

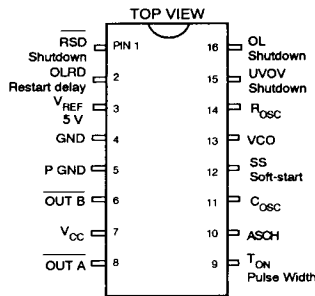


**FEATURES**

- frequency range of 1 kHz to 3 MHz
- operating frequency range set by a resistor (max.) and a capacitor (min.)
- pulse width set by a resistor and capacitor
- low start-up current
- synchronous overload shutdown with delayed soft restart
- synchronous overvoltage, undervoltage and remote shutdown
- asynchronous shutdown
- soft-start
- single-ended output
- drives power MOSFETs directly ( 1.6 A peak)
- low cost 16 pin DIP or SOIC

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Value & Units
Supply Voltage	20 V
Undervoltage/Overvoltage Input	-0.4 V - 6 V
Overload Input	-0.4 V - 6 V
Remote Shutdown	-0.4 V - $V_{CC}$
VCO Input	-0.4 V - $V_{CC}$
Storage Temperature	$-65^{\circ}\text{C} \leq T_S \leq 150^{\circ}\text{C}$
Lead Temperature (soldering, 10 sec.)	260°C
Junction Temperature	150°C
Power dissipation at $T_A \leq 70^{\circ}\text{C}$	720 mW
(derate 9 mW /°C for $T_A > 70^{\circ}\text{C}$ )	



**PIN CONNECTION**  
16 PIN DIP

**CIRCUIT DESCRIPTION**

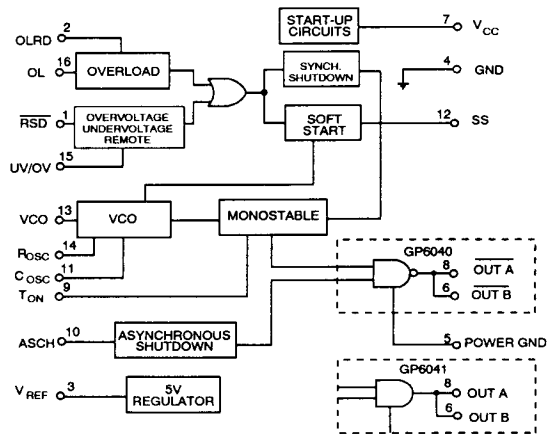
The GP6040 and GP6041 are highly reliable, single-ended, resonant mode power supply controllers. These devices support zero current switch (ZCS) resonant and quasi-resonant topologies operating in variable frequency mode. The pulse width is held constant while the frequency is varied by a feedback voltage over an operating range. Maximum and minimum frequency is set by an external resistor and capacitor. Fixed pulse width is adjusted by an external RC network.

The single totem pole output has a 1.6 A peak current capability. The GP6040 provides active low driver output. The GP6041 provides active high driver output.

The high operating frequency of up to 3 MHz results in significant reductions in EMI noise and minimizes the size of the required magnetic and capacitive components in the power supply.

Included on the chip are peripheral functions such as soft-start, undervoltage/overvoltage lockout, remote shutdown and overload shutdown with delayed restart. All shutdown modes are synchronous (the last output pulse is completed), and default to soft-start once the fault condition is removed. The asynchronous shutdown provides emergency OFF for catastrophic failures. The controller also contains power supply undervoltage lockout, minimizing supply current during the start-up condition.

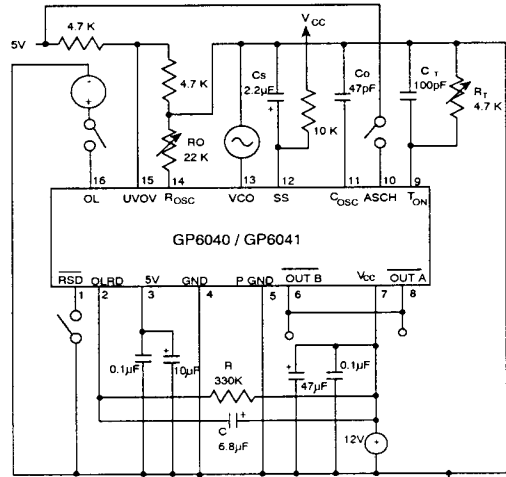
The GP6040 and GP6041 are upgraded single-ended, pin-to-pin compatible versions of the GP605. The controller has been design optimized to support zero current switching topologies.



**FUNCTIONAL BLOCK DIAGRAM**

Part Number (10 digits)	Package Type	Temperature Range
GP6040-CDC GP6041-CDC	16 Pin DIP	0° to 70° C
GP6040-CKC GP6041-CKC	16 Pin SOIC	0° to 70° C
GP6040-EDC GP6041-EDC	16 Pin DIP	-40° to 85° C
GP6040-EKC GP6041-EKC	16 Pin SOIC	-40° to 85° C

**ORDERING INFORMATION**



**OPEN LOOP TEST CIRCUIT**

**ELECTRICAL CHARACTERISTICS continued**

Limits apply over  
 0°C ≤ T<sub>A</sub> ≤ 70°C for the GP6040/41CDC, and GP6040/41CKC  
 -40°C ≤ T<sub>A</sub> ≤ 85°C for the GP6040/41EDC, and GP6040/41EKC

Parameters tested on open loop test circuit  
 Typical values are at T<sub>A</sub> = 25°C

\* Parameters marked with an asterisk\* are measured at T<sub>A</sub> = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Chip Supply</b>					
Supply Voltage		10	12	20	V
Chip Enable V <sub>CC</sub> Threshold *		-	13.5	14.3	V
V <sub>CC</sub> Undervoltage Lockout *		-	9.3	9.8	V
Supply Current	V <sub>CC</sub> = 11 V (UV condition) V <sub>CC</sub> = 12 V	- 18	2 24	5 26	mA mA

**Voltage Control Oscillator**

Maximum Frequency		2.4	3	-	MHz	
Tolerance of f <sub>MAX</sub> *	C <sub>O</sub> = 100 pF V <sub>VCO</sub> = 10 V	-	-	±5	%	
Tolerance of f <sub>MIN</sub> *	R <sub>O</sub> = 12 kΩ V <sub>VCO</sub> = 0 V	-	-	±20	%	
Temperature coefficient f <sub>MAX</sub>	R <sub>O</sub> = 12 kΩ C <sub>O</sub> = 100 pF	-400	-700	-900	ppm/°C	
Temperature coefficient f <sub>MIN</sub>	R <sub>T</sub> = 4.7 kΩ C <sub>T</sub> = 100 pF	600	900	1100	ppm/°C	
Dead Time T <sub>OFF</sub> *		-	90	-	ns	
Operating Range of VCO Input (Pin 13)	max	-	6.5	-	V	
	min	-	1.1	-	V	
Internal Pull-up Resistor (Pin 13) *		9.6	12	14.4	kΩ	
Output Pulse Width T <sub>ON</sub> Tolerance *	R <sub>T</sub> = 4.7 kΩ C <sub>T</sub> = 100 pF	-	-	±5	%	
Temperature Coefficient of T <sub>ON</sub>	T <sub>ON</sub> = 500 ns	GP6040	-	-200	-	ppm/°C
		GP6041	-	-780	-	ppm/°C

**ELECTRICAL CHARACTERISTICS** continued

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Output Section</b>					
Output Risetime	100 pF    100 kΩ load on $\overline{\text{OUT}}$ (See Fig. 7)	-	10	30	ns
Output Falltime		-	10	30	ns
Output Low Level (sink) *	$I_{\text{OUT B}} = 20\text{mA}$ $I_{\text{OUT B}} = 200\text{mA}$	-	-	0.7	V
		-	-	2.2	V
Output High Level (source) *	$I_{\text{OUT B}} = -20\text{mA}$ $I_{\text{OUT B}} = -200\text{mA}$	$V_{\text{CC}} - 2.0$	-	-	V
		$V_{\text{CC}} - 2.2$	-	-	V
<b>Reference Section</b>					
Output Voltage *	$I_{\text{REF}} = 10 \text{ mA}$	4.75	5.00	5.25	V
Temperature Stability		-200	100	300	ppm/°C
Maximum Current Capability		-	10	-	mA

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**Shutdown Section**

Prop. Delay to Sync. Shutdown ①		-	300	400	ns
Remote Shutdown Trigger Level	Enabled Disabled	$V_{\text{CC}} - 0.8$ -	- -	- 3	V V
Remote Shutdown Current Trigger *		-	250	-	μA
Overload Shutdown (OL) Threshold *		3.04	3.2	3.36	V
OL Threshold Temp. Coefficient		-200	100	300	ppm/°C
OL Hysteresis		-	3	-	%
OL Trigger Pulse Width		500	-	-	ns
OL Input Current Range (Pin 16)		-1	-	+15	μA
Overvoltage Threshold Lockout *		3.04	3.2	3.36	V
Undervoltage Threshold Lockout *		1.82	1.9	2.05	V
Temp. Coeff. of Threshold Voltage		-200	100	300	ppm/°C
Hysteresis of the Lockout Voltage		-	4	-	%
Input Current Range ( Pin 15 )		-1	-	+22	μA
Propogation Delay to Asynchronous Shutdown (ASCH) *		-	70	100	ns
ASCH Threshold Lockout *		3.32	3.5	3.68	V
Input Current Range (Pin 10)		-1	-	+22	μA
Reset Voltage		-	1.2	-	V
Thermal Impedance	16 pin DIL Plastic Pack. θ JC	-	42	-	°C/W
	16 pin DIL Plastic Pack. θ CA	-	70	-	°C/W
	16 Pin SOIC θ JA	-	112	-	°C/W

**NOTES**

① If the shutdown input is triggered 200 ns (typ.) or earlier (e.g. 300 ns) before the next output pulse is expected, there will be no pulses. If the shutdown input is triggered between 200 ns and the time the output pulse is on the output pin, this pulse will be completed in full before the output is disabled.

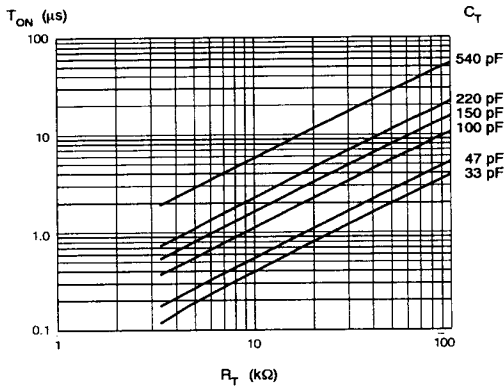


Fig. 1 Output Pulse Width GP6040

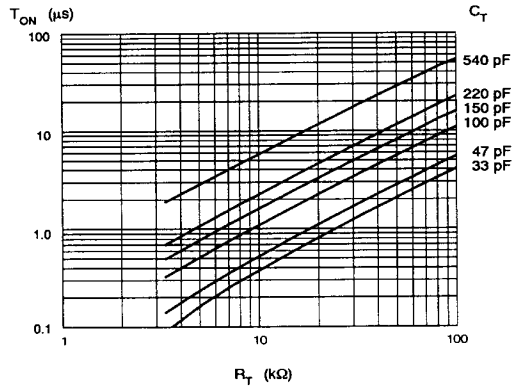


Fig. 2 Output Pulse Width GP6041

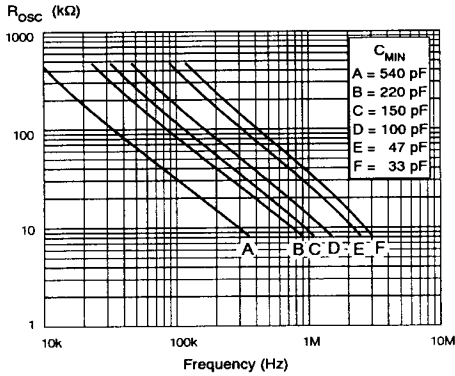


Fig. 3 Maximum Operating Frequency GP6040/41

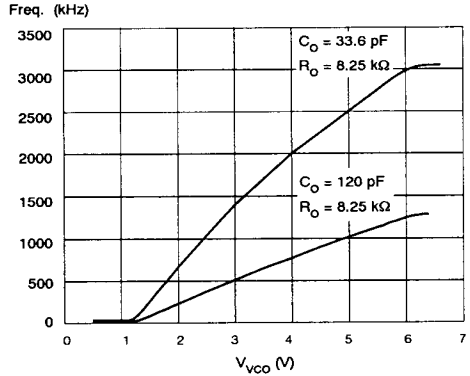


Fig. 4 VCO Frequency vs Input Voltage GP6040 / 41

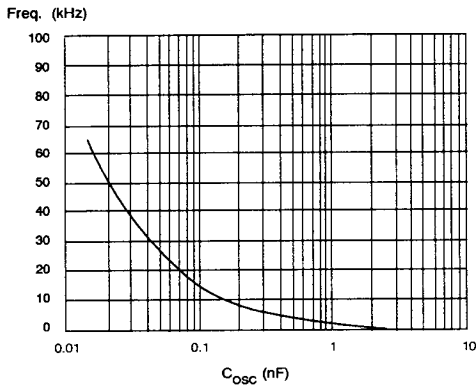


Fig. 5 Minimum Operating Frequency GP6040/41

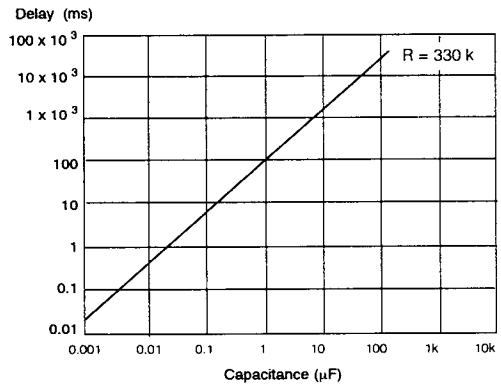


Fig. 6 Overload Restart Delay GP6040/41

TYPICAL PERFORMANCE CURVES OF THE GP6040 AND GP6041

For all graphs,  $V_{CC} = +12$  VDC and  $T_A = 25^\circ\text{C}$ . The curves shown above represent typical batch sampled results.

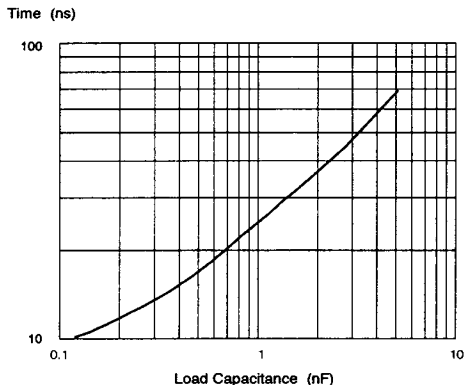


Fig. 7 Output Risetime/Falltime GP6040/41

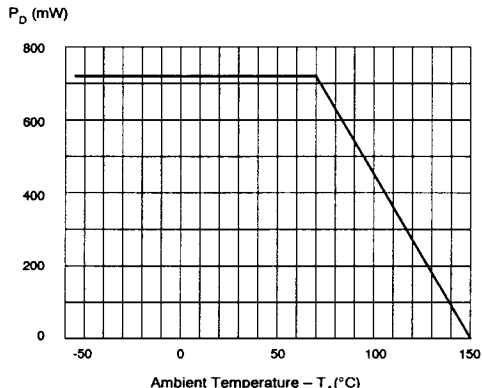


Fig. 8 Power Dissipation

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**PIN FUNCTIONS**

**Pin 1 (RSD) - Remote Shutdown**

A low level (or in current mode - high sink current) on Pin1 synchronously shuts down the GP6040 or GP6041. When the pin is released ( in current mode - zero current), the controller goes to soft-start. If remote shutdown is not used, leave Pin 1 open. In Fig. 9 the simplified remote shut down internal circuit is shown.

The transistors T1 and T2 constitute the current mirror. To activate shutdown it is necessary to source from the GP6040 or GP6041 current  $I_{RSD} = 250 \mu A$  (min). The ability to choose between current or voltage mode shutdown allows for operation in a noisy environment. Figure 10 shows some sample applications for the shutdown external circuits.

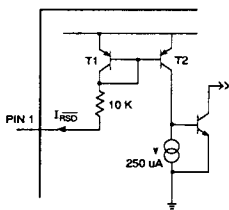


Fig. 9

**Pin 2 (OLRD) - Overload Restart Delay**

This input sets the overload restart delay if pin 16 (Overload sense) is activated. Timing starts when the overload is removed; upon time-out, soft-start begins. Refer to Fig. 6 to select proper value of the capacitor.

Recommended value of the bias resistor is  $330k\Omega$ . For overload restart delay time it makes no difference if the capacitor is connected to the ground or to the  $V_{CC}$  line. However if the capacitor is connected to the ground, during initial power-up condition, the soft-start will be delayed by the time equal to the overload restart delay time. If the capacitor is connected to the  $V_{CC}$  line, soft-start follows an internal delay time of 1ms (necessary to stabilise +5 V reference line).

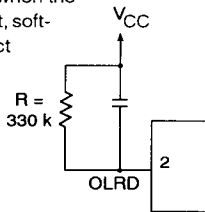


Fig. 11

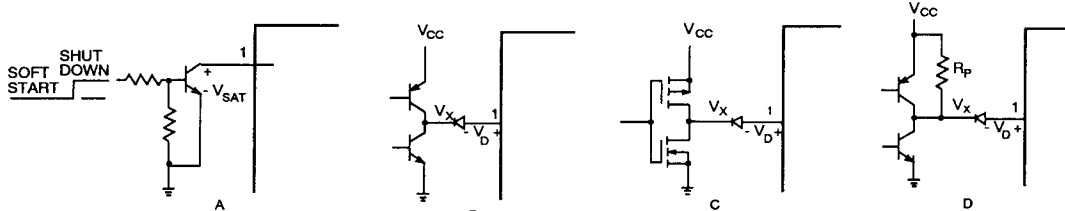


Fig. 10

**Pin 3 ( $V_{REF}$ ) - +5V Reference**

The 5% tolerance regulator is used to power most of the internal circuitry. It can be used as a reference for external circuitry as long as the load is less than 10 mA. For a 1% tolerance regulator contact Gennum's Power Products Department.

To improve noise rejection ratio it is recommended to decouple pin 3 to the logic ground with a 2.2  $\mu$ F tantalum capacitor in parallel with a 0.1  $\mu$ F ceramic capacitor.

**Pin 4 (GND) - Ground**

Great care must be taken to ensure that grounds are run so that any voltage drops from high ground currents are minimized and do not interfere with feedback voltages and references.

**Pin 5 (PGND) - Power Ground**

Only the output transistor should be connected to the power ground, to minimize interference with the logic circuitry. GND and PGND are to be connected outside the package. The connection point should be carefully chosen and decoupled.

**Pin 6 (OUT B) - Output B**

The GP6040 provides an active low fixed pulse width output. The GP6041 provides an active high fixed pulse width output. For the risetime and falltime characteristics refer to Fig. 7.

**Pin 7 ( $V_{CC}$ ) - Supply Voltage**

The power supply trace must be decoupled as close to pin 7 as possible. Currents of 1.6 A levels may be drawn by the GP6040 and GP6041. Minimum recommended decoupling is 10  $\mu$ F tantalum capacitor in parallel with 0.1  $\mu$ F ceramic capacitor.

The controller is equipped with a low startup current circuit. The hysteresis is adjusted as follows: turn on at 13 V (typ) and synchronous turn off if the voltage drops to 9 V (typ). The threshold voltage of the hysteresis was chosen to make controller compatible to its predecessor GP605. If different threshold voltages are required contact Gennum's Power Products Department.

**Pin 8 (OUT A) - Output A**

This output has all basic characteristics identical to the Output B (pin 6) but is connected into it through a 1.5  $\Omega$  ( $\pm 10\%$ ) serial resistor. Such a configuration allows for eliminating the series resistor in some applications. It is still possible to join Output A and Output B together.

**Pin 9 ( $T_{ON}$ ) - Pulse Width**

The constant pulse width  $T_{ON}$  is set by a resistor  $R_T$  and capacitor  $C_T$ . This relationship is shown in Fig. 1 for GP6040 and Fig. 2 for GP6041.  $R_T \times C_T$  should have a temperature coefficient of +200 ppm/ $^{\circ}$ C (GP6040) and +750 ppm/ $^{\circ}$ C (GP6041) for best stability. The  $T_{ON}$  time is generated by a monostable multivibrator and may have any required duration. The only limit is the minimum value of the resistor  $R_T \geq 3.3 \text{ k}\Omega$

due to the current capability of the pin 9. The monostable works in re-triggerable mode. It means that if the maximum frequency set by external components is higher than specified in description of the pin 14, the  $T_{ON}$  time remains constant, however the frequency will divide by two. This feature could be used as an inherent current limit. Under normal operation  $f_{MAX}$  should be clamped by proper choice of the resistor  $R_{OSC}$ .

**Pin 10 (ASCH) - Asynchronous Shutdown**

This input is added in place of the single-ended input used on the GP605. In zero current switching topology it may prevent transistor damage in some catastrophic failures (eg. short output diode). The triggering level of the asynchronous shutdown is set in such a way that it is possible to use it simultaneously with the overload sense circuit.

In ZCS topology ASCH input is meant to be used in emergency situations only. There are two ways to reset the asynchronous shutdown. By disconnecting the  $V_{CC}$  line or by forcing pin 10 to the level below 1.2 V. The release of the asynchronous shutdown does not provide any of the soft-start features. For soft-start options, connect pin 10 to either the OVUV or OL synchronous shutdown pins. The reset function is not available on early release devices marked "PRE" on the top of the package.

If pin 10 is not used, it should be grounded.

**Pin 11 ( $C_{OSC}$ ) - Oscillator Capacitor**

The capacitor on this pin,  $C_O$ , controls the minimum frequency  $f_{MIN}$  of the VCO operating range. The capacitor  $C_O$  must be selected as the first component of the oscillator section. Refer to Fig. 5 for selection. For good stability a capacitor with a temperature coefficient of -750 ppm/ $^{\circ}$ C is recommended.

**Pin 12 (SS) - Soft-Start**

A capacitor  $C_{SS}$  on this pin provides a controlled startup from  $f_{MIN}$  to the frequency set by the VCO input. The delay is approximately

$$T_{SS} \approx 0.6 \times R_{SS} \times C_{SS}$$

where

$C_{SS}$  - soft-start capacitor

$R_{SS}$  - external resistor (if resistor not used  $R \approx 5.1 \text{ M } 20\%$ )

The value of the  $C_{SS}$  is not limited. To ensure a full soft-start after UVUV fault, it is necessary to have the fault present for half the soft-start time (to ensure discharge of the  $C_{SS}$  capacitor).

**Pin 13 (VCO) - Voltage Controlled Oscillator Input**

The VCO input is designed for an optocoupler feedback network from the secondary (output) side of the power supply. An internal 12 k $\Omega$  (typ.) pull-up resistor is provided but an external resistor may be used if a lower value is required. The control characteristic is shown in Fig. 4.

**Pin 14 ( $R_{OSC}$ ) - Oscillator Resistor**

The resistor on this pin,  $R_O$ , controls  $f_{MAX}$ , the maximum frequency of the VCO operating range. Refer to Fig. 3

for selection of  $R_O$ . This resistor should be selected after  $C_O$  was chosen. The use of a 1%, zero temperature coefficient resistor is recommended for good stability. Minimum value for  $R_O$  is 8.2 k  $\Omega$ . For normal operation the maximum frequency should be set no higher than:

$$f_{MAX} \leq \frac{1}{T_{ON} + T_{DT}}$$

where  $T_{ON}$  - constant pulse width  
 $T_{DT}$  - dead time specified in the data sheet.  
 If this requirement is not fulfilled the controller divides the output frequency by two.

**Pin 15 (UVOV) - Undervoltage/Oversvoltage Shutdown**

This input is a window comparator. A higher or lower voltage than the thresholds specified will synchronously shutdown the power supply until the input voltage falls within the window again, at which point the GP6040 or GP6041 goes into soft-start. If Pin 15 is not used, it must be tied to  $V_{CC}$  via a voltage divider generating a bias voltage which falls within the window. The maximum input voltage on this pin is 6 V. To adjust the shutdown hysteresis levels use an additional resistor connected to the +5 V line.

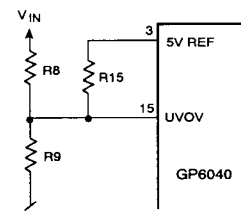


Fig. 12

To adjust the shutdown hysteresis levels use an additional resistor connected to the +5 V line. The value of the resistors can be calculated from the equations:

$$R15 = \frac{(V_O \times V_R) - (V_U \times V_R)}{(V_U \times V_{INO}) - (V_O \times V_{INU})} \times R8$$

$$R9 = \frac{R8 \times V_R \times (V_O - V_U)}{V_R \times (V_{INO} - V_{INU}) + V_U \times V_O + (V_O \times V_{INU} - V_U \times V_{INO})}$$

- where
- $V_O$  - the GP6040/41 overvoltage threshold lockout
  - $V_U$  - the GP6040/41 undervoltage threshold lockout
  - $V_R$  - reference voltage
  - $V_{INO}$  - requested line overvoltage lockout
  - $V_{INU}$  - requested line undervoltage lockout

**Pin 16 (OL) - Overload Input**

A voltage exceeding the specified threshold on this pin will cause the GP6040 or GP6041 to synchronously shutdown and activate the overload restart delay function. This delay starts when the input voltage drops below the threshold. On time-out soft-start begins. The maximum input voltage on this pin is 6V. If Pin 16 is not used, short it to ground.

**AVAILABLE PACKAGING**

- 16 pin PDIP
- 16 pin Wide SOIC

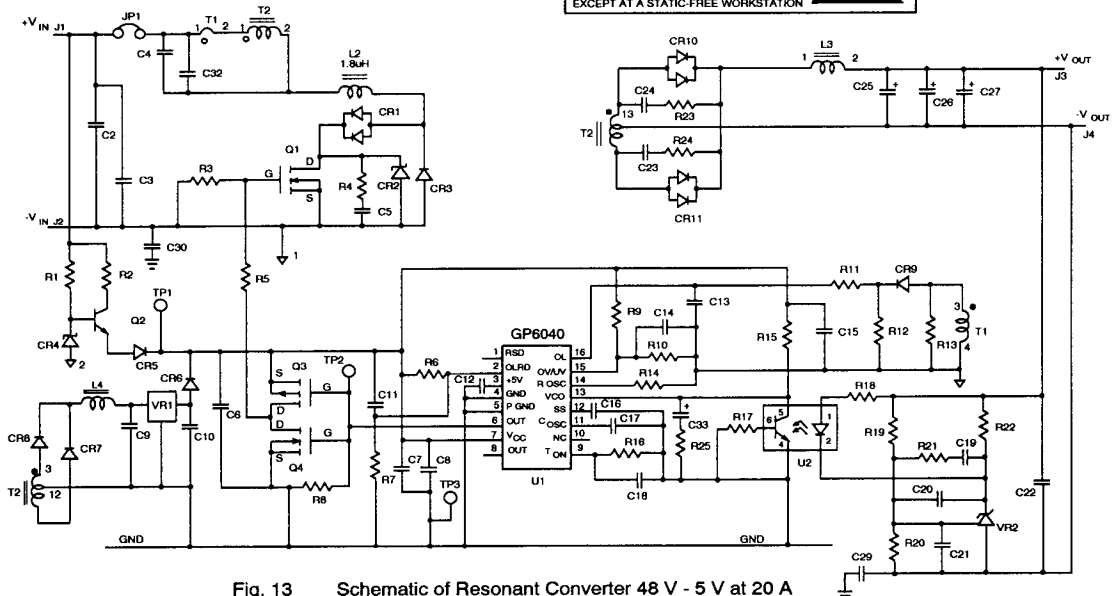


Fig. 13 Schematic of Resonant Converter 48 V - 5 V at 20 A

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