PRODUCT INTRODUCTION AND LOGISTICS

1.1 Product History

ABB Semiconductors' present range of Phase Control Thyristors (PCTs) consists of 25 families covering voltages from 1200 to 6500 V and currents from 300 A to 4500 A. This product range is designed with the following features:

- 4-inch (4") wafer technology
- Free floating silicon technology
- Optimum silicon utilisation for maximum power handling capability
- Double negative edge termination for long term voltage stability

The basic development of these products took place in the 70's when ASEA and BBC jointly developed free floating 4" technology which has since become the benchmark for performance and reliability in the field of high power semiconductors. Over 100,000 thyristors, based on this technology, have been supplied in HVDC (High Voltage Direct Current) projects and have bestowed ABB with early field and production experience.
After the merger of ASEA and BBC, all semiconductor production was concentrated in Lenzburg, Switzerland and ABB Semiconductors was founded in 1991. The thyristor ranges from the two companies overlapped as they were based on the same technology and designed for the same applications. It was therefore straightforward to standardise the range while continuing to serve the traditional customers as well as penetrating new market segments. Today's product range undergoes continuous improvement with respect to:

- production cycle-time, capacity and process capability
- application support, device data-bases and calculation tools

Investment and development are focused on utilising 5" silicon processing and innovative device concepts based on free floating silicon technology.

1.2 Product Matrix

Each of the 25 families are obtained from 4" raw silicon wafers and a common process by voltage class. This level of standardisation leads to optimised process flow and productivity. Mechanically, only 8 housings are used for the whole range.

"Prime" Product Matrix

Voltage Class	Wafer diameter					
	24 mm	34 mm	49 mm	73 mm	84 mm	96 mm
6500V		5STP 03X6500	5STP 08G6500	5STP 12M6500	5STP 18M6500	5STP 26N6500
5200V		5STP 04D5200		5STP 17L5200	5STP 25L5200	5STP 34N5200
4200V		5STP 04D4200	5STP 12F4200	5STP 18L4200	5STP 28L4200	5STP 38N4200
2800V		5STP 06D2800	5STP 16F2800	5STP 24L2800	5STP 33L2800	5STP 45N2800
1800V	5STP 03A1800	5STP 07D1800	5STP 18F1800	5STP 27L1800		
1600V			5STP 21F1600			
1200V			5STP 27F1200			

Standard Housings:

Code:	A	D	F	G	L	M	N
Flange diameter:	42 mm	57 mm	75 mm	75 mm	120 mm	120 mm	150 mm
Housing height:	18 mm	26 mm	26 mm	35 mm	26 mm	35 mm	35 mm

Housing code "X" corresponds to a special housing design. It currently designates a high voltage housing for 34 mm wafers and for an explosion resistant alternative to the "N" housing.

Part Numbering of Standard Products

5STP YYZNNNN (e.g. 5STP 45N2800)

5STP	Phase Control Thyristor from ABB Semiconductors AG
YY	average current in hundreds of amps (e.g. "45" = 4500 A)
Z	housing code
NNNN	voltage rating (e.g. 2800 V)

1.3 Application References

This product range has, for many years, served in advanced Industrial, Transmission and Traction applications. The table below gives an overview of the approximate number of devices in operation and the main device requirement for the specific application:

Application	N° of Devices	Type	Salient Requirements
HVDC	>100,000	4200–8800 V/M and N housings	long-term reliability, high voltage
SVC (Static VAR Control)	>50,000	4200–6500 V/M and N housings	long-term reliability, high voltage
Traction	>50,000	1800–2800 V/F and L housings	long-term reliability, shock, vibration
Crowbar	>6,000	4200–5200 V/L housing	DC stability
Large AC drives	>40,000	4200–6500 V/M, L and N housings	power handling
High current rectifiers	>25,000	1800–4200 V/F, L and N housings	low V_T drop, parallel connection
DC drives	>300,000	1800–4200 V/A, D, F, L, N housings	power handling, thermal cycling
Soft starters	>25,000	1200–6500 V/D, F, G and M housings	power handling

Field experience gathered over 20 years has proven the reliability of this product range in the most demanding applications.

1.4 Standard and Adapted Standard Products

A *standard* devices is defined by the datasheet, produced and tested according to a standard test routine, fitted with a standard gate lead and marked with the catalogue part number. All 25 data sheets define, as well as the prime voltage class, two additional standard products with lower voltage classes. The resulting 3*25 standard products are presented in our short form catalogue.

In order to meet specific application demands, we also supply *adapted standard* products. The philosophy behind the adapted standard is that a *standard product* is *adapted* to fulfil additional customer-specific requirements such as:

- Q banding for series connection
- V_T banding for parallel connection or loss minimisation
- tq selection for inverter applications
- special voltage ratings
- special surge current ratings with reapplied blocking voltage for fuseless converter operation
- explosion protection for high current operation
- housing changes
- special marking or leading

After agreement with the customer, the adapted standard device is given a unique part number (see also "Spec Review Process").

Part Numbering for Adapted Standards

	5STP YYNNZWWWW (e.g. 5STP 2665N0001)
5STP	Phase control thyristor from ABB Semiconductors AG
YY:	Average current in hundreds of amps (e.g. "26" = 2600 A)
NN:	Voltage code in hundreds of volts (e.g. "65" = 6500 V)
Z:	Housing code (e.g. N)
WWWW:	Running "adapted standard" number (e.g. 0001)

The advantage of this approach is that "front-end" wafer processing and bills-of-material are standard and the device is rendered customer-specific via "back-end processing" (electron-irradiation, assembly and test).

1.5 Production sequence

As described above, the production of ABB Phase Control Thyristors is based on standardised raw material and wafer-processing while allowing maximum flexibility for adapted standards. The table below shows the main production steps and corresponding cycle times.

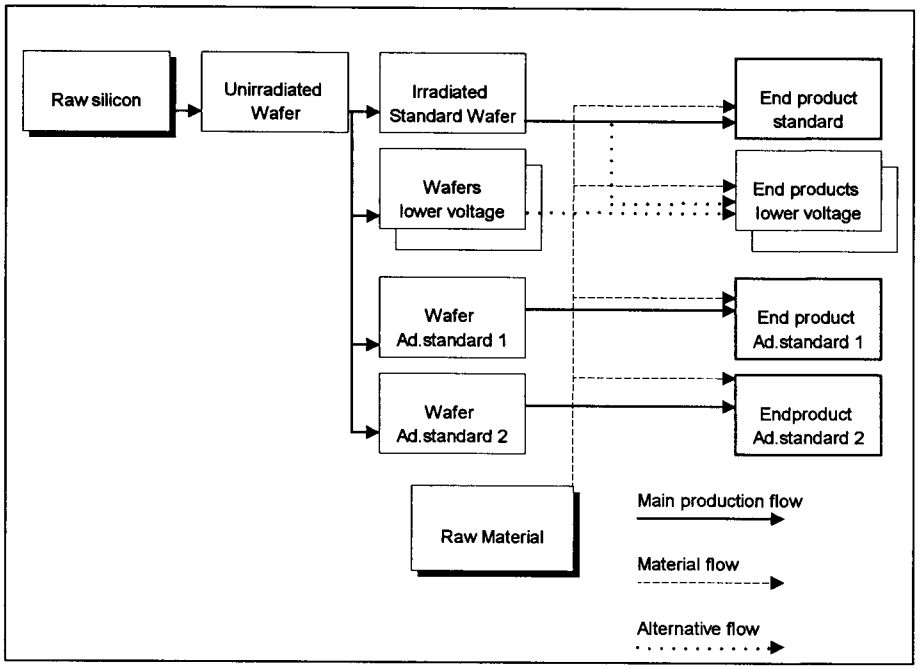
Production Steps and Cycle Times

Product Category	Un-irradiated Wafer	Classified Wafer	End-product
Product Status/Feature	a finished wafer that has not yet been subjected to carrier life-time control	an irradiated and tested wafer	a fully tested device with marking and gate-lead, ready to ship
Production Step	full processing from raw silicon to wafer, testing before irradiation	irradiation, test and classification of wafer	assembly, testing, marking, gate-leading and packing
Cycle Time	6–8 weeks	2–3 weeks	1 week

The basic production sequence is explained by the following process-flow.

Production Sequence of PCTs

(product structure with 3 *standard* and 2 *adapted-standard devices*)



Salient features of the production and planning processes are:

- Raw material: Purchase of silicon and housing parts are based upon the total backlog and forecast for all related end-products.
- Un-irradiated wafer: Planning and corresponding wafer-starts are based on the total backlog and forecasted need for all related end-products.
- Wafer: The wafers are irradiated, tested and classified to the specific backlog need.
- End product: Assembly and test of end-products is order-driven, based on standard parts and exploits the short assembly and test cycles common to both standard and adapted standard devices.

Fast Deliveries

The key to supplying our customers with short deliveries is firstly a standardisation of un-irradiated wafers and piece-parts, and secondly, a forecast per product group. These two inputs drive the purchase of raw material and wafer-starts, as these are the two longest manufacturing lead-times. Under these conditions, lead-time is a few weeks.

1.6 The Specification Review Process and Raising New Part Numbers

In order to provide our customers with adapted-standard products, a *spec. review process* is needed. This assures that the customer's true needs are captured and that they are correctly translated into our product structure and testing specifications. The spec review is the customer's assurance that the correct product will be supplied; the process is as follows:

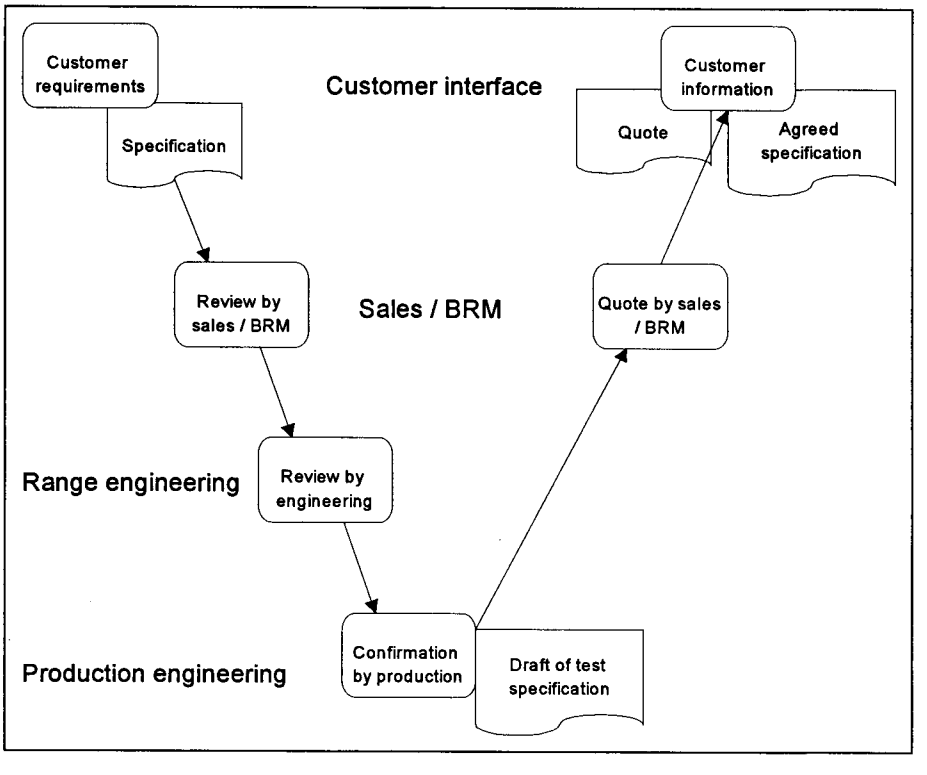
1 The customer requirement is reviewed and compared to our standard data-sheet, factory data-base and, if needed, additional device evaluation.

2 The request for quotation is reviewed by Sales and the BRM.

3 The technical content is reviewed by the product engineers and by production engineering. A preliminary testing specification is prepared. If the demand cannot be met, an alternative is proposed.

4 The technical review is returned to Sales who issue a quotation to the customer, including the specific part number.

Spec Review Process Flow



1.7 Old and New Part Numbers

The fusion of ASEA and BBC necessitated a new homogeneous numbering system. As shown above, the new numbers for PCTs start with "5STP". The following table cross-references the part numbering systems and indicates replacement philosophy:

Numbering System	Description	Replacement	New Part N°
YS NNN NNN-XX e.g. YS 190 110-AB	Old standard ASEA part numbers	Equivalent type, one-to-one replacement	5STP-standard type e.g. 5STP 25L5200
YS NNN NNN-X.... e.g. YS 190 001-XP42C Q31	Old adapted-standard ASEA part numbers	Equivalent type, one-to-one replacement	5STP-adapted standard type
YST NN-NN-**P**NNX e.g YST 45-21 P52G	Old ASEA type number	Equivalent type, one-to-one replacement	5STP-standard type e.g. 5STP 25L5200
CS XXX(X)-NNxx	Old standard or adapted standard BBC part numbers	Nearest equivalent type fulfilling the electrical spec.	5STP-adapted. standard type

Notes:
1) for original CS type replacement: – contact factory