

1 Crystal, chemical and material properties					
Property	Specification	Control frequency	Measuring Method	References	
Crystal Growing method	CZ	-	-	-	
Crystal Structure	Mono-crystalline	-	-	-	
Crystal Orientation	$\langle 1-0-0 \rangle \pm 3^\circ$	-	-	-	
Conductivity Type	P-type	Each block	-	-	
Dopant	Boron	-	-	-	
Oxygen Concentration <sup>1</sup>	$\leq 9,0 \times 10^{17}$ atoms/cm <sup>3</sup> [ $\leq 18$ ppma]	Each mother ingot - center value, seed and tail	FTIR	(new) ASTM F121 - 83	
Carbon Concentration <sup>2</sup>	$\leq 5,0 \times 10^{16}$ atoms/cm <sup>3</sup> [ $\leq 1,0$ ppma]	Each mother ingot - center value, seed and tail	FTIR	ASTM F1391-93a	

2 Electrical and Chemical properties					
Property	Specification	Control frequency	Measuring Method	References	
Specific Resistivity <sup>3</sup>	1,0 - 3,0 Ohmcm	Each mother ingot - center value, seed and tail	4-point probe	ASTM F84	
Bulk Lifetime <sup>4</sup>	$\geq 50 \mu\text{s}$	Each mother ingot - surface value, seed and tail	Sinton	QSS	
Defects <sup>5</sup>	No slip lines	Each mother ingot - seed and tail	Visual	-	

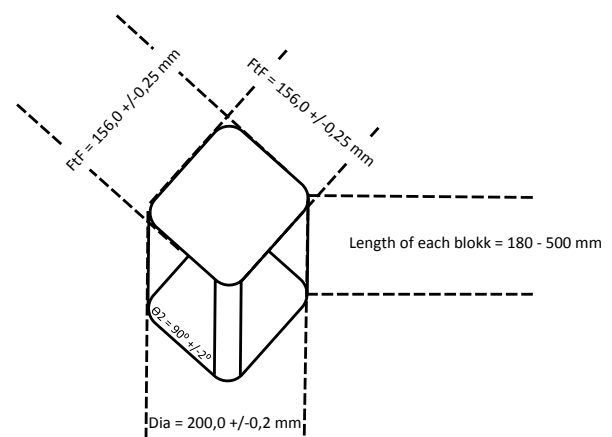
3 Geometry					
Property	Specification	Control frequency	Measuring Method	References	
Ingot overall shape	Pseudo square	100% - All blocks	Visual	-	
Ingot Diagonal	200 mm +/- 0,2 mm	100% - All blocks	Caliper and Vision system	Intego ORION	
Ingot Dimensions	156 mm +/- 0,25 mm	100% - All blocks	Caliper and Vision system	Intego ORION	
Corner length	15,4 mm +/- 1,0 mm	100% - All blocks	Caliper and Vision system	Intego ORION	
Angle between sides [ $\phi 1$ ]	$90^\circ \pm 0,2^\circ$	100% - All blocks	Caliper and- Vision system	Intego ORION	
Perpendicularity	$90^\circ \pm 0,2^\circ$	100% - All blocks	Caliper and Vision system	Intego ORION	
Block length	180 - 500 mm usable length	100% - All blocks	Caliper and Vision system	Intego ORION	

4 Surface Properties					
Property	Specification	Control frequency	Measuring Method	References	
Ingot surface	As polished block	100% - All blocks	Visual	-	

5 Apperance					
Property	Specification	Control frequency	Measuring Method	References	
Edge Defect	Length $\leq 0,3$ mm, Width $\leq 0,3$ mm	100% - All blocks	Vision system	Intego ORION	
Surface Chipping	Length $\leq 0,3$ mm, Width $\leq 0,3$ mm	100% - All blocks	Vision system	Intego ORION	
Crack	No cracks w/ size > 1 mm	100% - All blocks	Vision system	Intego ORION	

6 Packaging	
Property	Specification
Traceability	All lot is identified with a lot number.
Documantation	C of A pr block/lot. Oi, C, Res, Lifetime, line defects/slip, Rz
Packaging method	Wood material outside and inside with stable support
Labelling on wooden box	Lot number, specification and shipment number
Labelling /marking on ingot	Lot number and specification

### 7 Illustration



### 8 Explanations

- Oxygen is measured on 1,5 mm test wafer using FTIR (after Thermal donor removal)
  - Measurement is done in center - Average of 5 measurements.
  - Note: Oxygen conc. is guaranteed to the customer specification at crystal growing inspection using test samples specifically prepared for oxygen analysis. Oxygen is not characterized on prime solar wafers.
- Carbon is measured on 1,5 mm test wafer using FTIR (after Thermal donor removal)
  - Measurement is done in center - Average of 5 measurements.
  - Note: Carbon conc. is guaranteed to the customer specification at crystal growing inspection using test samples specifically prepared for carbon analysis. Carbon is not characterized on prime solar wafers.
- Specific resistivity is measured on 1,5 mm test wafer by using 4-point probe after thermal donor removal (single wafer annealing, 750°C, 120 sec cyclus, Ar-atmosphere)
  - Note: Resistivity is guaranteed to the customer specification at crystal growing inspection using test samples specifically prepared for resistivity analysis. Resistivity is not characterized on prime solar wafers.
- Bulk lifetime is measured on as cropped (i.e as squared) surface with Sinton BCT-0087 or BCT-210 equipment. QSS method is used for all values. Specific Minority Carrier Density [ $\text{cm}^{-3}$ ] is measured @  $2 \times 10^{15}$  (characteristic for p-type).
- Slip - lines is manually checked on as grown ingot before slabbing
- All chip length will be withdrawn from the total length and not included in the accepted length.