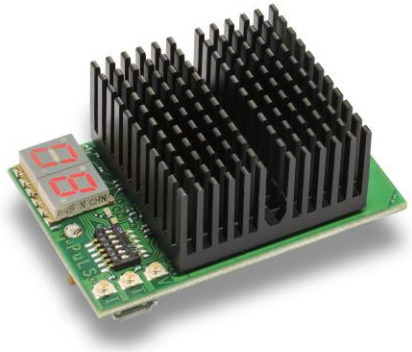
flex

Technical Specification

ROA 128 5552 series Electronic Loads Input 0.2-20 V, Current up to 45 A /25 W	1/28701-ROA 128 5552 Rev C April 2018 © Flex

Key Features

- Mounts directly on the application board
- Easy Programming with Graphical User Interface
- Pulse load with high di/dt up to 15 A/µs
- USB interface or PMBus dongle
- Emulates ASIC, FPGA or CPU transient loads
- Industry standard Quarter-brick foot-print
  57.9 x 36.8 x 32 mm (2.28 x 1.45 x 0.6 in.)



General Characteristics

- Programmable pulse parameters
- Variable pulse trigger options
- Address and information display
- Output voltage monitoring
- Temperature monitoring
- Over temperature protection
- Transient energy protection
- Compatible with Windows XP and later
- Easy mounting with fast-on socket connection
- ISO 9001/14001 certified supplier

Design for Environment

Meets requirements in high-temperature lead-free soldering processes.

Contents

Ordering Information

Product program	Ratings
ROA 128 5552/1 Uen	0.2-20 V/45 A

Connection socket	Type
See Mechanical Information	Mill-Max pin receptacles

Miscellaneous

Equipment	Type
10 way ribbon cable, pitch 0.635 mm (0.025 in)	3M 3756/10
2x5 pin IDC receptacle, pitch 1.27 mm (0.05 in)	SAMTEC FFSD-05-01-N
U.FL ↔ BNC(M) cable	Wellshow BH150WS121003-09
USB A ↔ USB Micro B Cable	

General Information

Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2011/65/EU and have a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of 0.01% by weight in homogeneous materials for cadmium.

Exemptions in the RoHS directive utilized in Flex Power Modules products are found in the Statement of Compliance document.

Flex Power Modules fulfills and will continuously fulfill all its obligations under regulation (EC) No 1907/2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH) as they enter into force and is through product materials declarations preparing for the obligations to communicate information on substances in the products.

Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, Six Sigma, and SPC are intensively in use to boost the continuous improvements strategy. Infant mortality or early failures in the products are screened out and they are subjected to an ATE-based final test. Conservative design rules, design reviews and product qualifications, plus the high competence of an engaged work force, contribute to the high quality of the products.

Warranty

Warranty period and conditions are defined in Flex Power Modules General Terms and Conditions of Sale.

Limitation of Liability

Flex Power Modules does not make any other warranties, expressed or implied including any warranty of merchantability or fitness for a particular purpose (including, but not limited to, use in life support applications, where malfunctions of product can cause injury to a person's health or life).

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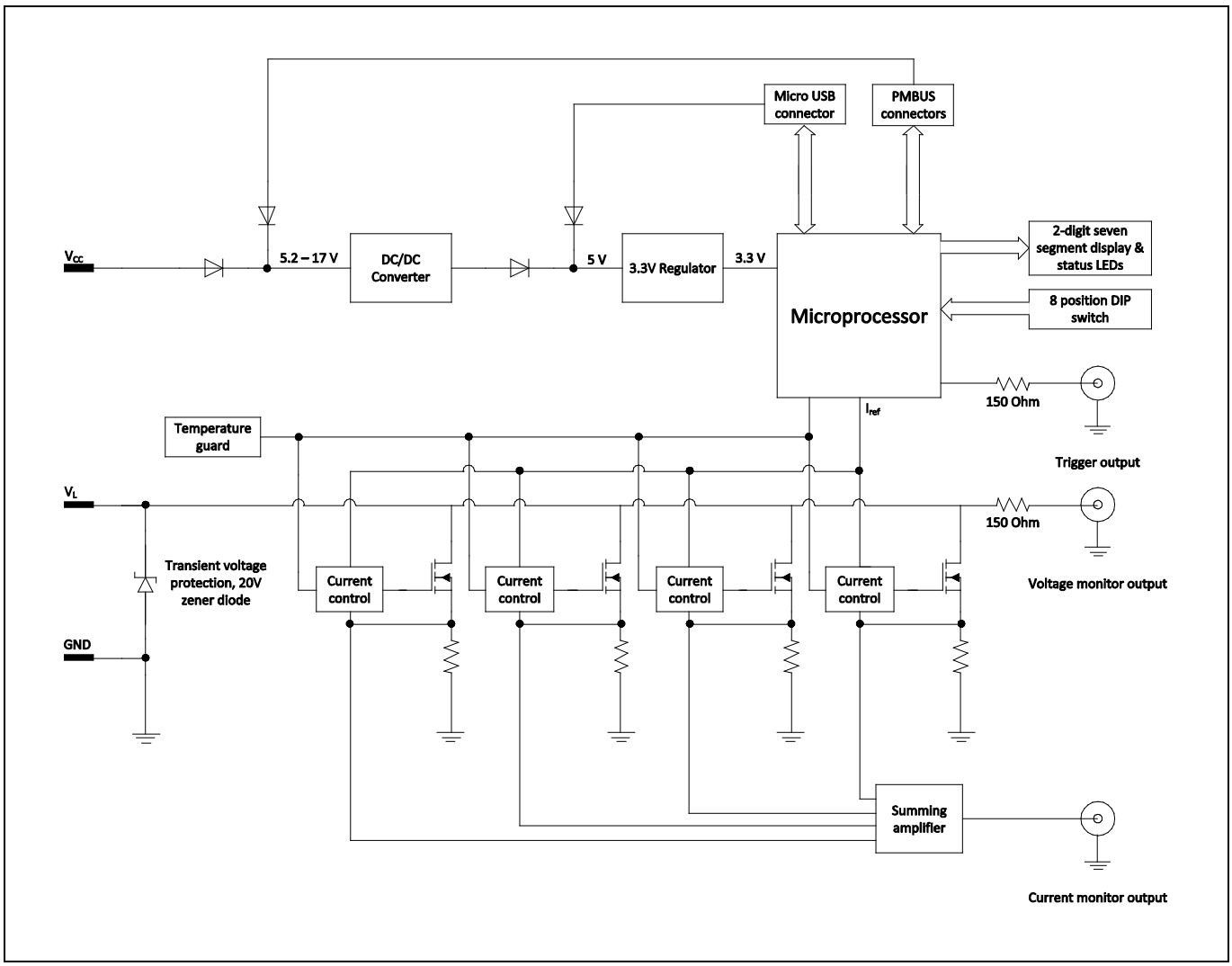
Absolute Maximum Ratings

Characteristics		min	typ	max	Unit
T_{P1}	Operating Temperature (see Thermal Consideration section)	–40		85	°C
T_S	Storage temperature	–55		125	°C
V_L	Load input voltage	0		20	V
V_{CC}	Supply voltage to control block	0		17	V
I_L	Load current	0		45	A
W_{tr}	Transient input energy (see Operating Information section)			0.48	Ws

Stress in excess of Absolute Maximum Ratings may cause permanent damage. Absolute Maximum Ratings, sometimes referred to as no destruction limits, are normally tested with one parameter at a time exceeding the limits in the Electrical Specification. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Fundamental Circuit Diagram



Electrical Specification

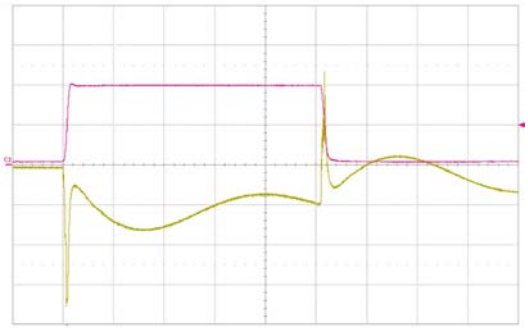
ROA 128 5552/1

$T_{P1} < T_{P1}max$, V_L = 0.2 to 20 V, unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25°C, V_L= 3.3 V, max I_L, unless otherwise specified under Conditions.

Characteristics		Conditions	min	typ	max	Unit
V_L	Load input voltage	I_L= 0-100% of I_L max	0.2		20	V
V_{CC}	Supply voltage to control block	I_L= 0-100% of I_L max	5.2		17	V
I_L	Load current		0		45	A
dI_L/dt	Load current slew rate		0.1		15	A/µs
	Slew rate tolerance			2	3	%
	Settling time	I_L= 10-70% of I_L max			5	µs
	Clock frequency	I_L= 10-70% of I_L max			50	kHz
OVP	Over voltage protection	I_L= 0-100% of I_L max			120	% of $V_L$max
$I_{L\ limit}$	Current limiting threshold				45	A
f_{CPU}	CPU clock frequency			72		MHz
f_{PS}	Internal power supply switching frequency			2.25		MHz

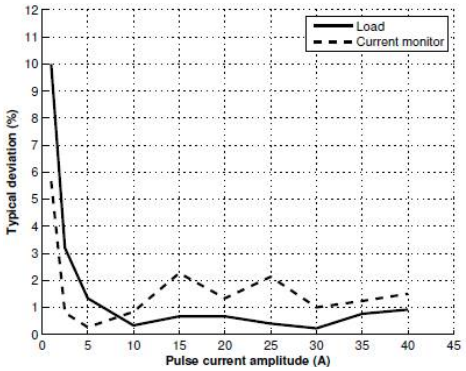
Typical Characteristics

Single pulse (example)



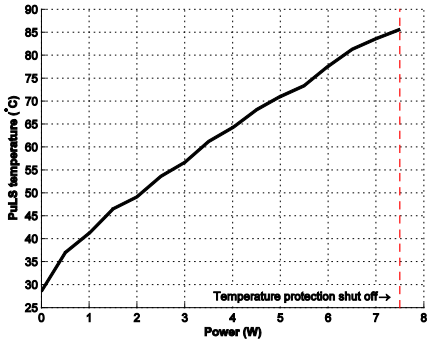
Load pulse current I_L at V_L= 3.3 V. T_{P1} = +25°C.
5 A/div, 200 mV/div, 10 µs/div

Load current and monitor accuracy



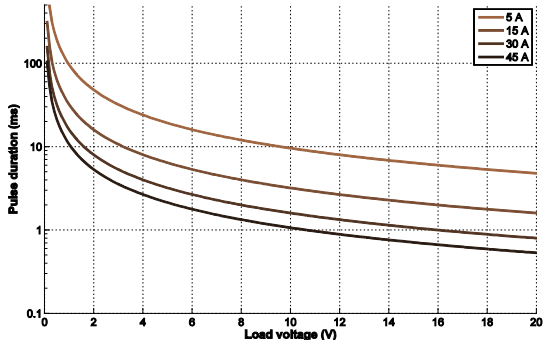
Load current I_L= 5-90% of $I_L$max at V_L= 3.3 V. T_{P1} = +25°C.

Maximum power dissipation



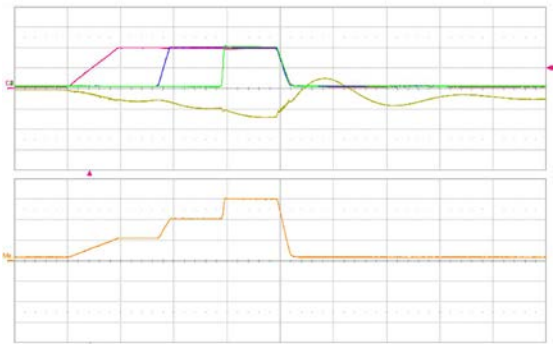
V_L= 3.3 V. T_{P1} = +25°C and free convection.

Maximum single pulse energy



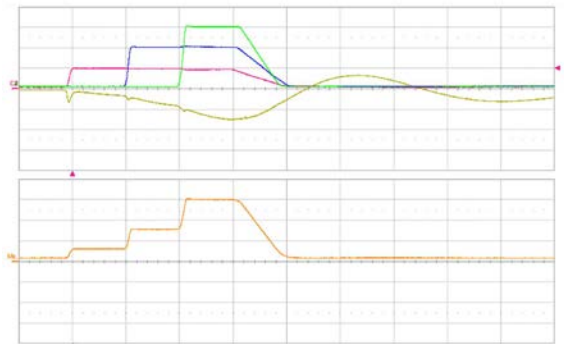
T_{P1} = +25°C.

Paralleled loads with synchronized trigger (example)



Top: Individual currents & load voltage deviation
Bottom: Total load current

Paralleled loads with synchronized trigger (example)



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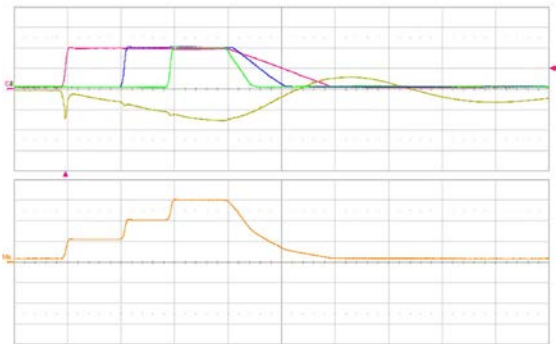

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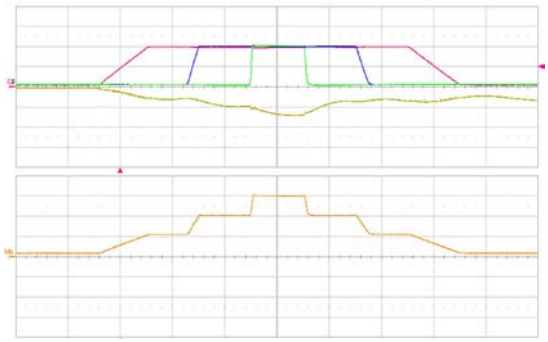
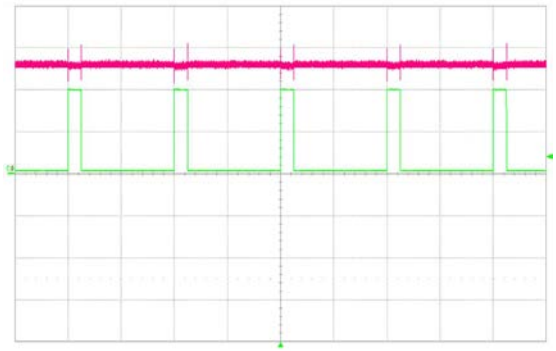
Paralleled loads with synchronized trigger (example)



Top: Individual currents & load voltage deviation
Bottom: Total load current

Pulse width 12.5% (example)



Load pulse current I_L at V_L= 5.2 V. T_{P1} = +25°C.
5 A/div, 2 V/div, 20 ms/div

Operating information

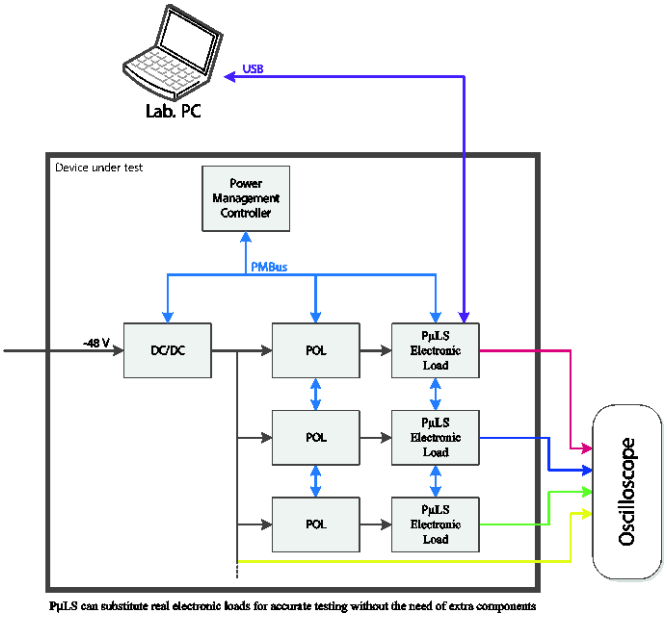
Overview

This active electronic load is primarily intended for high di/dt testing of on-board DC/DC converters and point-of-load (POL) regulators. On-board mounting means that long cables is avoided between the equipment and the load facilitating low inductance in the load current path, allowing maximum current slew rates. If it is connected with long cables the current slew rate will be limited and if the cables are longer than 0.3 m (1 ft) the inductive energy may cause permanent damage.

The electronic load is able to simulate the dynamic current of real integrated circuits and in this way test the DC/DC converter or POL regulator under realistic conditions. It can be programmed to emulate ASIC, FPGA or CPU transient loads using the Graphical User Interface and is also designed to generate heat to the equipment under test to facilitate thermal testing with increased accuracy and to characterize EMC performance at different load characteristics.

The electronic load is equipped with a PMBus interface and incorporates a wide range of monitorable and configurable features. Additionally, the product includes protection features that continuously safeguard it from damage due to unexpected system faults.

The block schematics below show the electronic load in typical test setup on printed board assemblies. The electronic load is attached to the on-board PMBus and all commands from the Lab PC are routed through the power management controller. The electronic load act as PMBus master and all parameters and functions can be reconfigured using the PMBus interface. If a stand-alone bus solution is preferred, a USB to PMBus dongle adapter must be used between the electronic load and the Lab PC.



PμLS can substitute real electronic loads for accurate testing without the need of extra components

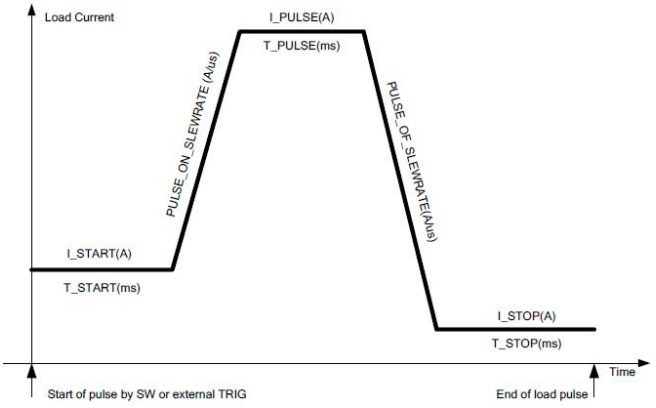
The product is delivered with a default configuration suitable for a wide range operation in terms of load voltage, load current and clock frequency. The configuration is stored in an internal Non-Volatile Memory (NVM).

Please contact your local Flex Power Modules representative for design support of custom configurations or appropriate SW tools for design and down-load.

Setting of Load Parameters

All parameters below are configured via PMBus.

- T_START: time [µs] between start trig and ramp start
- I_START: current level [A] before pulse
- PULSE_ON_SLEWRATE: ramp up [A/µs] of load current
- I_PULSE: peak current level [A] of pulse
- T_PULSE: pulse width [µs] at I_PULSE
- PULSE_OFF_SLEWRATE: ramp down [A/µs] of load current – I_STOP: current level [A] after pulse
- T_STOP: delay time [µs] after ramp down



Load Voltage

The load input voltage range 0.2 to 20 Vdc makes the product suitable for simulation of various electronics loads e.g. ASIC, FPGA or CPU transient loads.

Calibration

The load current can be calibrated via PMBus. It is recommended to calibrate the electronic load regularly on a yearly basis. The calibration values are stored in the NV memory of the controller.

Load Current Monitor

Load current can be monitored via an analog signal. The current monitor has a resolution of 0.01 A/mV.

The accuracy of the monitor is better than 3 %.

Trigger Control
The electronic load start a load pulse by detecting an external triggering signal via the trigger input pin.

In a test system with parallel configuration one of the electronic loads are set as master for the trigger signal and all trigger pins shall be tied together (open collector).

The trigger signal is active low.

Over Voltage SW Protection
The electronic load measures the voltage between positive load input pin and ground. The OVP (overvoltage protection) alarm is activated if the input load voltage is outside the V_L range, according to the Electrical Characteristics.

Over Temperature SW and HW Protection
If the heat sink temperature increases above T_{P1max} the electronic load is disabled. This function is fully autonomous and do not rely on the controller SW. The protection is non-latching and the electronic load will restart when the temperature is within the range specified in the Maximum Ratings. The over temperature protection indirectly act as a current limiter.

The controller will also register an over temperature condition and set the over temperature alarm. The PMBus temperature alarm is not set until the fault register is read.

Over Current Protection (OCP)
The electronic load has a SW current limiting function. The current sense resistors from each load branch are monitored by the controller ADC and the current signal sample rate is 1 MHz. All samples are controlled by an analog watchdog, and if a sample is over the trigger level an IRQ are set.

A secondary current limit function is achieved by the over temperature protection and shutdown (see above).

Display and LED
The electronic load has a display for presenting the local address and other status codes.

The electronic load is also equipped with a red and green status LED.

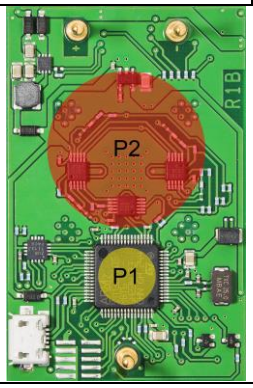
Thermal Consideration

General
The electronic load is designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.

Cooling is achieved by conduction, from the pins to the host board, and convection, which is dependant on the airflow across the product. Increased airflow enhances the cooling of the electronic load.

Operating Temperature
The heat sink and printed circuit board temperatures are used to monitor the temperatures of the electronic load, and proper thermal conditions can be verified by measuring the temperature at positions P1 and P2. The temperature at these positions (T_{P1} and T_{P2}) should not exceed the maximum temperatures in the table below. Temperatures above maximum T_{P1}, measured at the reference point P1 are not allowed and may cause permanent damage.

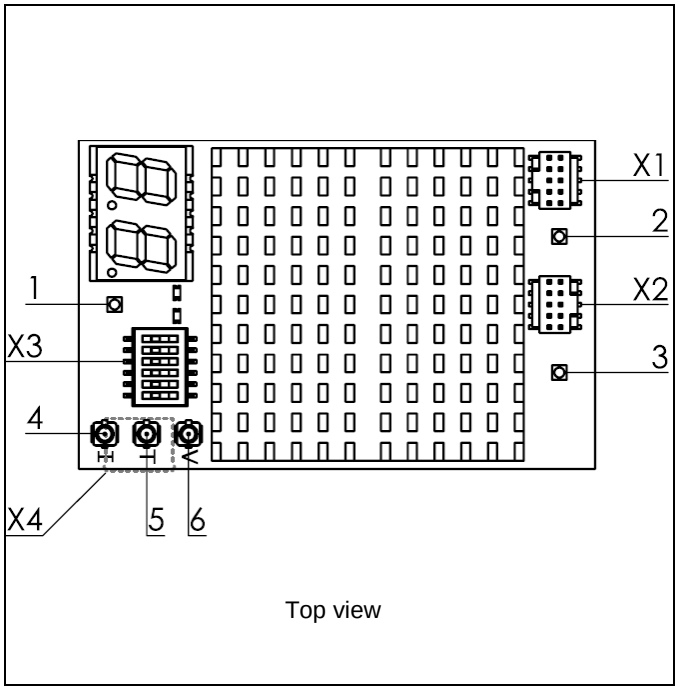
Position	Description	Max Temp.
P1	CPU reference point	T_{P1}=100ºC
P2	Printed circuit board	T_{P2}=125ºC



Bottom view

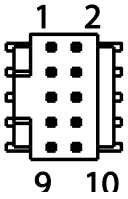
T_{P1} is also used to define the temperature range for normal operating conditions. T_{P1} is defined by the design and used to guarantee safety margins, proper operation and high reliability of the product.

Connections



Top view

IDC pins (X1 & X2)



Input and Output connections

Pin	Designation	Function
1	V_{CC}	Supply voltage to control block
2	GND	Negative load connection
3	+LOAD	Positive load connection
4	I_{Analog}	Analog monitor of load current
5	OUT_{trigg}	Digital Trigger output
6	V_{Analog}	Analog monitor of load voltage

PMBus connections (X1 & X2)

Pin	Designation	Function
1	V_{CC}	Supply voltage to control block
2	LOAD SYNC	Load trigger synchronization
3	V_{CC}	Supply voltage to control block
4	GND	Signal ground
5	NC	
6	GND	Signal ground
7	Ctrl	PMBus control signal
8	Alert	PMBus alert signal
9	SCK	PMBus serial clock
10	SDA	PMBus serial data

Address & Control (X3)

Switch	Function
1	PMBus address bit #4
2	PMBus address bit #3
3	PMBus address bit #2
4	PMBus address bit #1
5	PMBus address bit #0
6	Software update via USB

Micro USB connector (X4)

Standard micro USB for connection to a lab PC for configuration.

PMBus interface

The electronic load has a PMBus digital interface that enables the user to configure load parameters and functionality as well as monitor the voltages, load current and device temperature. The products can be used with any standard two-wire I^2C or SMBus host device. In addition, the device is compatible with PMBus version 1.1 and includes an SALERT line to help mitigate bandwidth limitations related to continuous fault monitoring.

Monitoring via PMBus

A system controller (host device) can monitor a wide variety of different parameters through the PMBus interface. The controller can monitor fault conditions by monitoring the SALERT pin, which will be asserted when any number of pre-configured fault or warning conditions occur. The system controller can also continuously monitor any number of power conversion parameters including but not limited to the following:

- Input voltage
- Output voltage
- Output current
- Internal junction temperature
- Switching frequency
- Duty cycle

Software tools for design and production

For this product Flex provides software for configuration and monitoring via the PMBus interface.
For more information please contact your local Flex sales representative.

PMBus addressing

The PMBus addressing is set by the binary switches 1 to 5 and the address offset is 32. This gives 32 possible PMBus addresses between 32-63. Note that the display does not show the offset when the electronic load is in operation. Setting all switches off (address 32) will put the electronic load in master mode and it will act as an USB to PMBus adapter.

PMBus Commands

The following table lists the implemented PMBus read commands. For more detailed information, see PMBus Power System Management Protocol Specification.

See also Operating Information, Setting of Load Parameters.

Designation	Description
READ_VIN	Read load input
READ_TEMPERATURE_1	Read system temperature
T_START	Load setting parameter
I_START	Load setting parameter
PULSE_ON_SLEWRATE	Load setting parameter
I_PULSE	Load setting parameter
T_PULSE	Load setting parameter
PULSE_OFF_SLEWRATE	Load setting parameter
T_STOP	Load setting parameter
I_STOP	Load setting parameter
T_OFF	Load setting parameter
UPDATE_SAMPLES	Apply new config parameter
STATUS_MFR_SPECIFIC	Fault status register
MFR_SERIAL	Load serial number
MFR_MODEL	Load model name/number
MFR_REVSION	Load revision state
OPERATION	Start/stop
CLEAR_FAULTS	Clear faults in status register
LOAD_TRIG	Load trigger (Master/Slave)
CALIBRATION	Calibrate current and voltage

Note: Two (2) byte commands uses the linear data format specified in the PMBUS standard.
Enter current in mA and time in µs.

READ_VIN

PMBus Command code	SMB Transaction type	Number of Data Bytes
88h	R Word	2

READ_TEMPERATURE_1

PMBus Command code	SMB Transaction type	Number of Data Bytes
8Dh	R Word	2

T_START (MFR_SPECIFIC_01)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D1h	R/W Word	2

I_START (MFR_SPECIFIC_02)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D2h	R/W Word	2

PULSE_ON_SLEWRATE (MFR_SPECIFIC_03)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D3h	R/W Word	2

I_PULSE (MFR_SPECIFIC_04)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D4h	R/W Word	2

T_PULSE (MFR_SPECIFIC_05)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D5h	R/W Word	2

PULSE_OFF_SLEWRATE (MFR_SPECIFIC_06)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D6h	R/W Word	2

I_STOP (MFR_SPECIFIC_08)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D7h	R/W Word	2

T_STOP (MFR_SPECIFIC_07)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D8h	R/W Word	2

T_OFF

PMBus Command code	SMB Transaction type	Number of Data Bytes
D9h	R/W Word	2

UPDATE_SAMPLES

PMBus Command code	SMB Transaction type	Number of Data Bytes
DAh	R Byte	1

STATUS_MFR_SPECIFIC (see description below)

PMBus Command code	SMB Transaction type	Number of Data Bytes
80h	R/W Byte	1

MFR_SERIAL

PMBus Command code	SMB Transaction type	Number of Data Bytes
9Eh	R/W Block	Variable

MFR_MODEL

PMBus Command code	SMB Transaction type	Number of Data Bytes
9Ah	R/W Block	Variable

MFR_REVISION

PMBus Command code	SMB Transaction type	Number of Data Bytes
9Bh	R/W Block	Variable

OPERATION (see description below)

PMBus Command code	SMB Transaction type	Number of Data Bytes
01h	R/W Byte	1

CLEAR_FAULTS

PMBus Command code	SMB Transaction type	Number of Data Bytes
03h	R/W Byte	1

LOAD_TRIG (MFR_SPECIFIC_00) (see description below)

PMBus Command code	SMB Transaction type	Number of Data Bytes
D0h	R/W Byte	1

CALIBRATE (MFR_SPECIFIC_11)

PMBus Command code	SMB Transaction type	Number of Data Bytes
DBh	W Byte	1

Note: Send 80h to run calibration.
Load input voltage should be between 1.5 - 3.3 V and from a source able to deliver 15 A.

Description of STATUS (80h) data byte

Bit designation	Description
B7	Over current
B6	Calibration fault
B5	Communication fault
B4	Invalid data
B3	Invalid command
B2	PMBus PEC failed
B1	Over temperature
B0	Over voltage

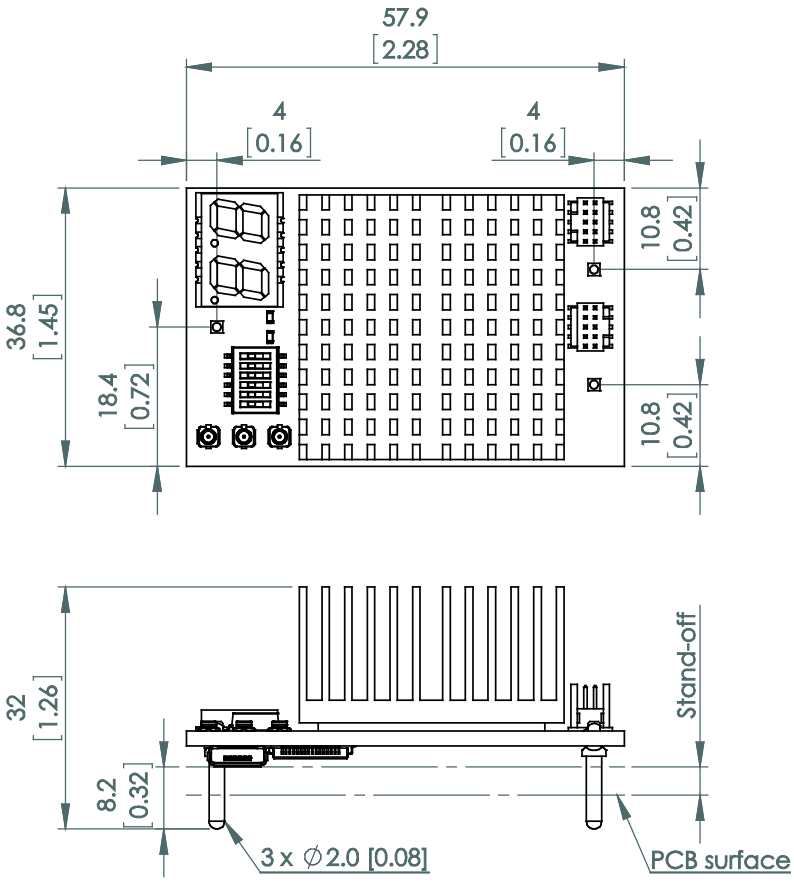
Description of OPERATION (01h) data byte

Bit designation	Description
01h	On
00h	Off

Description of LOAD_TRIG (D0h) data byte

Bit designation	Description
01h	Master setting
02h	Slave setting
03h	None (default value)

Mechanical Information



Weight: Typical 54g
All dimensions in mm [inch]
Tolerances unless specified ±0.25 [0.01]

Recommended pin receptacles		
Mill-Max part no.	PCB mounting type	PCB stand-off mm [in]
0350	Pressfit	3.7 [0.15]
0387	Solder	9.7 [0.38]
0391	Solder	1.8 [0.07]
0393	Solder	1.5 [0.06]
0493	Pressfit	3.7 [0.15]
8837	Solder	3.4 [0.13]
9214	Solder	18.9 [0.74]

Mounting Information

The electronic load is intended to be manually mounted to the host board using a fast-on connection socket or soldering iron. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

See Ordering Information for further information.

Delivery Package Information

The electronic load is delivered in a corrugated cardboard box.

Product Qualification Specification

Characteristics			
External visual inspection	IPC-A-610		
Change of temperature (Temperature cycling)	IEC 60068-2-14 Na	Temperature range Number of cycles Dwell/transfer time	-40 to 100°C 1000 15 min/0-1 min
Damp heat	IEC 60068-2-67 Cy	Temperature Humidity Duration	85°C 85 % RH 1000 hours
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	125°C 1000 h
Operational life test	MIL-STD-202G, method 108A	Duration	1000 h