Texas Instruments

Application Report

SNOA368B–May 2000–Revised April 2013

OA-18 Simulation SPICE Models for Comlinear's Op Amps

ABSTRACT

This application report is a collection of PSpice compatible models for Texas Instruments amplifiers.

Contents

List of Figures

All trademarks are the property of their respective owners.

List of Tables

1 Introduction

Texas Instruments is a manufacturer and supplier of high-performance analog signal processing components. Texas Instruments broad signal conditioning product line includes high-speed hybrid and monolithic operational amplifiers, buffers, video amplifiers, multiplexers, automatic gain control integrated circuits, track/hold amplifiers, and analog-to-digital converters. Texas Instruments continues as a leader in developing products offering exceptional performance, speed, quality, reliability and service.

For additional information about SPICE Models supporting existing or new products, customers can visit the TI website. These SPICE Models are created for use on an IBM compatible computer using analysis programs that accept Spice formats. Texas Instruments assumes no responsibility for designs created from these SPICE Models. These SPICE Model files model typical performance at room temperature. AC response is dominated by board layout and package parasitics at frequencies above 500MHz. Before designs are released to production, Texas Instruments suggests that topologies be verified by prototyping the circuit. The part-to-part and over-temperature performance variations of Texas Instruments amplifiers are specified in current data sheets found on the TI website. The changes from the last SPICE Model version are listed in Table 1.

Table 1. Updates to Spice Models

File Name	Description
CLC405.CIR	A new SPICE Model.
CLC406.CIR	A revised SPICE Model.
CLC407.CIR	A new SPICE Model.
CLC412.CIR	A new SPICE Model.
CLC430.CIR	A revised SPICE Model that improves disabled output response.
CLC440.CIR	A new SPICE Model.
CLC449.CIR	A new SPICE Model.
CLC450.MOD	A new SPICE Model.

Table 2. Spice Model Subcircuit Files

File Name	Description
CLC109.CIR	A Low-Power, Wideband, Closed-Loop Buffer.
CLC111.CIR	A Very Wideband, Ultra-High Slew Rate, Closed-Loop Buffer.
CLC400.CIR	A Wideband, Low-Gain Monolithic Current Feedback Op Amp with Fast Settling (0.05% in 12 ns), Low Power, and an Input Offset Adjustment Pin.
CLC401.CIR	A Wideband, High-Gain Monolithic Current Feedback Op Amp with Fast Settling (0.01% in 10 ns) and Low Power.
CLC402.CIR	A Low-Gain Monolithic Current Feedback Op Amp with Fast 14-bit Settling (0.0025% in 25 ns) and Low Power.
CLC404.CIR	A Wideband Monolithic Current Feedback Op Amp with High Slew Rate.
CLC405.CIR	A Low-Cost, Low Power, and 110 MHz Op Amp with Disable.
CLC406.CIR	A Wideband, Low-Cost, Low-Power Monolithic Current Feedback Op Amp.
CLC407.CIR	A Low-Cost, Low Power, Programmable Gain Buffer with Disable.
CLC409.CIR	A Very Wideband, Low Distortion Monolithic Current Feedback Op Amp.
CLC410.CIR	A Video Monolithic Current Feedback Op Amp with disable, Fast Settling (0.05% in 12 ns) and an Input Offset Adjust Pin.
CLC412.CIR	A Dual Wideband Video Op Amp.
CLC414.CIR	A Quad, Low-Power Monolithic Current-Feedback Op Amp.
CLC415.CIR	A Quad Wideband Monolithic Current Feedback Op Amp.
CLC420.CIR	A High-Speed, Unity Gain Stable Monolithic Voltage Feedback Op Amp.
CLC425.CIR	An Ultra Low-Noise, Wideband Monolithic Voltage Feedback Op Amp with Current Supply Adjust.
CLC426.CIR	An Ultra Low-Noise, Wideband Monolithic Voltage Feedback Op Amp with Current Supply Adjust and External Compensation.

Table 2. Spice Model Subcircuit Files (continued)

File Name	Description
CLC428.CIR	An Ultra Low-Noise, Wideband, Dual Monolithic Voltage Feedback Op Amp.
CLC430.CIR	A Wideband Monolithic Current Feedback Op Amp with disable and ±5V to ±15V supply capability.
CLC431.CIR	A Dual, Wideband Monolithic Current Feedback Op Amp with High Slew Rate.
CLC432.CIR	A Dual, Wideband Monolithic Current Feedback Op Amp with Disable and ±5V to ±15V Supply Capability.
CLC440.CIR	A High-Speed, Low-Power Voltage Feedback Op Amp.
CLC449.CIR	A 1.2 GHz Ultra-Wideband Monolithic Op Amp.
CLC450.MOD	A Single Supply, Low Power, High Output, Current Feedback Amplifier.
CLC501.CIR	A High-Speed Output Clamping Monolithic Current Feedback Op Amp for High Gains.
CLC502.CIR	A High-Speed Output Clamping Monolithic Current Feedback Op Amp with Fast 14-bit Settling (0.0025% in 25 ns) for Low Gain.
CLC505.CIR	A High-Speed, Programmable-Supply Current, Monolithic Current Feedback Op Amp.
CLC520.CIR	A Monolithic Amplifier with Voltage Controlled Gain (AGC).
CLC522.CIR	A Monolithic Wideband Variable Gain Amplifier.
CLC532.CIR	A High-Speed, 2:1 Analog Multiplexer with fast 12-bit settling (0.01% in 17 ns), Low Noise, Low Distortion, and Adjustable Noise Bandwidth.
CLC5644.CIR	A Quad, Low-Power Monolithic Current- Feedback Op Amp.
CLC5655.CIR	A Quad Wideband Monolithic Current Feedback Op Amp.
CLC5665.CIR	A Wideband Monolithic Current Feedback Op Amp with Disable and ±5V to ±15V Supply Capability.
CLC5801.CIR	An Ultra Low-Noise, Wideband Monolithic Voltage Feedback Op Amp with Current Supply Adjust.
CLC5802.CIR	An Ultra Low-Noise, Wideband, Dual Monolithic Voltage Feedback Op Amp.

2 Start Up Instructions

Download all SPICE Model files of interest to a library on the hard disk. If the library directory is not in the SPICE program's path, the user should set that path in the autoexec.bat for easier excess. The .INC statement in PSpice should be used in the simulation file to include the SPICE Models subcircuit.

Example: “.INC CLC400.CIR”

3 Amplifier Spice Models

These SPICE Model files are written in ASCII file format for IBM-compatible PCs. They are compatible with PSpice and other Spice 2G simulators. For additional detailed information about using PSpice, please contact MicroSim (see reference [2]). Texas Instruments amplifier SPICE Models are written in a subcircuit format for easy incorporation into larger circuits. A listing of any amplifier subcircuit may be obtained by printing its CLC*.CIR file to a local printer. The subcircuit node assignments match the device pin-outs as shown in the individual device data sheets. An example is an 8 pin op amp.

- Connections: NON-INVERTING INPUT PIN
- | INVERTING INPUT PIN
- | | OUTPUT
- | | | +V_{CC}
- | | | | −V_{CC}
- | | | | |
- .SUBCKT (NAME) 3 2 6 7 4

Some schematic capture software packages require a different pin connection other than what Texas Instruments uses. Changing the pin order in the .SUBCKT statement will not affect the SPICE Model performance.

4 Performance Results

When substitutions of current feedback op amps are made for voltage feedback op amps, results may not be acceptable. For a tutorial on current feedback op amp design, see *OA-13 Current Feedback Loop Gain Analysis and Performance Enhancement Application Report* (SNOA366).

5 Parameters Modeled

The following typical performance parameters are modeled by the SPICE Models.

5.1 DC Effects

- VIO, IBI, IBN
- Supply current vs. supply voltages
- Common mode input/output voltage range
- Load current from supplies
- CMRR

5.2 AC Effects < 500 MHz

- Frequency response vs. gain and load
- Open loop gain and phase
- Noise
- Small signal input/output impedance

5.3 Time Domain

- Rise/fall times
- Slew rates

5.4 Special Features (where applicable)

- Output clamping
- Supply current adjustment
- Offset voltage adjust
- Disable/enable times
- External compensation

6 Parameters Not Modeled

- Differential gain and phase
- PSRR
- Harmonic distortion
- Fine scale settling performance
- Thermal tail
- Overdrive recovery time (Except for the CLC501and the CLC502)
- Variation in performance vs. temperature
- Part-to-part performance variation

7 Notice

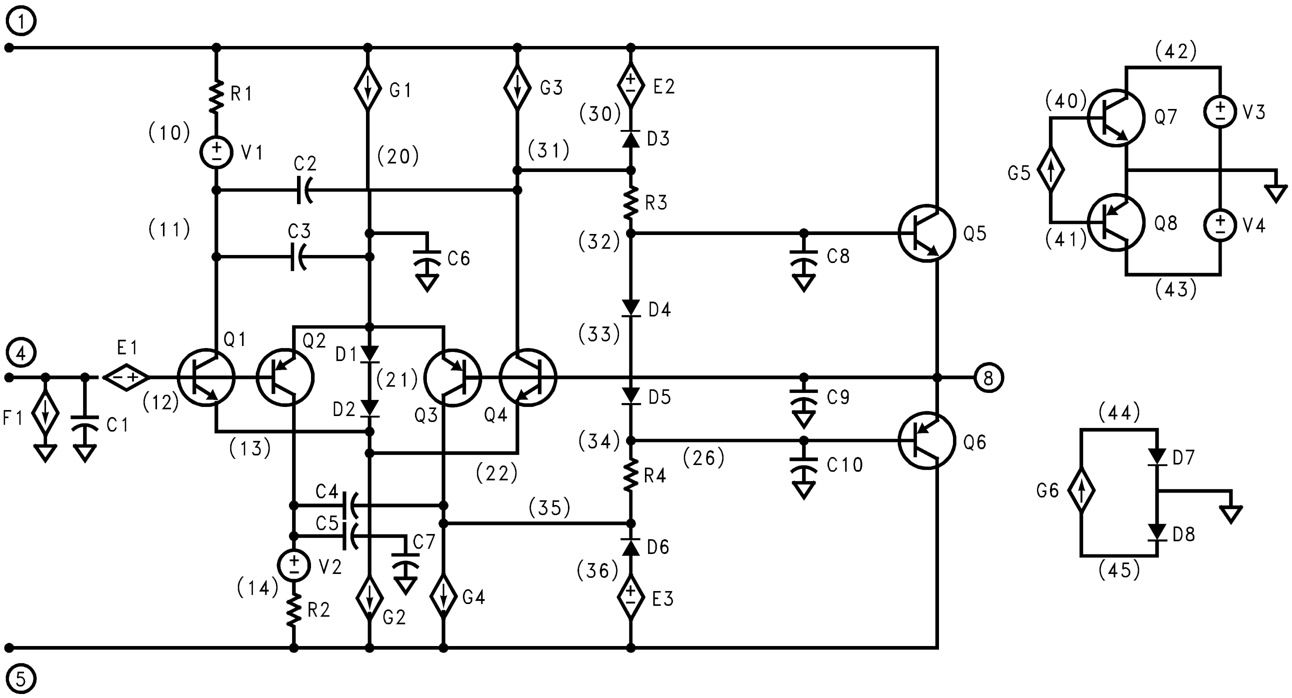
The information provided within these files and documents is believed to be reliable and correct. Texas Instruments assumes no responsibility for alterations, omissions or inaccuracies. Texas Instruments assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Texas Instruments does not grant licenses or patent rights to any of the circuits described within this document.

The circuits included in this application note have been tested with Texas Instruments parts that may have been obsoleted and/or replaced with newer products. Please refer to the CLC to LMH conversion table to find the appropriate replacement part for the obsolete device.

8 References

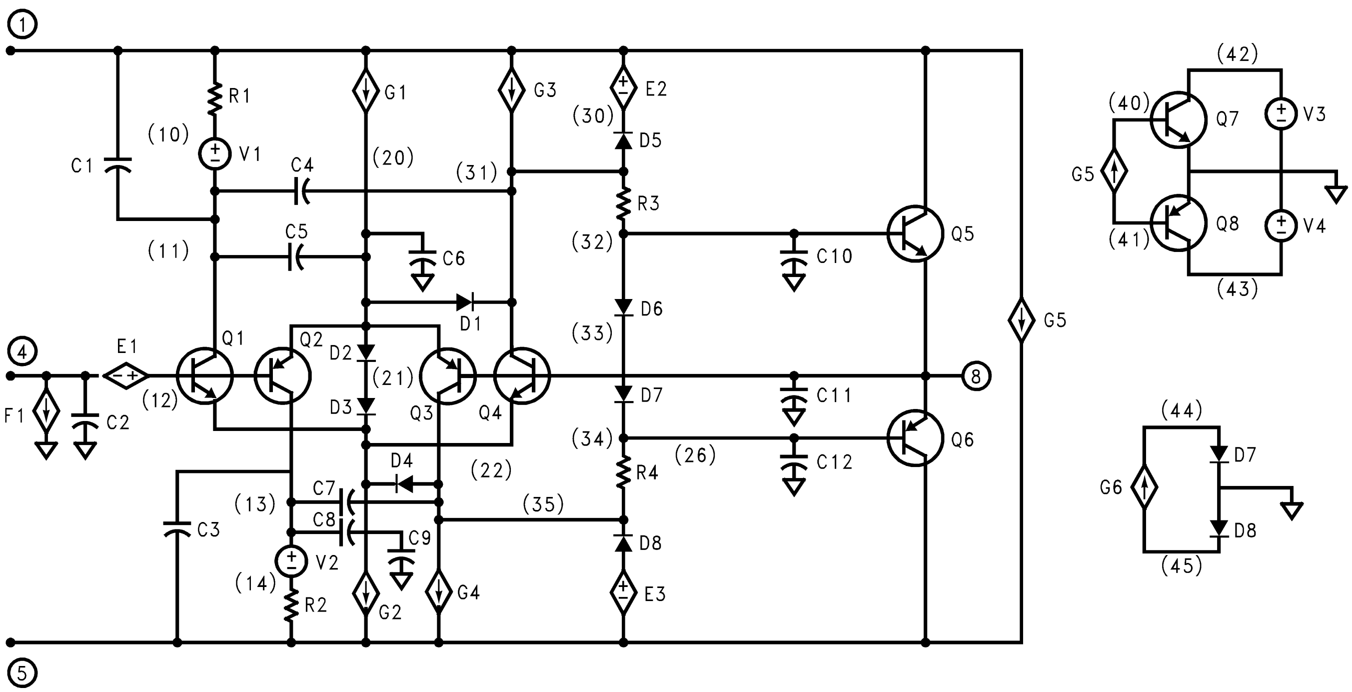
1. National's 1993/1994 Databook and 1995 Databook Supplement of standard products.
2. MicroSim Corporation, 20 Fairbanks, Irvine, CA 92718 USA, (714) 770-3022, (800) 245-3022.

9 Models



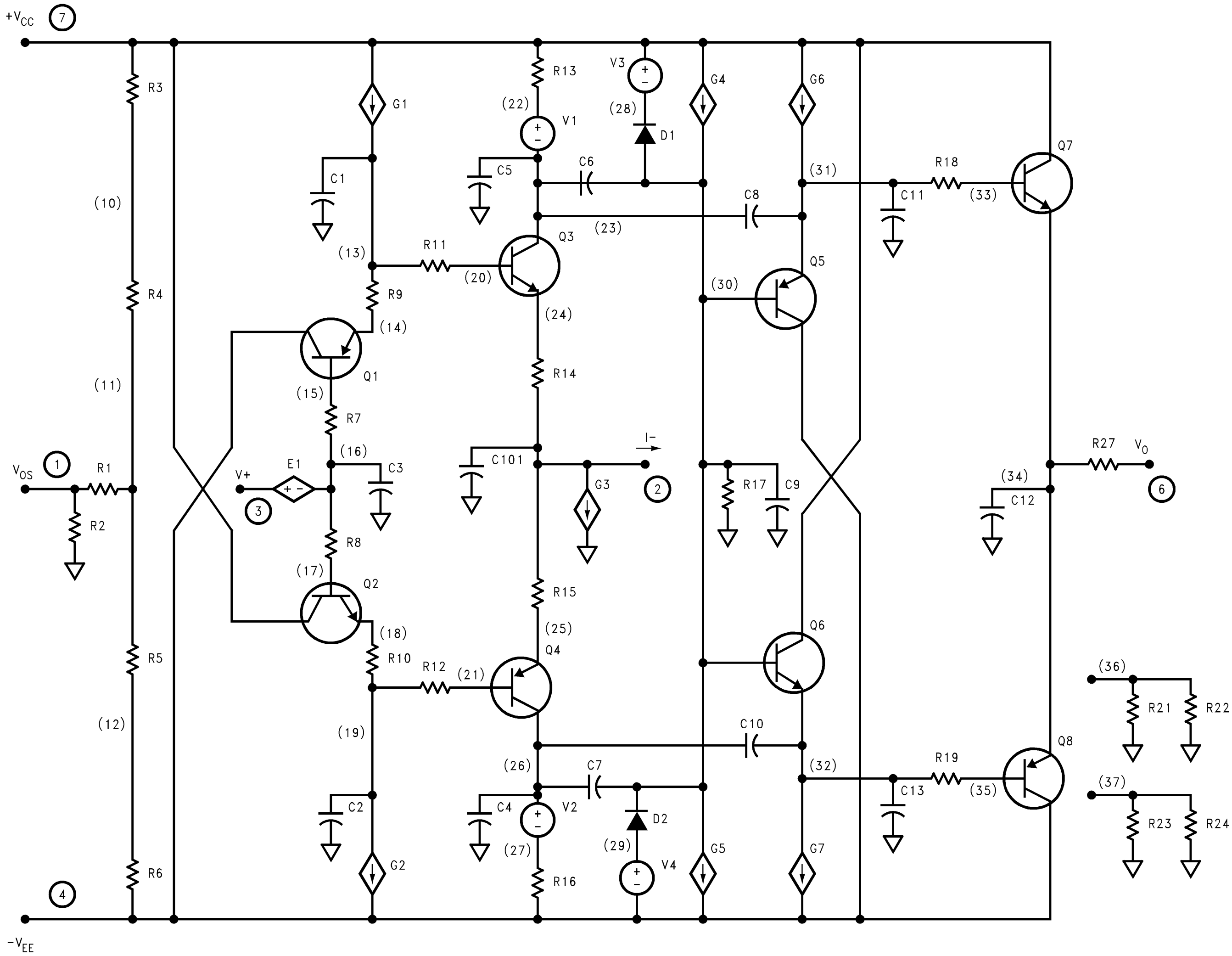
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 1. CLC109



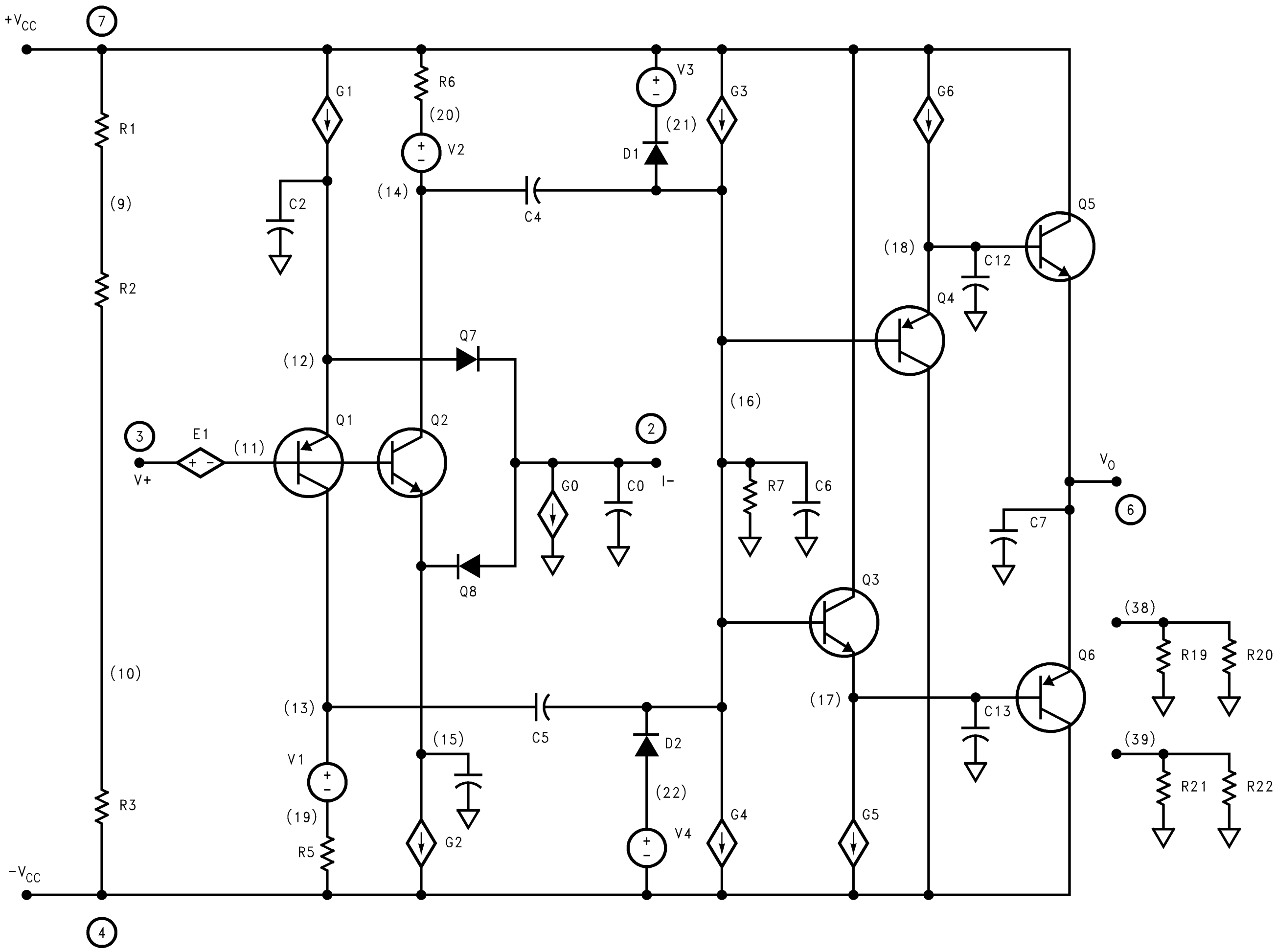
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 2. CLC111



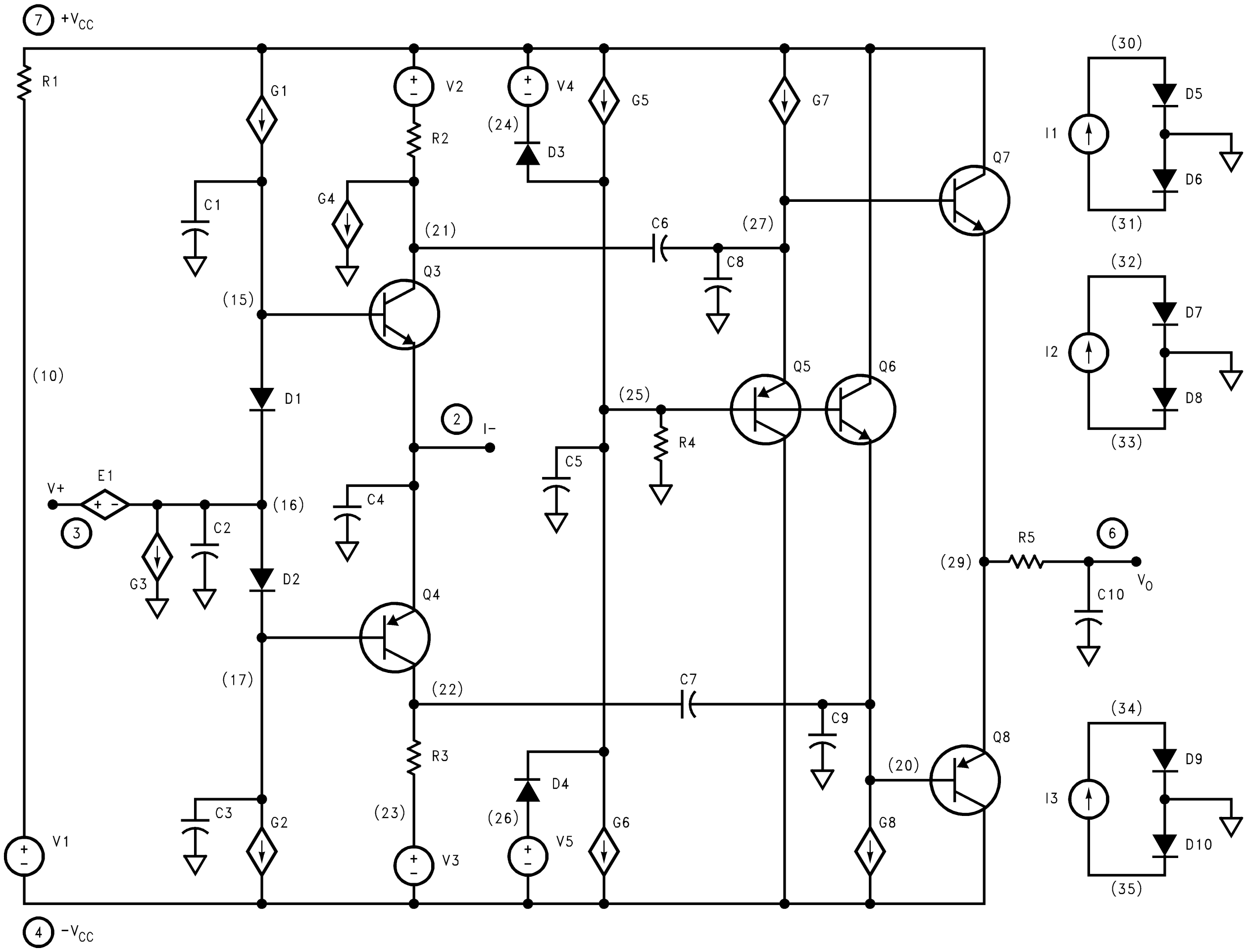
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 3. CLC400



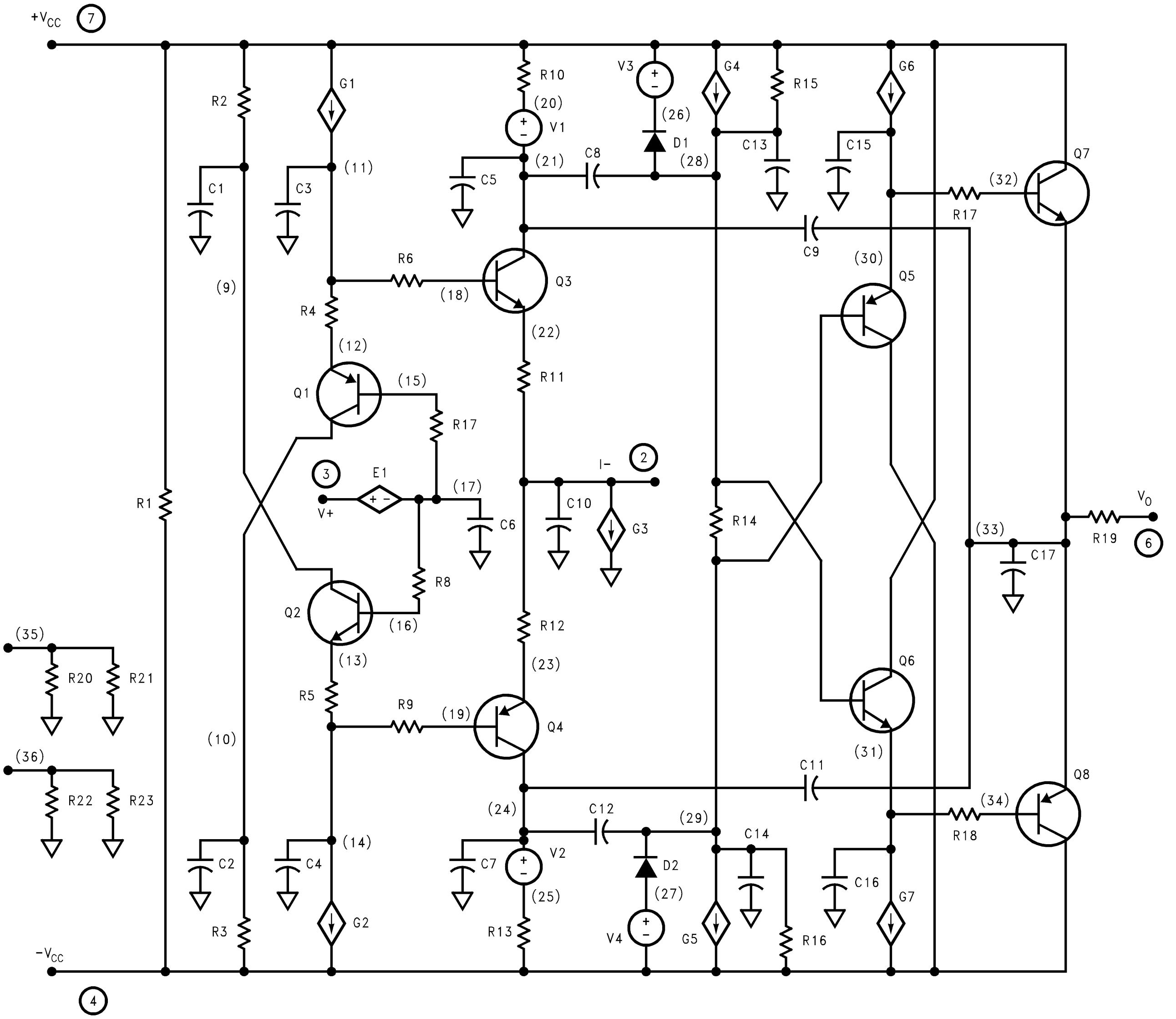
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 4. CLC401



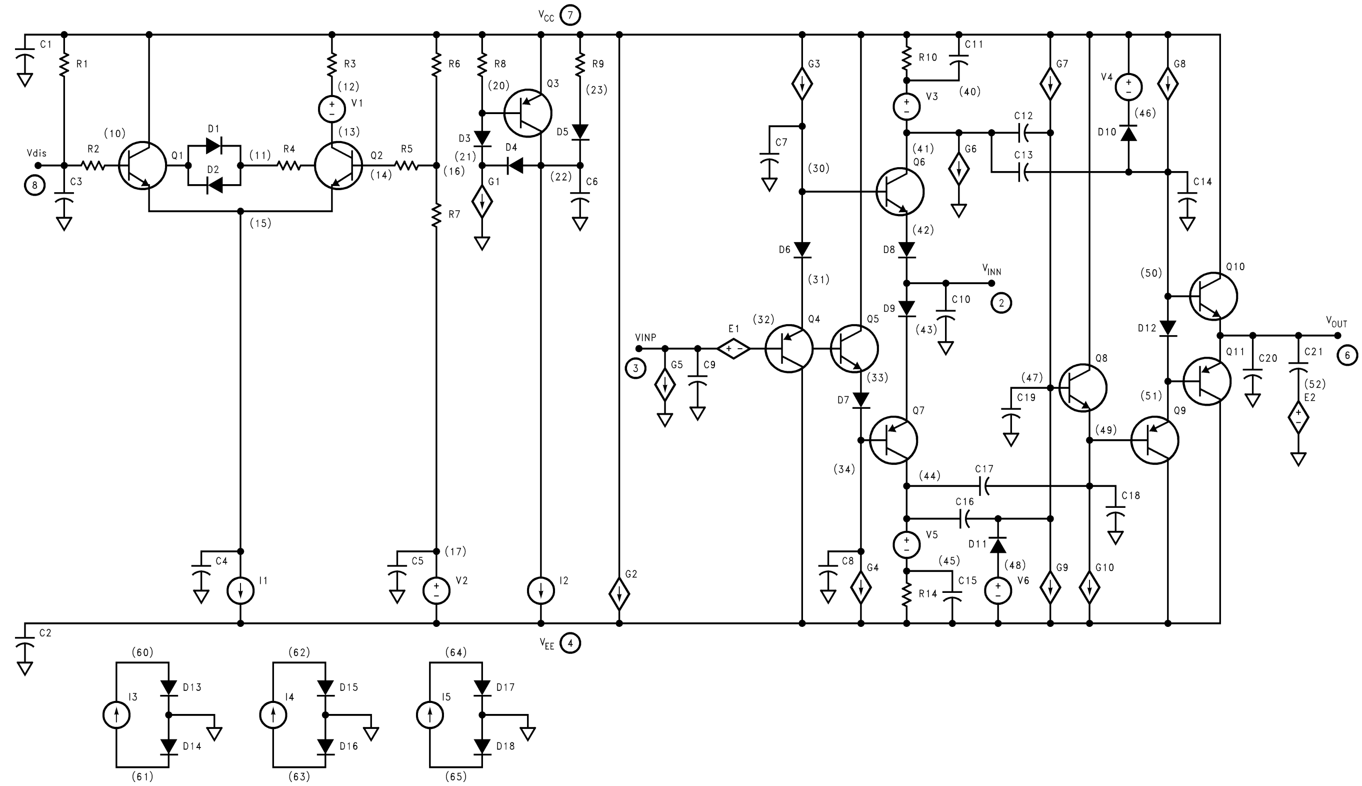
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 5. CLC402



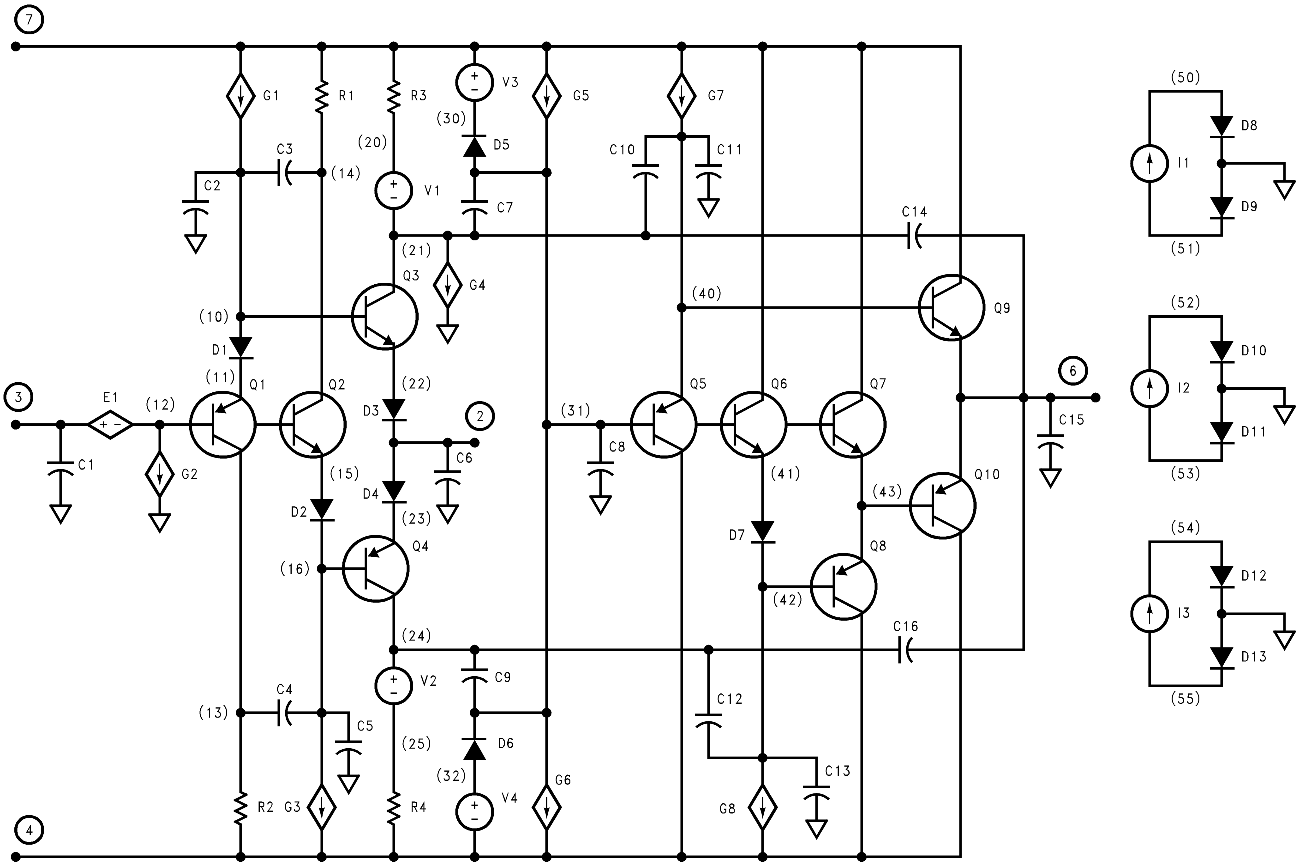
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 6. CLC404



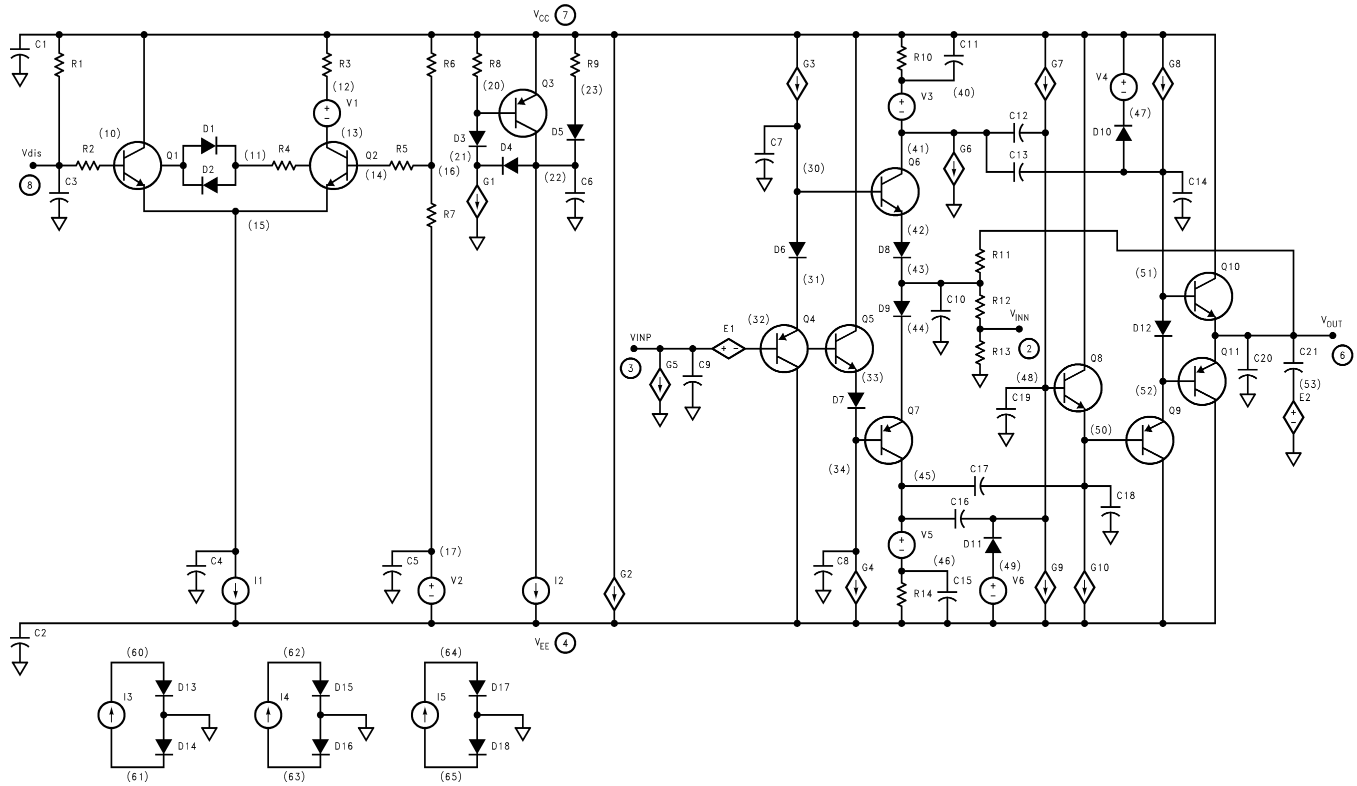
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 7. CLC405



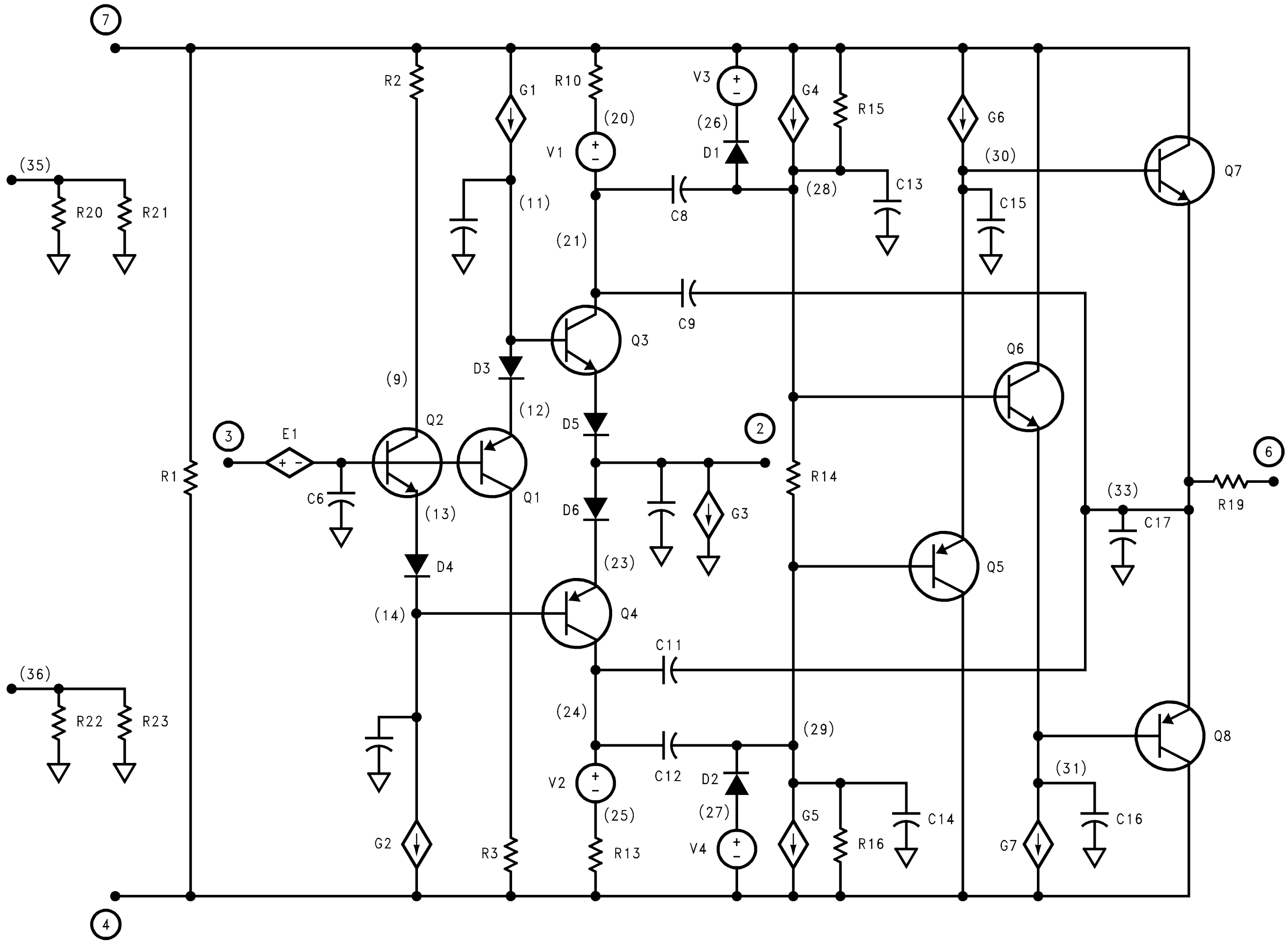
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 8. CLC406



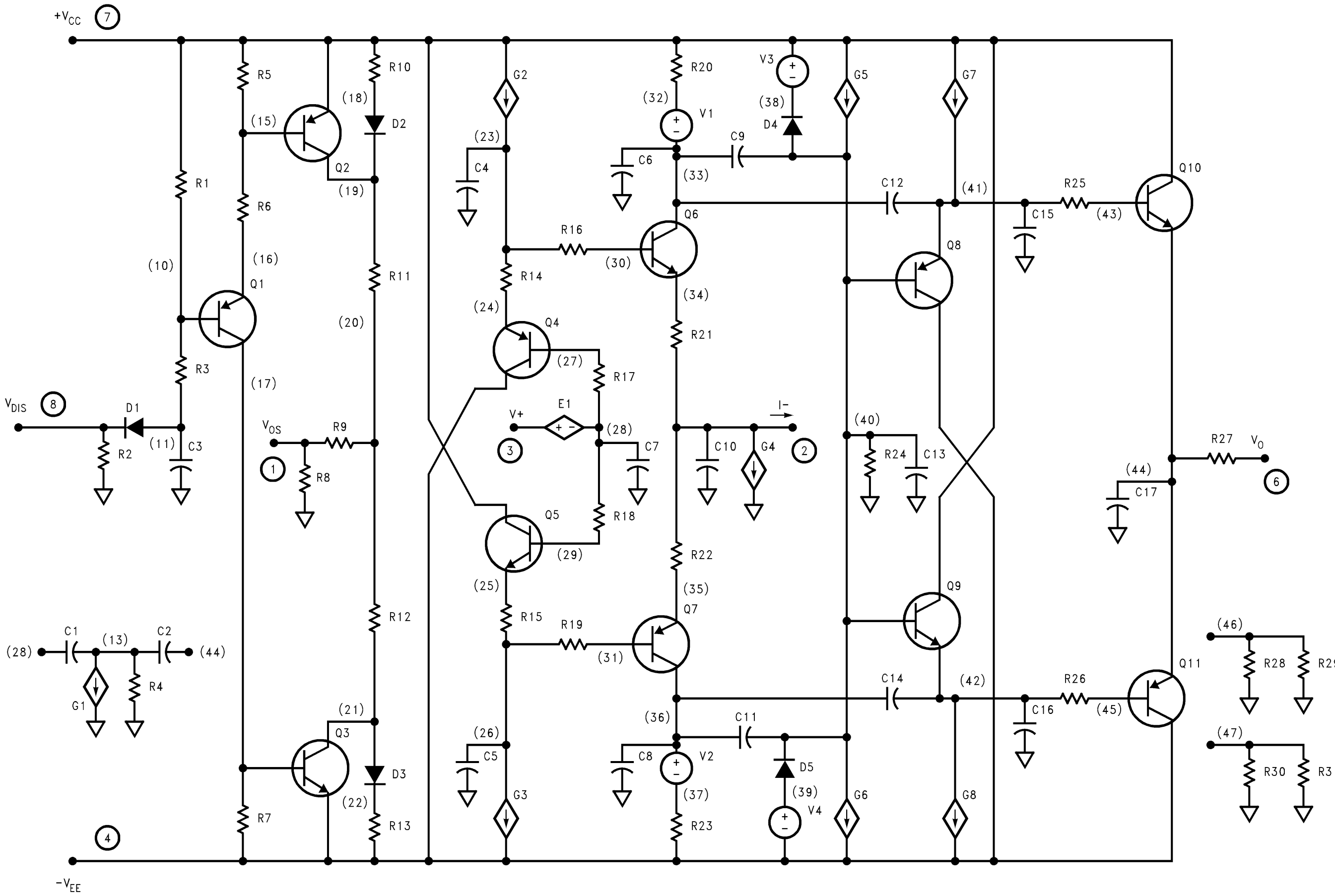
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 9. CLC407



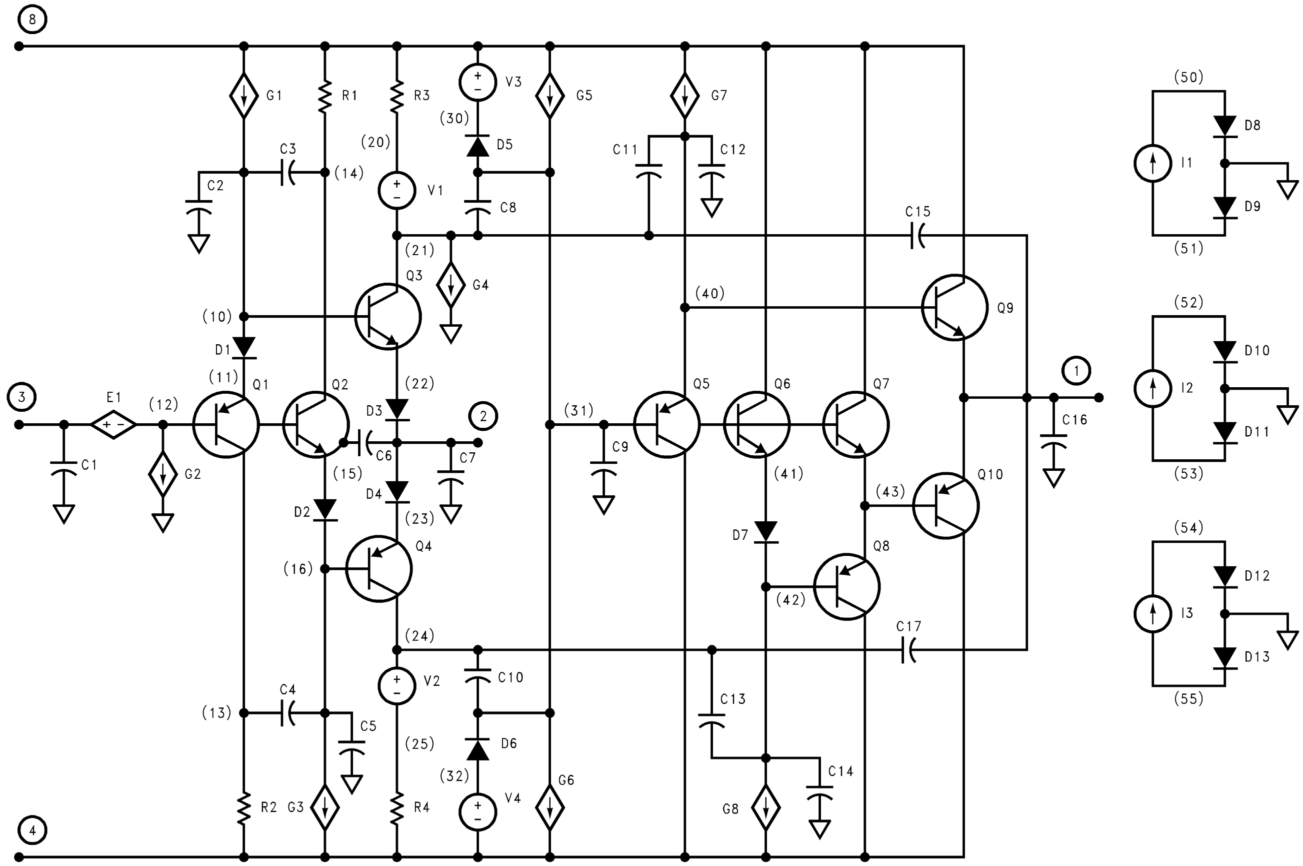
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 10. CLC409



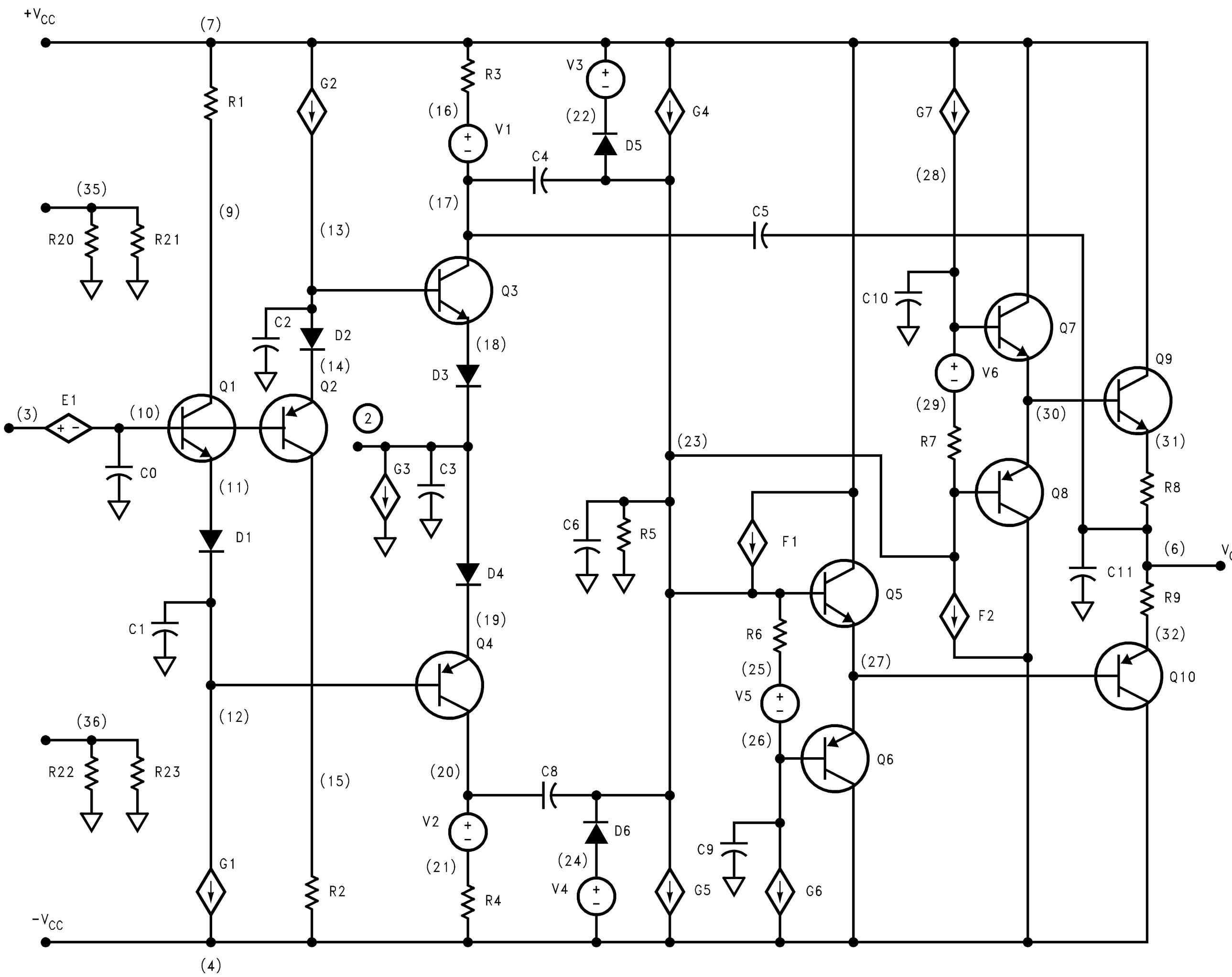
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 11. CLC410



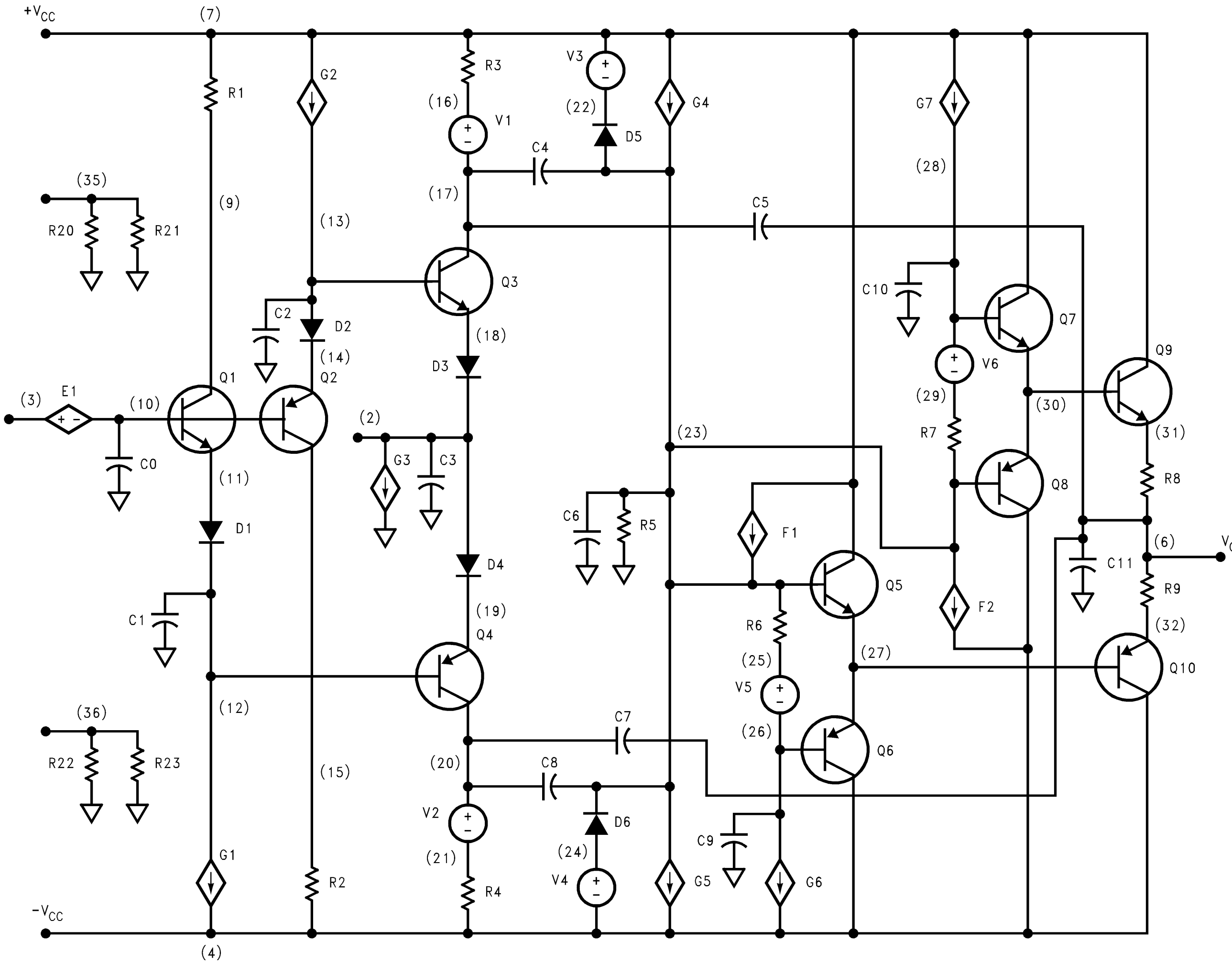
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 12. CLC412



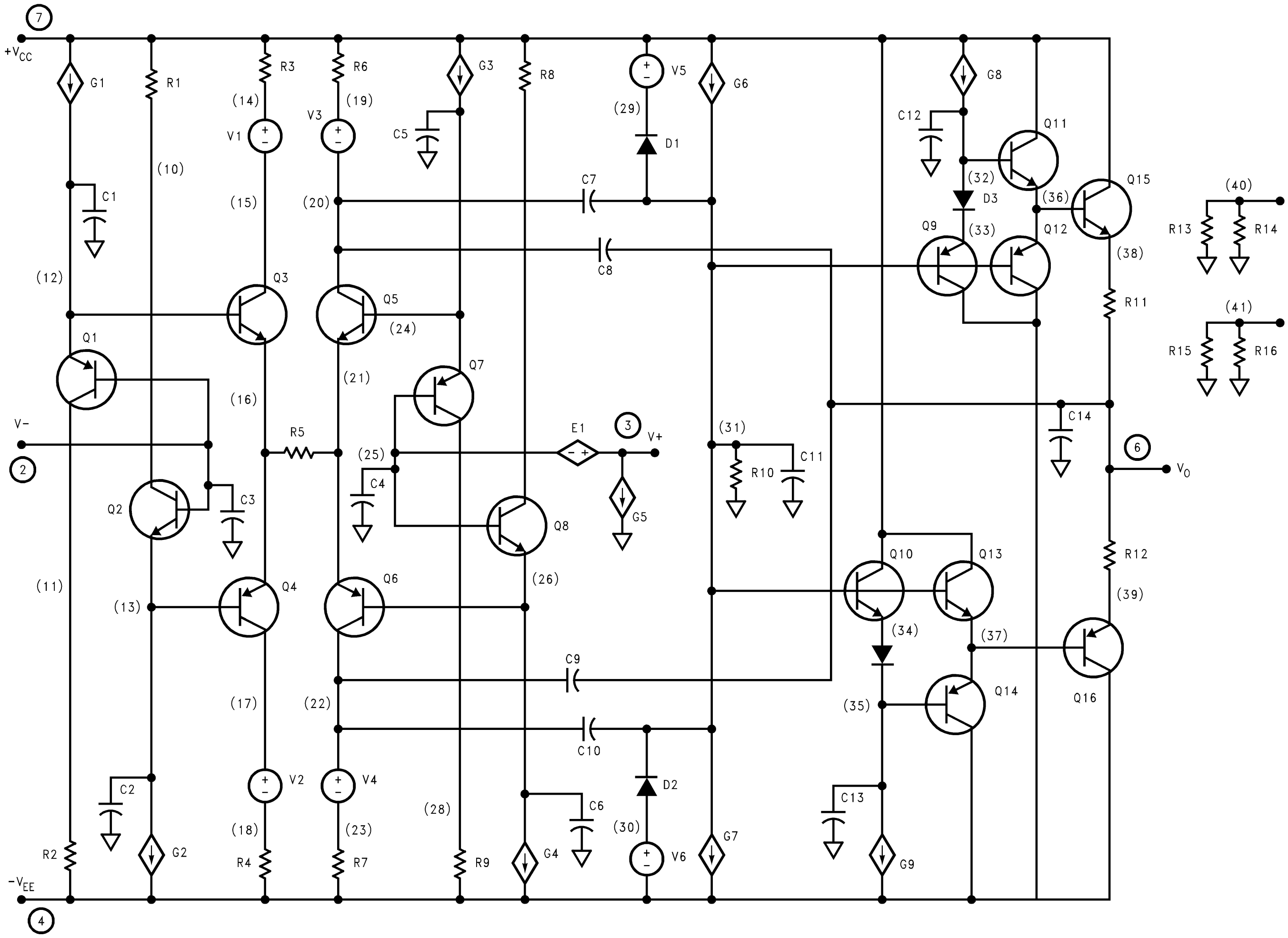
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 13. CLC414



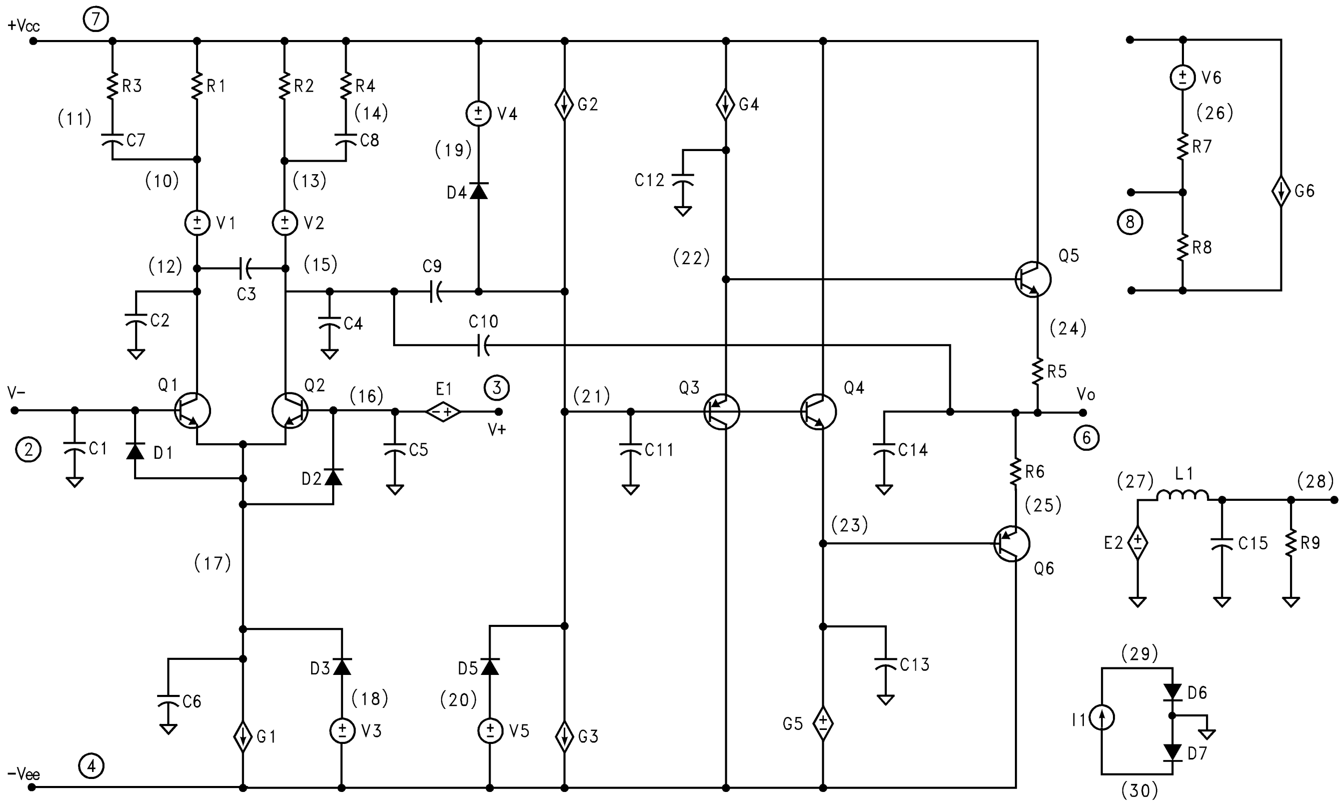
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 14. CLC415



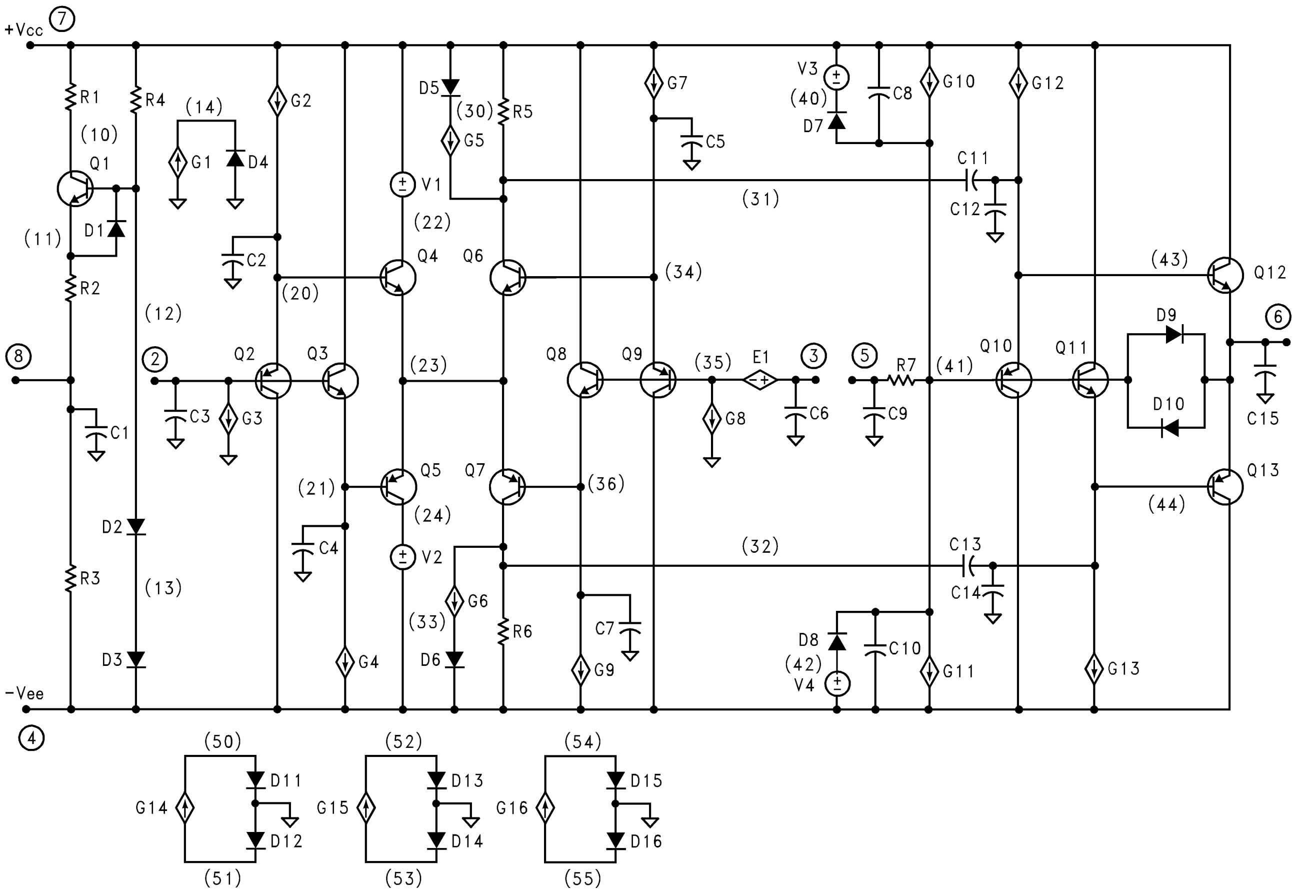
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 15. CLC420



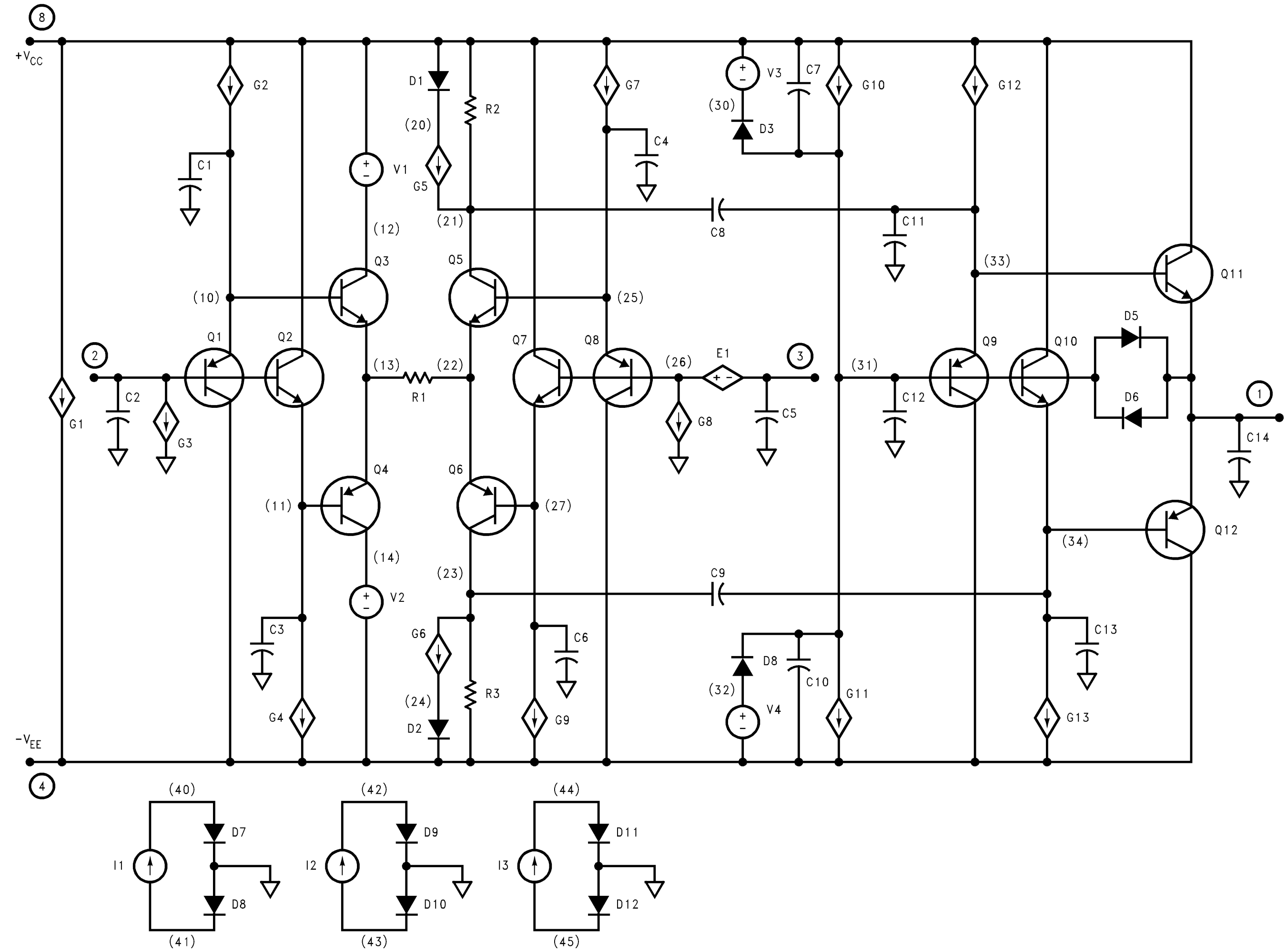
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 16. CLC425



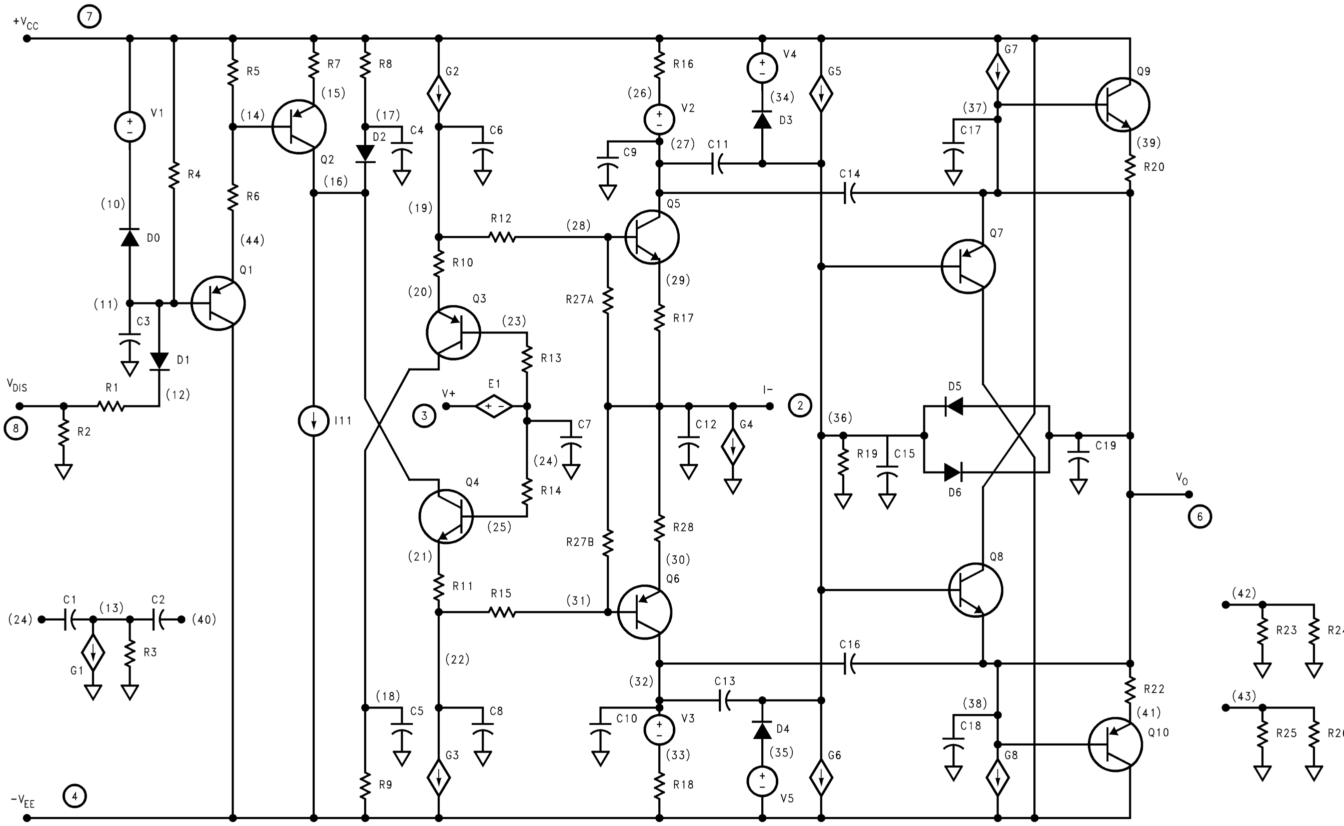
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 17. CLC426



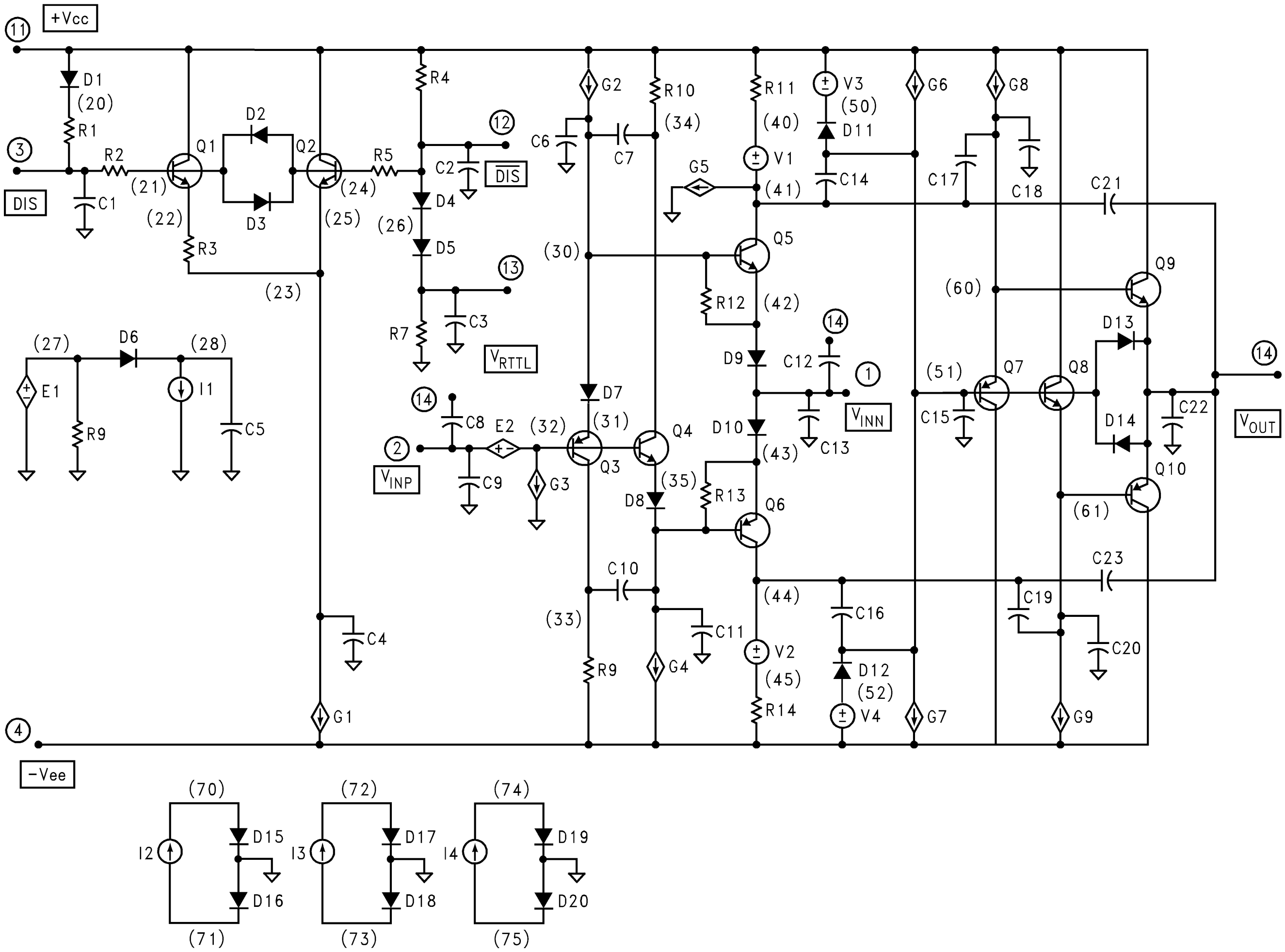
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 18. CLC428



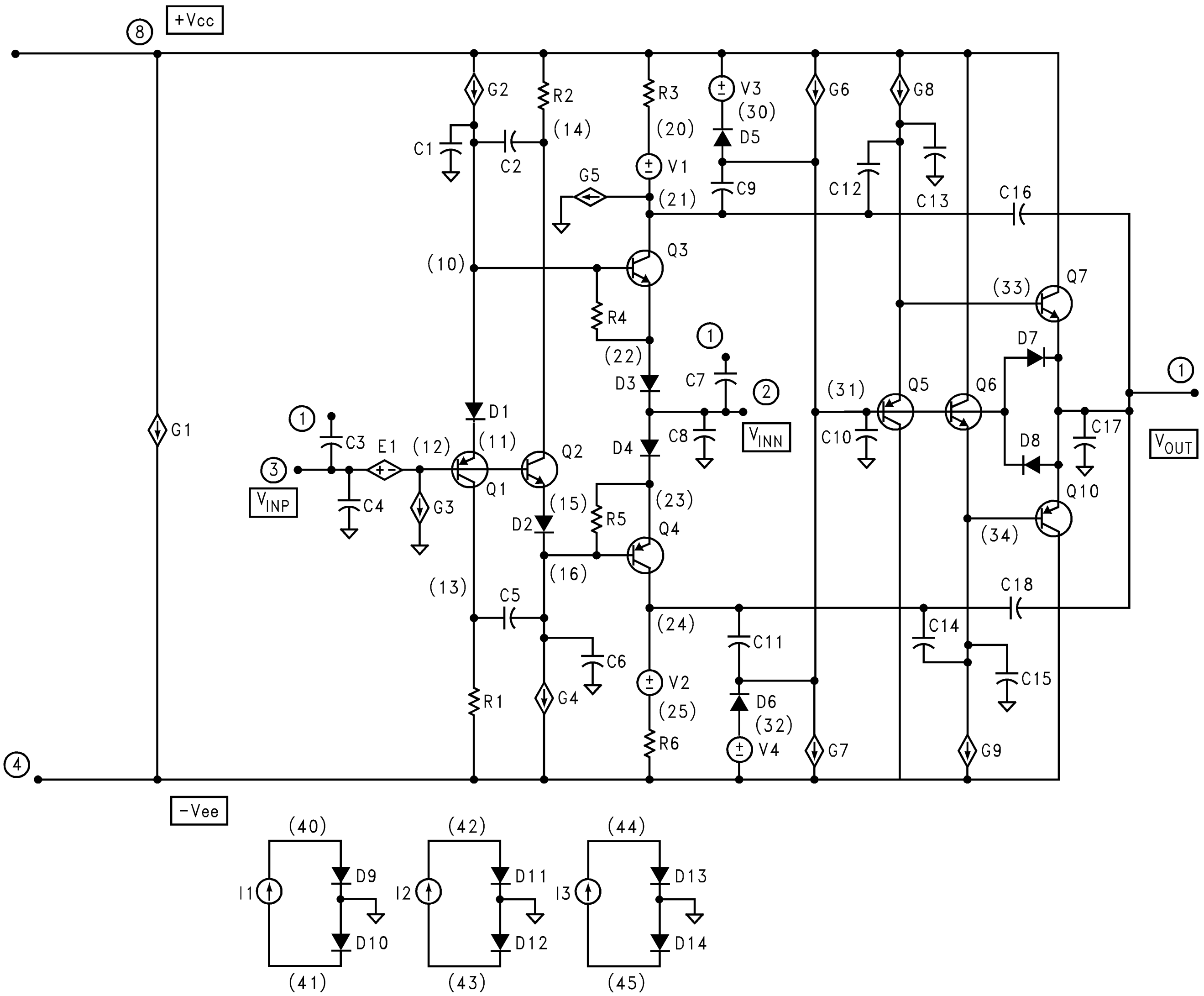
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 19. CLC430



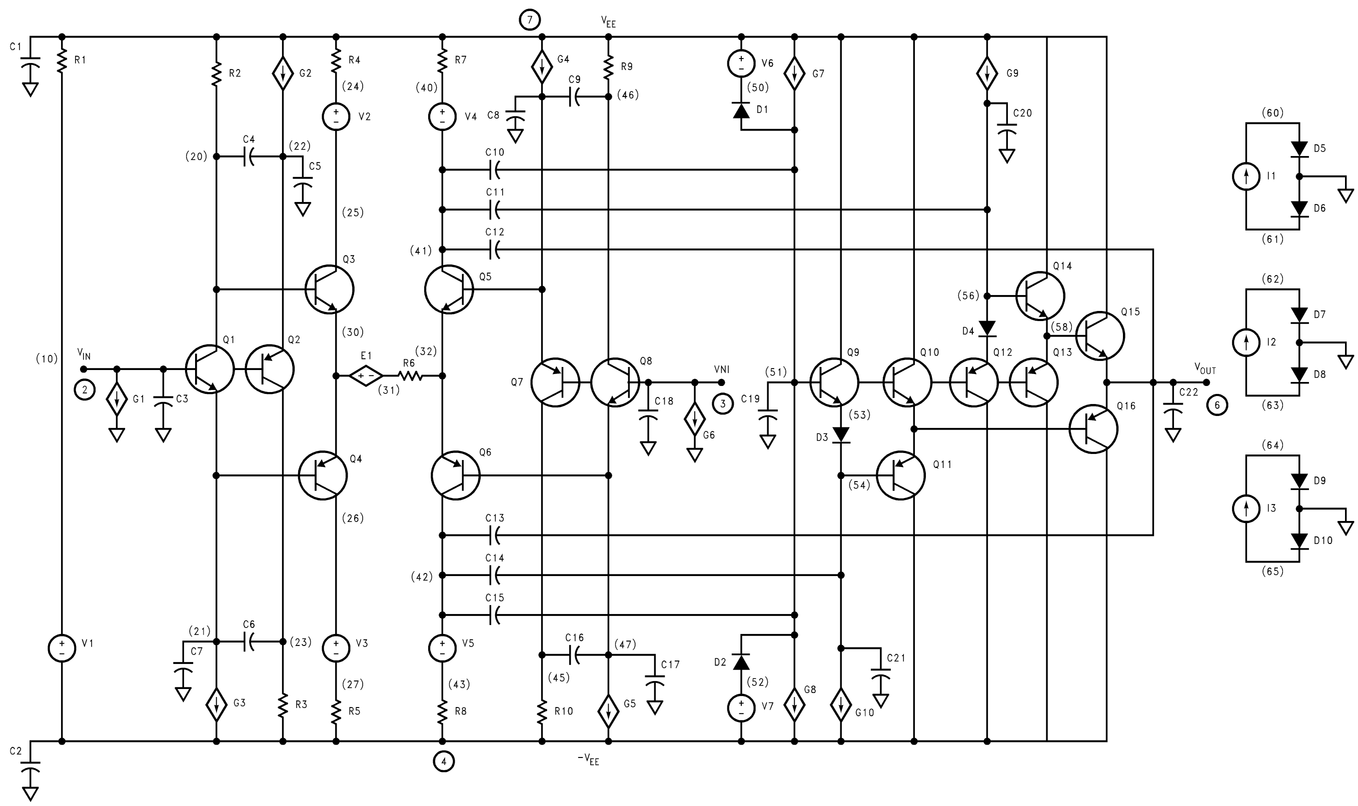
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 20. CLC431



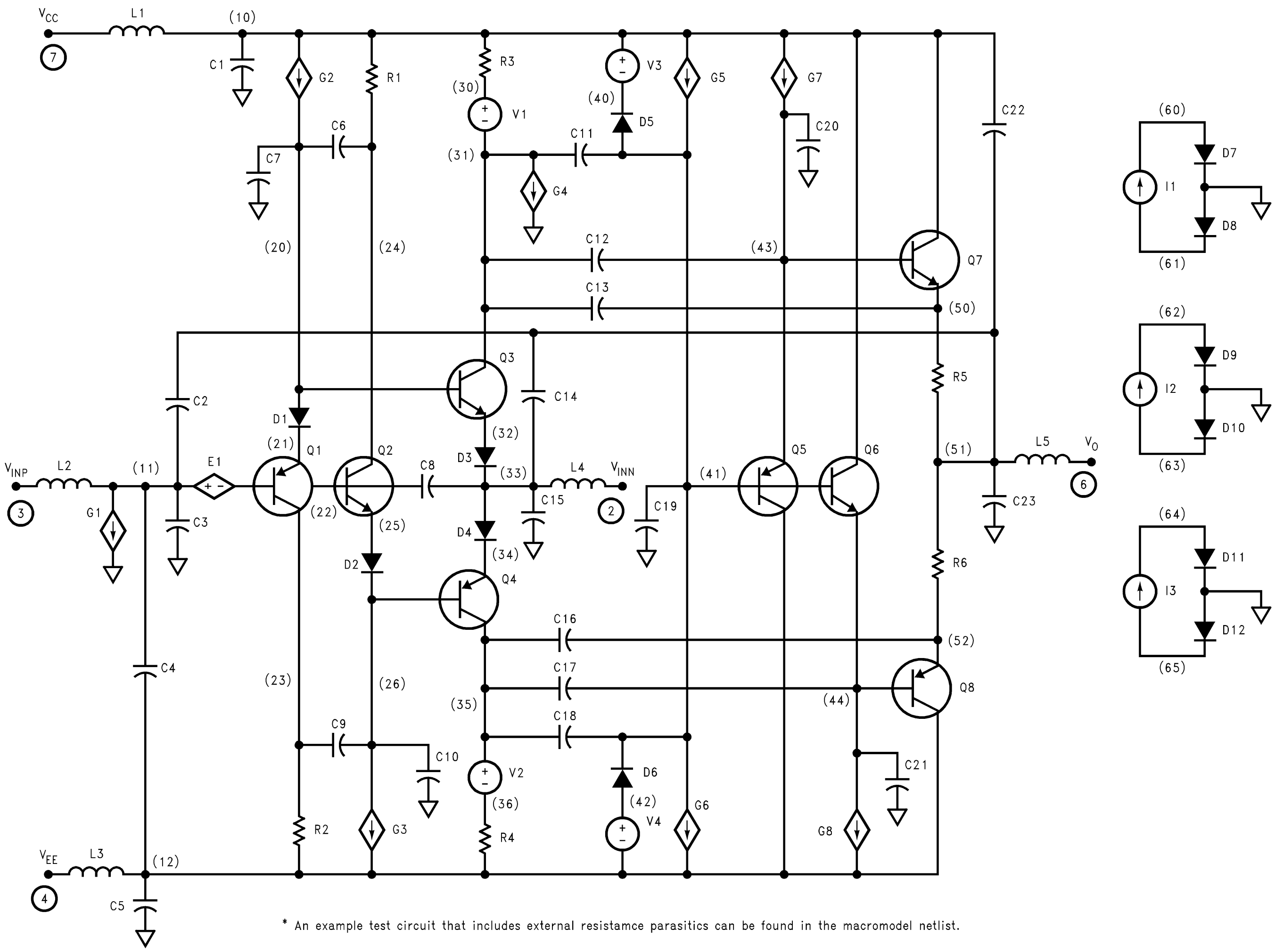
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 21. CLC432



Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

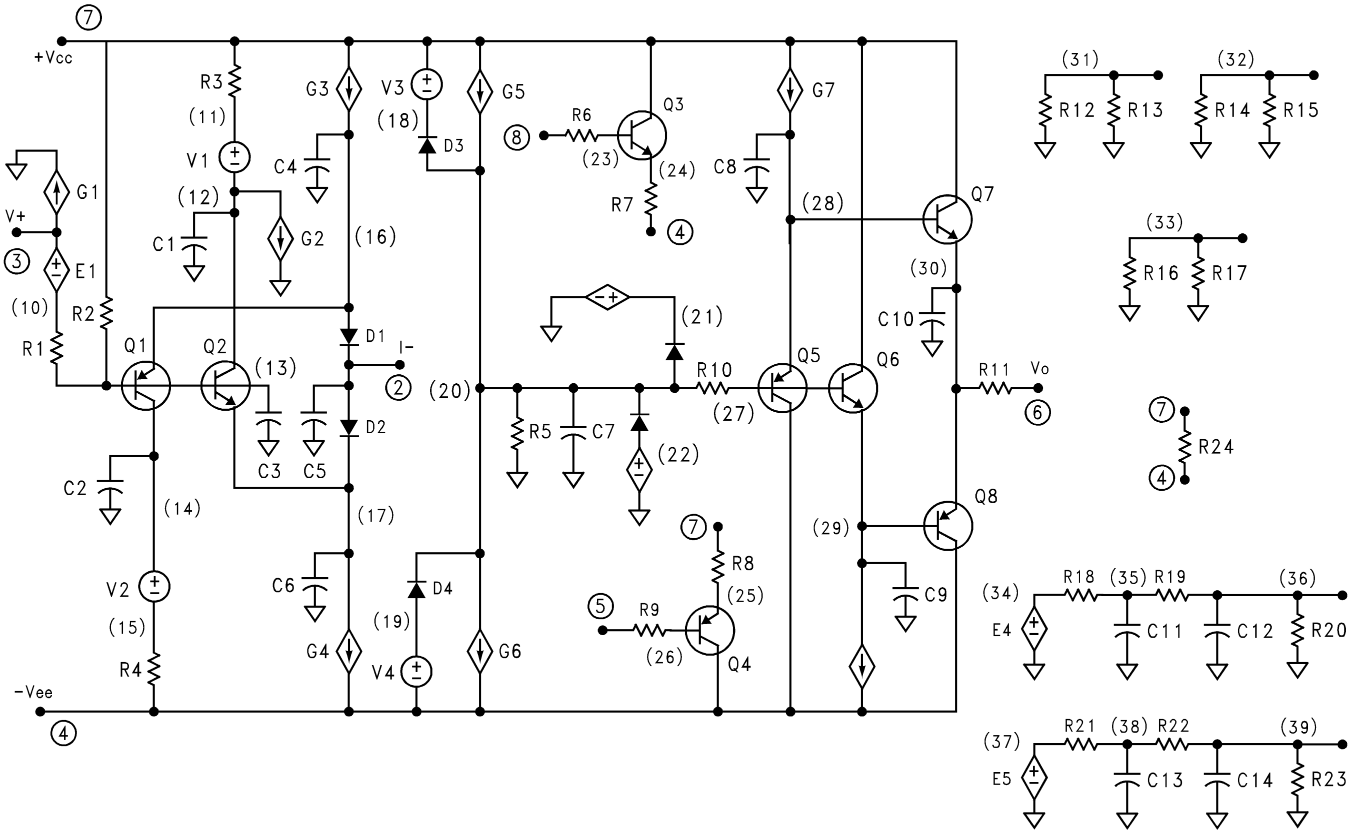
Figure 22. CLC440



* An example test circuit that includes external resistamce parasitics can be found in the macromodel netlist.

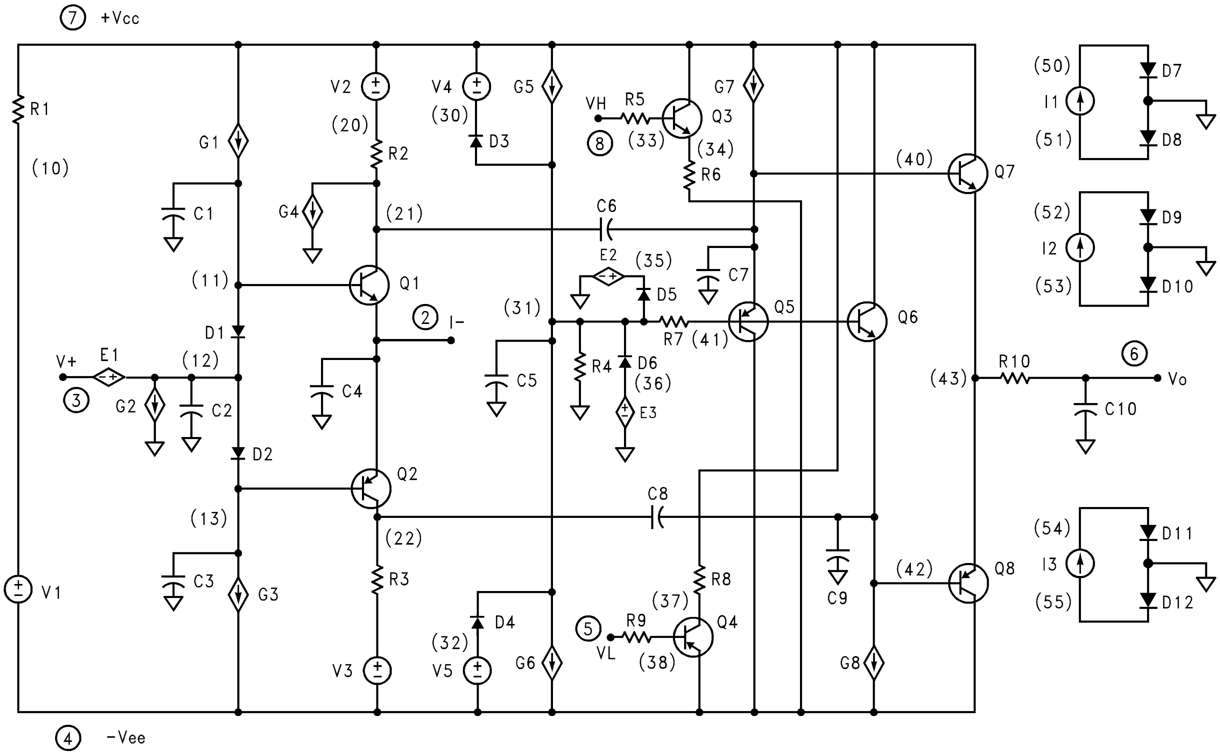
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 23. CLC449



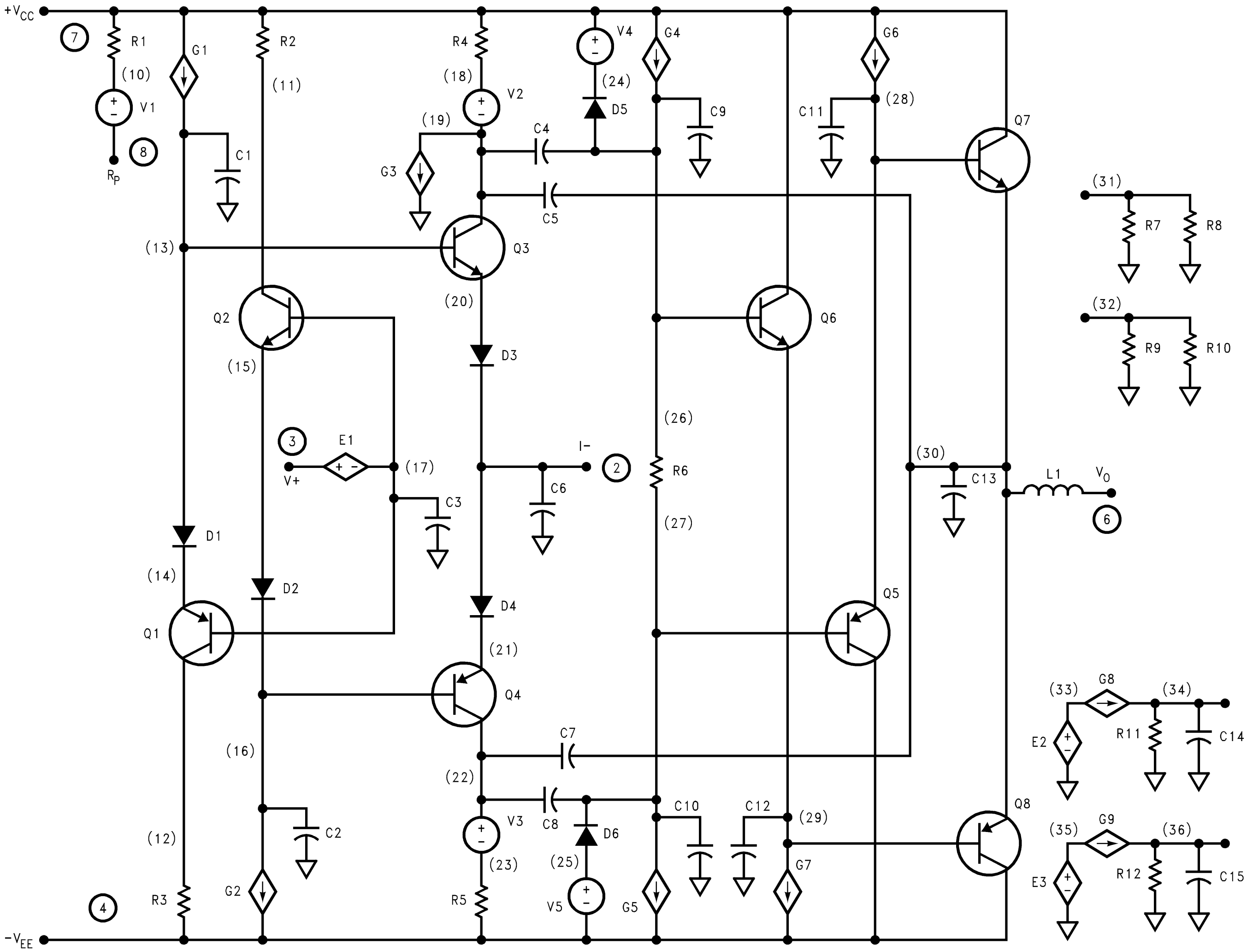
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 24. CLC501



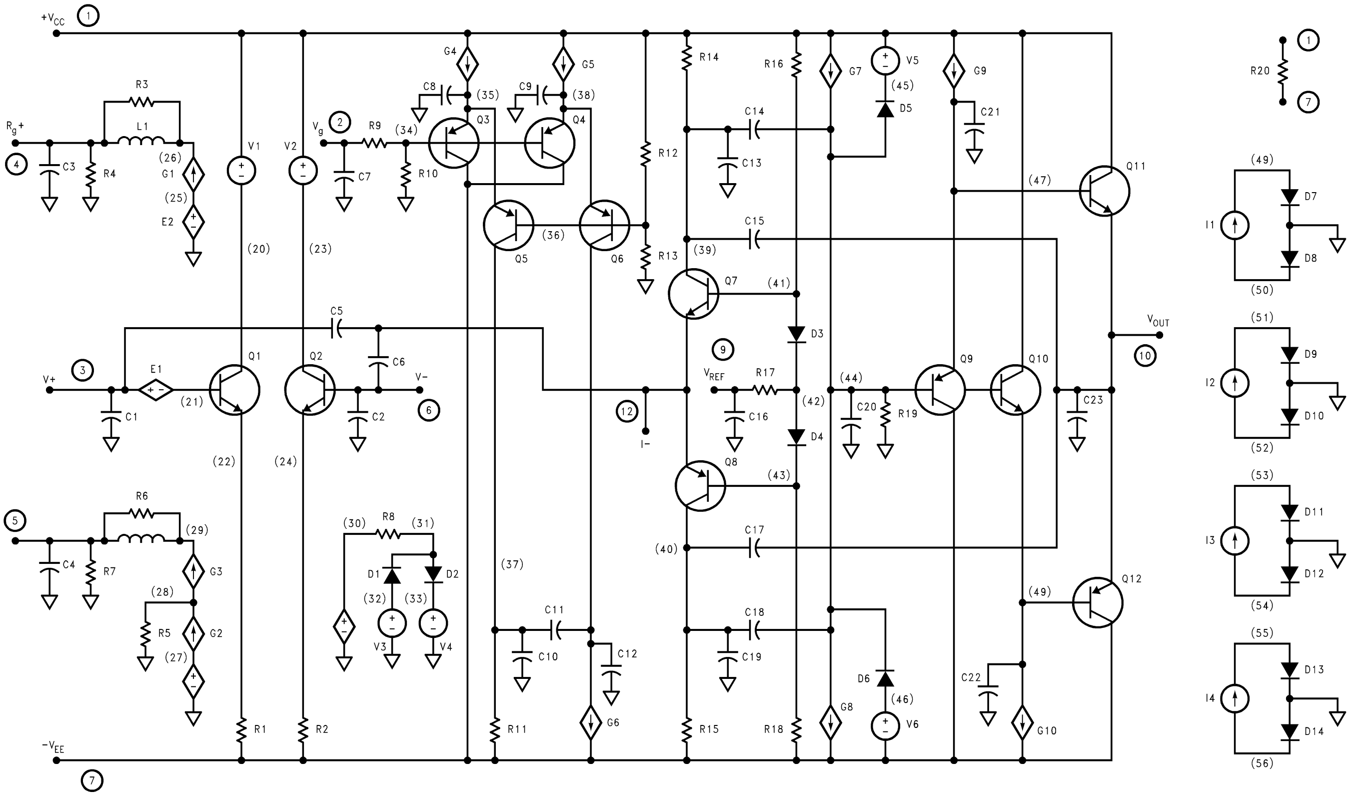
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 25. CLC502



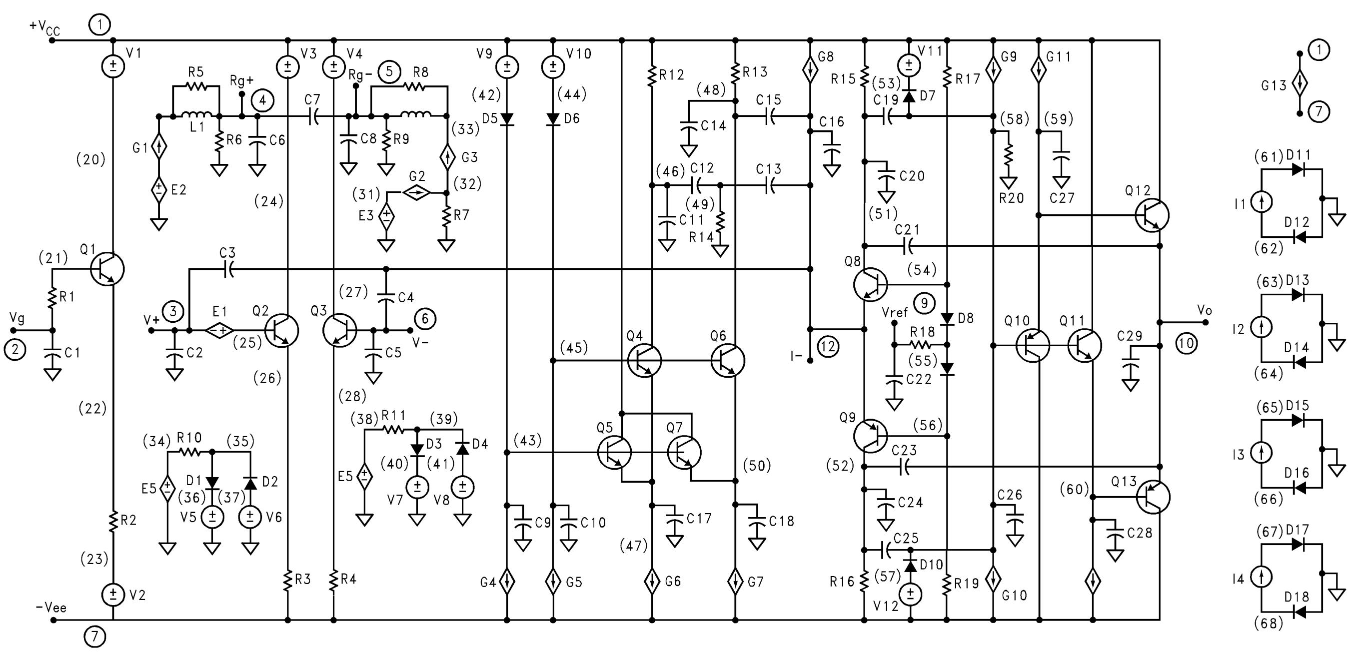
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 26. CLC505



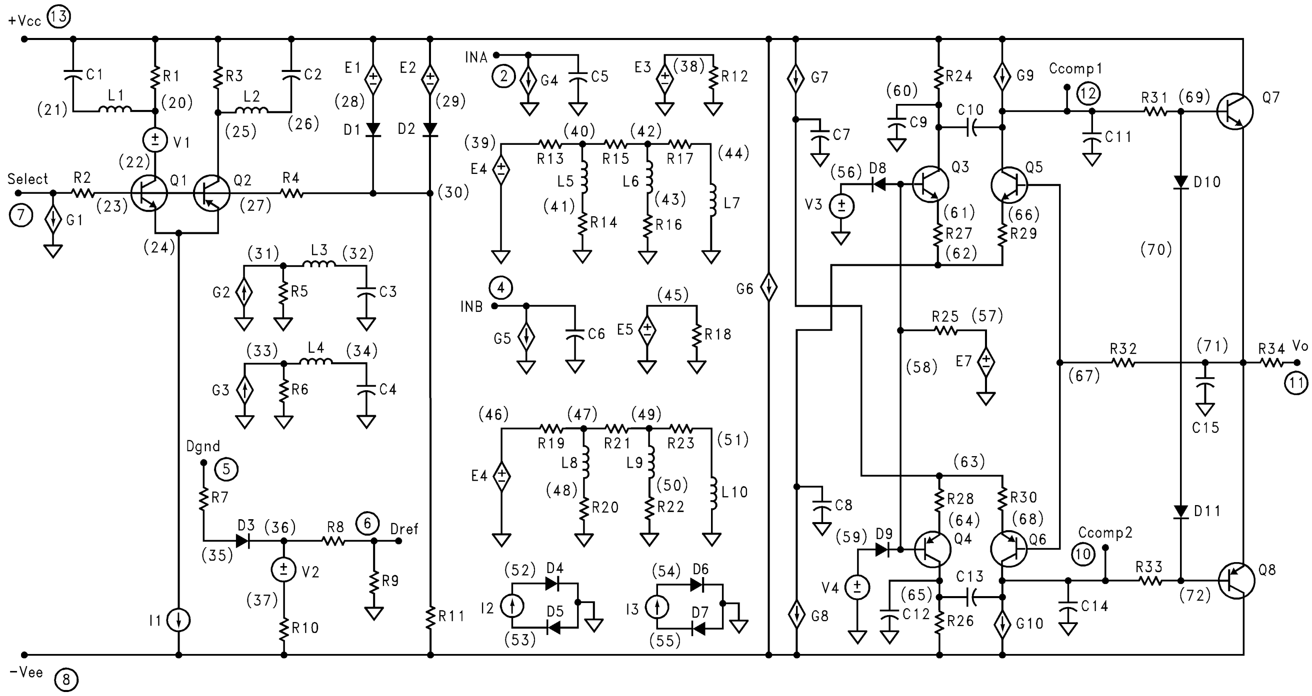
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 27. CLC520



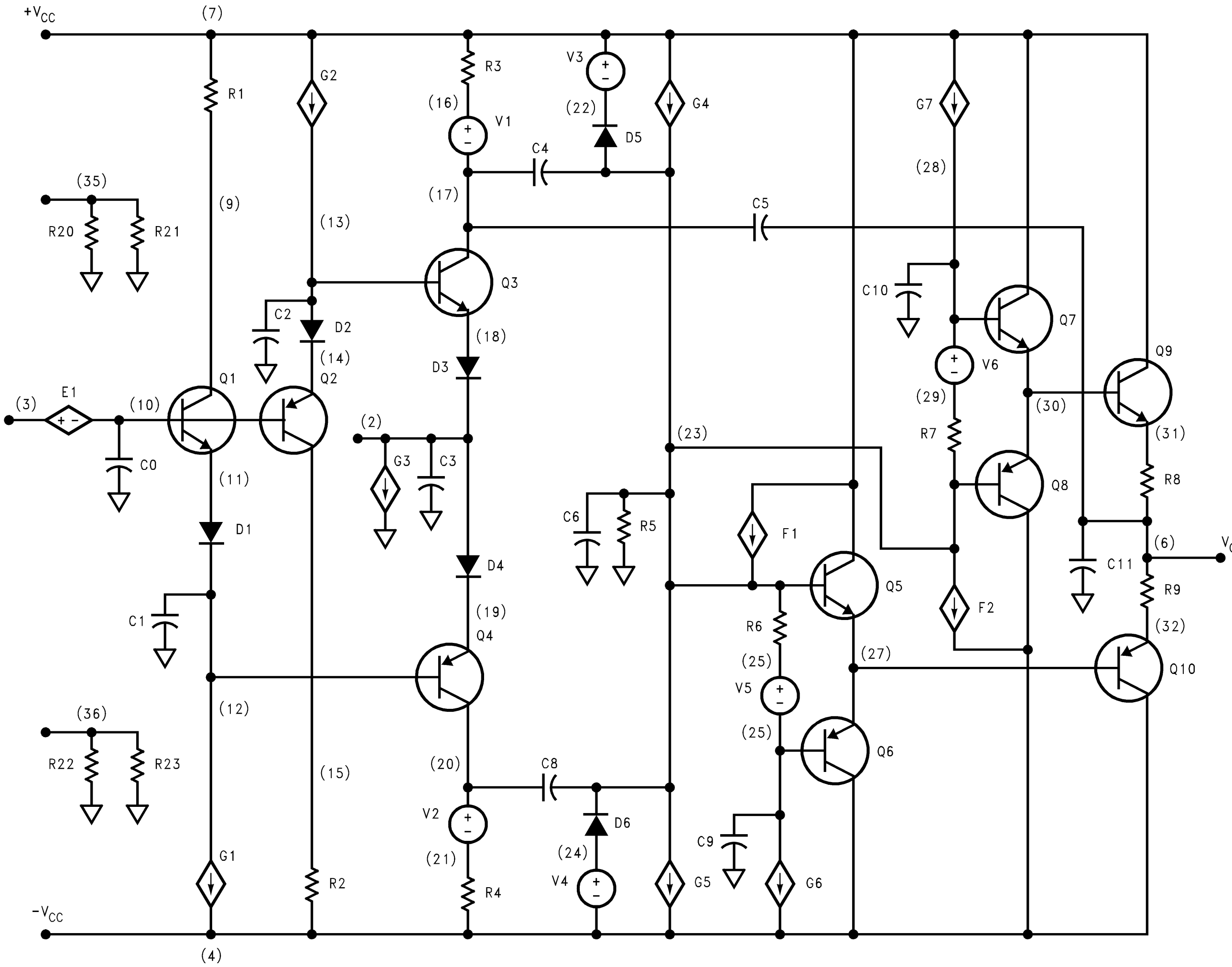
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 28. CLC522



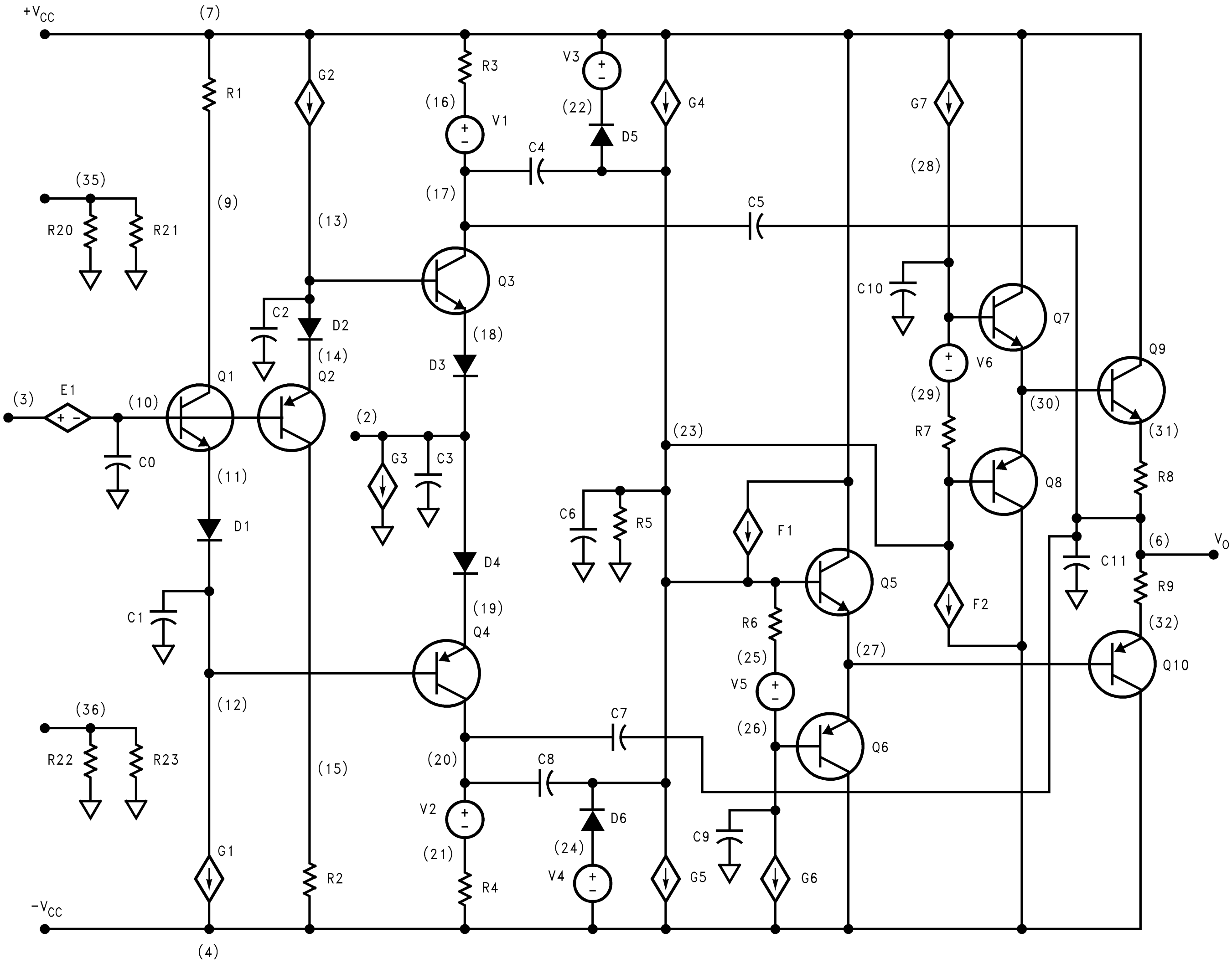
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 29. CLC532



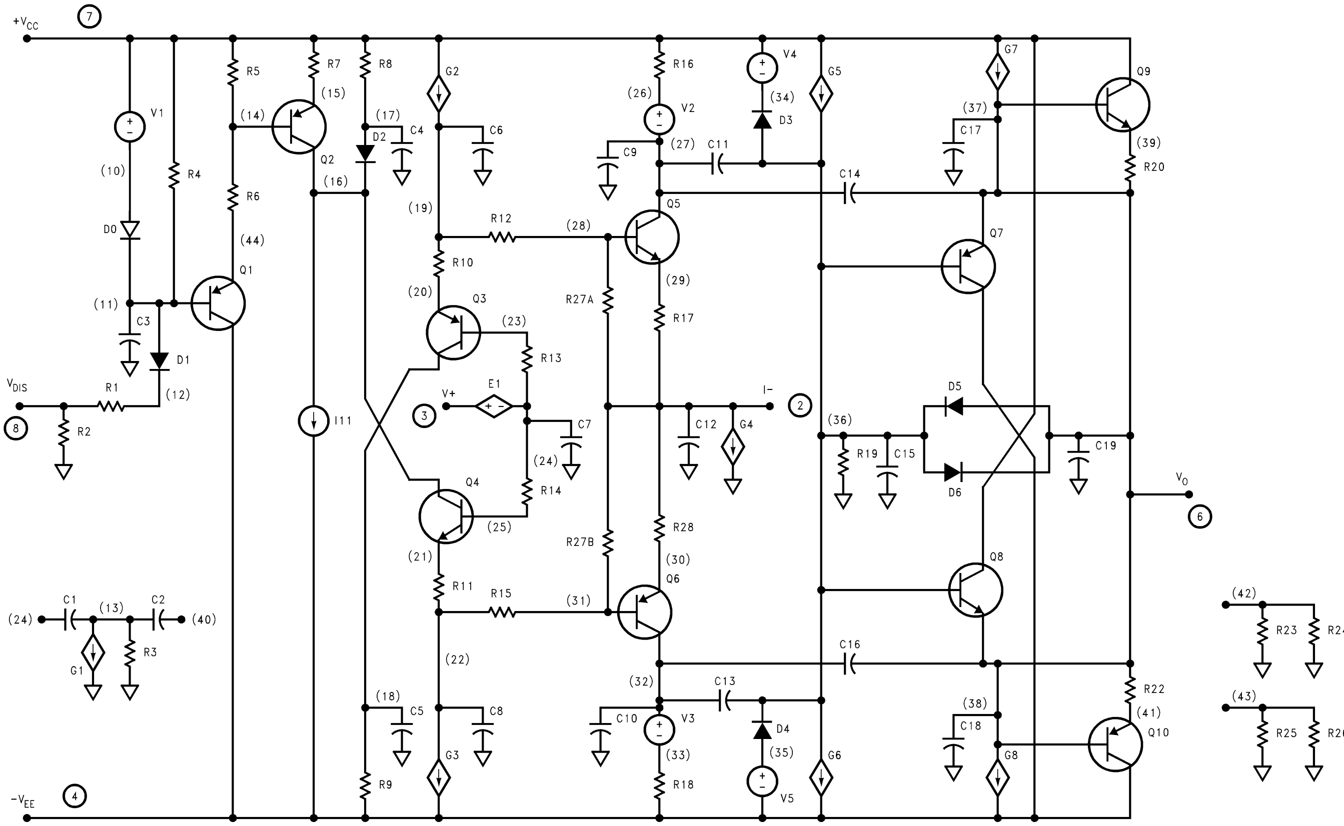
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 30. CLC5644



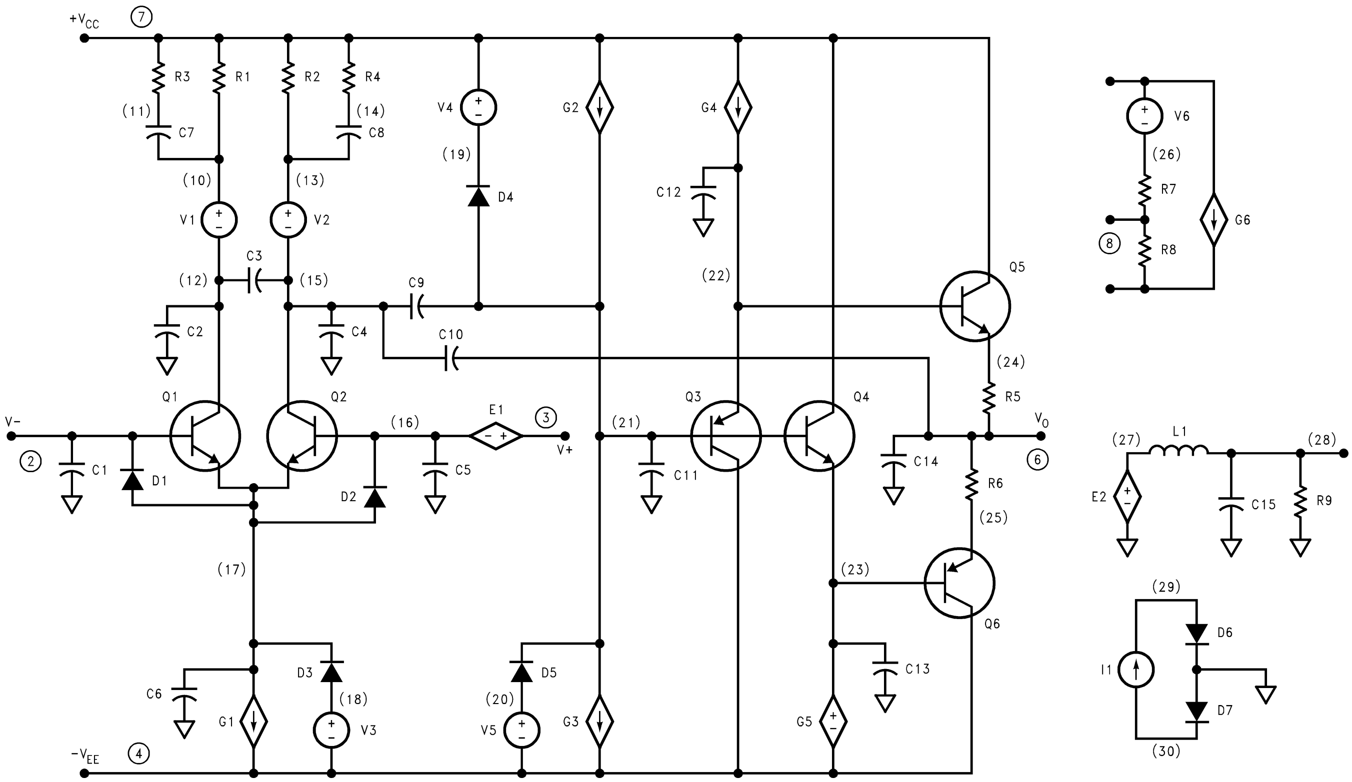
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 31. CLC5654



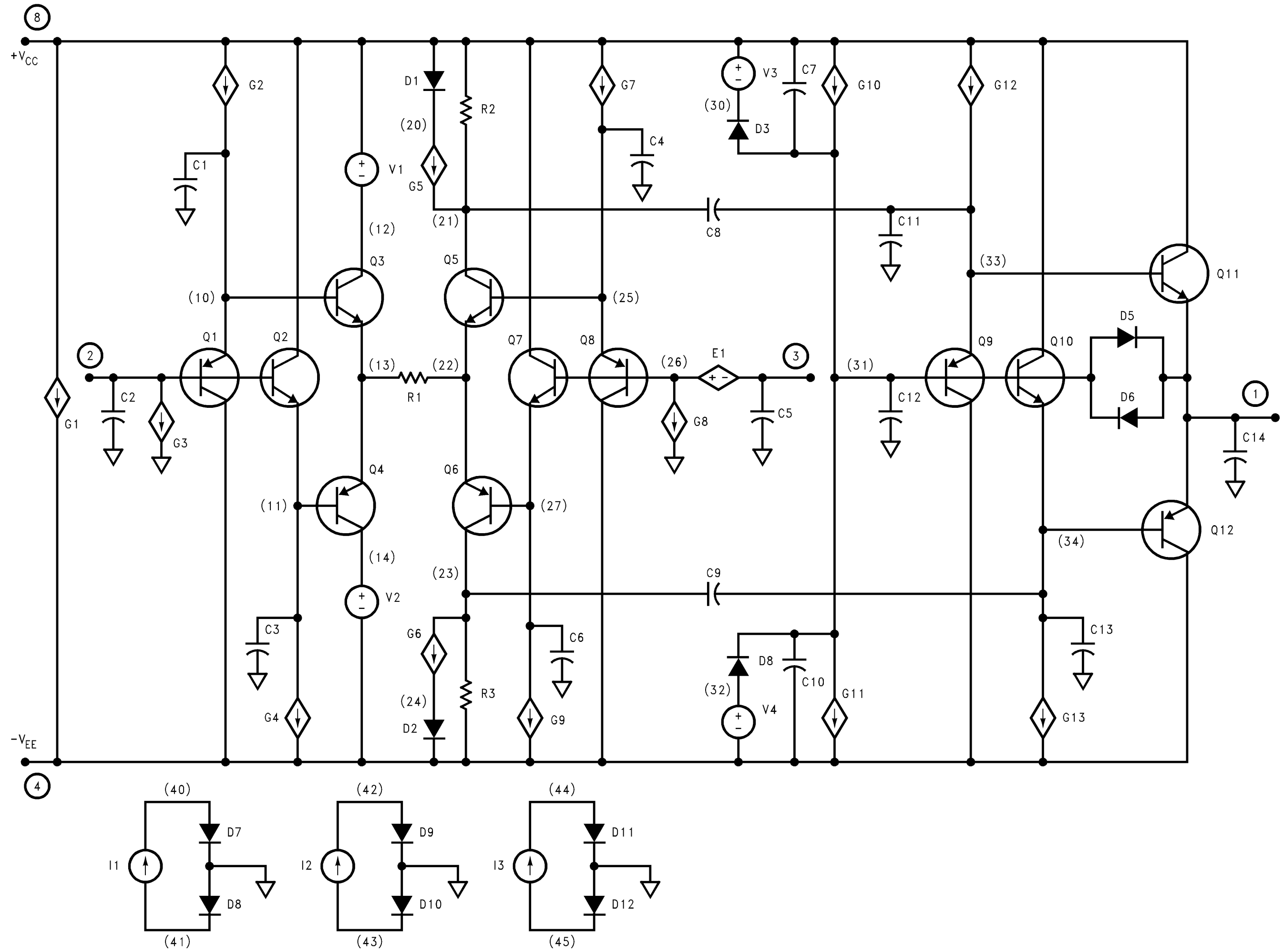
Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 32. CLC5665



Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 33. CLC5801



Note: Circled number denotes PIN number and number in parenthesis denotes NODE number.

Figure 34. CLC5802

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265