SGS-THOMSON MICROELECTRONICS

GS-R400/2 Family

SWITCHING VOLTAGE REGULATOR MODULES

- MTBF IN EXCESS OF 500.000 HOURS
- NO EXTERNAL COMPONENTS REQUIRED
- PC CARD OR CHASSIS MOUNTABLE
- HIGH OUTPUT CURRENT (4 A)
- HIGH INPUT VOLTAGE (40 V)
- FIXED OUTPUT VOLTAGE (5.1 V; 12 V)
- HIGH EFFICIENCY (up to 85 %)
- SOFT START
- NON-LATCHING SHORT CIRCUIT PROTECTION
- THERMAL PROTECTION
- CROW BAR PROTECTION FOR THE LOAD
- HIGH POWER/VOLUME RATIO (24 Watt/cubic inch)

DESCRIPTION

The GS-R400/2 is a family of SMALL SIZE HIGH CURRENT HIGH VOLTAGE SWITCHING VOLTAGE REGULATORS.

These step down regulators, shielded for EMI, can provide local on-card regulation, or be used in central power supply systems, in both professional and industrial applications.

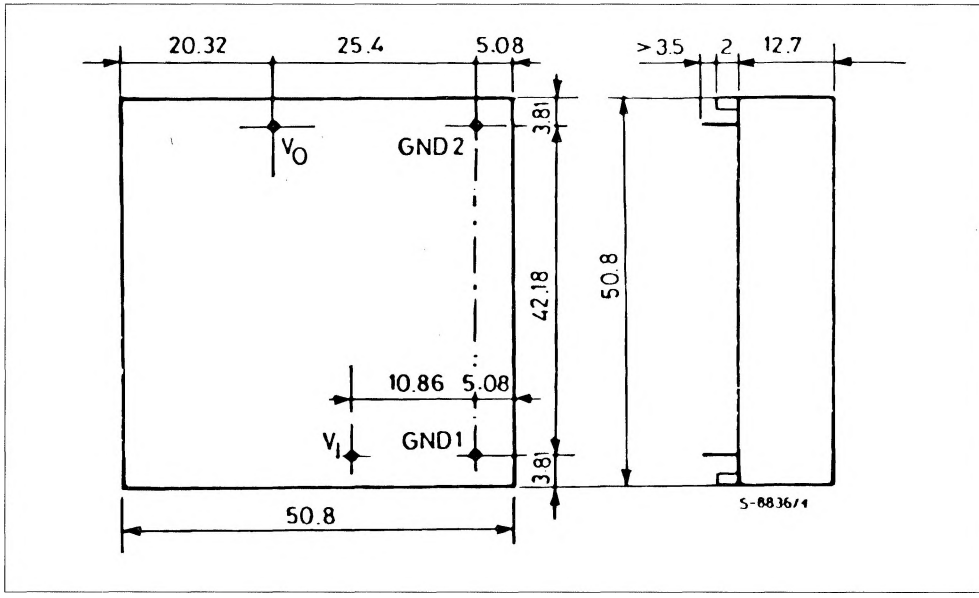
PRODUCTS FAMILY

Order Number	Output Voltage
GS-R405/2	5.1 V
GS-R412/2	12 V

ABSOLUTE MAXIMUN RATINGS

V_I	DC input voltage	40 V
I_O	Output Current	4 A
T_{stg}	Storage temperature range	- 40 to + 105°C
T_{cop}	Operating case temperature range	- 20 to + 85°C

MECHANICAL DIMENSIONS AND CONNECTION DIAGRAM (Bottom view)



PIN FUNCTIONS

	PIN	FUNCTION
V_i	- Input Voltage	Unregulated DC voltage input. Maximum voltage must not exceed 40 V.
GND_1	- Ground	Common ground for input voltage.
GND_2	- Ground	Common ground of high current path.
V_o	- Output Voltage	Regulated and stabilized DC voltage is available on this pin. Max output current is 4 A. The device is protected against short circuit of this pin to ground or to supply.

The case is electrically connected to GND.

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C Unless otherwise specified)

TYPE			GS-R 405/2			GS-R 412/2			UNIT
PARAMETER		Test Condit.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_o	Output Voltage	V_i = 24 V I_o = 1 A	5	5.1	5.2	11.5	12	12.5	V
V_o	Temperature Stability	V_i = 24 V I_o = 1 A		0.2			0.5		mv °C
V_i	Input Voltage	I_o = 1 A	9		40	16		40	V
I_O	Output Current*	V_i = 24 V	0.1		4	0.1		4	A
I_{OL}	Current Limit	V_i = V_o + 8 V		5	8		5	8	A
I_{isc}	Average Input Current	V_i = 40 V Output shorted		0.1	0.2		0.1	0.2	A
f_s	Switching Frequency			100			100		kHz
η	Efficiency	V_i = 24 V I_o = 2 A		80			85		%
ΔV_O	Line Regulation	I_o = 1 A V_i = 16 to 26 V		2			2		mV/V
SVR	Supply Voltage rejection	f = 100 Hz I_o = 1 A		4			6		mV/V
ΔV_O	Load Regulation	V_i = 24 V I_o = 0.5 to 1.5 A		20			40		mV/A
V_r	Ripple Voltage	I_{out} = 2 A		25			50		mV
V_n	Noise Voltage	I_{out} = 2 A		25			35		mV
I_r	Reflected I_{in}	V_i = 24 V I_o = 1 A		60			120		mA
T_{r1}	Line Transient recovery time	I_o = 1 A V_i = 16 to 26 V		500			500		ms
T_{r2}	Load Transient recovery time	V_i = 24 V V_i = 0.5 to 1.5		100			100		ms
R_{th}	Thermal resistance			8			8		°C/W
t_{ss}	Soft start time	V_{in} = V_{out} + 10 V		15			25		ms
t_{CB}	Crow bar Delay Time			5			5		ms
V_{CB}	Crow bar Delay Threshold			6			14.5		V

* The maximum current can be delivered when t_{case} < 85°C. Forced ventilation or additional heat-sink may be required to keep T_{case} < 85°C.

MODULE OPERATION

The GSR400/2 series is a family of step down switching mode voltage regulators.
Unregulated DC input voltage must be higher than nominal output voltage by, at least, 4 V.
Minimum input voltage is therefore 9 V for GS-R405/2 and maximum input voltage is 40 V for all the types.
The output voltage is fixed and the maximum current delivered by the output pin is 4A. A minimum output current of 100 mA is required for proper module operation. In no-load condition, the module still works, but the electrical characteristics are slightly modified vs. specifications.
To prevent excessive over current at switch on, a soft start function is provided. Nominal output voltage is approached gradually in about 15 to 25 ms.
The switching frequency of the module is 100 KHz. To prevent EMI, the module is contained in a metal box that provides shielding and heat-sink.

MODULE PROTECTIONS

Thermal Protection

The module is provided with a thermal protection. When ambient temperature reaches prohibitive values, so that internal junction temperature of active components reaches 150 °C, the module is switched off. Normal operation is restored when internal junction temperature falls below 130°C : this large hysteresis allows an extremely low frequency intermittent operation (ON - OFF) caused by thermal overload.

Short Circuit Protection

The module is protected against occasional and permanent short circuits of the output pin to ground or against output current overloads.
When the output current exceeds the maximun allowed value for safe operation, the output is automatically disabled. After a fixed time, the module starts again in a soft mode : if the overload is still present, the module switches off and the cycle is repeated until the overload condition is removed.The average overload current is limited to a safe value for the module itself. Input current during output short circuit is always lower than in regular operation.

Load Protection

The module protects, by a crow bar circuit, the load connected to its output against overvoltages. This circuit senses continuously the outpout voltage : if, for any reason, the output voltage of the module exceeds by + 20 % the nominal value, the crow bar protection is activated and it short circuits the output pin to ground. This protection prevents also damages to the module if the output pin is wrongly connected to the supply voltage.

OPERATING AMBIENT TEMPERATURE RANGE

The GS-R400/2 modules are power devices, i.e. devices that deliver and dissipate power. The power dissipation is related to the delivered output power by

$$P_d = P_o \left(\frac{1}{\eta} - 1\right)$$

where η = efficiency = $\frac{P_o}{P_{IN}}$

The operating ambient temperature range cannot be simply defined by numbers because it depends on many conditions that must be previously defined.

On the contrary, the operating case temperature is well defined and it ranges from - 20 to + 85 °C.

The two extremes are imposed by reliable operation of aluminium electrolytic capacitors that are housed inside the modules.

From these data, the maximun ambient temperature range can be easily calculated, as show in the following example :

V_{IN} = 24V V_{OUT} = 5 V ; 12V I_{OUT} = 3A.

The dissipated powers of GS-R405/2 and GS-R412/2 are respectively :

$P_{d\ 5V}$ = 3.75W $P_{d\ 12V}$ = 6.4W

By knowing the thermal resistance case to ambient R_{TH} = 8°C / W for natural convection condition, the maximun ambient temperature for a case maximum temperature of 85°C will be

$$T_{amb\ max} = T_{case\ max} - P_d \cdot R_{TH}$$

i.e.

$$T_{amb\ 5v} = 85 - 3.75 \cdot 8 = 55°C \text{ max}$$

$$T_{amb\ 12V} = 85 - 8 \cdot 64 = 34°C \text{ max}$$

This ambient temperature can be increased by lowering the thermal resistance case to ambient. Various methods can be adopted such as addition of external heat-sink on forced ventilation or both.

If an external heat-sink with R_{TH} = 10°C/W is used, the values are modified as follows.

The total thermal resistance case to ambient is the parallel of the two thermal resistances

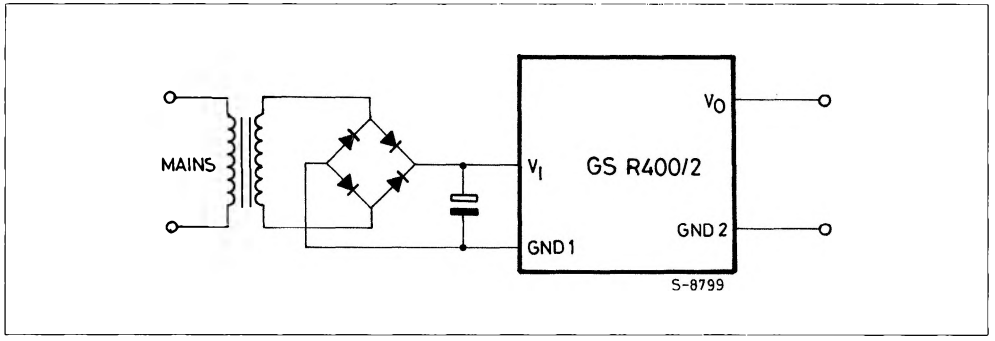
$$R_{TH\ TOT} = \frac{R_{TH\ CASE} \cdot R_{TH\ HEAT\text{-}SINK}}{R_{TH\ CASE} + R_{TH\ HEAT\text{-}SINK}} = 4.5°C/W$$

$T_{amb\ 5V}$ = 68°C max $T_{amb\ 12V}$ = 56°C max

TYPICAL APPLICATIONS

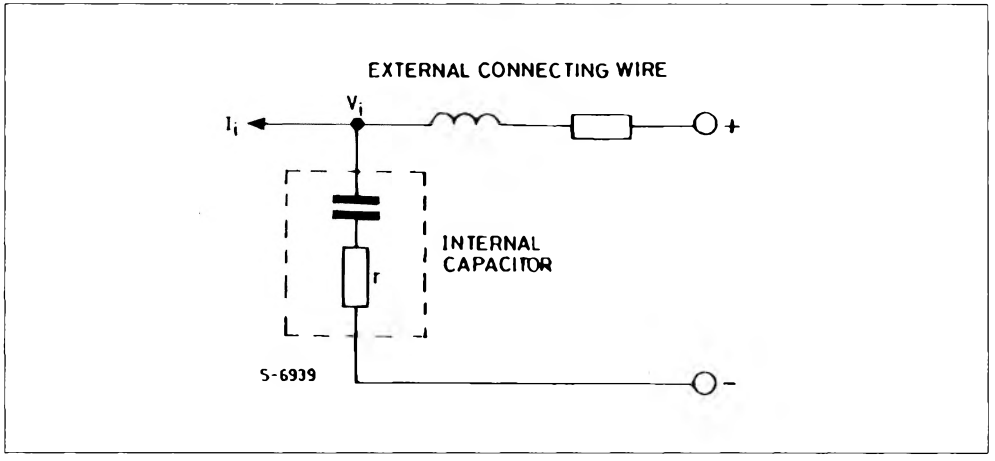
The high input voltage range allows both cost saving on 50/60 Hz transformer when the module is supplied from the mains, and the possibility to supply the module with batteries that, according to their charge status, can show large spread on voltage.

Figure 1 - A Typical Application of GS-R400/2 Voltage Regulator



The module has, internally, an input filtering capacitor between pin V_I and GND_1. Therefore, at the switching frequency the equivalent input circuit is as shown in fig. 2.

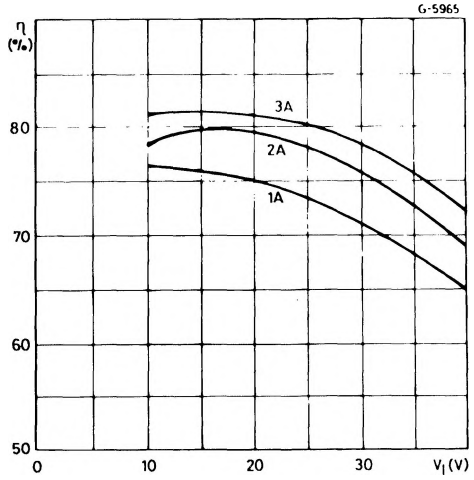
Figure 2 - Equivalent Input Circuit of GS-R400/2 Voltage Regulator



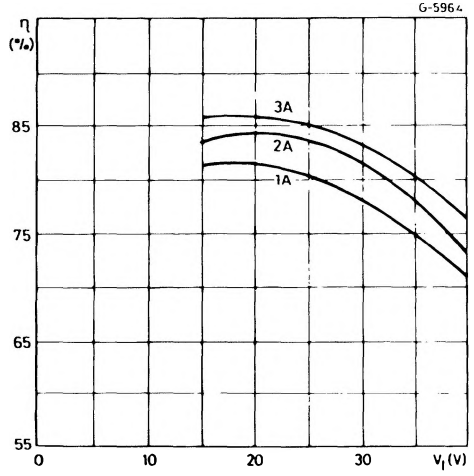
Since I_I is a high frequency alternating current, the inductance associated to long input connecting wire can cause a voltage ripple on point V_I that produces a ripple current across internal capacitor and a power dissipation on r.

When very long connecting wires are used, the input capacitor may be damaged by this power dissipation. For this reason it is suggested to keep input connecting wires as short as possible.

EFFECIENCY VS. INPUT VOLTAGE & OUTPUT CURRENT



GS-R405/2



GS-R412/2