

DIN EN 16603-60-20:2020-12 (E)

Space engineering - Star sensor terminology and performance specification; English version EN 16603-60-20:2020

Table of contents

European Foreword	5
Introduction	7
1 Scope	8
2 Normative references	9
3 Terms, definitions and abbreviated terms	10
3.1 Terms from other standards.....	10
3.2 Terms specific to the present standard	10
3.3 Abbreviated terms.....	29
3.4 Nomenclature	30
4 Functional requirements	31
4.1 Star sensor capabilities.....	31
4.1.1 Overview.....	31
4.1.2 Cartography	32
4.1.3 Star tracking.....	33
4.1.4 Autonomous star tracking.....	33
4.1.5 Autonomous attitude determination.....	34
4.1.6 Autonomous attitude tracking	35
4.1.7 Angular rate measurement.....	35
4.1.8 (Partial) image download.....	36
4.1.9 Sun survivability	37
4.2 Types of star sensors	37
4.2.1 Overview.....	37
4.2.2 Star camera	37
4.2.3 Star tracker	37
4.2.4 Autonomous star tracker	38
4.3 Reference frames	38
4.3.1 Overview.....	38
4.3.2 Provisions	38
4.4 On-board star catalogue	38

5 Performance requirements	40
5.1 Use of the statistical ensemble	40
5.1.1 Overview	40
5.1.2 Provisions	41
5.2 Verification methods	42
5.2.1 Overview	42
5.2.2 Provisions for single star performances.....	42
5.2.3 Provisions for attitude performances	42
5.2.4 Provision for tests	42
5.3 <<deleted>>	43
5.4 General performance requirements	43
5.5 General performance metrics	45
5.5.1 Overview	45
5.5.2 Bias.....	45
5.5.3 Thermo elastic error	46
5.5.4 FOV spatial error.....	46
5.5.5 Pixel spatial error	47
5.5.6 Temporal noise	48
5.5.7 Aberration of light.....	49
5.5.8 Measurement date error.....	50
5.5.9 Measured output bandwidth.....	50
5.6 Cartography.....	50
5.7 Star tracking	51
5.7.1 Additional performance conditions	51
5.7.2 Single star tracking maintenance probability	51
5.8 Autonomous star tracking	51
5.8.1 Additional performance conditions	51
5.8.2 Multiple star tracking maintenance level.....	52
5.9 Autonomous attitude determination	52
5.9.1 General	52
5.9.2 Additional performance conditions	52
5.9.3 Verification methods.....	53
5.9.4 Attitude determination probability	53
5.10 Autonomous attitude tracking	54
5.10.1 Additional performance conditions	54
5.10.2 Maintenance level of attitude tracking	55
5.10.3 Sensor settling time.....	56

5.11 Angular rate measurement	56
5.11.1 Additional performance conditions	56
5.11.2 Verification methods.....	56
5.12 Mathematical model.....	57
5.13 Robustness to solar events.....	57
5.13.1 Additional robustness conditions	57
5.13.2 Continuity of tracking during a solar event.....	58
5.13.3 Ability to solve the lost in space problem during a solar event.....	59
5.13.4 Flux levels	59

Bibliography.....88

Figures

Figure 3-1: Star sensor elements – schematic.....	13
Figure 3-2: Example alignment reference frame	15
Figure 3-3: Boresight reference frame	16
Figure 3-4: Example of Inertial reference frame.....	16
Figure 3-5: Mechanical reference frame	17
Figure 3-6: Stellar reference frame	18
Figure 3-7: Schematic illustration of reference frames.....	18
Figure 3-8: Schematic timing diagram	20
Figure 3-9: Field of View.....	22
Figure 3-10: Aspect angle to planetary body or sun.....	23
Figure 4-1: Schematic generalized Star Sensor model.....	32
Figure B-1 : Rotational and directional Error Geometry	65
Figure F-1 : Angle rotation sequence.....	76
Figure H-1 : Example of detailed data sheet.....	82

Tables

Table C-1 : Minimum and optional capabilities for star sensors	69
Table G-1 : Contributing error sources	78
Table I-1 : Command table	84
Table I-2 : Telemetry table.....	86