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## Thermal Control System electrical schemes

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<b>Team contributions</b>		
<b>Date</b>	02/10/2014	
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<b>Edition.Revision</b>	2.3	

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<b>MODIFICATIONS</b>
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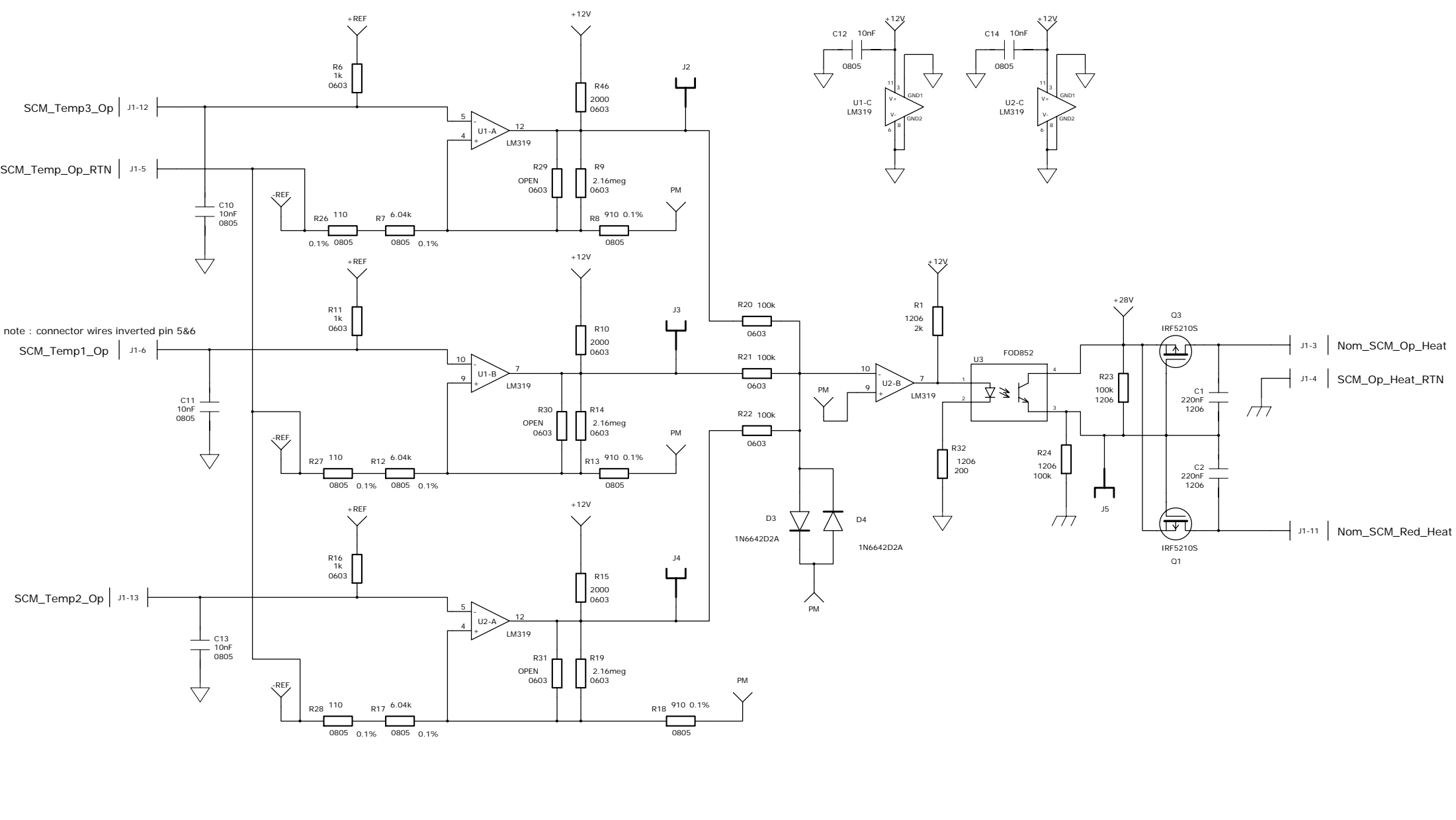
File name : SO-ED-RPW-SC-0102-LPC2E SCM-TCS electrical schemes V22

Edition	Révision	Date	Comments
1	0	15/04/2014	First issue
2	0	16/09/2014	Optocoupler added Separation between nominal and redundant 28V Separation between primary and secondary GND CM filtering on +12V/-5V
2	1	23/09/2014	Optocoupler added to have heater off when +12V is off 1Mohms resistor on optocoupler pin 4 Common CM filter for +12V/-5V Serial inductor MSC1 added on +12V/-5V Polarization of tantalum with 100k Ceramic increased to 100nF
2	2	25/09/2014	Command sign inversion at last comparator U2-B Second optocoupler removed MOSFET redundancy removed All tantalum replaced to ceramic 4.7uF 1812 Threshold resistances update §3 PCB routing recommendation added
2	3	02/10/2014	RC network between primary and secondary GND 2k pull down resistors for connector unused pins §3.1 RC network close to the connector

PLAN

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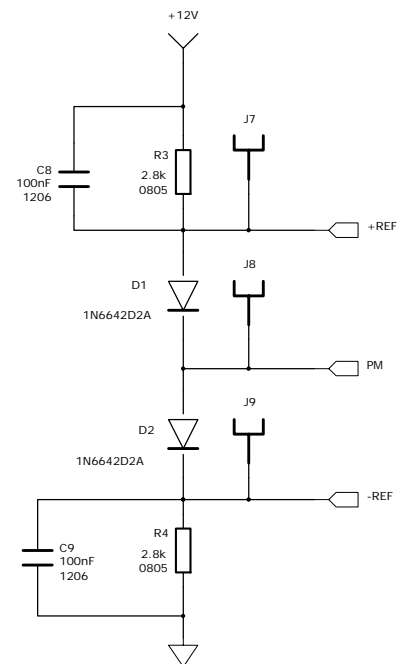
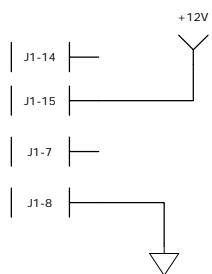
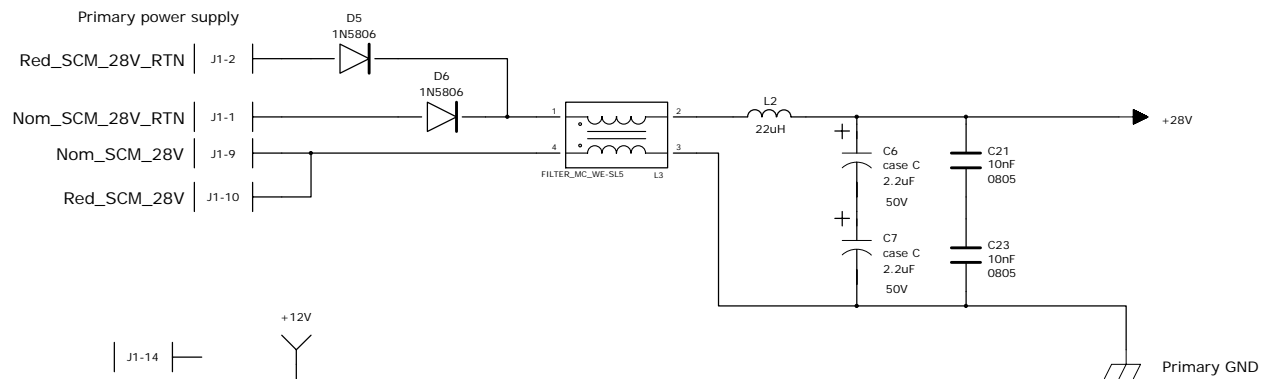
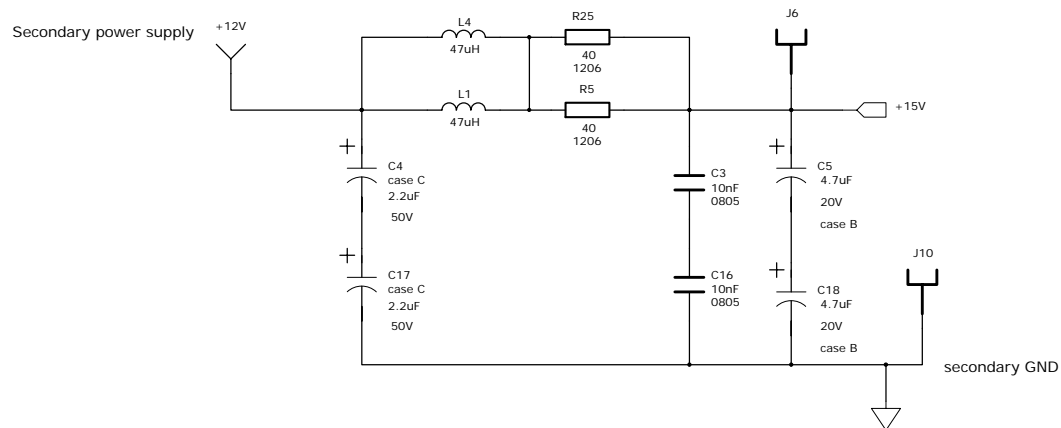
## 1. TCS EM2 ELECTRICAL SCHEME



note : connector wires inverted pin 5&6

Référence :		Ed : 1.0	
Projet: SOLAR ORBITER		CNRS / LPC2E	
RPW-SCM instrument		DRAW: JANNET G.	
Thermal Control System - EM2		DATE: 12/09/2014	
Heating control		SHEET: 1/2	
		FILE:	

MODIFICATIONS	DATE	AUTH.	IND
Modification directly done on EM1 board Separation between primary GND and secondary GND (plane) implementation of optocoupler FOD852 and components around diodes 1N5806 to separate nominal and redundant 28V	12/09/2014	G.J.	0

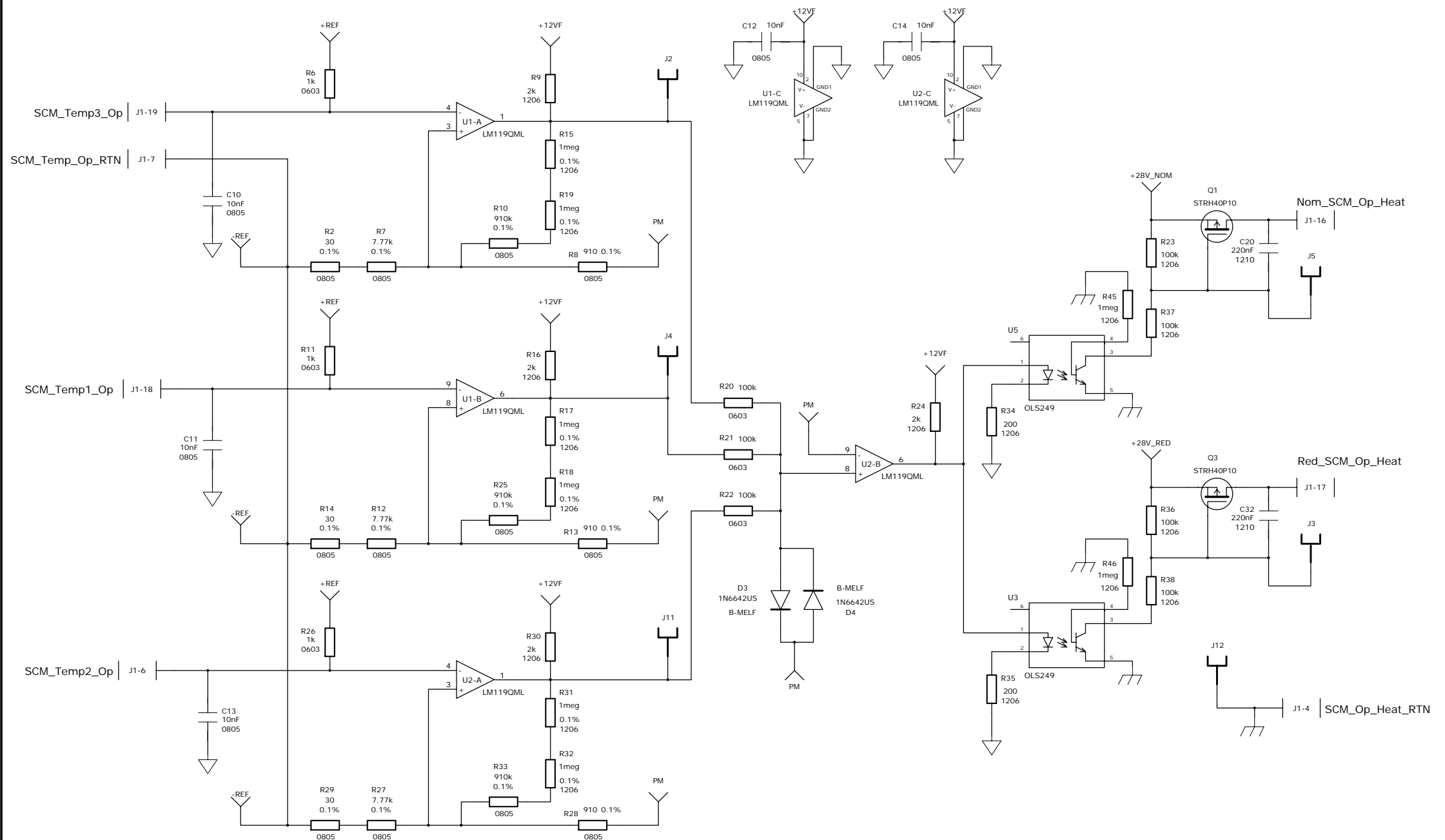


MODIFICATIONS	DATE	AUTH.	IND
Modification directly done on EM1 board Separation between primary GND and secondary GND (plane) implementation of optocoupler FOD852 and components around diodes 1N5806 to separate nominal and redundant 28V	12/09/2014	G.J.	0

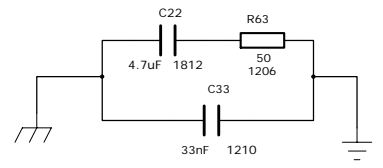
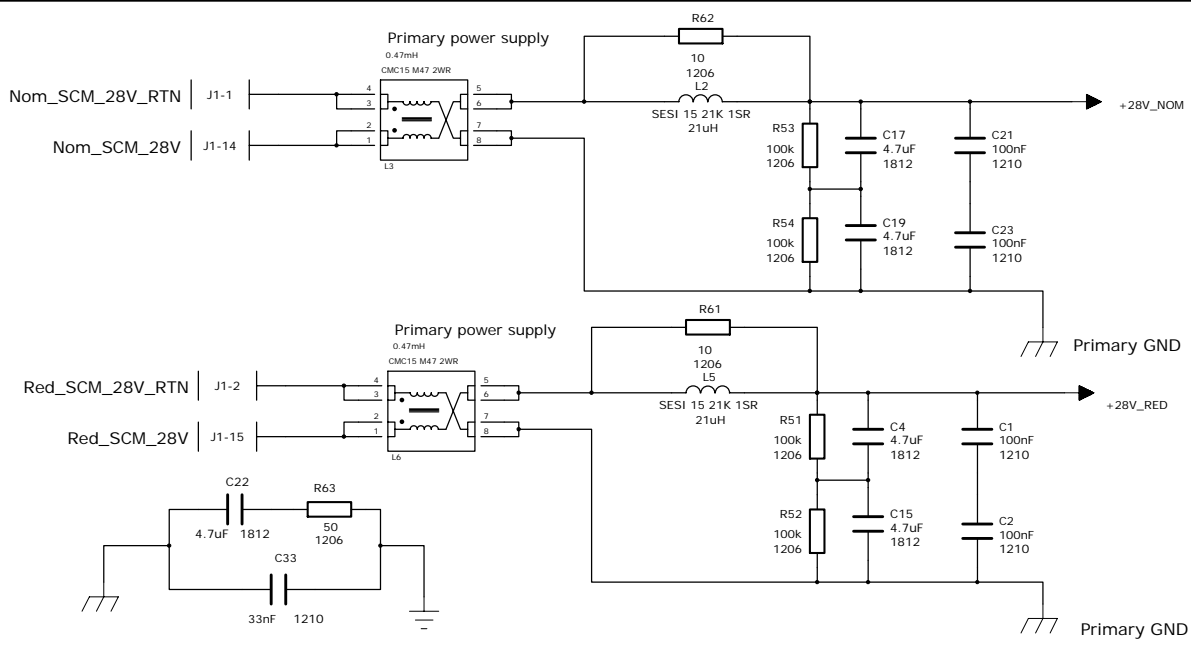
Référence :	Ed : 1.0
Projet: SOLAR ORBITER	CNRS / LPC2E
RPW-SCM instrument Thermal Control System - EM2 Power supply filtering	DRAW: JANNET G.
	DATE: 12/09/2014
	SHEET: 2/2
	FILE:

## 2. TCS QM/FM ELECTRICAL SCHEME



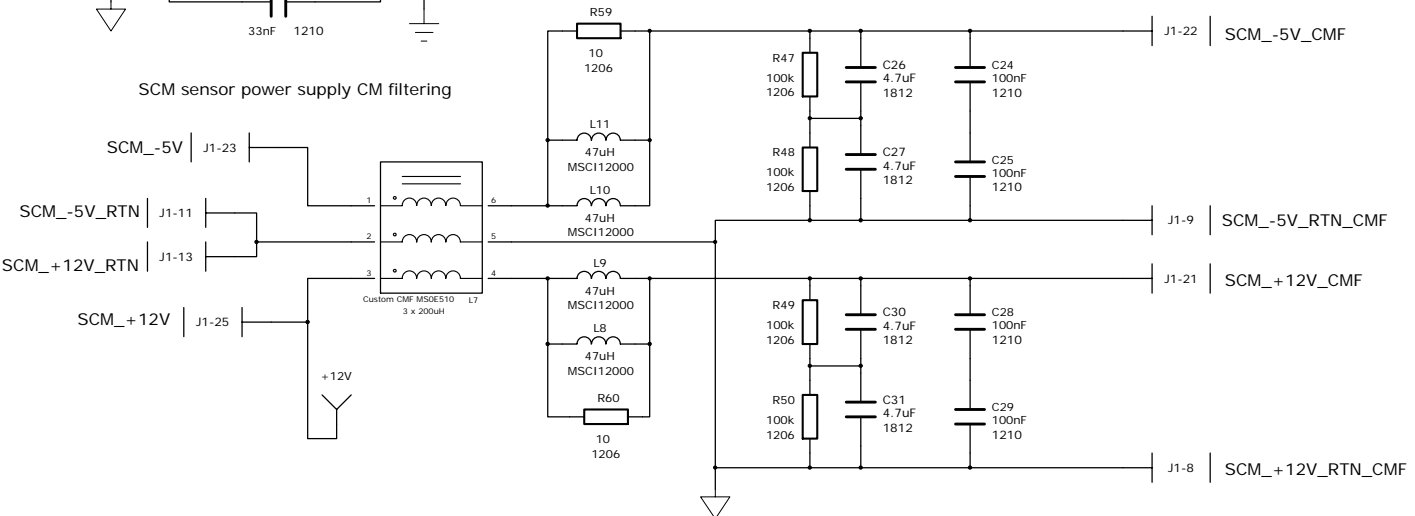


MODIFICATIONS	DATE	AUTH.	IND	Référence : SO-ED-RPW-SC-0102-LPC2E	Ed : 2.3
First issue	13/02/2014	G.J.	0	Projet: <b>SOLAR ORBITER</b> <b>RPW-SCM instrument</b> <b>Thermal Control System</b> <b>Heating control</b>	CNRS / LPC2E
+12V connection added, R10,R15,R46 to 2k, R23,R24 to 1k R20-21 to 100k, inversion pin 5 and pin 6	14/04/2014	G.J.	1		DRAW: JANNET G.
Optocoupler added to separate primary and secondary GND Separation between nominal and redundant 28V	16/09/2014	G.J.	2		DATE: 02/10/2014
Optocoupler added to have heater OFF when +12V is OFF 1Meg resistance on optocoupler pin 4	23/09/2014	G.J.	3		SHEET: 1/2
Inversion of the command sign : last comparator U2-B pin 8/9 inversion connecting scheme after optocoupler update. MOSFET redundancy removed	25/09/2014	G.J.	4	FILE:	

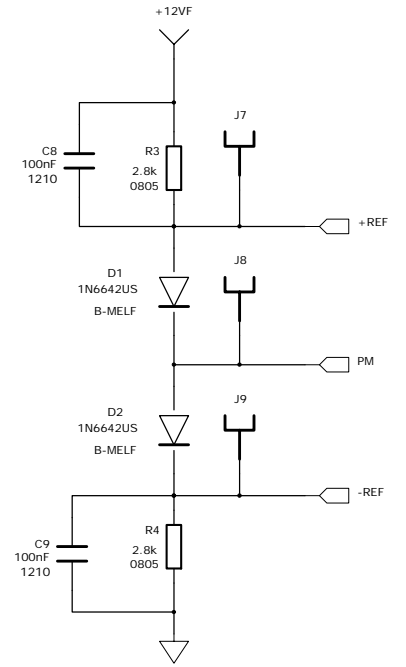
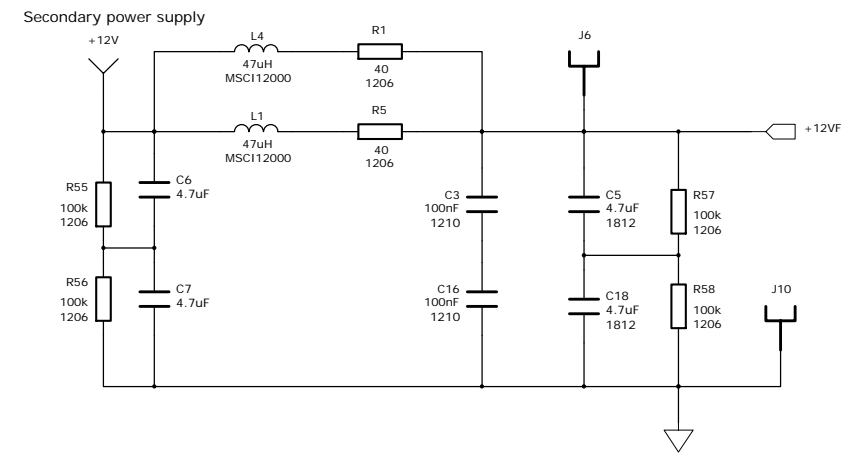
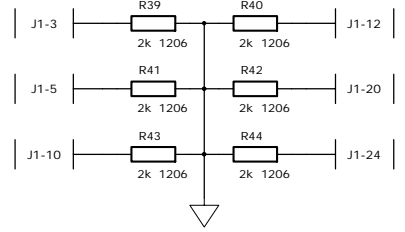


Mechanical structure

SCM sensor power supply CM filtering



Connector unused pins



MODIFICATIONS	DATE	AUTH.	IND
First issue	13/02/2014	G.J.	0
LM317 and resistors removed. +12V connection added	14/04/2014	G.J.	1
separation between primary and secondary GND (plane) CM filtering on nom & red 28V + CM filtering for sensor +12V/-5V	16/09/2014	G.J.	2
Common CM for +12V/-5V, serial inductors MSC1 added, damping with R10k Polarisation of tantalum with 100k, ceramic increased to 100nF	23/09/2014	G.J.	3
All tantalum capacitors replaced by 4.7uF ceramic 1812	25/09/2014	G.J.	4
2k pull down for unused pins RC network between GND and mechanical structure	02/01/2014	G.J.	5

Référence : SO-ED-RPW-SC-0102-LPC2E	Ed : 2.3
Projet: SOLAR ORBITER	CNRS / LPC2E
RPW-SCM instrument	DRAW: JANNET G.
Thermal Control System	DATE: 02/10/2014
Heating control	SHEET: 2/2
	FILE:

### 3. TCS ROUTING SPECIFICATIONS

#### 3.1. TCS components positions

TCS circuit must be implemented on LFR board in the area close to its dedicated connector as presented on figure 3.1. The components shall not be implemented beyond the red line defined on the figure.

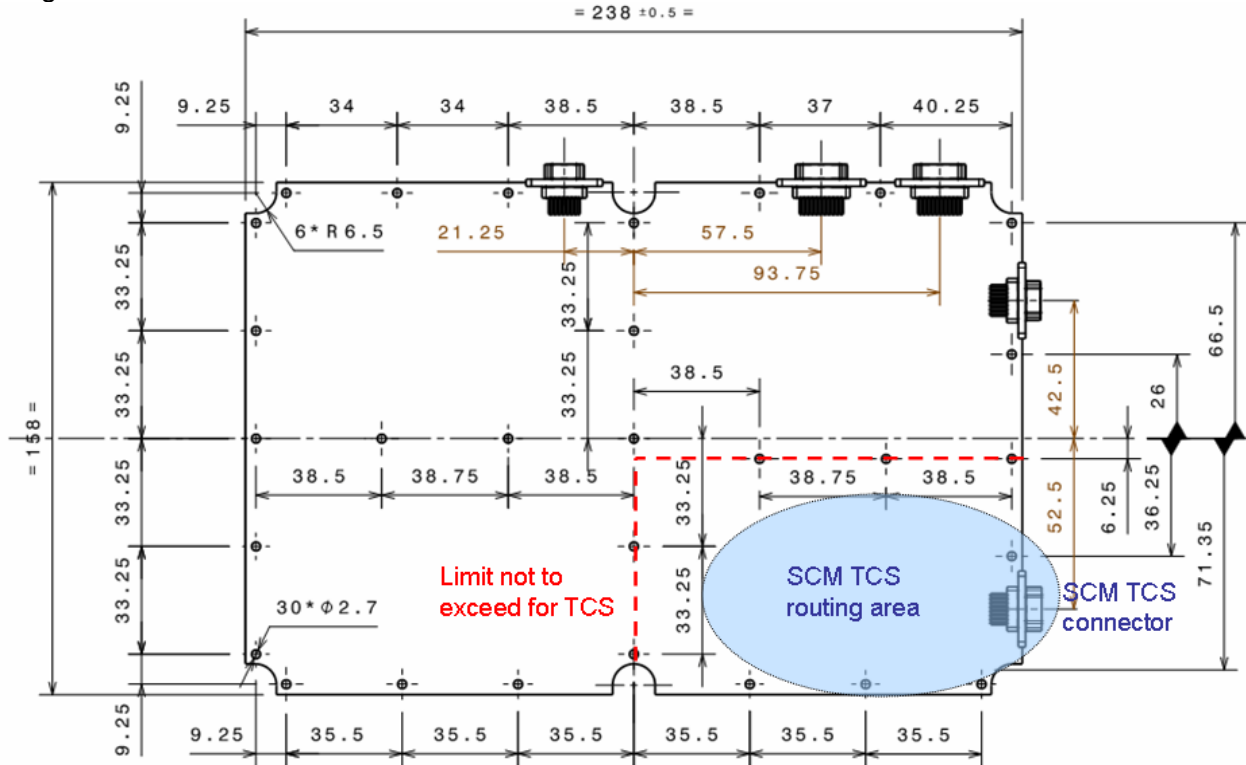


Figure 3.1 – TCS routing area (top view)

The board will be implemented in the MEB frame. Considering the frame dimension, the following restrictions shall be respected regarding the components heights

- Bottom components height shall not exceed 4mm
- Top components height shall not exceed 15mm

As a consequence, the following components must be imperatively placed on the top layer:



References	package	height
Common mode choke MS0E510	Custom	7.6mm
Common mode choke CMC15	SMD	7.9mm
Inductor SESI15	SMD	7.9mm
MOSFET STRH40P10	TO254AA	6.6mm
J2-J12 test points		

The positioning of the component shall be done preferably with respect to the following rules:

- Common mode chokes (L3, L6, L7) shall be implemented as close as possible to the TCS connector J1.
- The RC networks (C22, C33, R63 / C34, R64, C35) shall be implemented as close as possible to the connector.
- MOSFET transistors Q1 and Q3 are the heaviest components of the board. They shall be implemented close to a PCB fixing screw.
- The most dissipating components are the comparator LM119 (U1, U2). They shall be located close to the MEB frame wall (bottom of figure 3.1)

### 3.2. Grounding planes

TCS circuit has 2 grounding:

- Primary GND associated with 28V 
- Secondary GND associated to +12V and -5V 

2 separated grounding planes must be generated on layer 2 (TBC with LFR planes layer)

### 3.3. Routing rules

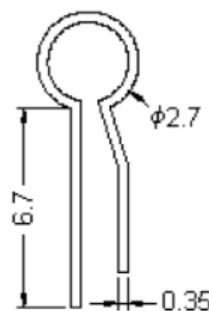
The routing of the circuit must be done in compliance with the following document: ECSS-Q-ST-70-12C, Design rules for PCB.

The table below gives the voltages and currents applied on each signal to match the routing with the voltages and current rating rules.

Signal/node name	Maximum voltage	Maximum Current
All the nodes linked to the primary power +28V_NOM (+ filtering structure tracks)	32V	170mA
All the nodes linked to the primary power +28V_RED (+ filtering structure tracks)		
Connections to the heating power name *_SCM_Op_Heat		
Primary GND	0V	170mA
SCM_-5V	-5V	15mA
SCM_+12V and +12V node	+12V	55mA
Secondary GND and SCM-5V_RTN, SCM_+12V_RTN	0V	70mA
All the nodes on the “SCM sensor power supply CM filtering” structure SCM_+12V_CMF	+12V	15mA
All the nodes on the “SCM sensor power supply CM filtering” structure SCM_-5V_CMF	-5V	15mA
Secondary power supply +12VF and filtering structure tracks	+12V	40mA
Others	+12V	6mA

### 3.4. Test points

Several test points named J2 to J12 are indicated on the electrical scheme. The pattern shall be defined to implement the element described on figure 3.2 (test point for hook clip probe).



Hole in PCB  $\phi 0.8$  to  $\phi 1$

Figure 3.2 - Test point dimensions