgrade
E220 / E500 Series Implanter

July 2003
Productivity Plus Value Statement

- The fastest and most cost effective way to add capacity to your E-series medium current implanter install base without:
  - Purchasing additional implanters
  - Sacrificing fab space

- Hardware installation time is only 24 hours plus fab re-qualification
Presentation Agenda

- Overview
- Key Benefits
- Performance Comparison
- Beta Data
- Key Features
- Hardware Images
- Performance Charting
- CoO Advantage
- Availability / Price / Installation
- Prerequisites
Overview

Productivity Plus

- High throughput package
  - Option for new tools
  - Upgrade for installed tools
  - Hardware and software

- Applies to all installed E220 and E500 Series Implanters
  - 150mm and 200mm electrostatic-clamp
  - Planned capability for mechanical clamp
Key Benefits

- **Throughput Increase**
  - All E Series: Maximum throughput to $= 250 \pm 3\%$ wph
  - Eliminates throughput loss due to cassette exchange time

- **Scalable:** Accommodates incremental capacity increases

- **No increase in floor space**

- **Improved CoO**
  - Reduced consumable consumption on a per wafer basis

- **EHP Benefits Carried Forward**
  - V12 Effective Throughput multitasking capacity
  - Redundant/independent operation of each side
  - EHP wafer breakage specification 1:40,000
  - No change in process or maintenance specifications
## Comparative Performance

**Throughput Matrix**

<table>
<thead>
<tr>
<th>MODE</th>
<th>200mm</th>
<th>E2E5</th>
<th>E2E5HP</th>
<th>E2E5EHP</th>
<th>E2E5EHPi</th>
<th>Any E2E5 with Productivity Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Simultaneous</td>
<td>6 Scan</td>
<td>190</td>
<td>190</td>
<td>200</td>
<td>210</td>
</tr>
<tr>
<td>B</td>
<td>Dual Load Lock</td>
<td>10 Scan</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>C</td>
<td>Alternating Load Lock</td>
<td>6 Scan</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>D</td>
<td>Single Load Lock</td>
<td>6 Scan</td>
<td>144</td>
<td>144</td>
<td>144</td>
<td>144</td>
</tr>
<tr>
<td>E</td>
<td>Super Shuffle</td>
<td>6 Scan</td>
<td>&lt;189</td>
<td>&lt;189</td>
<td>&lt;189</td>
<td>&lt;189</td>
</tr>
<tr>
<td>F</td>
<td>Productivity Plus</td>
<td>6 Scan</td>
<td>189</td>
<td>189</td>
<td>189</td>
<td>189</td>
</tr>
<tr>
<td>G</td>
<td>Productivity Plus</td>
<td>6 Scan</td>
<td>250 + 3%</td>
<td>250 + 3%</td>
<td>250 + 3%</td>
<td>250 + 3%</td>
</tr>
</tbody>
</table>

% Throughput improvement (Mode "G" over "A")

|                | 31.6% | 31.6% | 25.0% | 19.0% | 19.0% |

*This matrix is a mechanical throughput matrix and does not account for all real production items i.e. Beam Interval Check, Post Implant Orient etc…

** Super Shuffle Mode is not improved by the introduction of Productivity Plus Hardware
## Beta Site Results

Comparison: 6 E-Series VSEA Implanters, one with Productivity Plus

<table>
<thead>
<tr>
<th>JUNE 1-30, 2003</th>
<th>RUN</th>
<th>IDLE</th>
<th>PM</th>
<th>UDOWN</th>
<th>Uptime</th>
<th>Wafers</th>
<th>Wafers Per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2-EHP 037431</td>
<td>90.05%</td>
<td>6.40%</td>
<td>1.07%</td>
<td>0.43%</td>
<td>96.81%</td>
<td>72826</td>
<td>112.3</td>
</tr>
<tr>
<td>E2-EHP 037434</td>
<td>83.61%</td>
<td>6.13%</td>
<td>4.07%</td>
<td>0.00%</td>
<td>89.74%</td>
<td>68693</td>
<td>114.1</td>
</tr>
<tr>
<td>E2-EHP 037436</td>
<td>86.33%</td>
<td>6.90%</td>
<td>1.03%</td>
<td>1.55%</td>
<td>93.24%</td>
<td>76911</td>
<td>123.7</td>
</tr>
<tr>
<td>E2-EHP 037477</td>
<td>89.72%</td>
<td>7.55%</td>
<td>1.59%</td>
<td>0.32%</td>
<td>97.27%</td>
<td>79269</td>
<td>122.7</td>
</tr>
<tr>
<td>E5-EHPi 193645</td>
<td>89.82%</td>
<td>2.24%</td>
<td>2.40%</td>
<td>0.05%</td>
<td>92.06%</td>
<td>104012</td>
<td>160.8</td>
</tr>
<tr>
<td>E5-EHPi 193819</td>
<td>86.08%</td>
<td>10.56%</td>
<td>0.28%</td>
<td>0.22%</td>
<td>96.64%</td>
<td>83026</td>
<td>134.0</td>
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Average performance advantage over equally equipt EHPi: 25.3%

Average over all performance advantage: 36.6%
# Beta Site Results

**Why is the actual benefit greater than the mechanical improvement?**

## Mechanical Throughput Matrix

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<tr>
<th>MODE</th>
<th>200mm E-Clamp</th>
<th>E2E5</th>
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<th>Any E2E5 with Productivity Plus</th>
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</thead>
<tbody>
<tr>
<td>Standard Dual Load Lock Single Arm</td>
<td>6 Scan</td>
<td>190</td>
<td>190</td>
<td>200</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Productivity Plus Alternating Load Lock Dual Arm</td>
<td>6 Scan</td>
<td>250+ 3%</td>
<td>250+ 3%</td>
<td>250+ 3%</td>
<td>250+ 3%</td>
<td>250+ 3%</td>
</tr>
<tr>
<td>% Mechanical Throughput improvement</td>
<td>31.6%</td>
<td>31.6%</td>
<td>25.0%</td>
<td>19.0%</td>
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<td>83026</td>
</tr>
</tbody>
</table>

Average performance advantage over equally equipped EHPi: 25.3%

Average over all performance advantage: 36.6%
Answer: Alternate Load Lock Processing

- Vacuum Independent load locks:
  - Convert previously lost “idle time” into “production time”
  - Vent and Beam Tuning now occur simultaneously
  - Operators now have ~3.0 minutes to perform cassette exchange without interrupting production
    - Non-Productivity Plus tools lose vent, cassette exchange and pump time to “Idle Time” (~5% of total time)
Comparison: Productivity Plus to Control Tool

4,247 More Wafers Processed in 5 Days with Productivity Plus
Key Features

- **Alternate Load Lock Processing**
  - Vacuum Independent Load Locks (VIL) save on vent, cassette exchange, and pump time with successive batches using the same recipe

**Left load lock**
- Pump
- Implant
- Vent
- Cass. Exchange

**Right load lock**
- Pump
- Implant
- Vent
- Cass. Exchange
Constant Recipe: Successive Cassettes

- Left load lock
  Recipe A, Cassette 1

- Right load lock
  Recipe A, Cassette 2

- Left load lock
  Recipe A, Cassette 3 etc...

- Grey = Background Events
Key Features

- Additional right and left side wafer handling components:
  - Wafer handler pick, pick arm & alignment fixtures
  - Wafer handler drive assembly
  - Wafer present sensor

- New Wafer Handling Sequence (Patent Pending)

- Repackaged HW to accommodate additional components:
  - Wafer handler covers, pick and pick arm
  - Infrared orienter (sensing apparatus and pedestal only)
  - Break actuator (detent only)

- E-Clamp compatible

- Wafer motion handling speed is not increased
Key Features

- **System software Version 13**
  - Optimized wafer handling functions
    - Orient signal filtering, Bi-directional orienter motion
  - New user screens to support new hardware

- **High reliability hardware components**
  - Steel drive belts, Ferrofluidic seals
  - 1 Million wafers cycled
  - Components: 5 Million cycles / 75% confidence of 38 months MTBF

- **EHP\textsuperscript{i} / Effective Throughput benefits carried forward**
  - Simultaneous beam tuning with load lock pump and vent
  - Chained implant functionality
  - Recipe queuing - Preload 5 jobs via host or local control
Productivity Plus Hardware

1. Chamber cover
2. Wafer present sensor
3. Handler bed cover
4. Upper arm drive assembly
5. Pick access cover
Productivity Plus Hardware

**Servo Chassis:**
- Right Controller
  - Upper & Lower Arm
- Left Controller
  - Upper & Lower Arm

**Handler cover with drive assembly, pick, pick arm (and wafer present sensor - far side)**
Productivity Plus Hardware

Additional new hardware includes modified roplat components to lengthen the pins stroke
Productivity Plus in Action
## Pick Arm Function Summary

**Pick Arm Movement Summary**

<table>
<thead>
<tr>
<th>Pick Arm</th>
<th>Location</th>
<th>Function</th>
<th>Movement</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Lower handler</td>
<td>Transfers wafers to/from elevator</td>
<td>Rotates into target chamber</td>
<td>Does not deliver wafers to platen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delivers wafers to orientser pedestal</td>
<td>Linear movement into elevator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Removes wafer from platen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>Upper handler</td>
<td>Idles at edge of chamber</td>
<td>Rotates into target chamber</td>
<td>Does not enter the elevator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Picks wafers off of orientser</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delivers wafers to platen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Performance Charting

Calculated Productivity Plus Throughput Compared to Two-Load lock EHPi Operation

Throughput (wph)

Number of Scans

Percent Improvement (%)
Performance Charting

Calculated Productivity Plus Throughput Compared to Alternating Single Load Lock EHPi Operation

Throughput (wph)

Percent Improvement (%)

Number of Scans

EHPi
Productivity Plus
% Improvement
Performance Charting

Calculated Throughput Chart

- EHP
- EHPi
- Productivity Plus

Wafers Per Hour vs. # of Scans

Varian Semiconductor Equipment
Improved CoO

- No increase in floor space
- Increased beam utilization
  - Reduced consumable use on a per wafer basis
    - Source consumables
    - Gas bottle consumption
    - Beam-line consumables
    - Maintenance labor
- Higher Effective Throughput
  - More wafers through the tool
Availability / Price

- **Availability**
  - 1st Beta shipment - April, 2003
  - 1st order acceptance - June, 2003
  - 1st Upgrade deliveries - 12 to 16 weeks ARO
  - 1st production tool delivery - contact Tactical Marketing

- **Price**
  - Contact your local Service Office
# Upgrade Prerequisites

*All systems require: Version 13 software and HOST programming modifications to permit Alternate Load Lock processing*

## General configuration table

<table>
<thead>
<tr>
<th>Required Prequisites</th>
<th>E220/E500</th>
<th>E220HP/E500HP</th>
<th>E220EHP/E500EHP</th>
<th>E220EHPi/E500EHPi</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIS/TVL Traveling Faraday</td>
<td>N</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Cassette Presence</td>
<td>N</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Infrared Orienter</td>
<td>N</td>
<td>N</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Load Lock Door Sensors</td>
<td>N</td>
<td>N</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Cassette Pivot Sensors</td>
<td>N</td>
<td>N</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Wafer Position Detect (LL)</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>Wafer Handler Position Detect</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>400MHz Control CPU</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>O</td>
</tr>
<tr>
<td>Latest Release Roplat Drive</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>S</td>
</tr>
</tbody>
</table>

- **Non-Standard**
- **Standard Equipment**
- **Option at the time of original build**
- **Standard Late Cut-in**
Installation

- Upgrade Installation
  - Pre-qualification: 4 hours
  - Hardware installation: 2 people, 2 shifts (48 labor hours)
    - SW must be previously installed and qualified
      - Enable Alternate Load Lock processing
  - VSEA re-qualification: 1 person, 2 shifts (24 labor hours)
    - includes 24hrs continuous: 2 shift marathon
  - Customer re-qualification - TBD
Supplemental Information

New Wafer Handler Chronograph and Sequence for Productivity Plus
The following slide graphically illustrates the handling steps and timing for the new wafer handling sequence.

Use the “New 16 Step Wafer Handling Sequence” slides to narrate the graphical slide.

First understand the red and blue graphs by reading the red and blue legend for each mechanical component represented.
Cycle time for one wafer = 13.45 Seconds
New 16 step Handling Sequence

Wafer Handler Processing Steps

1. The primary pick arm moves into the elevator and picks a wafer from the cassette.
2. The primary arm deposits the wafer on the pedestal in the low position.
3. The orients pedestal lifts and removes the wafer in the low position, orients and centers the wafer, and moves to the new higher pedestal position.
Handling Sequence

4. The secondary pick removes the wafer from the orienter pedestal in the new higher position. The orienter pedestal lowers to a position below both picks.

5. The secondary arm rotates into the target chamber and deposits the wafer onto the platen and simultaneously the primary arm moves into the elevator to get another wafer.
Handling Sequence

6. The secondary arm rotates to the idle position and the primary arm moves the wafer to the orien ter pedestal.
7. The platen rotates and wafer implantation begins.
8. The orien ter pedestal lifts and removes the wafer in the low position, orients and centers the wafer, and moves to the new higher pedestal position while the wafer is implanted.
9. The secondary pick removes the wafer from the orien ter pedestal in the new higher position. The orien ter pedestal lowers to a position below both picks.
Handling Sequence

13. The secondary arm rotates to the platen, the platen pins lift and remove the wafer from the secondary arm, the primary arm moves into the elevator to deposit the implanted wafer.

14. The secondary arm rotates out of the target chamber to the idle position, the platen rotates to the implant position, the implant begins, and the primary pick arm moves out of the elevator without a wafer.

15. The elevator moves down to the next wafer slot.

16. The process repeats from step 1 until all of the wafers in the batch are processed.