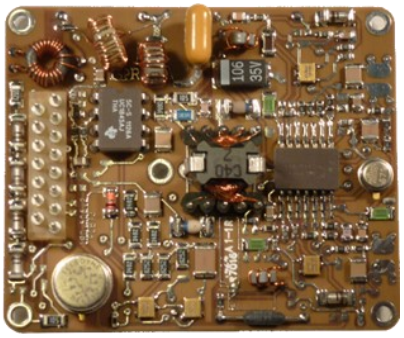
MLN10005D

100V Input, Dual Output

MLN-Series
MLN10005D
Part Number:12159
HIGH RELIABILITY
RADIATION HARDENED
LOW POWER
DC-DC CONVERTER



Description

The MLN series is a family of high reliability dual output, low power DC/DC converters designed for space applications.

The design lifetime is 18 year and the converters are designed for radiation environments encountered by geostationary earth orbit satellites, deep space probes and communication systems.

It offers good tolerance to total ionizing dose, single event effects, and environmental stresses such as temperature extremes, mechanical shock and vibration. All components are fully derated to meet the requirements of EEE-INST-002 (NASA) and ECSS-Q-30-11A (ESA).

Features include isolated telecommand and telemetry interface, internal EMI filter and under voltage protection (UVP) and the design can be tailored to fit all major satellite platforms.

Due to excellent output stability and sequencing between outputs, the MLN-series is well suited for use in RF-applications where low noise, high output voltage accuracy and high CS attenuation is required.

Each converter is provided as a complete board assembly for installation into the host equipment

Extensive documentation including worst case analysis, radiation susceptibility, thermal analysis, stress analysis, and reliability analysis is available.

Applications

- General low power space applications
- Low power RF systems (like LNA)
- Master reference oscillators

Features

General

- O/P 1: +1.5V to +15V, up to 750mA or 4W
- O/P 2: -1.5V to -15V, up to 200mA, or 1W
- Input ranges can be accommodated within an overall range from 20VDC to 100VDC
- Short circuit and overload protection
- Input under-voltage protection
- Output sequencing: Neg. O/P rises first at turn-on and falls last at turn off
- Galvanic isolation, >10MΩ @ 100VDC

Telecommand/Telemetry

- Isolated On/Off control via high level pulse command (latching relay)
- On/Off Status telemetry (relay contact type)
- Output status telemetry (Analog/bi-level)

EMC

- Output Ripple: <1mVrms (100Hz – 50MHz)
- CS rejection input to outputs: > 80dB (50Hz – 100kHz)
- Internal EMI filter: Meets conducted emission requirements of major satellite power buses

Radiation

- TID Rating : 100k rad(Si)
- SEE Rating: 60 MeV/cm^2/mg

Quality

- Meets derating requirements of EEE-INST-002 and ECSS-Q-30-11A
- Workmanship per J-STD-001 with space addendum J-STD-001FS
- FIT: <70 @ 35°C, SF env.
- Design life: 18 years

Mechanical

- Small dimensions: 60x50x18mm (LxBxH)
- Vibration and shock resistant
- Low weight, < 45 grams
- Board is coated with ARATHANE-5750

1 Specification Overview, MLN10005D, PN12159

Section 2 in this datasheet presents the generic design envelope, while this section present the data for part number 12159.

Absolute Maximum Ratings		**Recommended Operating Conditions**	
Input Voltage	-0.5V_{DC} to +120V_{DC}	Input voltage range (note 9)	+97V_{DC} to +103V_{DC}
Output power	Internally limited	Output power	0 to 4W
Operating mounting point temperature	-55°C to +100°C	Operating mounting point temperature (note 9)	-35°C to +70°C*
Storage temperature	-55°C to +125°C	Cold start temperature (note 9)	-40°C

* The DC/DC converter will keep derating as per EEE-INST-002 and ECSS-Q-30-11A. In order to respect the required component temperatures, the host chassis must provide a good thermal conductive path through the fixation screws .

1.1 Electrical Performance Characteristics

Parameter	**Conditions**	**Conditions** **-35°C ≤ T_C ≤ +70°C** **V_{IN} = 100V DC ± 0.5%, C_L = 0** **unless otherwise specified**	**Limits**			**Unit**
			Min	**Nom**	**Max**	
Fundamental Characteristics						
Input voltage (V_{IN})			97	100	103	V
Output voltage (V_{OUT1} / V_{OUT2}) +5V -5V +5V -5V +5V -5V	 1 1 2 2 3 3	 0% ≤ I_{OUT} = 100% rated load Note 1 0% ≤ I_{OUT} = 100% rated load Note 1 0% ≤ I_{OUT} = 100% rated load Note 1	 +4.975 -4.975 +4.950 -4.950 +4.925 -4.925	 +5.00 -5.00	 +5.025 -5.025 +5.050 -5.050 +5.075 -5.075	V
Output power (P_{OUT1} / P_{OUT2}) +5V -5V	1,2,3				3.75 0.25	W
Output current (I_{OUT1} / I_{OUT2}) +5V -5V	1,2,3	Note 1	0 0		750 50	mA
Current Limit Point (CL_{OUT1} / CL_{OUT2}) +5V -5V	1,2,3	Note 1	 800 80		 1000 110	mA
Input current (I_{IN})	1,2,3	Commanded Off Commanded On, I_{OUT} = 0 Maximum load Failure mode (short circuit)		1.2 10 57	2 15 65 85	mA
Switching frequency (F_S)	1,2,3	Notes 1, 7	129	140	151	kHz
Efficiency (E_{FF})	1,2 1,2 1,2 3	1/3 load 2/3 load Full load Full load, EOL	54 61 62 61	60 65 66 64		%
Detailed Output Characteristics						
Line regulation (VR_{LINE}) Both Output	1,2,3	V_{IN} = 97, 100, 103 Volts I_{OUT} = 0, 50%, 100% rated, Note 4	-5		+5	mV
Load regulation (VR_{LOAD}) Both Output	1,2,3	I_{OUT} = 0, 50%, 100% rated, Note 4 V_{IN} = 97, 100, 103 Volts	-5		+5	mV

For Notes to Electrical Performance Characteristics, refer to page 5

1.1 Electrical Performance Characteristics (continued)

Parameter	Conditions	Conditions -35°C ≤ T_C ≤ +70°C V_{IN} = 100V DC ± 0.5%, C_L = 0 unless otherwise specified	Limits			Unit
			Min	Nom	Max	
Cross regulation (VR_{CROSS})	1,2,3	Both Output, Note 1 V_{IN} = 97, 100, 103 Volts	-5.0		+5.0	mV
Output ripple (V_{RIP}) +5V -5V +5V -5V	1 1,2	Frequency domain 100Hz – 50MHz Time domain 100Hz – 50MHz Notes 1, 2			1 1 30 30	mVrms mVp-p
Output response to step load changes (V_{TLD}) +5V -5V	1,2,3	20% to 100% Load, Notes 3,4	-100 -50		+100 +50	mVpk
Recovery time, step load changes (T_{TLD})	1,2,3	20% to 100% Load, Notes 3,4			2.5	ms
Output response to Single Event Transients (V_{SET}) +5V -5V	1,2,3	In 20% to 100% rated load, Note 3			200 100	mVpk
Recovery time, Single Event Transients (V_{SET}) +5V -5V	1,2,3	In 20% to 100% rated load, Note 3	-350 -100		+100 +150	µs
Turn-on Response Overshoot (V_{OS}) +5V -5V Turn-on Delay (T_{DLY})	1,2,3	Notes 1,5	 2.0		 50 300 10	 mV ms
Output Sequencing Turn-on delay -5V to +5V Turn-off delay +5V to -5V	1,2,3	Note 1 See section 2.2.5 for details 5V <10% of nom, -5V >90% of nom. 5V <10% of nom, -5V >90% of nom.	 2 1		 12 8	 ms
Capacitive load (C_L)	1,2,3	Notes 1, 6 Max capacitive load, each output			100	µF
Telemetry & Telecommand (TM & TC)						
Telecommand I/F ON command pulse Neg. Pulse Voltage Pulse duration	1,2,3	Note 10	+22.3 -40 10	+26	+30 +0.5 1000	V ms
Status Telemetry Converter On Converter Off	1,2,3	Note 10 Closed contact Open contact	 1		10	Ω MΩ
Bilevel Telemetry	1,2,3	Output impedance = 1kohm No load voltage	4.9	5.0	5.1	V
Undervoltage Protection (UVP)						
Under voltage Protection Trig level – turn off Hysteresis	1,2,3	0% ≤ I_{OUT} ≤ 100% of rated load	77 2.0	81.4 2.4	84.5 2.9	V

For Notes to Electrical Performance Characteristics, refer to page 5

1.1 Electrical Performance Characteristics (continued)

Parameter	Conditions	Conditions -35°C ≤ T_C ≤ +70°C V_{IN} = 100V DC ± 0.5%, C_L = 0 unless otherwise specified	Limits			Unit
			Min	Nom	Max	
Conducted emission (CE) on outputs +5V -5V	1,2,3				 60 55	dBuVrms
Electromagnetic Compability (EMC)						
EMC conducted susceptibility (Line rejection)	1,2,3	Primary power sine wave injection of 2Vp-p, 100Hz to 1MHz Both outputs	80	90		dB
Electromagnetic Interference (EMI), conducted emission (CE) on input	1	@ switch frequency See also section 1.2 EMI Performance		70	75	dBuArms
Mechanical Characteristics						
Dimensions Length Width Height	1,2,3	See also section 2.4 Mechanical Design		 60.0 50.0 18.0	 60.2 50.2 18.4	mm
Mass	1,2,3	Excl. mounting bolts			45	g
Vibration	1,2	See also section 2.4.1 Vibration and Shock			39.9	grms
Shock	1,2	See also section 2.4.1 Vibration and Shock			4200	G
Radiation						
Total Ionizing Dose (TiD)	1,2,3		100			krad
Single Event Effect tolerant (SEE)	1,2,3		60			MeV/cm^2/mg
Other Characteristics						
Isolation	1,2,3	Input to Output, any potential to telecommand input and any potential to telemetry output, test @ 100VDC See also section 2.3 Grounding and Isolation	10			MΩ
Failure Rate		MIL-HDBK-217 Notice 2, SF, 35°C, Note 8			65	FITs

For Notes to Electrical Performance Characteristics, refer to page 5

Notes: Electrical Performance Characteristics Table

General: All parameters are specified within recommended operating conditions unless otherwise stated.

1. Parameter is analyzed and tested.
2. Guaranteed for a DC to 50MHz bandwidth. Tested using a 10.7MHz bandwidth.
3. Load step transition time ≥ 10 µs.
4. Recovery time is measured from the initiation of the transient to where V_{OUT} has returned to within 90% of its steady state value.
5. Turn-on delay time from application of telecommand pulse to the point where output 2 >90% of nominal output voltage.
6. Capacitive load may be any value from 0 to the maximum limit without compromising the output sequencing performance. A capacitive load in excess of the maximum limit may influence the output sequencing performance and start-up time, but the converter operation and dc performance will remain intact.
7. The switching frequency and 1st and 2nd harmonic of the input ripple is tested on every unit.
8. MIL-HDBK-217Fn2 stress-dependent method is used with 2 exceptions: For soldering a fixed failure rate at 0.035FIT is used and for power MOSFETs the dissipated power (instead of rated power) is used for the Pr parameter. 1 FIT is 1 failure in 109 hours.
9. The converter meets full derating per EEE-INST-002 and ECSS-Q-30-11A with the following exception: For Schottky diode JANS1N5819 a maximum derated junction temperature of +110°C. For EEE-INST-002 it is required that ceramic capacitors with a voltage stress below 10V shall be rated for minimum 100V – in the design such capacitors is rated for 50V minimum.
10. Generic TM/TC circuit and configuration for specific part number is presented in section number 2.2.3 Telecommand and Status Telemetry.

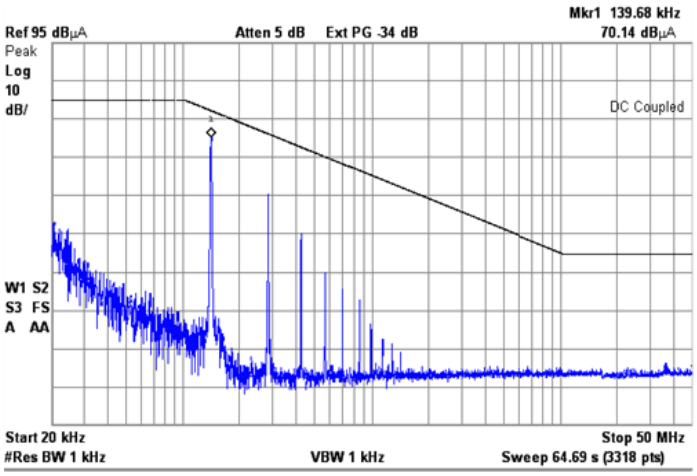
Electrical Performance Characteristics - Definition of Conditions

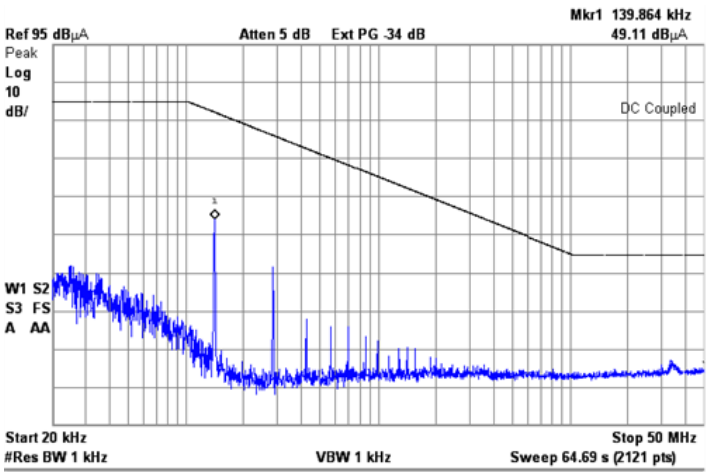
Conditions	Definition	Comment
1	BOL @ +25°C interface temperature	Initial setting
2	BOL @ -35°C to +70°C interface temperature	Initial setting and worst case temperature variation
3	EOL @ -35°C to +70°C interface temperature	Worst case performance including initial setting, temperature variation, ageing and radiation degradation

1.2 EMI Performance, MLN10005D, PN12159

1.2.1 Conducted Emission Input

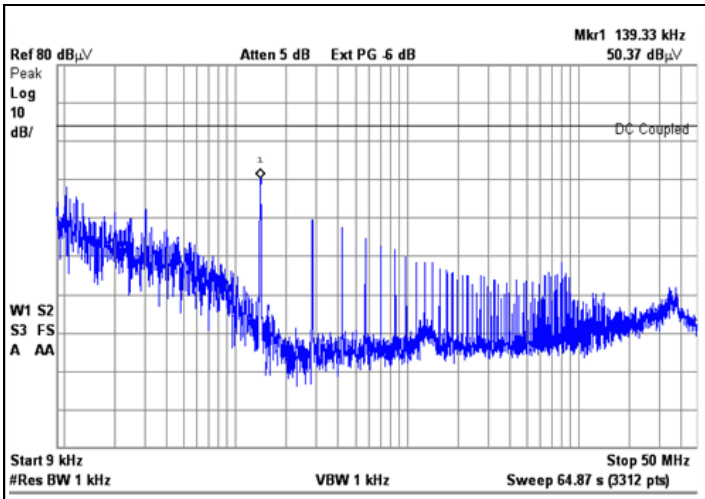
The MLN series include integrated EMI filter.

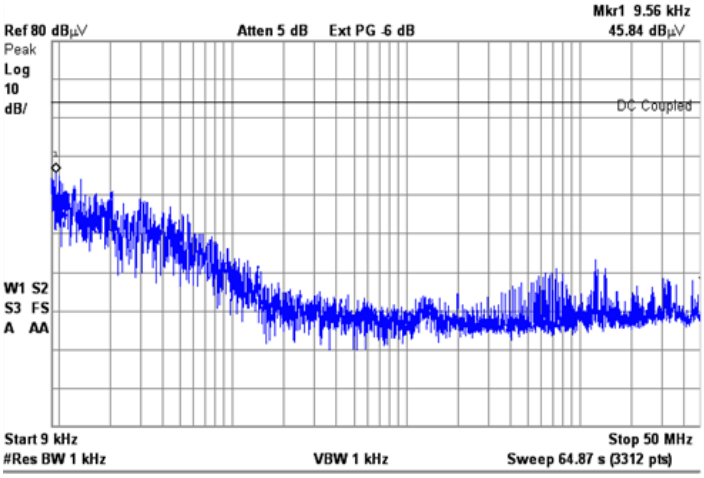




Conducted emission on input line - typical performance – full load. Left: Differential mode, Right: Common mode

1.2.2 Conducted Emission Output





Conducted emission, differential mode - typical performance – full load. Left: Pos. output, Right: Neg. output

2 MLN SERIES

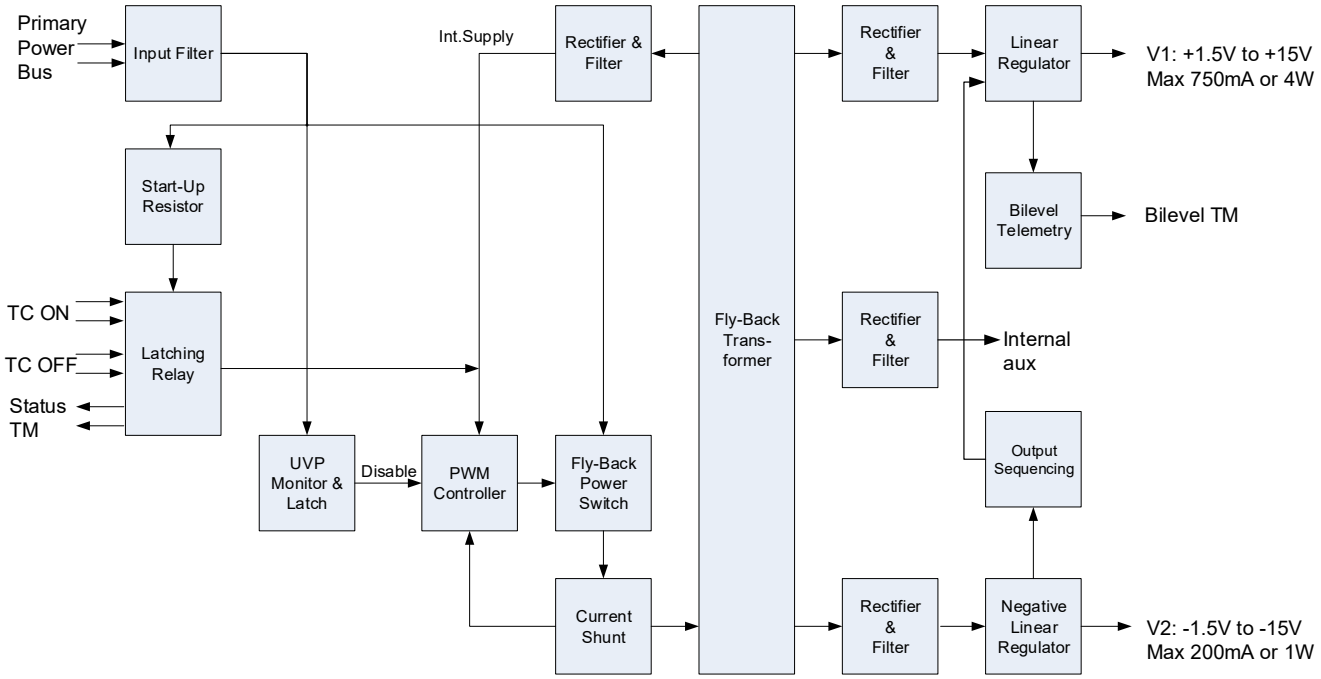
Section 1 in this datasheet presents the data for part number 12159. While this section present the generic design envelope, for which the MLN series can be tailored by changing parts while re-using the generic printed circuit board.

2.1 General

The MLN-Series use two-stage regulation with a DC/DC converter (Fly-back topology) followed by a linear post regulator for each output. The Fly-back DC/DC converter provides the basic step down and galvanic isolation. The linear regulators ensure high voltage accuracy, low cross loading sensitivity and excellent noise suppression.

Each output provides individual and independent current limiter, thus failure propagation from the output to the input bus, through the converter, is not possible

Block Diagram



2.2 Design Envelope

2.2.1 Input bus Voltage Range

Input voltage range can be configured for different satellite power busses. Best performance is achieved when connected to a bus with a narrow tolerance bus voltage such as 100±3V or 50±3V busses. The MLN can also be configured to low voltage busses such as 28±8V. In general the input voltage range is configurable from 20V to 100V, however the full input range cannot be accommodated in one single design as this will sacrifice performance and derating requirements. Instead the primary side of the design must be adjusted from project to project.

2.2.2 Output Voltage Range and Power

The MLN has a total output capability of 5W, where 4W is delivered from the positive output.

The circuit allows for 2 fixed voltage outputs: one positive and one negative.

The outputs can be configured in the range from 1.5V to 15V. Maximum current capability is limited to 750mA.

2.2.3 Telecommand & Status Telemetry

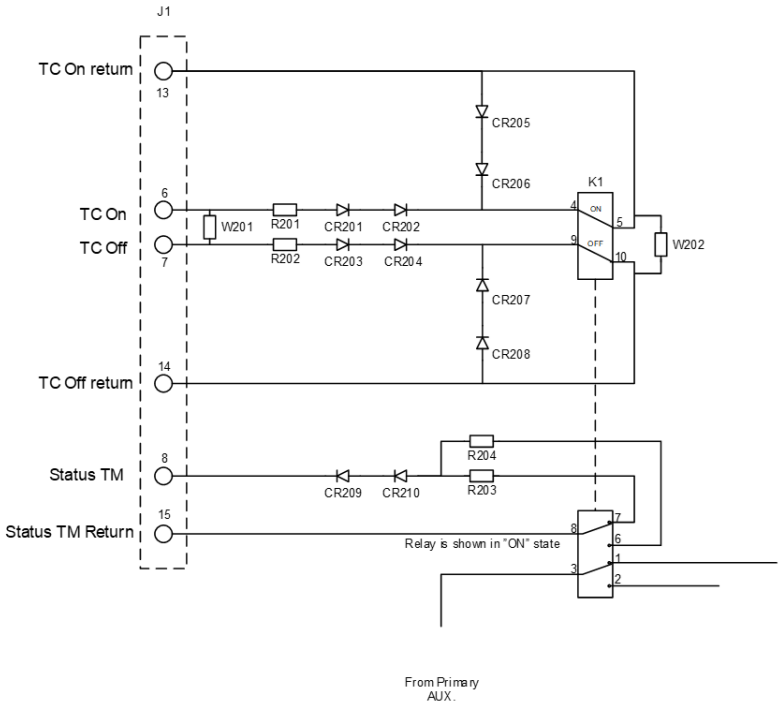
The MLN series includes telecommand and telemetry options. The interfaces can be tailored to fit all major satellite platforms.

Telecommand interface:

- TC voltage: can be customized to fit 12V-17V or 22V-34V command voltage ranges
- Freewheeling diodes/inductive kick back protection on TC lines are optional
- Telecommand pulse length: >10ms
- Telecommand interface is galvanically isolated from other circuits
- Telecommand ON return and OFF return can be isolated from each other or tied together
- Circuit concept is based on a latching relay

Status Telemetry interface:

- Switch closure acquisition with closed (or specific impedance) or open contact
- Switch closure acquisition with or without series diodes and series resistance
- Status TM circuit is galvanically isolated from other circuits
- Circuit concept is based on a latching relay



Ref Des	PN12159
CR201	1N6640US, 0.3A, 75V
CR202	1N6640US, 0.3A, 75V
CR203	1N6640US, 0.3A, 75V
CR204	1N6640US, 0.3A, 75V
CR205	Not fitted
CR206	Not fitted
CR207	Not fitted
CR208	Not fitted
CR209	Strap
CR210	Strap
K1	J422-26M Shock Res. 26V
R201	121Ω, 100V, SMD1206,
R202	121Ω, 100V, SMD1206,
R203	Strap
R204	Strap
W201	Not fitted
W202	Not fitted

Figure 2.2.3-1: TM/TC circuit implemented on PWB. Note: not all components are to be mounted at the same time, but can be mounted or left out according to require-

2.2.4 Analog/Bi-level Telemetry interface

Bilevel Telemetry is derived from the positive output (Output 1) and will be proportional with this output voltage.

Status TM voltage cannot exceed output 1's voltage, but can be similar or divided down. For output 1 voltages above 5V status TM voltage is normally limited to 5V. In case output 1 is below 5V status TM will be correspondingly lower.

- Bi-level TM can be used as supplement to the status TM and will be "high" when the converter is operating
- Bi-level TM is implemented by default, but can be left unused if not required
- Bi-level TM refers to secondary (output) return

2.2.5 Under Voltage Protection (UVP)

- The Under voltage protection circuit can be configured as latching or non-latching
- In case of latching configuration, the MLN series requires an OFF command followed by an ON command in order to restart.
- In case of a non-latching configuration the MLN series will restart automatically when input voltage resume back to normal

2.2.6 Output Timing/sequencing

The MLN series features timing between outputs during turn on, turn off and overload situations. This feature is very convenient in many RF amplifier applications where negative bias is required before positive power is applied.

- At turn ON the negative output will come up before the positive.
- At turn OFF the positive output will be switched off before the negative output [1)]
- An overload situation on the positive output, causes this output to behave like a constant current source while the negative output remains.
- An overload situation on the negative output causes the positive output to shut down, while the negative act like a constant current source.
- The converter will automatically resume to normal operation when the overload is removed.

1) There is no active pull down associated with the positive line. If there is no load on the positive output energy stored it the output capacitor will remain and timing cannot be fully respected. However, energy is limited to the energy stored in the output capacitor and if implemented an external decoupling capacitor. Generally, timing is respected down to 20% load on the positive line.

2.3 GROUNDING & ISOLATION

Parameter	Grounding & Isolation performance
Isolation: Primary to Secondary: Telecommand: Status TM:	 >10Mohm // < 50nF Floating / Galvanically isolated Floating / Galvanically isolated
Grounding :	Secondary Return bound to chassis via multiple screw connections.

2.4 MECHANICAL DESIGN

The DC/DC is considered a module forming part of the complete host equipment. The DC/DC is 'open PWB board' ready for installation into the host equipment housing.

The PWB board is mounted directly into the host mechanics. The screws act as both mechanical fixation and thermal path. Hence, the screw positions is a result of the mechanical and thermal design.

- Input terminals: Solder pins, 1-15 (accessible from top side only) or D-SUB15 male [1)]
- Output Terminals: Solder pads, 1-8 (outputs are accessible from both sides of the board) [1)]
- Mounting: 5 pcs M2 screws or equivalent
- The DC/DC converter is conformal coated with Arathane 5750 (except on mating surfaces and terminals)

[1)] All soldering must be performed according to J-STD-001 or equivalent.

Dimensions are outlined below and the Interface control drawing (ICD) with detailed terminal information and dimensions can be delivered upon request

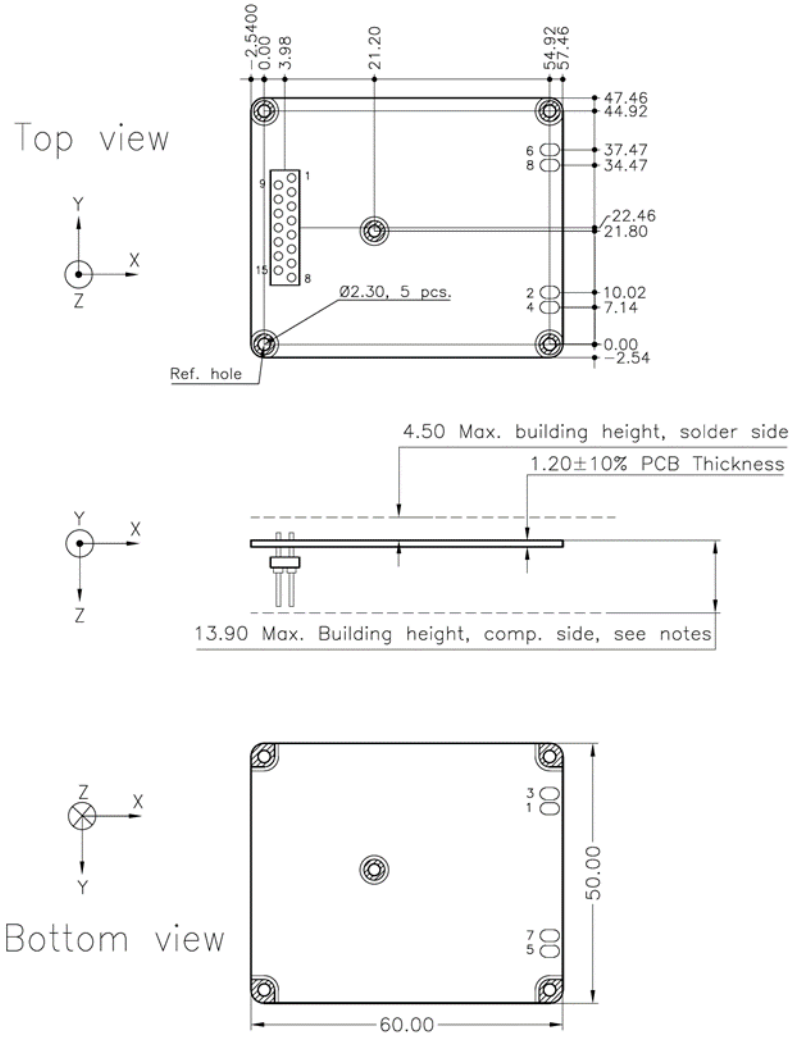


Figure 2.4-1: Mechanical Interface

Pin Designation Tables

Input Terminal Assignment List		
Terminals: PN 12159: solder pins, straight Option for D-SUB Male)		
Pin #	**Pin #**	**Description**
	1	Input Power Return
9		Input Power Return
	2	Reserved (internally connected)
10		Reserved (internally connected)
	3	Input Power
11		Input Power
	4	Chassis
12		Bi-level/Analog telemetry
	5	Bi-level/Analog telemetry return
13		TC On Return
	6	TC On
14		TC Off Return
	7	TC Off
15		TM Status Return
	8	TM Status

Output Terminal Assignment List		
Terminals: Solder Pads		
Pin #	**Pin #**	**Description**
1	2	Output 1
3	4	Chassis Return
5	6	Chassis Return
7	8	Output 2

2.4.1 Vibration and Mechanical Shock

1st resonance is approximately 800Hz. Critical components are supported by staking.
The MLN is qualified to the following vibration and shock levels:

Random Vibration

Axis	Frequency (Hz)	Level
All	20-100	+6.0 dB/oct
	100– 1000	1.0 g^2/Hz
	1000 -1500	-3.0 dB/oct
	1500 - 2000	-6.0 dB/oct
Overall Level : 39.9Grms		

Mechanical Shock (SRS, Q =10)

Frequency (Hz)	Level (G) [1)]
100	52
4000	4200
10000	4200

Note 1) Relay might change state during exposure, but will not be damaged or degraded.

3 Application Information

Standard Documentation

Each converter is delivered with the following documentation:

- Interface Control Drawing
- User's Manual
- End Item Data Package with CoC, applicable configuration, MIP photo and acceptance test results

Design Justification Documentation

The following documentation can be made available upon request:

- Worst Case Analysis
- Parts Stress Analysis
- Thermal Analysis
- Mechanical Analysis
- FMECA
- Reliability Assessment
- Declared Components List
- Declared Materials List
- Declared Process List

4 Ordering Information

This datasheet covers the specific part number 12159 which can be ordered through IR HiRel sales team. The MLN platform is highly customizable on the input and output side and can be adapted for most satellite platforms. For adaptation request please contact IR HiRel sales and marketing.

Part Number	Description
12159EBB	Elegant Bread Board
12159EM	Engineering Model
12159QM	Qualification Model
12159FM	Flight Model

Model Testing

Part Number	12159EBB	12159EM	12159QM	12159FM
Temperature cycling	No	No	Optional	Optional
Electrical acceptance test in temperature, note 1	Yes, Q-level	Yes, Q-level	Yes, Q-level	Yes, A-level
Thermal Vacuum	No	No	Optional	Optional
EMC, note 2	Optional (CE & CS only)	No	Optional	No
Vibration	No	No	Optional (sine, random)	Optional (random only)
Mechanical Shock	No	No	Optional	No

Note 1: A-Level Temperatures corresponds to Recommended Operating mounting point temperatures defined in section 1. Q-Level temperatures are 5ºC higher at hot and 5ºC lower at cold, compared to A-Level.

Note 2: The electrical acceptance test includes limited EMC characterization (e.g. CE for power input and power output)

Model Build Standard

Model	Build Standard
EBB	The PWB will be hand soldered by the engineering group (workmanship checked by certified inspector). Assembly processes may differ from flight standard processes. Components will be staked, magnetic components will not be impregnated, no conformal coating is applied. The EBB is suitable for electrical testing. Preferably lower grade of same type of EEE parts as intended for flight for all parts, but different types with same basic characteristics are allowed.
EM	The PWB will be hand soldered by the engineering group (workmanship checked by certified inspector). Assembly processes may differ from flight standard processes. Magnetics will be impregnated, components staked, and the board will be conformal coated. The EM will be suitable for environmental testing. Preferably lower grade of same type of EEE parts as intended for flight for all parts, but different types with same basic characteristics are allowed.
QM	Full Flight standard. The only difference between QM and FM is the testing.
FM	Full Fight standard

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