

## 20W TO 140W STEP-DOWN SWITCHING REGULATOR FAMILY

### FEATURES

- MTBF in excess of 200,000 hours
- 4A max output current
- 46V max input voltage
- 4V max drop-out voltage
- Soft start
- Remote logic inhibit/enable
- Remote output voltage sense
- Non-latching overload and short circuit protection
- Crow-bar output overvoltage protection

### DESCRIPTION

The GS-R400 series is a versatile family of high current, high voltage step-down switching voltage regulators.

The integral heatsink allows a large power handling capability and it provides also an effective shielding to minimize EMI.



### SELECTION CHART

| Type<br>Ordering<br>Number | Output<br>Voltage<br>(V) | Input<br>Voltage<br>(V) | Output<br>Ripple<br>(mVpp) | Regulation     |                | Efficiency<br>(%) | Notes  |
|----------------------------|--------------------------|-------------------------|----------------------------|----------------|----------------|-------------------|--|
|                            |                          |                         |                            | Line<br>(mV/V) | Load<br>(mV/A) |                   |  |
| GS-R405                    | 5.1 ± 2%                 | 9 to 46                 | 25                         | 2              | 20             | 70                | Fixed output voltage                                 |
| GS-R412                    | 12.0 ± 4%                | 16 to 46                | 50                         | 5              | 40             | 80                | "  |
| GS-R415                    | 15.0 ± 4%                | 19 to 46                | 65                         | 5              | 60             | 85                | "  |
| GS-R424                    | 24.0 ± 4%                | 28 to 46                | 100                        | 6              | 90             | 90                | "  |
| GS-R405S                   | 5.1 ± 2%                 | 9 to 46                 | 25                         | 2              | 20             | 70                | Reset output   |
| GS-R400V                   | 5.1 to 40                | V <sub>O</sub> +4 to 46 | 25 to 100                  | 6              | 20 to 90       | 70 to 90          | Progr. output voltage                                |
| GS-R400VB                  | 5.1 to 40                | V <sub>O</sub> +4 to 46 | 25 to 100                  | 6              | 20 to 90       | 70 to 90          | Progr. output voltage and current. Frequency synchr. |

**Note:** The line regulation is measured at I<sub>out</sub>=1A  
The load regulation is measured at V<sub>in</sub>=V<sub>O</sub>+8V and I<sub>out</sub>=1 to 3A  
For V<sub>O</sub> ≥ 36V and I<sub>O</sub> = 4A an external heatsink or forced ventilation are required.

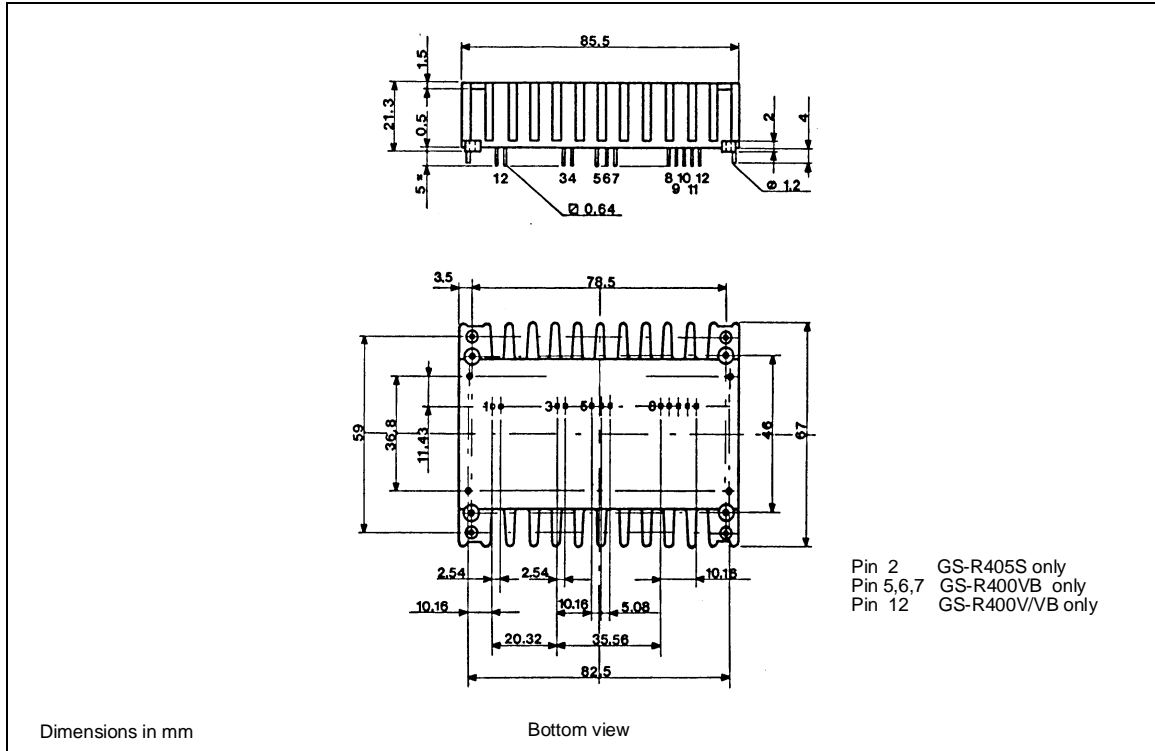
### ABSOLUTE MAXIMUM RATINGS

| Symbol            | Parameter                        | Value        | Unit |
|-------------------|----------------------------------|--------------|------|
| V <sub>i</sub>    | DC Input Voltage                 | 48           | V    |
| I <sub>rt</sub> * | Reset Output Sink Current        | 20           | mA   |
| T <sub>stg</sub>  | Storage Temperature Range        | - 40 to +105 | °C   |
| T <sub>cop</sub>  | Operating Case Temperature Range | - 20 to +85  | °C   |

\* GS-R405S only

## GS-R400 FAMILY

### CONNECTION DIAGRAM AND MECHANICAL DATA



### PIN DESCRIPTION

| Pin | Function         | Description  |
|-----|------------------|--|
| 1   | Inhibit          | The module is disabled by a high logic level applied to this pin.  |
| 2   | Reset            | Reset output (GS-R405S only).  |
| 3   | + Input          | DC input voltage. Recommended maximum voltage is 46V.  |
| 4   | Input GND        | Return for input voltage source.   |
| 5   | Oscillator       | 100kHz oscillator output. To be connected to Sync (pin 6) input if the unit is a master and left open if it is a slave (GS-R400VB only). See fig. 5. |
| 6   | Sync             | Synchronization input. To be connected to the Oscillator output (pin 5) of the master (GS-R400VB only). See fig. 5.                                  |
| 7   | Current limiting | A resistor ( $\geq 2.2k\Omega$ ) connected from this pin to pin 9 sets the current limiting level (GS-R400VB only).                                  |
| 8   | Output GND       | Return for output current path. Internally connected to pin 4.   |
| 9   | - Sense          | Senses the remote load return. Must be tied to pin 8 when the remote sensing feature is not used. See fig. 1.  |
| 10  | + Sense          | Senses the remote load high side. Must be tied to pin 11 when the remote load sensing feature is not used. See fig. 1.                               |
| 11  | + Output         | Regulated DC output voltage.   |
| 12  | Program          | A resistor ( $\leq 18k\Omega$ ) connected between this pin and pin 10 sets the output voltage (GS-R400V and GS-R400VB only).                         |

**ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)

| Symbol                | Parameter                       | Test Conditions                                 | Min | Typ              | Max        | Unit          |
|-----------------------|---------------------------------|---|-----|------------------|------------|---------------|
| $\Delta V_o/\Delta T$ | Temperature Stability           | $V_i = V_o+8V$ $I_o = 1A$                       |     | 0.2/1.6          |            | mv/°C         |
| $I_o$                 | Output Current                  | $V_i = V_o+8V$                                  | 0.2 |                  | 4          | A             |
| $I_{oL}$              | Current Limit                   | $V_i = V_o+8V$                                  |     | 5                | 8          | A             |
| $I_{isc}$             | Average Input Current           | $V_i = 46V$ Output Shorted                      |     | 0.1              | 0.2        | A             |
| $f_s$                 | Switching Frequency             | $I_o = 1A$                                      |     | 100              |            | KHz           |
| SVR                   | Supply Voltage Rejection        | $f_o = 100\text{Hz}$ $I_o = 1A$                 |     | 4/12             |            | mV/V          |
| $V_r$                 | Ripple Voltage                  | $I_o = 2A$                                      |     | 25/150           |            | mVpp          |
| $t_{ss}$              | Soft Start Time                 | $V_i = V_o+8V$                                  |     | 10/35            |            | ms            |
| $V_{inhl}$            | Low Inhibit Voltage             |   |     |                  | 0.8        | V             |
| $V_{inhh}$            | High Inhibit Voltage            |   | 2   |                  | 5.5        | V             |
| $I_{inhh}$            | High Inhibit Input Current      | $V_{inh} = 5V$                                  |     |                  | 500        | $\mu\text{A}$ |
| $t_{cb}$              | Crow-bar Delay Time             |   |     | 5                |            | $\mu\text{s}$ |
| $V_{rh}^*$            | Reset High Level                |   |     | 5                |            | V             |
| $V_{rl}^*$            | Reset Low Level                 | $I_{rl} = 5\text{mA}$<br>$I_{rl} = 10\text{mA}$ |     |                  | 0.2<br>0.4 | V             |
| $t_{rd}^*$            | Reset Delay Time                |   |     | 100              |            | ms            |
| $V_{cth}$             | Crowbar Intervention Threshold  |   |     | $V_o \cdot 1.25$ |            | V             |
| $\Delta V_o$          | Total Remote Sense Compensation |   |     |                  | 500        | mV            |
| $R_{th}$              | Thermal Resistance              | Case to ambient                                 |     | 5                |            | °C/W          |

\* GS-R405S only

**USER NOTES****Input Voltage**

The recommended operating maximum DC input voltage is 46V inclusive of the ripple voltage.

**Remote Sensing**

The remote voltage sense compensation range is for a total drop of 500mV equally shared between the load connecting wires. It is a good practice to shield the sensing wires to avoid oscillation.

Each sense input must be connected to its companion output power pin when the remote sense capability is not used (see fig. 1).

**Case Grounding**

The module case is isolated from the electrical circuit of the switching regulator. It can be grounded using the 4 corner pins.

The PCB area below the module can be used as an effective sixth side shield against EMI.

**Thermal Characteristics**

The case-to-ambient thermal resistance of all the GS-R400 modules is about 5°C/W. This produces a 50°C temperature increase of the module surface for 10W of internal power dissipation.

Depending on the ambient temperature and/or on the power dissipation, an additional heatsink or forced ventilation may be required.

**Input Impedance**

The module has an internal capacitor connected between the input pins in order to assure PWM stability. This capacitor cannot handle large values of high frequency ripple current and it can be permanently damaged if the primary energy source impedance is not adequate. The use of an external low ESR, high ripple current capacitor located as close the module as possible is recommended.

Suitable capacitors should have a RMS current capability of 2.5ARMS with a working voltage of 50 VDC and an ESR of 0,1 $\Omega$  at 100 kHz. When space

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is a limitation, a 22 $\mu$ F ceramic multilayer capacitor must be connected to the module input pins.

### Output Voltage Programming

The GS-R400V and GS-R400VB output voltage is programmed by using a resistor (see pin function table and fig. 4). The resistor must be located very close the module and the PCB layout must minimize injected noise. The value of the resistor is calculated by using the following formula:

$$R_V = 2.67 \left( \frac{V_O}{5.1} - 1 \right) \text{ k}\Omega$$

$V_O$  can be adjusted between 5.1 and 40V.

### Current Limiting Programming

The GS-R400VB current limiting is programmed by using a resistor (see pin function table and fig. 4).

The value of the resistor is calculated by using the following formula:

$$R_i = [2.2 + (5 \cdot I_o)] \text{ k}\Omega$$

### Module Protection

The modules are protected against occasional and permanent short circuits of the output pin to ground, as well as against output current overload.

When the output current exceeds the maximum value, the output is automatically disabled. After a fixed time the module starts again in a soft mode. The cycle is repeated until the overload condition is removed.

A crowbar output overvoltage protection is activated whenever the output voltage exceeds the nominal output voltage by more than 25%.

Figure 1. Load Connection

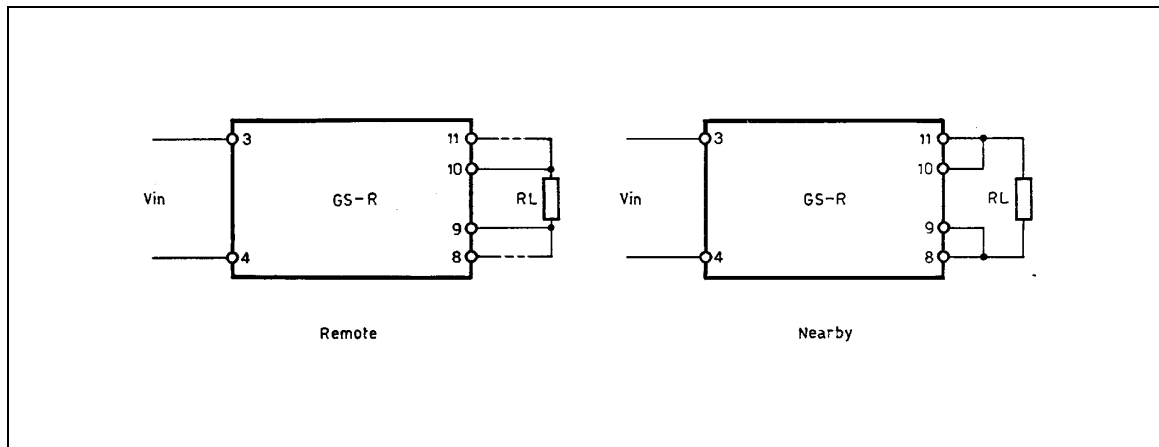


Figure 2. Remote Inhibit Operation

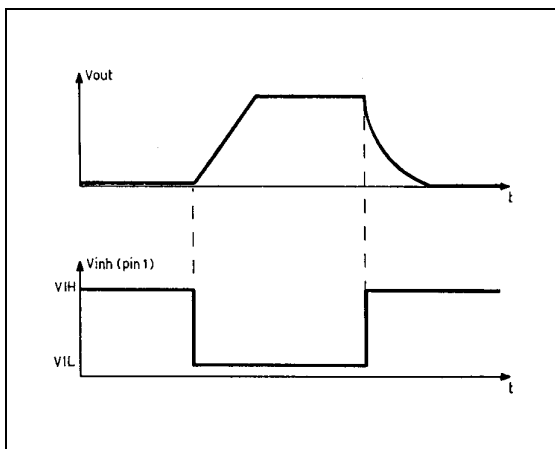


Figure 3. Reset Operation

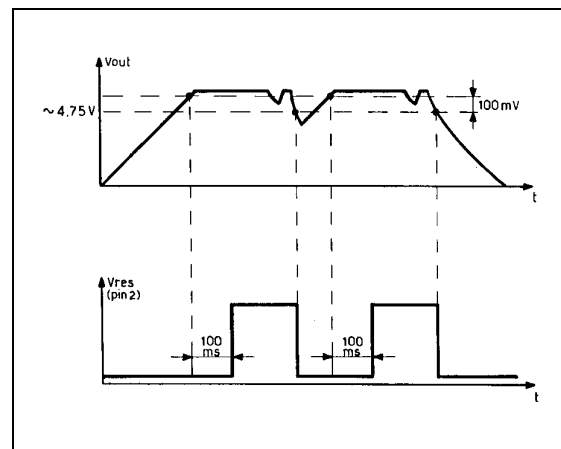


Figure 4. Voltage and Current Programming

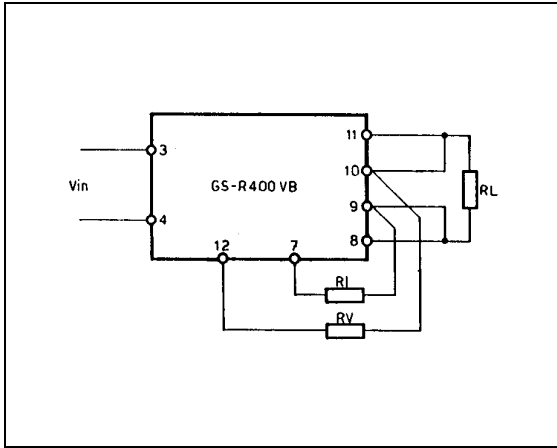
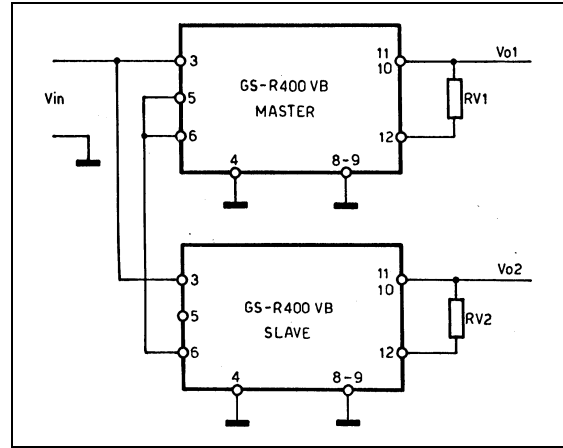


Figure 5. Multiple Units Synchronization



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