



**“Scheduling System Upgrading & Downbinning Project” at
Qimonda Portugal S.A.**

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Scheduling System Upgrading & Downbinning Project

Melhoramento do Sistema de *Scheduling* & Projecto *Downbinning*

Resumo

Este relatório descreve o trabalho realizado durante o estágio curricular de seis meses na Qimonda Portugal S. A. Esta empresa é a única produtora de memórias em Portugal e também a maior da Europa. A Qimonda Portugal S. A. é igualmente a maior exportadora portuguesa.

No início do estágio, a Qimonda Portugal S. A. utilizava um sistema de sequenciamento de lotes que consistia em dois programas distintos para áreas diferentes de produção, *Pre-Assemblagem* e *Assemblagem*. Ambos os programas tinham erros estruturais que criavam dificuldades, tanto na linha de produção como no planeamento, que levavam a soluções temporárias pouco convencionais. Estas soluções passavam por “contornar” o sistema para obter os resultados desejados sempre que tal fosse necessário. Para além deste facto, estas interfaces tinham ainda uma margem de melhoria considerável enquanto *Schedulers*.

Outra necessidade da linha de produção da Qimonda Portugal S. A. era a criação de uma ferramenta de sequenciamento para outra área distinta de produção, denominada de *Burn-In*. Esta necessidade surgiu de um aumento na variedade dos produtos. Assim, no projecto “Melhoramento do Sistema de *Scheduling*”, depois de se eliminarem os erros estruturais e de melhorar a qualidade dos programas já existentes, seria necessário conceber uma nova interface para a área de *Burn-In* com base nas suas necessidades específicas.

Em simultâneo, foi efectuado um outro projecto que visava reduzir a complexidade de gestão no teste de alta velocidade (*high speed*) dos produtos. Na área de teste é feito um teste *high speed* que irá determinar a que frequência consegue cada componente trabalhar. Sendo que os resultados destes testes não são controláveis e que existe uma procura para cada velocidade, torna-se por vezes complicado equilibrar a procura com a oferta. Para adaptar as frequências dos componentes à procura, existia já um processo que era extremamente demorado e que exigia um esforço humano enorme, tendo consequências também ao nível de tempo de ciclo. Por este motivo, o objectivo era tornar este processo tão automático quanto possível, sem retirar às pessoas responsáveis o controlo na gestão da produção. Este projecto tinha aplicação não só na Qimonda Portugal S. A., mas sim em todos os sites de assemblagem e teste de componentes.

Abstract

This report describes the work done during a six month internship at Qimonda Portugal S. A. This company is the only memory component producer in Portugal and also the biggest one in Europe. Qimonda Portugal S. A. is also the biggest exporting company in Portugal.

At the beginning of the internship, Qimonda Portugal S. A. had a scheduling system that was made up of two programmes for different productive areas, Pre-Assembly and Assembly. Both programmes had structural errors that created problems for operators in the production line as well as for people in the Planning section and led to temporary and unconventional solutions. These solutions consisted mainly of working around the system in order to obtain the desired results. Other than this, these interfaces still had a big margin for improvement in their function as *schedulers*.

Another request of the production line was the creation of another scheduling tool for a completely different productive area (Burn-In). This request appeared from the fact that there was an increase in the variety of products. As a consequence, in the “Scheduling System Update” project, after the two existing schedulers were improved, the following step would be to conceive and specify a new interface for another production area according to it’s necessities.

Another project that intended to reduce the management complexity in *high speed testing* was carried out simultaneously. In Test Operations there is an area called *High Speed Testing* that will determine at what frequency each component (chip) can work. Since the results of this type of test are uncontrollable and because there is a demand for each speed beforehand, it is somewhat difficult sometimes to make production meet demand. There was already a procedure to adapt *speeds* on components, but this procedure was very time-consuming and demanded a big human effort, affecting also the overall cycle time of components. As a result, the objective of this project was to turn this process as automatic as possible without ever taking away the control in production management to the people in charge. This whole project did not only concern Qimonda Portugal S. A., but all the *backend* sites (package assembly and test). Consequently, this project would be carried out at a Qimonda AG level.

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1 Introduction

The following report describes the projects carried out during the internship at Qimonda Portugal S.A. between February and August of 2007. This internship is equivalent to the last semester of the Industrial Engineering and Management course at *Faculdade de Engenharia da Universidade do Porto* (Engineering Faculty – Porto University).

This first chapter will allow the reader to be more acquainted to the industry, the company, its final product and its production process so to better understand the projects, the company's needs and the expected results.

1.1 Introduction to Qimonda Portugal S. A.

The Porto site was built in 1996 by *Siemens AG*, but then *Infineon Technologies AG* was created in April 1999 as part of the *Siemens Group* and carried on the manufacturing of semiconductors in the same premises. In similar conditions, *Qimonda AG* was created in April 2006 as part of the *Infineon Technologies Group* and took on the semiconductor business, the same as Infineon had 7 years earlier.



Figure 1 – Qimonda Portugal S. A.

Since this site was raised in 1996 it hasn't stopped growing. With only 110 people at the beginning, Qimonda Portugal S. A. was already almost 15 times larger by the end of last year. During the year of 2007, the predictions are of a growth in production of 60%, which also requires headcount increase.

The following image shows the company’s growth and its most important milestones:

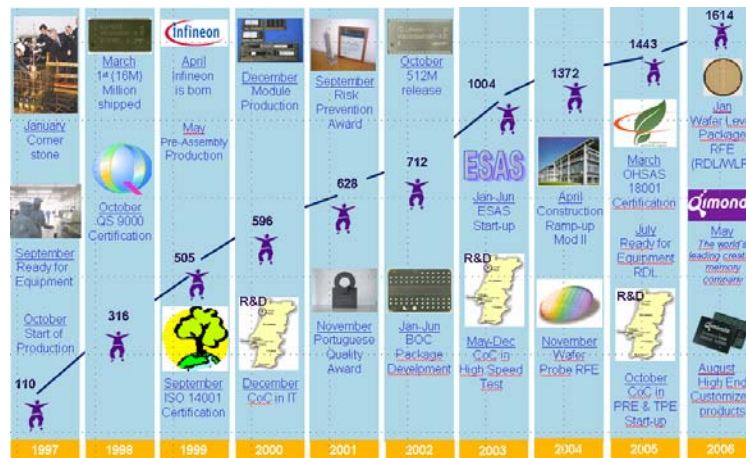


Figure 2 – Porto Site Milestones

Qimonda AG is in the semiconductor industry, a very competitive industry where speed and innovation dictate the leaders. These days, Qimonda is one of the biggest companies and its main competitors are Samsung and Hynix, amongst others. Production at QAG is done in two distinct phases. This way, the company is divided in two types of sites:

- Front End sites
- Backend sites

Other than these types of sites, there are also subcontracted companies that manufacture semiconductors for Qimonda as well as R&D sites (Research & Development).



Figure 3 – Qimonda sites world wide

The first phase of the manufacturing of semiconductors is done at Front End sites, where the final product is the wafer. Wafers are silicon disks that will later be divided into several little rectangular dies that contain the memory capacity.

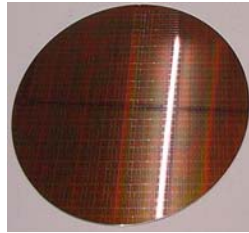


Figure 4 – Wafer

This division is done at Backend sites. Backend sites also build the package over each die to form the final product, the semiconductor. After this, each component must be tested for quality and speed of response.

Qimonda Portugal S. A. (QPT) is a Backend site, but also performs two Front End operations that make it the most versatile Qimonda Backend site. Other Backend sites include Suzhou (China) and Malacca (Malaysia). This last one, throughout the first semester of 2007, exchanged heavy machinery with Porto. All Porto modules lines have been moved to Malacca, the same way as all component lines from Malacca have been transferred to Porto. Malacca now produces only modules and Porto produces only components.



Figure 5 – Memory module

Dresden (Germany) also has a Backend but it does not perform mass production like the other Backend sites. Dresden is mainly a Front End site. Other Front End sites, besides Dresden, include Richmond (USA) and Inotera (Taiwan).

1.2 Qimonda Portugal S. A. production process

The production process at Qimonda Portugal S. A. can be divided into:

- Front End Operations
- Backend Operations

The *Front End Operations* are divided into two areas:

- WLA/RDL (**Wafer Level Assembly/ReDistribution Layer**)
- Wafer Test

The *Backend Operations* are divided into two areas:

- Assembly Operations
- Test Operations

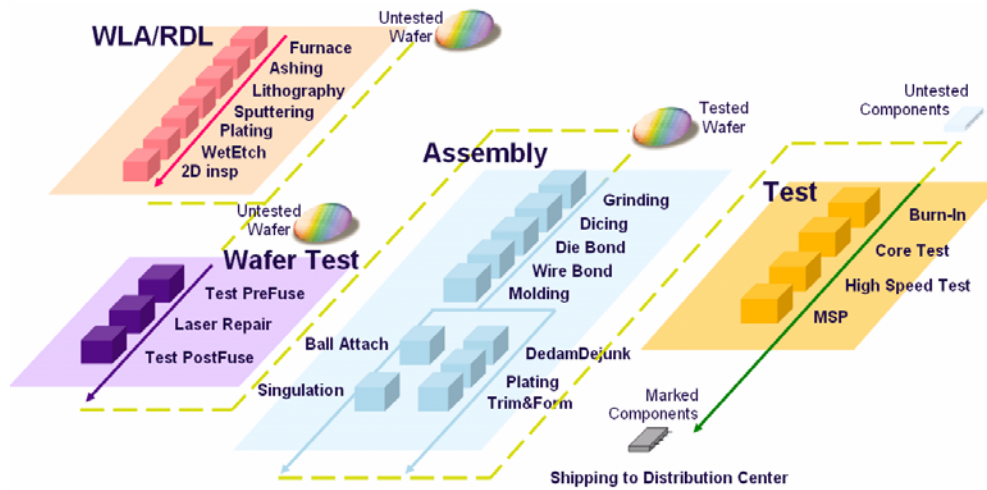


Figure 6 – QPT production Line

1.2.1 Front End Operations

1.2.1.1 WLA/RDL (Wafer Level Assembly/ReDistribution Layer)

A new technology called “Multi-Die Package” was recently introduced at Qimonda. This new technology consists of making components that have more than one die inside. Presently, Qimonda produces only Dual-Die chips (chips with two dies).

The WLA area will process the wafers so to prepare each die for multi-die packaging. Thus, only dies that are going to be used in multi-die packages go through this procedure.

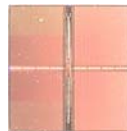


Figure 7 - Die

Knowing that the *bond pads*¹ of a die are aligned down the middle of a die, as shown in the picture above, it is necessary to “drag” these pads to the periphery of the die, so that the wire bonding (Assembly Operations) can be performed successfully.

Because this production area is the most delicate and photosensitive, it is performed in a 1K clean room² and under yellow light.

⁽¹⁾ Small platforms on the die and on the leadframe/substrate where the gold wire connection is made

⁽²⁾ Less than 1 thousand particles with a diameter no smaller than 0.5 micron per cubic foot. There are also 10k and 100k rooms, where what varies is the number of particles

1.2.1.2 Wafer Test

Wafer Testing is the final Front End area. This area will test every wafer (and each die within them) to make sure that, according to established standards of quality, they are fit to proceed to Backend Operations to later become individual components.

As the wafers are tested, and since not all dies in a wafer have the same quality, a proper software will keep information on each and every die. This information is presented in the form of a *Wafer Map*.

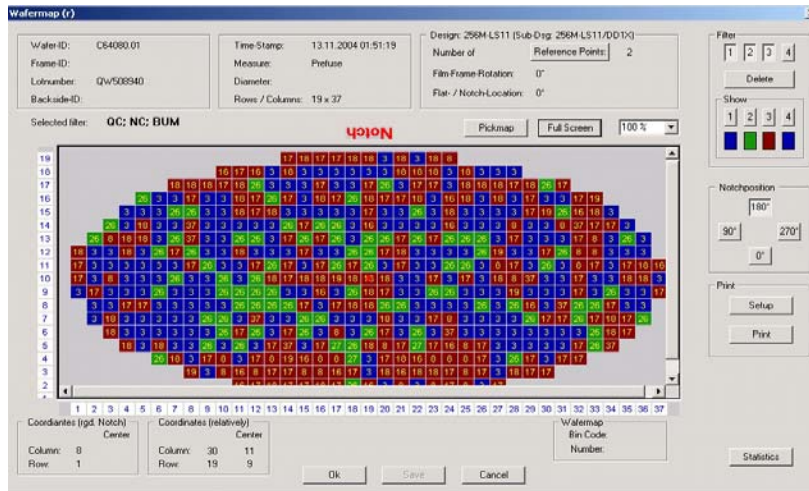


Figure 8 – Wafer Map

Wafer Maps show on each wafer, the quality of each die through colour and number coding. These maps will later be useful in Backend Operations for when the dies are extracted from the wafer.

This production area occurs inside a 10K clean room.

1.2.2 Backend Operations

1.2.2.1 Assembly Operations

Assembly Operations can be divided into three different sections:

- Pre-Assembly
- Assembly
- End of Line

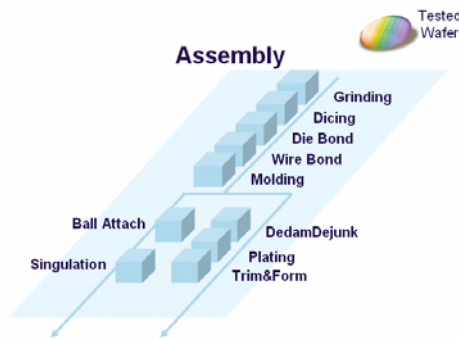


Figure 9 – Assembly Operations

1) Pre-Assembly

This area includes the **Grinding** and **Dicing** operations (see fig. 9). In this stage of production we are still handling wafers, therefore it is not important to distinguish types of packages (TSOP/BOC).

Because of freight transportation, wafers cannot be produced with their final thickness (under 1mm), or else they would not survive the journeys. Because of this, wafers need to go through **Grinding** until they have the desired thickness.

After acquiring the desired thickness, the wafer will go through an operation called **Dicing** so to individualize each die. From now onward, the production line deals with dies and not wafers.

2) Assembly

This stage of production includes the *bond operations*: **Die Bond** and **Wire Bond**.

From this stage onward, it is important to consider the type of package being dealt. Depending on whether the package is TSOP (Thin Small Outline Package) or BOC (Board on Chip) we will see different processes and materials. BOCs represent approximately 80% of the whole production at QPT as they are technologically improved, compared to TSOPs.



Figure 10 – BOC



Figure 11 - TSOP

At **Die Bond**, BOCs are placed on substrates and TSOPs are placed on leadframes:

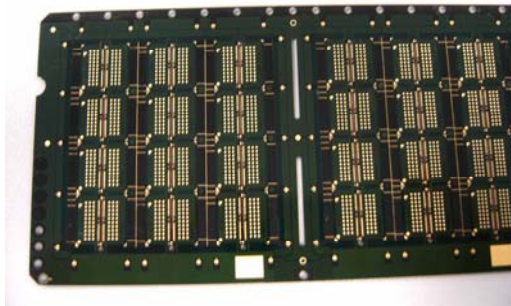


Figure 12 – BOC Substrates

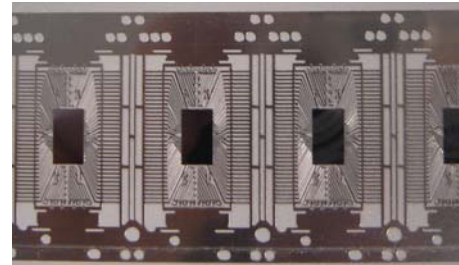


Figure 13 – TSOP Leadframes

At **Wire Bond**, the die is connected to the substrate/leadframe through gold wire so that the electric contact is established between the die and the exterior.

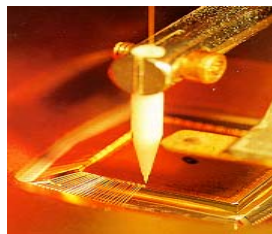


Figure 14 – Wire bonding

3) End of Line

At this stage of the process, TSOP and BOC packages will perform one common operation and then diverge into different processes. This common operation is called **Molding** and at this operation the die is covered with an epoxy resin that is generally known as the chip's "body". The epoxy resin is a black substance that will cover and protect the most sensitive areas of the component, preventing from oxidising and from general physical damage.

After this last stage, **BOCs** will go through two other stages: **Ball Attach** and **Singulation**. The first of these two operations will place the *solderballs* on the bottom side of the chip. *Solderballs* are the electrical contacts of BOCs. Finally, at **Singulation**, the chips (still on substrates) will have to be separated into individual chips.

The process for **TSOPs** is quite different, as they go through three other operations: **DeDam/DeJunk**, **Plating** and **Trim&Form**.

The **DeDam/DeJunk** operation will cut off the excess of epoxy resin on the sides of the chip as well as cutting the *dambar* (small metallic bar that unites all leads on each side – see fig. 13). The **Plating** operation consists of a series of chemical baths that will remove all oxidations and reductions as well as giving the leads a protective cover. Finally, at **Trim&Form**, the leads will be given their final shape, as shown in figure 15.

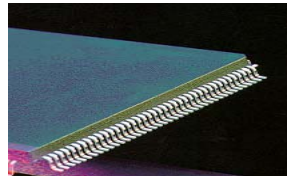


Figure 15 – leads after trim&form

1.2.2.2 Test Operations

At Test Operations, all components will have to go through a series of tests so that, according to their performance, they can be marked with the correspondent quality.

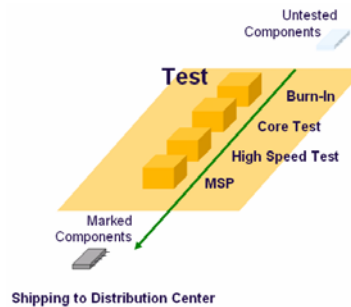


Figure 16 – Test Operations

The first operation is **Burn-In**. At this stage, the components will be placed in ovens so to age the components and reduce the failing rate of each one. As it is shown in the graph below, at the beginning, the components present a high failing rate, therefore, the ageing must be accelerated so that they leave the site at their best.

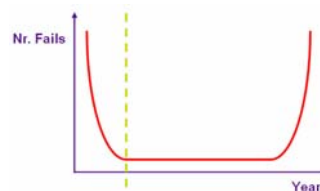


Figure 17 – Fail rate curve

Then, at **Core Test**, components go through “stress tests”. More specifically, the chips will be put through electric currents at extreme temperatures (high and low) to test their functionality.

Next up is **High Speed Test** where the speed of response of each component will be tested. Depending into which bin⁵ each component is placed, they will be marked in the following operation accordingly.

At **Mark, Scan & Pack**, the components will be marked with the brand and the sales description and then they will be scanned to make sure that they are correctly marked. Finally they will be packed and taken into the shipping area.

⁵⁾ When the components are tested, they will be placed into bins/containers according to the speed of response.

2 Introduction to the projects

During this internship, two distinct projects were carried out.

The first and main project is called *Scheduling System Upgrading*. This project had two main goals. To start with, it was important that the already existing scheduling programmes were improved, by correcting their conceptual errors and creating solutions to newly risen needs. The second part of this project was to specify a new scheduling programme for a production area that was going to require a programme of the sort in the near future.

The second project is the *Downbinning Project*. This project has the ultimate objective of automatically attributing different speeds (lower speeds) to components if this helps to better meet demand. As the project is to be launched for Qimonda worldwide and it is too big to be completed in 6 months, the internship will include only an impact study and a solid project proposal.

2.1 Scheduling system upgrading

2.1.1 Scheduling theory

To better understand the *scheduling* concept, it is necessary to differentiate it from *dispatching* and *sequencing*.

Scheduling is the act of attributing a specific lot to a certain machine at a given time. Scheduling answers to the following questions: “Which lots go where? When?”

Dispatching decides which lot goes to the next machine to become vacant. This way, dispatching answers the following question: “Which lot should go on this machine now?”

Sequencing is the act of creating a queue in the buffer before the process following an established criterion. This does not take into consideration time or resources, only lot order.

2.1.2 QPT scheduling system

At Qimonda Portugal S. A., for scheduling purposes, the production line can be divided into 3 main areas:

- Pre-Assembly
- Assembly (Assembly + End of Line)
- Test Operations

Before each one of these 3 areas there is a buffer that feeds it. As it is shown in the picture below, *Pre-Assembly* is fed by the *Die Bank*, *Assembly* is fed by the *Assembly Buffer* and *Test Operations* is fed by the *Test Buffer*.

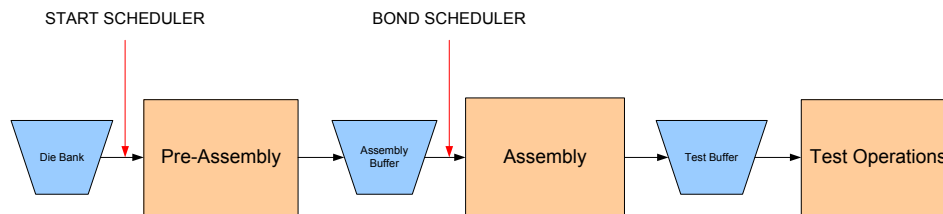


Figure 18 – Initial production line diagram

At QPT there are already two scheduling softwares working. One of them is the *Start Scheduler* and operates between the *Die Bank* and *Pre-Assembly*. The other is the *Bond Scheduler* and it operates between the *Assembly Buffer* and *Assembly* (fig.17).

The schedulers operate always between the buffers and the areas that they feed for two essential reasons:

- To make the allocation to machines of lots that have already completed the previous stage of production
- Perform the change of *baunumber* (product code).

A *baunumber* is an 8 digit number that gives us all the production information of a lot. As a lot progresses along the line, more information has to be kept because new characteristics are attributed to the lot. This way, *baunumber* structures are divergent (one-to-many relations).

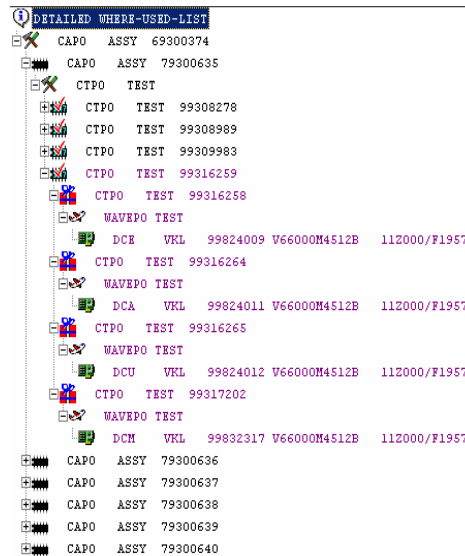


Figure 19 – *Baunumber* structure

For instance, as a lot progresses from Pre-Assembly to Assembly it is then important to know what type of package it will have. This means that the same product at Pre-Assembly can generate several different products at Assembly being, therefore, necessary to change *baunumbers*. Two components that have the same *baunumber* are exactly the same product and must be at the same stage of production, having followed the exact same path.

Looking at a *baunumber*, one can tell at what point of production it is:

Area	Die Bank	WLA	Pre-Assembly	Assembly	Test Operations
<i>Baunumber</i>	493*****	593*****	693*****	793*****	993*****

Table 1 – *Baunumber* types

The scheduling at QPT is done under the FIFO criterion (First In, First Out). As the operator chooses the product to be produced, he must then choose the lot that has been stored at the respective buffer for the longest amount of time, because the programme will not allow him/her to do otherwise.

The following picture is the Bond Scheduler interface. The top part shows the list of products and within each product there will be lots that have the same characteristics (in this case: **class**, **package** and **organization**). As the operator presses “Show Lot(s)”, a list of lots will appear in order of age (from the oldest to the most recent). The operator must then choose the oldest lot and press *Move OUT* to initiate it in production.

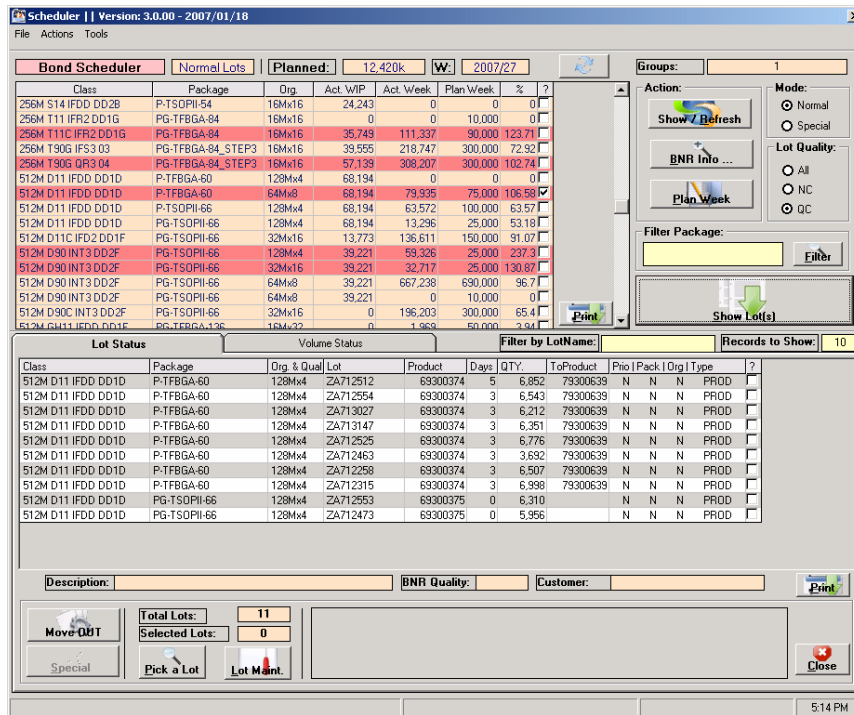


Figure 20 – Old Bond Scheduler interface

2.1.3 Required improvements and new functionalities

The upgrading of the scheduling system had two distinct objectives, which also represented two distinct phases of the project.

The first part of the project consisted on improving the two already existing scheduling interfaces by resolving conceptual errors and adding methods that improve the control of WIP (work in progress) in the production line.

The second part of the project was to conceptualize and create a specification for a new scheduling interface that was to be introduced at the beginning of the *Test Operations* (just before *Burn-In*). This way, there will be a scheduler between the *Test Buffer* and the *Test Operations*, as shown in the diagram below:

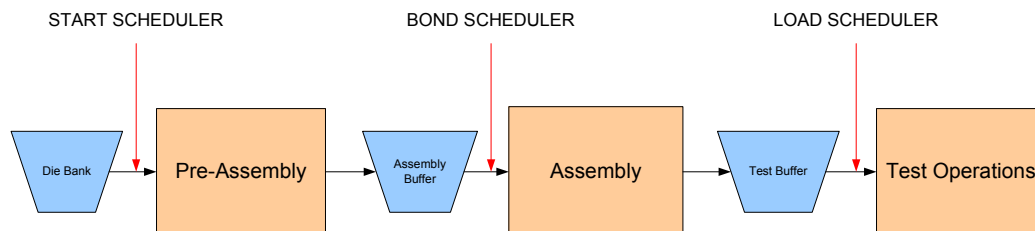


Figure 21 – Final production line diagram

In a more advanced phase, the first part of the project can be applied to the second part. This means that by doing the first part, the knowledge attained from it can be applied to create a better tool for Burn-In from the start.

2.2 Downbinning project

2.2.1 Grading system at QPT

In Test Operations at QPT, more specifically, at *High Speed Testing* is where components are “graded” for speed. As each component is tested it can be graded as one of three possible speeds (depending on the test it is submitted to) or as speedless. If a component is speedless, this means it is classified as NC (non-conformity), whereas if it does have a speed it is QC (quality conformity). There is still another option, if the component cannot be sold, which is to be classified as scrap and therefore, up for termination.

As a lot is introduced in a testing machine, the machine will test each component individually for frequency (speed of response). This parameter is usually measured in Megahertz (MHz), but within Qimonda what is essential is to know the value in nanoseconds of the response time. This way, each tester will have a series of “bins” into which the components will fall into according to the result of the test.

There are bins for NC and scrap material, but what is important in this project is to analyse what goes on within the QC section. There can be up to 3 QC bins and for every product there is a **standard speed** that always occupies the third bin, as shown in the following table:

		Bin 1	Bin 2	Bin 3	Bin x	Bin y
Tested speed	No extension	-	-	Standard Sort	NC	Scrap
	Speed 1	Speed 1	-	Standard Sort	NC	Scrap
	Speed 2	Speed 2	Speed 1	Standard Sort	NC	Scrap
	Speed 3	Speed 3	Speed 1	Standard Sort	NC	Scrap

Table 2 – Generic speed programmes table

Standard speed (or standard sort) is always the slowest speed meaning that any component that does not pass as standard sort ceases automatically to be QC. This way, the bins are distributed in the following fashion:

- Bin 1: Speed, different to the standard sort, to which the test is referring.
- Bin 2: An intermediate optional speed between the test’s main speed and standard sort
- Bin 3: Standard sort

Because the results of these tests are not controllable, it is very important to keep an updated record of the outcome of this testing so that in the future the **speed shares** can be more easily predicted. This information is fundamental to be able to plan the production in the near future.

2.2.2 Current downbinning process at QPT

To *downbin* is to change the speed of a component (attained by high speed testing) to another speed of lower quality. To better understand the current *downbinning* process and all the problems it generates, it is important to first understand in what process *downbinning* can be useful.

Every Friday, it is necessary to report the expected production forecast for the following week. This forecast is done based on the existing demand and the production plan. In this same forecast, quantities are allocated to different speeds and within each speed to different destinations. Also, because of the uncertainty of being able to complete the weekly plan, it is necessary to establish priorities.

If, for any reason, it is absolutely necessary to downbin a lot of components, the procedure is the following:

- In the short run: it is necessary to place lots on hold to prevent them to progress and so to be able to change the *baunumbers*.
- In the long run: it is necessary to rework *baunumber* structures to be able to change speed programmes on testers.

All of these actions imply a huge human effort, wasted time for machinery and manpower and increased cycle times, when in fact all of this could be done more easily if a proper tool existed to solve these types of problems.

2.2.3 Downbinning main goals

Due to the increasing complexity of products, more and more it is harder to make production meet demand. This topic is the main origin of the grading problem. So, alongside the fact that making production meet demand is very important, the *downbinning* project will try to solve a few other problems allowing future adaptation to be more accessible.

The method used presently to perform what *downbinning* will perform in the future is extremely extensive time wise and requires far too many human resources. It is fair to say that there is no real methodology implemented, or at best, there is a completely obsolete one.

Another problem that has been reported is the fact that all the information and details regarding high speed testing can only be obtain through a difficult, complicated and slow procedure. Because every product suffers a lot of changes in small details, there has not been any proper documentation that could keep up with this whole evolution. Therefore, most

pieces of information can only be obtained by communication with certain people directly related to the topic.

This way, the *downbinning* project will try to meet the following goals:

- Make production meet demand more easily
- Relieve human effort and prevent unnecessary time-wasting
- Have an updated and central database with all the necessary and organized information
- Have an interface at each backend linked to that database that can perform *downbinning* correctly.

Analysing this project and all its implications, it is easy to conclude that it is not possible to complete it within the time of the internship due to its dimension. Knowing this, it is necessary to establish an intermediate goal that is executable within the deadline previously established.

In terms of the internship, it was established that the *downbinning* project would have a goal that could be divided into two distinct parts:

- Global: This part of the project is the one that is more time consuming due to the fact that it involves all Q-sites. Consequently, most of the project will be oriented to the local part of it and the global part of the project will be to create a detailed proposal for how the *downbinning* should work globally and locally.
- Local: In terms of Qimonda Portugal S. A., the objective is to conceive the information technology behind the *downbinning* concept, including all the logic and algorithms. This conceptualization must be performed without reducing the *production controller's* management autonomy. This means that there is a certain limit to how automatic this algorithm should turn out.

3 Scheduling system upgrading results

This chapter will report the steps taken towards the final solution and the results that this solution brought to the company. It will be sectioned into different parts, as each scheduling interface has its own characteristics.

3.1 “Start Scheduler” and “Bond Schedulers” improvement solutions

As mentioned in chapter 2.1.3, the first part of the Scheduling System Updating project is to improve the already functional schedulers.

Both programmes (Start Scheduler and Bond Scheduler) were considered to be schedulers, when in fact, under the definition of scheduling, there was not much of that being done before the beginning of the project. Knowing that the scheduling science seeks to know which lot goes to which machine and when, in this case it was always the oldest lot that had to go to the next machine to become free, as soon as it did. This way, all that the scheduler did, was to create a queue of lots under the FIFO logic and make the *baunumber* transition from the buffer to the production line. All the rest was done manually by the operator.

The improvement of these tools had two distinct objectives:

- Solving conceptual errors that until then implied less conventional solutions
- Creating real scheduling functionalities

The document created for Qimonda Portugal S. A. that specifies the requirements for the improvement of these two scheduling tools is attached in the “*Appendix A – QPT Start & Bond Schedulers Improvement*”.

3.1.1 Start Scheduler

1. Conceptual errors

As a search was performed to find out what conceptual errors this Scheduling tool had, there was one that had been creating problems and forcing unorthodox solutions.

The Start Scheduler interface uses a few filters to define which lots of components will belong to each product. These filters are Class and Package. These represent the first two

columns of the interface. The conceptual error in this filtering resides in the Package where it is over defined.

The way that this filter is defined causes, in some cases, for the exact same group of lots to appear in two different lines.

The products at Qimonda can be grouped according to *ProductGroup* codes where certain characteristics of each product are considered. In *ProductGroup1* each code contains information on *Generation*, *Shrink*, *Front End* and *Design* (e.g. 512M T80G QD3 03). In *ProductGroup3* there is a higher level of complexity. The code construction rules can be seen in *Appendix F – ProductGroup3 Creation rules*. Within *ProductGroup3* there are several descriptions that have been created that are used to filter the *ProductGroup3* codes according to one or several of their characteristics. As you can see from the picture below, the first column has been filled with the *ProductGroup3* code and the following columns contain the descriptions from 1 to 5 respectively.

Package	Description	Description2	Description3	Description4	Description5
WC000-S1	128M D11 IFR2 DD1L NC-T WTEST	PG-TSOPII-66	n/a	TSOP	STANDARD
W0000-S1	128M D11 IFR2 DD1L QC WTEST	PG-TSOPII-66	n/a	TSOP	STANDARD
WC230-03	128M S11N QR2 DD1C WaferTest	PG-TSOPII-54	n/a	TSOP	STANDARD
W0350-06	1G T11 IFS3 DD2D QC RDL	PG-TFBGA-71	n/a	BOC	STANDARD
W01190-05	1G T90 IMB3 05 QC RDL	PG-TFBGA-71	n/a	BOC	STANDARD
W01190-06	1G T90 IMB3 06 QC RDL	PG-TFBGA-71	n/a	BOC	STANDARD
W01190-07	1G T90 IMB3 07 QC RDL	PG-TFBGA-71	n/a	BOC	STANDARD
W01190-08	1G T90 IMB3 08 QC RDL	PG-TFBGA-71	n/a	BOC	STANDARD
WC001-01	256M D11 IFR2 DD11 NC-T WTEST	PG-TSOPII-66	n/a	TSOP	STANDARD
W0001-01	256M D11 IFR2 DD11 QC WTEST	PG-TSOPII-66	n/a	TSOP	STANDARD
WC000-01	256M D11 IFR2 DD1L NC-T WTEST	PG-TSOPII-66	n/a	TSOP	STANDARD
W0000-01	256M D11 IFR2 DD1L QC WTEST	PG-TSOPII-66	n/a	TSOP	STANDARD
W0036-06	256M D11C QR2 DD1L QC WTEST	PG-TSOPII-66	n/a	BOC	STANDARD
W0000-07	256M GT11M IFR2 DD1G QC WTEST	PG-TFBGA-84	n/a	BOC	STANDARD
WF000-07	256M GT11M IFR2 DD1G QC-F WTEST	PG-TFBGA-84	n/a	BOC	STANDARD
WL000-07	256M GT11M IFR2 DD1G QC-L WTEST	PG-TFBGA-84	n/a	BOC	STANDARD
W0000-03	256M LS14 IFDD DD1B QC WTEST	P-TSOPII-54	n/a	TSOP	STANDARD
W0038-02	256M S11C QR2 DD1C QC WTEST	PG-TSOPII-54	n/a	TSOP	STANDARD
W0038-02	256M S11C QR2 DD1C QC WTEST	PG-TSOPII-54	n/a	TSOP	STANDARD
WC130-01	256M S11N IFR2 DD1B NC-T WaferTest	PG-TSOPII-54	n/a	TSOP	STANDARD
W0130-02	256M S11N IFR2 DD1B QC WTEST	PG-TSOPII-54	n/a	TSOP	STANDARD
W0130-01	256M S11N IFR2 DD1B QC WaferTest	PG-TSOPII-54	n/a	TSOP	STANDARD
W0130-03	256M S11N IFR2 DD1C QC WTEST	PG-TSOPII-54	n/a	TSOP	STANDARD
W0000-02	256M S14 IFR2 DD2B QC WTEST	P-TSOPII-54	n/a	TSOP	STANDARD
WC000-02	256M S14 IFR2 DD2B QC WTEST	P-TSOPII-54	n/a	TSOP	STANDARD

Figure 22 – ProductGroup3 descriptions

Focusing now on the problem, we know that a lot processed at Pre-Assembly can generate more than one product at Assembly. Looking at *ProductGroup3 description2* it is possible to see that it defines whether a product is P-black or PG-green (presence or absence of lead) when this is defined only at plating. It also defines the type of package (TSOP/TSOPII/TFBGA/VFBGA) and the number of contacts. All of this information must be defined only at Assembly, meaning that the same wafers at Pre-Assembly can be used to produce more than just one of these packages. This is the reason why some groups of lots appear in more than one line in the Start Scheduler.

To give an example, we can see in the following picture that the two lines surrounded in a black line contain the same lots (same Act. WIP) and all that is different between them is whether the number of contacts on the chip. Knowing that the process in Pre-Assembly to produce any of these two packages is exactly the same, it is unnecessary to have this much information at this stage.

Scheduler System Upgrading & Downbinning Project

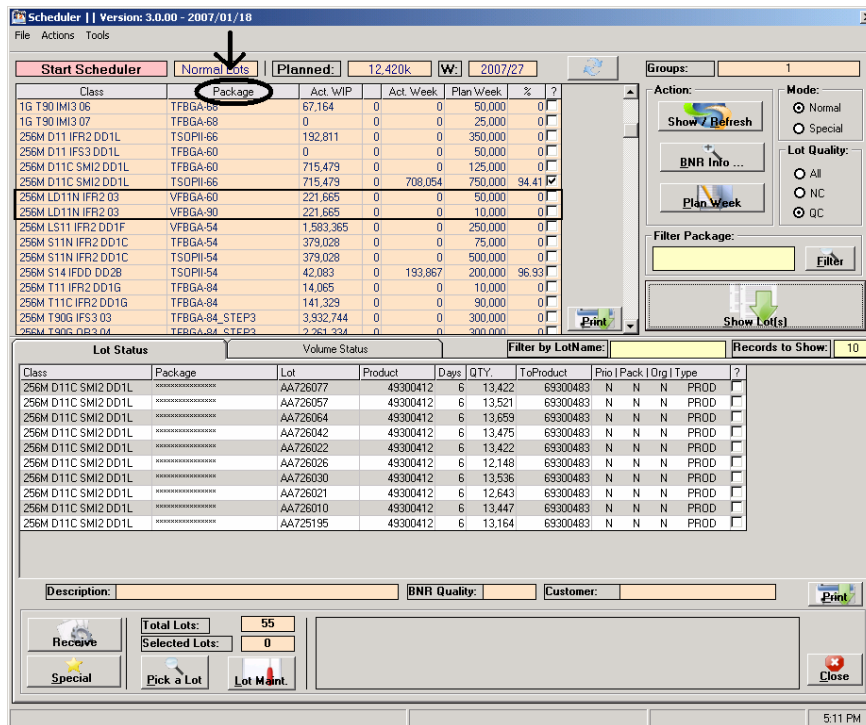


Figure 23 – Double line at Start Scheduler main window

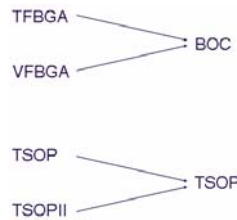
Solution:

In order to eliminate unnecessary information it is necessary to re-define the *Package* column. Since *description2* and *description3* are being used in the *Bond Scheduler* it is not possible to use any of them to reconfigure. Since *description4* was not being used at the time for any scheduler, it was a question of reconfiguring this description in order to have associated to each *ProductGroup3* code all the necessary information and nothing more than the necessary information.

The way to guarantee that the description is properly defined is to make sure that, within the same *class*, products with the same process at Pre-Assembly have the same description and that products with different processes have different descriptions. The product characteristic that is closer to following this logic is package type (TSOP/BOC). If a product is defined in *description4* as being either TSOP or BOC then it will cover most cases, leaving a few exceptions that will have to be defined separately.

The new “ProductGroup3 Description4” will be specified under the following general rules:

- All TFBGA and VFBGA will now be BOC
- All TSOP and TSOPII will now be TSOP



There are a few exceptions that will take on the following nominations:

- All STEP3 lots must be described as **BOC_STEP3** (STEP3 is a type of substrate used for BOCs – see figure 12).
- All lots destined for dual die components with different processes for top and bottom dies must be defined as **BOC_TOP** or **BOC_BOT** respectively (applied only to BOCs).
- All lots to which process differences depend on the number of contacts on the chip must be defined under the generic nomination **BOC_x** where “x” must be replaced by a number that corresponds to the number of contacts of the component (applied only to BOCs).
- There is also a specific case in which products perform a different wafer testing (Front End) that implies that they have separate *baunumber* structures and must not be mixed from then onward (in the Backend process which includes Pre-Assembly). This case is for EMC products and is currently specific for 512M D90 TSOP. In ProductGroup3 Description 4 will be defined as **TSOP_EMC**.

With this data inserted into *ProductGroup3 Description4* it is now possible to have the *Package* column in the Start Scheduler to call this description instead of *ProductGroup3 Description2*.

2. Scheduling functionalities

In order to make the Start Scheduler work more like a scheduler, there are a few measures that could be taken. One of the biggest difficulties that there is due to the diversity of products at QPT is to control the amount of WIP in the Pre-Assembly area as well as the WIP in the Assembly Buffer (between Pre-Assembly and Assembly). Other than finding solutions for this problem, there are also other “nice-to-have” items that can be included in the improvement of the quality of this tool.

For supervision and line control purposes a few suggestions were made in order to allow the scheduler to work more as a scheduler and make the control of the production on the line more automatic according to a few established rules.

As you can see in the picture below, the future Start Scheduler will take on a structure similar to what it looks like presently but with a few additions in terms of presenting information. This new format will also contain new restrictions that will stabilize the levels of WIP that should exist at each step of the process.

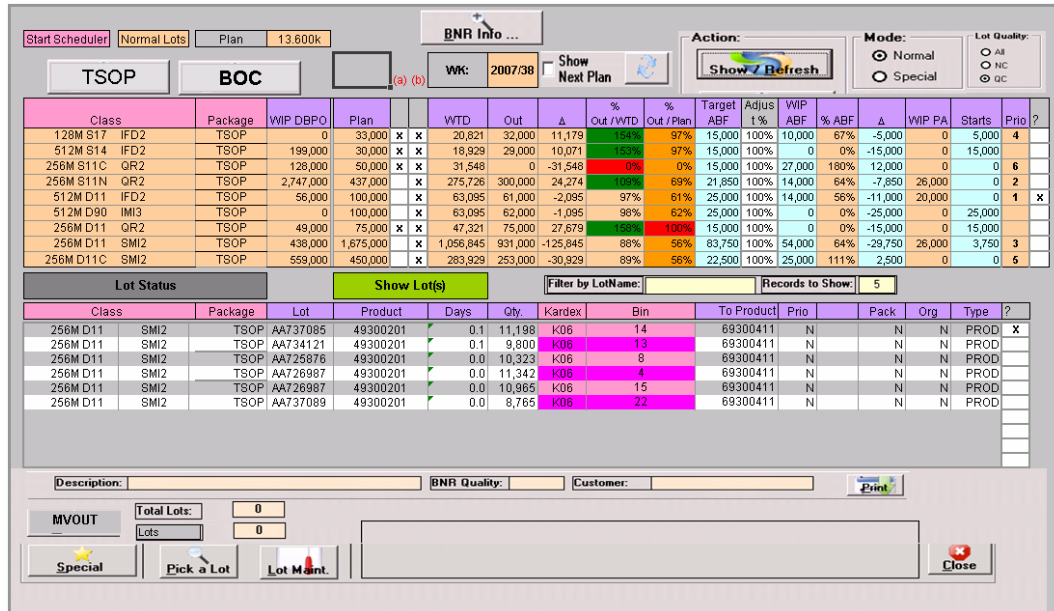


Figure 24 – New Start Scheduler interface

The additions to be made to the present Start Scheduler are the following:

- a) There will be two new buttons:
 - TSOP
 - BOC

These buttons work as filters when pressed. The first of the two will show on the main window the products (groups of lots) that have as package “TSOP”. The second button will do the same for products for which the package is/contains “BOC”.

- b) Two new columns will be introduced for production restriction purposes.

Column (a) is deactivated by default, but when the supervisor activates this option, no releases will be permitted until deactivation or until the change of plan (Fridays at 23h00 GMT).

Column (b) is activated by default and will not allow more releases if at least 100% of the plan has been produced. If the supervisor deactivates this restriction, then the operators may release more material until the restriction is reactivated or until the change of plan (Fridays at 23h00 GMT).

c) Another set of columns will be introduced to the interface. This set will be composed by 5 columns:

- WTD (work to date)
- Out
- Δ
- % Out/WTD
- % Out/Plan

The “WTD” column represents the theoretical Volume Out until that moment. This value corresponds to the portion of the plan that should have been completed by then, admitting that the production will be evenly distributed throughout the week.

This way, a minute-by-minute update can be done. Knowing that a week has 10 080 minutes, the WTD at each point should be:

$$WTD = plan \times \frac{ElapsedTime(min)}{10080}$$

The “Out” column represents the amount of production completed in that week. (This column already exists)

The “ Δ ” represents the difference between the two previous columns:

$$\Delta = Out - WTD$$

The “% Out/WTD” column represents the percentage of production completed against the WTD:

$$\% = \frac{Out}{WTD} \times 100$$

The “% Out/Plan” column represents the percentage of production completed against the weekly Plan:

$$\% = \frac{Out}{Plan} \times 100$$

d) In order to control the quantity of material that can be started at each moment a set of columns will be introduced. These columns are:

- Target ABF
- Adjust %
- WIP ABF
- %ABF
- Δ
- WIP PA
- Starts

The column “Target ABF” (Target Inventory for Assembly Buffer) shows the ideal quantity of material of each product that there should be in the Assembly Buffer. The calculation is the following:

If Plan ≤ 100.000 then Target = 15.000*Adjust%
If 100.000 < Plan ≤ 450.000 then Target = 30.000*Adjust%
If 450.000 < Plan ≤ 650.000 then Target = 40.000*Adjust%
If Plan > 650.000 then Target = (Plan/7)*0,35*Adjust%

The column “Adjust %” represents the percentage of the plan that we want to produce. This column allows the supervisor or the line controller to manage the start restrictions. The average of all the values in this column must be 100%.

The column “WIP ABF” shows the amount of material present in the Assembly Buffer.

The column “% ABF” shows the percentage of WIP ABF against the Target ABF:

$$\%ABF = \frac{WIP_ABF}{Target_ABF} \times 100$$

The column “Δ” shows the difference between the WIP and the Target for the Assembly Buffer:

$$\Delta = Target_ABF - WIP_ABF$$

The column “WIP PA” shows the amount of Work In Progress in the Pre-Assembly area.

The column “Starts” shows the amount of starts that the operators are allowed to do based on the following calculations:

If (-Δ-WIP PA)>0 then Starts=(-Δ-WIP PA)
Else Starts=0

e) The already existent “Prio” column will now operate under different rules. Before, this column presented by default the letter N (no), but if the product had high priority it would show a Y (yes). The rules now shall be the following:

- The higher the value, the higher the priority
- Priorities for TSOP and BOC are independent (they do not compete)
- Priorities for 200mm and 300mm wafers are independent (*)
- Priorities if WIP > 0 in DBPO:
 - Highest priority must be allocated to product with lowest %ABF
 - For products with equal %ABF, highest priority goes to product with lower plan

f) Finally, in the “Lot Status” section of the interface, there will another two columns that will indicate for each lot, in what Kardex the lots is in and in which Bin inside that Kardex. This information before was only available in the SAP programme, but the idea is to make this information available without having to have two programmes open.

3.1.2 Bond Scheduler

1. Conceptual errors

There was a new product released recently that was found to be incompatible with the Bond Scheduler. This product was a dual-die, meaning that it carries two dies within the package. Usually, dual-die products use two of the same dies to occupy the top and the bottom positions, but in this case, these dies will be different.

The difference between the dies is their thickness. For this product, in Pre-Assembly, when the grinding is done to the wafers, some will have to be more grinded than others since the top die is thinner than the bottom one. As a consequence, this will generate lots of “top die wafers” and lots of “bottom die wafers”, each kind with their own *baunumbers*.

This problem actually affects both Pre-Assembly and Assembly areas, but the solution found would be applied to the Bond Scheduler.

In terms of **Pre-Assembly**, there will have to be different plan entries for each one of top and bottom dies because the process is different due to the wafer thickness. This way, it is necessary the existence of separate *baunumbers* and in terms of Start Scheduler a different ProductGroup3 so that in the Package column they can be differentiated.

In terms of **Assembly**, it is imperative that there is only one plan because for each dual die chip there must be one and one only top chip and the same for bottom chips. It is important to assure that the move in of lots is controlled by the scheduler. Because the bottom chip has to be moved-in first (since it comes first in the assembly of the chips), the only plan due to appear on the Bond Scheduler will be BOC_BOT.

The following diagram shows how, in theory, the process of assembling a dual-die chip should be in the production line:

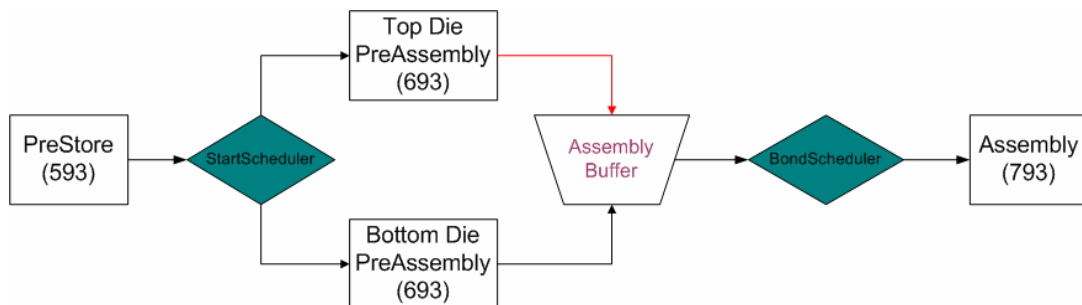


Figure 25 – Dual Die Chips Process Flow Problem

As this is not possible, a solution must be found. Knowing that the bottom chip is the one to be pulled along the whole process, the difficult part is to “re-unite” the top chip (connection in red) in the Assembly-Test transition.

Solution:

In order to avoid that top and bottom dual die chip *baunumbers* do not get mixed inside the same buffer, the solution found is to forward all top chips into a separate virtual buffer, that will release the top chips as the bottom chips are released in the actual buffer (that serves the Bond Scheduler). This way, besides solving the problem, this solution is prepared for the next logical evolutionary step that is multi die chips with more than two dies.

The following diagram, illustrates the flow that each die takes in the system:

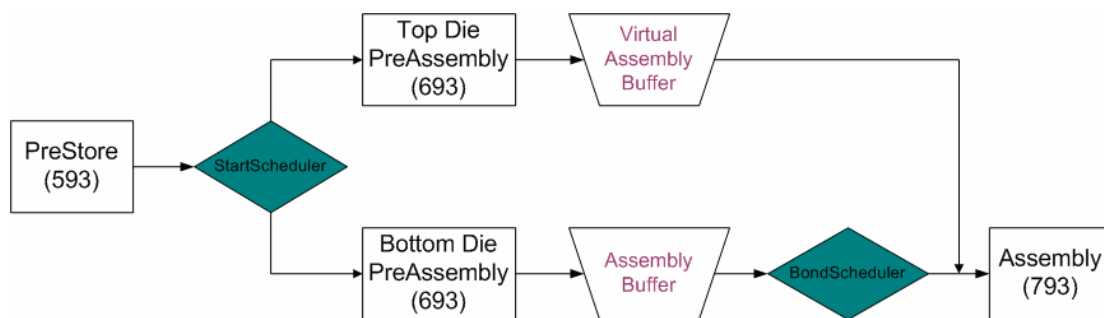


Figure 26 – Dual Die Chips Process Flow Solution

In the operator’s point of view, he will find only lots of *bottom dies* in the scheduler and will have to release one of those for production, but when he collects the lot from the *physical* Assembly Buffer he will have to collect a *top die* lot as well, so that the dual die package can be produced.

2. Scheduling functionalities

As well as made for the Start Scheduler, a few additions will be done to the new Bond Scheduler.

As you can see in the following picture, the future Bond Scheduler will take on a structure similar to what it looks like presently but with a few additions in terms of presenting information. This new format will also contain new restrictions that will level the WIP that should exist at each step of the process.

Scheduler System Upgrading & Downbinning Project

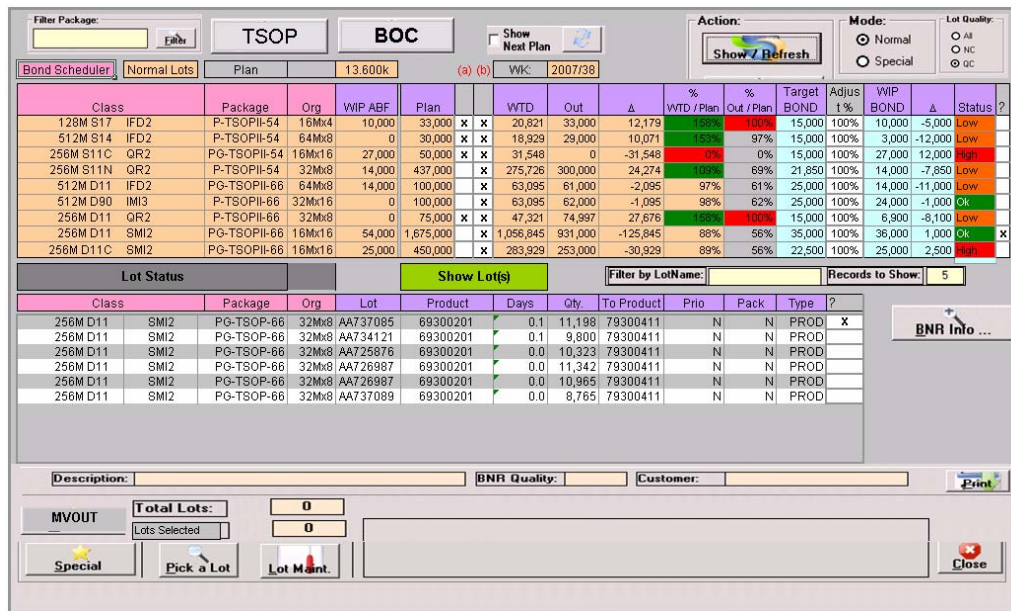


Figure 27 – New Bond Scheduler

The additions made to the Bond Scheduler are the following:

- a) There will be two new buttons:
 - TSOP
 - BOC

These buttons work as filters when pressed. The first of the two will show on the main window the products (groups of lots) that have as package “TSOP”. The second button will do the same for products for which the package is/contains “BOC”.

- b) Two new columns will be introduced for production restriction purposes.

Column (a) is deactivated by default, but when the supervisor activates this option, no releases will be permitted until deactivation or until the change of plan (Fridays at 23h00 GMT).

Column (b) is activated by default and will not allow more releases if at least 100% of the plan has been produced. If the supervisor deactivates this restriction, then the operators may release more material until the restriction is reactivated or until the change of plan (Fridays at 23h00 GMT).

c) Another set of columns will be introduced to the interface. This set will be composed by 5 columns:

- WTD (work to date)
- Out
- Δ
- % Out/WTD
- % Out/Plan

The “WTD” column represents the theoretical Volume Out until that moment. This value corresponds to the portion of the plan that should have been completed by then, admitting that the production will be evenly distributed throughout the week.

This way, a minute-by-minute update can be done. Knowing that a week has 10 080 minutes, the WTD at each point should be:

$$WTD = plan \times \frac{ElapsedTime(min)}{10080}$$

The “Out” column represents the amount of production completed in that week (this column already exists).

The “ Δ ” represents the difference between the two previous columns:

$$\Delta = Out - WTD$$

The “% Out/WTD” column represents the percentage of production completed against the WTD:

$$\% = \frac{Out}{WTD} \times 100$$

The “% Out/Plan” column represents the percentage of production completed against the weekly Plan:

$$\% = \frac{Out}{Plan} \times 100$$

d) In order to control the quantity of material that can be started at each moment a set of columns will be introduced. These columns are:

- Target Bond
- Adjust %
- WIP Bond
- Δ
- Status

The column “Target Bond” (Target Inventory in the Bond area) shows the ideal quantity of material of each product that there should be in the Bond production area. The

calculation is done based on the PL WIP rules. This calculation takes into account the planned volume and the product's cycle time.

The column "Adjust %" represents the percentage of the plan that we want to produce. This column allows the supervisor or the line controller to manage the start restrictions. The average of all the values in this column must be 100%.

The column "WIP Bond" shows the amount of material present in the Bond production area.

The column " Δ " shows the difference between the WIP and the Bond area Target:

$$\Delta = Target_ABF - WIP_ABF$$

The column "Status" will show comments on how the WIP in Bond presents itself compared to the target. This way, the comments will be:

- "Low" – If $WIP\ BOND < TargetBOND * 0.9$
- "Ok" – If $TargetBOND * 0.9 \leq WIP\ BOND \leq TargetBOND * 1.1$
- "High" – If $WIP\ BOND > TargetBOND * 1.1$

There is also a colour coding for easier and quicker comprehension of the Status of each product. Such colour coding is represented in figure 25.

3.2 "Load Scheduler" conception and specification

After improving the previous two schedulers, it was much easier to understand the requirements that the Load Scheduler had in its conception and specification.

The objective of the Load Scheduler was to conceive a tool that was as much as possible similar to the other scheduling tools, so that less time was wasted creating the interface and training the future users of the tool.

Main interface

The main interface requires a few additions compared to the Bond Scheduler. This would be expected because as the components advance along the production line it is only normal that they acquire more characteristics, the same way that the *baunumber* structure has, at each stage, a one-to-many relation with other *baunumbers*.

These additions are shown in the following table that represents the sequence of columns of the main interface that defines the products:

Scheduler System Upgrading & Downbinning Project

Group1 Description	Group3 description2	Group3 description3	Group3 description5	Actual WIP	BUI Prep WIP	Planned WIP	Actual Week	Plan Week
This shall be taken from the field description on CRM MFG.Types. Key is Group1 (Type)	This shall be taken from the field description2 on the field description2 on CRM MFG.PackageNames. Key is Group3 (PackageName) (e.g. PG-TFBGA-54)	This shall be taken from the field description3 on the field description3 on CRM MFG.PackageNames. Key is Group3 (PackageName) (e.g. 16Mx16)	This shall be taken from the field description5 on CRM MFG.PackageNames. Key is Group3 (PackageName) (to be defined)	Get WIP where ML = CTEST and PCA= PROD	Get WIP where ML = CTEST and PCA = PROD and STEP = Burn In Preparation	Currently not in use	For the given week this shall be the Moveln at Step receiving (Mimoso?)	As defined above in the section demand

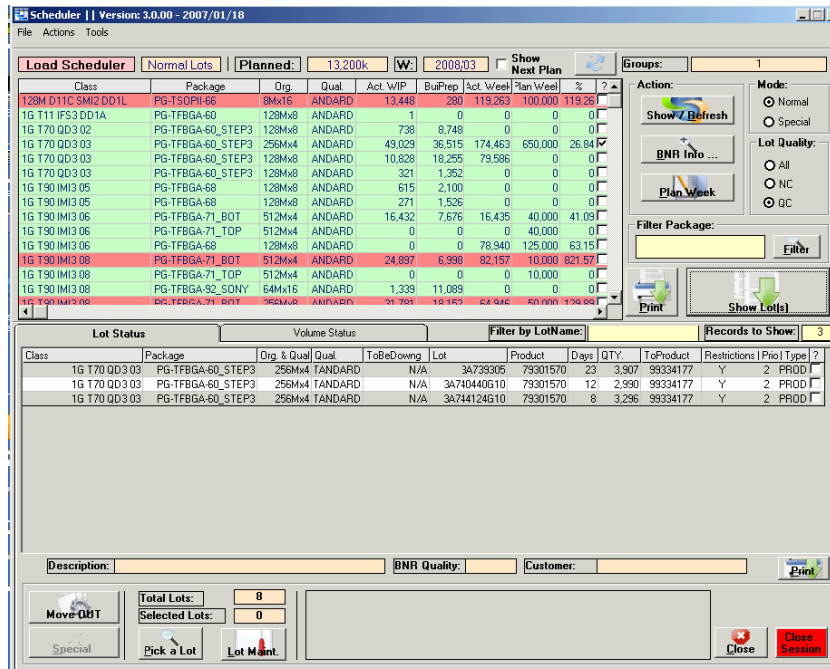
Table 3 – Load Scheduler main window columns

In terms of “Lot Status”, it is necessary to add the following fields between “Org.” and “Lot” (additions in blue):

Qual.	Downgrade
This shall be taken from the field description5 on CRM MFG.PackageNames. Key is Group3 (PackageName) (to be defined)	if ToBeDowngraded = "Y", then Downgrade = "NC"

Table 4 – Load Scheduler “Lot Status” column additions

The following picture shows the Load Scheduler interface:



Picture 28 – Load Scheduler

Product Group 3 Description 5

Product Group 3 Description 5 will be a new description created for Product Group 3 that determines what products with the same Class, Package and Organization take different routes in Burn In. This description will take on the name “Quality” in the Load Scheduler. Furthermore, this fifth description will have 2 different classifications. These classifications are:

- **Standard** - Quality conformity/Non-Conformity (QC/NC)
- **WB** - White Box

NC Products

Alongside the “Load Scheduler project” there was also a parallel project going on that had the objective of performing all downgrades never before Burn-In. Presently, it is possible to downgrade lots at any stage of the process, but as this happens, these lots take on 993 NC *baunumbers*. As a consequence, when the lots actually get to Test Operations (where *baunumbers* are 993), there is no *baunumber* relation that allows the lot to proceed without any human intervention.

With this other project called “Downgrades @ Pre-Assembly and Assembly”, the idea was to have a lot attribute (*ToBeDowngraded*) that would indicate at Burn-In if the lot was to be downgraded or not. This attribute would be activated when it was decided that the lot should be NC. Of course the lot would remain QC until Burn-In. The tool that should “read” this attribute and activate should be the Load Scheduler. Unfortunately, due to some delays, this is a functionality that has not been released yet. This way, the column “Downgrade” in the “Lot Status” section is present but not yet activated.

Burn In Preparation Interface

The Burn In Preparation Interface is a secondary interface that will appear as a lot is “moved out” and will show all lots in *Burn In Preparation* (a step between Test Buffer and Burn In) that can be merged with the previously selected lot.

This window should be only available if “Burn In Prep WIP” does not equal zero and a lot is selected in the scheduler main window under Lot Status (in Test Buffer or Test Store).

If only the second condition is met, then “Move OUT” should be done automatically.

If the second condition is not met, nothing should happen, other than the appearance of a message box that warns the user of this fact.

As the “Burn In Preparation Interface” is opened, it should show the data for both the selected lot and for all the lots in Burn In Preparation that can be merged with the initially selected lot. Beside each lot at Burn In Preparation there should be a “check box” that allows the selection of that lot for merging purposes.

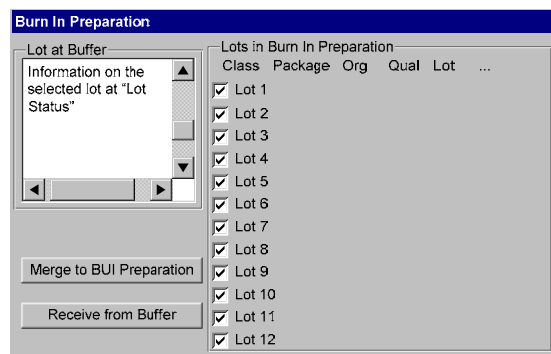
The lots in the “Burn In Preparation Interface” must be able to merge with the selected lot at lot status. This is determined under pre-established rules that apply for other softwares.

In addition to this information, the “Burn In Preparation window” should have two buttons:

- Merge to Burn In Preparation: This button merges the lot from Lot Status with the lots checked at Burn In Preparation and does Move OUT.

- Receive from Buffer: Simply does Move OUT to the lot from Lot Status as it is (with no merging with any other lots from Burn In Preparation).

The following picture shows the “Burn In Preparation Interface”:



Picture 29 – Burn In Preparation Interface

Scheduling Algorithms

The *Lot Status Logic*, *Special Lots Logic* and *How To Account Actual Week* is the same in all Schedulers. It can be seen in *Appendix B – QPT Load Scheduler*.

4 Downbinning project specification

This chapter will describe the proposal made for a global *downbinning* project and the routes taken. The main topics are the *Downbinning Table* and the *Downbinning Logic* that correspond to the Global and Local parts respectively, mentioned in chapter 2.2.3.

4.1 Downbinning Table

Downbinning Tables will be in fact matrices built for each product (under a specific key) that will be found in PGS+ Planning. This table will show for each speed within each product, what speeds can be generated by each test programme. To create these tables, it is necessary to define the key that will filter the products and what type of information will keep on each speed.

PGS+ is a Qimonda global software that accesses a very heavy database. PGS+ is mostly used in Backend sites to get information about *baumnumber* structures. PGS+ Planning is an option within the PGS+ programme that gives access to a big database that provides very accurate information on products that serves the whole of the Qimonda sites.

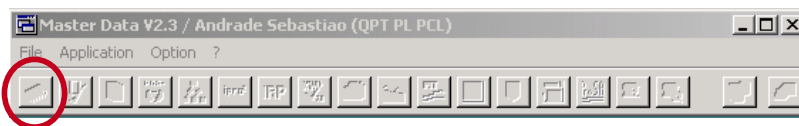


Figure 30 – PGS+ initial interface

The *downbinning* table key is the following:

- Generation
- Shrink
- Package
- Organization
- Design

Each different combination of the parameters mentioned above will have its own table.

It is also important to keep in the PGS+ Planning database the following aspects regarding each speed within the table:

- ❖ Power
- ❖ Voltage
- ❖ BE Grade
- ❖ Temperature
- ❖ Customer

The upkeeping of all the information, once the system is implemented, will be made by Front End sites. More specifically, the Project Managers should insert the information for the first time and the Product Managers should upkeep it.

The following table shows an example of a *downbinning* table:

GH11	1.2	1.4 SONY	1.3	1.4 NIN	1.4	1.4-1.8V	1.6-1.8V	2.0
1.2	Bin1 4	2		Bin2 3				Bin3 1
1.4 SONY		Bin1 2						Bin3 1
1.3			Bin1 2					Bin3 1
1.4 NIN		Bin2 2		Bin1 3				Bin3 1
1.4					Bin1 2			Bin3 1
1.4-1.8V						Bin1 2		Bin3 1
1.6-1.8V							Bin1 2	Bin3 1
2								Bin3 1

Figure 31 – Downbinning table

Entering this matrix horizontally, it is possible to see which other speeds are generated by each speed programme. The filled cells represent the speeds that can be generated. A speed programme is always named by the speed placed in bin1 and this speed is always the fastest within that test.

Each filled cell will inform what bin it corresponds to, if it corresponds to a bin at all. Apart from this, each filled cell will have a number that will automatically show the order of downgrades. A speed can only downgrade to another speed with a lower **downgrade number**. These numbers are independent from speed test to speed test (line to line).

4.2 Downbinning Logic

Demand Manager

The *Downbinning* logic applied to each backend will have to take action in a software that the backend will modify or create to execute this functionality.

QPT has already a software that provides information on quantities of tested components as well as the destinations of shipments and correspondent priorities. This software is called *Demand Manager*.

The *downbinning* project will not imply any changes to the interface as it is presented to the user:

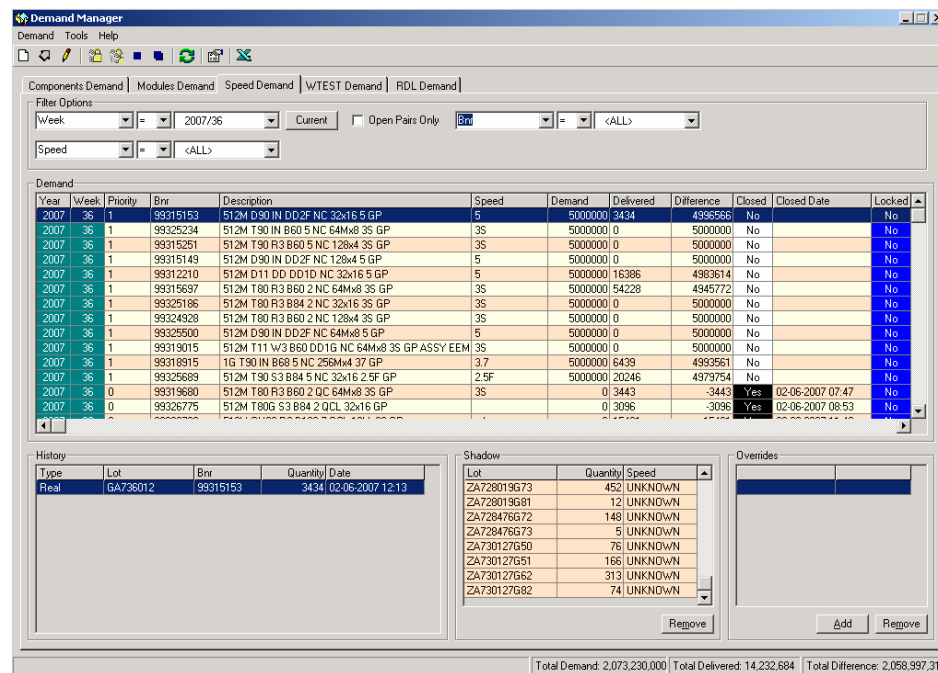


Figure 32 – Demand Manager Interface

The whole logic behind the Demand Manager programme is the only thing that changes as it performs the whole *downbinning* process at a *baunumber* level.

The algorithm would perform the following steps:

- Collect speeds that have demand > 0 and correspondent priorities.
- Creation of a “QPT *baunumber* downbinning table”:
 - Collect *baunumbers* from Splits per Product
 - Collect *baunumbers* from Product Relations

- Retrieve Speed + SPI/Customer from all *baunumbers* collected in Product Relations
- Using Speed + SPI/Customer + Voltage and Downgrade Numbers (see *Downbinning Table*), create a “local *downbinning table*” of *baunumbers*. Define on the table which speeds correspond to each bin through Splits per Product.
- Test speeds from highest to lowest priority:
 - Test for same speed until fulfilment of forecast for speed in bin1 is complete
 - In bins 2 and 3, downgrade if speed with lower “*downbinning grade*” is lower
 - Speeds with the same priority are fulfilled in proportion to forecast
 - Subtract the fulfilled volume to the forecast to re-run cycle with next speed
- As all speeds with demand are fulfilled it is important to check if any speed exceeded its demand and use that volume as pre production (subtract to next week)
- If after the demand is fulfilled, there is still production to be done (plan>demand), then this volume should be used for pre-production and run the algorithm for the following week’s demand.

Logistical implications

The conclusion that was taken, regarding logistical implications in the production line of implementing the *downbinning* project, is that there will be none. As the *downbinning* algorithm comes in to action, the SPPRs (Splits per product) are performed in BOC EOT LAC (End of Test, Lot Acceptance). When the lots are transferred from Test Gate to MSP Gate, the lot traveller would be printed out (as it always is) with the new necessary information. This way it is expected that there are no real logistical changes when the implementation of the *downbinning* algorithm happens.

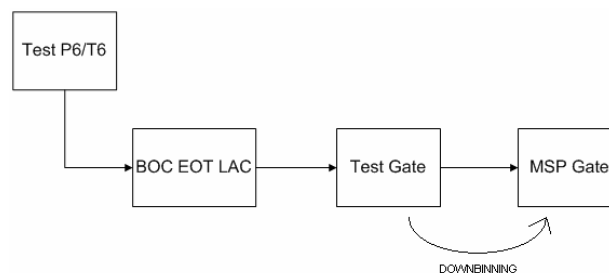


Figure 33 – Test-MSP Flow

5 Conclusions and future improvement opportunities

5.1 Scheduling System Upgrading

The Scheduling System is a very important tool at Qimonda Portugal S. A. because it is used by the operators directly in the production line. For production to be possible, two conditions are necessary: the lot must be at the right step of production physically and in the system. The schedulers take care of the system part, as they are the gate between the buffers and the production of each area. This shows the importance attributed to these tools.

Other than solving the conceptual problems for both *Start Scheduler* and *Bond Scheduler*, this project also allowed the new scheduling interfaces to control the work in progress in the production line. This new functionality not only controls quantities in their respective productive areas, but also in the surrounding buffers. By coming into use, this new solution relieves some human effort that is never precise or accurate enough to be able to control this type of balance. As QPT has a very high complexity in terms of product mix compared to any other backend site, the assurance of control over such unstable factors brings a lot of efficiency to production control and planning.

The *Load Scheduler* comes at a time of product complexity increase to the Test Operations and is a brand new tool with whole new needs. Based on the experience gained from the previous schedulers, this tool contains all the qualities of the previously performed updates to the tool. In terms of scheduling functionalities, the *Load Scheduler* will look a lot more like the “old” *Start* and *Bond Schedulers*. After having the *Load Scheduler* completely operational, the next logical step would be to study the best ways to have this tool control the work in progress in the Test Operations as well as of the *Test Buffer*.

5.2 Downbinning Project

The *Downbinning* Project is still at a very early stage and it is possible that the route that is being taken may change with time. This initial stage shows already some level of detail into how this project should be handled, but does not really allow for any revolutionary changes. This is due to the fact that the complexity of this project limits completely the way that this problem is being taken care of. There is no real other way to look at a problem as rigid as this one.

It is also a fact that, to get to the final solution of this problem, it will require some time. It is necessary to build the central database as well as every single backend *downbinning* interface (for example: Demand Manager at QPT). But since the urgency of this project is extremely high, temporary solutions can be arranged. The *downbinning* algorithm could be adapted to the Demand Manager before even having a database in PGS+ Planning. With this algorithm and an improvised and simpler database that could work for the most important products, it would be possible to execute *downbinning*. This temporary solution could be applied for products with higher volume of production of higher priority. If a temporary solution like this one could be prepared in a time span smaller than the final solution, then it would certainly pay off, for the importance of improving this process is fundamental in reducing unnecessary costs and responding to the market.

6 Bibliography

- Teixeira, António; IFPT Starts & Bond Scheduler – Detailed Specification; 11-03-2006
- <http://eu-intranet.qimonda.com/Porto/en/en/index.htm>
- www.qimonda.com

APPENDIX A: QPT Start & Bond Schedulers Improvement

**QPT_PL
3 Facilities Scheduler
Program Rollout**

**QPT Start & Bond Schedulers
Improvement
Detailed Specification**

Version: V01

Author, Department: Sebastião Andrade (QPT PL)



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1. Purpose of the Document

The purpose of this document is to provide a detailed specification for the improvement of the already existing schedulers: **Start Scheduler** and **Bond Scheduler**.

2. Overview

Both Start and Bond Schedulers have a few conceptual errors that can be corrected in order to improve the quality of the programme's interface with the user. Furthermore, there are other improvement suggestions that will try to improve the scheduling functionalities of this tool.

3. Pre-Requisites

It's assumed that some Context Resolution Manager tables require to be changed. It's also a fact that some changes will still require validation by the final user.

Current complexity force and tool criticality force us to maintain some logic that at the time being could be erased.

This tool is FrontEnd Learning compliant and assures that proper priority is given to these lots.

This tool requires Business Objects reports to assure that line control has a complete picture in terms of WIP availability. These reports are to be developed by the Production engineer of the area and therefore out of scope for this tool.

4. Plan Import

The plan for the Bond Scheduler is done by the Volume Planners (QPT PL PCL) on a Microsoft Excel template where each product is given a quantity of production. After the plan is completed and confirmed, it is loaded onto the Bond Scheduler.

The Start Scheduler production plan is automatically calculated and extrapolated from the Bond Scheduler.

5. Scheduler improvement

For the two already existing scheduling programmes a few problems will be laid out and for those problems a convenient solution will be presented. Furthermore there a few suggestions that have been included in order to increase the quality of the programme.

5.1 Start Scheduler

5.1.1 Multiple lines

Problem:

In the Start Scheduler main window, the second column shows “Package” or “Product Group 3 Description 2”, as show in the picture below. This means that each product will be specified with more information than it is necessary at this stage.

A lot processed at Pre-Assembly can generate different products at Assembly and if “Product Group 3 Description 2” is specified in the Start Scheduler, this will often generate multiple groups (double groups) with the exact same lots and “ToProduct” baunumbers. As it is possible to observe in the following picture, the two groups bordered by a black line are the same except for “Package” and “Plan Week”. Whether the product is going to be VFBGA-60 or VFBGA-90 is only important in the following stage (Assembly). The lots within these groups are exactly the same, explaining the fact that the “Act. WIP” (Actual Work In Progress) is the same for both.

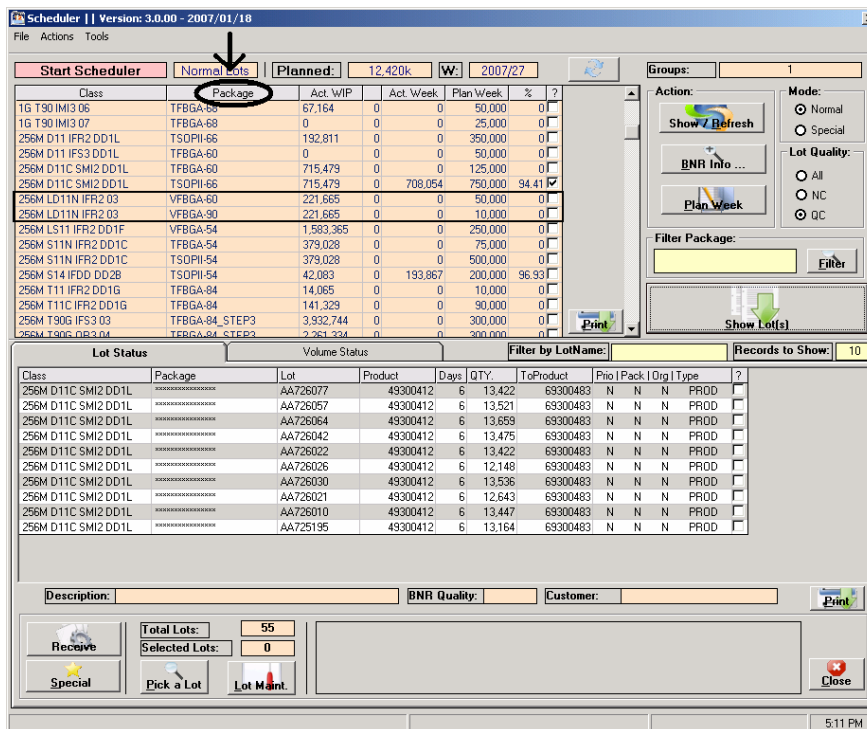


Figure 1 – Double line at Start Scheduler main window

Proposed Solution:

To solve this problem it is necessary to change the “Package” field from “ProductGroup3 Description2” to “ProductGroup3 Description4” that is currently not being used. This measure is not enough because “ProductGroup3 Description4” does not solve the problem entirely since it unites groups that must remain separate. Knowing that this description is not currently in use, it is possible to reformulate it in order to guarantee that all redundancies are eliminated and nothing more than just redundancies.

To reformulate “ProductGroup3 Description4”, the initial idea was to distinguish only which products are TSOP and which are BOC. This would certainly eliminate all redundant groups of lots, but on the other hand would also unite groups of lots that should not be mixed, since they have different processes at Pre-Assembly.

An example of two groups that could be merged is the following:

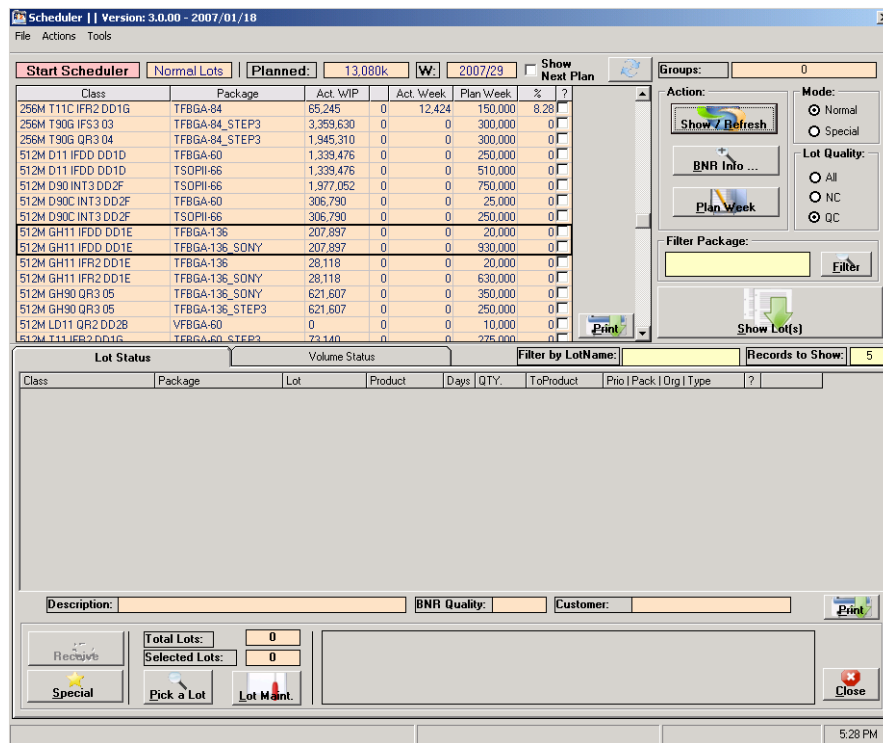


Figure 2 – Double line that can be merged at Start Scheduler main window

In the picture above we can see within the black rectangle ProductGroup1 **512M GH11 IFDD DD1E** with two ProductGroup3: **TFBGA-136** and **TFBGA-136_SONY**. If these two were to be classified as “BOC” and consequently merged, this would be acceptable because the Pre-Assembly process for both these products is the same.

The following example shows us that not always it is possible to make the distinction specified above:

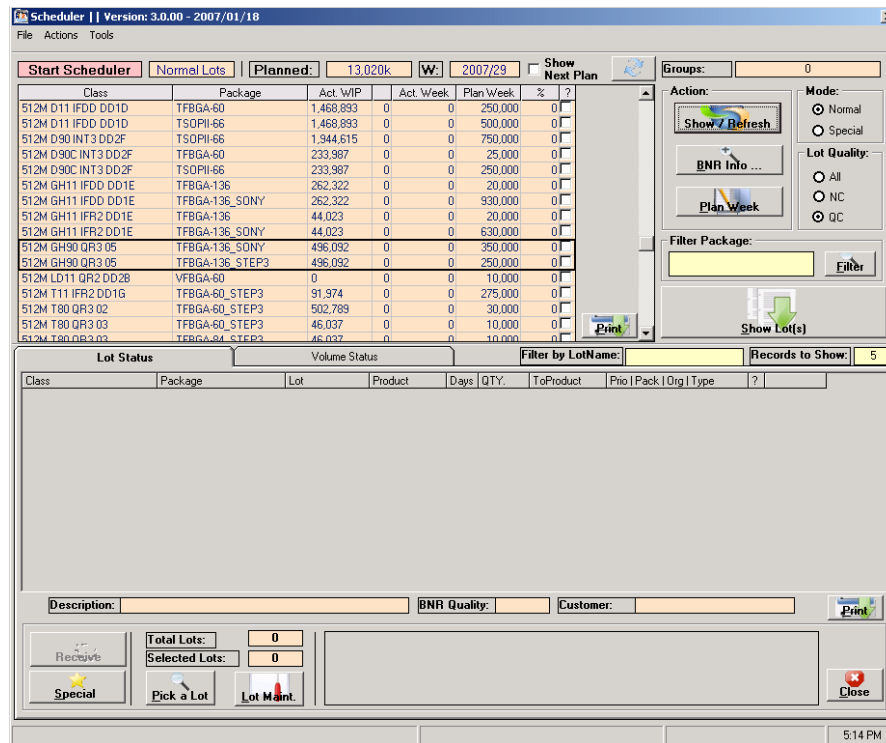


Figure 3 – Double line that cannot be merged at Start Scheduler main window

In the picture above we can see within the black rectangle ProductGroup1 **512M GH90 QR3 05** with two ProductGroup3: **TFBGA-136_SONY** and **TFBGA-136_STEP3**. In this case, if these two products were to be classified as BOC and consequently merged, this would be unacceptable since the Pre-Assembly process for these two products is different. Knowing this, these two groups of lots must not be merged, or else, products with different plans would be laid out in the same FIFO list (Lot Status).

This last example was one of a few exceptions. There are a few exceptions to consider:

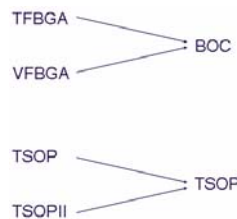
- There are two different “Substrate Types” that imply different processes at Pre-Assembly: **Standard** and **STEP3**.
- In some cases, the number of contacts on the chip also determines the process that the wafer will go through at Pre-Assembly. An example of that would be **256M T11 TFBFGA-60** and **256M T11 TFBFGA-84**.
- When the dies are processed for dual die components, there can be differences between the **TOP DIE** and the **BOTTOM DIE** in some products.
- EMC products such as 512M D90 TSOP have a different wafer test process from the normal version and therefore have a different and separate baunumber structure. As a consequence it is necessary to distinguish this product at Pre-Assembly.

For supervision and line control purposes a few suggestions were made in order to allow the scheduler to work more as a scheduler and make the control of the production on the line more automatic according to a few established rules.

As you can see in the picture below, the future Start Scheduler will take on a structure similar to what it looks like presently but with a few additions in terms of presenting information. This new format will also contain new restrictions that will stabilize the levels of WIP that should exist at each step of the process.

The new "ProductGroup3 Description4" will be specified under the following general rules:

- All **TFBGA** and **VFBGA** will now be **BOC**
- All **TSOP** and **TSOPII** will now be **TSOP**



There are a few exceptions that will take on the following nominations:

- All STEP3 lots must be described as "**BOC_STEP3**"
- All lots destined for dual die components with different processes for top and bottom dies must be defined as "**BOC_TOP**" or "**BOC_BOT**" respectively.
- All lots to which process differences depend on the number of contacts on the chip must be defined under the generic nomination "**BOC_x**" where "x" must be replaced by a number that corresponds to the number of contacts of the component.
- There is also a specific case in which products perform a different wafer testing (Front End) that implies that they have separate baunumber structures and must not be mixed from then onward (in the Backend process which includes Pre-Assembly). This case is for EMC products and is currently specific for 512M D90. In ProductGroup3 Description 4 will be defined as "**TSOP_EM**C".

5.1.2 Supervision control methods – new additions to interface

For supervision and line control purposes a few suggestions were made in order to allow the scheduler to work more as a scheduler and make the control of the production on the line more automatic according to a few established rules.

As you can see in the picture below, the future Start Scheduler will take on a structure similar to what it looks like presently but with a few additions in terms of presenting information. This new format will also contain new restrictions that will stabilize the levels of WIP that should exist at each step of the process.

Figure 4 – New Start Scheduler

The additions to be made to the present Start Scheduler are the following:

- a) There will be two new buttons:
 - TSOP
 - BOC

These buttons work as filters when pressed. The first of the two will show on the main window the products (groups of lots) that have as package “TSOP”. The second button will do the same for products for which the package is/contains “BOC”.

- b) Two new columns will be introduced for production restriction purposes.

Column (a) is deactivated by default, but when the supervisor activates this option, no releases will be permitted until deactivation or until the change of plan (Fridays at 23h00 GMT).

Column (b) is activated by default and will not allow more releases if at least 100% of the plan has been produced. If the supervisor deactivates this restriction, then the operators may release more material until the restriction is reactivated or until the change of plan (Fridays at 23h00 GMT).

c) Another set of columns will be introduced to the interface. This set will be composed by 5 columns:

- **WTD** (work to date)
- **Out**
- **Δ**
- **% Out/WTD**
- **% Out/Plan**

The “**WTD**” column represents the theoretical *Volume Out* until that moment. This value corresponds to the portion of the plan that should have been completed by then, admitting that the production will be evenly distributed throughout the week.

This way, a minute-by-minute update can be done. Knowing that a week has 10 080 minutes, the WTD at each point should be:

$$WTD = plan \times \frac{ElapsedTime(min)}{10080}$$

The “**Out**” column represents the amount of production completed in that week. (This column already exists)

The “**Δ**” represents the difference between the two previous columns:

$$\Delta = Out - WTD$$

The “**% Out/WTD**” column represents the percentage of production completed against the WTD:

$$\% = \frac{Out}{WTD} \times 100$$

The “**% Out/Plan**” column represents the percentage of production completed against the weekly Plan:

$$\% = \frac{Out}{Plan} \times 100$$

d) In order to control the quantity of material that can be started at each moment a set of columns will be introduced. These columns are:

- **Target ABF**
- **Adjust %**
- **WIP ABF**
- **%ABF**
- **Δ**
- **WIP PA**
- **Starts**

The column “**Target ABF**” (Target Inventory for Assembly Buffer) shows the ideal quantity of material of each product that there should be in the Assembly Buffer. The calculation is the following:

If **Plan** ≤ 100.000 then **Target** = 15.000*Adjust%

If 100.000 < **Plan** ≤ 450.000 then **Target** = 30.000*Adjust%

If 450.000 < **Plan** ≤ 650.000 then **Target** = 40.000*Adjust%

If **Plan** > 650.000 then **Target** = (Plan/7)*0,35*Adjust%

The column “**Adjust %**” represents the percentage of the plan that we want to produce. This column allows the supervisor or the line controller to manage the start restrictions. The average of all the values in this column must be 100%.

The column “**WIP ABF**” shows the amount of material present in the Assembly Buffer.

The column “**% ABF**” shows the percentage of WIP ABF against the Target ABF:

$$\%ABF = \frac{WIP_ABF}{Target_ABF} \times 100$$

The column “**Δ**” shows the difference between the WIP and the Target for the Assembly Buffer

$$\Delta = Target_ABF - WIP_ABF$$

The column “**WIP PA**” shows the amount of Work In Progress in the Pre-Assembly area.

The column “**Starts**” shows the amount of starts that the operators are allowed to do based on the following calculations:

If **(-Δ-WIP PA)>0** then **Starts=(-Δ-WIP PA)**
Else **Starts=0**

e) The already existent “**Prio**” column will now operate under different rules. The rules shall be the following:

- The higher the value, the higher the priority
- Priorities for TSOP and BOC are independent (they do not compete)
- Priorities for 200mm and 300mm wafers are independent
- Priorities if WIP > 0 in DBPO:
 - Highest priority must be allocated to product with lowest %ABF
 - For products with equal %ABF, highest priority goes to product with lower plan

f) Finally, in the “Lot Status” section of the interface, there will another two columns that will indicate for each lot, in what **Kardex** the lots is in and in which **Bin** inside that Kardex. This information before was only available in the SAP programme, but the idea is to make this information available without having to have two programmes open.

5.2 Bond Scheduler

5.2.1 PREASSY Dual Die Planning

Problem:

Dual Die products that have different processes at Pre-Assembly for top and bottom dies will cause problems to the schedulers due to baunumber relations.

In terms of **Pre-Assembly**, there will have to be different plan entries for each one of top and bottom dies because the process is different due to the wafer thickness. This way, it is necessary the existence of separate baunumbers and in terms of Start Scheduler a different ProductGroup3.

In terms of **Assembly**, it is imperative that there is only one plan because for each dual die chip there must be one and one only top chip and the same for bottom chips. It is important to assure that the move in of lots is controlled by the scheduler. Because the bottom chip has to be moved-in first (since it comes first in the assembly of the chips), the only plan due to appear on the Bond Scheduler will be “*BOC_BOT*”.

The following diagram shows how, in theory, the process of assembling a dual-die chip should be in the production line:

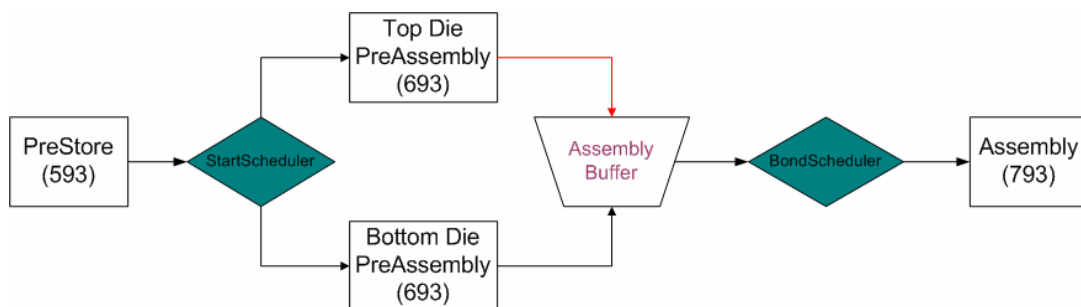


Figure 5 – Dual Die Chips Process Flow Problem

As this is not possible, a solution must be found. Knowing that the bottom chip is the one to be pulled along the whole process, the difficult part is to “re-unite” the top chip in the Assembly-Test transition.

Proposed Solution:

In order to avoid that top and bottom dual die chip baunumbers do not get mixed inside the same buffer, the solution found is to forward all top chips into a separate virtual buffer, that will release the top chips as the bottom chips are released in the actual buffer (that serves the Bond Scheduler). This way, besides solving the problem, this solution is prepared for the next logical evolutionary step that is multi die chips with more than two dies.

The following diagram, illustrates the course that each die takes in the system:

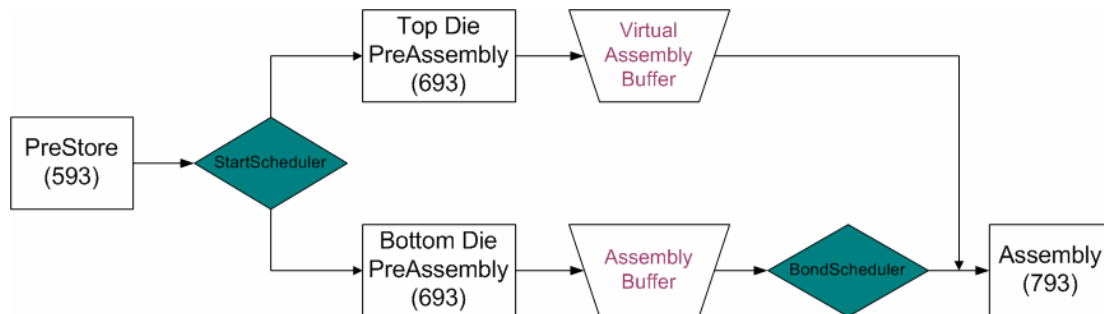


Figure 6 – Dual Die Chips Process Flow Solution

5.2.2 Name change in organization column

Taking into consideration the imminent creation of a new scheduler for the Burn-In Area, for coherence reasons, it is necessary to change the *ProductGroup3 Description3* column under *Lot Status* from “**Org. & Qual.**” to just “**Org.**”. This change would allow the new *ProductGroup3 Description5* column that will take part in the Burn-In Loader to be called “**Qual.**”

5.2.3 Supervision control methods – new additions to interface

The same way that a few additions were made to the Start Scheduler, the same will be done to the new Bond Scheduler.

As you can see in the picture below, the future Bond Scheduler will take on a structure similar to what it looks like presently but with a few additions in terms of presenting information. This new format will also contain new restrictions that will stabilize the levels of WIP that should exist at each step of the process.

Scheduler System Upgrading & Downbinning Project

Figure 7 – New Bond Scheduler

a) There will be two new buttons:

- TSOP
- BOC

These buttons work as filters when pressed. The first of the two will show on the main window the products (groups of lots) that have as package “TSOP”. The second button will do the same for products for which the package is/contains “BOC”.

b) Two new columns will be introduced for production restriction purposes.

Column (a) is deactivated by default, but when the supervisor activates this option, no releases will be permitted until deactivation or until the change of plan (Fridays at 23h00 GMT).

Column (b) is activated by default and will not allow more releases if at least 100% of the plan has been produced. If the supervisor deactivates this restriction, then the operators may release more material until the restriction is reactivated or until the change of plan (Fridays at 23h00 GMT).

c) Another set of columns will be introduced to the interface. This set will be composed by 5 columns:

- **WTD** (work to date)
- **Out**
- **Δ**
- **% Out/WTD**
- **% Out/Plan**

The “**WTD**” column represents the theoretical *Volume Out* until that moment. This value corresponds to the portion of the plan that should have been completed by then, admitting that the production will be evenly distributed throughout the week.

This way, a minute-by-minute update can be done. Knowing that a week has 10 080 minutes, the WTD at each point should be:

$$WTD = plan \times \frac{ElapsedTime(min)}{10080}$$

The “**Out**” column represents the amount of production completed in that week. (This column already exists)

The “**Δ**” represents the difference between the two previous columns:

$$\Delta = Out - WTD$$

The “**% Out/WTD**” column represents the percentage of production completed against the WTD:

$$\% = \frac{Out}{WTD} \times 100$$

The “**% Out/Plan**” column represents the percentage of production completed against the weekly Plan:

$$\% = \frac{Out}{Plan} \times 100$$

d) In order to control the quantity of material that can be started at each moment a set of columns will be introduced. These columns are:

- **Target Bond**
- **Adjust %**
- **WIP Bond**
- **Δ**
- **Status**

The column “**Target Bond**” (Target Inventory in the Bond area) shows the ideal quantity of material of each product that there should be in the Bond production area. The calculation is done based on the PL WIP rules. This calculation takes into account the planned volume and the product’s cycle time.

The column “**Adjust %**” represents the percentage of the plan that we want to produce. This column allows the supervisor or the line controller to manage the start restrictions. The average of all the values in this column must be 100%.

The column “**WIP Bond**” shows the amount of material present in the Bond production area.

The column “**Δ**” shows the difference between the WIP and the Target for the Bond area:

$$\Delta = Target_ABF - WIP_ABF$$

The column “**Status**” will show comments on how the WIP in Bond presents itself compared to the target. This way, the comments will be:

- “**Low**” – If **WIP BOND < TargetBOND*0.9**
- “**OK**” – If **TargetBOND*0.9 ≤ WIP BOND ≤ TargetBOND*1.1**
- “**High**” – If **WIP BOND > TargetBOND*1.1**

There should also be a colour coding for easier and quicker comprehension of the Status of each product.

6. Appendix 1 – List of Abbreviations

ABF	Assembly Buffer
BO	Business Objects
BOC	Board on Chip
CRM	Context Resolution Manager
FE	Front End
FIFO	First In First Out
GMT	Greenwich Mean Time
PA	Pre-Assembly
PCL	Production Control and Logistics
PL	Planning and Logistics department
PREASSY	Pre-Assembly
QPT	Qimonda Portugal
TFBGA	Thin & Fine-Pitch Ball Grid Array
TSOP	Thin Small Outline Package
VFBGA	Very Fine-Pitch Ball Grid Array
WIP	Work In Progress
WTD	Theoretical Work To Date

APPENDIX B: QPT Load Scheduler

**QPT_PL
3 Facilities Scheduler
Program Rollout**

**QPT Load Scheduler
Detailed Specification**

Version: V01

Author, Department: Sebastião Andrade (QPT PL)



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1. Purpose of the Document

The purpose of this document is to provide a detailed specification for the implementation of the new to-be scheduler with the 3 facilities at Porto.

2. Overview

As a consequence of the changes in the productive process in Burn In, it is necessary to create a programme that executes the same functions as the two previously created Schedulers. These functions are: to assist the user in the choice of the next lot to be moved in and processed; and to automatically adjust the baunumber from End Of Line to the correct baunumber in Burn In.

3. Pre-Requisites

It's assumed that some CRM tables require to be changed. It's also a fact that some changes will still require validation by the final user.

Current complexity force and tool criticality force us to maintain some logic that at the time being could be erased.

This tool is FE Learning compliant and assures that proper priority is given to these lots.

This tool requires BO reports to assure that line control has a complete picture in terms of WIP availability. These reports are to be developed by the Production engineer of the area and therefore out of scope for this tool.

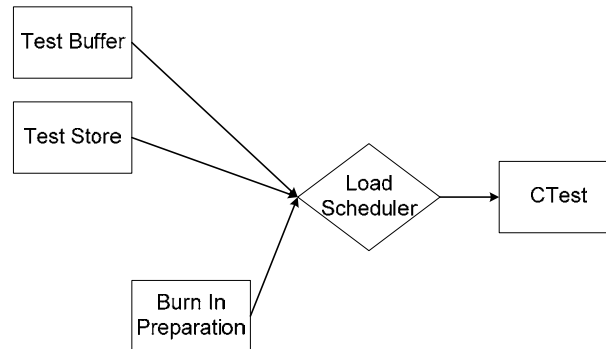
As a direct consequence of the 3 facilities implementation in Porto (CPPO, CAPO, CTPO) the process installed at Backend to allow downgrades at Pre-Assembly and Assembly is currently being reviewed. It's assumed that the effective downgrade to NC baunumbers should be performed by the Load Scheduler at the start of the Test Operations Area. (Effective downgrade means baunumber adjustment from QC to NC)

This document is based on the premises that the document "**Start&Bond_Schedulers_QPT**" was taken into consideration and is directly connected to it:

I:\PL\Reporting\PCL\Projects\Scheduler @ B\Scheduler docs\Start&Bond\Start&Bond_Schedulers_QPT.doc

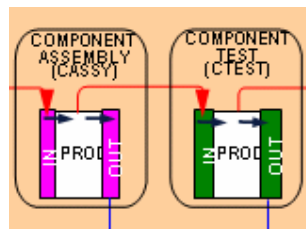
4. Load Scheduler

Load scheduler takes care of defining for each assembled component lot which BNR shall be used at Test Operations, taking in consideration the demand and product availability.



Picture 1 – Load Scheduler function

The lots are stored at two main areas (TestBuffer and TestStore) as they arrive from Component Assembly:



Picture 2 – USCM

4.1. Production Demand

Demand is defined by the Planning and Logistics department and it is the materialization of the SPL/MPL/FPL plan received and agreed upon each month/week with MCH.

Currently the plan is loaded on the Bond Scheduler for FOL by the Volume Planner and from there the plan for PREASSY is extrapolated. To obtain the plan for Test Operations, it will now be necessary to load a separate and different plan.

4.2. Production Requisites

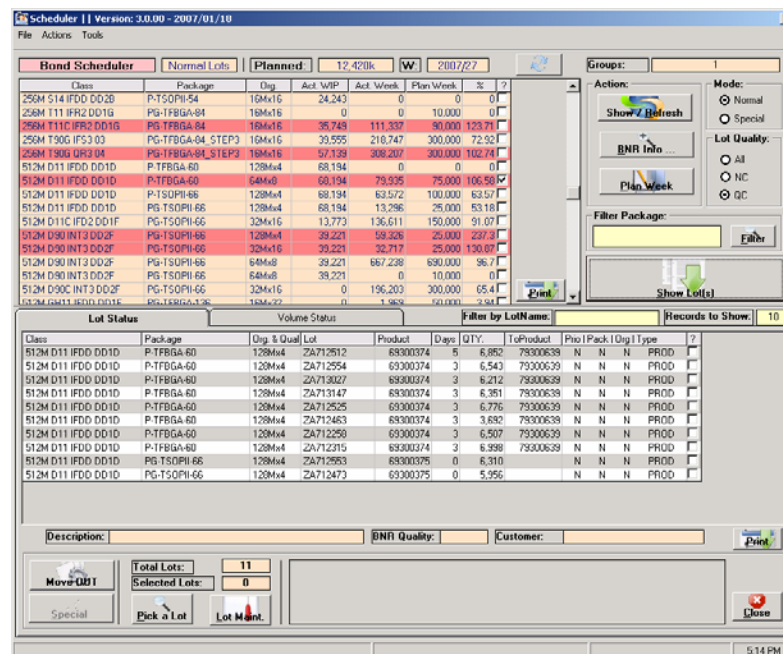
The programme must not allow “move out” from the buffer when the production has already reached or passed 110% of the plan for that same week. Further production must only be possible under the login of the supervisor.

5. Load Scheduler logic

5.1. Main window model

5.1.1 Main interface

The Load Scheduler must be as close as possible structure-wise to the previous schedulers. This way, the programming won't use up too much time and the required training will not come as something new. Taking these facts into account, the Load Scheduler's main window should take on, for instance, the Bond Scheduler's as a model.



Picture 3 – (Bond Scheduler main window)

The first window needs to change so it can provide the following information (additions in blue):

Group1 Description	Group3 description2	Group3 description3	Group3 description5	Actual WIP	BUI Prep WIP	Planned WIP	Actual Week	Plan Week
This shall be taken from the field description on CRM MFG.Types. Key is Group1 (Type)	This shall be taken from the field description2 on CRM MFG.PackageNames. Key is Group3 (PackageName) (e.g. PG-TFBGA-54)	This shall be taken from the field description3 on CRM MFG.PackageNames. Key is Group3 (PackageName) (e.g. 16Mx16)	This shall be taken from the field description5 on CRM MFG.PackageNames. Key is Group3 (PackageName) (to be defined)	Get WIP where ML = CTEST and PCA= PROD	Get WIP where ML = CTEST and PCA = PROD and STEP = Burn In Preparation	Currently not in use	For the given week this shall be the Moveln at Step receiving (Mimoso?)	As defined above in the section demand

In terms of "Lot Status", it is necessary to add the following fields between "Org." and "Lot" (additions in blue):

Qual.	Downgrade
This shall be taken from the field description5 on CRM MFG.PackageNames. Key is Group3 (PackageName) (to be defined)	if ToBeDowngraded = "Y", then Downgrade = "NC"

In terms of "Volume Status" there are no changes to point out when comparing with the other schedulers.

5.1.2 Product Group 3 Description 5

Product Group 3 Description 5 will be a new description created for PG3 that determines what products with the same *Class*, *Package* and *Organization* take different routes in Burn In. This description will take on the name "Quality" in the Load Scheduler. Furthermore, this fifth description will have 2 different classifications. These classifications are:

- **Standard** - Quality conformity/Non-Conformity (QC/NC)
- **WB** - White Box

NC lots, within *Standard*, will become a possibility in PG3 after the downgrading process is transferred from both Pre-Assembly and Assembly to Burn In exclusively. The lots will always be considered to be QC until the contrary is indicated. The indication of a lot being downgraded to NC will be given by a lot attribute "ToBeDowngraded" and will appear in a field called "Downgrade" at "Lot Status".

5.1.3 NC Products

With the restructuring of the downgrade logic at Pre-Assembly and Assembly, lots downgraded at these areas follow production with the correspondent QC BNRs and are downgraded upon the Auto Receive Lot at CTEST.

In order to support this process, the Load Scheduler should perform the following actions:

- Upon an arrival to CTEST
 - If the lot att ToBeDowngraded is equal to 'Y' then
 1. Access the current BNR PG1/PG3
 2. Access the CRM DownGradeRule and retrieve the correspondent NCT bnr (993xxxx) correspondent to the PG1/PG3 of the actual BNR
 3. Downgrade the lot to the correspondent NCT bnr (993xxxx).
 4. Set the lot att ToBeDowngraded = 'N'
 5. Remove the LotRestriction = 'NC'
 6. Print a MsgBox in OWS with the following message: "The lot " & lot number " was downgraded to " & correspondent NCT bnr

5.1.4 Burn In Preparation Interface

A necessary addition to the previously established scheduler main window models is that the Load Scheduler should open a separate window that shows lots in *Burn In Preparation* when pressing “Move OUT”. This window should be only available if “Burn In Prep WIP” does not equal zero and a lot is selected in the scheduler main window under Lot Status (in Test Buffer or Test Store).

If only the second condition is met, then “Move OUT” should be done automatically.

If the second condition is not met, nothing should happen, other than the appearance of a message box that warns the user of this fact.

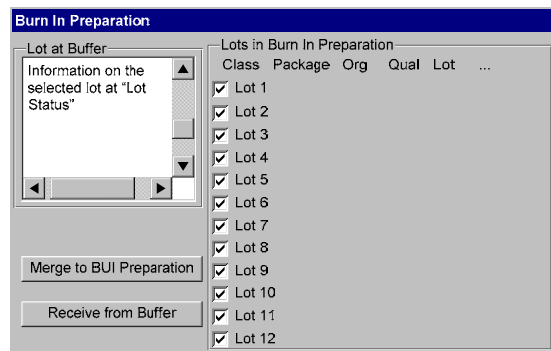
As the “Burn In Preparation Interface” is opened, it should show the data for both the selected lot and for all the lots in *Burn In Preparation* that can be merged with the initially selected lot. Beside each lot at *Burn In Preparation* there should be a “check box” that allows the selection of that lot for merging purposes.

The lots in the “Burn In Preparation Interface” must be able to merge with the selected lot at lot status. For that to happen, it is necessary to apply the rules found in the OWS for merging purposes.

In addition to this information, the “Burn In Preparation window” should have two buttons:

- Merge to Burn In Preparation: This button merges the lot from *Lot Status* with the lots checked at *Burn In Preparation* and does *Move OUT*.
- Receive from Buffer: Simply does *Move OUT* to the lot from *Lot Status* as it is (with no merging with any other lots from *Burn In Preparation*).

The “Burn In Preparation Interface” should have a formatting similar to the following picture:



Picture 4 – Burn In Preparation Interface model example

5.1.5 Lot attributes

In addition, for lot merging purposes, the exposed lots should contain “lot attribute” information. Since all the attributes a lot can have are too many and would make the Scheduler too heavy, the only attributes to be used are the ones that provide useful information within groups of lots that can be merged.

To provide “lot attributes” information, a colour code should be used on the interface.

Note: The lot attributes to be used and the colour coding have not yet been defined and will later be added on another specification.

5.2. Filter Logic

Filter logic shall be kept because it will be required for future enhancements in the tool.

5.3. Lot Status logic

Demand is set on Group1 and Group3.

First step is to take the WIP available (LS_WIP_Available) to be started

- Steps (TestBuffer, TestStore)
- Lot conditions
 - o HOLD Flag = "N"
 - o MoveIn Flag = "Y"
 - o Owner =(PROD, ENTW)
 - o Attribute OrganisationalIndicator =""
 - o Attribute Package = ""
 - o Priority <> "4"
- Criteria for lot sorting (ordered by priority)
 - o Priority = "3"
 - o BackEndPerformanceValueNo5 <>"0"
 - o FIFO (First in first out)

When the check box Show and the button "SortLots" is clicked upon the following shall happen

- Check which Group1-Group3 the operator desires to start
- Get from LS_WIP_Available all the products with the same Group1-Group3(TB_PRODUCT)
- Retrieve from CRM ProductSupplyRelationships the To products defining as key:
 - o FromProduct="TB_PRODUCT"
 - o ToFacility = "CTPO"
- Match the retrieved products (TEST_PRODUCTS) Group3 Description2 against the demand, defining what shall be the Product in CTPO

Finally, 3 lots shall be shown. If 3 lots are not available then show 2. If 2 lots are not available then show 1. Finally if no lot available then message "There's no WIP available to be started"

5.4. Special Lots logic

When “Special lots” is selected then the same window with the corresponding lots shall be opened.

Take the WIP available (LS_Special_WIP_Available) to be started

- Steps (TestBuffer, TestStore)
- Lot conditions
 - o HOLD Flag = “N”
 - o MoveIn Flag = “Y”
 - o Attribute OrganisationalIndicator <>”” or Attribute Package <>””
- Criteria for lot sorting (ordered by priority)
 - o Priority = “4”
 - o OrganisationalIndicator <>””
 - o Package <>””

When the CheckBox is selected then lot the lot shall be started

The CTPO BNR is determined by the operator: A combo box with all the CTPO BNRS linked actual lot Product shall be shown. This list of products can be retrieved by Retrieve from CRM ProductSupplyRelationships defining as key:

- FromProduct=“TB_PRODUCT”
- ToFacility = “CTPO”

Lots shall be started independently of existing or not demand

5.5. How to account Actual Week

Volume of Actual Week shall be accounted whenever the lot arrives at step (Test P1; BurnInPrep)

Actual Week = SUM of Qty if Owner = (PROD; EVAL; ENTW) where [New Step <> Old Step and New Step = (TestP1; BurnInPreparation) and Old Step = (TestBuffer; TestStore)]

6. Appendix 1 – List of Abbreviations

BNR	Baunumber
BO	Business Objects
CPREASSY	Components Pre-Assembly
CRM	Context Resolution Manager
CTPO	Components Test Porto
ENTW	Non-Qualified Engineering Lots
EVAL	Evaluation Engineering Lots
FE	Front End
FIFO	First In First Out
FOL	Front Of Line
FPL	Factory Planning
LS	Load Scheduler
MCH	München (Headquarters)
MFG	Manufacturing
ML	Manufacturing Level
MPL	Master Planning
OWS	Operator Work Space
PCA	Process Chain Area
PCL	Production Control and Logistics
PG1	Product Group 1
PG3	Product Group 3
PL	Planning and Logistics
PREASSY	Pre-Assembly
PROD	Production
QPT	Qimonda Portugal
SPL	Supply Planning
TB	Test Buffer
UDA	User Defined Attributes
USCM	Unified Supply Chain Model
WIP	Work In Progress

APPENDIX C: QPT *Downbinning* Table

**QPT_PL
Test Downgrading
Program Rollout**

**QPT Downbinning Table
Detailed Specification**

Version: V01

Author, Department: Sebastião Andrade (QPT PL)



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1. Purpose of the Document

The purpose of this document is to define the utility and format of “Downbinning tables” and their advantages in the process of grading products.

2. Overview

“Downbinning tables” will be an instrument that will assist production controllers in the attribution of the products to the ideal speed according to the demand for each speed.

This type of information will be presented under the shape of a matrix that will show which downgrades are possible.

3. Pre-Requisites

It is considered that systematic maintenance will be required to update variable data such as speed shares and also other information directly connected to each product.

4. Downbinning

4.1. Downbinning table concept

A Downbinning table will be in fact a matrix that shows for each speed within a product, what speeds can be generated by each test programme.

The downbinning table key is the following:

- Generation
- Shrink
- Package
- Organization
- Design

Each different combination of the parameters mentioned above will have its own table.

Other than this information, it is also important to keep in the PGS+ Planning database the following aspects regarding each speed within the table:

- ❖ Power
- ❖ Voltage
- ❖ BE Grade
- ❖ Temperature
- ❖ Customer

4.2. Downbinning tables

The following table shows an example of a downbinning table:

GH11	1.2	1.4 SONY	1.3	1.4 NIN	1.4	1.4-1.8V	1.6-1.8V	2.0
1.2	Bin1 4	2		Bin2 3				Bin3 1
1.4 SONY		Bin1 2						Bin3 1
1.3			Bin1 2					Bin3 1
1.4 NIN		Bin2 2		Bin1 3				Bin3 1
1.4					Bin1 2			Bin3 1
1.4-1.8V						Bin1 2		Bin3 1
1.6-1.8V							Bin1 2	Bin3 1
2								Bin3 1

Table 1 – Downbinning table

Consulting this matrix horizontally, it is possible to see which other speeds are generated by each speed programme. The filled cells represent the speeds that can be generated. A speed programme is always named by the speed placed in **bin1** and this speed is always the fastest within that test.

Each filled cell will inform what bin it corresponds to, if it corresponds to a bin at all. Apart from this, each filled cell will have a number that will automatically show the order of downgrades. A speed can only downgrade to another speed with a lower **downgrade number**. These numbers are independent from speed test to speed test (line to line).

5. Appendix A – List of Abbreviations

BE	Backend
BO	Business Objects
CRM	Context Resolution Manager
WIP	Work In Progress

APPENDIX D: QPT *Downbinning* Project Logic

**QPT_PL
Test Downgrading
Program Rollout**

**QPT Downbinning Project Logic
Detailed Specification**

Version: V01

Author, Department: Sebastião Andrade (QPT PL PCL)



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1. Purpose of the Document

The purpose of this document is to describe the Downbinning logic by specifying a *Downbinning Algorithm* and all the changes made to the proper interfaces.

2. Overview

Because there are uncontrollable factors in the testing process, such as speed shares, components speeds often do not turn out as desired (client demand). This way, the only type of manipulation that can be made is to downgrade components to lower speeds in order to meet the demands and execute the production plan accordingly.

Since manual downbinning requires an enormous human effort, it is far easier and faster to have an algorithm to execute the same job.

3. Downbinning concept

Downbinning is the act of optimizing the allocation of different speeds to the demand by downgrading components from faster to slower speeds.

This method will have to be introduced into “PGS+ Planning” as well as Demand Manager (@QPT), a software that already performs the allocation of components to different speeds.

4. Downbinning logic

4.1. Requisites

- It will be necessary to perform a few changes to **PGS+ Planning** so that it can host the downbinning procedures and logic.
- It will also be necessary to perform the necessary changes to the **Demand Manager** interface so that the relevant downbinning information is available.
- There are necessary production line logistic changes to be made to complement system procedures and logic.
- The upkeeping all the information once the system is implemented will be of the responsibility of the **Frontend sites (Project Managers and Product Managers)**.

4.2. Logical sequence

- The key is: **Generation – Shrink – Package – Organization – Design**
- Information to upkeep: **Speed – Power – Voltage – BE Grade – Temperature – SPI/Customer**

The algorithm would perform the following steps:

- Collect speeds that have **demand > 0** and correspondent **priorities**.
- Creation of a “QPT baunumber downbinning table”
 - Collect baunumbers from *Splits per Product*
 - Collect baunumbers from *Product Relations*
 - Retrieve *Speed + SPI/Customer* from all baunumbers collected in *Product Relations*
 - Using *Speed + SPI/Customer + Voltage* and *Downgrade Numbers* (see Downbinning Table), create a “local downbinning table” of baunumbers. Define on the table which speeds correspond to each bin through *Splits per Product*.

- Test speeds from highest to lowest priority:
 - Test for same speed until fulfilment of forecast for speed in bin1 is complete
 - In bins 2 and 3, downgrade if speed with lower “downbinning grade” is lower
 - Speeds with the same priority are fulfilled in proportion to forecast
 - Subtract the fulfilled volume to the forecast to re-run cycle with next speed
- As all speeds with demand are fulfilled it is important to check if any speed exceeded its demand and use that volume as pre production (subtract to next week)
- If after the demand is fulfilled, there is still production to be done (plan>demand), then this volume should be used for pre-production and run the algorithm for the following week’s demand.

5. Interfaces

To be able to execute downbinning, it is necessary to keep information on a local and on a central level. For this to be possible there will be a central database that will serve all sites with all the necessary information regarding downbinning: **PSG+ Planning**. There must also be a local database that performs downbinning. Particularly in QPT, this programme is **Demand Manager**.

5.1. PGS+ Planning

PGS+ Planning is an option within the PGS+ programme that gives access to a big database that provides very accurate information on products that serves the whole of the Qimonda sites.

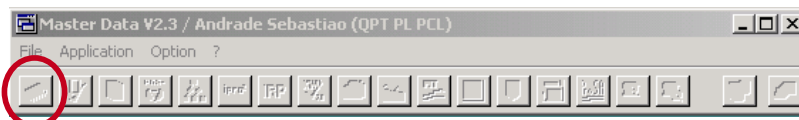


Figure 1 – PGS+ initial interface

This option can now be used to store all relevant information regarding high speed testing for every product manufactured by Qimonda AG.

The downbinning database will provide information in the shape of a table that shows which downgrades are possible for each speed. This table will be specified in the file “**Downbinning_Table_QPT**”.

5.2. Demand Manager

This interface, more specifically Speed Manager, provides information on quantities of tested components as the destinations of shipments and correspondent priorities. The downbinning project will not imply any changes to the interface as it is presented to the user:

Scheduler System Upgrading & Downbinning Project

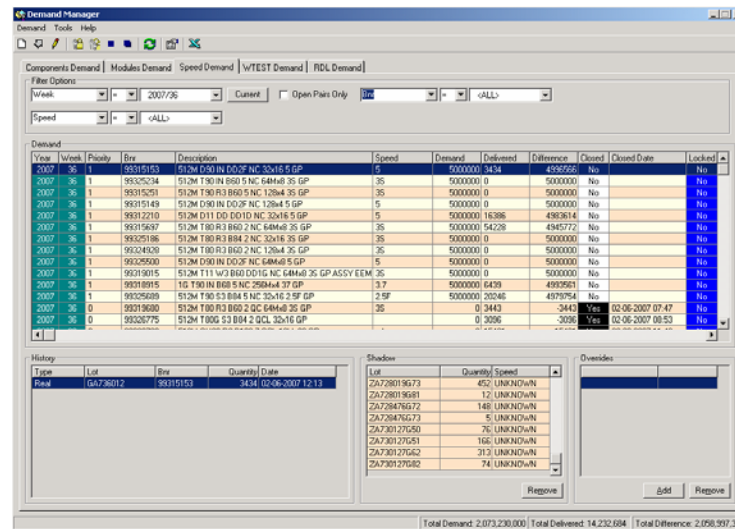


Figure 2 – Demand Manager interface

The whole logic behind the Demand Manager programme is the only thing that changes as it performs the whole downbinning process at a baunumber level.

6. Logistical implications

In terms of logistical implications in the production line, there will be none. As the downbinning algorithm comes in to action, the SPPRs are performed in BOC EOT LAC. When the lots are transferred from Test Gate to MSP Gate, the lot traveller would be printed out (as it always is) with the new necessary information. This way it is expected that there are no real logistical changes when the implementation of the downbinning algorithm happens.

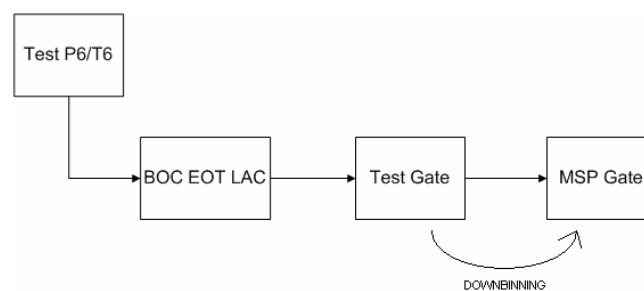


Figure 3 – Test-MSP Flow

7. Appendix A – List of Abbreviations

BE	Backend
BO	Business Objects
CRM	Context Resolution Manager
WIP	Work in Progress
RAP-UI	Requests and Promises – User Interface

APPENDIX E: QPT *Downbinning* Proposal

QPT Downbinning Proposal

August 2nd, 2007

Sebastião Andrade



What is “Downbinning”?



- In high speed testing, components can be classified for different qualities (speeds), being placed into a specific bin according to their frequency.
- Each component can be marked as the speed of the bin into which it fell or any other speed below that one of that same high speed test. In some cases, components can be marked as other speeds besides the ones mentioned.
- Because demand for each speed can be very different to the speed shares of a product, downbinning can make production meet demand.

Demand management procedures @ QPT



According to the weekly plan and the demand proposed by MCH, backend sites needs to define for each product the following:

- For what speeds they should be tested (according to the sort table)
- To what destinations they should be shipped
- Priorities for both speeds and destinations

Demand management difficulties @ QPT

When you want to downgrade a product, it is necessary to:

- Put lots on hold or place future holds
- In the short run for isolated cases, one has to change the baunumber manually
- In the long run, it is necessary to rework baunumber structures to change binning programmes on testers.

All this implies:

- Big human effort
- Wasted time for manpower and machinery
- Increased cycle times

Example – 512M GH11

TFBGA136 512M GH11 STANDARD SORT = 2.0 ns (DDR3 1000)					
2.0ns (DDR3 1000)					
1.2ns (DDR3 1600)	-14B3IR		1.4ns Nintendo (DDR3 1400)	2.0ns (DDR3 1000)	
1.4ns SONY (DDR3 1400)	- SONYIR			2.0ns (DDR3 1000)	
1.3ns (DDR3 1500)	- MSIR			2.0ns (DDR3 1000)	
1.4ns Nintendo (DDR3 1400)	-14BSIR		1.4ns SONY (DDR3 1400)	2.0ns (DDR3 1000)	
1.4ns (DDR3 1400)	- MSIR			2.0ns (DDR3 1000)	
1.4ns, 1.8V (DDR3 1400)	-14NBIR		1.4ns (DDR3 1400)	2.0ns (DDR3 1000)	
1.6ns, 1.8V (DDR3 1250)	-16NBIR			2.0ns (DDR3 1000)	

If we have demand for -1.2 and -1.4 SONY, we might want to test for -1.2 and then downgrade.

Main Goals

- Create an automatic downgrading procedure that can:
 - Make production and demand meet more easily
 - Relieve human effort and prevent unnecessary time wasting
 - Have an updated central database with all the necessary information
 - Have a software (at each Backend) linked to that database that executes downbinning

Central Database

- Centrally:
 - PGS+ Planning



- In this Database, the information kept would show all the possibilities of speed downgrades for each type of product

- This information could be kept in the form of a table (matrix)

Downbinning Table

GH11	1.2	1.4 SONY	1.3	1.4 NN	1.4	1.4 1Bv	1.6 1Bv	2.0
1.2	Bin1 4	2		Bin2 3				Bin3 1
1.4 SONY		Bin1 2						Bin3 1
1.3			Bin1 2					Bin3 1
1.4 NN		Bin2 2		Bin1 3				Bin3 1
1.4					Bin1 2			Bin3 1
1.4 1Bv						Bin1 2		Bin3 1
1.6 1Bv							Bin1 2	Bin3 1
2								Bin3 1

Example - 512M GH11 downbinning table

Key & Speed information

Key information for each table:

- Generation
- Shrink
- Package
- Organization
- Design

- Every combination of these characteristics will generate a table with several test speeds.

Information to Upkeep (for each speed of the table):

- Power
- Voltage
- BE Grade
- Temperature
- Customer

Upkeep responsibilities



Front End Sites:

- Project Managers: introduce data for new products
- Product Managers: introduce updates for current products

Local Softwares



Each Backend should develop an algorithm that will be able to downgrade components to other speeds without having to affect the production in previously mentioned ways.

At Qimonda Portugal, downbinning would be inserted into “Demand Manager”, a software already used to define demand for speeds and destinations as well as priorities for each:

- Porto: Demand Manager
- Suzhou: ?
- Dresden: ?



Other advantages of downbinning



- This database should be able to store information on NC components
- This method can also allow downbinning from QC to NC lots, mainly when there is no demand for standard speeds.
- This database can also include useful information on testing programmes and recipes.

Thank you

**The World's Leading
Creative Memory Company**



APPENDIX F: Product Group 3 Creation Rules

X1	T	DDR2
	N ou M	SDR TSOP
	D	DDR1 TSOP
	B	DDR1 ou SDR BOC
	L	GSD Low Power
	W	Wafer
	H	Graphic DRAMs
	F	???

X2	0	QC
	C	NC-T
	R	SR
	S	FE NC
	Q	QC2
	V	QC-C
	F	QC-F
	L	QC-L
	E	FE QC-L
	H	High Power
	W	WHITEBOX

X3	Dx4xx	128M D11 TSOP HG
	Dx5xx	256M D11 TSOP HG
	Dx6xx	256M D11 TSOP
	Dx7xx	512M D80 TSOP
	Dx8xx	512M D11 TSOP
	Dx9xx	512M D90 TSOP
	Dx10xx	256M GD11 TSOP
	Bx1xx	256M S11N BOC
	Bx2xx	128M S11N BOC

Bx5xx	256M D11 BOC HG
Bx6xx	256M D11 BOC
Bx7xx	512M D80 BOC
Bx8xx	512M D11 BOC
Bx9xx	512M D90 BOC
Bx10xx	256M GD11 BOC
Mx2xx	128M S17 TSOP
Nx1xx	256M S11N TSOP
Nx2xx	128M S11N TSOP
Nx3xx	256M S11N TSOP HG
Nx6xx	256M S14 TSOP
Nx7xx	512M S14 TSOP
Tx1xx	512M T11 BOC
Tx2xx	256M T11 BOC
Tx3xx	1G T11 BOC
Tx4xx	256M GT11M BOC
Tx5xx	512M T90 BOC
Tx6xx	512M GH11 BOC (OLD)
Tx7xx	512M GT90M BOC
Tx8xx	512M T11 BOC HG
Tx9xx	512M T70 BOC
Tx10xx	512M T90 BOC HG
Tx11xx	1G T90 BOC
Tx12xx	512M T80 BOC
Tx13xx	256M T90 BOC
Tx14xx	1G T70 BOC
Tx15xx	1G T90 BOC HG
Hx1xx	512M GH11 BOC (NEW)
Hx2xx	256M GH11 BOC
Hx3xx	512M GH90 BOC
Hx4xx	256M GT11M BOC
Hx6xx	256M T90G BOC
Hx7xx	512M T90G BOC
Hx8xx	512M T70G BOC
Hx9xx	512M T80G BOC
Hx10xx	256M GH90 BOC
Hx11xx	1G GH70 BOC
Hx12xx	512M GH80 BOC
Lx3xx	256M LS11 BOC
Lx4xx	256M LS11N BOC
Lx5xx	512M LD11 BOC

	Lx6xx	256M LD11N BOC	
	Lx7xx	512M LD70 BOC	
	Lx8xx	512M LS70 BOC	
	Fx1xx	512M H90 BOC	
	Fx2xx	512M H70 BOC	
	Antigos	256M D14 TSOP	Dx1xx
			Dx2xx
			Dx3xx
			Dx4xx
			Nx6xx
	256M D14 BOC	Bx1xx	
		Bx2xx	
		Dx1xx	
		Dx8xx	
	512M D14	Dx0xx	
		Dx2xx	
		Dx5xx	

X4	1	IFDD	IFD2	DD
	2	WIN3	WEC3	W3
	3	IFR2	QR2	RI
	4	SMI3	SMI3	SMI3
	5	IFS3	QD3	S3
	6	IFR3	QR3	R3
	7	WIN2	WEC2	W2
	8	SMI2	SMI2	S2
	9	INT3	IMI3	IN

X5	4	x4
	8	x8
	6	x16
	2	x32
	0	Wafer



X6	G	Green
	0	Assy IFPT
	1	Assy IFDD/QD3
	2	Assy EEM
	3	Assy EEMCN
	4	Assy IFIC
	5	Assy UTAC
	6	Assy QSZC Black
	7	Assy QSZC Green
	A	Assy Only
	EX	Excursion Only
	S	Special cases
	D	Dual Die
	T	Step3
	C	Consumer Green
	B	Consumer Black
	K	KGD
Y	YAHSIN	
E	EMC Black	

X7	...	Designs
		As shown in Prod Group 1