INTEGRATED CIRCUITS, SILICON MONOLITHIC, BCD-SOI, 2A SYNCHRONOUS RECTIFIED STEP-DOWN CONVERTER

BASED ON TYPE SPPL12420RH

ESCC Detail Specification No. 9102/014

Issue 1	November 2021

Document Custodian: European Space Agency – see https://escies.org

LEGAL DISCLAIMER AND COPYRIGHT

DOCUMENTATION CHANGE NOTICE

(Refer to https://escies.org for ESCC DCR content)

DCR No.	CHANGE DESCRIPTION

TABLE OF CONTENTS

1 GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics and test and inspection data for the component type variants and/or the range of components specified below. It supplements the requirements of, and shall be read in conjunction with, the ESCC Generic Specification listed under Applicable Documents.

1.2 APPLICABLE DOCUMENTS

The following documents form part of this specification and shall be read in conjunction with it:

(a) ESCC Generic Specification No. 9000.

1.3 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

For the purpose of this specification, the terms, definitions, abbreviations, symbols and units specified in ESCC Basic Specification No. 21300 shall apply.

1.4 THE ESCC COMPONENT AND COMPONENT TYPE VARIANTS

1.4.1 The ESCC Component Number

The ESCC Component Number shall be constituted as follows:

Example: 910201401P

- Detail Specification Reference: 9102014
- Component Type Variant Number: 01
- Total Dose Radiation Level Letter: P (as required)

1.4.2 Component Type Variants

The component type variants applicable to this specification are as follows:

Variant Number	Based on Type	Case	Lead Material and Finish	Weight max g	Total Dose Radiation Level Letter
01	SPPL12420RH	FP-16	G14	0.7	P [30krad(Si)]

The terminal material and finish shall be in accordance with the requirements of ESCC Basic Specification No. 23500.

The total dose radiation level letter shall be as defined in ESCC Basic Specification No 22900. If an alternative radiation test level is specified in the Purchase Order the letter shall be changed accordingly.

1.5 MAXIMUM RATINGS

The maximum ratings shall not be exceeded at any time during use or storage. Functional performance for extended periods at the maximum ratings may adversely affect device reliability.

Maximum ratings shall only be exceeded during testing to the extent specified in this specification and when stipulated in Test Methods and Procedures of the ESCC Generic Specification.

Characteristics	Symbols	Maximum Ratings	Units	Remarks
Supply Voltage	V_{IN}	-0.3 to +18	V	Note 1, 2
Switch Voltage	V_{SW}	-1 to V_{IN} +0.3	V	Notes 1, 3
Boost Voltage	V_{BS}	V_{SW} -0.3 to V_{SW} +6	V	Note 4
Input Voltage (EN, SS, FB, CMP Inputs)	V_{EN} V_{SS} V_{FB} V_{CMP}	-0.3 to +6	V	Note 1
Operating Temperature Range	T_{op}	-55 to +125	°C	T_{amb}
Storage Temperature Range	T_{stg}	-65 to +150	°C	
Soldering Temperature	T_{sol}	+260	°C	Note 5
Junction Temperature	T_j	+150	°C	
Thermal Resistance Junction to Case	$R_{th(j-c)}$	10	°C/W	

NOTES:

1. All voltages are with respect to GND/AGND.
2. Device is functional when operated with a supply voltage in the range: $4.5 \leq V_{IN} \leq 24V$; however, device long-term reliability is not guaranteed when operated with a supply voltage exceeding 18V.
3. Applied DC value. V_{SW} ringing due to inductive switching is allowed to exceed these values.
4. Voltage is with respect to SW.
5. Duration 10 seconds maximum at a distance of not less than 1.6mm from the device body and the same terminal shall not be resoldered until 3 minutes have elapsed.

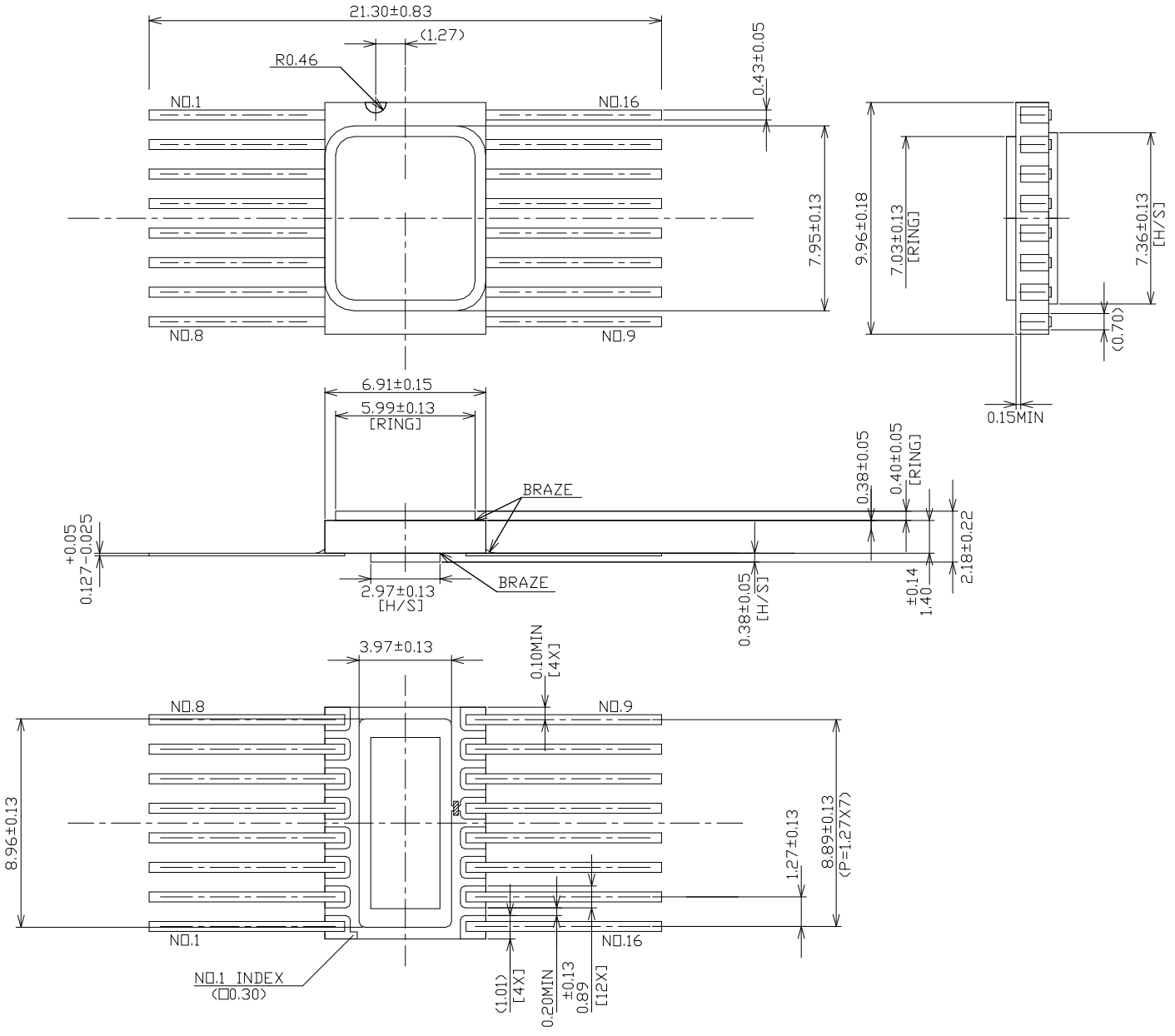
1.6 HANDLING PRECAUTIONS

These devices are susceptible to damage by electrostatic discharge. Therefore, suitable precautions shall be employed for protection during all phases of manufacturing, testing, packaging, shipment and any handling.

These components are categorised as Class 2 per ESCC Basic Specification No. 23800 with a Minimum Critical Path Failure Voltage of 4000 Volts.

1.7 PHYSICAL DIMENSIONS AND TERMINAL IDENTIFICATION

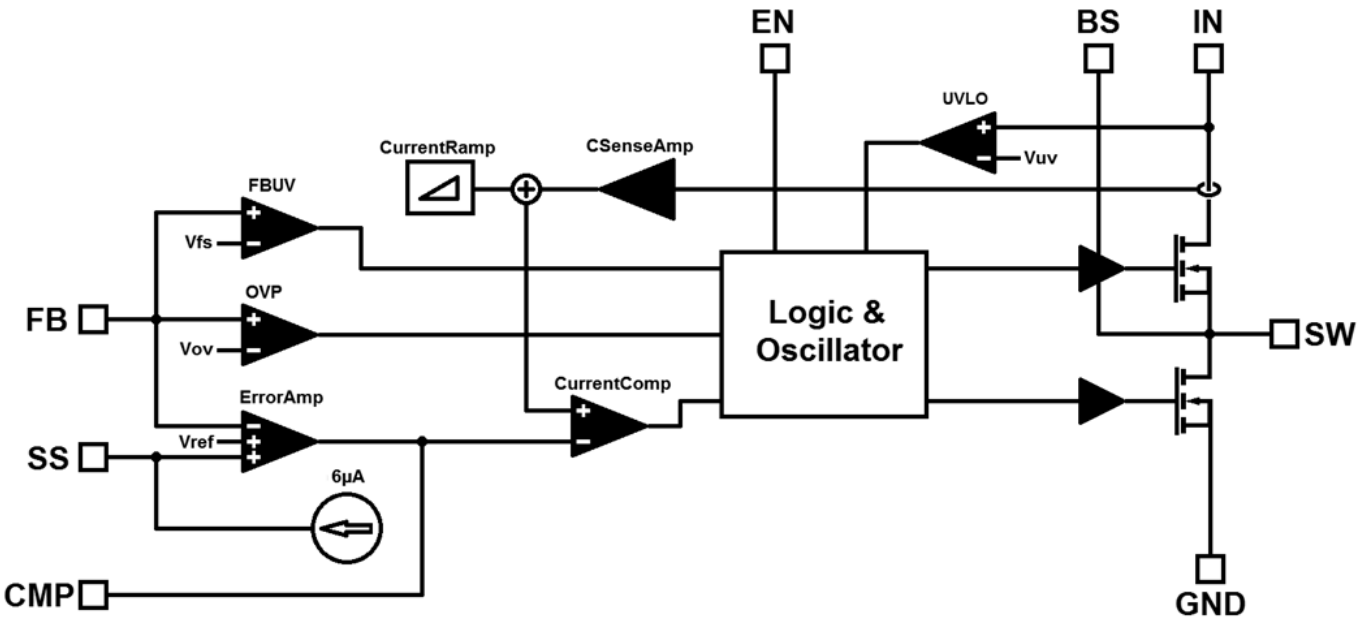
1.7.1 Ceramic Flat Package (FP-16) - 16 lead



NOTES:

1. All dimensions are in mm.
2. Terminal identification: The No. 1 terminal is identified by reference to the index notch on the top side and by the plating appendix index on the bottom side.

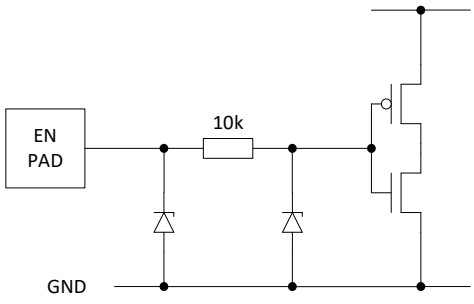
1.8 FUNCTIONAL DIAGRAM

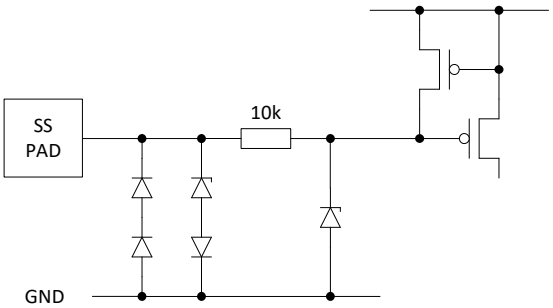


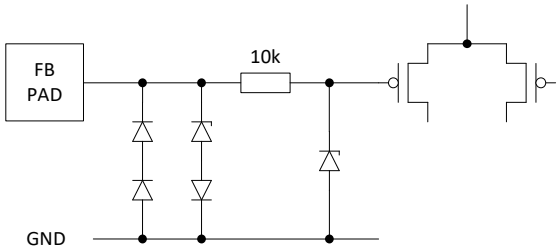
1.9 PIN ASSIGNMENT

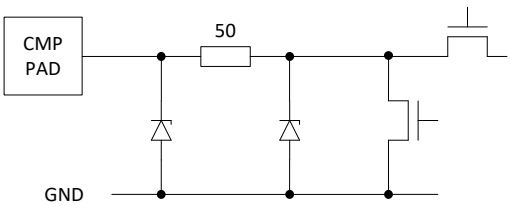
Pin No.	Pin Name	Function
1	EN	Enable Input
2	SS	Softstart Control IO
3	IN	Power Input
4	IN	Power Input
5	IN	Power Input
6	BS	High-Side Gate Drive Boost Input
7	SW	Power Switching Output
8	SW	Power Switching Output
9	SW	Power Switching Output
10	SW	Power Switching Output
11	GND	Power Ground
12	GND	Power Ground
13	GND	Power Ground
14	AGND	Analog Ground
15	FB	Feedback Input
16	CMP	Compensation IO

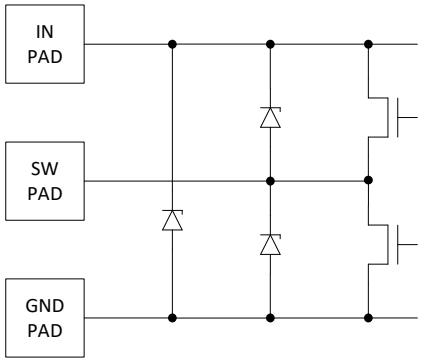
1.10 PROTECTION NETWORKS

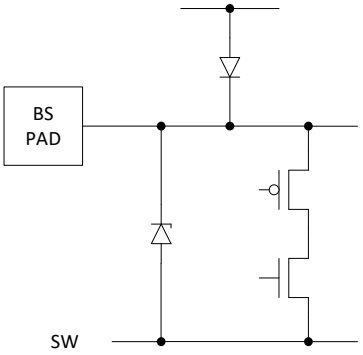












2 REQUIREMENTS

2.1 GENERAL

The complete requirements for procurement of the components specified herein are as stated in this specification and the ESCC Generic Specification. Permitted deviations from the Generic Specification, applicable to this specification only, are listed below.

Permitted deviations from the Generic Specification and this Detail Specification, formally agreed with specific Manufacturers on the basis that the alternative requirements are equivalent to the ESCC requirement and do not affect the component's reliability, are listed in the appendices attached to this specification.

2.1.1 Deviations from the Generic Specification

None.

2.2 MARKING

The marking shall be in accordance with the requirements of ESCC Basic Specification No. 21700 and as follows.

The information to be marked on the component shall be:

(a) The ESCC qualified components symbol (for ESCC qualified components only).
(b) The ESCC Component Number (see Para. 1.4.1).
(c) Traceability information.

2.3 ELECTRICAL MEASUREMENTS AT ROOM, HIGH AND LOW TEMPERATURES

Electrical measurements shall be performed at room, high and low temperatures.

2.3.1 Room Temperature Electrical Measurements

The measurements shall be performed at T_{amb} = +22 ±3°C.

Characteristics	Symbols	Test Conditions (Note 1)	Limits		Units
			Min	Max	
Shutdown Supply Current	I_{SD}	V_{EN} = 0V	0.05	2.4	µA
Supply Current	I_{IN}	V_{EN} = 2V, V_{FB} = 1V	500	900	µA
Feedback Voltage	V_{FB}	Note 2, V_{IN} = 4.5V, V_{IN} = 24V	906	942	mV
Feedback Over-Voltage Threshold	V_{FBth}	V_{FB} rising	1.03	1.17	V
Error Amplifier Voltage Gain	A_{EA}	V_{IN} = 4.5V, V_{IN} = 24V	350	850	V/V
Error Amplifier Transconductance	G_{EA}	ΔI_{CMP} = 10µA	580	1050	µA/V
High-Side Switch ON Resistance	$R_{DS(ON)1}$	Note 3, I_{SW} = 0.75A	50	220	mΩ
Low-Side Switch ON Resistance	$R_{DS(ON)2}$	I_{SW} = -0.75A	50	220	mΩ
High-Side Switch Leakage Current	$I_{DS(OFF)1}$	V_{EN} = 0V, V_{SW} = 0V	-8.7	1	µA
Low-Side Switch Leakage Current	$I_{DS(OFF)2}$	V_{EN} = 0V, V_{SW} = 10V	-1	8.7	µA
Upper Switch Current Limit	$I_{DS(lim)1}$	Note 3, Note 4	3	4.45	A
Lower Switch Current Limit	$I_{DS(lim)2}$		0.75	1.5	A
COMP to Current Sense Transconductance	G_{CS}	Note 3, I_{SW} = -0.8A & -0.3A	2	6	A/V
Oscillation Frequency	f_{OSC}	V_{FB} = 0.8V	300	430	kHz
Short-Circuit Oscillation Frequency	$f_{OSC(SC)}$	V_{FB} = 0V	70	160	kHz
Maximum Duty Cycle	D_{MAX}	V_{FB} = 0.8V	80	98	%

Characteristics	Symbols	Test Conditions (Note 1)	Limits		Units
			Min	Max	
Enable Shutdown Threshold Voltage	$V_{EN(sd\_th)}$	V_{EN} rising	1.15	1.65	V
Enable Shutdown Threshold Voltage Hysteresis	$V_{EN(sd\_th\_hyst)}$		130	250	mV
Enable Lockout Threshold Voltage	$V_{EN(lo\_th)}$	V_{EN} rising	2.25	2.75	V
Enable Lockout Threshold Voltage Hysteresis	$V_{EN(lo\_th\_hyst)}$		90	330	mV
Input Under-Voltage Lockout Threshold Voltage	$V_{IN(lo\_th)}$	V_{IN} rising	3.65	4.35	V
Input Under-Voltage Lockout Threshold Voltage Hysteresis	$V_{IN(lo\_th\_hyst)}$		115	270	mV
Soft-Start Current	I_{SS}	V_{SS} = 0V	5	8	µA
Soft-Start Period	t_{SS}	Note 5, C_{SS} = 0.1µF	11	18	ms

NOTES:

1. Unless otherwise specified, V_{IN} = 12V.
2. Measured with internal oscillator disabled.
3. Measured with internal oscillator disabled and high-side switch turned on.
4. Current pulses width low duty cycle to avoid self-heating.
5. Calculated parameter: $t_{SS} = C_{SS} * V_{FB} / I_{SS}$.

2.3.2 High and Low Temperatures Electrical Measurements

The measurements shall be performed at T_{amb} = +125 (+0 -5)°C and T_{amb} = -55 (+5 -0)°C. The characteristics, test methods, conditions and limits shall be as specified in Para. 2.3.1 Room Temperature Electrical Measurements.

2.4 PARAMETER DRIFT VALUES

Unless otherwise specified, the measurements shall be performed at T_{amb} = +22 ±3°C.

The test methods and test conditions shall be as per the corresponding test defined in Para. 2.3.1 Room Temperature Electrical Measurements.

The drift values (Δ) shall not be exceeded for each characteristic specified. The corresponding absolute limit values for each characteristic shall not be exceeded.

Characteristics	Symbols	Limits			Units
		Drift Value Δ	Absolute		
			Min	Max	
Supply Current	I_{IN}	±30	500	900	µA
Feedback Voltage	V_{FB}	±4	906	942	mV
Feedback Over-Voltage Threshold	V_{FBth}	±0.015	1.03	1.17	V
High-Side Switch ON Resistance	$R_{DS(ON)1}$	±10	50	220	mΩ
Low-Side Switch ON Resistance	$R_{DS(ON)2}$	±10	50	220	mΩ
Upper Switch Current Limit	$I_{DS(lim)1}$	±0.15	3	4.45	A
Lower Switch Current Limit	$I_{DS(lim)2}$	±0.15	0.75	1.5	A
Oscillation Frequency	f_{OSC}	±12	300	430	kHz
Input Under-Voltage Lockout Threshold Voltage	$V_{IN(lo\_th)}$	±0.05	3.65	4.35	V
Soft-Start Current	I_{SS}	±0.2	5	8	µA

2.5 INTERMEDIATE AND END-POINT ELECTRICAL MEASUREMENTS

Unless otherwise specified, the measurements shall be performed at T_{amb} = +22 ±3°C.

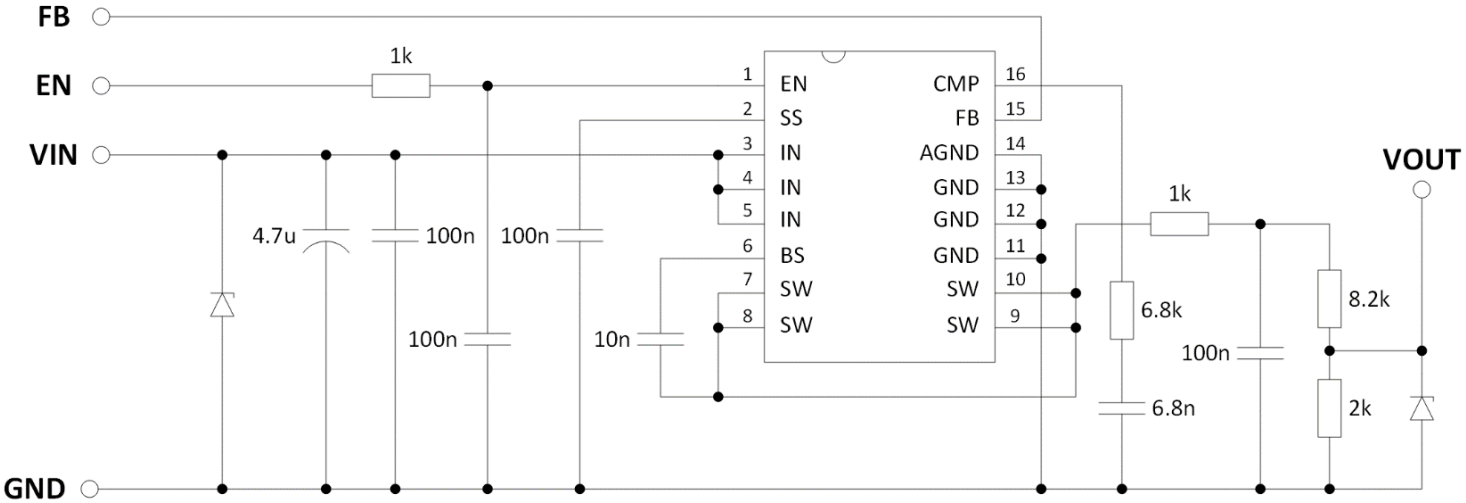
The characteristics, test methods, conditions and limits shall be as specified in Para. 2.3.1 Room Temperature Electrical Measurements.

2.6 HIGH TEMPERATURE REVERSE BIAS BURN-IN CONDITIONS

The test circuit and test conditions shall be as follows:

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+125 (+0 -5)	°C
Supply Voltage	V_{IN}	18	V
Feedback Voltage	V_{FB}	0	V
Enable Voltage	V_{EN}	0	V
Duration	t	240	Hours

HTRB BURN-IN TEST CIRCUIT



2.7 POWER BURN-IN CONDITIONS

The test circuit shall be as specified in Para. 2.6 HTRB Burn-in. The conditions shall be as follows:

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+125 (+0 -5)	°C
Supply Voltage	V_{IN}	12	V
Feedback Voltage (Note 1)	V_{FB}	0.6	V
Enable Voltage	V_{EN}	3	V

NOTES:

1. Set for maximum duty cycle.

2.8 OPERATING LIFE CONDITIONS

The conditions and test circuit shall be as specified in Para. 2.7 Power Burn-in.

2.9 TOTAL DOSE RADIATION TESTING

All lots shall be irradiated in accordance with ESCC Basic Specification No. 22900, low dose rate (window 2: 36rad(Si) to 360rad(Si) per hour).

2.9.1 Bias Conditions and Total Dose Level for Total Dose Radiation Testing

The following bias conditions shall be used during irradiation testing:

- 5 samples: unbiased (all terminals connected to ground).
- 5 samples: continuous bias shall be applied as below (see Para. 2.9.1.1).

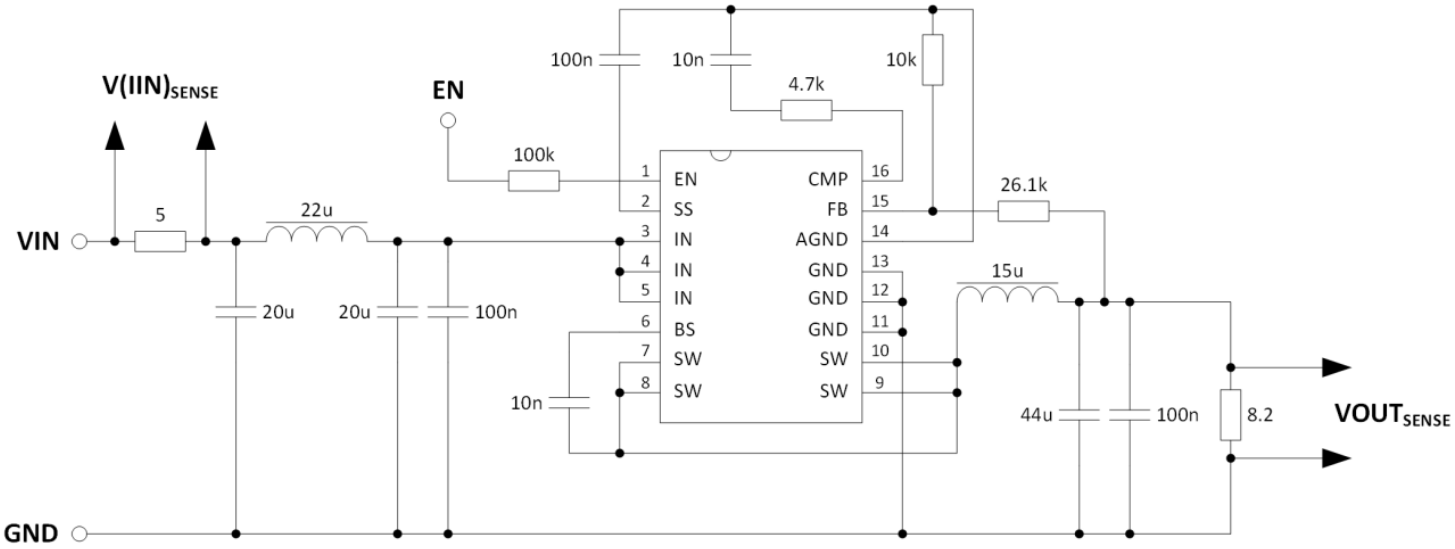
Unless otherwise specified, the total dose level applied shall be as specified in Para. 1.4.2 or in the Purchase Order.

2.9.1.1 Continuous Bias Test Conditions

The test circuit and test conditions shall be as follows:

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+22 ±3	°C
Supply Voltage	V_{IN}	12	V
Enable Voltage	V_{EN}	3	V

CONTINUOUS BIAS TEST CIRCUIT



2.9.2 Electrical Measurements for Total Dose Radiation Testing

Prior to irradiation testing the devices shall have successfully met Para. 2.3.1 Room Temperature Electrical Measurements.

Unless otherwise specified, the measurements shall be performed at T_{amb} = +22 ±3°C.

The test methods and test conditions shall be as per the corresponding test defined in Para. 2.3.1 Room Temperature Electrical Measurements.

The parameters to be measured during and on completion of irradiation testing are shown below.

Characteristics	Symbols	Limits		Units
		Min	Max	
Shutdown Supply Current	I_{SD}	0.05	2.4	µA
Feedback Voltage	V_{FB}	906	942	mV
Feedback Over-Voltage Threshold	V_{FBth}	1.03	1.17	V
Error Amplifier Voltage Gain	A_{EA}	350	850	V/V
Error Amplifier Transconductance	G_{EA}	580	1050	µA/V
High-Side Switch ON Resistance	$R_{DS(ON)1}$	50	220	mΩ
Low-Side Switch ON Resistance	$R_{DS(ON)2}$	50	220	mΩ
High-Side Switch Leakage Current	$I_{DS(OFF)1}$	-8.7	1	µA
Low-Side Switch Leakage Current	$I_{DS(OFF)2}$	-1	8.7	µA
Upper Switch Current Limit For unbiased test: For biased test:	$I_{DS(lim)1}$	 3 3	 4.8 4.45	A
Lower Switch Current Limit	$I_{DS(lim)2}$	0.75	1.5	A
COMP to Current Sense Transconductance	G_{CS}	2	6	A/V
Oscillation Frequency For unbiased test: For biased test:	f_{OSC}	 300 300	 470 430	kHz
Short-Circuit Oscillation Frequency For unbiased test: For biased test:	$f_{OSC(SC)}$	 70 15	 180 160	kHz
Maximum Duty Cycle	D_{MAX}	80	98	%
Soft-Start Current	I_{SS}	5	8	µA
Soft-Start Period	t_{SS}	11	18	ms

APPENDIX A

ADDITIONAL DATA – SPACE IC GMBH (D)

(a) Derating for Space Application
These components are susceptible to Single Event Burnout, Single Event Gate Rupture or Single Event Snapback if operated in a space environment unless the following derating is applied:

- LET ≤ 60MeV.cm^2/mg : V_{IN} ≤ 13V
- LET ≤ 85MeV.cm^2/mg : V_{IN} ≤ 11V

Note: V_{IN} refers to the applied DC value. V_{IN} ringing due to switching in application is allowed to exceed these values.