5.1.1.3 PIN FUNCTION

The pin function of each PDS connector is listed in the following tables.

Connector label	J100	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		6	3	9

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuoto)	1P_120V	A	AWG12	1
	1P_120V_RTN	B	AWG12	1
	1P_FAULT	C	AWG12	1
	AI_120V	E	AWG8	1
	AI_120V_RTN	D	AWG8	1
	AI_FAULT	F	AWG8	1
Totale complessivo				6

Tab. 5-3: J100 pin function

Connector label	J101	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		6	3	9

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuoto)	T0_120V	A	AWG12	1
		B	AWG12	1
	T0_120V_RTN	G	AWG12	1
		H	AWG12	1
	T0_SENSE	C	AWG12	1
	T0_SENSE_RTN	I	AWG12	1
Totale complessivo				6

Tab. 5-4: J101 pin function

Connector label	J102	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		12	12	24

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuote)	AO_CCEB	L	AWG12	1
		M	AWG12	1
	AO_CCEB_RTN	A	AWG12	1
		P	AWG12	1
	AO_CCS	D	AWG12	1
		E	AWG12	1
	AO_CCS_RTN	B	AWG12	1
		R	AWG12	1
Totale complessivo				8

Tab. 5-5 J102 pin function

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Connector label	J103	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	18	18

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuoto)	AH_OUT1	G	AWG20	1
	AH_OUT1_RTN	S	AWG20	1
	AH_OUT3	H	AWG20	1
	AH_OUT3_RTN	T	AWG20	1
	AH_OUT4	J	AWG20	1
	AH_OUT4_RTN	K	AWG20	1
	AH_OUT5	A	AWG20	1
		L	AWG20	1
	AH_OUT5_RTN	M	AWG20	1
		N	AWG20	1
	AH_OUT6	C	AWG20	1
	AH_OUT6_RTN	B	AWG20	1
	AH_OUT7	P	AWG20	1
	AH_OUT7_RTN	D	AWG20	1
Totale complessivo				14

Tab. 5-6: J103 pin function

Connector label	J104	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	18	18

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuoto)	AH_OUT10	A	AWG20	1
	AH_OUT10_RTN	N	AWG20	1
	AH_OUT11	L	AWG20	1
	AH_OUT11_RTN	M	AWG20	1
	AH_OUT2	D	AWG20	1
		H	AWG20	1
		J	AWG20	1
	AH_OUT2_RTN	K	AWG20	1
		S	AWG20	1
		T	AWG20	1
	AH_OUT8	C	AWG20	1
	AH_OUT8_RTN	B	AWG20	1
	AH_OUT9	G	AWG20	1
	AH_OUT9_RTN	P	AWG20	1
Totale complessivo				14

Tab. 5-7: J104 pin function

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Connector label	J110	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		12	12	24

Pinout				
Box	Line name	Pin label	AWG size	Totale
CAB	CAB_N	A	AWG12	1
		D	AWG12	1
		E	AWG12	1
	CAB_N_RTN	B	AWG12	1
		S	AWG12	1
		T	AWG12	1
TPD5	TPD5	J	AWG16	1
		K	AWG16	1
	TPD5_RTN	V	AWG16	1
		W	AWG16	1
TSPD1	SPD0_N	F	AWG16	1
		G	AWG16	1
	SPD0_N_RTN	H	AWG16	1
		U	AWG16	1
TTPD	TTPD_N	L	AWG12	1
		M	AWG12	1
	TTPD_N_RTN	X	AWG12	1
		Y	AWG12	1
UPD0	UPD0	C	AWG16	1
		N	AWG16	1
	UPD0_RTN	a	AWG16	1
		Z	AWG16	1
Totale complessivo				22

Tab. 5-8: J110 pin function

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Connector label	J111	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	29	29

Pinout				
Box	Line name	Pin label	AWG size	Totale
ERPD0	ER0_N	B	AWG16	1
		C	AWG16	1
		D	AWG16	1
	ER0_N_RTN	d	AWG16	1
		U	AWG16	1
		V	AWG16	1
TPD0	TPD0	A	AWG16	1
		R	AWG16	1
		S	AWG16	1
	TPD0_RTN	c	AWG16	1
		f	AWG16	1
		T	AWG16	1
TSPD4	SPD2_N	K	AWG16	1
		Z	AWG16	1
	SPD2_N_RTN	J	AWG16	1
		Y	AWG16	1
	TPD4	L	AWG16	1
		M	AWG16	1
		N	AWG16	1
	TPD4_RTN	a	AWG16	1
		b	AWG16	1
		P	AWG16	1
UGPD	UGPD_N	E	AWG16	1
		F	AWG16	1
		G	AWG16	1
	UGPD_N_RTN	H	AWG16	1
		W	AWG16	1
		X	AWG16	1
Totale complessivo				28

Tab. 5-9: J111 pin function

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Connector label	J112	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	29	29

Pinout				
Box	Line name	Pin label	AWG size	Totale
TMPD2	MPD_N	E	AWG16	1
		F	AWG16	1
		G	AWG16	1
	MPD_N_RTN	H	AWG16	1
		W	AWG16	1
		X	AWG16	1
	TPD2	B	AWG16	1
		C	AWG16	1
		D	AWG16	1
	TPD2_RTN	d	AWG16	1
		U	AWG16	1
		V	AWG16	1
TSPD6	SPD3_N	K	AWG16	1
		Z	AWG16	1
	SPD3_N_RTN	J	AWG16	1
		Y	AWG16	1
	TPD6	L	AWG16	1
		M	AWG16	1
		N	AWG16	1
	TPD6_RTN	a	AWG16	1
		b	AWG16	1
		P	AWG16	1
UPD1	UPD1	A	AWG16	1
		S	AWG16	1
	UPD1_RTN	c	AWG16	1
		T	AWG16	1
Totale complessivo				26

Tab. 5-10: J112 pin function

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Connector label	J113	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	29	29

Pinout				
Box	Line name	Pin label	AWG size	Totale
ERPD1	ER1_N	B	AWG16	1
		C	AWG16	1
		D	AWG16	1
	ER1_N_RTN	d	AWG16	1
		U	AWG16	1
		V	AWG16	1
JPD	JPD_N	E	AWG16	1
		F	AWG16	1
		G	AWG16	1
	JPD_N_RTN	H	AWG16	1
		W	AWG16	1
		X	AWG16	1
TPD7	TPD7	A	AWG16	1
		R	AWG16	1
		S	AWG16	1
	TPD7_RTN	c	AWG16	1
		f	AWG16	1
		T	AWG16	1
TSPD3	SPD1_N	K	AWG16	1
		Z	AWG16	1
	SPD1_N_RTN	J	AWG16	1
		Y	AWG16	1
	TPD3	L	AWG16	1
		M	AWG16	1
		N	AWG16	1
	TPD3_RTN	a	AWG16	1
		b	AWG16	1
		P	AWG16	1
Totale complessivo				28

Tab. 5-11: J113 pin function

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Connector label	J120	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	9	9

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuote)	CAN1	2	AWG26	1
	CAN1_RTN	1	AWG26	1
	CAN2	4	AWG26	1
	CAN2_RTN	3	AWG26	1
	SHIELD	9	AWG26	1
	TEMP1	5	AWG26	1
	TEMP1_RTN	7	AWG26	1
	TEMP2	6	AWG26	1
	TEMP2_RTN	8	AWG26	1
Totale complessivo				9

Tab. 5-12: J120 pin function

Connector label	J200	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		6	3	9

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuoto)	2P_120V	A	AWG12	1
	2P_120V_RTN	B	AWG12	1
	2P_FAULT	C	AWG12	1
	BI_120V	E	AWG8	1
	BI_120V_RTN	D	AWG8	1
	BI_FAULT	F	AWG8	1
Totale complessivo				6

Tab. 5-13: J200 pin function

Connector label	J201	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		6	3	9

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuote)	AP_120V	D	AWG8	1
	AP_120V_RTN	E	AWG8	1
	AP_FAULT	F	AWG8	1
Totale complessivo				3

Tab. 5-14: J201 pin function

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Connector label	J202	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		12	12	24

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuote)	BO_CCEB	L	AWG12	1
		M	AWG12	1
	BO_CCEB_RTN	A	AWG12	1
		P	AWG12	1
Totale complessivo				4

Tab. 5-15: J202 pin function

Connector label	J203	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	18	18

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuoto)	BH_OUT1	G	AWG20	1
	BH_OUT1_RTN	S	AWG20	1
	BH_OUT3	H	AWG20	1
	BH_OUT3_RTN	T	AWG20	1
	BH_OUT4	J	AWG20	1
	BH_OUT4_RTN	K	AWG20	1
	BH_OUT5	A	AWG20	1
		L	AWG20	1
	BH_OUT5_RTN	M	AWG20	1
		N	AWG20	1
	BH_OUT6	C	AWG20	1
	BH_OUT6_RTN	B	AWG20	1
	BH_OUT7	P	AWG20	1
	BH_OUT7_RTN	D	AWG20	1
Totale complessivo				14

Tab. 5-16: J203 pin function

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Connector label	J204	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	18	18

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuoto)	BH_OUT10	A	AWG20	1
	BH_OUT10_RTN	N	AWG20	1
	BH_OUT11	L	AWG20	1
	BH_OUT11_RTN	M	AWG20	1
	BH_OUT2	D	AWG20	1
		H	AWG20	1
		J	AWG20	1
	BH_OUT2_RTN	K	AWG20	1
		S	AWG20	1
		T	AWG20	1
	BH_OUT8	C	AWG20	1
	BH_OUT8_RTN	B	AWG20	1
	BH_OUT9	G	AWG20	1
	BH_OUT9_RTN	P	AWG20	1
Totale complessivo				14

Tab. 5-17: J204 pin function

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Connector label	J210	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		12	12	24

Pinout				
Box	Line name	Pin label	AWG size	Totale
CAB	CAB_R	A	AWG12	1
		D	AWG12	1
		E	AWG12	1
	CAB_R_RTN	B	AWG12	1
		S	AWG12	1
		T	AWG12	1
TSPD1	SPD0_R	F	AWG16	1
		G	AWG16	1
	SPD0_R_RTN	H	AWG16	1
		U	AWG16	1
	TPD1	J	AWG16	1
		K	AWG16	1
		N	AWG16	1
	TPD1_RTN	a	AWG16	1
		V	AWG16	1
		W	AWG16	1
TTPD	TTPD_R	L	AWG12	1
		M	AWG12	1
	TTPD_R_RTN	X	AWG12	1
		Y	AWG12	1
Totale complessivo				20

Tab. 5-18: J210 pin function

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Connector label	J211	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	16	16

Pinout				
Box	Line name	Pin label	AWG size	Totale
ERPD0	ER0_R	B	AWG16	1
		C	AWG16	1
		D	AWG16	1
	ER0_R_RTN	A	AWG16	1
		M	AWG16	1
		N	AWG16	1
TSPD4	SPD2_R	K	AWG16	1
		L	AWG16	1
	SPD2_R_RTN	J	AWG16	1
		S	AWG16	1
UGPD	UGPD_R	E	AWG16	1
		F	AWG16	1
		G	AWG16	1
	UGPD_R_RTN	H	AWG16	1
		P	AWG16	1
		R	AWG16	1
Totale complessivo				16

Tab. 5-19: J211 pin function

Connector label	J212	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	16	16

Pinout				
Box	Line name	Pin label	AWG size	Totale
TMPD2	MPD_R	E	AWG16	1
		F	AWG16	1
		G	AWG16	1
	MPD_R_RTN	H	AWG16	1
		P	AWG16	1
		R	AWG16	1
TSPD6	SPD3_R	K	AWG16	1
		L	AWG16	1
	SPD3_R_RTN	J	AWG16	1
		S	AWG16	1
Totale complessivo				10

Tab. 5-20: J212 pin function

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Connector label	J213	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	16	16

Pinout				
Box	Line name	Pin label	AWG size	Totale
ERPD1	ER1_R	B	AWG16	1
		C	AWG16	1
		D	AWG16	1
	ER1_R_RTN	A	AWG16	1
		M	AWG16	1
		N	AWG16	1
JPD	JPD_R	E	AWG16	1
		F	AWG16	1
		G	AWG16	1
	JPD_R_RTN	H	AWG16	1
		P	AWG16	1
		R	AWG16	1
TSPD3	SPD1_R	K	AWG16	1
		L	AWG16	1
	SPD1_R_RTN	J	AWG16	1
		S	AWG16	1
Totale complessivo				16

Tab. 5-21: J213 pin function

Connector label	J220	available pins 2nd AWG size	available pins 1st AWG size	Total available pins
		0	9	9

Pinout				
Box	Line name	Pin label	AWG size	Totale
(vuote)	CAN1	2	AWG26	1
	CAN1_RTN	1	AWG26	1
	CAN2	4	AWG26	1
	CAN2_RTN	3	AWG26	1
	SHIELD	9	AWG26	1
	TEMP3	5	AWG26	1
	TEMP3_RTN	7	AWG26	1
	TEMP4	6	AWG26	1
	TEMP4_RTN	8	AWG26	1
Totale complessivo				9

Tab. 5-22: J220 pin function

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SIGNAL NAME	Pin label	AWG Size
HEATER_1	A	AWG20
HEATER_2	B	AWG20
HEATER_3	C	AWG20
HEATER_7	D	AWG20
HEATER_8_SPARE	E	AWG20
HEATER_4_RTN	F	AWG20
HEATER_1_RTN	G	AWG20
HEATER_2_RTN	H	AWG20
HEATER_3_RTN	J	AWG20
HEATER_7_RTN	K	AWG20
HEATER_4	L	AWG20
HEATER_8_SPARE_RTN	M	AWG20
HEATER_5	N	AWG20
HEATER_6	P	AWG20
SPARE	R	AWG20
HEATER_5_RTN	S	AWG20
HEATER_6_RTN	T	AWG20
SPARE	U	AWG20

Tab. 5-23: J121 pin function

SIGNAL NAME	Pin label	AWG Size
HEATER_1	A	AWG20
HEATER_2	B	AWG20
HEATER_3	C	AWG20
HEATER_7	D	AWG20
HEATER_8_SPARE	E	AWG20
HEATER_4_RTN	F	AWG20
HEATER_1_RTN	G	AWG20
HEATER_2_RTN	H	AWG20
HEATER_3_RTN	J	AWG20
HEATER_7_RTN	K	AWG20
HEATER_4	L	AWG20
HEATER_8_SPARE_RTN	M	AWG20
HEATER_5	N	AWG20
HEATER_6	P	AWG20
SPARE	R	AWG20
HEATER_5_RTN	S	AWG20
HEATER_6_RTN	T	AWG20
SPARE	U	AWG20

Tab. 5-24: J221 pin function

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SIGNAL NAME	Pin label	AWG Size
TH 1_1	A	AWG 24
TH1_2	B	AWG 24
TH 2_1	C	AWG 24
TH2_2	D	AWG 24
THERM_ILOCK_A_1	E	AWG 24
THERM_ILOCK_A_2	F	AWG 24
THERM_ILOCK_B_1	G	AWG 24
THERM_ILOCK_B_2	H	AWG 24
TEST+_A	J	AWG 24
TEST2+_A	K	AWG 24
TEST-_A	L	AWG 24
TEST+_B	M	AWG 24
TEST2+_B	N	AWG 24
TEST-_B	P	AWG 24
VCC_IN_A	R	AWG 24
VCC_A	S	AWG 24
VCC_IN_B	T	AWG 24
VCC_B	U	AWG 24

Tab. 5-25: J300 pin function

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5.1.1.4 PDS END-USER CONNECTORS AND PINOUTS

This section defines the box side connectors and pin-outs for the end-user power feeds of the PDS. This is not part of the PDS itself but included for completeness.
Each power cable from the PDS is a "spider" type cable, with many endpoints. Cabling is planned to be unshielded, hand-twisted pairs with M22759/44 wire.

5.1.1.4.1 120V (NOMINAL) CONNECTIONS

CAB/CSS connector for magnet charging located on top of the CAB:

Connector		**CAB/J01**		
P/N (Box Side)		**MS27508E16F6PA**		
Voltage (nominal)		**120V**		
Rated Current		**20A**		
From PDS Connector		**J102**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	not used			empty
B	not used			empty
C	AO_CCS	#1	12	12
D	AO_CCS	#2	12	12
E	AO_CCS_RTN	#2	12	12
F	AO_CCS_RTN	#1	12	12

Note: Key "A"

CCEB connectors for cryocoolers, one each for A and B, total flight quantity of 2:

Connector		**CCEB 120V inputs**		
P/N (Box Side)		**MS27508E16F6PA**		
Voltage (nominal)		**120V**		
Rated Current		**8A**		
From PDS Connector		**J102, J202**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	not used			empty
B	not used			empty
C	[A, B]O_CCEB	#1	12	12
D	[A, B]O_CCEB	#2	12	12
E	[A, B]O_CCEB_RTN	#2	12	12
F	[A,B]O_CCEB_RTN	#1	12	12

Note: Key "A"

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Ram radiator heater connectors, one each for A and B, total 2:

Connector		**ram radiator heaters**		
P/N (Box Side)		**MS27508E10F98P**		
Voltage (nominal)		**120V**		
Rated Current		**2.8A**		
From PDS Connector		**J104, J204**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	[A,B]H_OUT2_RTN	#1	20	20
B	[A,B]H_OUT2	#1	20	20
C	[A,B]H_OUT2	#2	20	20
D	[A,B]H_OUT2	#3	20	20
E	[A,B]H_OUT2_RTN	#3	20	20
F	[A,B]H_OUT2_RTN	#2	20	20

HV Brick (EHV, RHV) heater connectors, one per brick, total 10:

Connector		**Brick 120V A+B heaters**		
P/N (Box Side)		**MS27508E10F98PA**		
Voltage (nominal)		**120V**		
Rated Current		**1.2A**		
From PDS Connector		**J103, J203 via HPP**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	A_RTN	#1	20	20
B	A	#1	20	20
C	not used			empty
D	B	#1	20	20
E	B_RTN	#1	20	20
F	not used			empty

Note: Key "A"

Note: A + B lines are on the same connector (HPP = heater patch panel). SHV has no heaters.

Heater connectors, used for HPP to ECAL, RICH and LUSS Boxes, TRD and TRD Gas, Tracker Wake and Ram, LTOF, Cryocoolers; Wake Main Radiator and CAB, A and B on separate connectors, total about 28:

Connector		**other 120V heaters and HPP**		
P/N (Box Side)		**MS27508E10F98P**		
Voltage (nominal)		**120V**		
Rated Current		**1.2A and 1.6A***		
From PDS Connector		**J103,J 104, J203, J204**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	[A,B]H_OUT2_RTN	#1	20	20
B	[A,B]H_OUT2	#1	20	20
C	not used			empty
D	not used			empty
E	not used			empty
F	not used			empty

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28V connections

For CAB and TT 28V power, nominal and redundant, total of 4:

Connector		**10A 28V**		
P/N (Box Side)		**MS27508E16F6P**		
Voltage (nominal)		**28V**		
Rated Current		**10A**		
From PDS Connector		**J110, J210**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	[CAB,TTPD]_[N,R]_RTN	#1	12	12
B	[CAB,TTPD]_[N,R]	#1	12	12
C	[CAB,TTPD]_[N,R]	#2	12	12
D	not used			empty
E	not used			empty
F	[CAB,TTPD]_[N,R]_RTN	#2	12	12

Note: PDS line "TTPD..." is a misnomer. The TTPD has been suppressed; these lines connect directly to the TT-Crate (also known as TTCE).

For high power or long distance 28V power, used for nominal and redundant of ERPD, JPD, MPD, UGPD and nominal only of TPD, total of 26:

Connector		**5A 28V Hi Drop**		
P/N (Box Side)		**MS27508E16F8P**		
Voltage (nominal)		**28V**		
Rated Current		**5A**		
From PDS Connector		**J111, J112, J113, J210, J211, J212, J213**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	[x]_RTN	#1	16	16
B	[x]	#1	16	16
C	[x]	#2	16	16
D	[x]_RTN	#2	16	16
E	[x]_RTN	#3	16	16
F	[x]	#3	16	16
G	not used			empty
H	not used			empty

Note that, in fact, TPD5 will receive only two pairs, but internally should be wired for three.

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For low power or nearby 28V power, used for nominal and redundant of SPD and nominal only of UPD, total of 10:

Connector		**5A 28V Lo Drop**		
P/N (Box Side)		**MS27508E16F8P**		
Voltage (nominal)		**28V**		
Rated Current		**5A**		
From PDS Connector		**J110, J111, J112, J113, J210, J211, J212, J213**		
Pin	**PDS Line Name**	**Pair**	**AWG**	**Size**
A	[x]_RTN	#1	16	16
B	[x]	#1	16	16
C	not used			empty
D	not used			empty
E	[x]_RTN	#2	16	16
F	[x]	#2	16	16
G	not used			empty
H	not used			empty

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5.2 POWER INTERFACE REQUIREMENTS

5.2.1 INPUT POWER CHARACTERISTICS

The PDS is powered by 3 different power upstream as describe Tab. 5-1.

The input requirements have been derived from the document [AD] 1 SSP 57003 Attached Payload Interface Requirements Document) since are the most restricted with respect to the other input upstream requirements..

5.2.1.1 STEADY STATE VOLTAGE RANGE

The PDS is fully operational for a steady state input voltage range of

113VDC - 126 VDC

5.2.1.2 RIPPLE VOLTAGE SPECTRUM

The input voltage ripple susceptibility limits are shown in the following figure

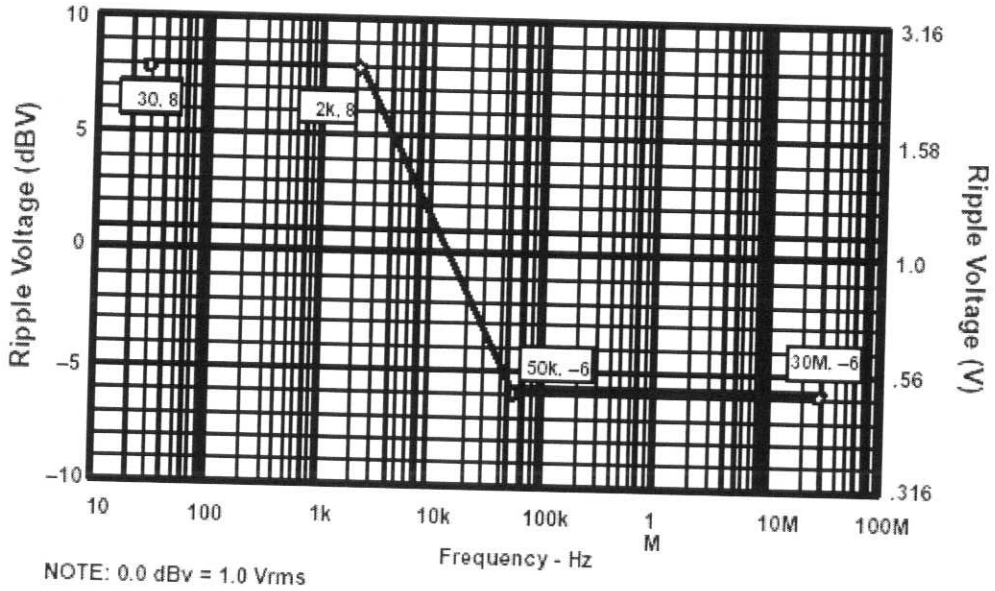

Fig. 5-7: Maximum Input Voltage Ripple Susceptibility Limit (Spectral Components)

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5.2.1.3 TRANSIENT VOLTAGE

5.2.1.3.1 NORMAL TRANSIENT VOLTAGE

The PDS is compatible with the limit of magnitude and duration of the voltage transient as shown in the following figure.

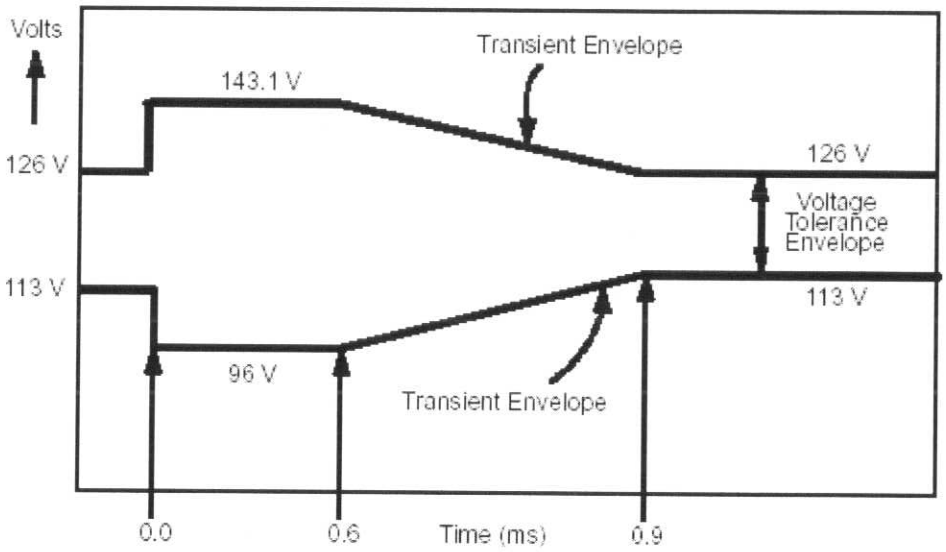

Fig. 5-8: PDS input Normal Voltage Transient

5.2.1.3.2 FAULT CLEARING AND PROTECTION

The PDS is compatible with the transient voltage conditions that are within the limits shown in the following figure.

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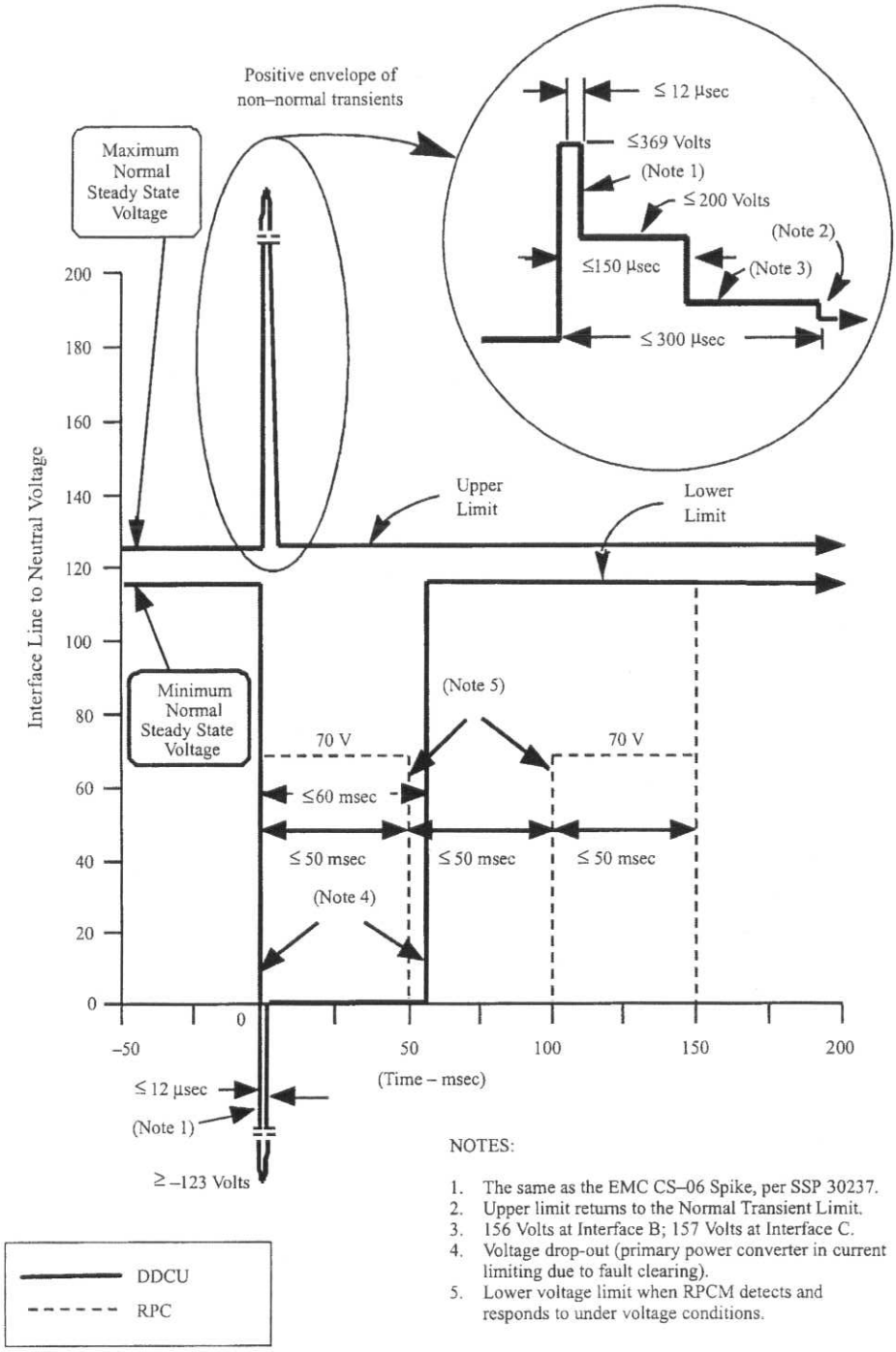

NOTES:

1. The same as the EMC CS–06 Spike, per SSP 30237.
2. Upper limit returns to the Normal Transient Limit.
3. 156 Volts at Interface B; 157 Volts at Interface C.
4. Voltage drop-out (primary power converter in current limiting due to fault clearing).
5. Lower voltage limit when RPCM detects and responds to under voltage conditions.

Fig. 5-9: fault clearing and protection transient limits

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5.2.1.3.3 NON NORMAL VOLTAGE RANGE

The PDS will not produce an unsafe condition or one that could result in damage to ISS equipment with the following non-normal voltage characteristics:

- Maximum over voltage of + 165 Volts direct current (Vdc) for up to 10 sec.
- Under voltage conditions of +102 Vdc for an indefinite period of time.

5.2.1.4 INPUT CURRENT RATING

The PDS is compatible with power supply current defined in the following paragraphs.

5.2.1.4.1 ISS POWER BUS CHARACTERISTICS

The AMS 02 experiment will be located on the ISS in the following position:

Payload Attached System (PAS) location in Integrated Truss Segment (ITS) S3

ITS S3 PAS 2

The power supply of this location is guaranteed by two separated Electrical Power System – for AMS called BUS A and BUS B :

INPUT BUS	Max Power [KW]	PIN	Current Rating	Lowest Current Limitation Level	Minimum Trip Decision Time	TYPE	CONNECTOR I/F	PDS connector
A	3	3 x AWG8	25 A	27.5 A	31 ms	RPCM II	EVA PANEL P121	J100
B	3	3 x AWG8	25 A	27.5 A	31 ms	RPCM II	EVA PANEL P122	J200

Tab. 5-26: ISS Power Supply Characteristic

The electrical characteristic are described in the [AD] 1 SSP 57003 Attached Payload Interface Requirements Document

5.2.1.4.1.1 INPUT CURRENT CHARACTERISTIC (I PEAK – INRUSH)

The PDS input current limit are described in the following table as defined in [AD] 1 para 3.2.2.2.4:

Steady State Input voltage		Iss (Steady State current)	Ipk (For 5A < Iss < 50A Ipk= 0.667*Iss+16.667)	Current Rate Of Change dI/dt (For 0A < Ipk < 50A dI/dT = 300 – 5*Ipk
MAX	126 V	2000 W / 126 V = 15.9 A	27.3 A	163.5 A/ms
MIN	113 V	2000 W / 113 V = 17.7 A	28.5 A	157.5 A/ms

Tab. 5-27: PDS input current characteristic

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5.2.1.4.2 PVGF POWER BUS CHARACTERISTICS

During the transfer phase from Shuttle to the ISS the AMS 02 will be connected to the robotic arm Power Video Grapple Fixture (PVGF).

The power supply is guaranteed by two separated Electrical Power System as described in [AD] 2 SSP 57004 Attached Payload Hardware Interface Control Document Template and resumed in the following table:

INPUT BUS	Internal BUS connection	PIN	Max Power for AMS [KW]	Current Rating [@ 120V]	Lowest Current Limitation Level	Minimum Trip Decision Time	TYPE	CONNECTOR I/F	PDS connector
PVGF 1	A	3 x AWG12	1.8	15A	27.5A	31 ms	RPCM II	BCS P12	J100
PVGF 2	B	3 x AWG12	1.8	15A	27.5A	31 ms	RPCM II	BCS P9	J200

Tab. 5-28: PVGF Power Supply Characteristic

the two input buses listed on the table are operationally constrained for redundancy. It is planned to only have one or the other bus active at any time.

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5.2.1.4.2.1 INPUT CURRENT CHARACTERISTIC (I PEAK – INRUSH)

See Tab. 5-27

5.2.1.4.3 STS POWER SUPPLY CHARACTERISTICS

The power supply is guaranteed by two different line:

- T0 – when the shuttle is on the Launch Pad before lifting off
- APCU – when the shuttle is on orbit after launch

The main characteristics are described in the following table:

INPUT BUS	Internal BUS connection	PIN	Max Power [KW]	Current Rating	Lowest Current Limitation Level	Minimum Trip Decision Time	TYPE	CONNECTOR I/F	PDS connector
T0	A	6 x AWG12	3	25 A	27.5 A	31 ms	RPCM II	IFPA P8	J101
APCU	B	3 x AWG8	1.8 3.6 (1)	14.7 A 29.4A (1)	22 A	100 msec	--	IFPA P1	J201

Tab. 5-29: STS Power Supply Characteristic

(1) If two APCU in parallel are used

5.2.1.4.3.1 INPUT CURRENT CHARACTERISTIC (I PEAK – INRUSH)

See Tab. 5-27

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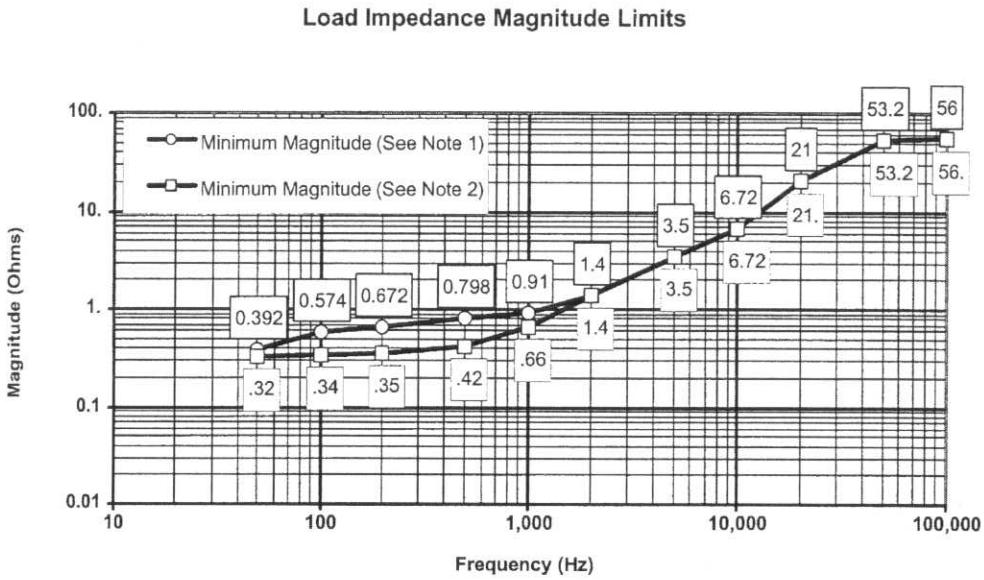
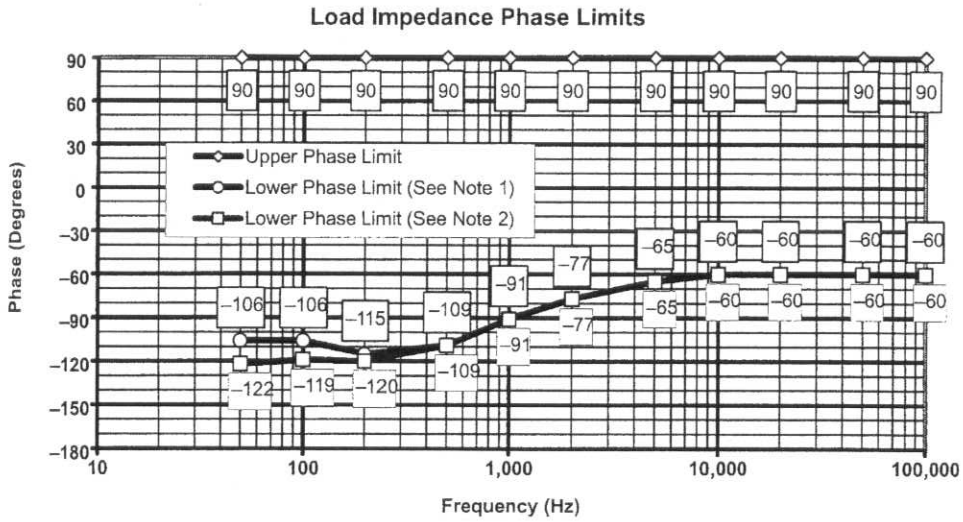
5.2.1.5 POWER INPUT IMPEDANCE

The PDS input impedance minimum limits for magnitude and phase are showed in the following figure.

SSP 57003 September 22, 1999





Notes:
1. Limit when steady state EPCE loading is less than 800 watts (see note 3).
2. Limit when steady state EPCE loading is at least 800 watts (see note 3).
3. 800 watts if from two DDCUs operating in parallel, or 400 watts from a single DDCU.

Fig. 5-10: Input impedance limits

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5.2.2 POWER DISSIPATION

The power dissipation of the PDS is strictly dependent of the load configuration considered.

It has been estimated considering the maximum nominal dissipation configuration that is defined as "Step4 configuration"

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Voltage	Element	Subsystem / Instruments	Minimum Nominal Powered Required (step 0,1)	Maximum Nominal Powered Required (step 4)
	PDS	Heaters	260,0	0
	CAB	120V A	0	0
@120V	ESEM3B			
	CCEB	120V A	0	460,2
	Heater-1	Ram Tracker Radiator/Condenser	137,0	0
	Heater-2	Ram main radiator	362,0	0
	Heater-3	TRD Gas Box+TTCB+LowerUSS	154,0	154,0
	Heater-4	Wake Tracker Radiator/Condenser	137,0	0
	Heater-5	Wake Main Radiator + CAB	258,0	0
	Heater-6	Zenith radiator I + II	0	0
	Heater-7	Zenith radiator III + IV	0	0
	Heater-8	Rich + Tof	154,0	0
	Heater-9	Ecal + E-Crate	154,0	0
	Heater-10	Cryocoolers I + II	154,0	0
	Heater-11	Cryocoolers III + IV	154,0	0
@28V	PB2+ESEM3A - 1		*(50)*	*(365)*
	28V.1.1	TPD3	0	80,0
	28V.1.2	TPD7	0	80,0
	28V.1.3	JPD_N	50,0	50,5
	28V.1.4	SPD1_N	0	41,9
	28V.1.5	UGPD_N	0	32,7
	28V.1.6	SPD0_R	0	0
	28V.1.7	TPD1	0	80,0
	28V.1.8	TTPD_R	0	0
	PB2+ESEM3A - 2		*(00)*	*(410)*
	28V.2.1	ER1_N	0	74,8
	28V.2.2	TPD2	0	80,0
	28V.2.3	TPD6	0	80,0
	28V.2.4	SPD3_N	0	41,9
	28V.2.5	MPD_N	0	45,6
	28V.2.6	UPD1	0	45,4
	28V.2.7	SPD2_N	0	41,9
	28V.2.8	CAB_R	0	0
	PB2+ESEM3A - 3		*(00)*	*(335)*
	28V.3.1	TPD0	0	80,0
	28V.3.2	TPD4	0	80,0
	28V.3.3	ER0_N	0	74,8
	28V.3.4	MPD_R	0	0
	28V.3.5	SPD3_R	0	0
	28V.3.6	UGPD_R	0	0
	28V.3.7	SPD2_R	0	0
	28V.3.8	CAB_N	0	100,0
	PB2+ESEM3A		*(50)*	*(304)*
	28V.4.1	JPD_R	50,0	0
	28V.4.2	ER1_R	0	0
	28V.4.3	SPD1_R	0	0
	28V.4.4	ER0_R	0	0
	28V.4.5	UPD0	0	45,4
	28V.4.6	SPD0_N	0	41,9
	28V.4.7	TPD5	0	80,0
	28V.4.8	TTPD_N	0	136,3
		total 28V out	*100*	*1413*
		total 120V out	*1924*	*614*
		total load	**2.024,0**	**2.027,7**

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Fig. 5-11: PDS Nominal power configuration

It should be pointed out that the power dissipation is also dependent from the input voltage bus that modify the dcdc converters working point rising the power consumption of each module.

Two cases are thus analyzed:

- Input bus @ nominal value: 120V
- Input bus at lower value: 113V

Next figures shows the 2 cases estimations.

Board	Internal consumption	Switching losses	Distribution losses	Pdissipated module	Pdelivered	I TOT	GLOBAL/ ESEM ON/OFF	Out1 [A]	Out2 [A]	Out3 [A]	Out4 [A]	Out5 [A]	Out6 [A]	Out7 [A]	Out8 [A]	Out9 [A]	Out10 [A]	Out11 [A]	Out12 [A]
Inrush MOS (input stage)			13.70	13.70															
EMI inductors			20.56	20.56			1												
Input Telemetry	4		2.06	6.06		CAB													
ESEM1-A (*)	23.7	0.0	0.00	23.72	67.0														
CAN BUS I/F (2xHOT)	12.0	0.0	0.0	12.0	0.0														
E3-B (120V distribution)	5.0	0.0	1.31	6.31	620.7	5.18													
E3-B Rds_ON+Rsense [ohm]=										1.30									
Num MOS								0.51	0.17	0.51	0.51	0.255	0.51	0.51	0.51	0.51	0.51	0.51	3.88
PB2/1 (120V to 28V dcdc)	7.5			46.71	384.8	13.04	1	1	3	1	1	2	1	1	1	1	1	1	0.03
PB2/2 (120V to 28V dcdc)	7.5			54.12	431.7	14.63	1	6.52	6.52	EFFoverall module			90,8%	Pin	423,98	Iin	3,5	1	4
PB2/3 (120V to 28V dcdc)	7.5			42.34	352.9	11.96	1	7.32	7.32	EFFoverall module			90,3%	Pin	478,3	Iin	4,0		
PB2/4 (120V to 28V dcdc)	7.5			38.41	319.9	10.84	1	5.98	5.98	EFFoverall module			91,0%	Pin	387,72	Iin	3,2		
SUB TOT 28V converter	**30,0**	**0,0**	**0,00**	**181,58**	**1489,2**	50.48		5.42	5.42	EFFoverall module			91,2%	Pin	350,78	Iin	2,9		
E3-A/1 (28V distribution)	5.0	0.0	9.97	14.97	374.8	13.04		28V.1.1	28V.1.2	28V.1.3	28V.1.4	28V.1.5	28V.1.6	28V.1.7	28V.1.8				
								2.86	2.86	1.80	1.50	1.17		2.86					
E3-A/2 (28V distribution)	5.0	0.0	10.97	15.97	420.7	14.63		28V.2.1	28V.2.2	28V.2.3	28V.2.4	28V.2.5	28V.2.6	28V.2.7	28V.2.8				
								2.67	2.86	2.96	1.50	1.63	1.52	1.50					
E3-A/3 (28V distribution)	5.0	0.0	9.71	14.71	343.2	11.96		28V.3.1	28V.3.2	28V.3.3	28V.3.4	28V.3.5	28V.3.6	28V.3.7	28V.3.8				
								2.86	2.86	2.67					3.57				
E3-A/4 (28V distribution)	5.0	0.0	8.99	13.99	310.9	10.84		28V.4.1	28V.4.2	28V.4.3	28V.4.4	28V.4.5	28V.4.6	28V.4.7	28V.4.8				
SUB TOT 28V distribution	**20,0**	**0,0**	**39,65**	**59,65**	**1449,6**	50.48						1.52	1.50	2.86	4.87				

	Dissipated [W]	Delivered [W]	Distributed 120V [W]	Distributed 28V [W]	Input [W]	Distr 120V %	Distr 28V %
resume	326.8	2070.2	620.7	1449.6	2397.0	30.0%	70.0%
BUS A	326.8	2070.2	620.7	1449.6	2397.0	30.0%	70.0%

Fig. 5-12: PDS Step 4 Nominal power configuration – dissipation evaluation @ 120V input bus

Board	Internal consumption	Switching losses	Distribution losses	Pdissipated module	Pdelivered	I TOT	GLOBAL/ ESEM ON/OFF	Out1 [A]	Out2 [A]	Out3 [A]	Out4 [A]	Out5 [A]	Out6 [A]	Out7 [A]	Out8 [A]	Out9 [A]	Out10 [A]	Out11 [A]	Out12 [A]
Inrush MOS (input stage)			15.85	15.85															
EMI inductors			23.77	23.77			1												
Input Telemetry	4		2.38	6.38		CAB													
ESEM1-A (*)	23.7	0.0	0.00	23.72	67.0														
CAN BUS I/F (2xHOT)	12.0	0.0	0.0	12.0	0.0														
E3-B (120V distribution)	5.0	0.0	1.48	6.48	621.0	5.51													
E3-B Rds_ON+Rsense [ohm]=										1.38									
Num MOS								0.51	0.17	0.51	0.51	0.255	0.51	0.51	0.51	0.51	0.51	0.51	4.13
E4/1 (120V to 28V dcdc)	7.5			54.07	384.8	13.04	1	1	3	1	1	2	1	1	1	1	1	1	0.03
E4/2 (120V to 28V dcdc)	7.5			62.35	431.7	14.63	1	6.52	6.52	EFFoverall module			87,7%	Pin	438,85	Iin	3,9	1	4
E4/3 (120V to 28V dcdc)	7.5			49.58	352.9	11.96	1	7.32	7.32	EFFoverall module			87,4%	Pin	494,02	Iin	4,4		
E4/4 (120V to 28V dcdc)	7.5			45.78	319.9	10.84	1	5.98	5.98	EFFoverall module			87,7%	Pin	402,45	Iin	3,6		
SUB TOT 28V converter	**30,0**	**0,0**	**0,00**	**211,78**	**1489,2**	50.48		5.42	5.42	EFFoverall module			87,5%	Pin	365,65	Iin	3,2		
E3-A/1 (28V distribution)	5.0	0.0	9.97	14.97	374.8	13.04		28V.1.1	28V.1.2	28V.1.3	28V.1.4	28V.1.5	28V.1.6	28V.1.7	28V.1.8				
								2.86	2.86	1.80	1.50	1.17		2.86					
E3-A/2 (28V distribution)	5.0	0.0	10.97	15.97	420.7	14.63		28V.2.1	28V.2.2	28V.2.3	28V.2.4	28V.2.5	28V.2.6	28V.2.7	28V.2.8				
								2.67	2.86	2.86	1.50	1.63	1.52	1.50					
E3-A/3 (28V distribution)	5.0	0.0	9.71	14.71	343.2	11.96		28V.3.1	28V.3.2	28V.3.3	28V.3.4	28V.3.5	28V.3.6	28V.3.7	28V.3.8				
								2.86	2.86	2.67					3.57				
E3-A/4 (28V distribution)	5.0	0.0	8.99	13.99	310.9	10.84		28V.4.1	28V.4.2	28V.4.3	28V.4.4	28V.4.5	28V.4.6	28V.4.7	28V.4.8				
SUB TOT 28V distribution	**20,0**	**0,0**	**39,65**	**59,65**	**1449,6**	50.48						1.52	1.50	2.86	4.87				

	Dissipated [W]	Delivered [W]	Distributed 120V [W]	Distributed 28V [W]	Input [W]	Distr 120V %	Distr 28V %
resume	363.2	2070.5	621.0	1449.6	2433.8	30.0%	70.0%
BUS A	363.2	2070.5	621.0	1449.6	2433.8	30.0%	70.0%

Fig. 5-13: PDS Step 4 Nominal power configuration – dissipation evaluation @ 113V input bus

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Considering the estimation accuracy it can be resumed that the PDS power dissipation is:

PDS DISSIPATED POWER BUDGET	
Nominal case	333W
Worst case	365W

Fig. 5-14: PDS Dissipated Power Budget

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5.3 GROUNDING AND ISOLATION

The PDS follows the distributed single point grounding system. Primary power is isolated from equipment chassis and secondary power is grounded at one single location within the equipment chassis.

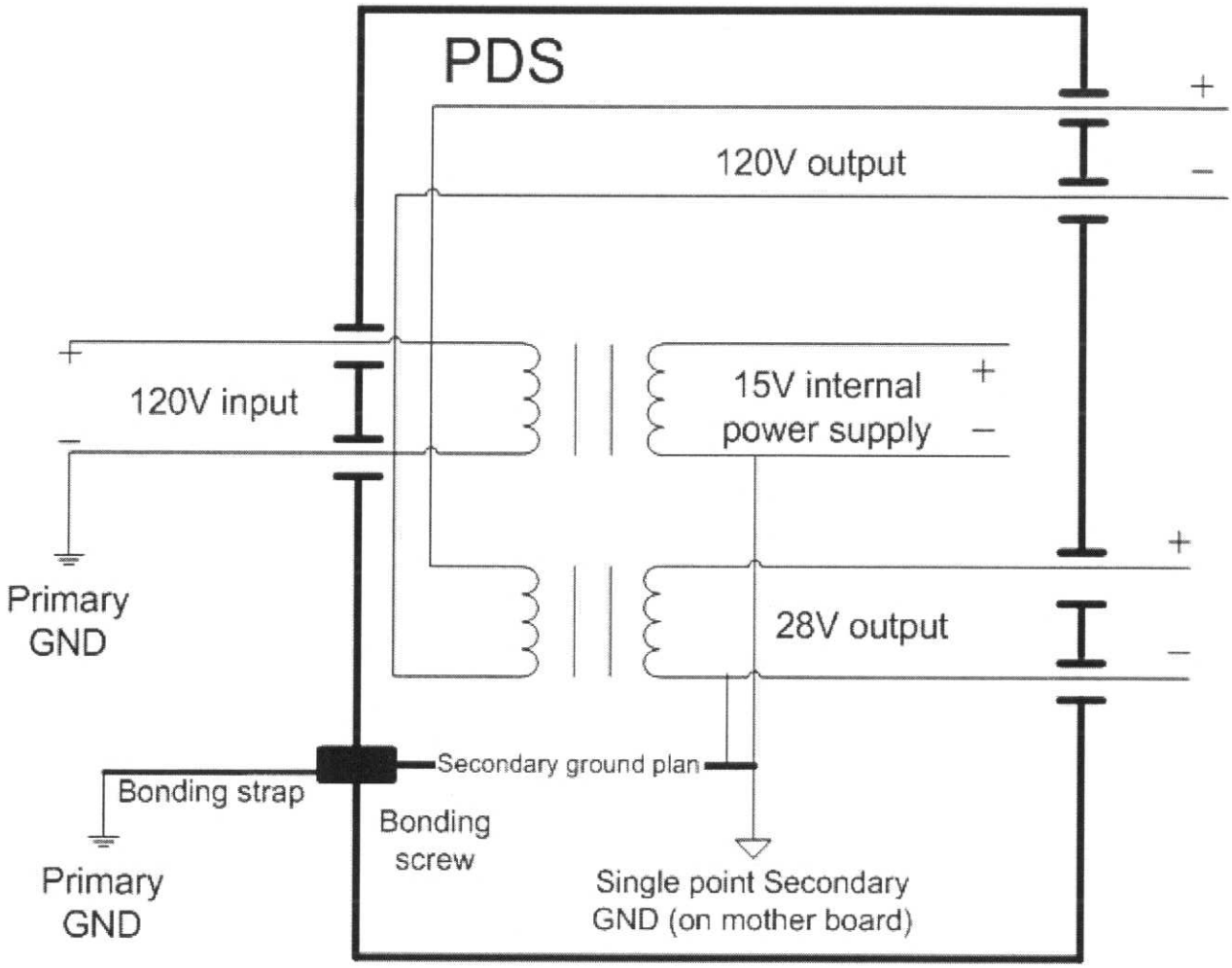

Fig. 5-15: PDS grounding and isolation

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5.4 ELECTRICAL BONDING

The bonding path is via the bonding stub defined in the mechanical interface drawing.

The PDS internal bonding path is represented in the following picture:

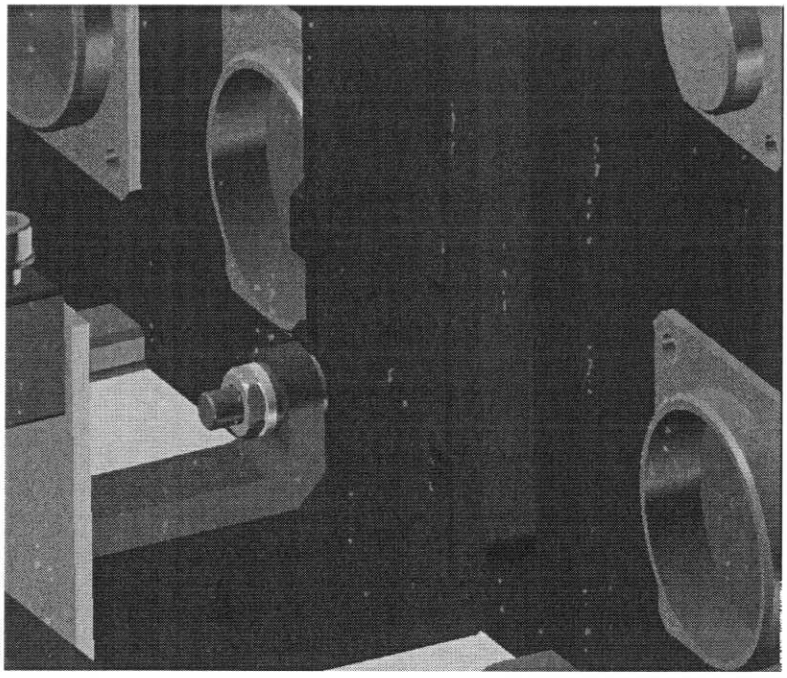

Fig. 5-16: PDS internal bonding mechanical drawing

The bonding screw is located in the rear panel of the PDS (connectors panel).

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5.5 POWER OUTPUTS

The PDS consists of the following outputs:

- 32 X 28V outputs (connected to side A and B of the PDS)

Of which
  - 28 X 5A each
  - 4 X 10A each
- 19 X 120V (side A)

Of which
  - 11 X various fix current value for AMS heaters
  - 1 X 10A
  - 7 X fix current value for PDS heaters
- 19 X 120V (side B)

Of which
  - 11 X various fix current value for AMS heaters
  - 1 X 10A
  - 7 X fix current value for PDS heaters

5.5.1 28V OUTPUT CARACTHERISTICS

On each side the 28V is generated by 4 PB2 module (120V to 28V dcdc converter), and distributed by 4 ESEM3-A board.
Each ESEM3-A board consists of 8 outputs which have the electrical characteristics described in the following paragraphs.

5.5.1.1 OUTPUT VOLTAGE RANGE

The steady state output voltage range is 27 VDC to 29 VDC.

5.5.1.2 SOURCE BROAD BAND VOLTAGE RIPPLE

The generated broadband voltage ripple does not exceed 350 mVpp at the output of the PDS when measured with a bandwidth of ≤ 5 MHz.

5.5.1.3 LOAD BROAD BAND VOLTAGE RIPPLE

The generated broadband voltage ripple generated by the user does not exceed 200 mVpp when measured with a bandwidth of ≤ 50MHz

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5.5.1.4 SOURCE IMPEDANCE

The impedance of the 28 VDC outlet source does not exceed the limits as given in Fig. 5-17 and Fig. 5-18 respectively for magnitude and phase.

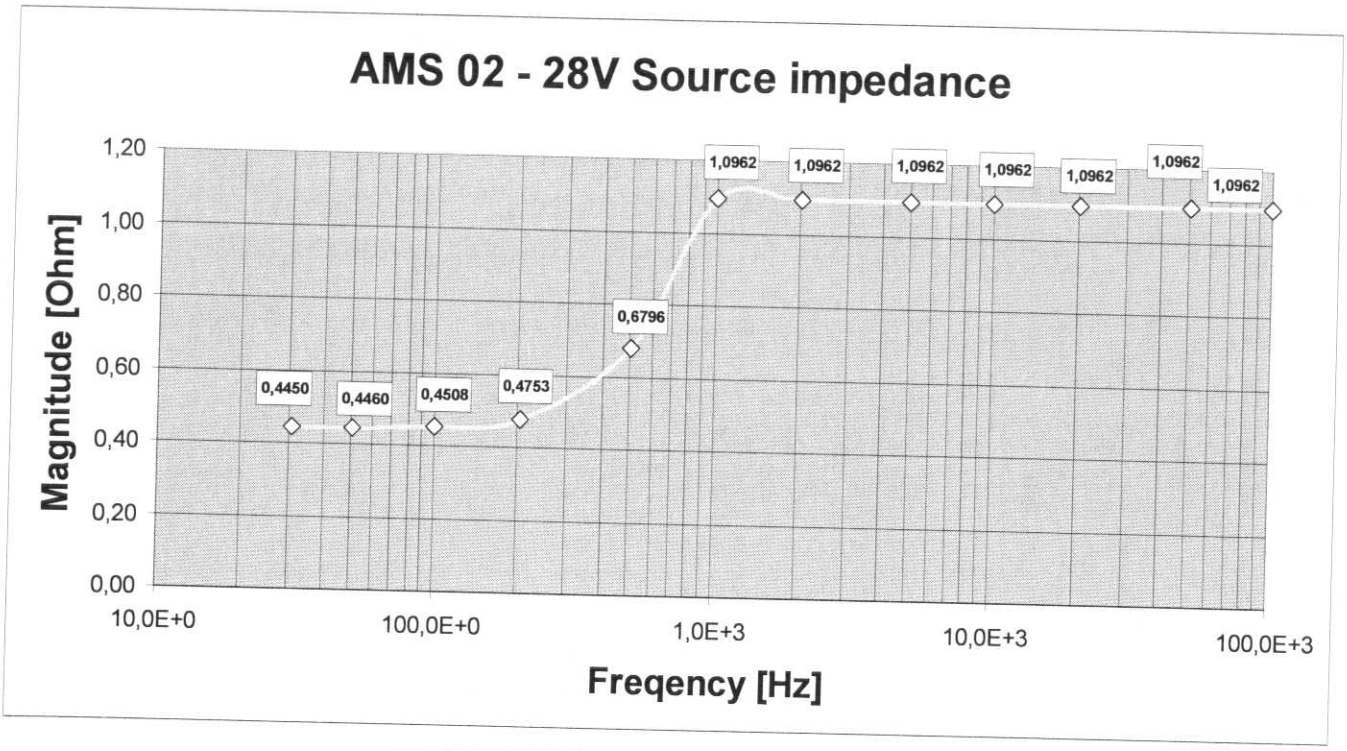

Fig. 5-17: 28V Source Impedance – Magnitude

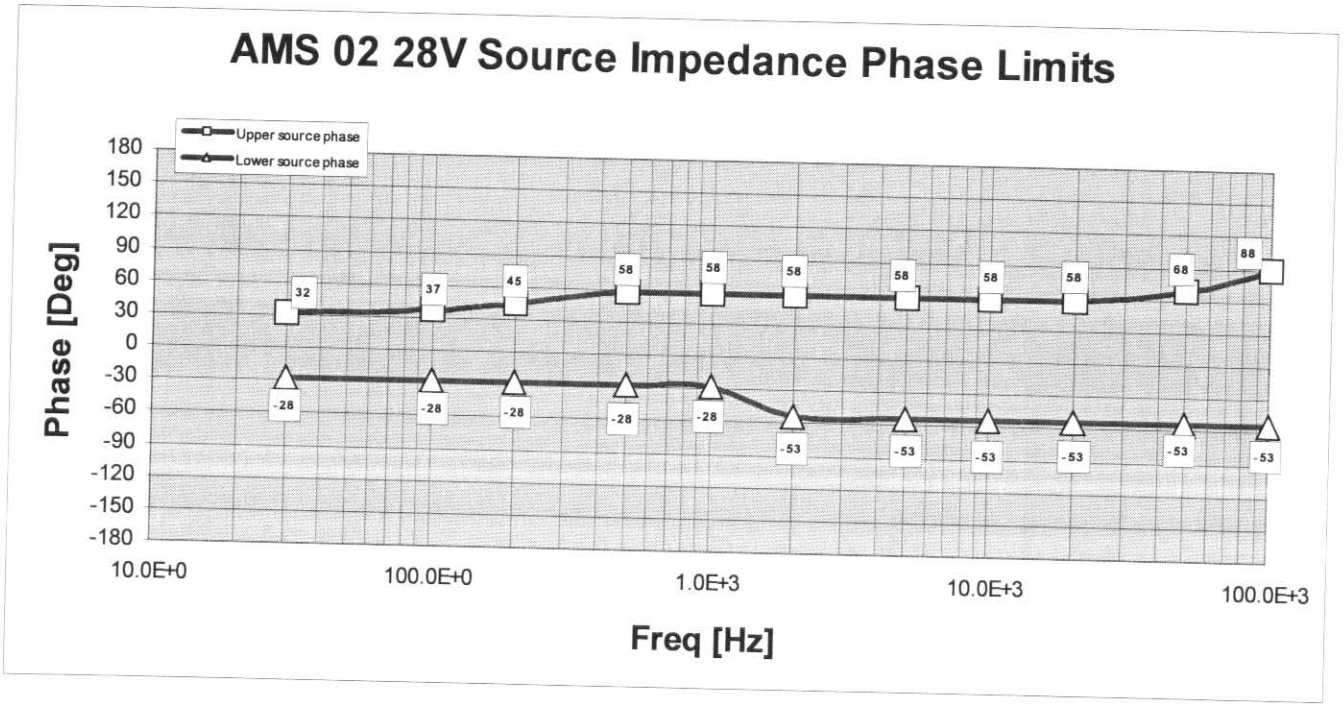

Fig. 5-18: 28V Source Impedance – Phase Limits

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5.5.1.5 LOAD IMPEDANCE

The load impedance limits of the user of the 28 VDC outlet are shown in Fig. 5-19 and Fig. 5-20 respectively for magnitude and phase.

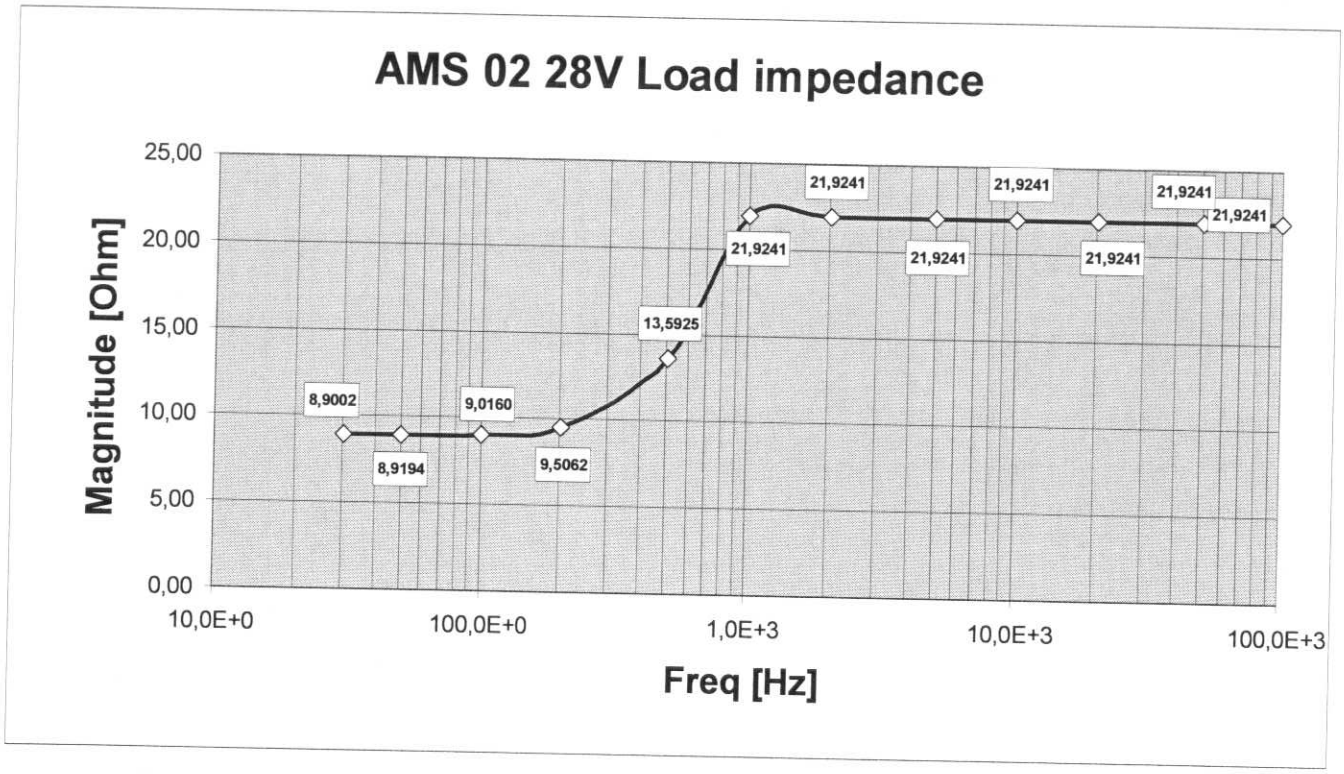

Fig. 5-19: 28V Typical Minimum Load Impedance (all user absorbing 2.5A each) - Magnitude

The magnitude limit of the load impedance is adjustable depending of the user current absorption.

The conversion rule for minimum load impedance limit (in ohm) is:

Mask value(Ohm) * 2 * (1.25/ I(A)), where I(A) is the user input current in Amperes.

The limit must be adjusted for current absorption of: $1,25 < I(A) < 5$

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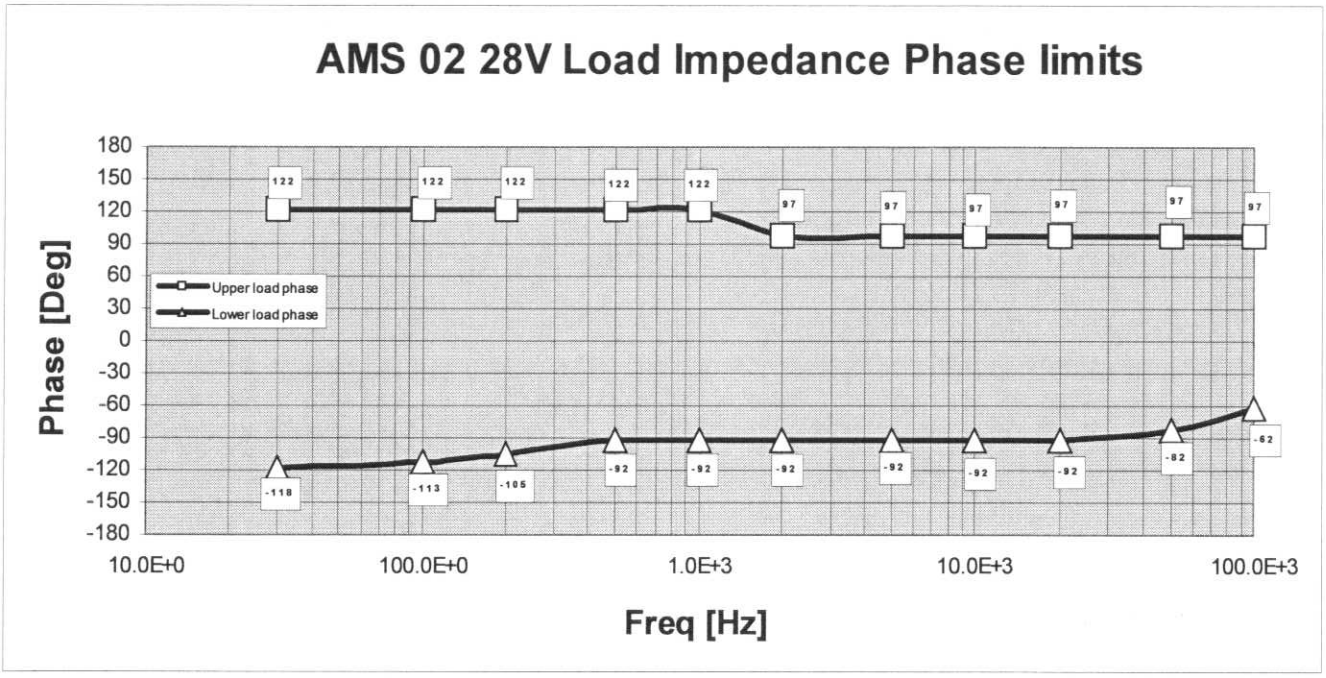

Fig. 5-20: 28V Load Impedance – Phase Limits

The equivalent load impedance when all the user (absorbing 2.5A each) are connected shall not be less than the mask of Fig. 5-17.

At frequency where the magnitude component of the user input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in Fig. 5-20.

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5.5.1.6 ABNORMAL OPERATION

The voltage transients for abnormal operation is inside the limits given in the following figure.

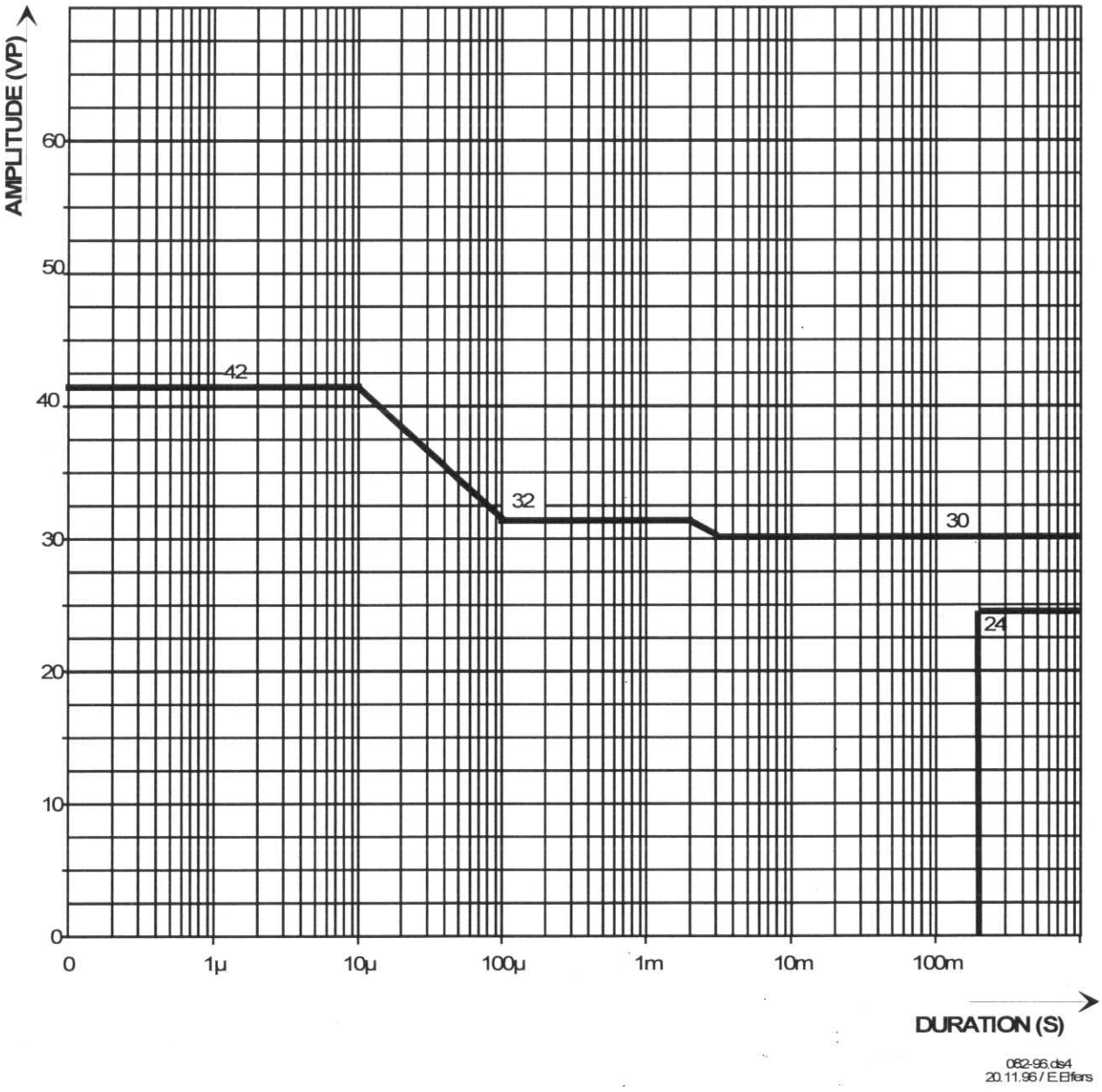

Fig. 5-21: Voltage Transients for Abnormal Operations 28 VDC

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5.5.1.7 CURRENT RATING

For each ESEM3-A the maximum current rating is set to 5A for all the outlet with the exception of outlet 8 that is set to 10A.

5.5.1.8 OUTPUT PROTECTION

The trip characteristic of the 28V outputs is shown in the following figure.

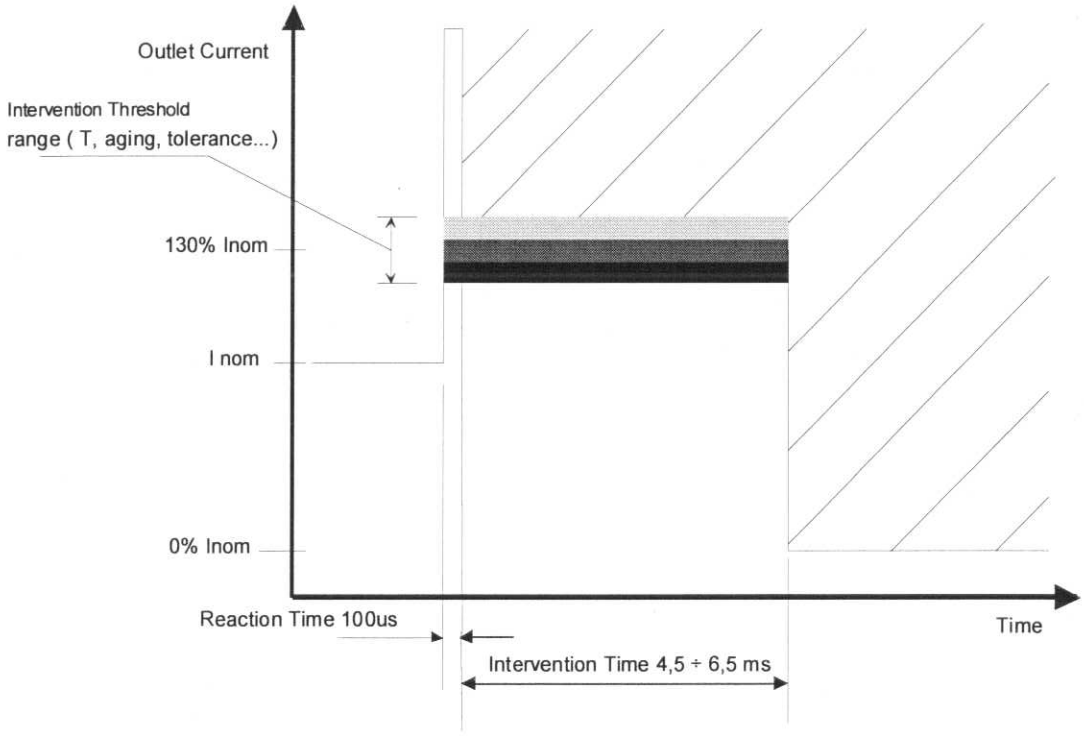

Fig. 5-22: 28V output trip characteristic

The modules provides remote re-settable over current protection. After tripping no automatic reset is performed.

5.5.1.9 LOAD IN-RUSH CURRENT SLOPE

The load in-rush current slope shall not exceed the value of 5A/msec

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5.5.2 120V OUTPUT CHARACTHERISTIC

The 120V coming from the power input bus of the PDS is distributed by the ESEM3-B board.
The board consists of 12 outputs: 11 dedicated to the AMS heaters; 1 dedicated to CCEB power supply.

5.5.2.1 VOLTAGE RANGE

The PDS user shall be fully operational for a steady state voltage range of

113VDC - 126 VDC

5.5.2.2 VOLTAGE RIPPLE

The user connected to the 120V output of the PDS shall operate and be compatible with the ripple voltage spectrum as shown in the following figure.

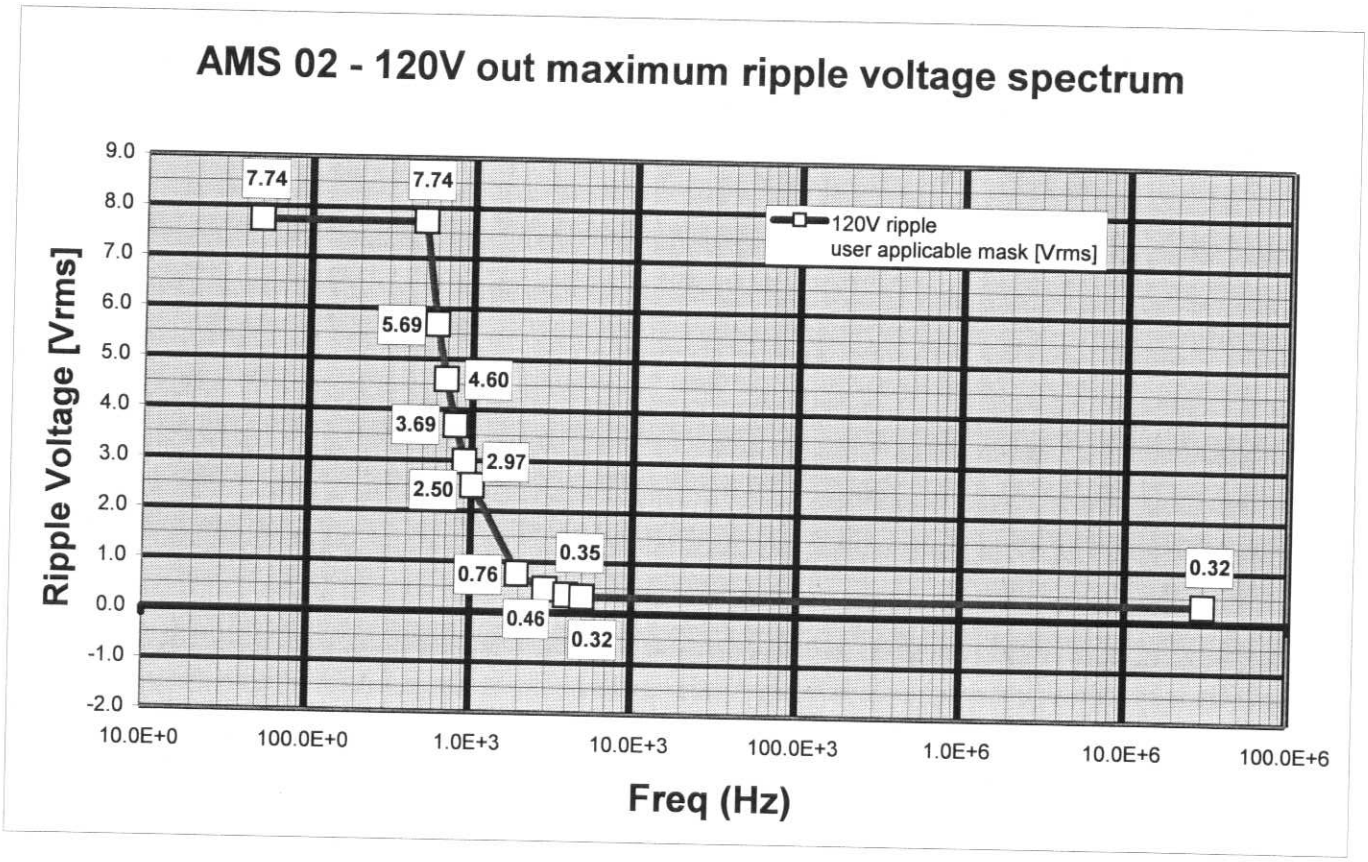

Fig. 5-23: 120V Out maximum ripple voltage spectrum

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5.5.2.3 OUTLET SOURCE IMPEDANCE

The source impedance of the 120V out is shown in the following figure.

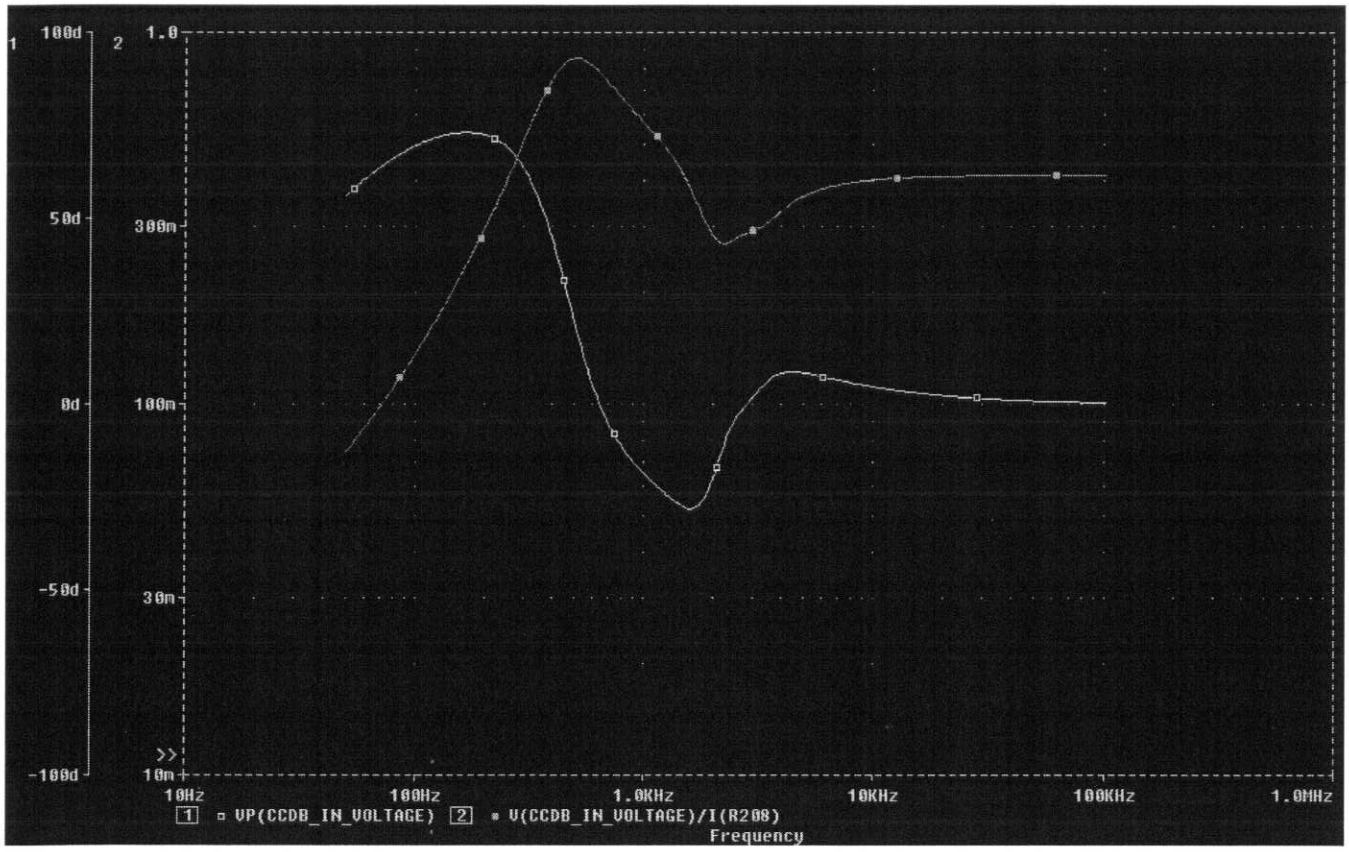

Fig. 5-24: 120V source impedance

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5.5.2.4 LOAD IMPEDANCE

The magnitude component of the attached input load shall not be less then the minimum defined in the following figure.

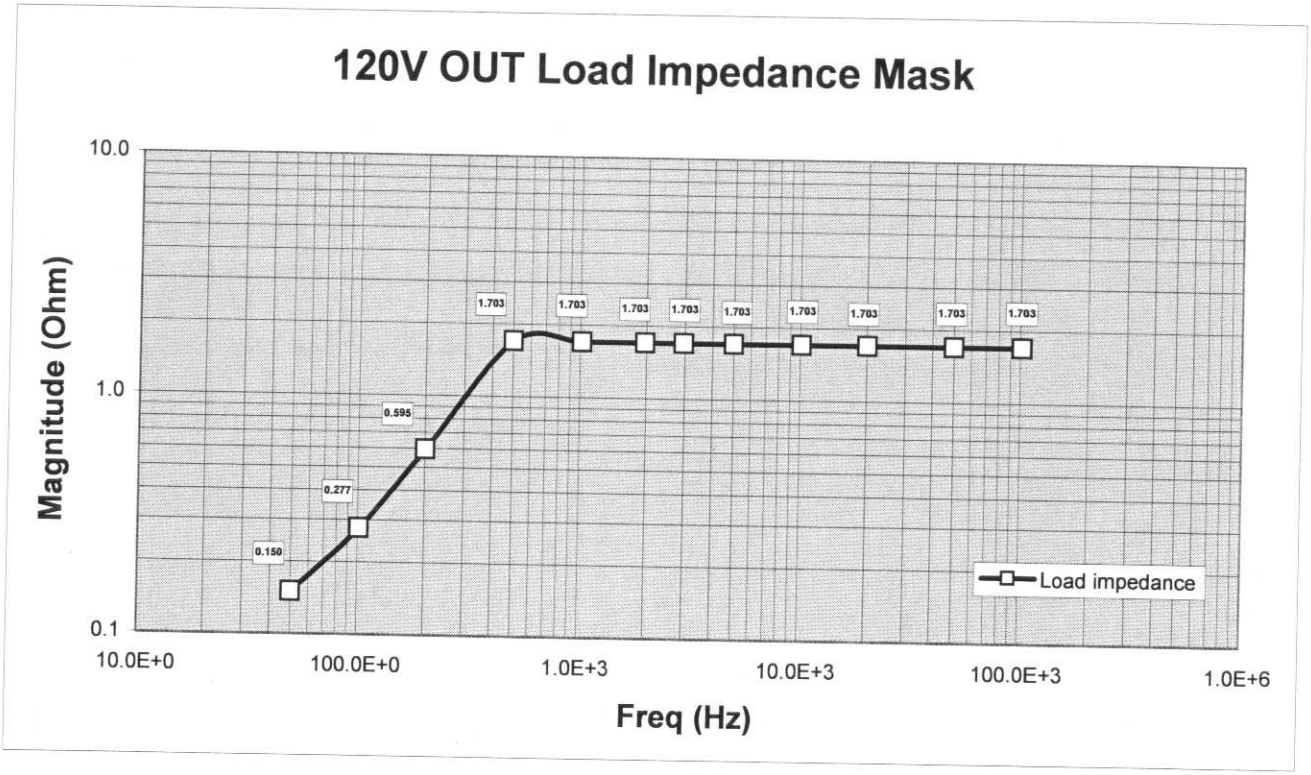

Fig. 5-25: 120V OUT Minimum Load Impedance Mask

At frequency where the magnitude component of the attached load input impedance is less than the minimum defined in Fig. 5-25, the phase component of the load input impedance shall not exceed the bounds defined in Fig. 5-26.

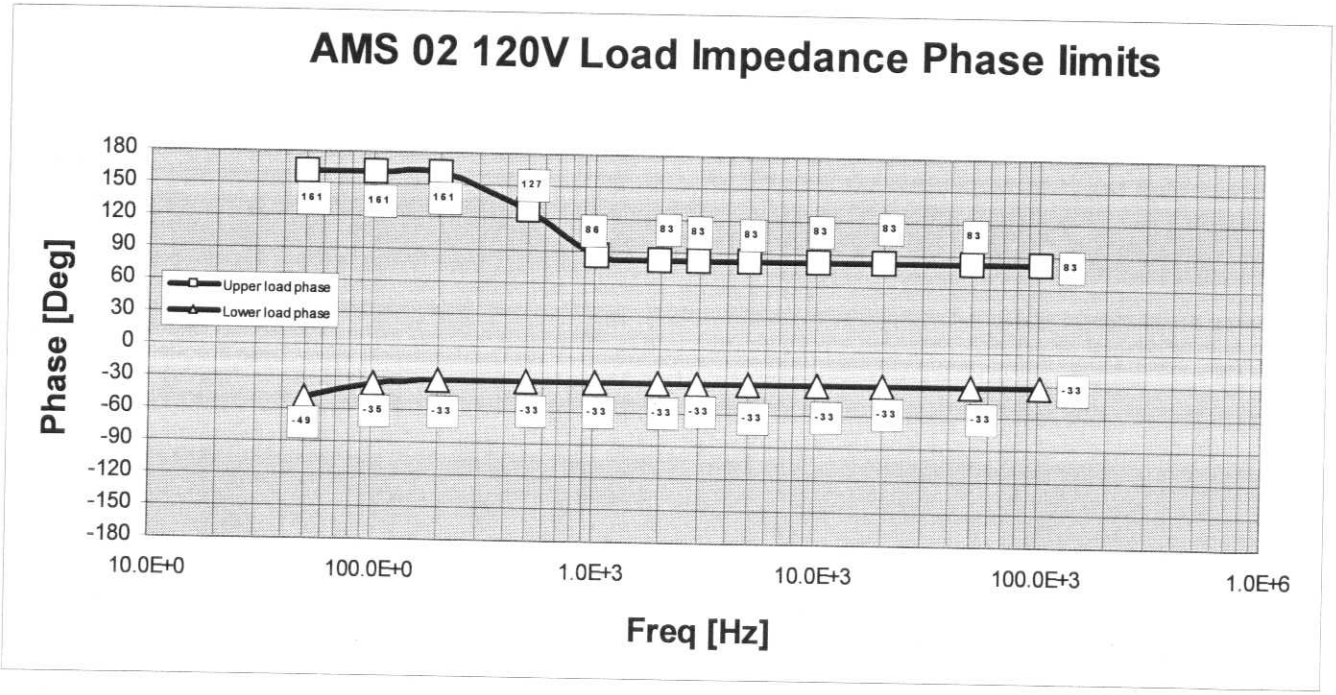

Fig. 5-26: Load Impedance Phase Limits

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5.5.2.5 LOAD ABNORMAL OPERATION

The user connected to the 120V output of the PDS shall operate and be compatible with the abnormal voltage as showed in the following figures.

NOTE:

- The figures have been derived by simulation injecting in the circuit the fault clearing and protection transient limits (see Fig. 5-9).
- For convenience the signal have been split in different impulse shape

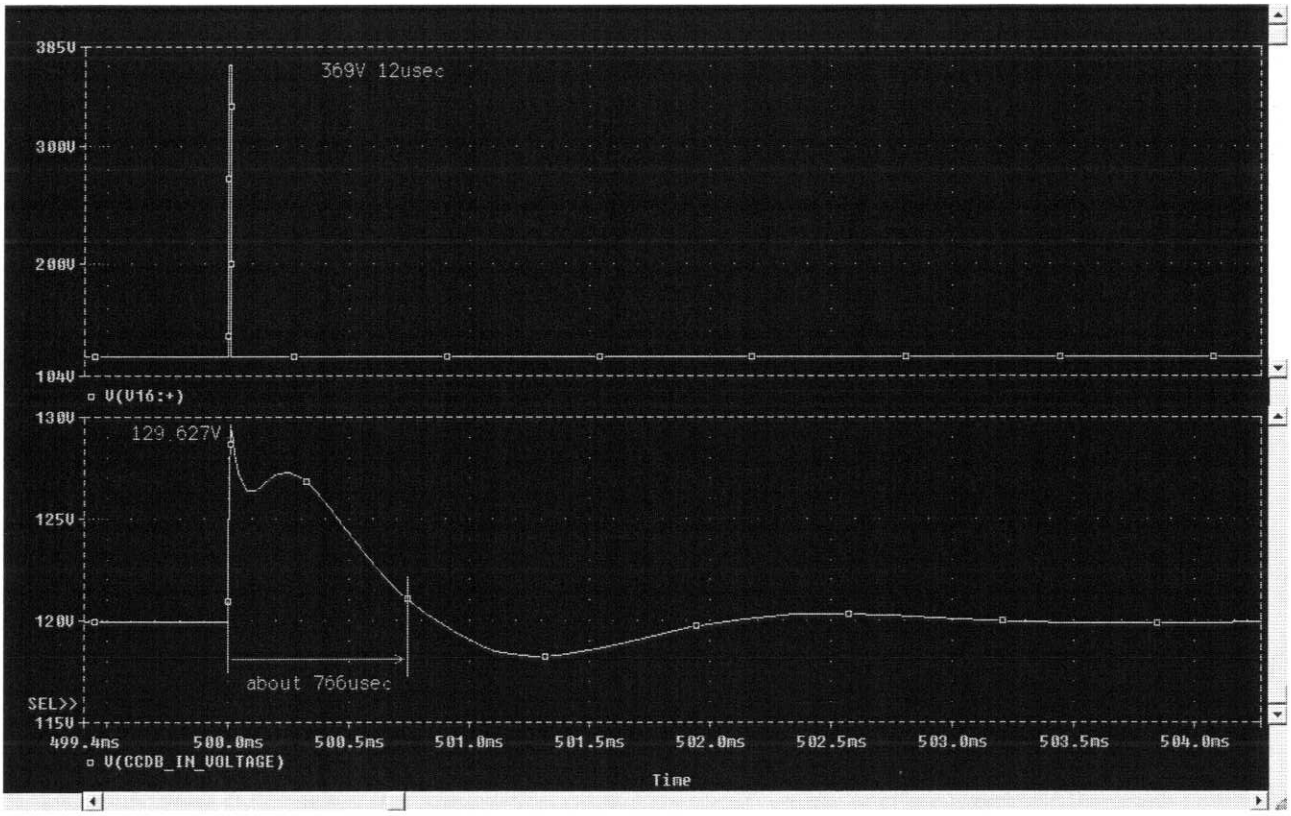

Fig. 5-27: 120V Load Abnormal operation (369V 12usec)

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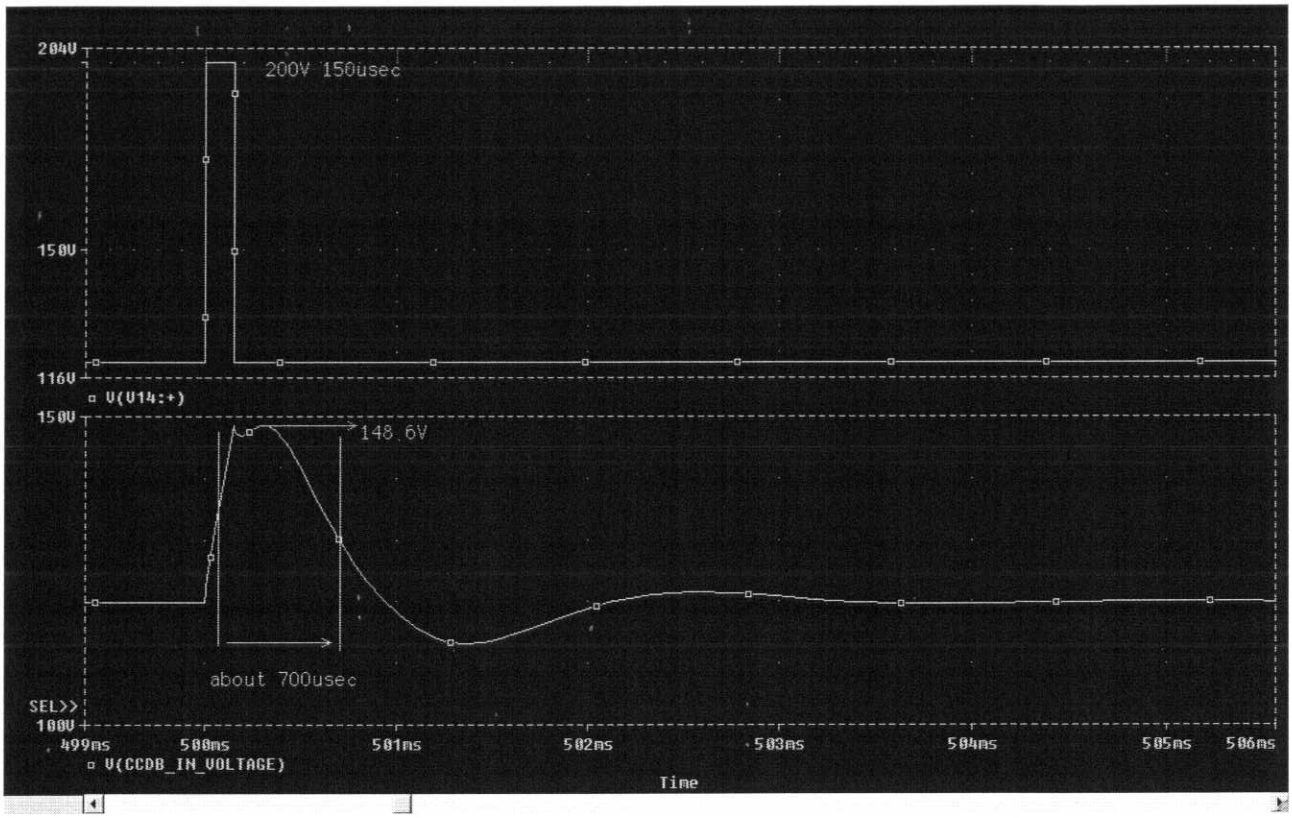

Fig. 5-28: 120V Load Abnormal operation (200V 150usec)

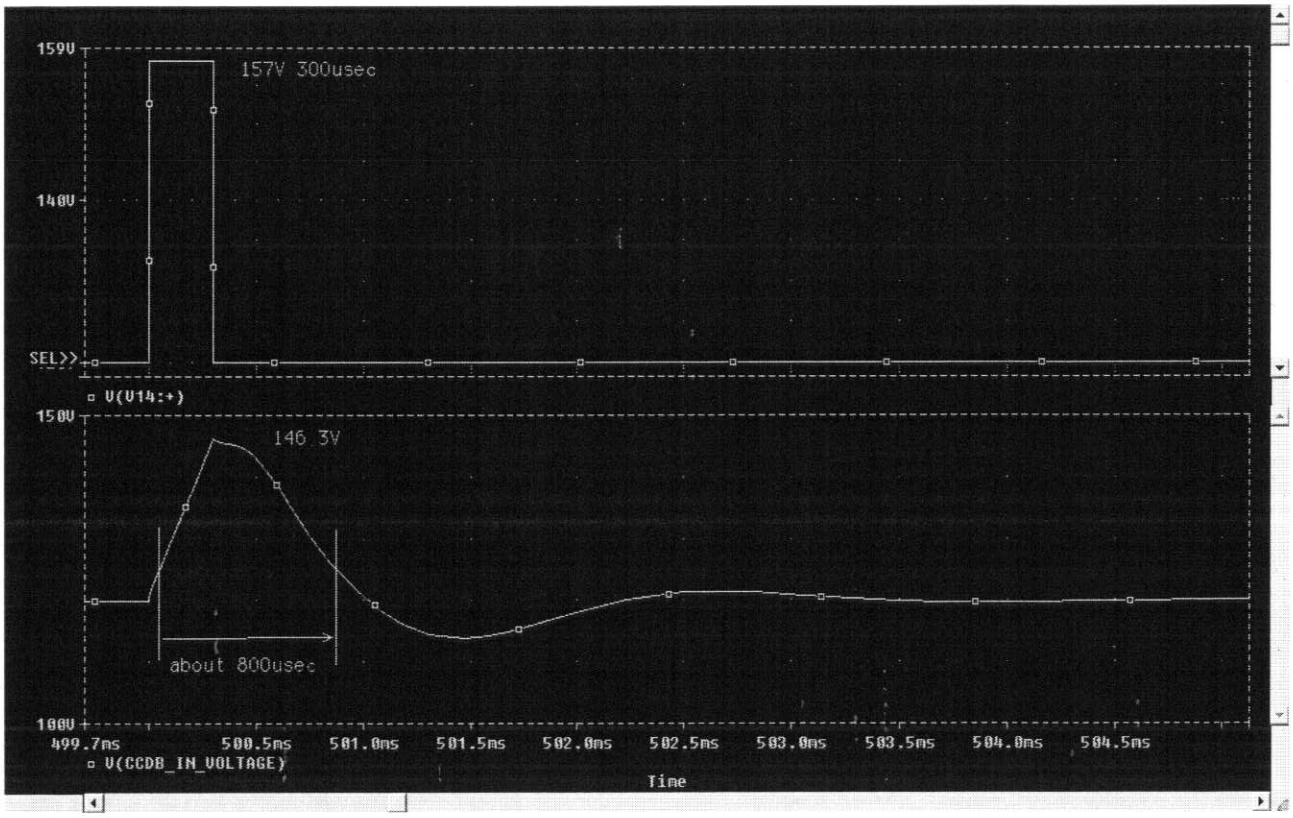

Fig. 5-29: 120V Load Abnormal operation (157V 300usec)

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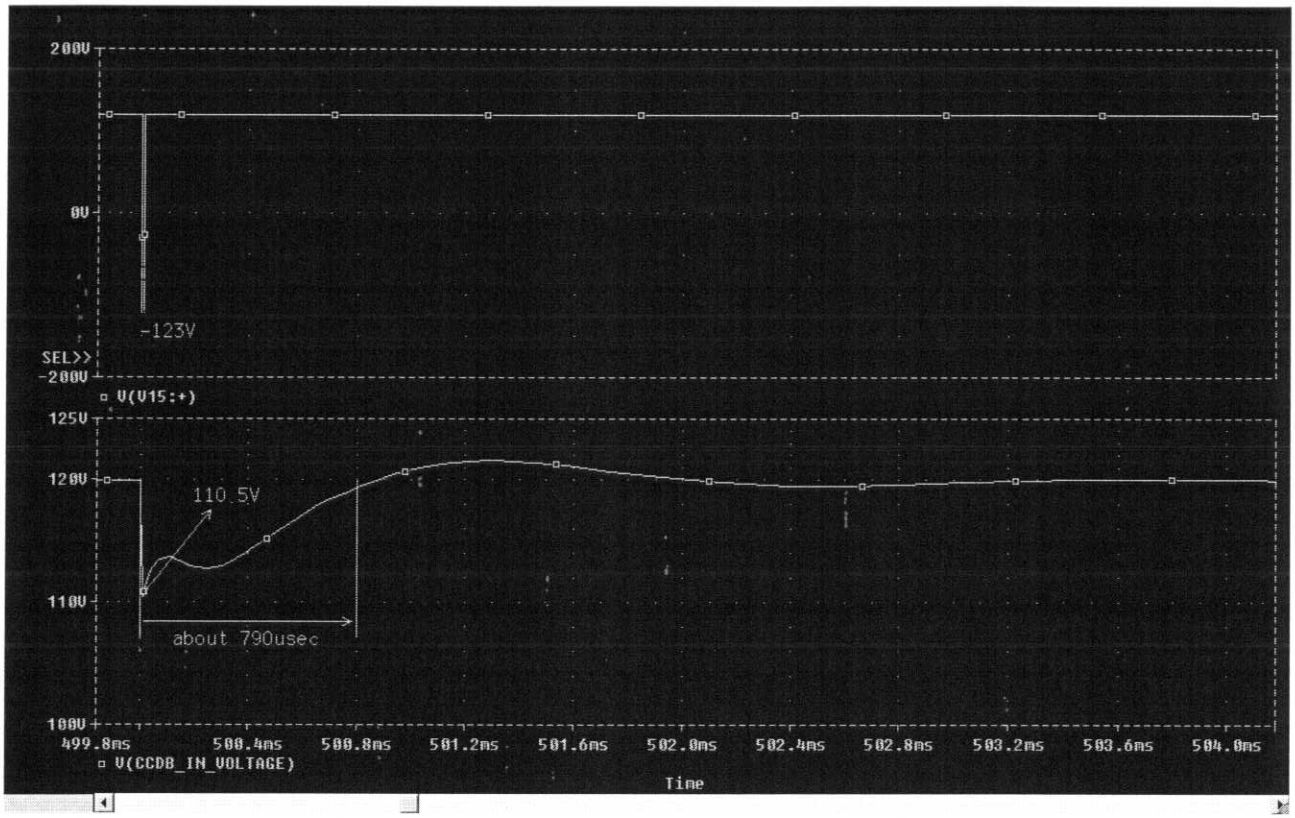

Fig. 5-30: 120V Load Abnormal operation (- 123V 12usec)

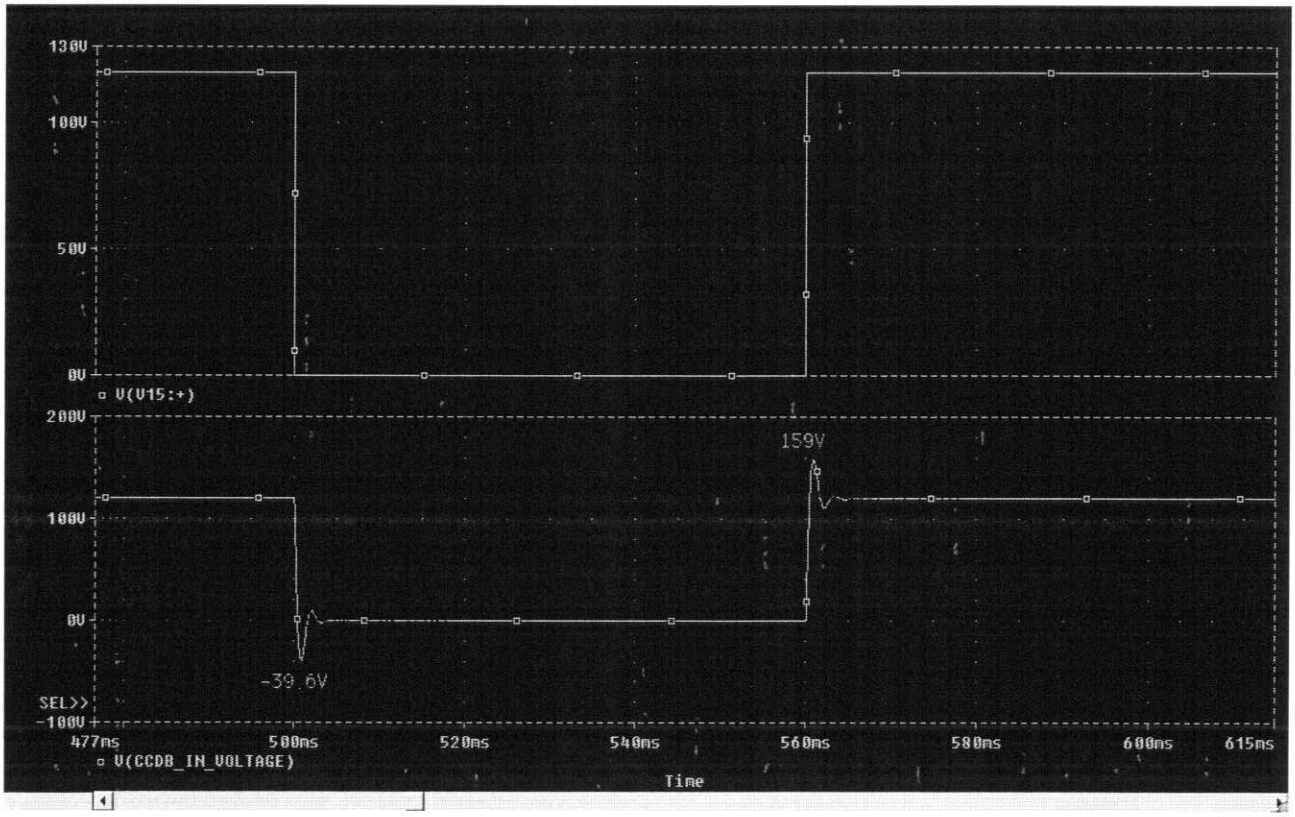

Fig. 5-31: 120V Load Abnormal operation (0V 60msec)

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5.5.2.6 CURRENT RATING

The rating of the 120V outputs from ESEM 3-B is showed in the following table.

Output lines	Description	Available Power @113V A side [W]	I @113V [A]	MINIMUM R heaters @113V' [ohm]	I @126.5V [A]	Ifuse as for ESA derating Ifuse=I*2*110% [A]	Fuse to be used [A]	blowing current =Fuse rating*2' [A]	N° of MOS 2N7237 for Heaters
1		137	1,21	93,20	1,4	2,99	3	6	1
2		321	2,84	39,78	3,2	7,00	7,5	15	3
3		137	1,21	93,20	1,4	2,99	3	6	1
4		137	1,21	93,20	1,4	2,99	3	6	1
5		229	2,03	55,76	2,3	4,99	5	10	2
6		137	1,21	93,20	1,4	2,99	3	6	1
7		137	1,21	93,20	1,4	2,99	3	6	1
8		137	1,21	93,20	1,4	2,99	3	6	1
9		137	1,21	93,20	1,4	2,99	3	6	1
10		137	1,21	93,20	1,4	2,99	3	6	1
11		137	1,21	93,20	1,4	2,99	3	6	1
	TOT	1783							
12	CCEB				10				

Tab. 5-30: 120V current rating

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5.5.2.7 OUTPUT PROTECTION

The outlet from 1 to 11 (AMS heaters power supply) are remote control-able and fuses protected.

Outlet 12 is dedicated for the CCEB power supply and is current limited protected.
The trip characteristic of the 120V output12 is shown in the following figure.

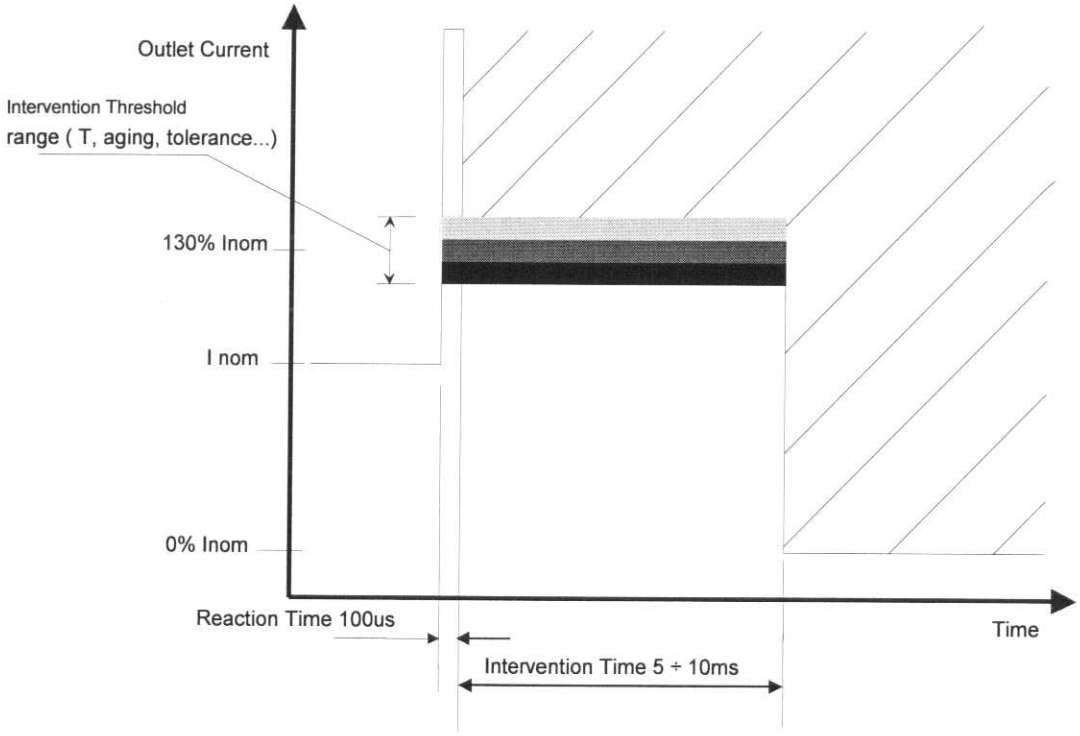

Fig. 5-32: 120V out trip characteristic

See note on page **Errore. Il segnalibro non è definito.**.

5.5.2.8 LOAD IN-RUSH CURRENT SLOPE

The load in-rush current slope shall not exceed the value of 5A/msec

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6. THERMAL INTERFACE

The PDS unit has the following thermal interfaces:

1. chassis – AMS radiator
2. ESEMs - housing

Heat transfer between chassis and AMS radiator

The main thermal interface of the PDS unit is the box base plate (conductive I/F), screwed to the AMS02 Wake radiator.

Temperature range	Operative: -25°C ÷ +48°C Survival: -40°C ÷ +80°C *Measured at PDS TRP (Temperature Reference Point)*

Heat transfer between the top cover rear and free space

Another radiative interface is the top cover of the harness side (Top cover rear) that is finished with clear Anodize and/or thermal coating. The other sides of the unit will be covered with MLI (external properties Beta cloth)

Heat transfer between internal board base plate

All the boards are thermally connected to the base plate. An expanding retainer device provides the thermal link with the actuation of the retaining levers.

In the engaged position of the locking retainer an heat path is established on the opposite side of the board with respect to the retainer which provides heat transfer along the entire length of the PCB

In the case of the input stage board the thermal path to the base plate is through aluminium spacers.

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7. DATA INTERFACE COMMUNICATION AND STATUS

The PDS will automatically start, as soon as the input power (120V) is available and the thermal interlock circuit is in the nominal environmental range, in the default status.

7.1 PDS DEFAULT STATUS

The default status can be divided in the following sections

7.1.1 BOARDS DEFAULT STATUS

This status is set by design and can not be controlled/changed via I/F communication

ESEM1-A	ON	internal auxiliary dcdc converter functioning
ESEM3-A	ON	internal auxiliary dcdc converter functioning
PB2	ON	internal auxiliary dcdc converter functioning
ESEM3-B	ON	internal auxiliary dcdc converter functioning
CAN BUS I/F	ON	internal auxiliary dcdc converter functioning communication allowed

Tab. 7-1: PDS board default status

7.1.2 28V CONVERTER DEFAULT STATUS

This status can be defined during board producing by means of a jumper soldering.
In any case it is possible to command ON or OFF the converter status.
The actual design foresee two PB2 boards (connected to the JPD) in ON status.

PB2 – 1	ON	(means 28V delivered to the ESEM3-A board)
PB2 – 2	OFF	
PB2 – 3	OFF	
PB2 – 4	ON	(means 28V delivered to the ESEM3-A board)

Tab. 7-2: PDS 28V converter default status

Refer to Fig. 4-13 for the board positioning

7.1.3 OUTLET DEFAULT STATUS

This status can be defined during board producing by means of a jumper soldering.
In any case it is possible to command ON or OFF the outlets status
The actual design foresee the following outlet default status.

- ESEM3-B

Out1	ON
Out2	ON
Out3	ON
Out4	OFF
Out5	OFF
Out6	ON
Out7	OFF
Out8	OFF
Out9	OFF
Out10	OFF
Out11	OFF
Out12	OFF

Tab. 7-3: ESEM3-B outlet default status

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- ESEM3-A #1

Out1	OFF
Out2	OFF
Out3	ON
Out4	OFF
Out5	OFF
Out6	OFF
Out7	OFF
Out8	OFF

Tab. 7-4: ESEM3-A #1 outlet default status

- ESEM3-A #2

Out1	OFF
Out2	OFF
Out3	OFF
Out4	OFF
Out5	OFF
Out6	OFF
Out7	OFF
Out8	OFF

Tab. 7-5: ESEM3-A #2 outlet default status

- ESEM3-A #3

Out1	OFF
Out2	OFF
Out3	OFF
Out4	OFF
Out5	OFF
Out6	OFF
Out7	OFF
Out8	OFF

Tab. 7-6: ESEM3-A #3 outlet default status

- ESEM3-A #4

Out1	ON
Out2	OFF
Out3	OFF
Out4	OFF
Out5	OFF
Out6	OFF
Out7	OFF
Out8	OFF

Tab. 7-7: ESEM3-A #4 outlet default status

NOTE: Refer to Fig. 4-13 for the board positioning

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7.2 COMMUNICATION

For the PDS the communication allows to perform the following operations:

- Send command
- Read digital status
- Read analogue telemetry

Inside the PDS the communication is performed by means of a serial Carlo Gavazzi Interface protocol.

In the AMS-02 the communication is performed by means of the serial CAN BUS I/F protocol.

7.2.1 DATA BUS INTERFACE

All PDS monitoring and commanding is performed by a CAN BUS I/F

7.2.2 BUS CONTROL

Bus control is performed by the following CAN BUS controller:

VAL	DESCRIPTION	SUPPLIER	PART NO.
PCA82C250	PCA82C250 CAN controller interface SOIC-8	PHILIPS	PCA82C250TD

7.2.3 PROGRAMMABILITY OF ADDRESS

Each CAN BUS board has a proper BORN ID number defined during the programming of the EEPROM.

This address is defined by the AMS software responsible.

For the FM the board address are set to:

- 30 for the CAN BUS board inserted in the side A
- 31 for the CAN BUS board inserted in the side B

For the communication the proper address should be used to communicate with the board.

7.2.4 PDS COMMINICATION PROCEDURE

The boards of each side are inserted in two separated power motherboards.
The motherboards are connected together by means of an interconnection cable for CGS I/F serial communication and for analog telemetry.

All the I/F lines output to CANBUS Boars are duplicate for Site A and Site B.
The selection of Site is possible trough the signals GEN_ENABLE_M port P1.1 of Microcontroller and GEN_ENABLE_R Port P5.7 of Microcontroller.

With the GEN_ENABLE_M and GEN_ENABLE_R selection only the desired section will interpret the I/F commands.

At the start up of the PDS both the GEN_ENABLE_ are disabled so no communication is allowed.

At the end the procedure for the correct communication can be resumed in the following step, it is valid for both Canbus Board:

1. select the CAN BUS board: 30 (side A for the EM) or 31 (side B for the EM)

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2. set the enables signal:
   a. GEN_ENABLE_M : if communication is requested on the same side
   b. GEN_ENABLE_R : communication is requested on the opposite side
3. Write command to CGS interface controller.
4. Clear enable, end of communication.

7.2.5 AUTONOMOUS OPERATION

The PDS maintains its operational mode with respect to the last state of the power outlets even in case of loss of Can BUS communication.

7.2.6 PDS MONITORING

The command and monitoring that can be performed are listed in the tables below.

7.2.6.1 ESEM1-A MONITORING/COMMAND

	Name	Channel Address	Note	Codification	
				1	0
Digital Flag	OK/NOT_OK	00H	Board status	NOK	OK
	DC/DC1-MAIN-OVERCURRENT (Threshold 1.6A)	03H	Primary over current alarm	OVC	OK
	DC/DC2-MAIN-OVERCURRENT (Threshold 1.6A)	04H	Primary over current alarm	OVC	OK
	DC/DC1-MAIN-ON	05H	DC/DC1 status	ON	OFF
	DC/DC2-MAIN-ON	07H	DC/DC2 status	ON	OFF
	MAIN-POWER-ON_	09H	Main Power bus ON	ON	OFF
Command Flag	DIG_TEST_OUT	06H	Digital register output for testing	-	-
	DIG_TEST_IN	06H	Digital register input for testing	-	-
	GLB-SW-OFF	07H	Global switch off command	Command OFF	--
Analog Monitor	TEMPERATURE	01H	Temperature of board: -40℃ ~ +90℃		
	MAIN-POWER	02H	BUS (120V) voltage: 0 ~ 150V		
	ANALOG-REFERENCE	06H	Analog bus and voltage reference: 4V		

Tab. 7-8: ESEM1-A Digital status/command flags and analog monitor

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7.2.6.2 PB2 MONITORING/COMMAND

	Name	Channel Address	Note	Codification	
				1	0
Digital Flag	OK_NOT_OK	00H	Board status	NOK	OK
	OVER_TEMP_	01H	Over temperature alarm	OK	OVT
	OVERCURR_	04H	Input over current alarm	OK	OVC
	120V_28V_DCDC STS	05H	28V output present status	ON	OFF
	27V_TRIP_	15H	Output voltage below 27V detected It makes no trip	OK	UNV
	29V_TRIP	16H	Output voltage above 29V	TRIP	OK
	OFF_CMD	17H	Equal to last dc off cmd sent	--	--
	DIG_TEST_OUT	06H	Digital register output for testing	-	-
Command Flag	DIG_TEST_IN	06H	Digital register input for testing	-	-
	DC_OFF_CMD	17H	ON/OFF command for DC/DC converter	OFF	ON
Analog Monitor	TEMPERATURE	01H	Temperature of board: -40°C ~ +90°C		
	28V_MON	04H	Output (28V) voltage:0 ~ 36.4V		
	ANALOG REFERENCE	06H	Reference voltage: 2V		

Tab. 7-9: PB2 Digital status/command flags and analog monitor

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7.2.6.3 ESEM3-A MONITORING/COMMAND

	Name	Channel Address	Note	Codification	
				1	0
Digital Flag	OK/NOT_OK	00H	Board status	NOK	OK
	OVERTEMP_	01H	Over temperature alarm	OVT	OK
	O1_OUT_ON_IN	0AH	Outlet1 OUT status	ON	OFF
	O2_OUT_ON_IN	0BH	Outlet2 OUT status	ON	OFF
	O3_OUT_ON_IN	0CH	Outlet3 OUT status	ON	OFF
	O4_OUT_ON_IN	0DH	Outlet4 OUT status	ON	OFF
	O5_OUT_ON_IN	0EH	Outlet5 OUT status	ON	OFF
	O6_OUT_ON_IN	0FH	Outlet6 OUT status	ON	OFF
	O7_OUT_ON_IN	10H	Outlet7 OUT status	ON	OFF
	O8_OUT_ON_IN	11H	Outlet8 OUT status	ON	OFF
	O1_OFF_CMD_IN	02H	Outlet1 CMD monitor	ON	OFF
	O2_OFF_CMD_IN	03H	Outlet2 CMD monitor	ON	OFF
	O3_OFF_CMD_IN	04H	Outlet3 CMD monitor	ON	OFF
	O4_OFF_CMD_IN	05H	Outlet4 CMD monitor	ON	OFF
	O5_OFF_CMD_IN	06H	Outlet5 CMD monitor	ON	OFF
	O6_OFF_CMD_IN	07H	Outlet6 CMD monitor	ON	OFF
	O7_OFF_CMD_IN	08H	Outlet7 CMD monitor	ON	OFF
	O8_OFF_CMD_IN	09H	Outlet8 CMD monitor	ON	OFF
	DIG_TEST_OUT	12H	Digital register output for testing	-	-
Command Flag	O1_OFF_CMD_IN	02H	Outlet1 ON/OFF command	ON	OFF
	O2_OFF_CMD_IN	03H	Outlet2 ON/OFF command	ON	OFF
	O3_OFF_CMD_IN	04H	Outlet3 ON/OFF command	ON	OFF
	O4_OFF_CMD_IN	05H	Outlet4 ON/OFF command	ON	OFF
	O5_OFF_CMD_IN	06H	Outlet5 ON/OFF command	ON	OFF
	O6_OFF_CMD_IN	07H	Outlet6 ON/OFF command	ON	OFF
	O7_OFF_CMD_IN	08H	Outlet7 ON/OFF command	ON	OFF
	O8_OFF_CMD_IN	09H	Outlet8 ON/OFF command	ON	OFF
	DIG_TEST_IN	0AH	Digital register input for testing	-	-
	ALL_OFF_CMD	13H	All outlet ON/OFF	ON	OFF
Analog Monitor	O1_CURRENT	00H	Outlet 1 (5A) current: 0 ~ 7.5A		
	O2_CURRENT	01H	Outlet 2 (5A) current: 0 ~ 7.5A		
	O3_CURRENT	02H	Outlet 3 (5A) current: 0 ~ 7.5A		
	O4_CURRENT	03H	Outlet 4 (5A) current: 0 ~ 7.5A		
	O5_CURRENT	04H	Outlet 5 (5A) current: 0 ~ 7.5A		
	O6_CURRENT	05H	Outlet 6 (5A) current: 0 ~ 7.5A		
	O7_CURRENT	06H	Outlet 7 (5A) current: 0 ~ 7.5A		
	O8_CURRENT	07H	Outlet 8 (10A) current: 0 ~ 15A		
	TEMPERATURE	08H	Temperature of board: -40°C ~ +90°C		
	ANALOG_REFERENCE	09H	Reference voltage: 3V		

Tab. 7-10: ESEM 3-A Digital status/command flags and analog monitor

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7.2.6.4 ESEM3-B MONITORING/COMMAND

	Name	Channel Address	Note	Codification	
				1	0
Digital Flag	OK/NOT_OK	00H	Board status	NOK	OK
	OVERTEMP_	01H	Over temperature alarm	OVT	OK
	O1_OFF_CMD_IN	02H	Outlet1 CMD monitor	ON	OFF
	O2_OFF_CMD_IN	03H	Outlet2 CMD monitor	ON	OFF
	O3_OFF_CMD_IN	04H	Outlet3 CMD monitor	ON	OFF
	O4_OFF_CMD_IN	05H	Outlet4 CMD monitor	ON	OFF
	O5_OFF_CMD_IN	06H	Outlet5 CMD monitor	ON	OFF
	O6_OFF_CMD_IN	07H	Outlet6 CMD monitor	ON	OFF
	O7_OFF_CMD_IN	08H	Outlet7 CMD monitor	ON	OFF
	O8_OFF_CMD_IN	09H	Outlet8 CMD monitor	ON	OFF
	O9_OFF_CMD_IN	0AH	Outlet9 CMD monitor	ON	OFF
	O10_OFF_CMD_IN	0BH	Outlet10 CMD monitor	ON	OFF
	O11_OFF_CMD_IN	0CH	Outlet11 CMD monitor	ON	OFF
	O12_OFF_CMD_IN	0DH	Outlet12 CMD monitor	ON	OFF
	O1_OUT_ON_IN	0EH	Outlet1 OUT status	ON	OFF
	O2_OUT_ON_IN	0FH	Outlet2 OUT status	ON	OFF
	O3_OUT_ON_IN	10H	Outlet3 OUT status	ON	OFF
	O4_OUT_ON_IN	11H	Outlet4 OUT status	ON	OFF
	O5_OUT_ON_IN	12H	Outlet5 OUT status	ON	OFF
	O6_OUT_ON_IN	13H	Outlet6 OUT status	ON	OFF
	O7_OUT_ON_IN	14H	Outlet7 OUT status	ON	OFF
	O8_OUT_ON_IN	15H	Outlet8 OUT status	ON	OFF
	O9_OUT_ON_IN	16H	Outlet9 OUT status	ON	OFF
	O10_OUT_ON_IN	17H	Outlet10 OUT status	ON	OFF
	O11_OUT_ON_IN	18H	Outlet11 OUT status	ON	OFF
	O12_OUT_ON_IN	19H	Outlet12 OUT status	ON	OFF
	O12_TRIP_OUT	1AH	Outlet12 in TRIP status (limit.: 13A)	TRIP	OK
	DIG_TEST_OUT	1BH	Digital register output for testing	-	-
Command Flag	O1_OFF_CMD_IN	02H	Outlet1 ON/OFF command	ON	OFF
	O2_OFF_CMD_IN	03H	Outlet2 ON/OFF command	ON	OFF
	O3_OFF_CMD_IN	04H	Outlet3 ON/OFF command	ON	OFF
	O4_OFF_CMD_IN	05H	Outlet4 ON/OFF command	ON	OFF
	O5_OFF_CMD_IN	06H	Outlet5 ON/OFF command	ON	OFF
	O6_OFF_CMD_IN	07H	Outlet6 ON/OFF command	ON	OFF
	O7_OFF_CMD_IN	08H	Outlet7 ON/OFF command	ON	OFF
	O8_OFF_CMD_IN	09H	Outlet8 ON/OFF command	ON	OFF
	O9_OFF_CMD_IN	0AH	Outlet9 ON/OFF command	ON	OFF
	O10_OFF_CMD_IN	0BH	Outlet10 ON/OFF command	ON	OFF
	O11_OFF_CMD_IN	0CH	Outlet11 ON/OFF command	ON	OFF
	O12_OFF_CMD_IN	0DH	Outlet12 ON/OFF command	ON	OFF
	ALL_OFF_CMD	1CH	All outlets ON/OFF command	ON	OFF

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	DIG_TEST_IN	1BH	Digital register input for testing	-	-
Analog Monitor	TEMPERATURE	00H	Temperature of board: -40°C ~ +90°C		
	O12_CURRENT	01H	Outlet 12 (10A) current: 0 ~ 15A		
	ANALOG_REFERENCE	02H	Reference voltage: 2.5V		

Tab. 7-11: ESEM3-B Digital status/command flags and analog monitor

7.2.7 ANALOGUE TELEMETRY

The analogue telemetry coming from each board have a dedicated analogue line acquisition on the can bus board. The separated lines are multiplexed and sampled on the CAN BUS board.
The following address tables shall be used to correlate each board with the corresponding CAN BUS channel.

Control	PDS SIDE	SLOT NO.	BOARD NAME	BOARD ADDRESS	ADC ADDRESS	NOTE
CAN I/F Board A (30)	My side	1	ESEM3B	00H	07H	ADC CHIP0
		2	PB2-1	01H	06H	
		3	ESEM3A-1	02H	05H	
		4	PB2-2	03H	04H	
		5	ESEM3A-2	04H	03H	
		6	PB2-3	05H	02H	
		7	ESEM3A-3	06H	01H	
		8	PB2-4	07H	00H	
		9	ESEM3A-4	08H	0FH	ADC CHIP1
		10	ESEM1A	0AH	0EH	
		--	INPUT STAGE Voltage	--	0DH	
		--	INPUT STAGE current	--	0CH	
	Neighbour side	1	ESEM3B	00H	17H	ADC CHIP2
		2	PB2-1	01H	16H	
		3	ESEM3A-1	02H	15H	
		4	PB2-2	03H	14H	
		5	ESEM3A-2	04H	13H	
		6	PB2-3	05H	12H	
		7	ESEM3A-3	06H	11H	
		8	PB2-4	07H	10H	
		9	ESEM3A-4	08H	1FH	ADC CHIP3
		10	ESEM1A	0AH	1EH	
		--	INPUT STAGE Voltage	--	1DH	
		--	INPUT STAGE current	--	1CH	

Tab. 7-12: PDS board address and ADC channels – ID 30

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Control	PDS SIDE	SLOT NO.	BOARD NAME	BOARD ADDRESS	ADC ADDRESS	NOTE
CAN I/F Board B (31)	My side	1	ESEM3B	00H	07H	ADC CHIP0
		2	PB2-1	01H	06H	
		3	ESEM3A-1	02H	05H	
		4	PB2-2	03H	04H	
		5	ESEM3A-2	04H	03H	
		6	PB2-3	05H	02H	
		7	ESEM3A-3	06H	01H	
		8	PB2-4	07H	00H	
		9	ESEM3A-4	08H	0FH	ADC CHIP1
		10	ESEM1A	0AH	0EH	
		--	INPUT STAGE Voltage	--	0DH	
		--	INPUT STAGE current	--	0CH	
	Neighbour side	1	ESEM3B	00H	17H	ADC CHIP2
		2	PB2-1	01H	16H	
		3	ESEM3A-1	02H	15H	
		4	PB2-2	03H	14H	
		5	ESEM3A-2	04H	13H	
		6	PB2-3	05H	12H	
		7	ESEM3A-3	06H	11H	
		8	PB2-4	07H	10H	
		9	ESEM3A-4	08H	1FH	ADC CHIP3
		10	ESEM1A	0AH	1EH	
		--	INPUT STAGE Voltage	--	1DH	
		--	INPUT STAGE current	--	1CH	

Tab. 7-13: PDS board address and ADC channels – ID 31

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The conversion rule for the analogue telemetry is contained in the following table.

BOARD	TELEM.	OUT	Min	Max	Vmin	Vmax
ESEM3-A	current	1 - 7	0	7,5	0	4,096
		8	0	15	0	4,096
	temp		-40	90	0	4,096
PB2	voltage		0	36,4	0	4,096
	temp		-40	90	0	4,096
ESEM3-B	current	12	0	15	0	4,096
	temp		-40	90	0	4,096
ESEM1-A	input voltage [V]		0	150V	0	4,096
	temp [°C]		-40	90	0	4,096
INPUT STAGE	input voltage [V]		0	190	0	4,096
	Input Current [A]		-5	33	4,096	0

Tab. 7-14: PDS telemetry conversion rule

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7.2.8 PDS TEST

Some preliminary verification can be performed after in order to verify the correct start-up of the unit.

7.2.8.1 ANALOGUE REFERENCE TEST

Each type of board have a different voltage reference that can be monitored.
The reading means that all the internal auxiliary dcdc converter are functioning and that the internal voltages generated are correct.

The relevant values are reported in the following table:

Module	Analogue Reference
ESEM1-A	4V
PB2	2V
ESEM3-A	3V
ESEM3-B	2.5V
CAN BUS I/F	N. A.

Tab. 7-15: Boards analog reference

7.2.8.2 DIGITAL TEST

To verify the functioning of the FPGA a writing/reading procedure can be performed on each FPGA.

It is possible to send a command to a dedicated register of each board and then to acquire and compare this datum with the one sent to see if they are the same.

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Annex A

AMS02-PDS Interface Control Drawing

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