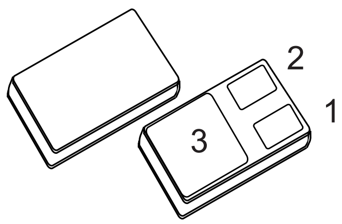
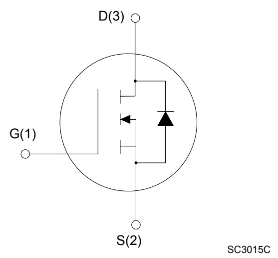
STRHMF16N20

Datasheet

Rad-Hard 200 V, 16 A, N-channel Power MOSFET



SMD.5



Product status link
Internal

Features

V_{DS}	I_D	$R_{DS(on)}$ typ.	Q_g
200 V	16 A	70 mΩ	52 nC

- ESCC qualified as per detail specification 5205/034
- 100 krad total ionizing dose guaranteed
- Wide RBSOA under heavy-ions radiation exposure
- Low $R_{DS(on)}$
- Low total gate charge
- Fast switching

Description

The STRHMF16N20 is a N-channel Power MOSFET able to operate in extreme environment conditions and severe radiation exposure. It provides superior high reliability performance and high immunity to the total ionizing dose (TID) and single event effects (SEE).

Qualified as per ESCC detail specification 5205/034 and available in SMD.5 hermetic package, it is specifically recommended for space and harsh environment applications and suitable for power conversion, motor control and power switch circuits.

Device summary

Product summary				
Part number	Quality level	Package	Lead finish	Radiation level
STRHMF16N20S1	Engineering model	SMD.5	Gold	-
STRHMF16N20SG	Flight model			100 krad
STRHMF16N20ST	Flight model		Solder dip	100 krad

Note: See Table 8 for ordering information.

1 Electrical ratings

T_{amb} = 25 °C unless otherwise specified

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{DS}	Drain-source voltage (V_{GS} = 0)	200	V
V_{GS} (1)	Gate-source voltage	+20/-16	V
I_D (2)	Drain current (continuous)	16	A
	Drain current (continuous) at T_{amb} = 100 °C	10	A
I_{DM} (3)	Drain current (pulsed)	64	A
P_{TOT}	Total power dissipation	66	W
T_{op}	Operating temperature range	-55 to 150	°C
T_j	Max. operating junction temperature range	150	°C

1. *This value is guaranteed over the full range of temperature.*
2. *Rated according to the $R_{thj\text{-}case}$ + $R_{thc\text{-}s}$*
3. *Pulse width limited by safe operating area.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case (maximum)	1.53	°C/W
R_{thCS}	Thermal resistance, case-to-heatsink (typical)	50	°C/W

Table 3. Avalanche data

Symbol	Parameter	Value	Unit
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, V_{DD} = 60 V, I_D = 8 A, R_g = 47 Ω)	120	mJ

2 Electrical characteristics

T_a = 25 °C unless otherwise specified

Table 4. **Electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	V_{DS} = 160 V, V_{GS} = 0 V		10	µA
		V_{DS} = 160 V, V_{GS} = 0 V, T_a = 125 °C		100	
I_{GSS}	Gate body leakage current	V_{GS} = 20 V		100	nA
		V_{GS} = 20 V, T_a = 125 °C		200	
		V_{GS} = -16 V	-100		
		V_{GS} = -16 V, T_a = 125 °C	-200		
$V_{(BR)DSS}$	Drain-to-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	200		V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA, T_a = 125 °C	1.5		V
		V_{DS} = V_{GS}, I_D = 1 mA, T_a = -55 °C	2.3	5.5	
		V_{DS} = V_{GS}, I_D = 1 mA	2	4.5	
$R_{DS(on)}$ (2)	Static drain-source on resistance	V_{GS} = 12 V, I_D = 16 A		90	mΩ
		V_{GS} = 12 V, I_D = 16 A, T_a = 125 °C		180	
C_{iss} (1)	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0 V		5200	pF
C_{oss} (1)	Output capacitance			120	pF
C_{rss} (1)	Reverse transfer capacitance			3	pF
Q_g (1)	Total gate charge	V_{DS} = 160 V, I_D = 16 A, V_{GS} = 10 V		78	nC
Q_{gs} (1)	Gate-to-source charge			34	nC
Q_{gd} (1)	Gate-to-drain ("Miller") charge			6.1	nC
R_G (1)	Gate input resistance	f = 1 MHz gate DC bias = 0, test signal level = 20 mV open drain		23	Ω
$t_{d(on)}$ (1)	Turn-on delay time	V_{DD} = 100 V, I_D = 8 A, R_G = 4.7 Ω, V_{GS} = 12 V		20	ns
t_r (1)	Rise time			7	
$t_{d(off)}$ (1)	Turn-off delay time			345	
t_f (1)	Fall time			113	
V_{SD} (2)	Diode forward voltage	I_{SD} = 16 A, V_{GS} = 0 V		1.2	V
		I_{SD} = 16 A, V_{GS} = 0 V, T_a = 125 °C		1.1	
t_{rr}	Reverse recovery time	V_{DS} = 100 V, I_{SD} = 8 A, di/dt = 100 A/µs		380	ns

1. *Not tested in production, guaranteed by process.*
2. *Pulse duration = 680 us, duty cycle ≤ 2%*

3 Radiation characteristics

The STRHMF16N20 is guaranteed in radiation exposure in single event effects (SEE) as per ESCC25100 and total ionizing dose (TID) as per ESCC 22900.

Each lot is tested in radiation and accepted according to the characteristics of Table 5.

3.1 Total dose radiation (TID) testing

During the irradiation exposure the device is biased at V_{GS} = + 15 V and V_{DS} = 0 V.

The parameters listed in Table 5 are measured:

- Before irradiation
- After irradiation
- After 24 hrs at room temperature
- After 168 hrs at 100 °C anneal

Table 5. Post-irradiation electrical characteristics (T_{amb} = 25 °C unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 160 V, V_{GS} = 0 V		10	µA
I_{GSS}	Gate body leakage current(V_{DS} = 0)	V_{GS} = 20 V		100	nA
		V_{GS} = -16 V	-100		
$V_{(BR)DSS}$	Drain-to-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	200		V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA	2	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 12 V, I_D = 16 A		90	mΩ
V_{SD}[(1)]	Diode forward on voltage	V_{GS} = 0 V, I_{SD} = 16 A		1.2	V

1. Pulse duration = 680 us, duty cycle ≤ 2%

3.2 Single event effect RBSOA

The STRHMF16N20 is able to withstand heavy ions exposure according to the MIL-STD-750E test method 1080. Reverse Biased Safe Operating Area is characterized using the circuit depicted in Figure 2.

SEB and SEGR tests are performed with a fluence of 3e+5 ions/cm² with the following acceptance criteria:

- SEB test: drain voltage checked, trigger level is set to V_{DS} = - 5 V. Stop condition: as soon as a SEB occurs or if the fluence reaches 3e+5 ions/cm².
- SEGR test: the gate current is monitored every 200 ms. A gate stress is performed before and after irradiation. Stop condition: as soon as the gate current reaches 100 nA (during irradiation or during PIGS test) or if the fluence reaches 3e+5 ions/cm².

Table 6. Single event effect (SEE), safe operating area (SOA)

Ion	Let (Mev/(mg/cm^2))	Energy (MeV)	Range (µm)
Kr	31.1	845	111
Xe	48.5	2059	155
Xe	62	1091	81

Figure 1. Single event effect, SOA

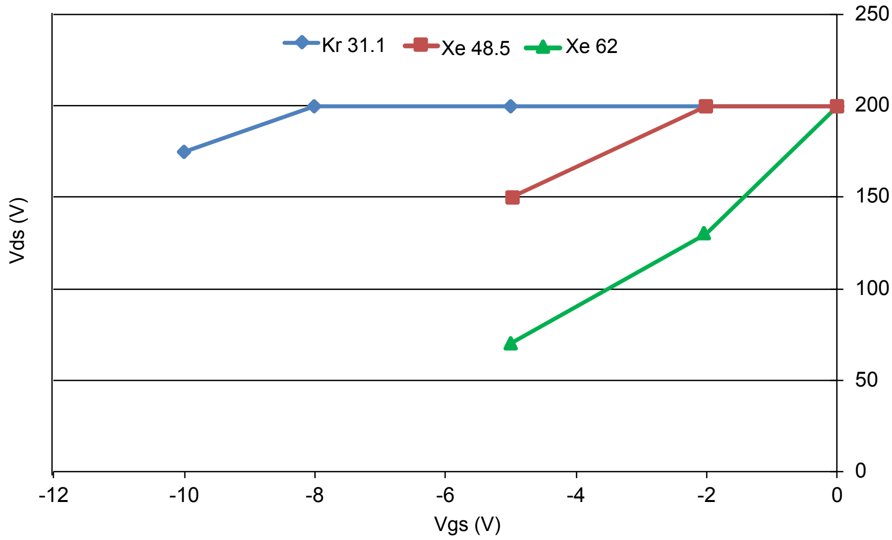
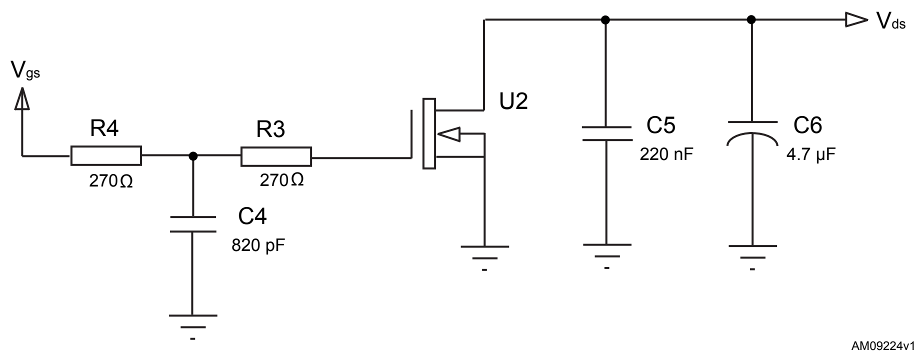


Figure 2. Single event effect, bias circuit



3.3 Electrical characteristics (curves)

Figure 3. Safe operating area

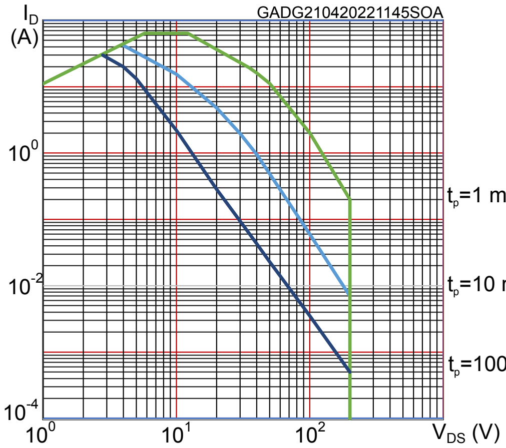


Figure 4. Normalized Thermal Impedance

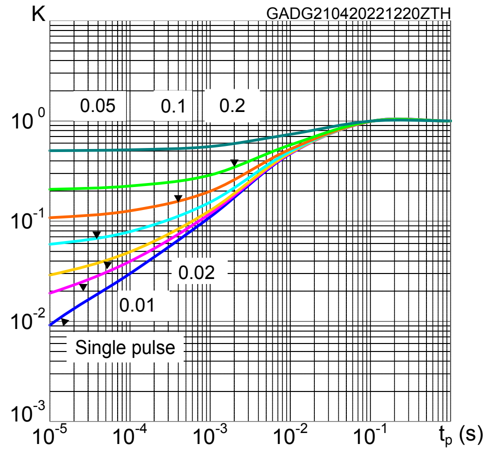


Figure 5. Normalized $V_{(BR)DSS}$ vs. temperature

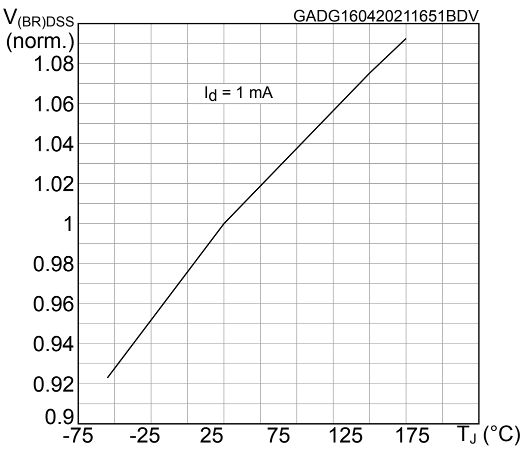


Figure 6. Static drain-source on-resistance

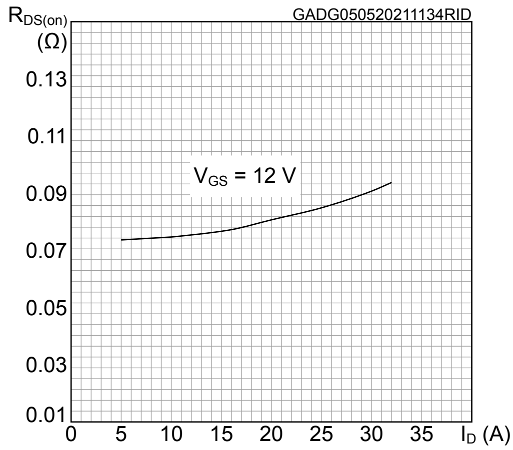


Figure 7. Normalized on-resistance vs. temperature

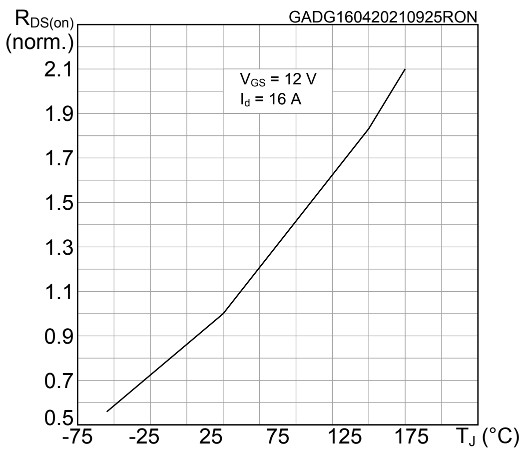
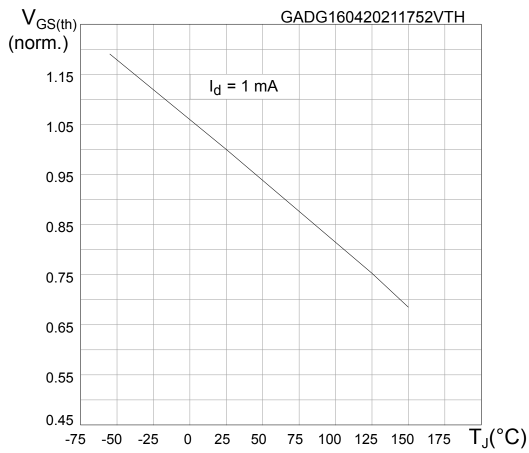


Figure 8. Normalized gate threshold voltage vs. temperature



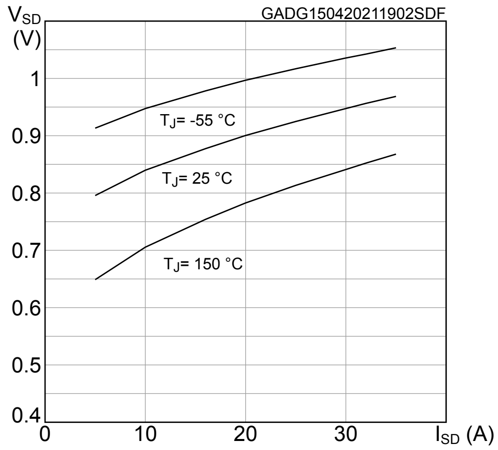
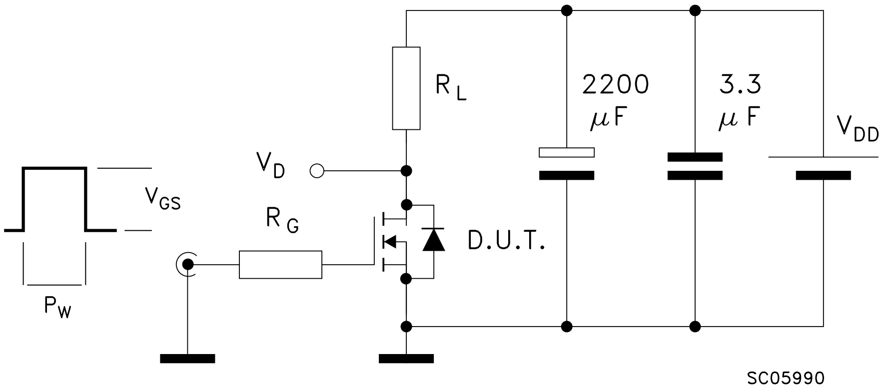


Figure 9. **Source-drain diode forward characteristics**

4 Test circuits

Figure 10. **Switching times test circuit for resistive load**



Note: Max driver V_{GS} slope = 1 V/ns (no DUT)

Figure 11. **Source drain diode waveform**

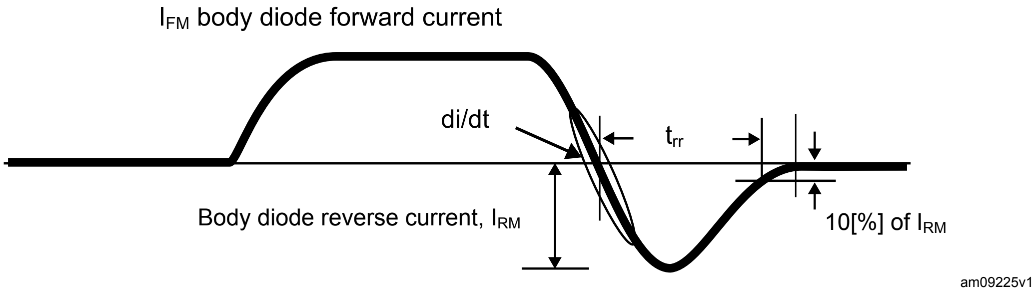
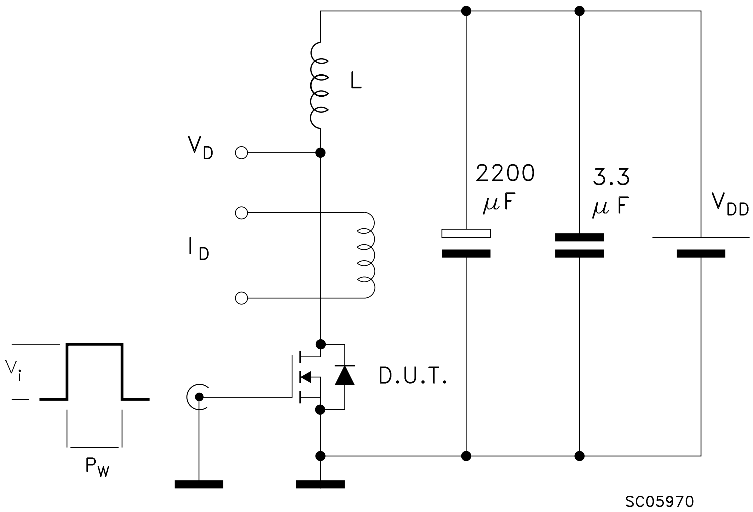


Figure 12. **Unclamped inductive load test circuit (single pulse and repetitive)**



5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

5.1 SMD.5 package information

Figure 13. **Surface mount SMD.5 package outline (3-terminal)**

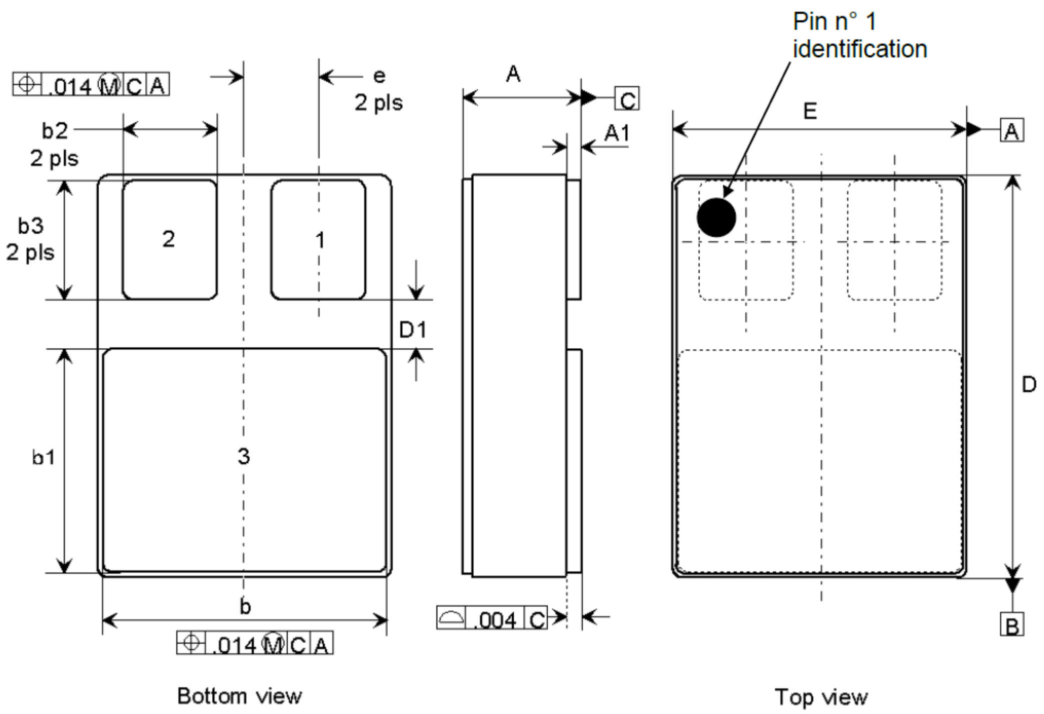


Table 7. **SMD.5 package mechanical data**

Symbols	Dimensions (mm)			Dimensions (inches)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.84		3.30	0.112		0.130
A1	0.25	0.38	0.51	0.010	0.015	0.020
b	7.13	7.26	7.39	0.281	0.286	0.291
b1	5.58	5.72	5.84	0.220	0.225	0.230
b2	2.28	2.41	2.54	0.090	0.095	0.100
b3	2.92	3.05	3.18	0.115	0.120	0.125
D	10.03	10.16	10.28	0.395	0.400	0.405
D1	0.76			0.030		
E	7.39	7.52	7.64	0.291	0.296	0.301
e		1.91			0.075	

6 Order codes

Table 8. **Ordering information**

Part number	ESCC specification	Screening type	Radiation level	Package	Weight	Lead finish	Marking	Packing
STRHMF16N20S1	-	Engineering model	-			Gold	STRHMF16N20S1	
STRHMF16N20SG	5205/034/01	Flight model	100 krad	SMD.5	1 g		520503401	Strip pack
STRHMF16N20ST	5205/034/02	Flight model	100 krad			Solder dip	520503402	

1. *Specific marking only. The full marking includes in addition: For the Engineering Models: ST logo, date code; country of origin (FR). For ESCC flight parts: STlogo, date code, country of origin (FR), ESA logo, serial number of the part within the assembly lot.*

Contact ST sales office for information about specific conditions for products in die form.

7 Other information

Table 9. Traceability and documentation

Screening type	Date code[1]	Radiation level	Documentation
Engineering model	3yywwN	-	Certificate of conformance
Flight model	yywwN	100 krad	Certificate of conformance ESCC qualification maintenance lot reference Radiation verification test (RVT) report at 25 / 50 / 70 / 100 krad at 0.1 rad / s.

1. *yy = year, ww = week number, N = lot index in the week.*

Revision history

Table 10. **Document revision history**

Date	Revision	Changes
02-Aug-2021	1	First release.
27-Jul-2022	2	Updated *Features*, *Table 4* and *Figure 4*. Added *Figure 3* and *Section 3.1*. Minor text changes.
02-Jan-2023	3	Updated *Table 6* and *Figure 1*.
05-May-2023	4	Updated Table 4.