EL326 CMOS OP-AMP

Report to : อ. อิทธิภูมิ บุญพิคำ (3C)

อ. วรากร เกษมสุวรรณ(2R)

Requirement: 1. Objective

2. การทดลอง
3. ผลการทดลอง(รวมกราฟ)
4. วิเคราะห์ผลการทดลอง
5. สรุปผลการทดลอง
6. ตอบคำถามท้ายบททุกข้อ

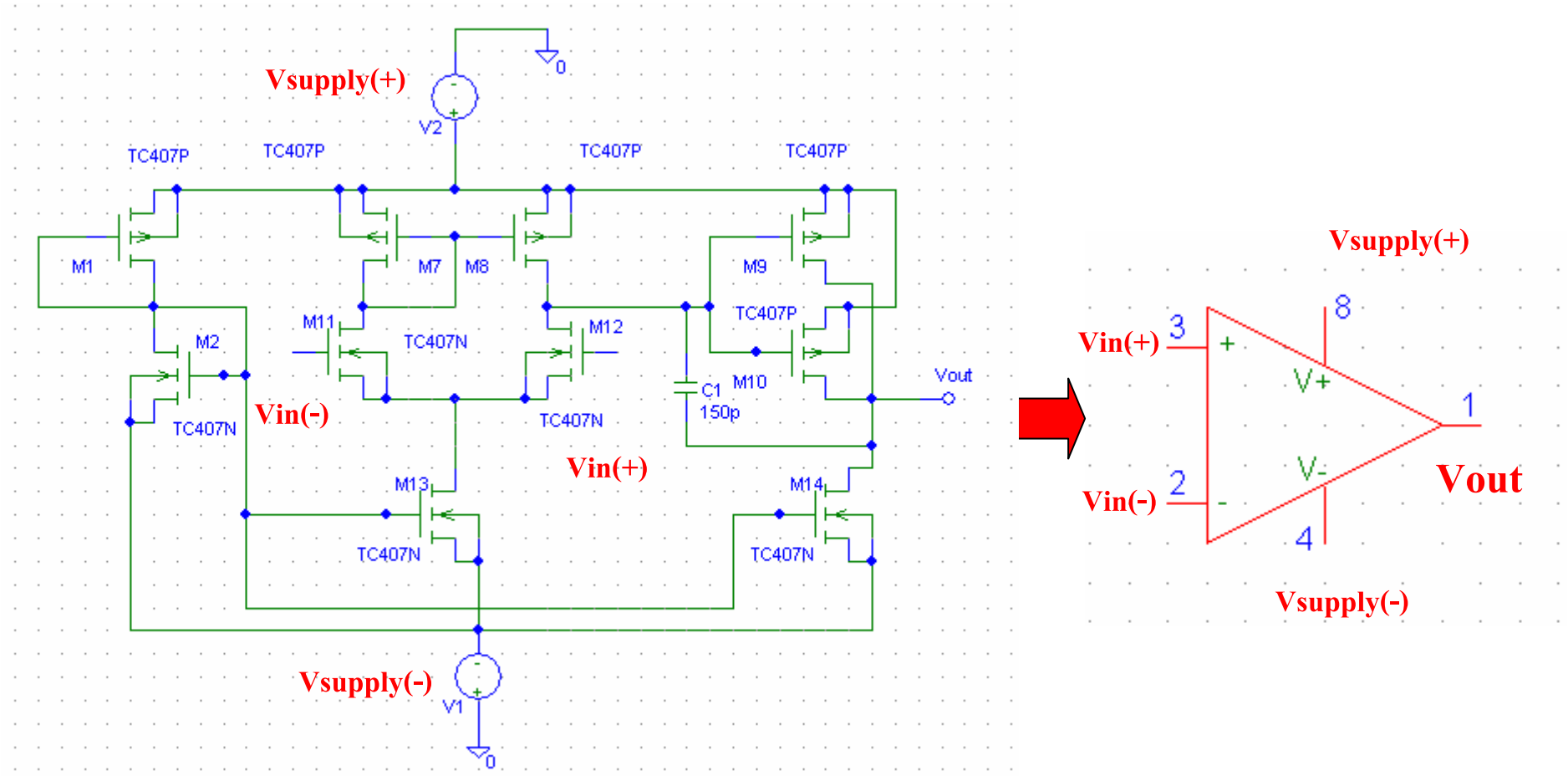
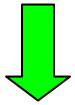


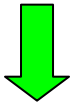
Fig. CMOS OP-Amp Circuit

Working steps

Create Library สร้าง Library สำหรับ NMOS และ PMOS

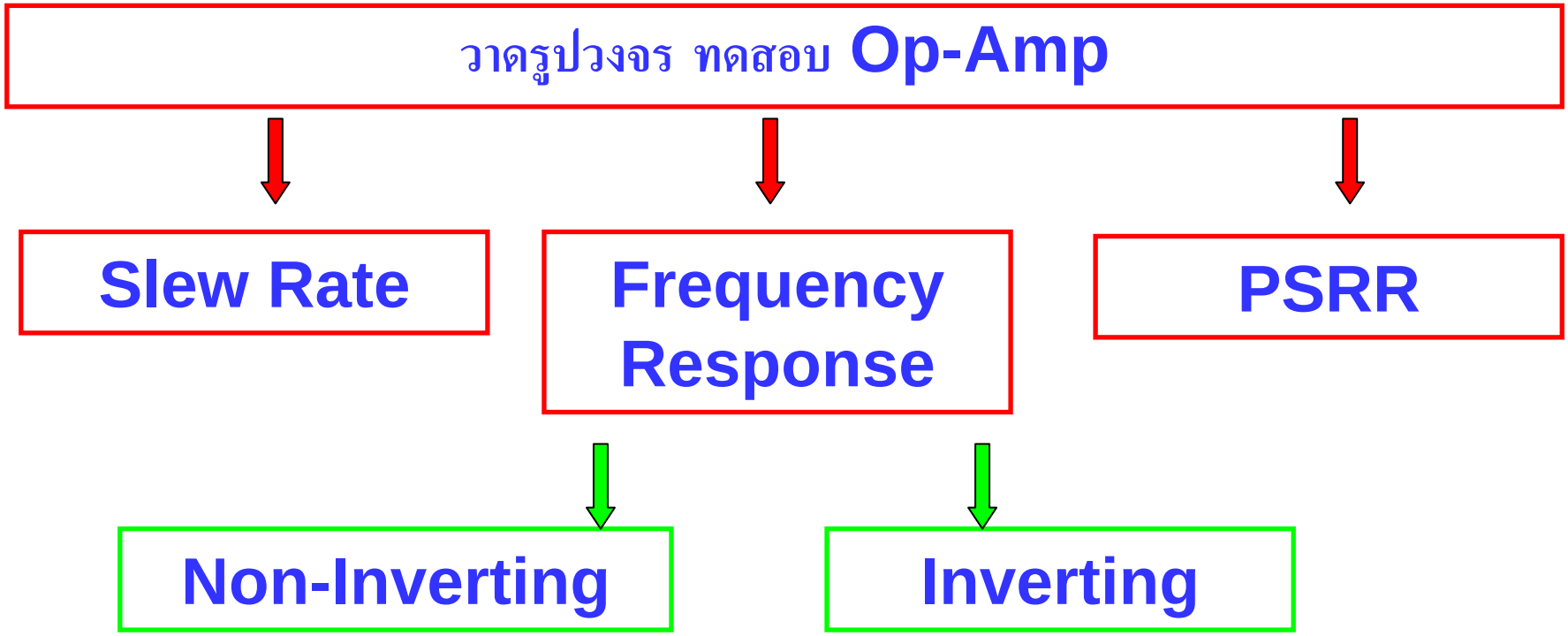


เพิ่ม NMOS และ PMOS ไว้ใน Library ของ PSPICE



วาดรูปวงจร เพื่อสร้าง Op-Amp

วาดรูปวงจร ทดสอบ Op-Amp



Note: PSRR: Power Supply Rejection Ratio

Create Library สร้าง Library สำหรับ NMOS และ PMOS

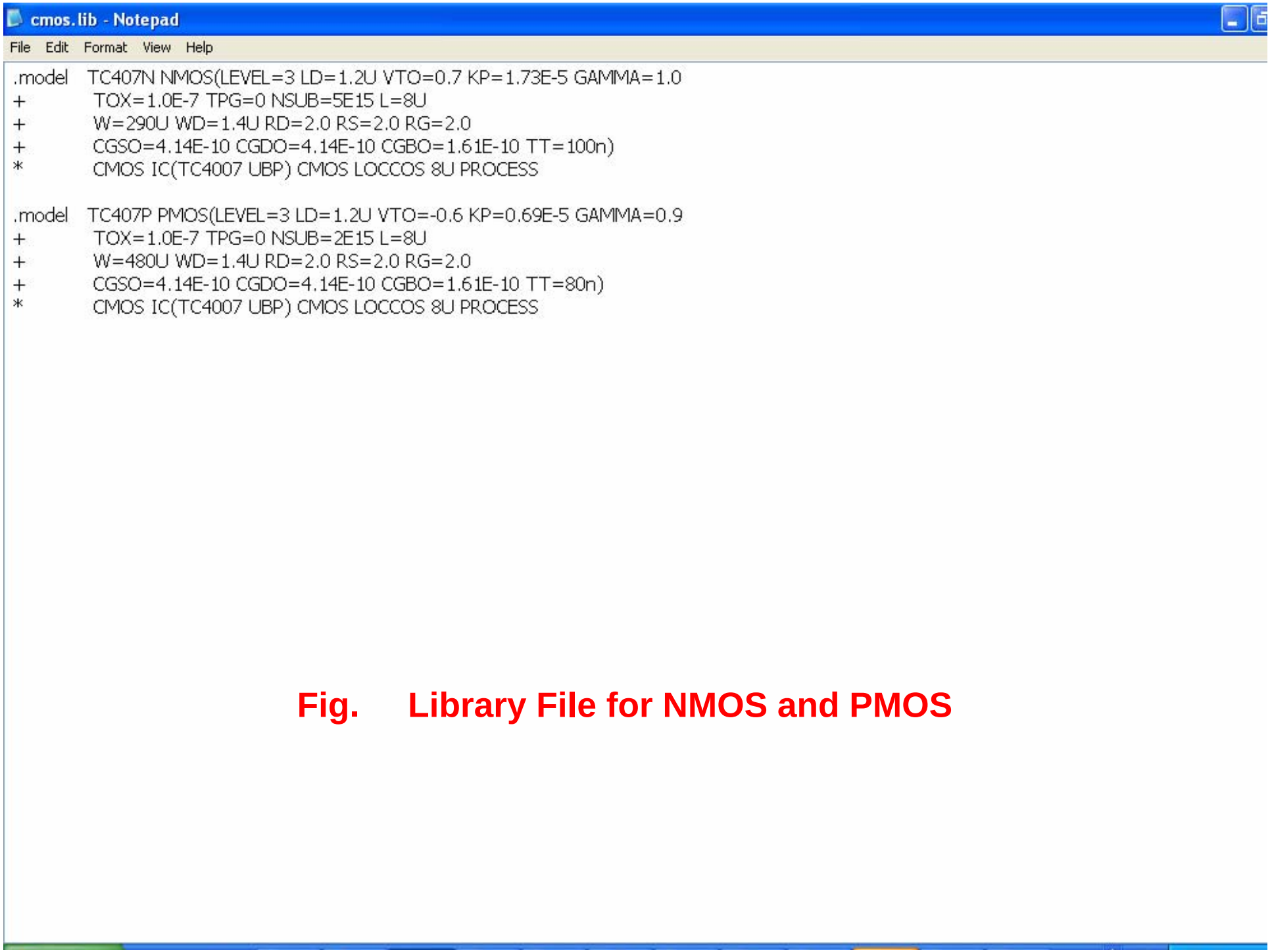


Fig. Library File for NMOS and PMOS

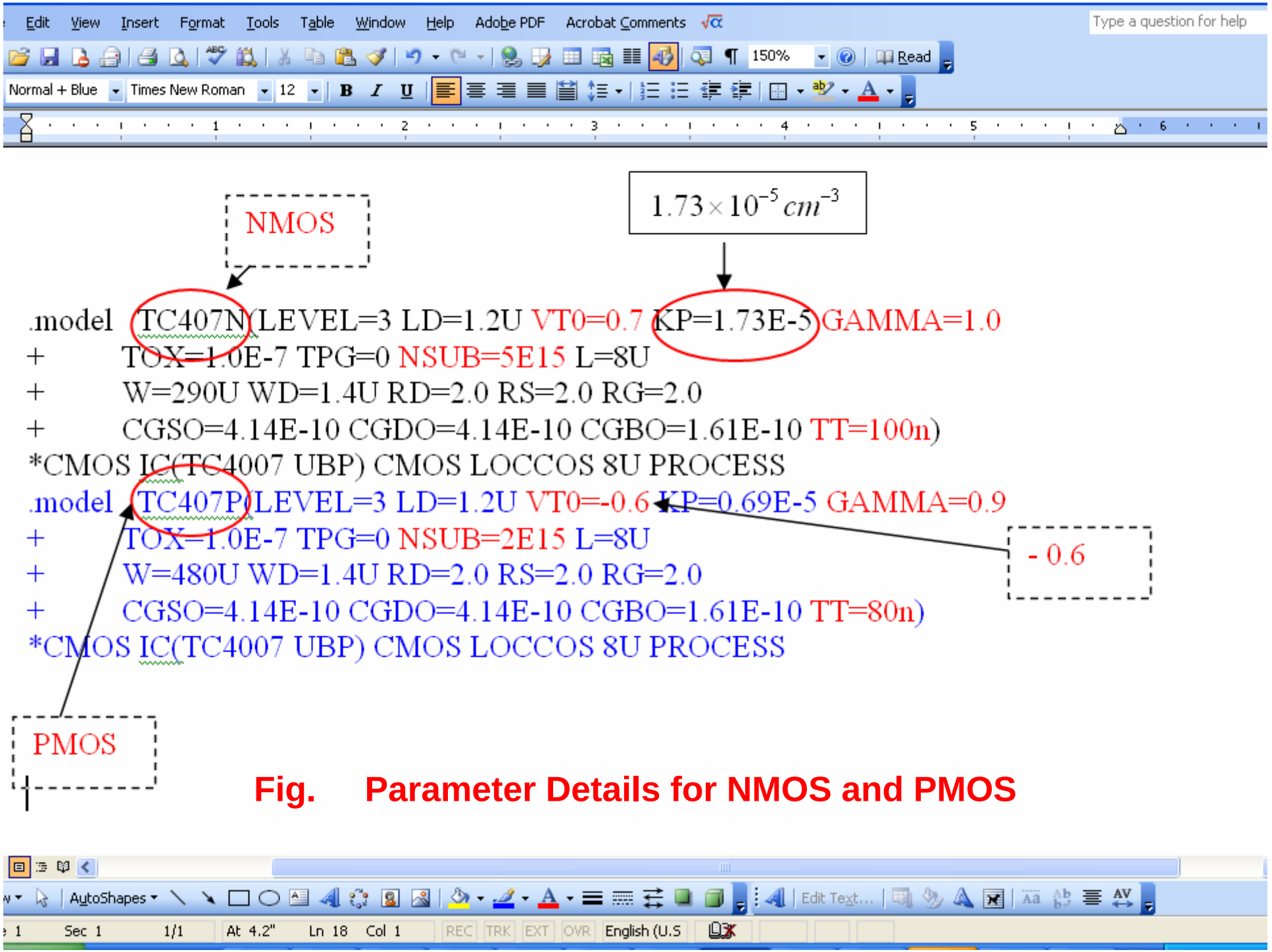


Fig. Parameter Details for NMOS and PMOS

เพิ่ม NMOS และ PMOS ไว้ใน Library ของ PSPICE

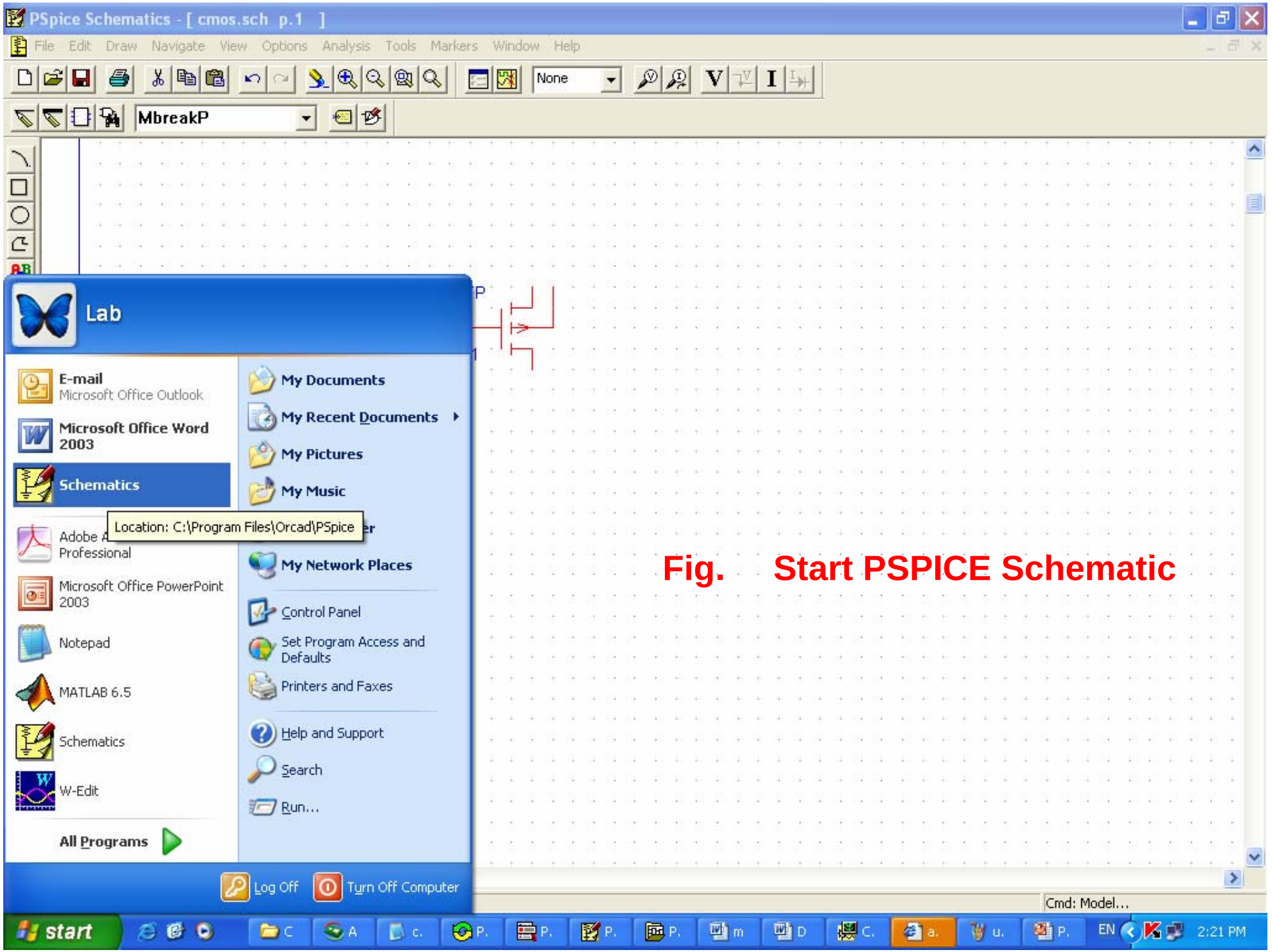


Fig. Start PSPICE Schematic

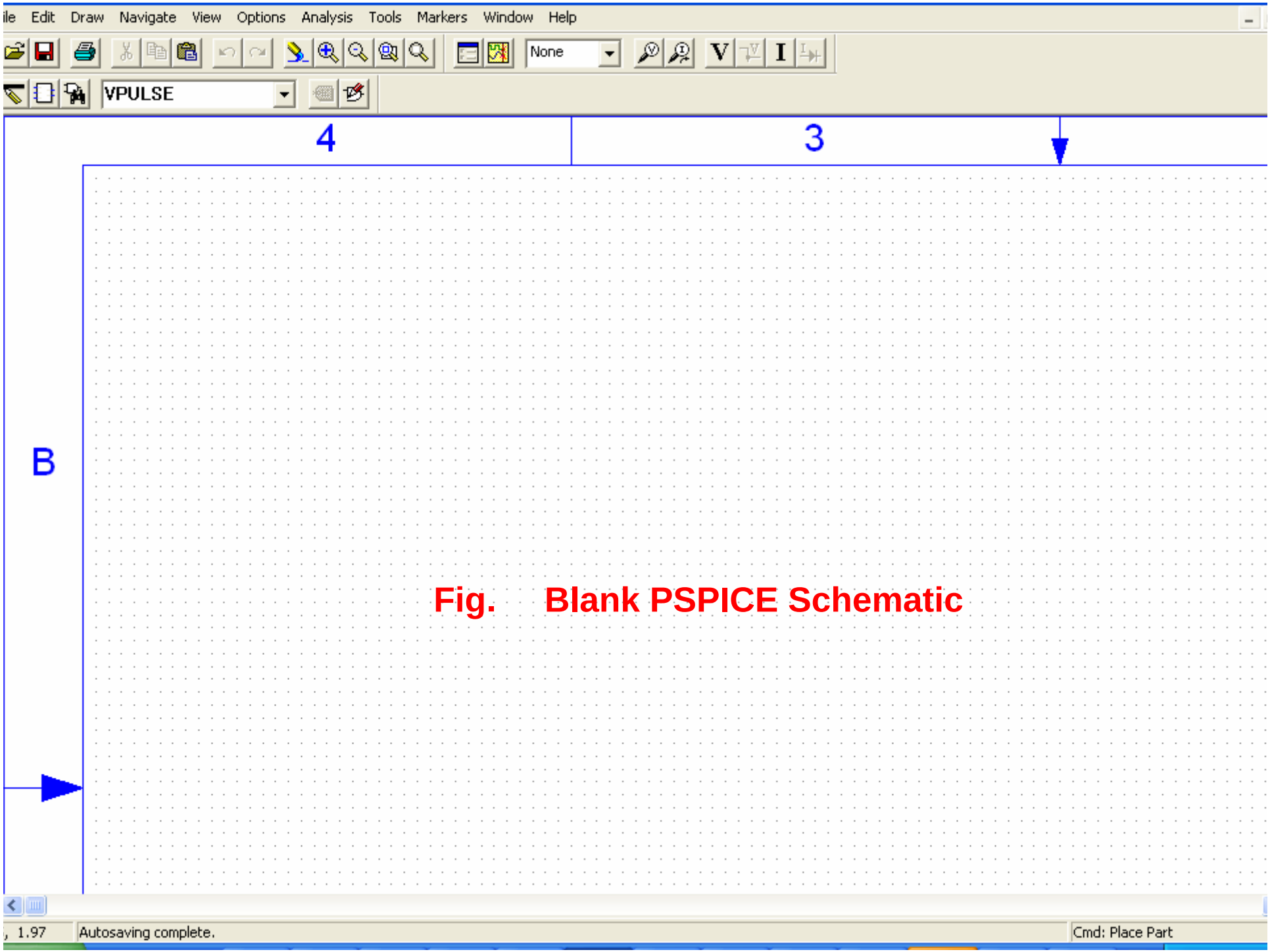


Fig. Blank PSPICE Schematic

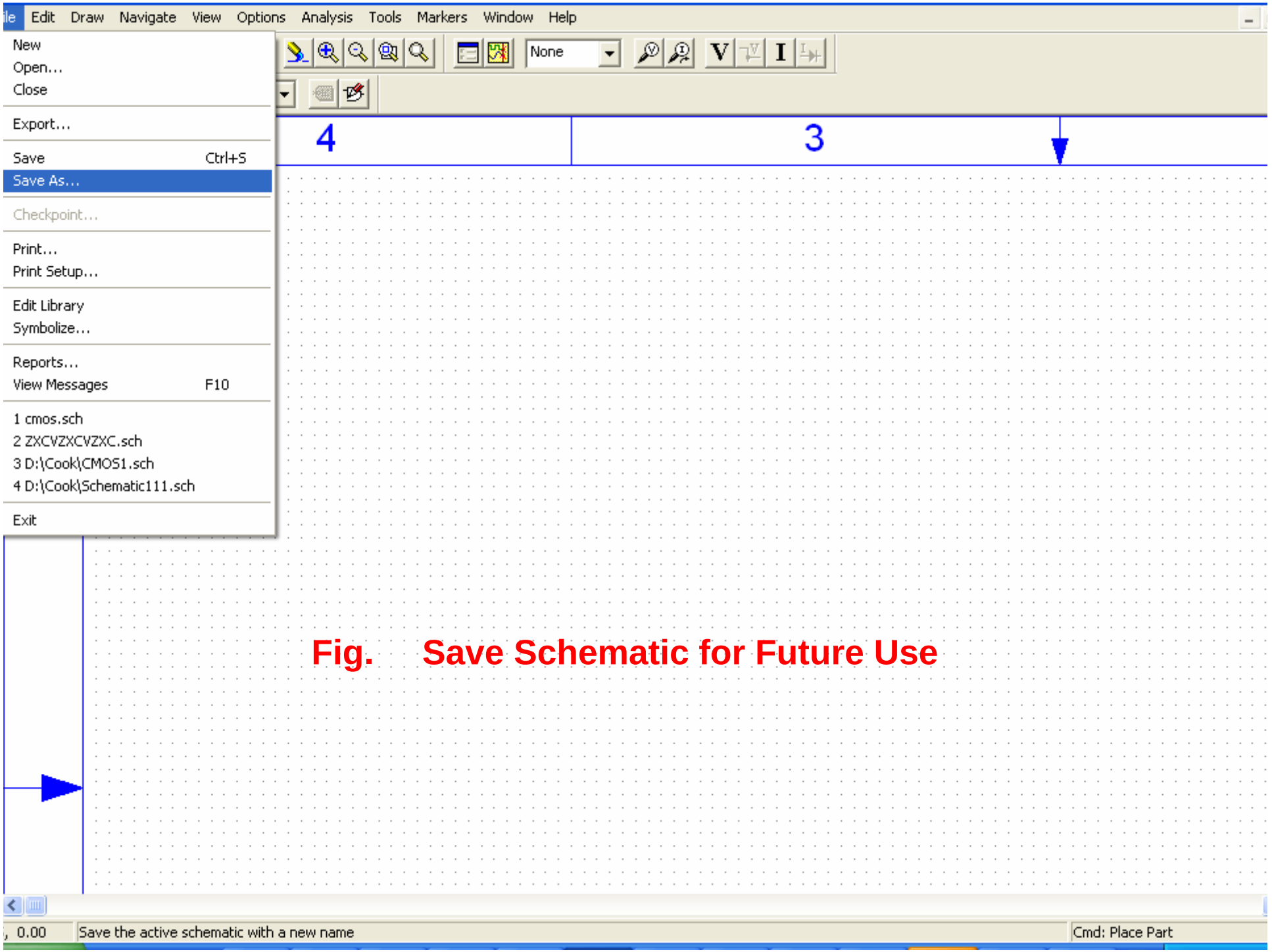


Fig. Save Schematic for Future Use

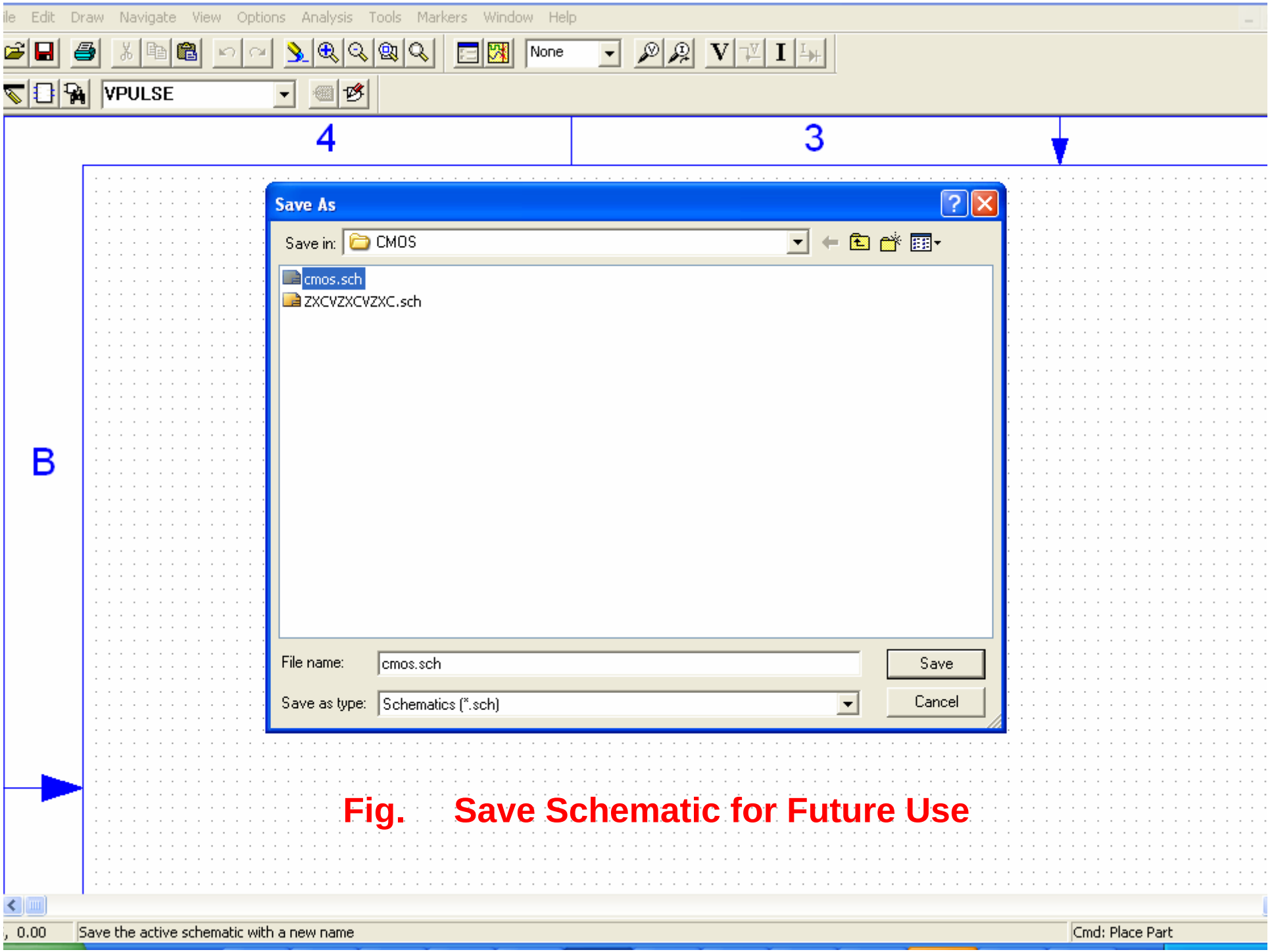


Fig. Save Schematic for Future Use

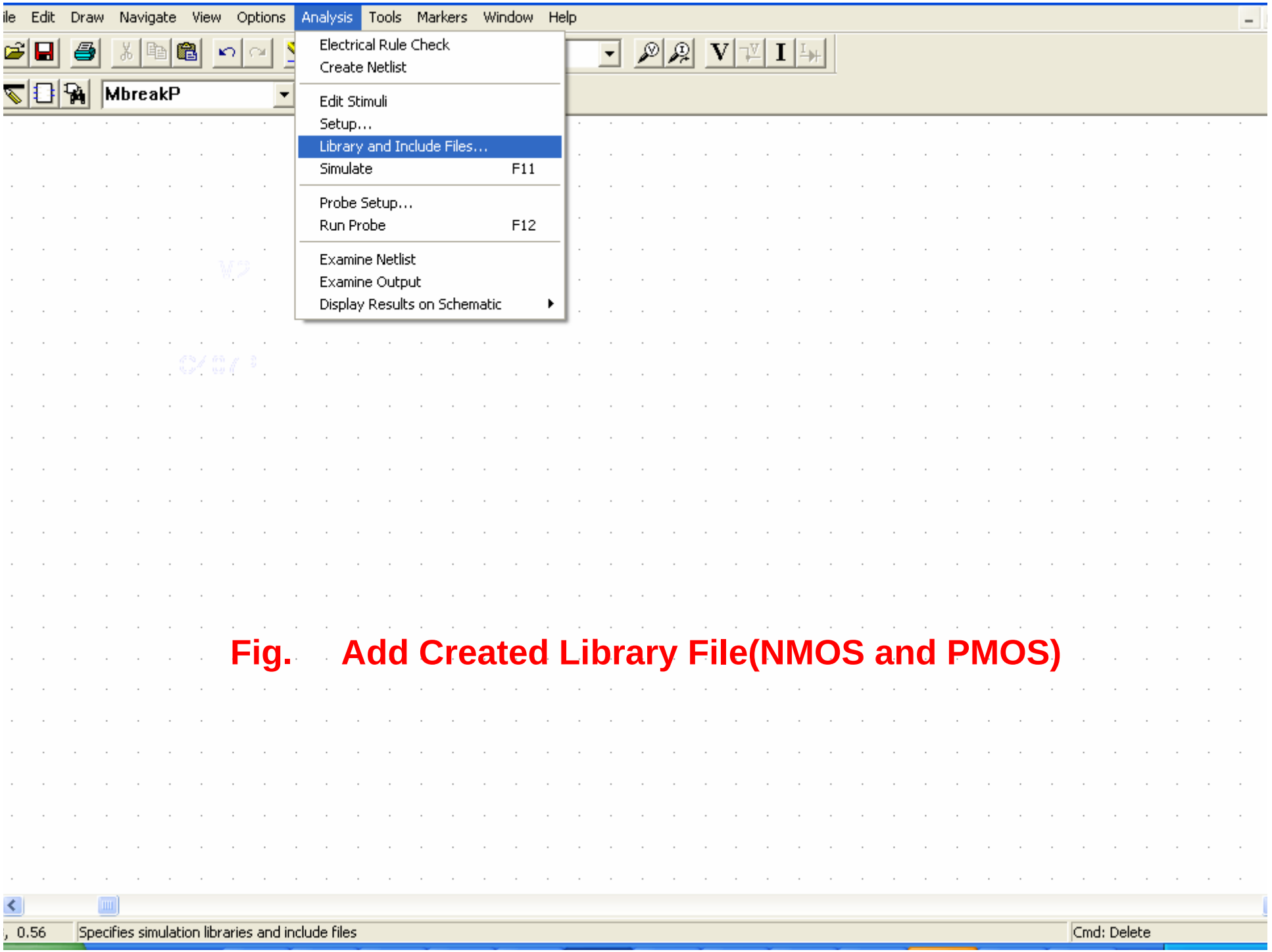


Fig. Add Created Library File(NMOS and PMOS)

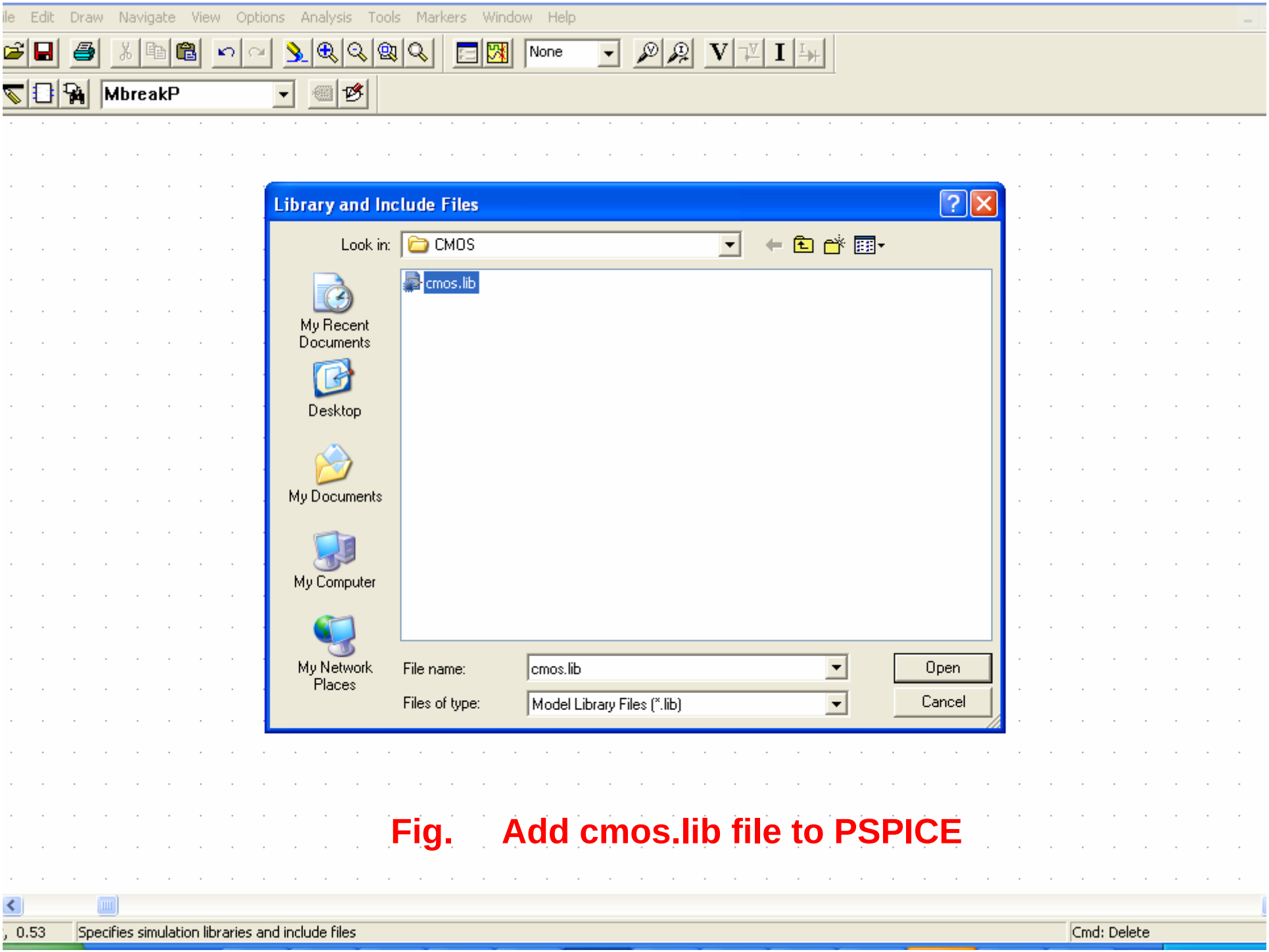


Fig. Add cmos.lib file to PSPICE

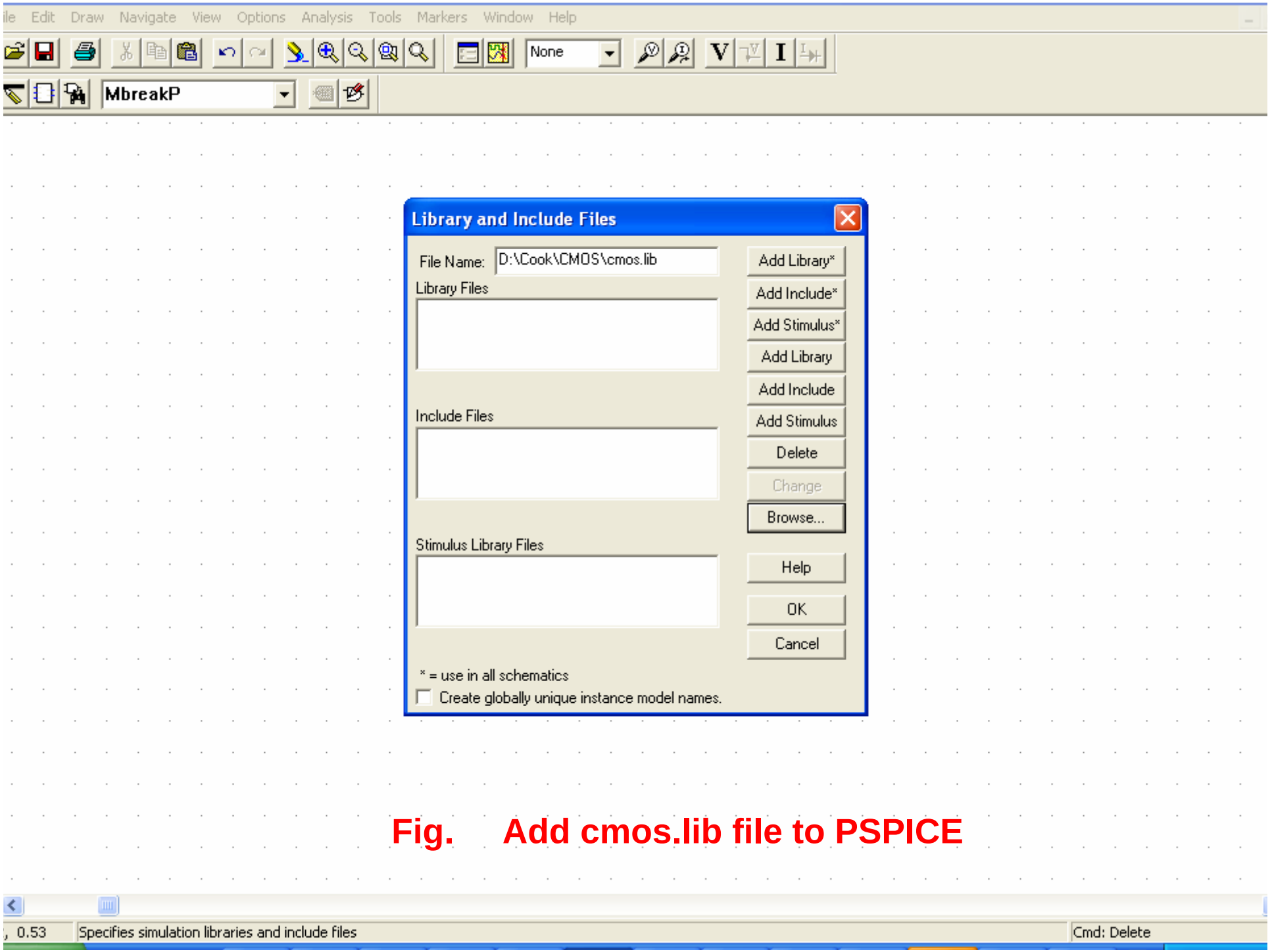


Fig. Add cmos.lib file to PSPICE

วาดรูปวงจร เพื่อสร้าง Op-Amp

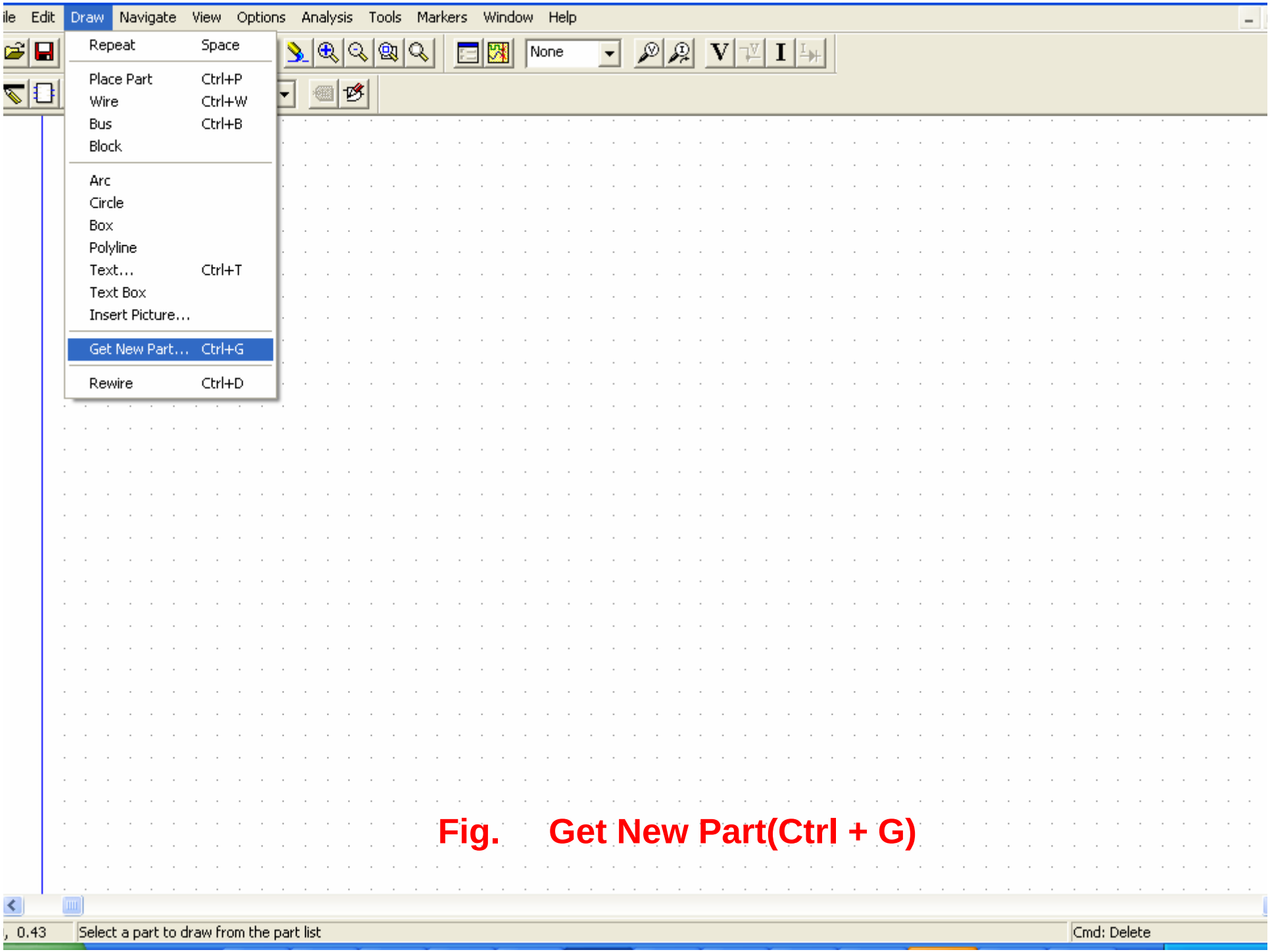


Fig. Get New Part(Ctrl + G)

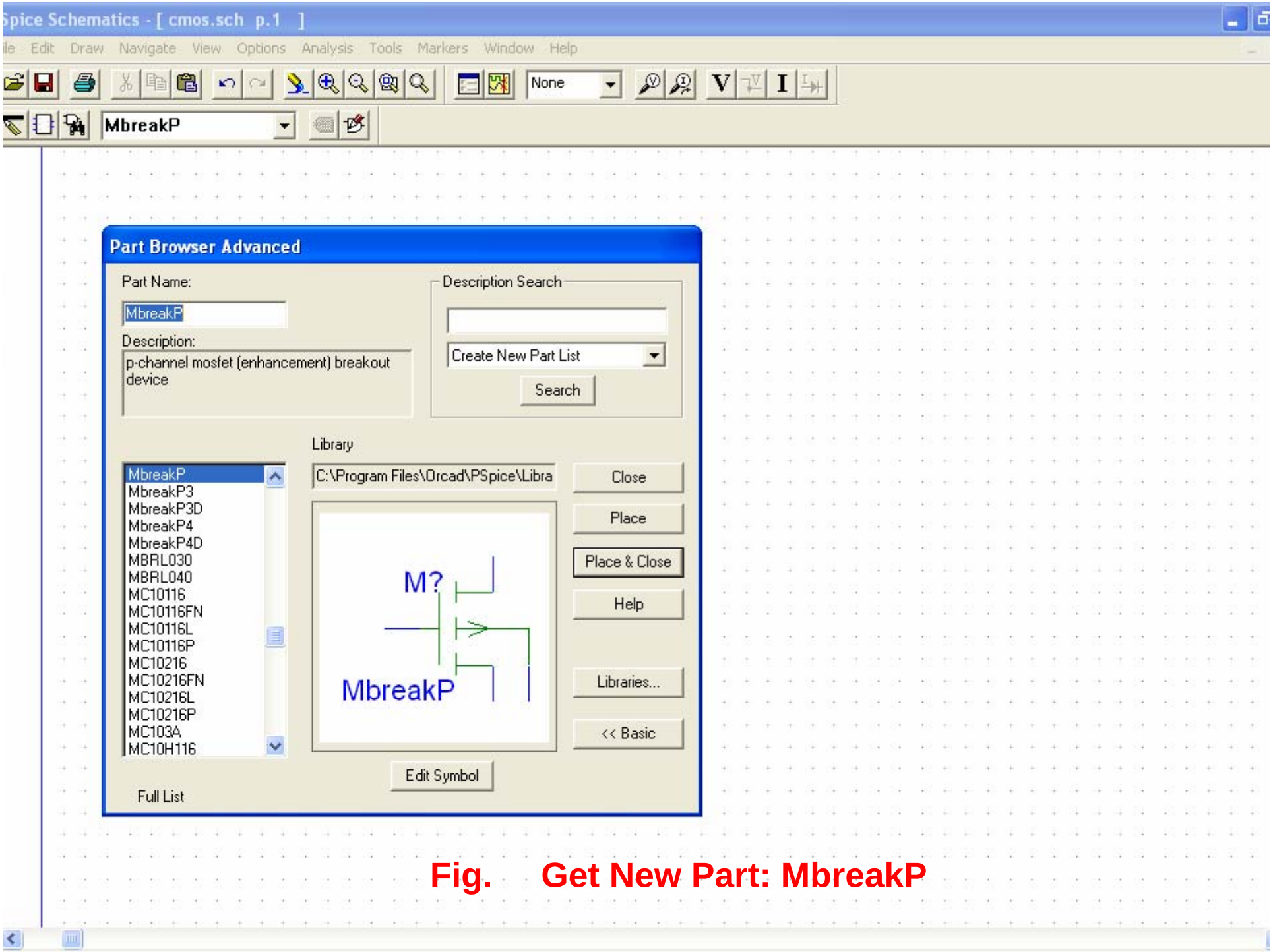


Fig. Get New Part: MbreakP

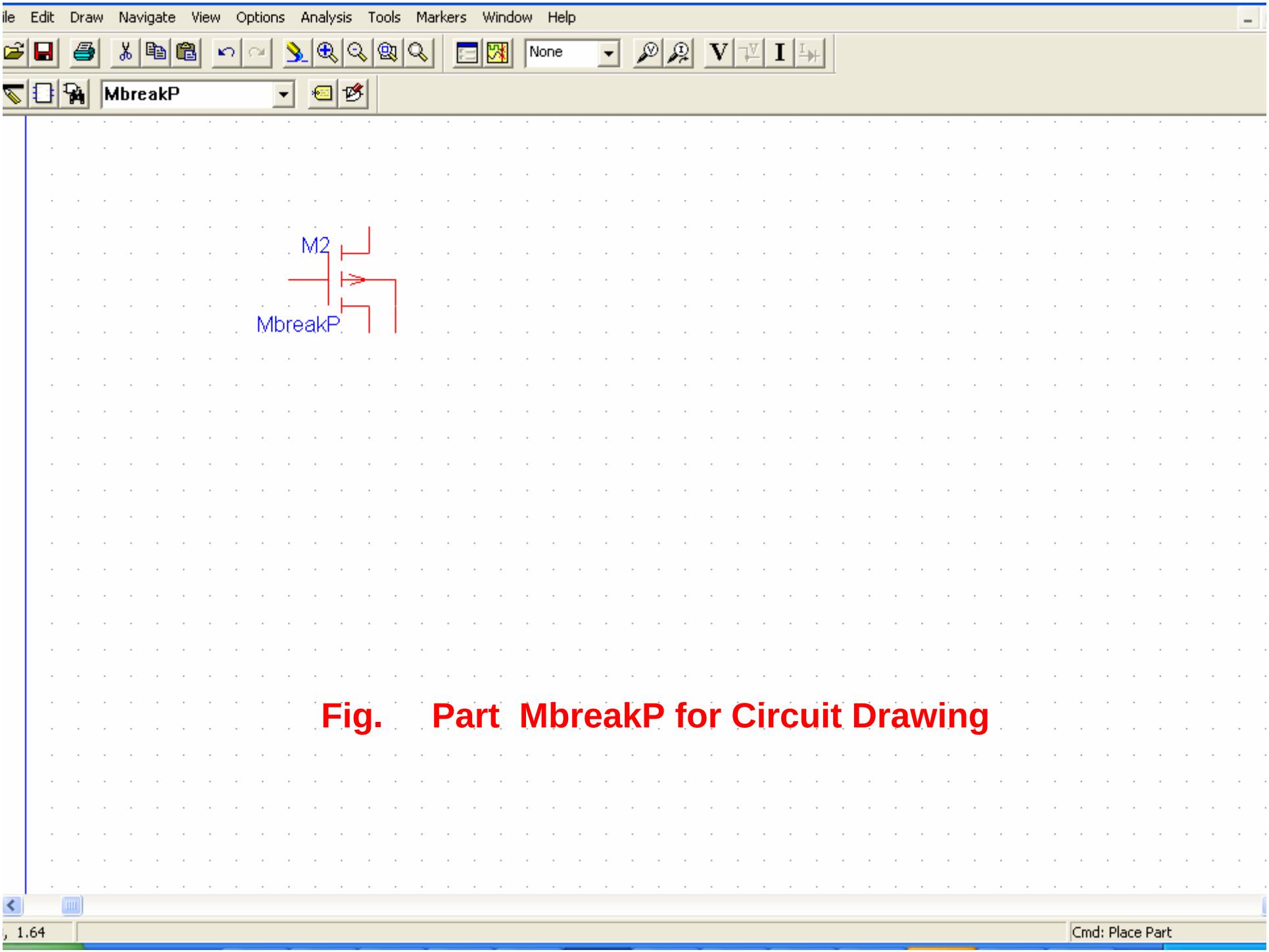


Fig. Part MbreakP for Circuit Drawing

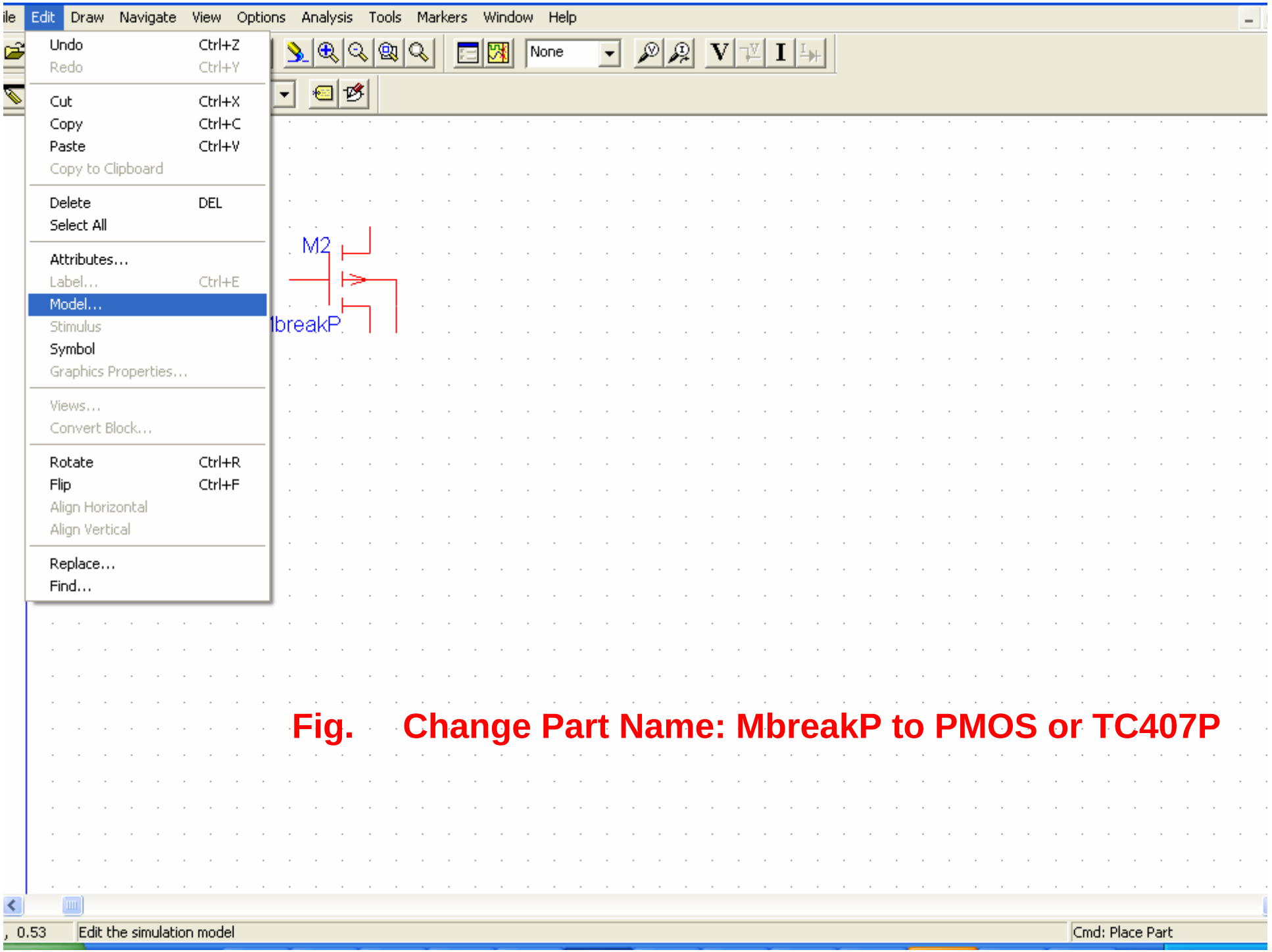


Fig. Change Part Name: MbreakP to PMOS or TC407P

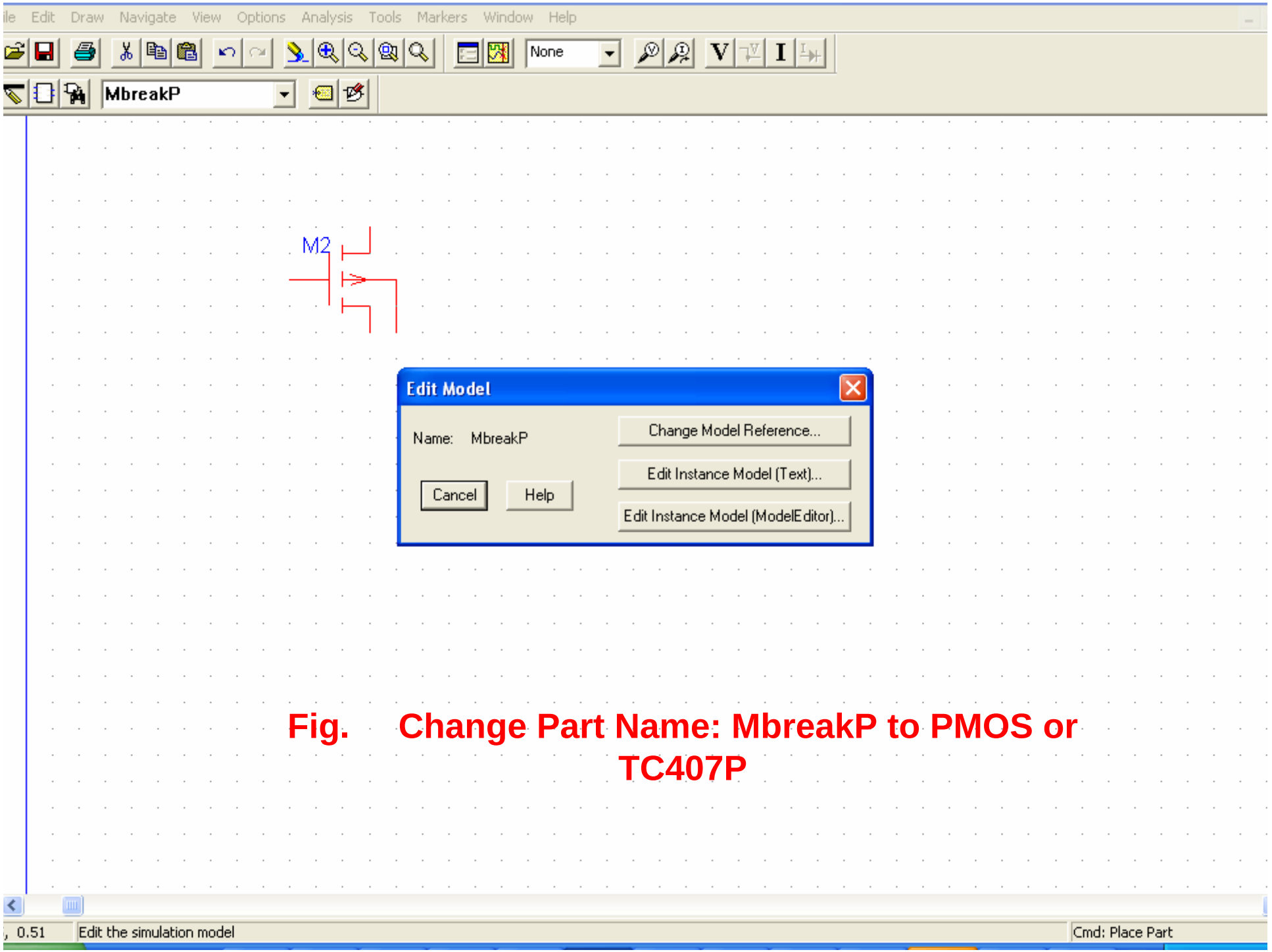


Fig. Change Part Name: MbreakP to PMOS or TC407P

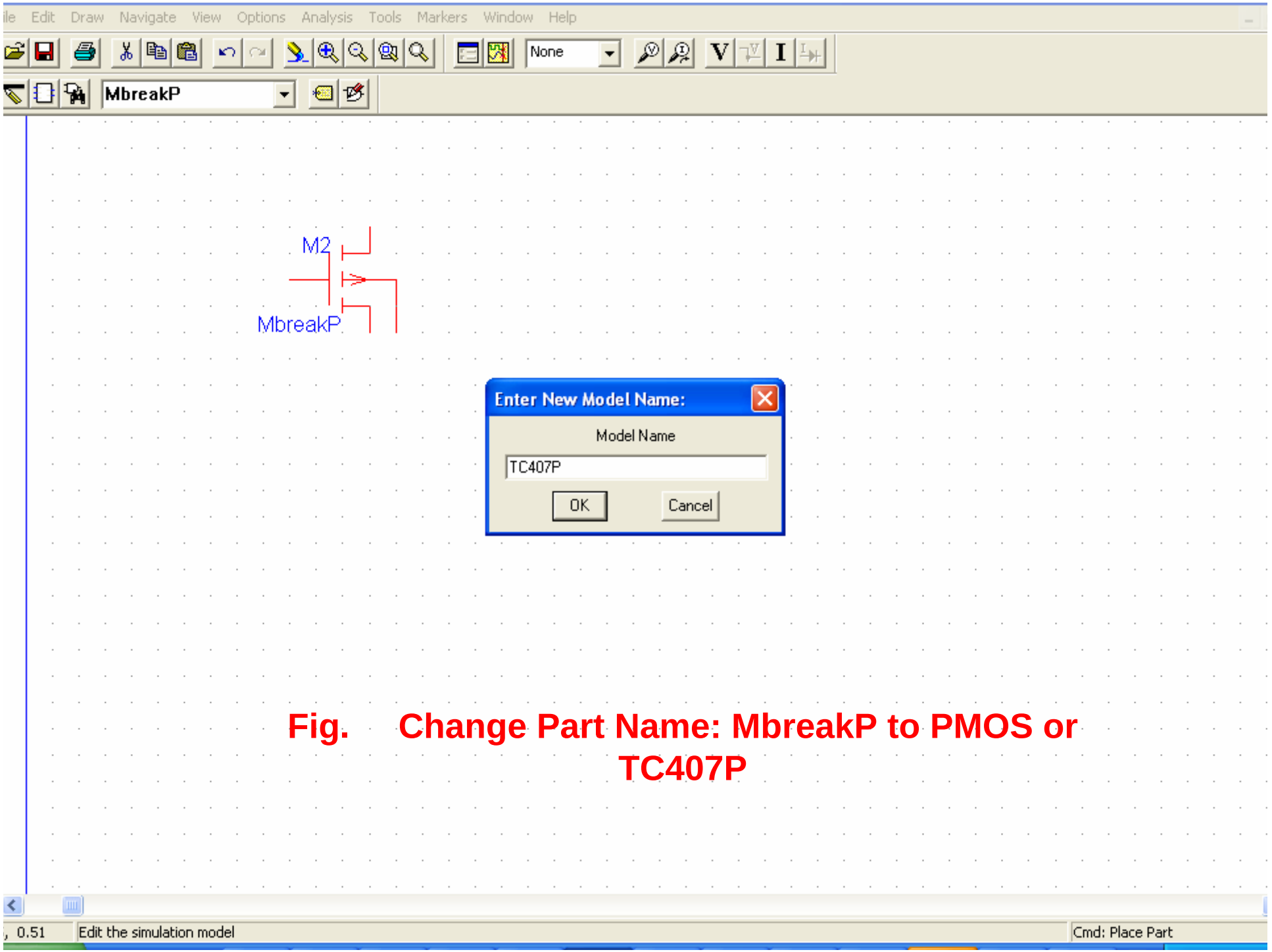


Fig. Change Part Name: MbreakP to PMOS or TC407P

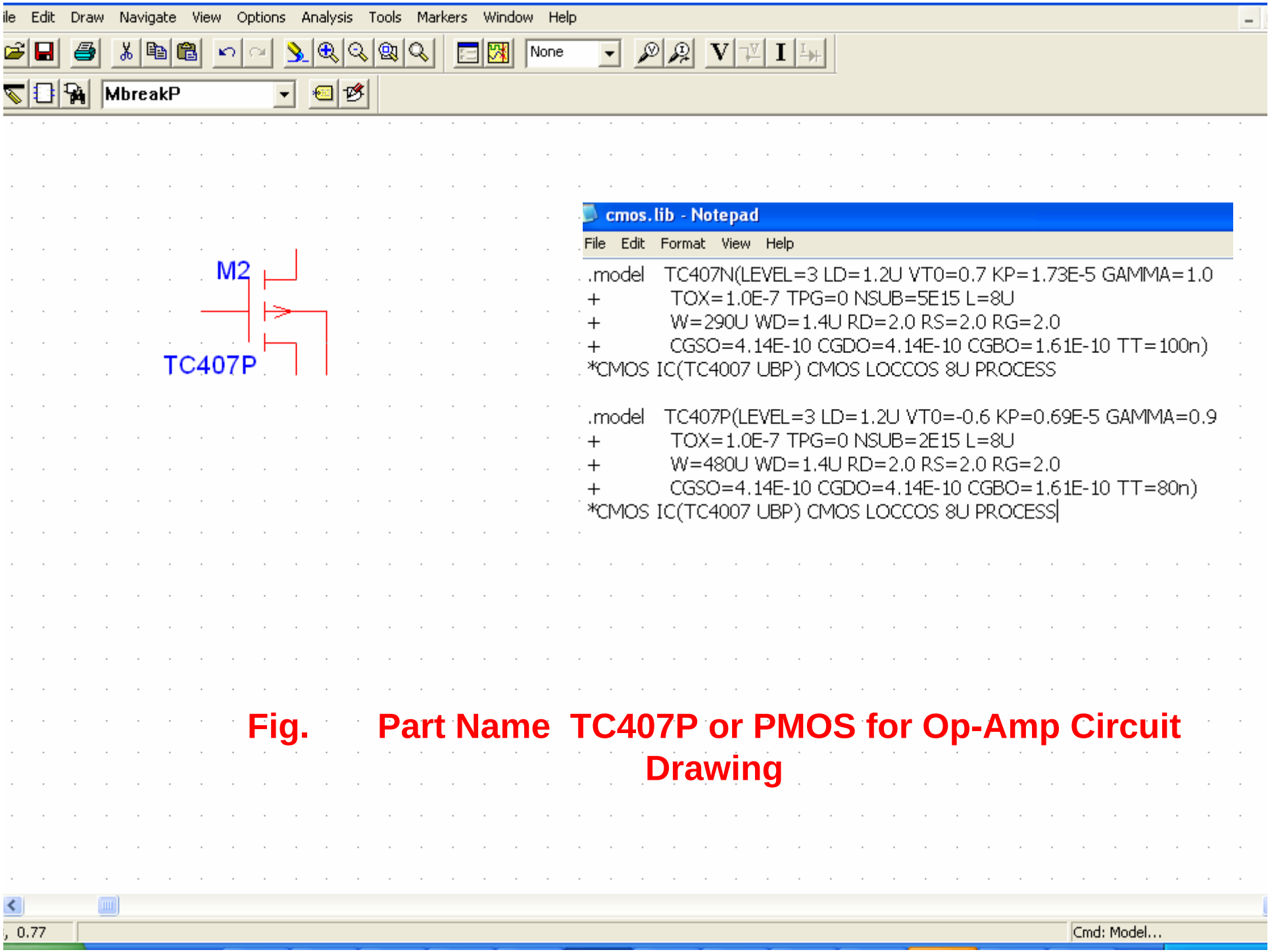


Fig. Part Name TC407P or PMOS for Op-Amp Circuit Drawing

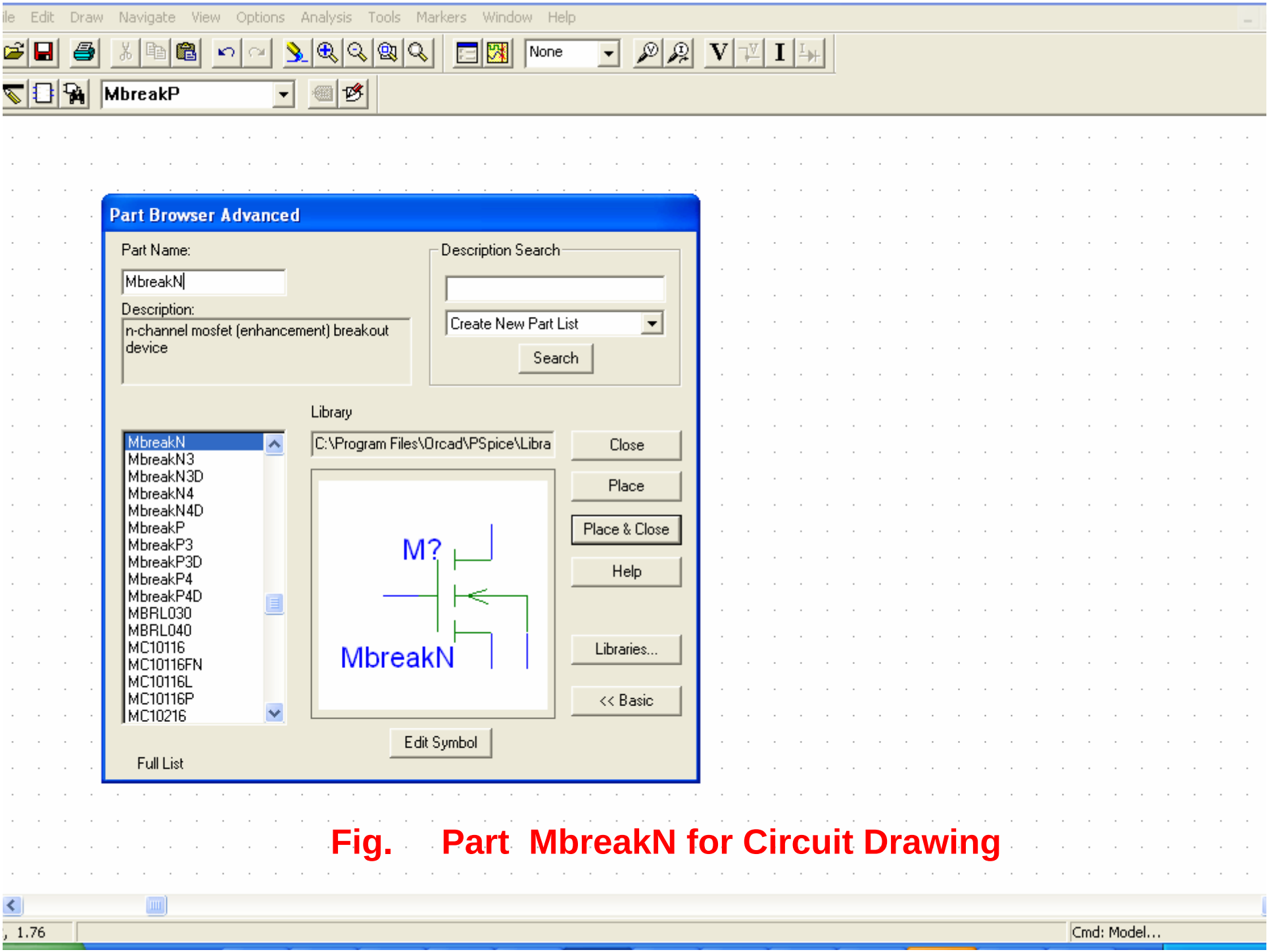


Fig. Part MbreakN for Circuit Drawing

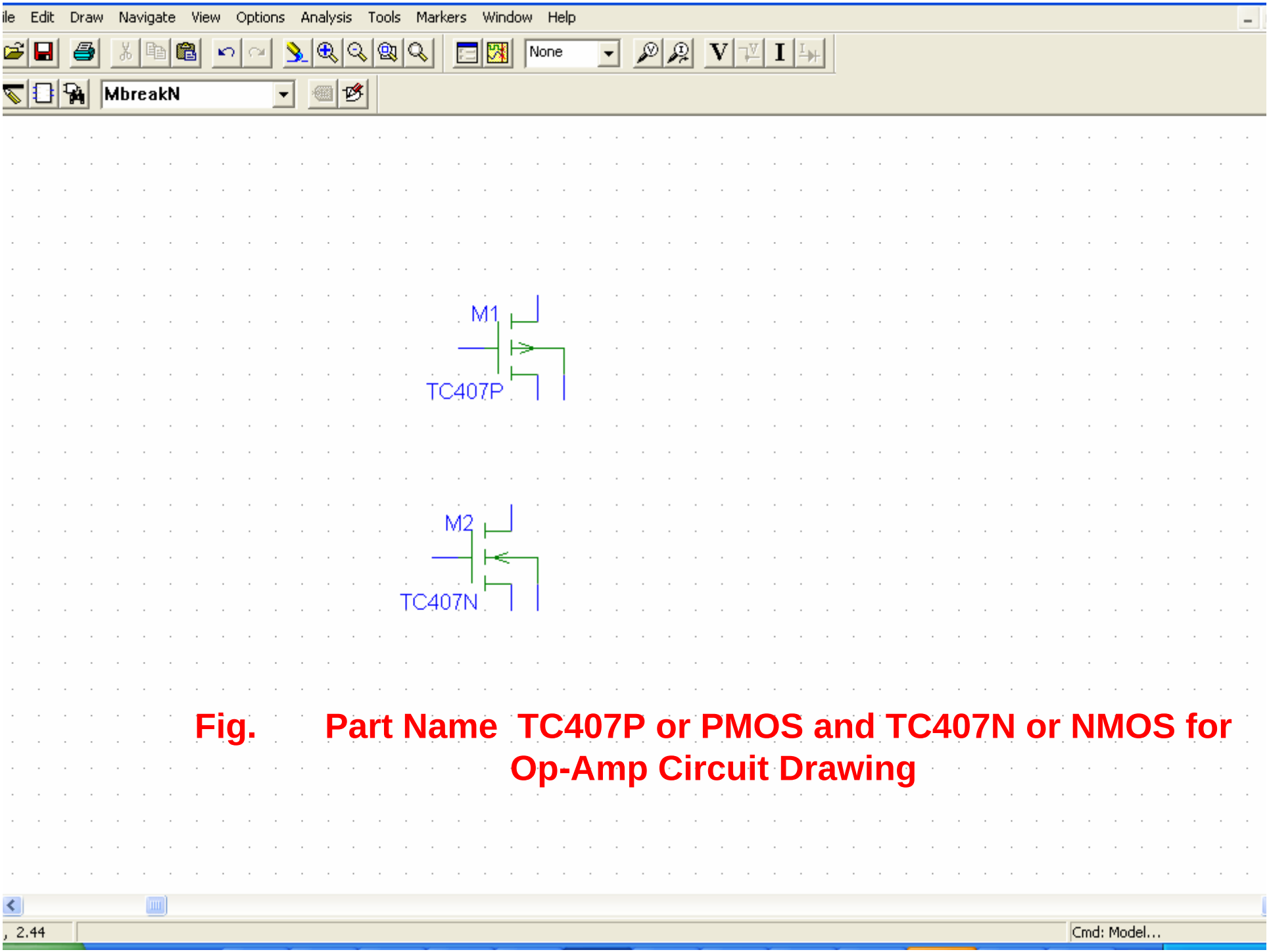


Fig. Part Name TC407P or PMOS and TC407N or NMOS for Op-Amp Circuit Drawing

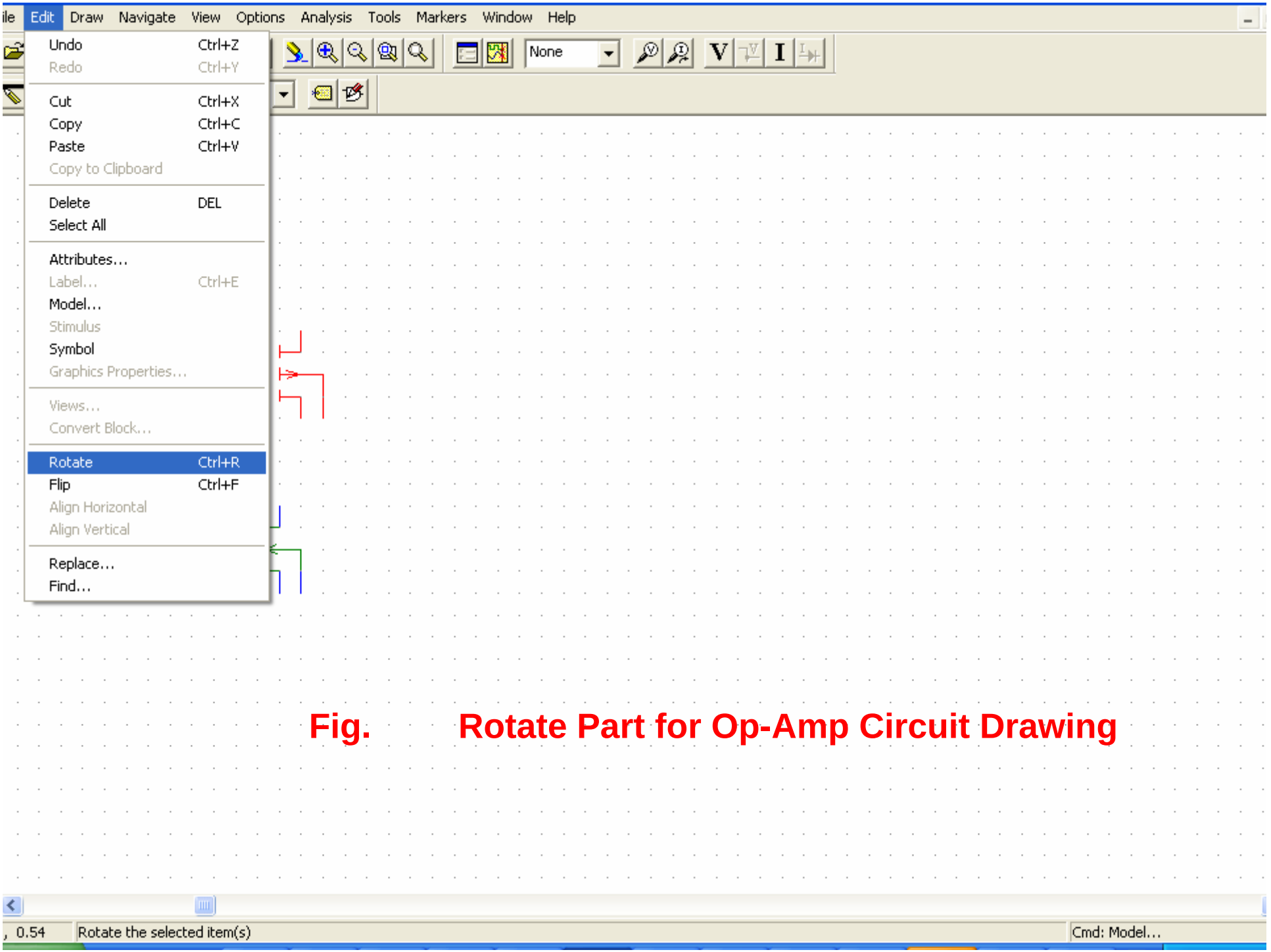


Fig. Rotate Part for Op-Amp Circuit Drawing

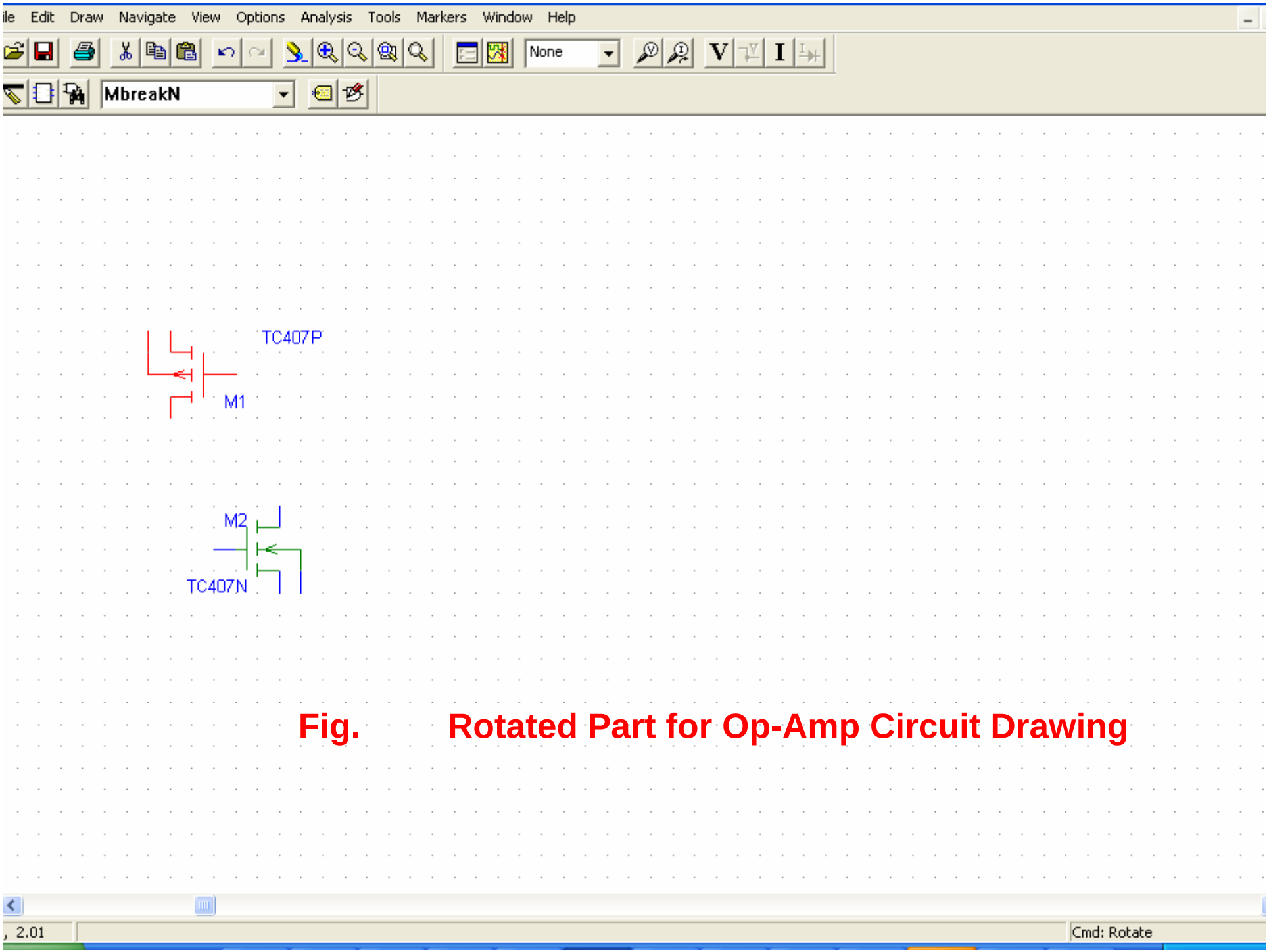


Fig. Rotated Part for Op-Amp Circuit Drawing

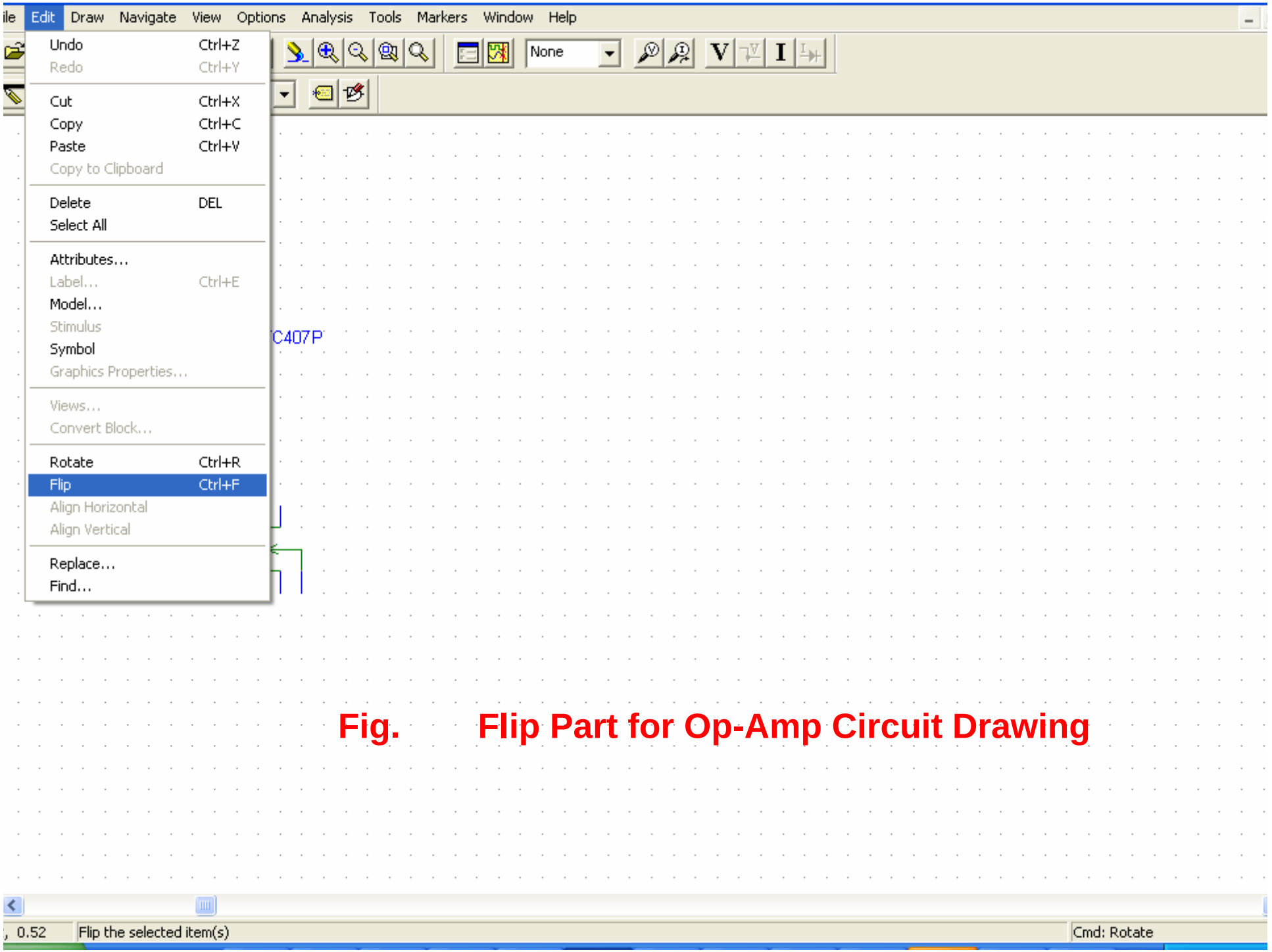


Fig. Flip Part for Op-Amp Circuit Drawing

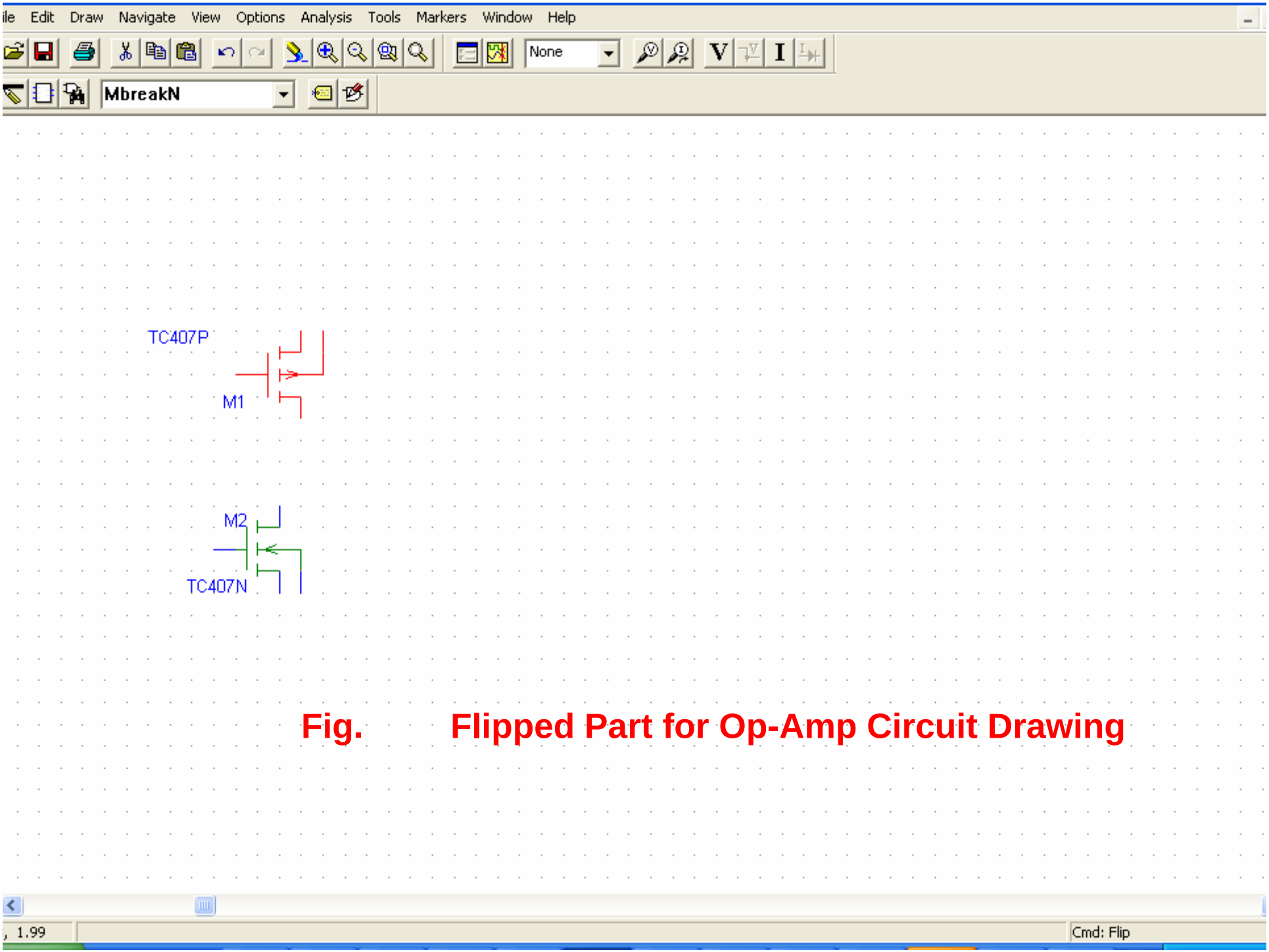


Fig. Flipped Part for Op-Amp Circuit Drawing

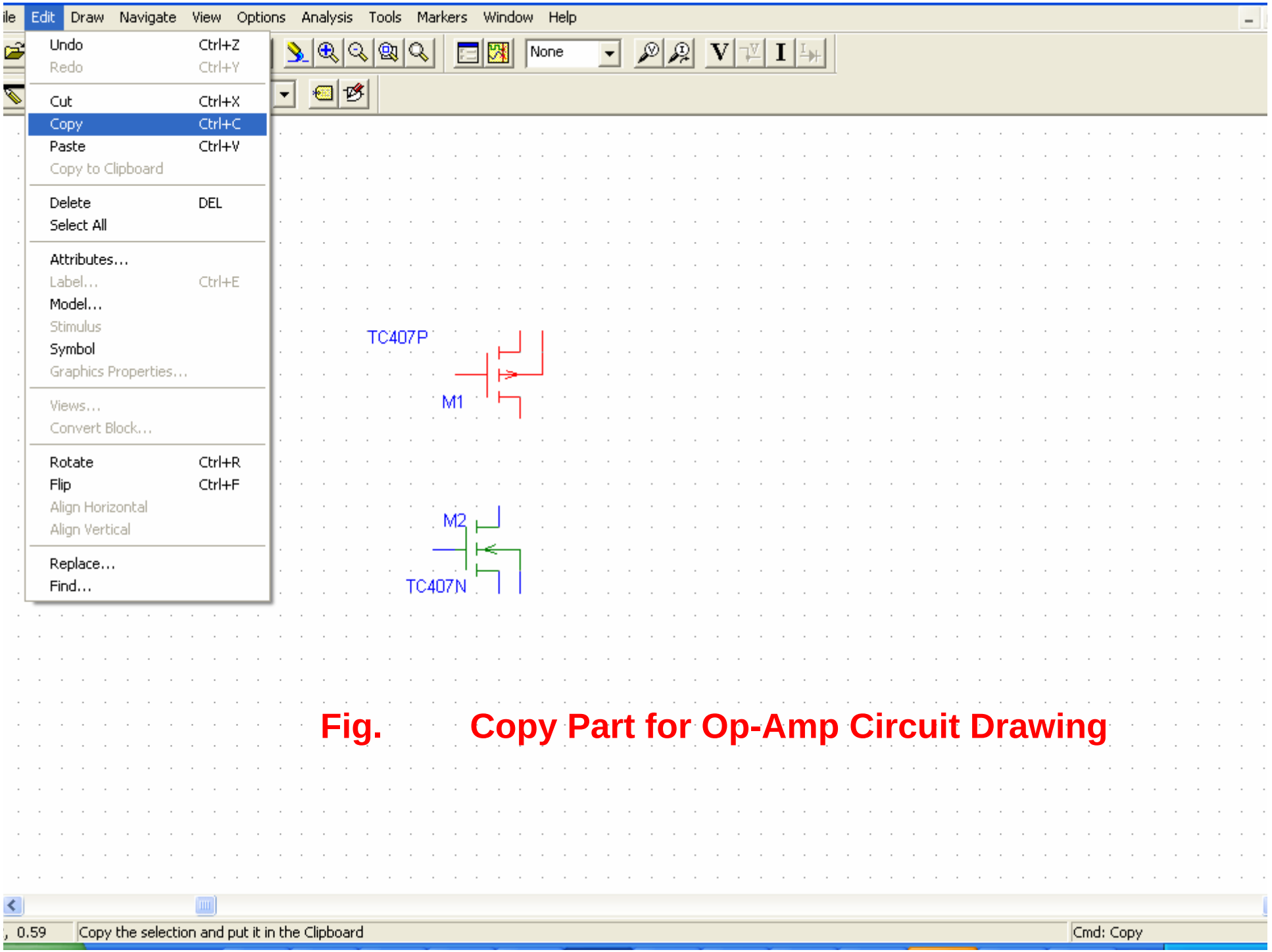


Fig. Copy Part for Op-Amp Circuit Drawing

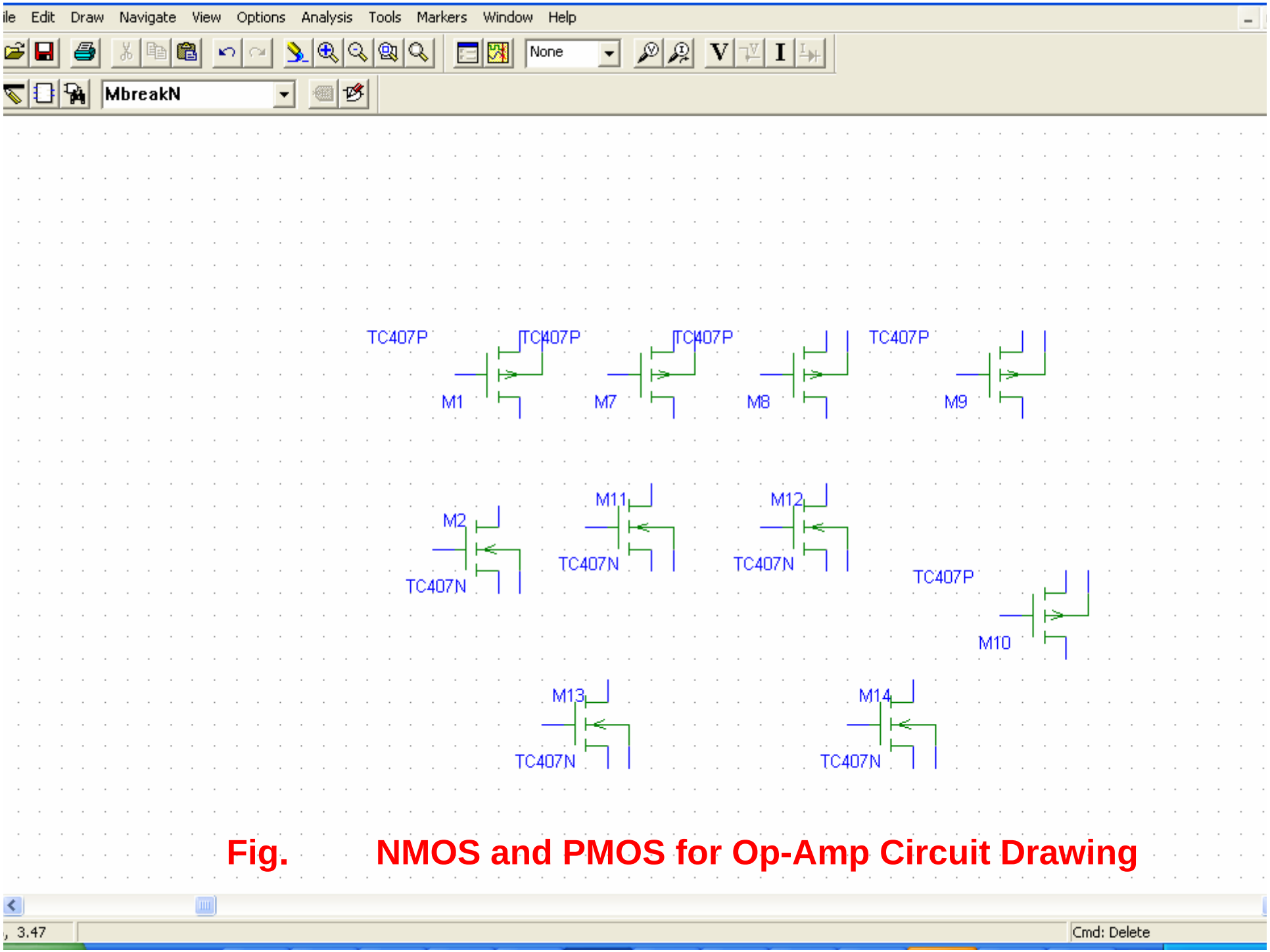


Fig. NMOS and PMOS for Op-Amp Circuit Drawing

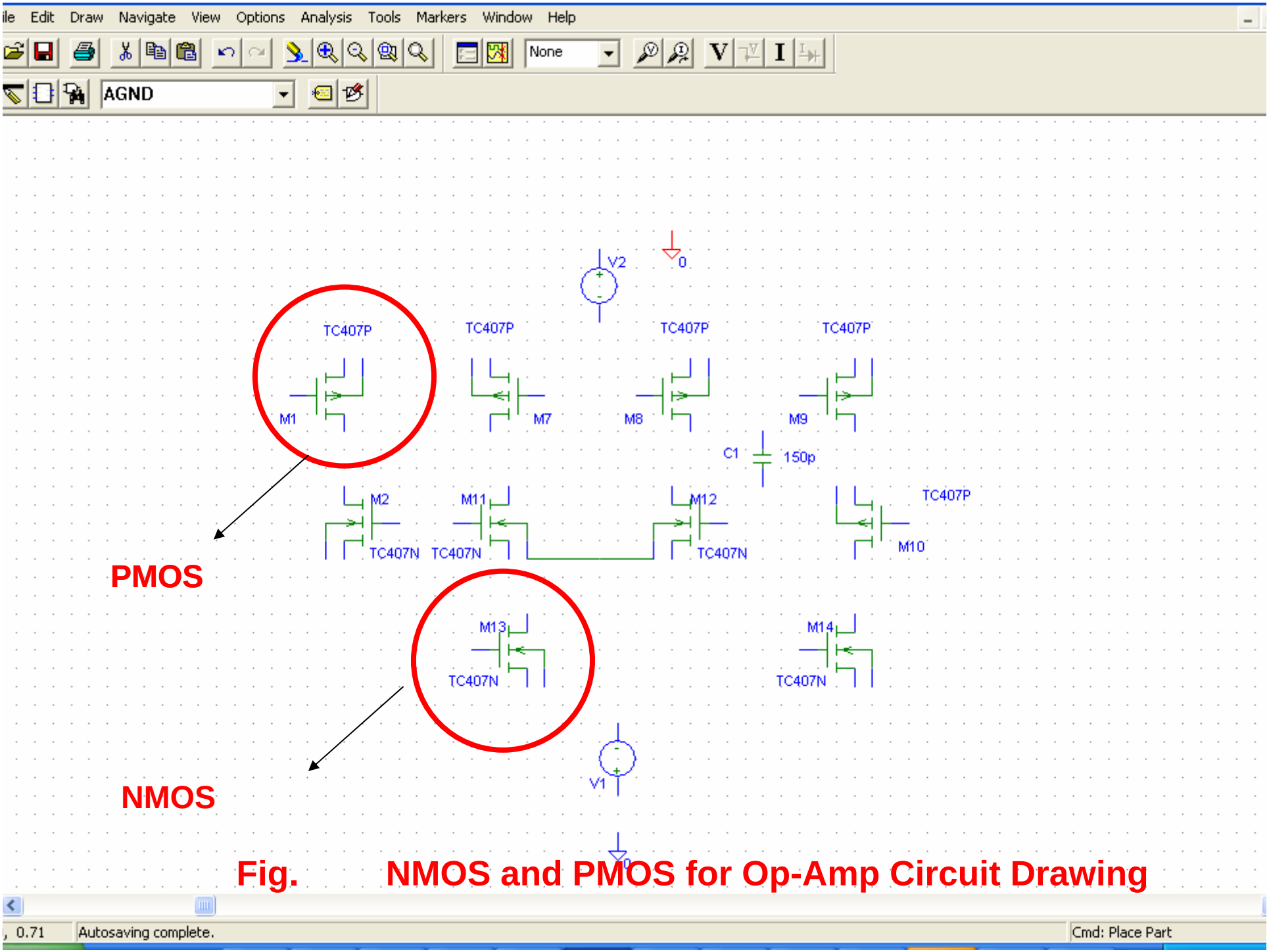


Fig. NMOS and PMOS for Op-Amp Circuit Drawing

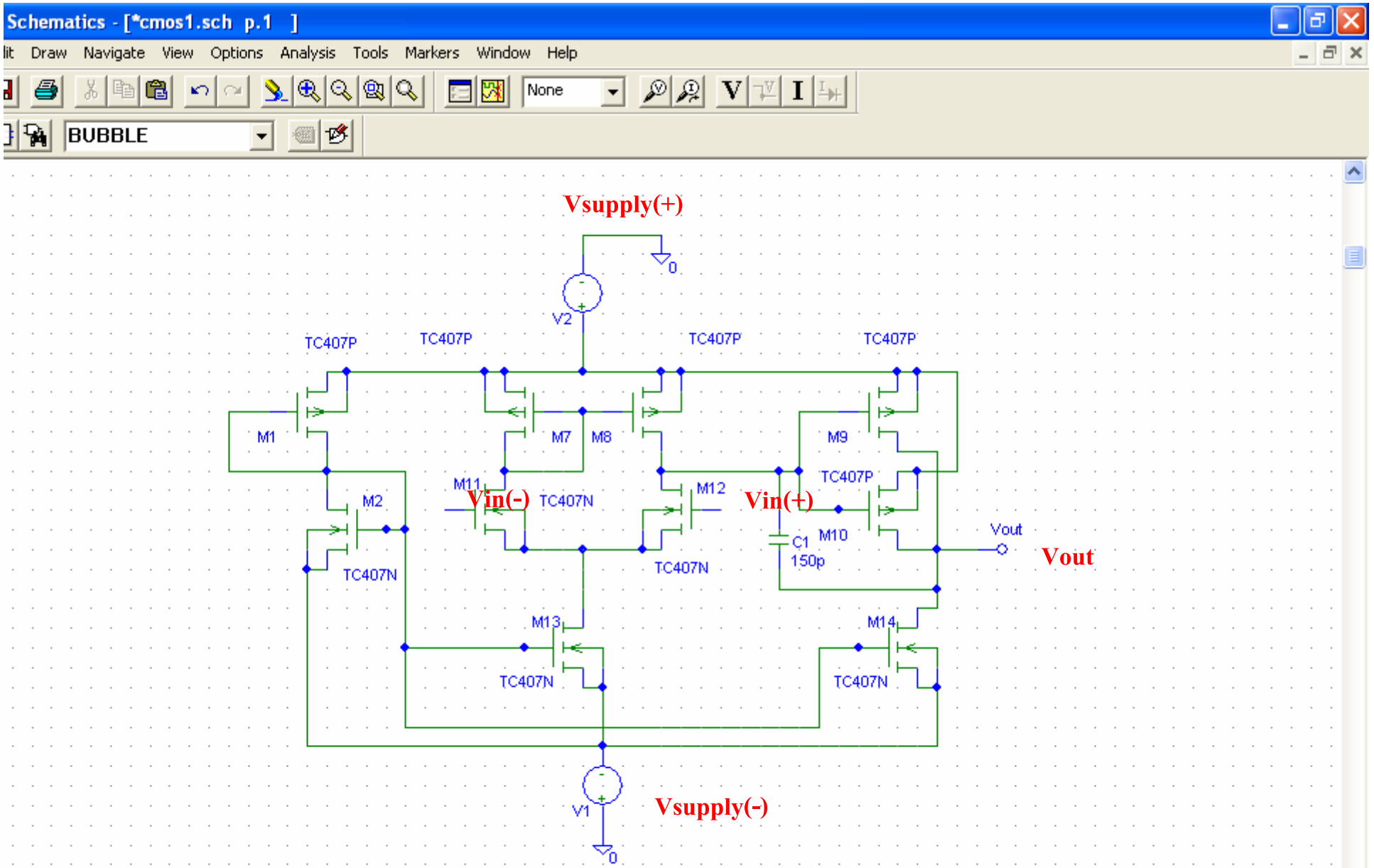


Fig. CMOS- OP-Amp Circuit

วาดรูปวงจร ทดสอบ Op-Amp

Slew Rate

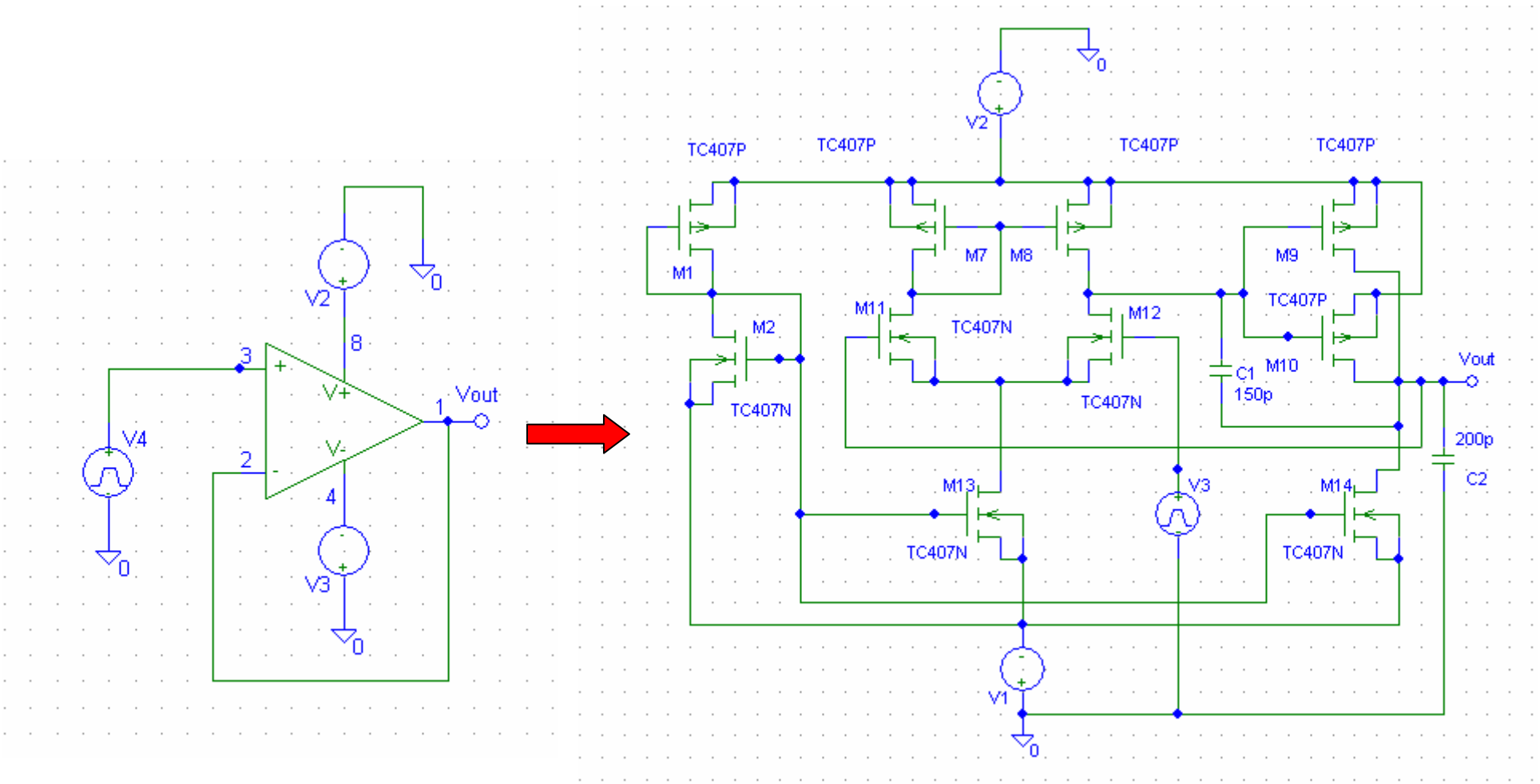


Fig. SLEW RATE TESTING CIRCUIT

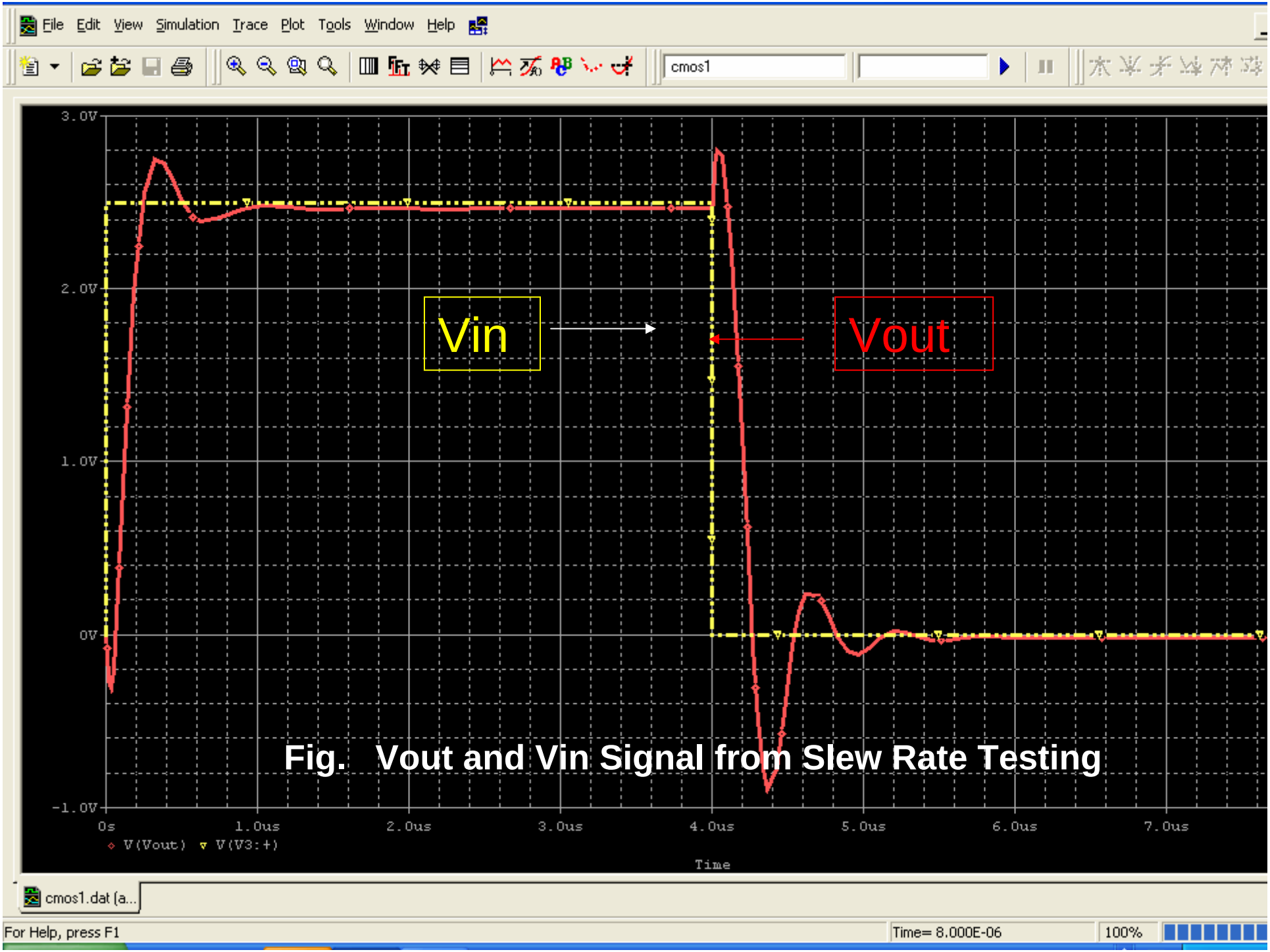


Fig. Vout and Vin Signal from Slew Rate Testing

การทดลองที่ 1: Slew Rate ของ Op Amp

ช่วง	ค่า
Slew Rate ขาขึ้น	$\frac{\Delta V}{\Delta t} = \frac{2.5}{\Delta t} = \ldots\ldots\ldots\ldots Volt/\mu\text{sec}$
Slew Rate ขาลง	$\frac{\Delta V}{\Delta t} = \frac{2.5}{\Delta t} = \ldots\ldots\ldots\ldots Volt/\mu\text{sec}$
Settling Time	$\ldots\ldots\ldots\ldots\ldots\mu\text{sec}$

Fig. Record for Results

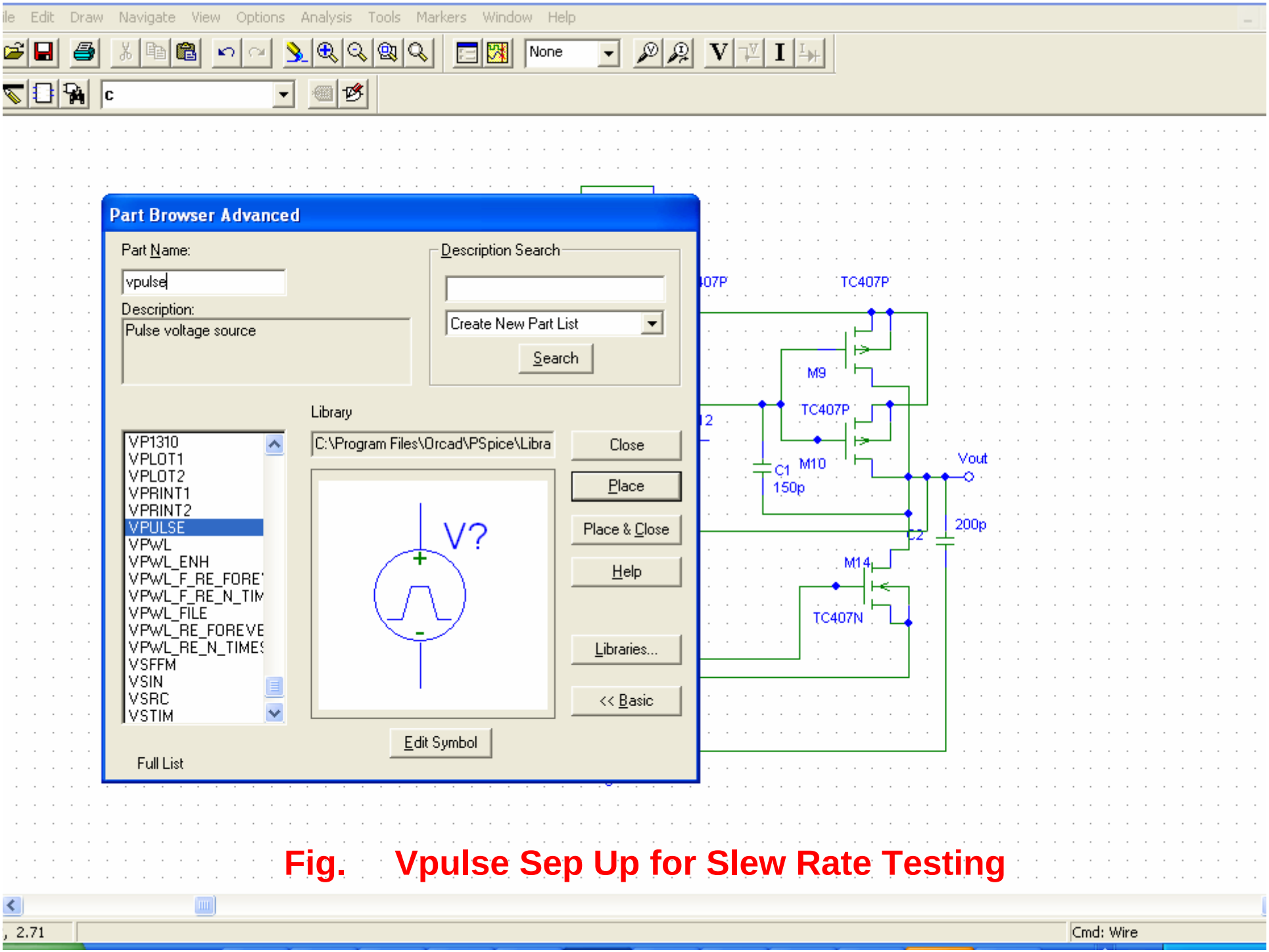


Fig. Vpulse Sep Up for Slew Rate Testing

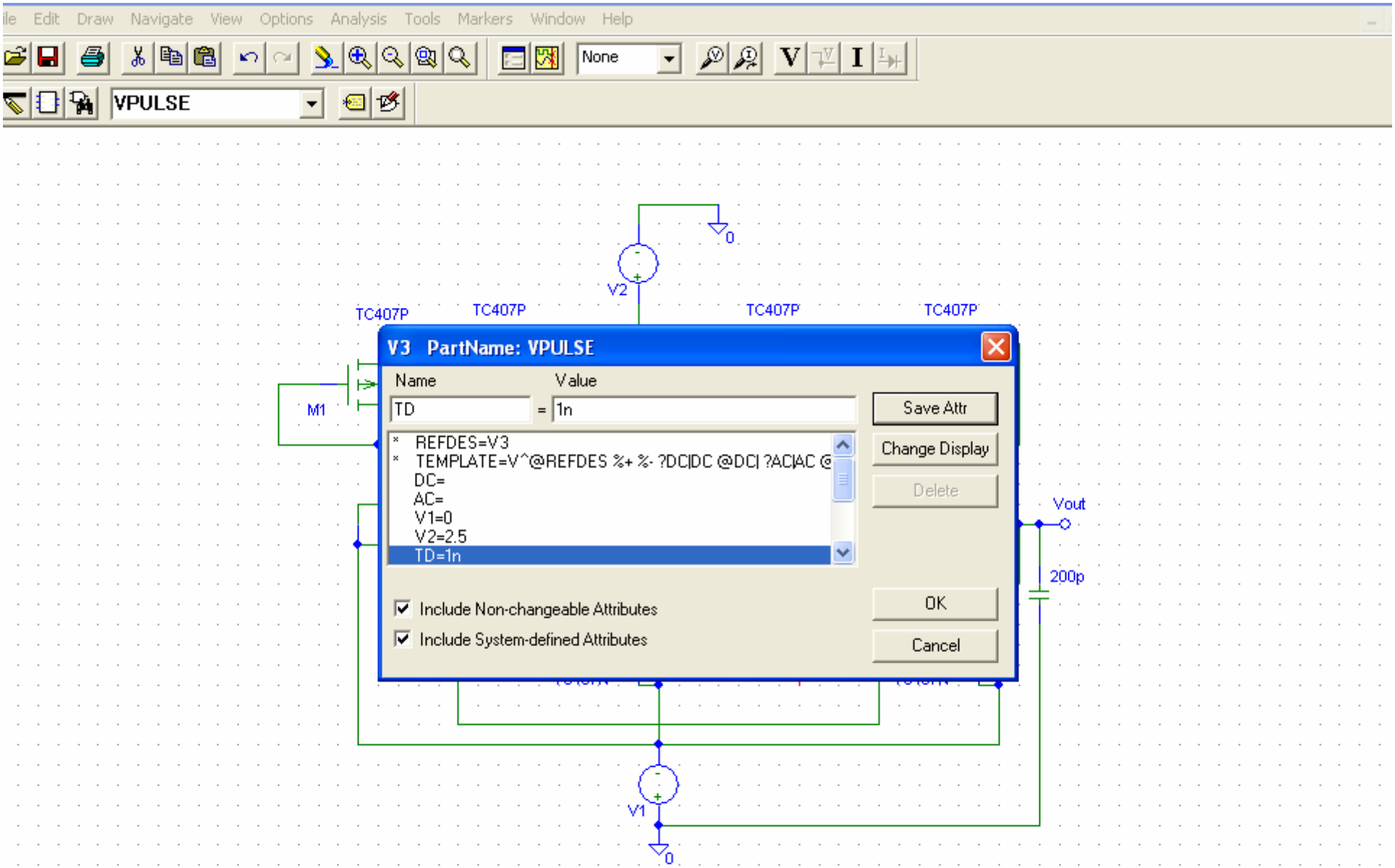


Fig. Vpulse Sep Up for Slew Rate Testing

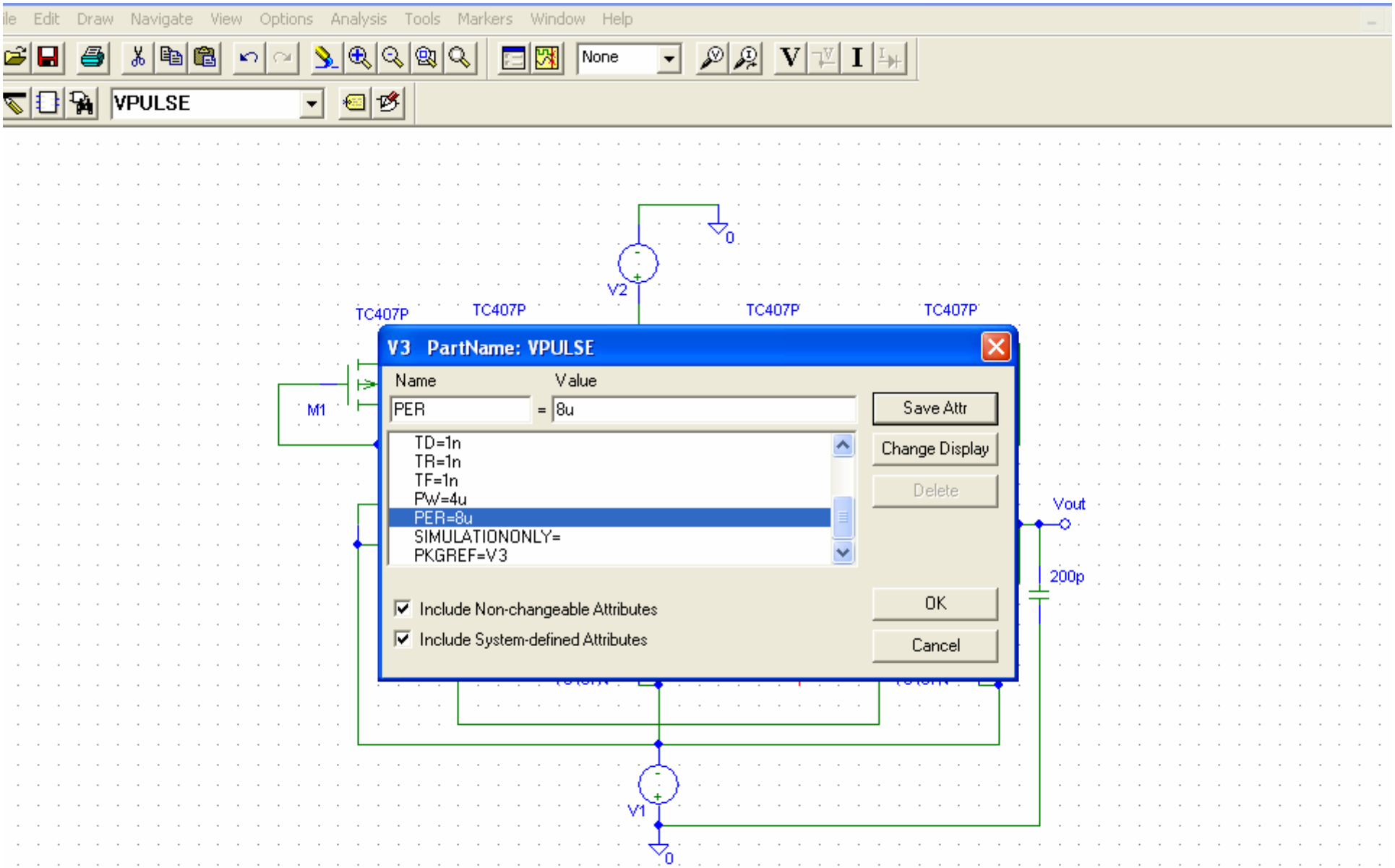


Fig. Vpulse Sep Up for Slew Rate Testing

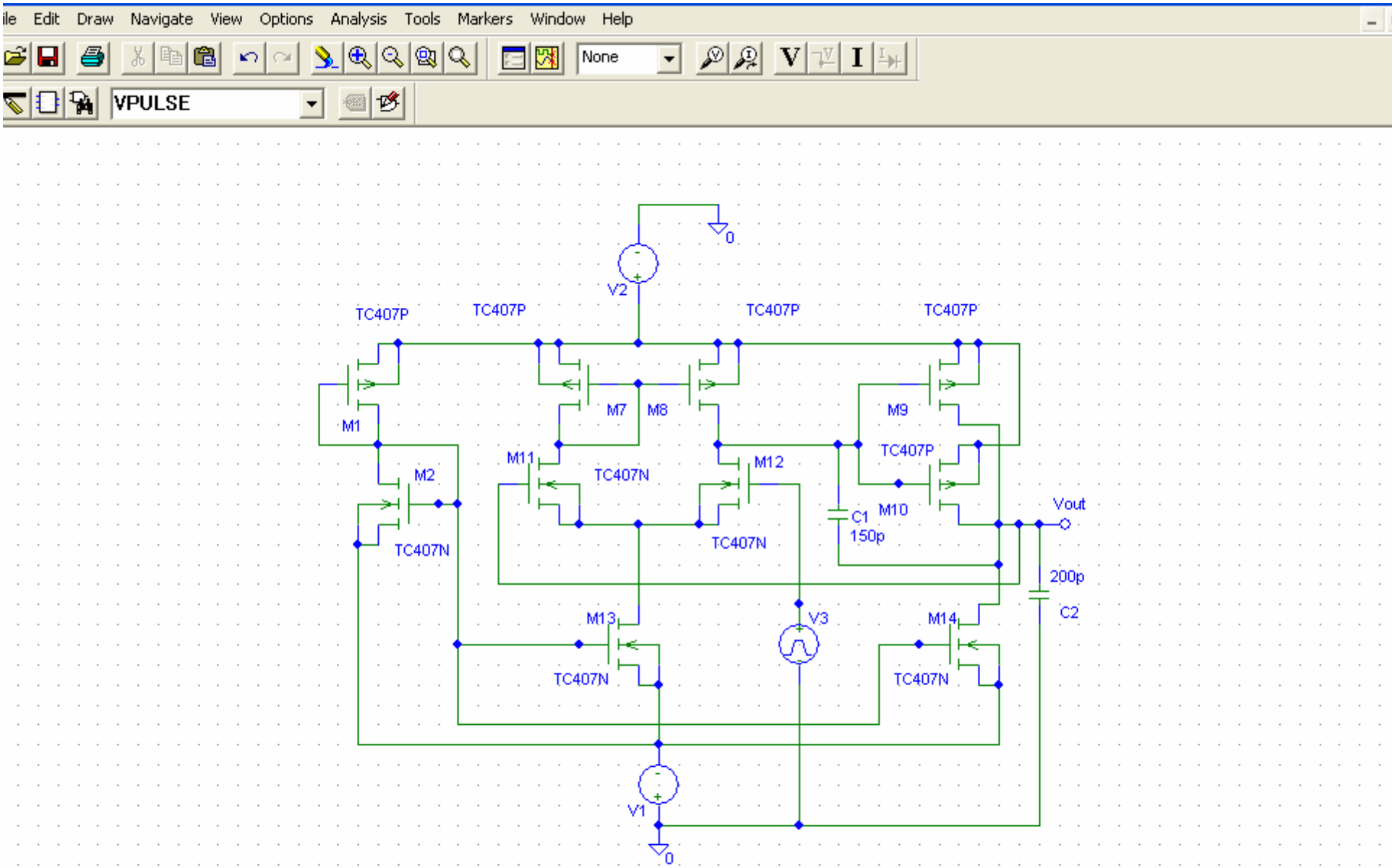


Fig. Slew Rate Testing Complete Circuit

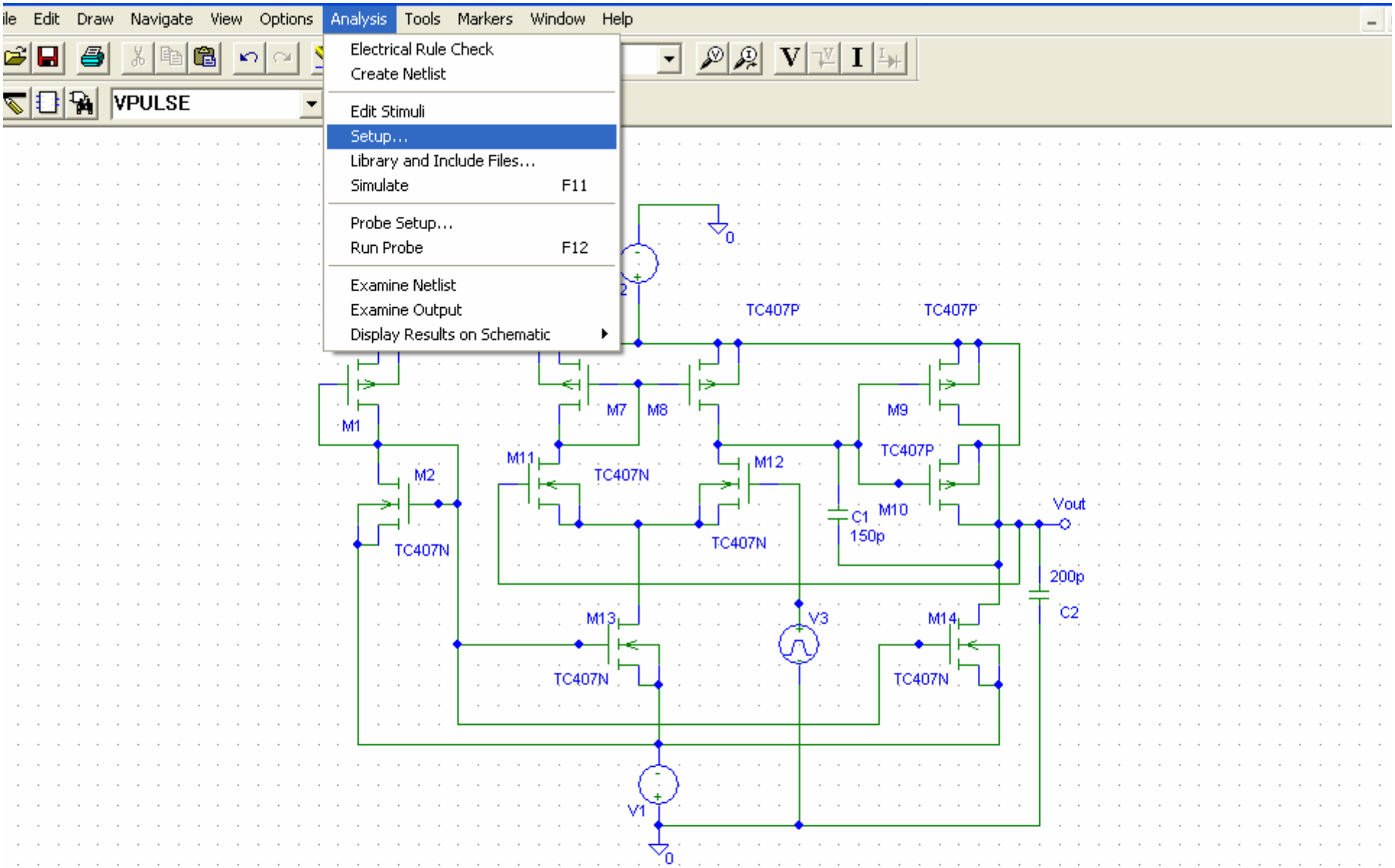


Fig. Sep Up for Slew Rate Testing

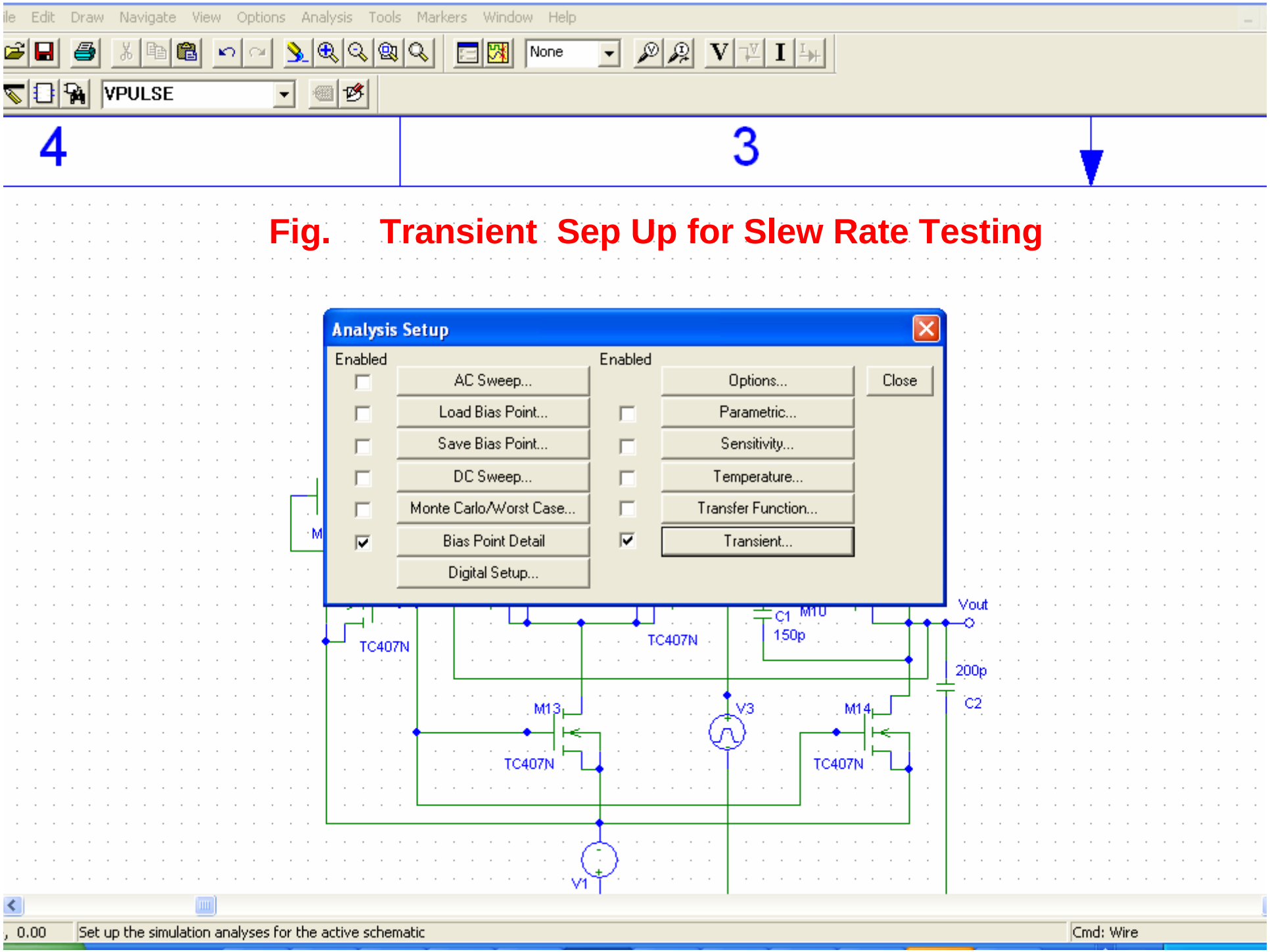
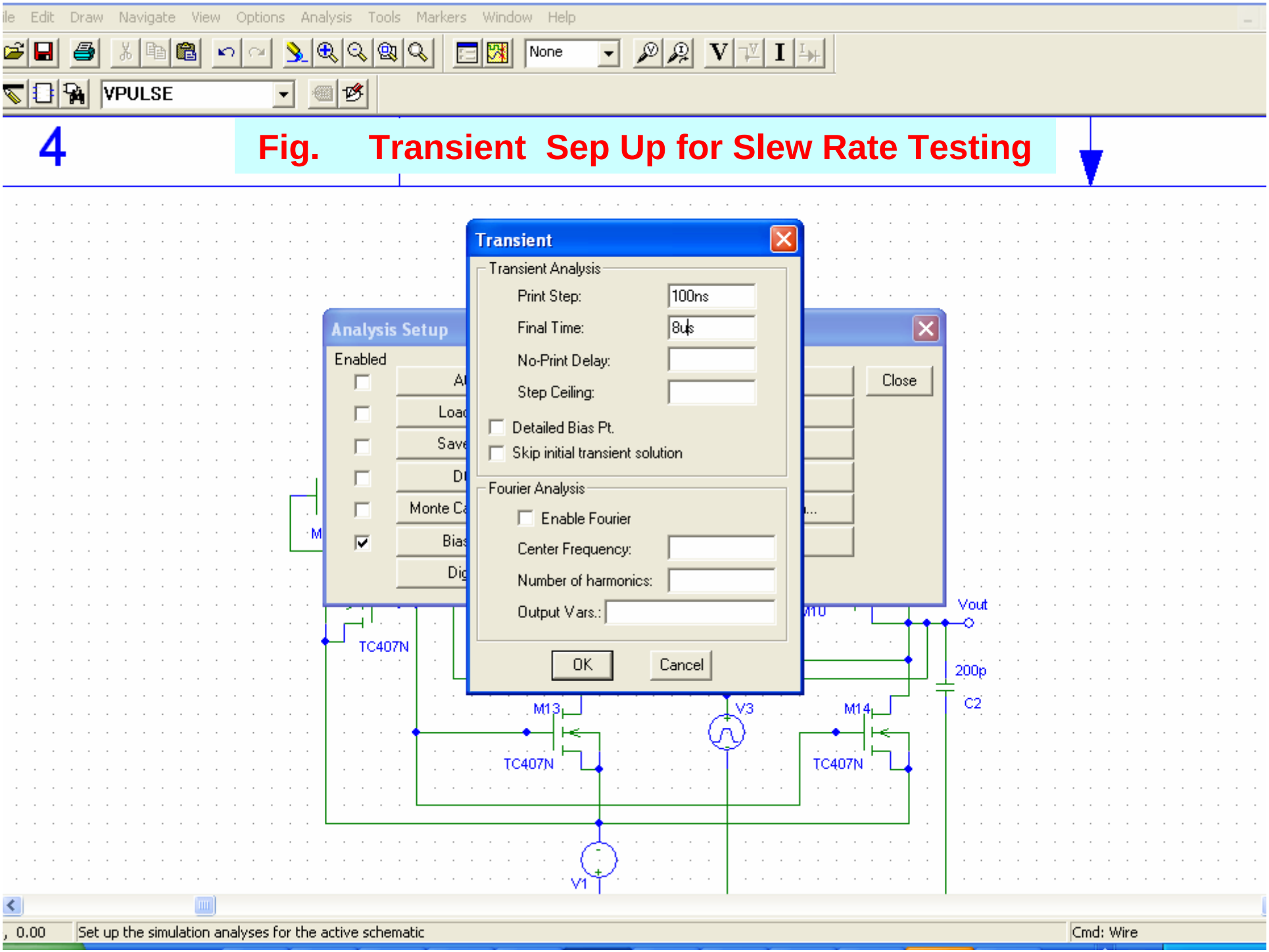


Fig. Transient Sep Up for Slew Rate Testing

4

Fig. Transient Sep Up for Slew Rate Testing



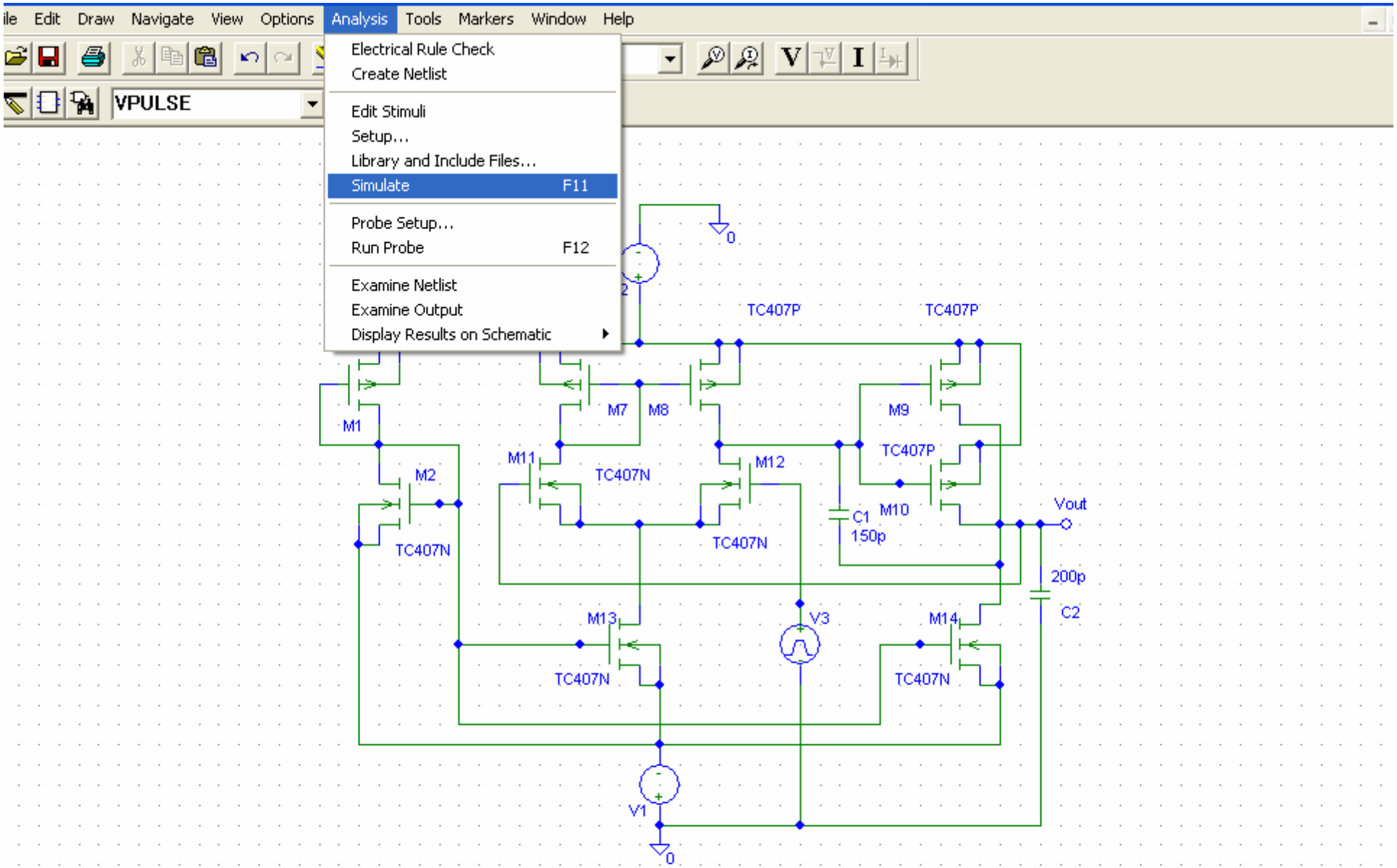


Fig. Simulate PSPICE for Slew Rate Testing

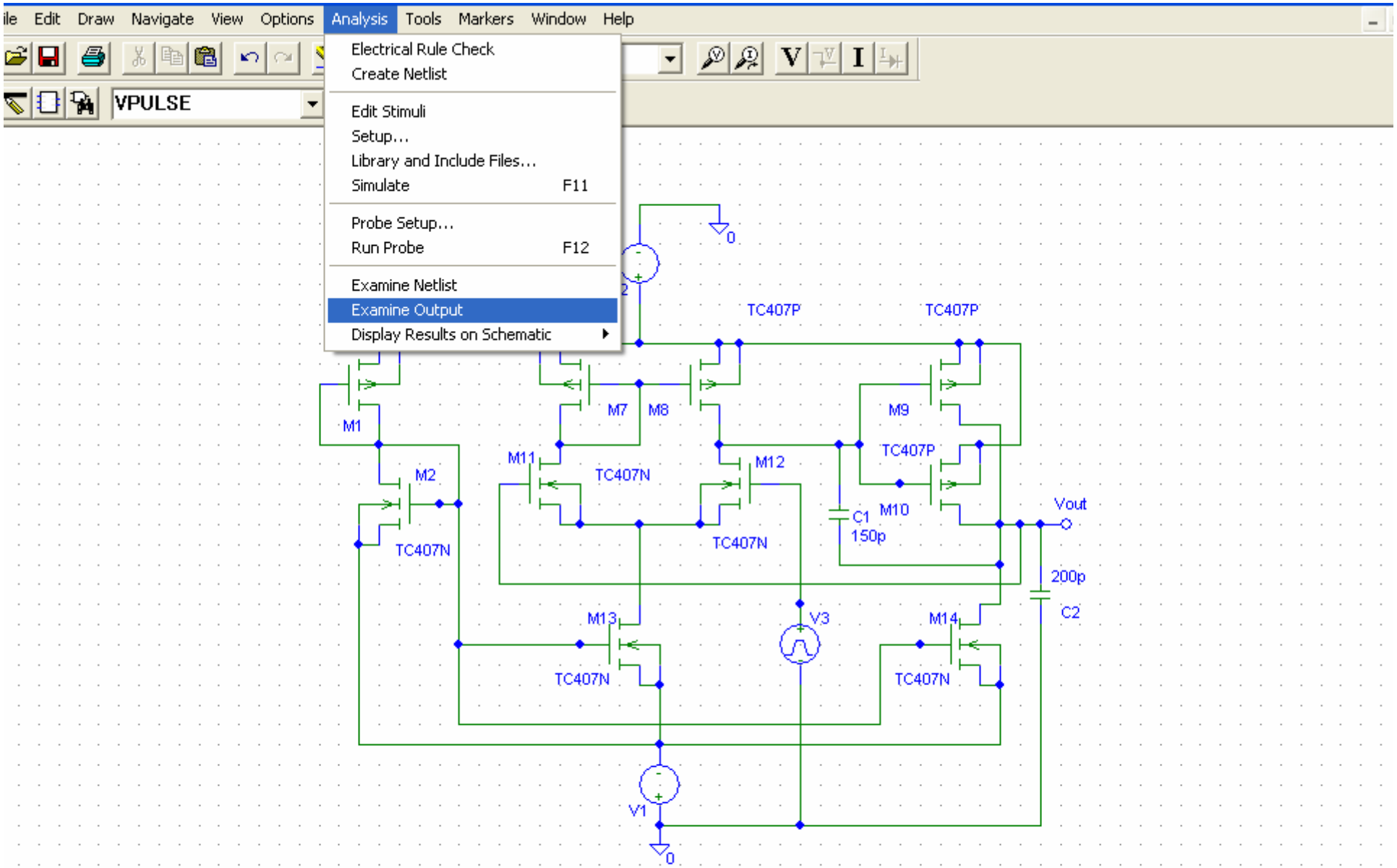


Fig. Open Output File for Error Checking

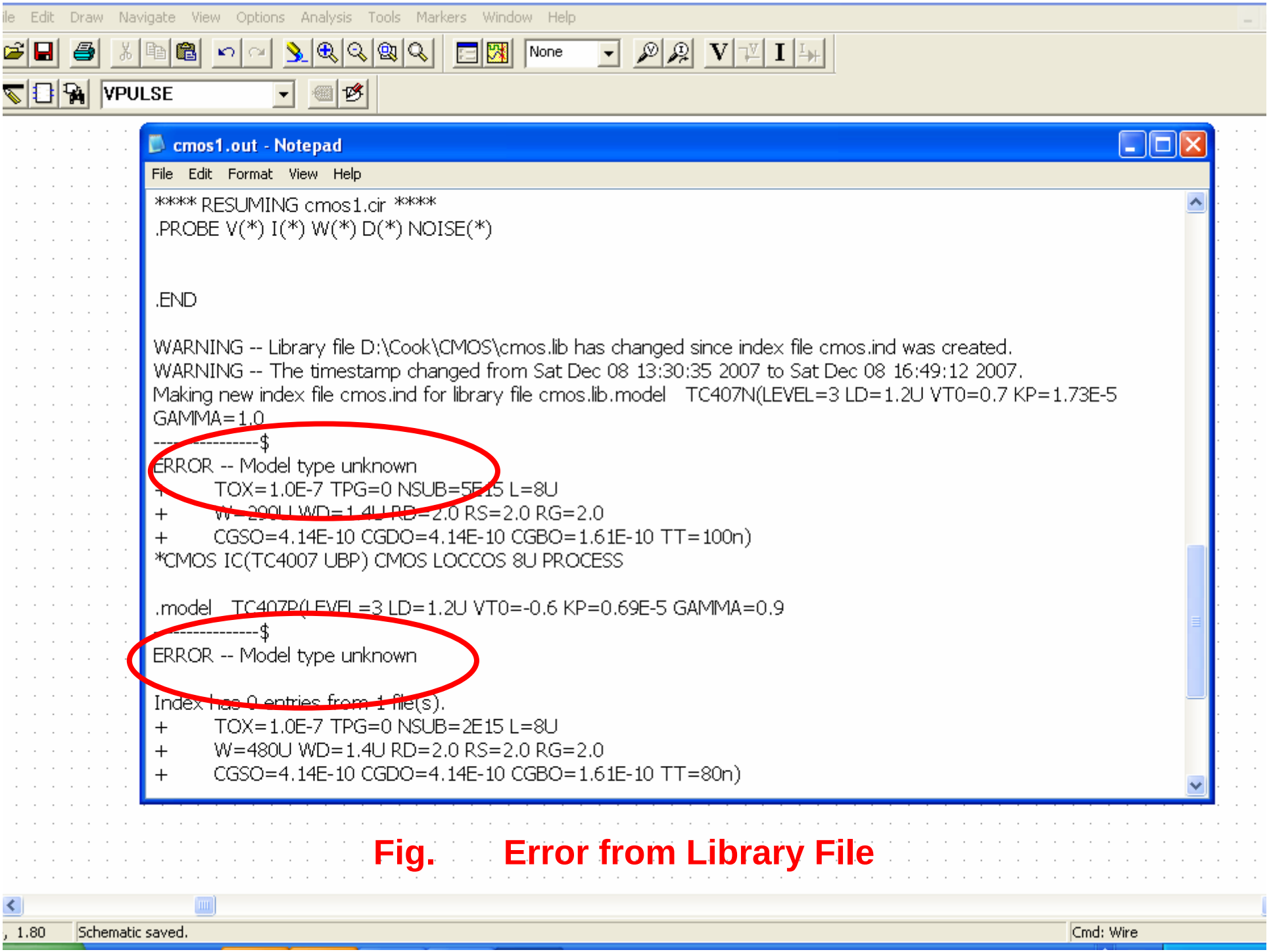


Fig. Error from Library File

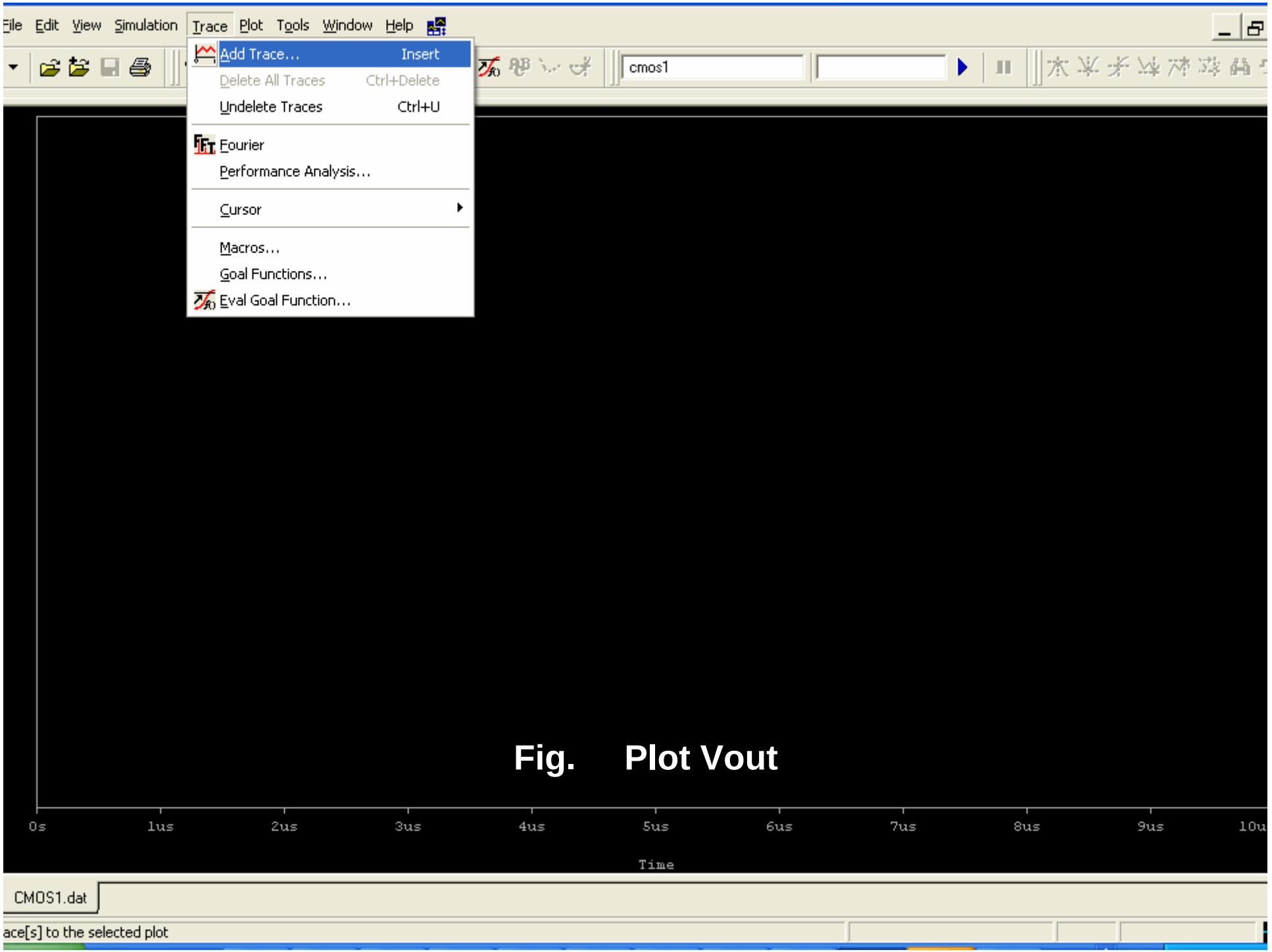


Fig. Plot Vout

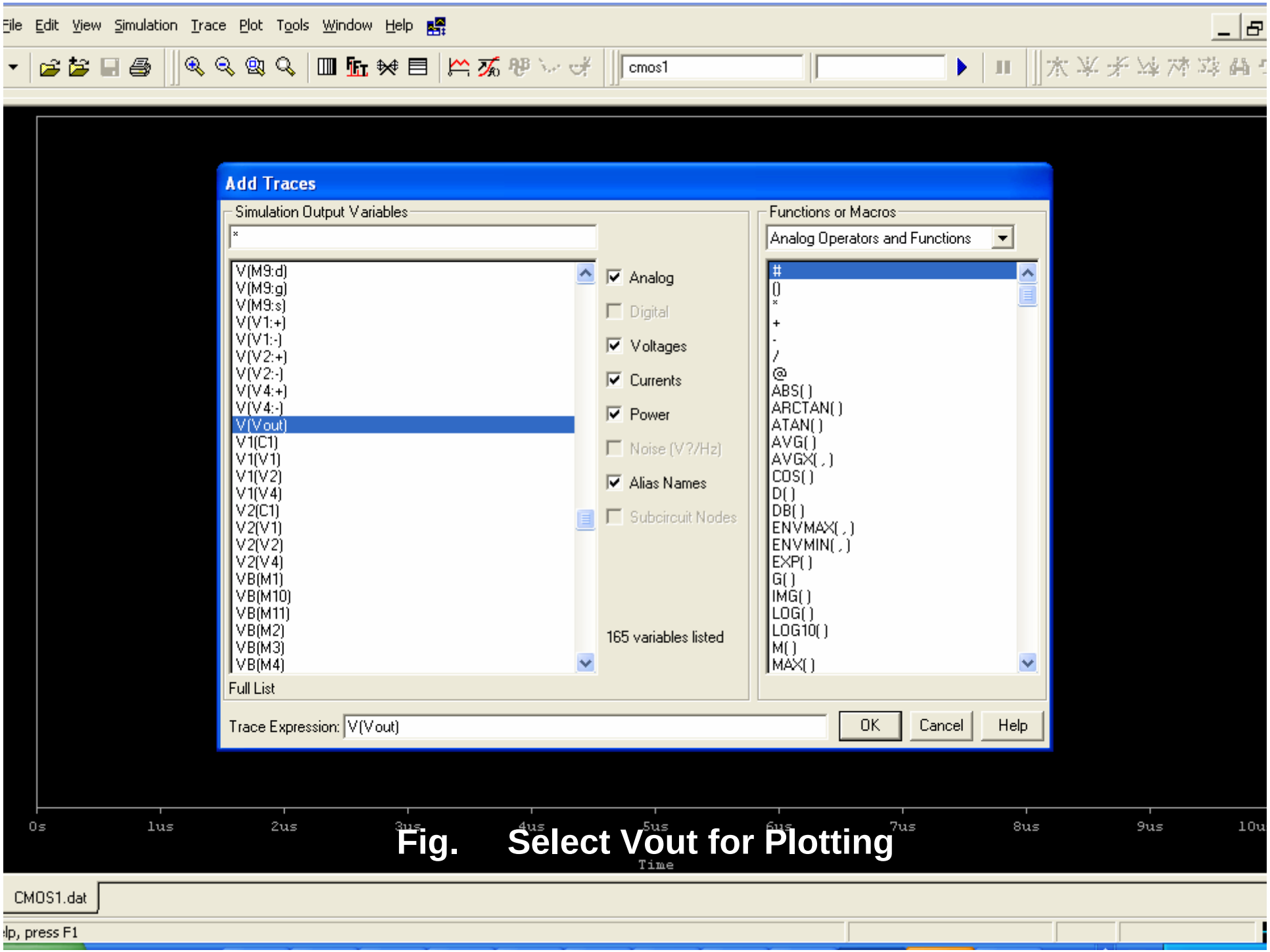
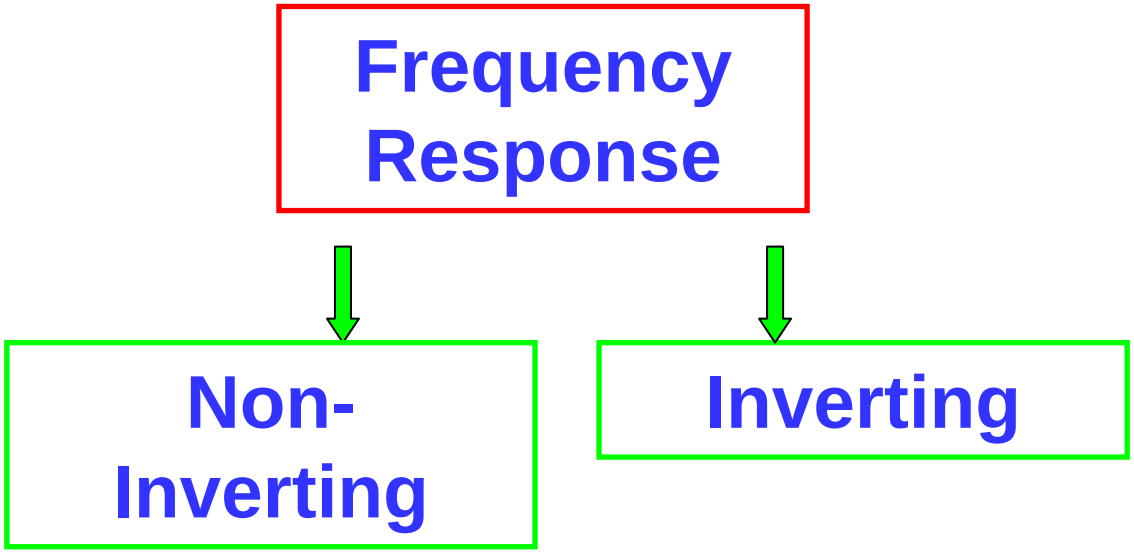


Fig. Select Vout for Plotting


Frequency Response
Non-Inverting
Inverting

Frequency Response

Non-Inverting

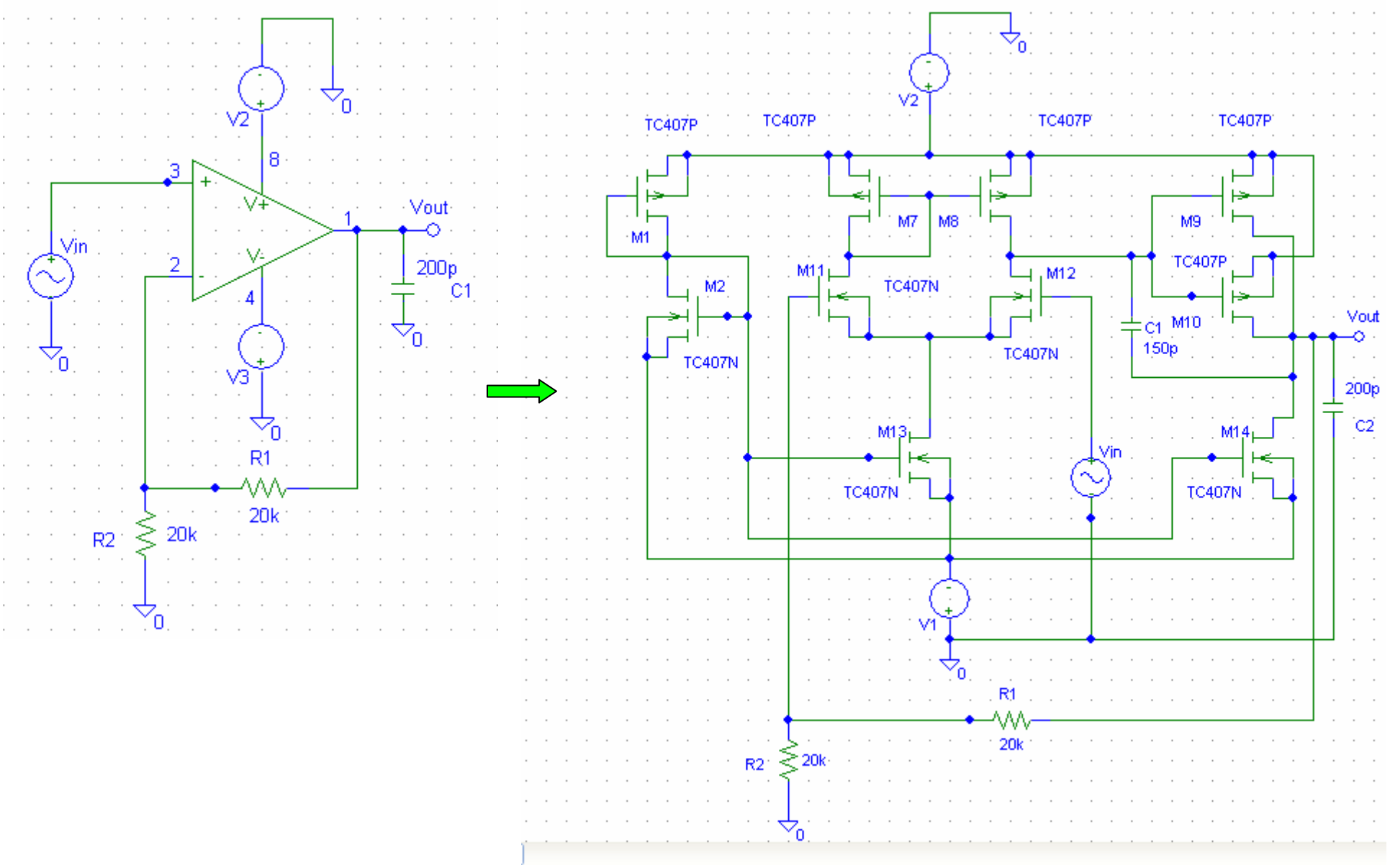


Fig. Frequency Response Testing for Non-Inverting Amplifier

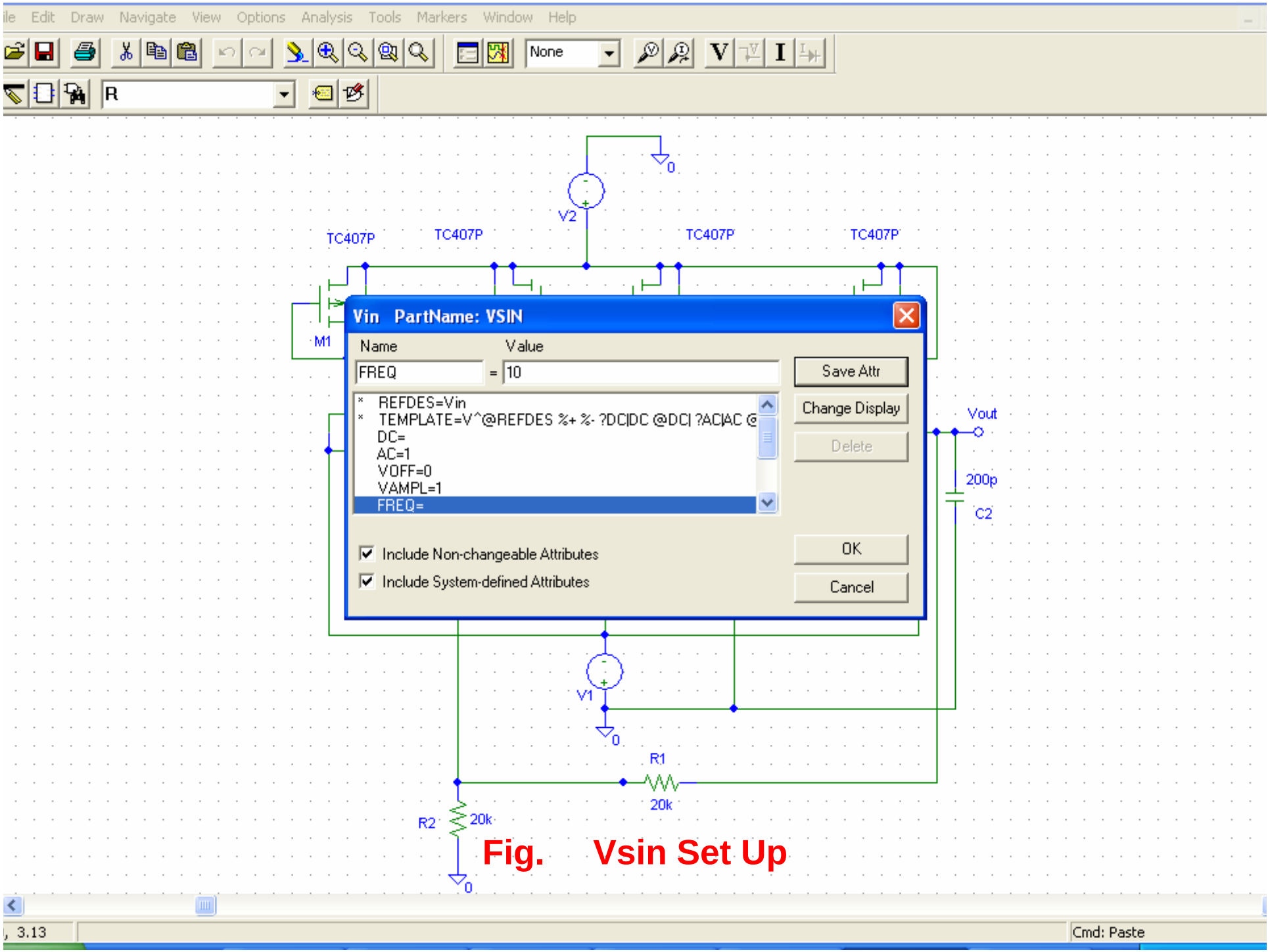


Fig. Vsin Set Up

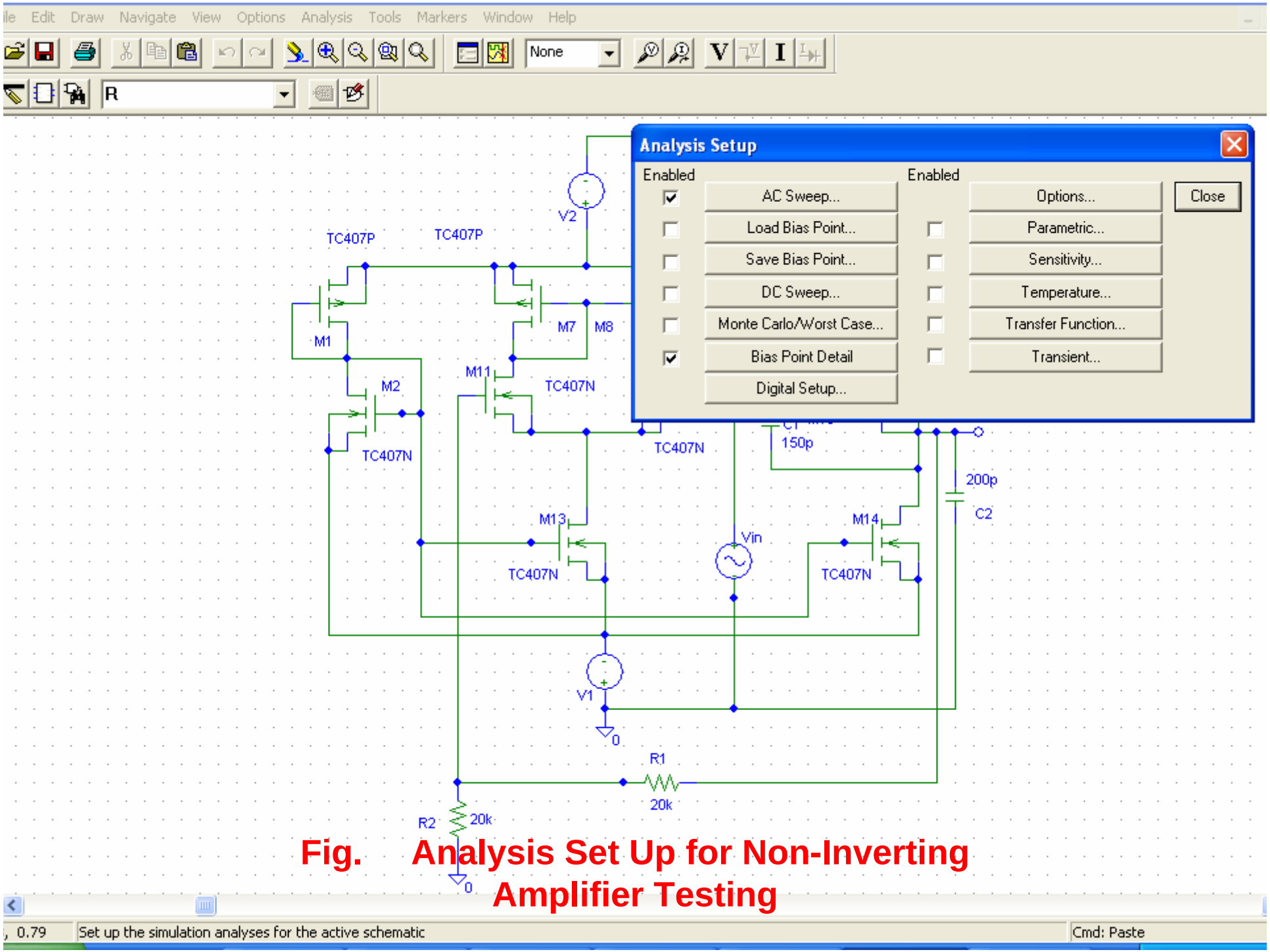


Fig. Analysis Set Up for Non-Inverting Amplifier Testing

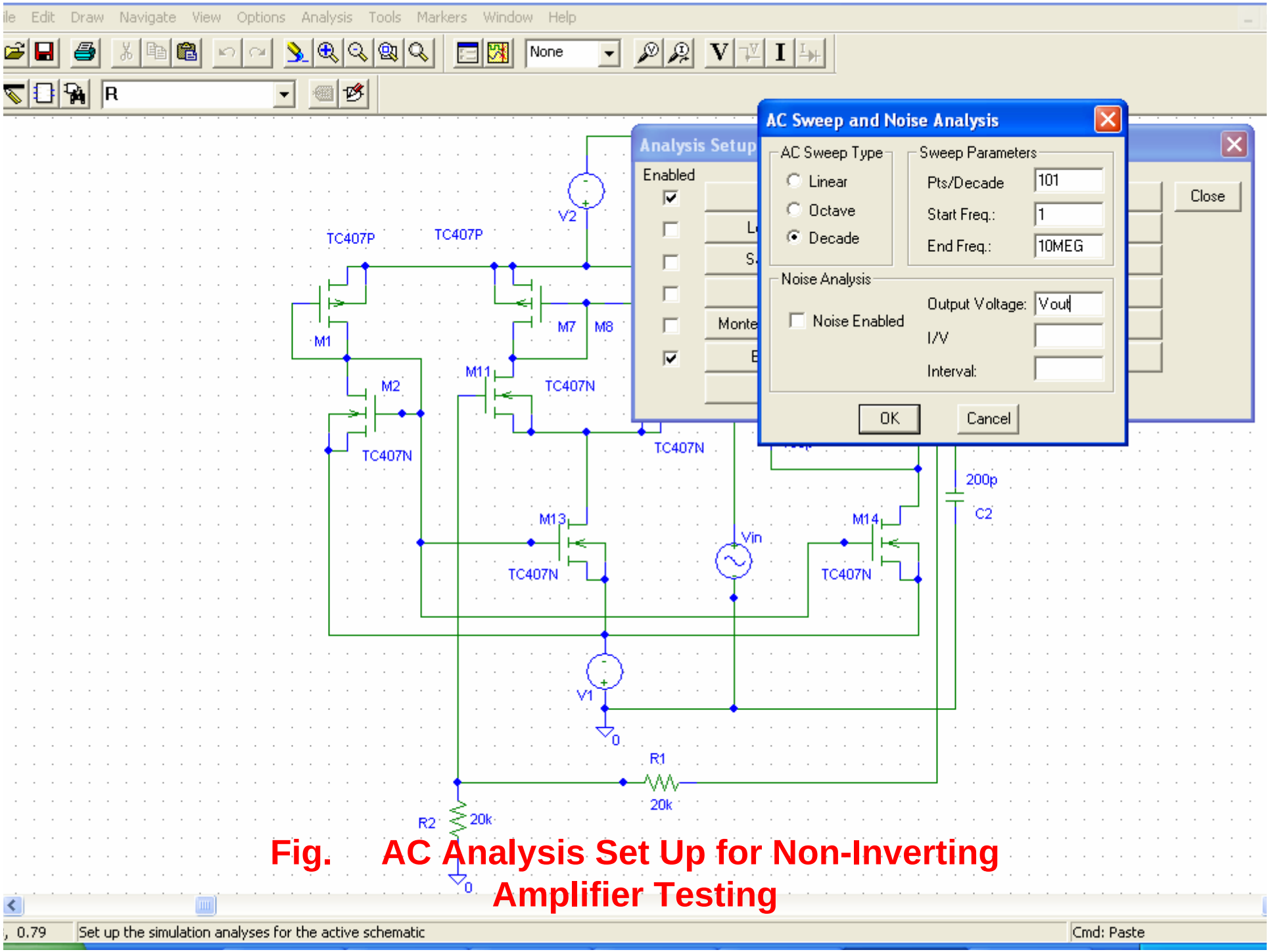


Fig. AC Analysis Set Up for Non-Inverting Amplifier Testing

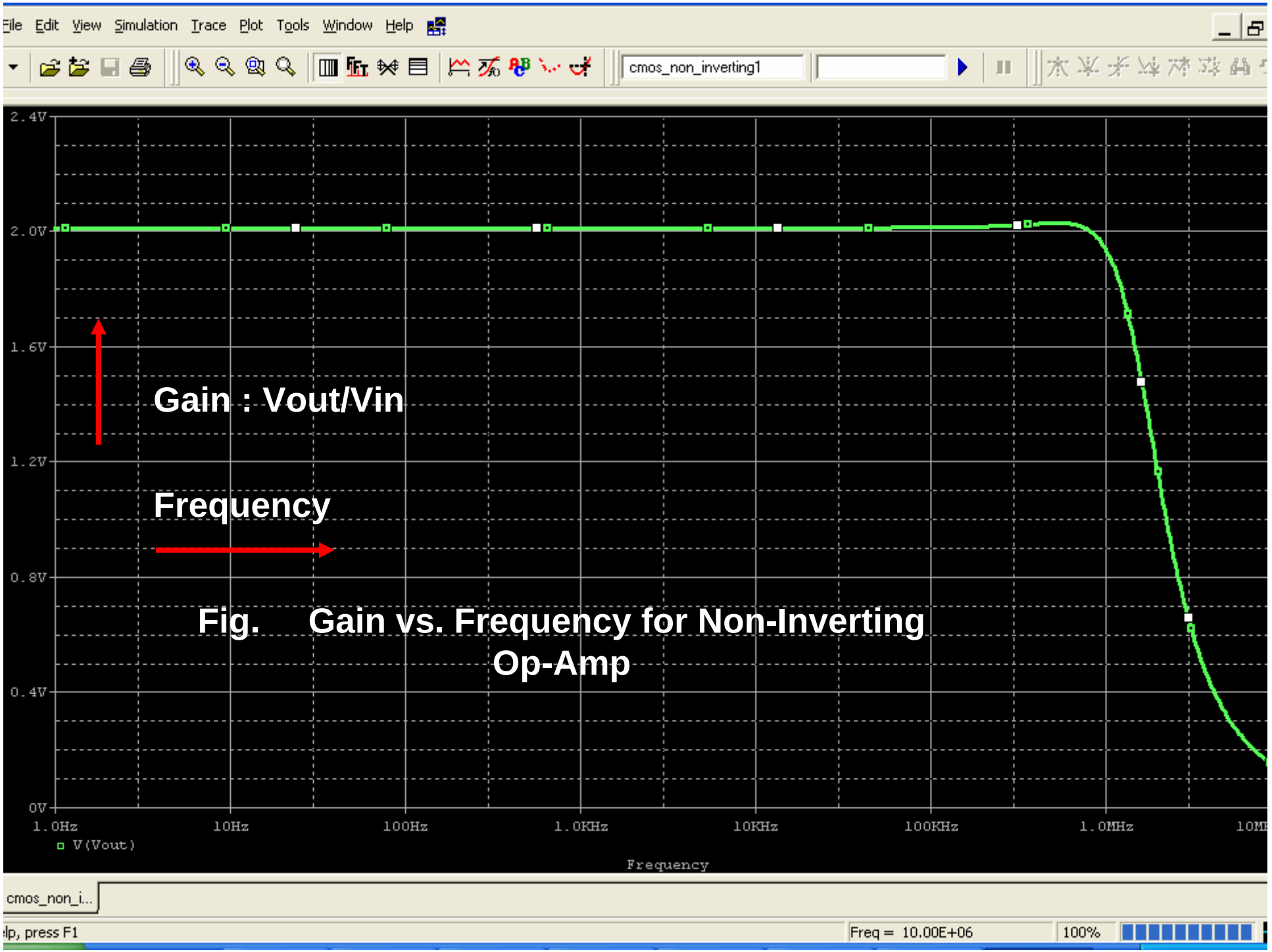


Fig. Gain vs. Frequency for Non-Inverting Op-Amp

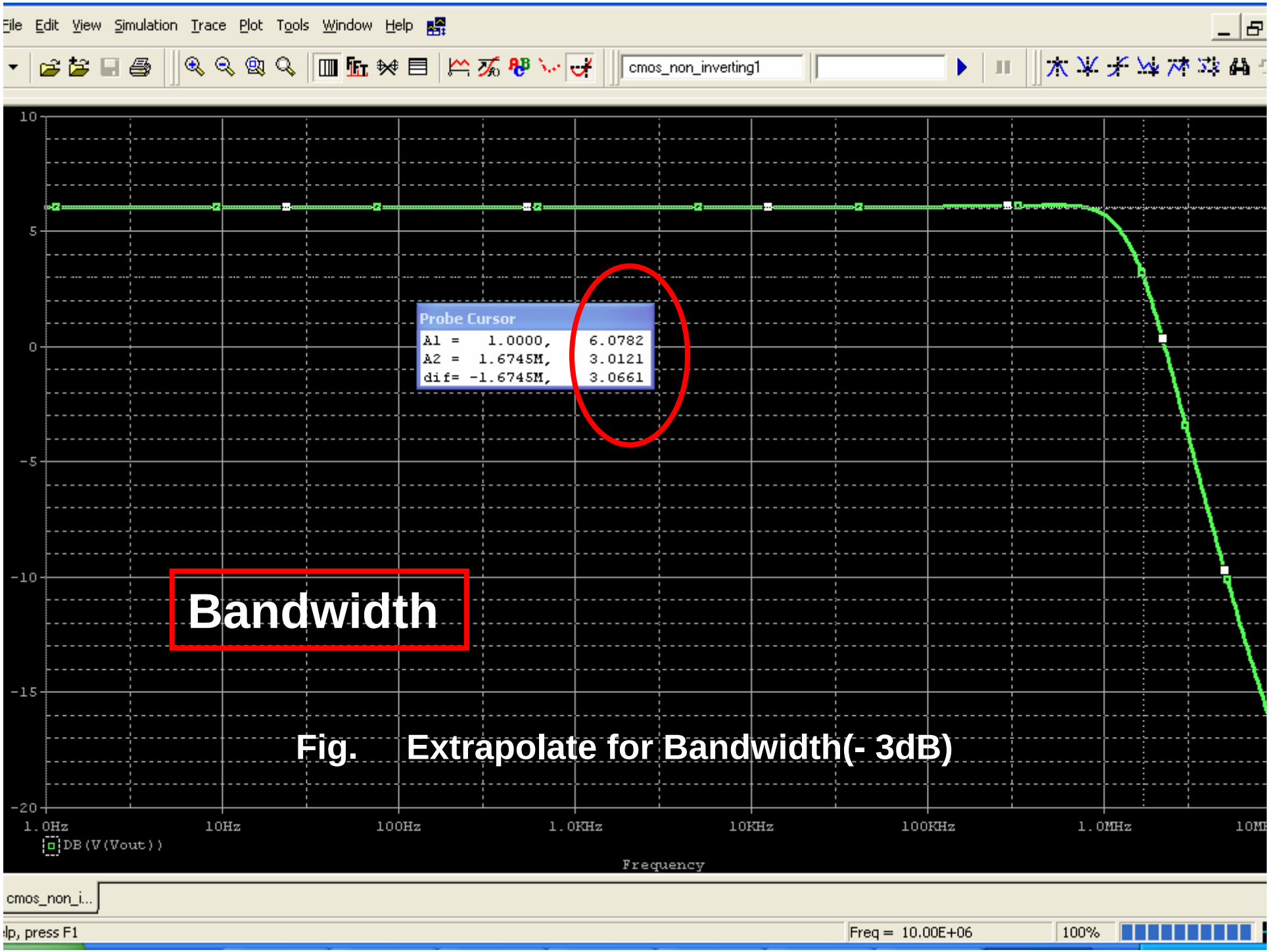


Fig. Extrapolate for Bandwidth(- 3dB)

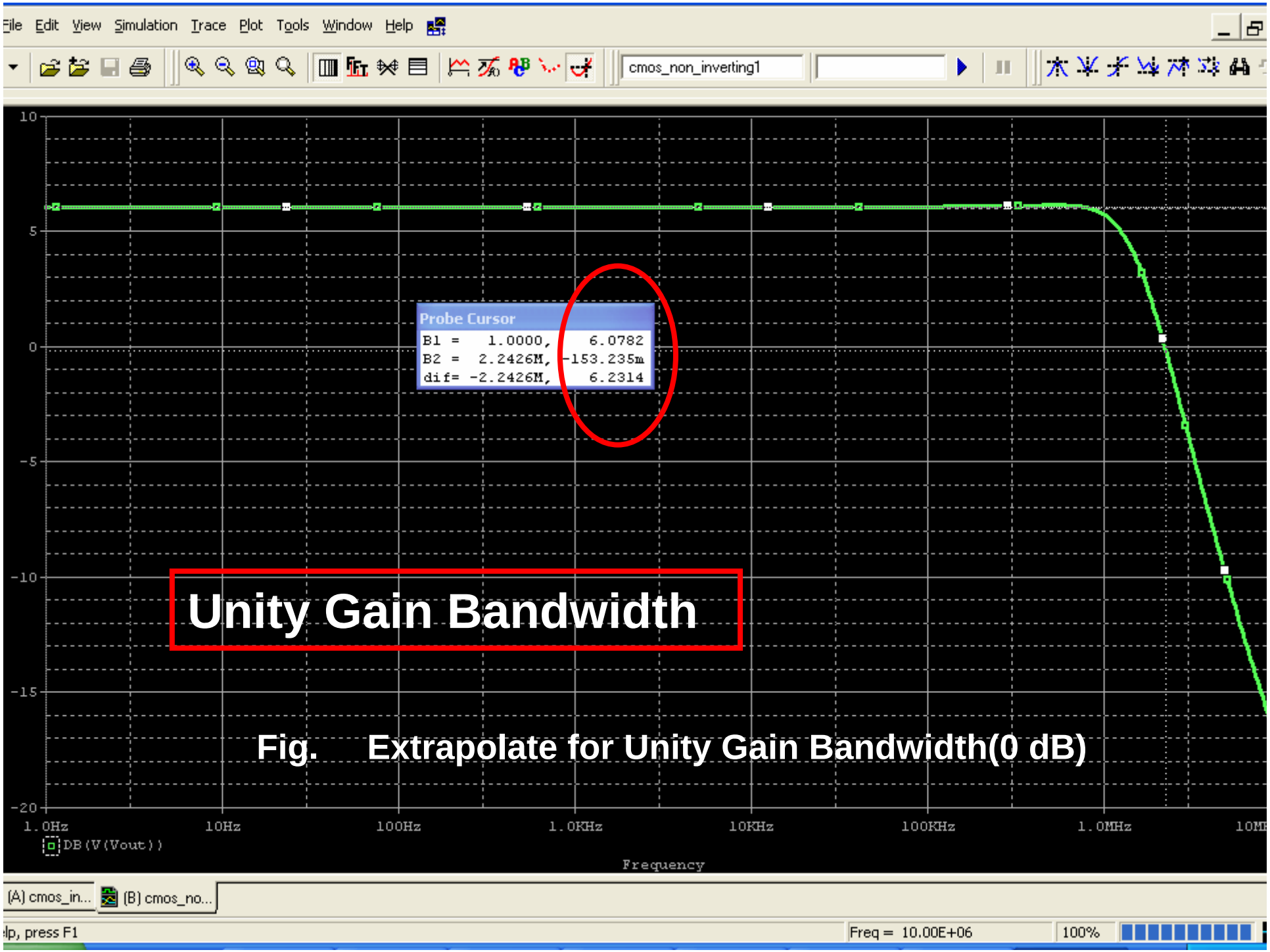


Fig. Extrapolate for Unity Gain Bandwidth(0 dB)

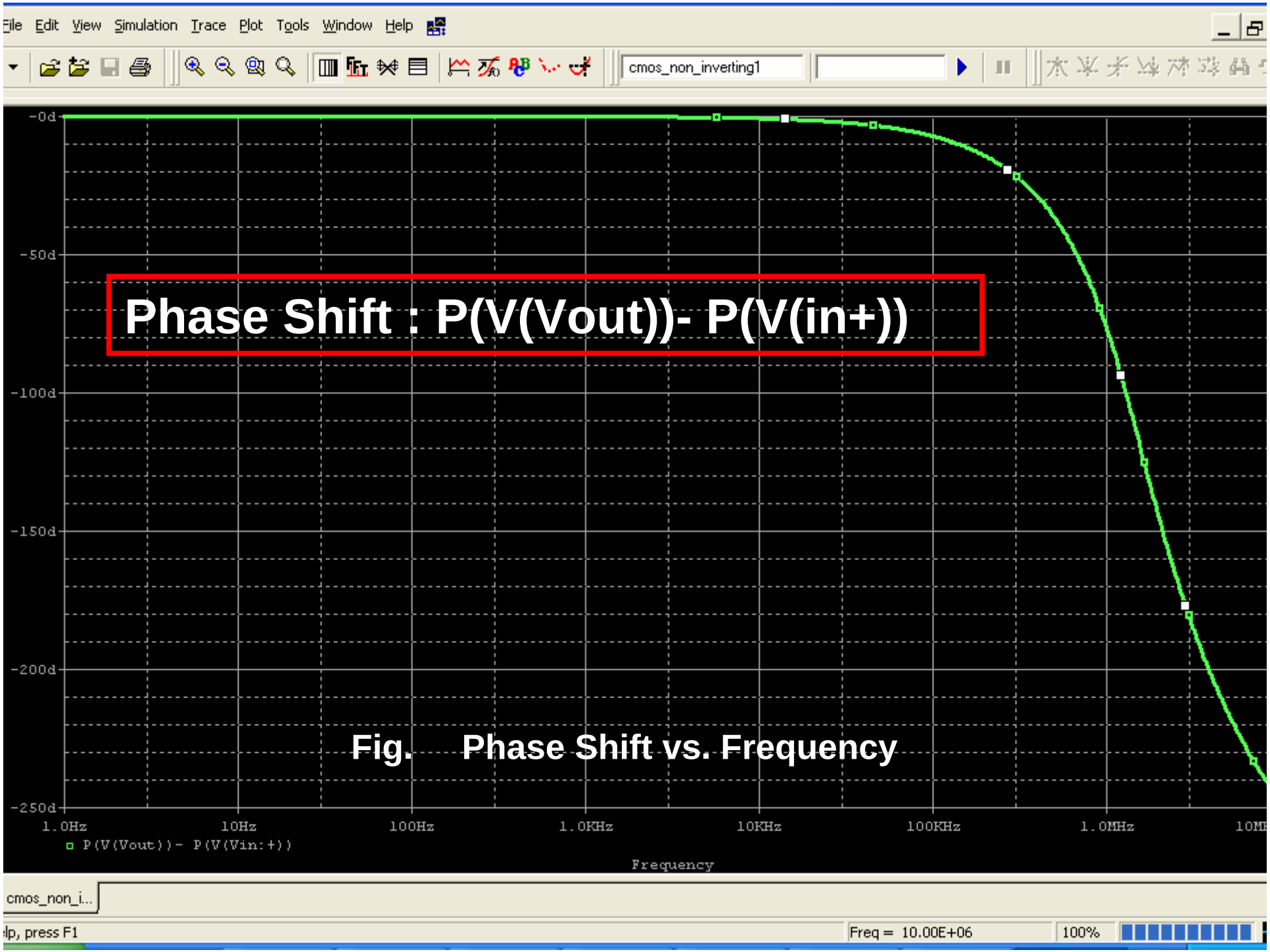


Fig. Phase Shift vs. Frequency

การทดลองที่ 2: การตอบสนองการขยายและ Phase ต่อความถี่

2.1 Non-Inverting Amplifier

Frequency(Hz.)	1	10	100	1k	10k	100k	1M	10M
Gain(dB)								
Phase Shift(Degree)								

จาก Bode Plot ได้ค่า

Bandwidth(f_{-3dB}) ..... *Hz*

Unity Gain Bandwidth (f_T) ..... *Hz*

Unity Gain Phase Shift ..... *Degree*

Fig. Record Test for Non-Inverting Amplifier Testing

Frequency Response

Inverting

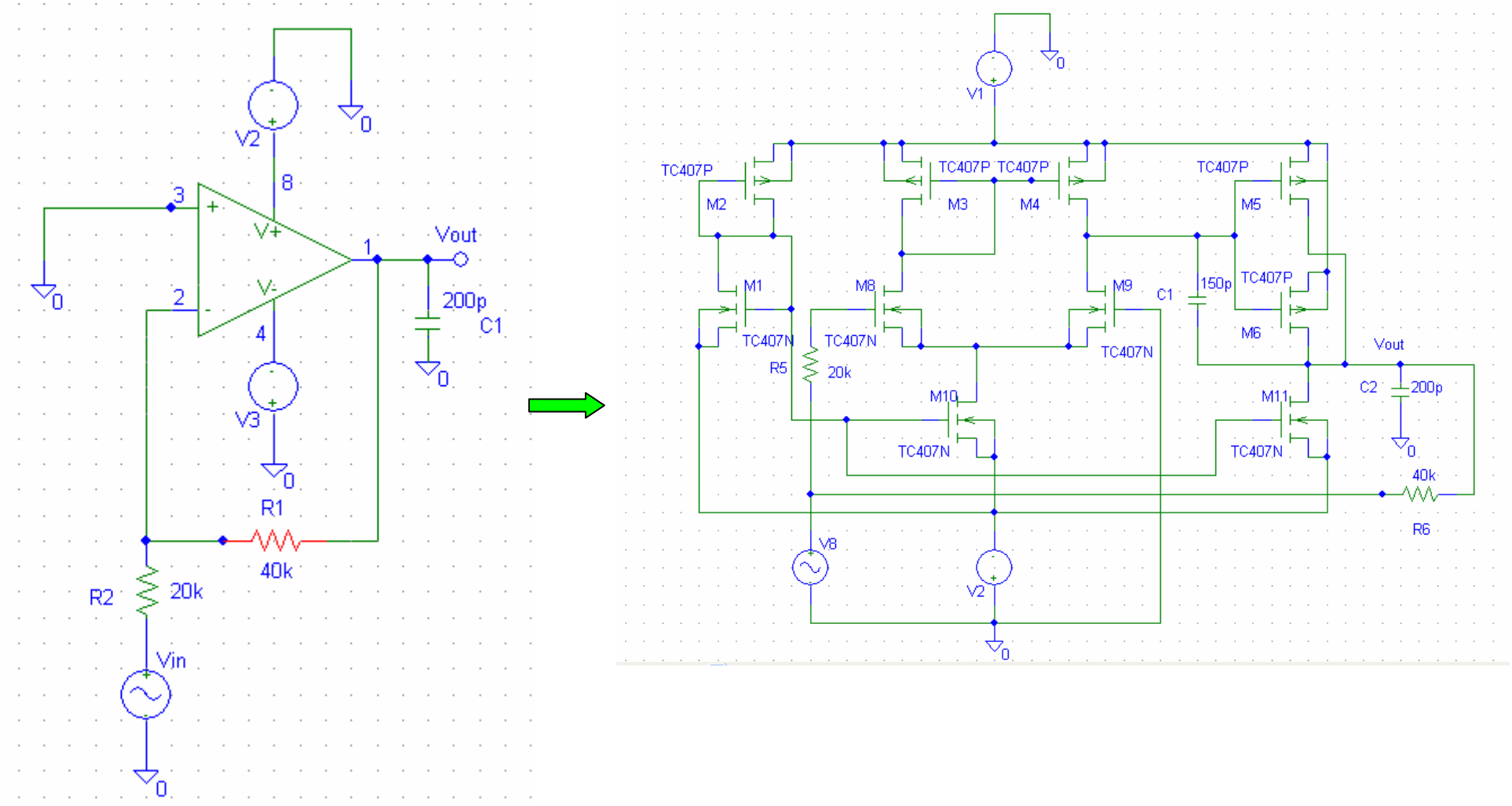


Fig. Inverting Amplifier

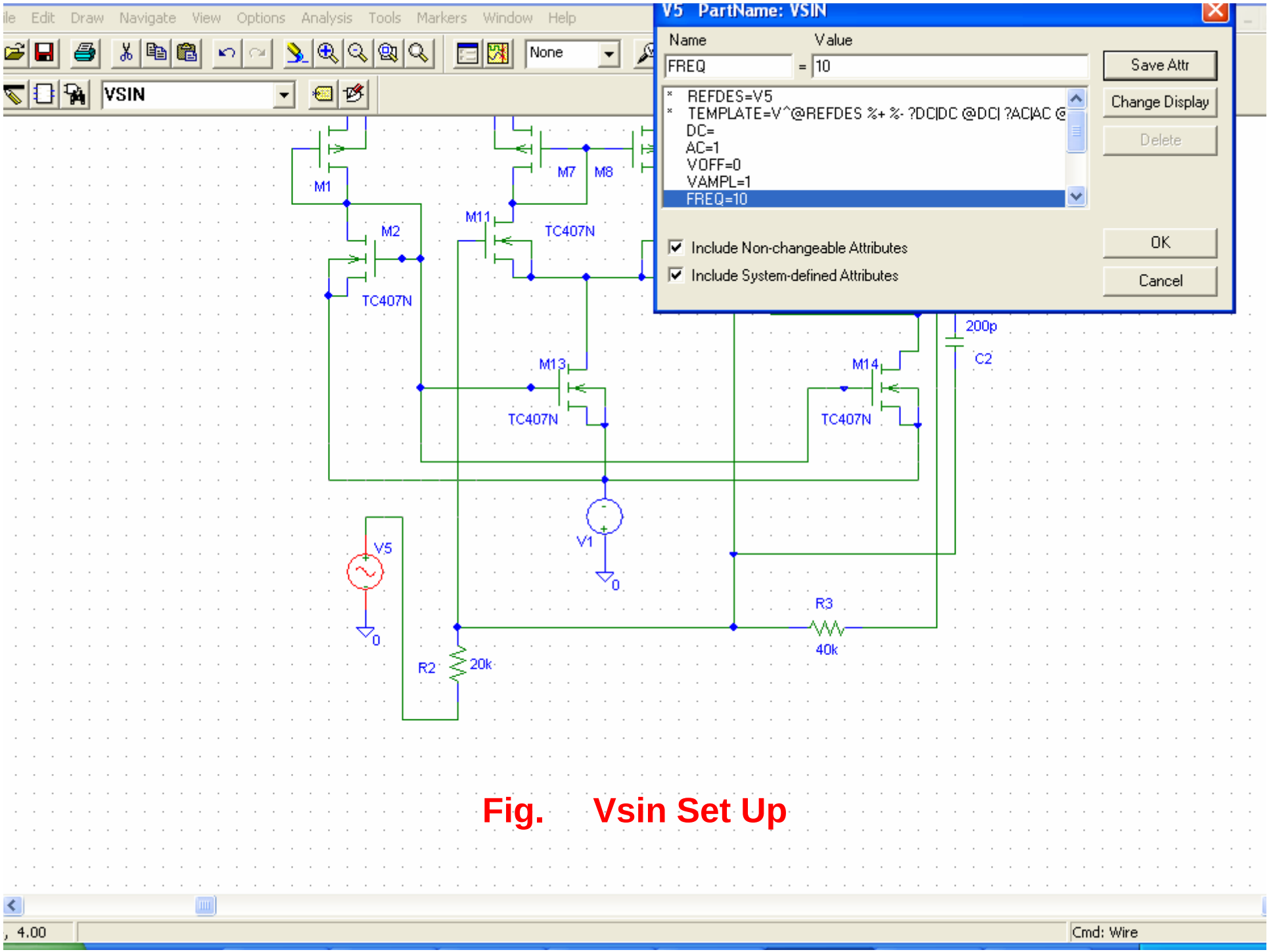


Fig. Vsin Set Up

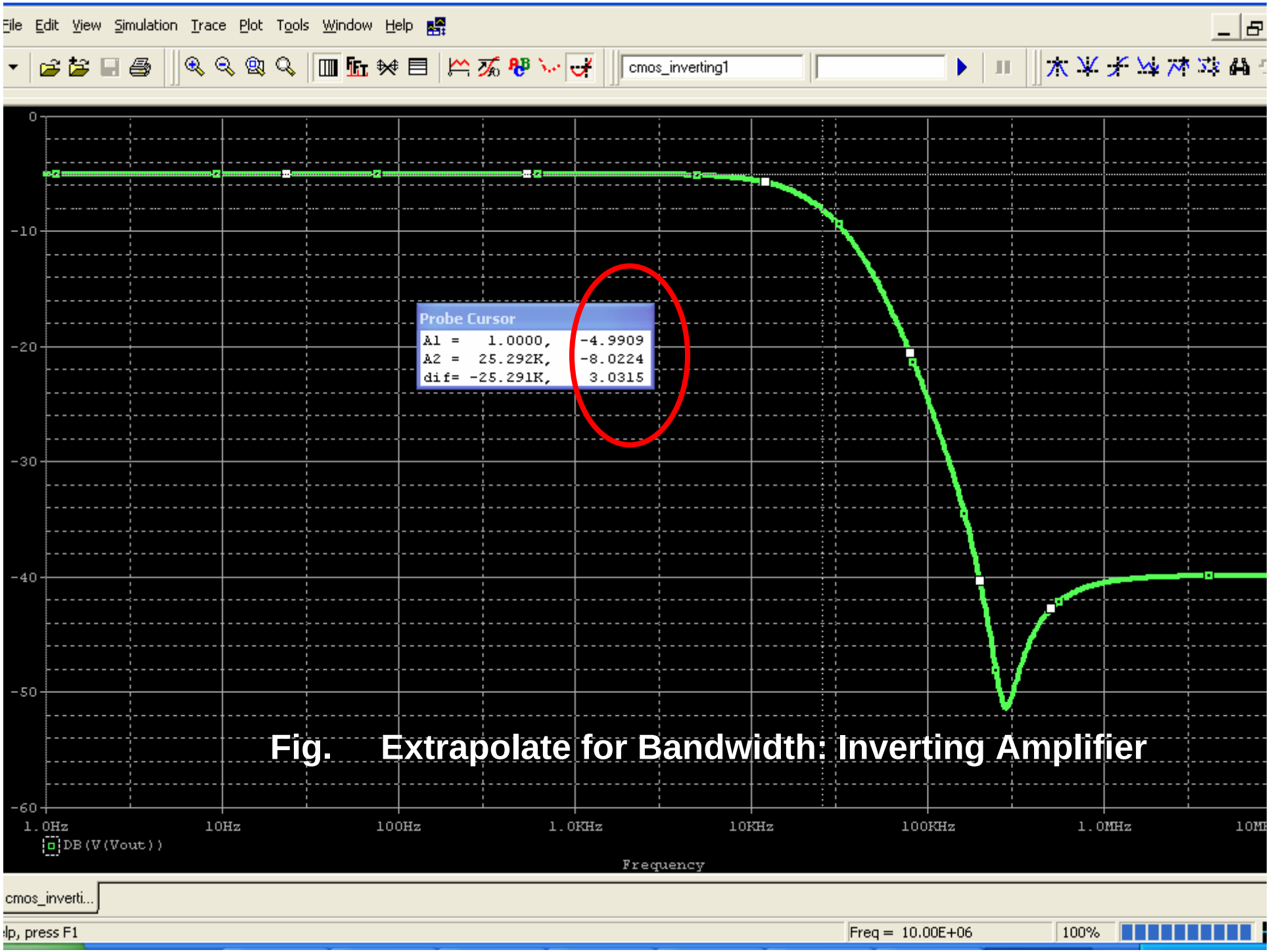


Fig. Extrapolate for Bandwidth: Inverting Amplifier

2.2 Inverting Amplifier

Frequency(Hz.)	1	10	100	1k	10k	100k	1M	10M
Gain(dB)								
Phase Shift(Degree)								

จาก Bode Plot ได้ค่า

Bandwidth(f_{-3dB}) ..... Hz

Unity Gain Bandwidth f_T ..... Hz

Fig. Record Test for Non-Inverting Amplifier Testing

PSRR: POWER SUPPLY REJECTION RATIO

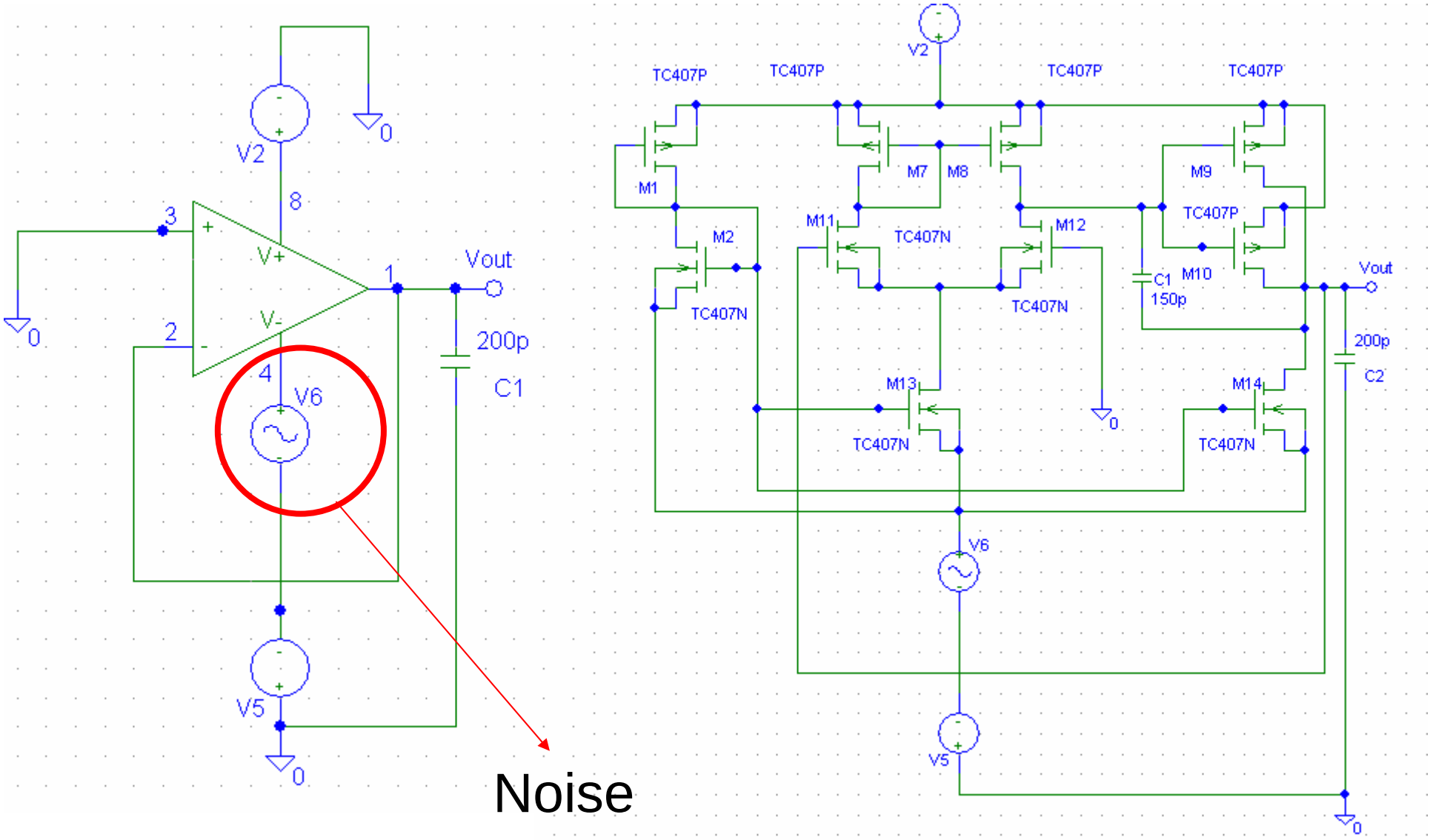


Fig. PSRR Testing

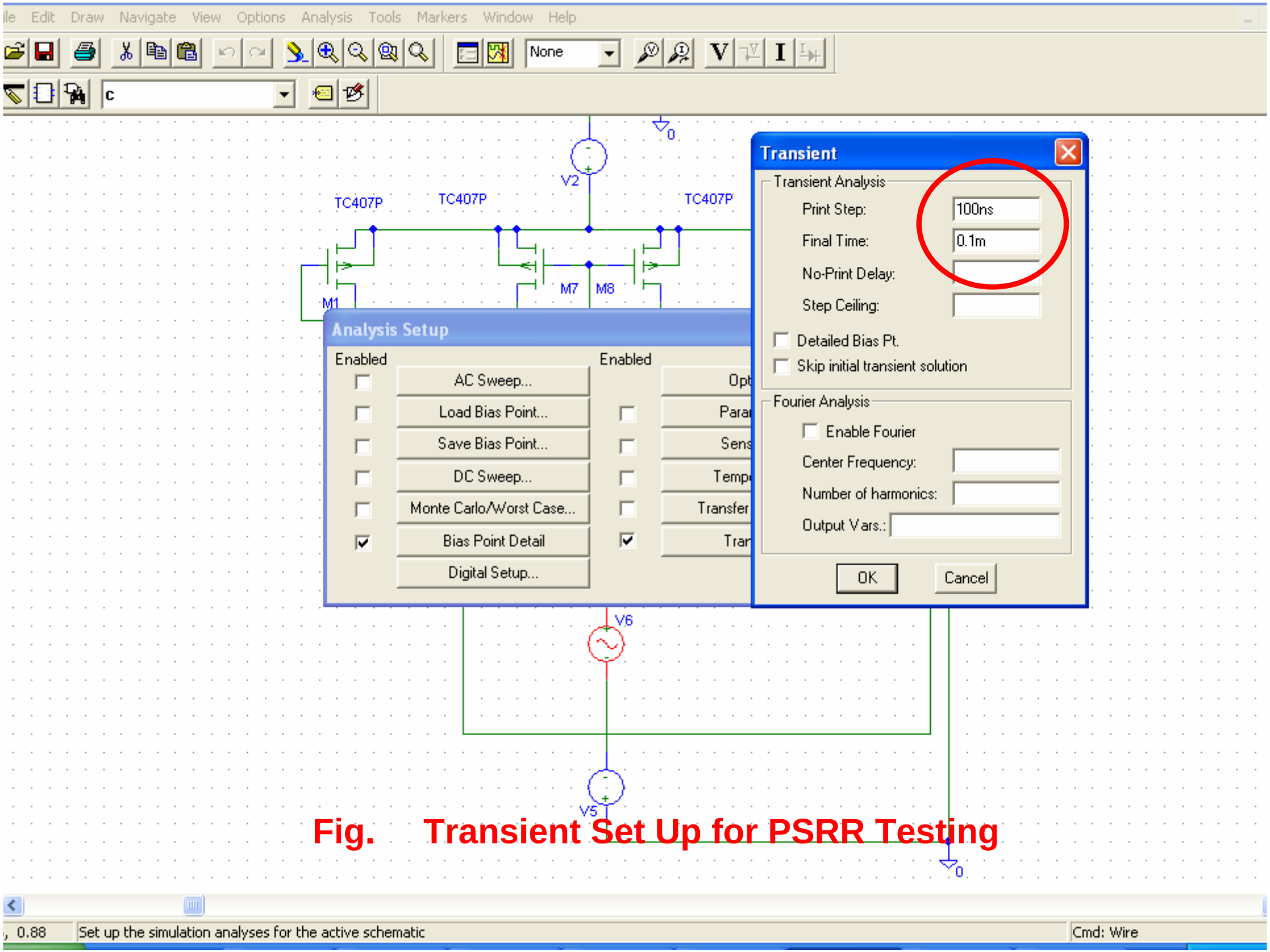


Fig. Transient Set Up for PSRR Testing

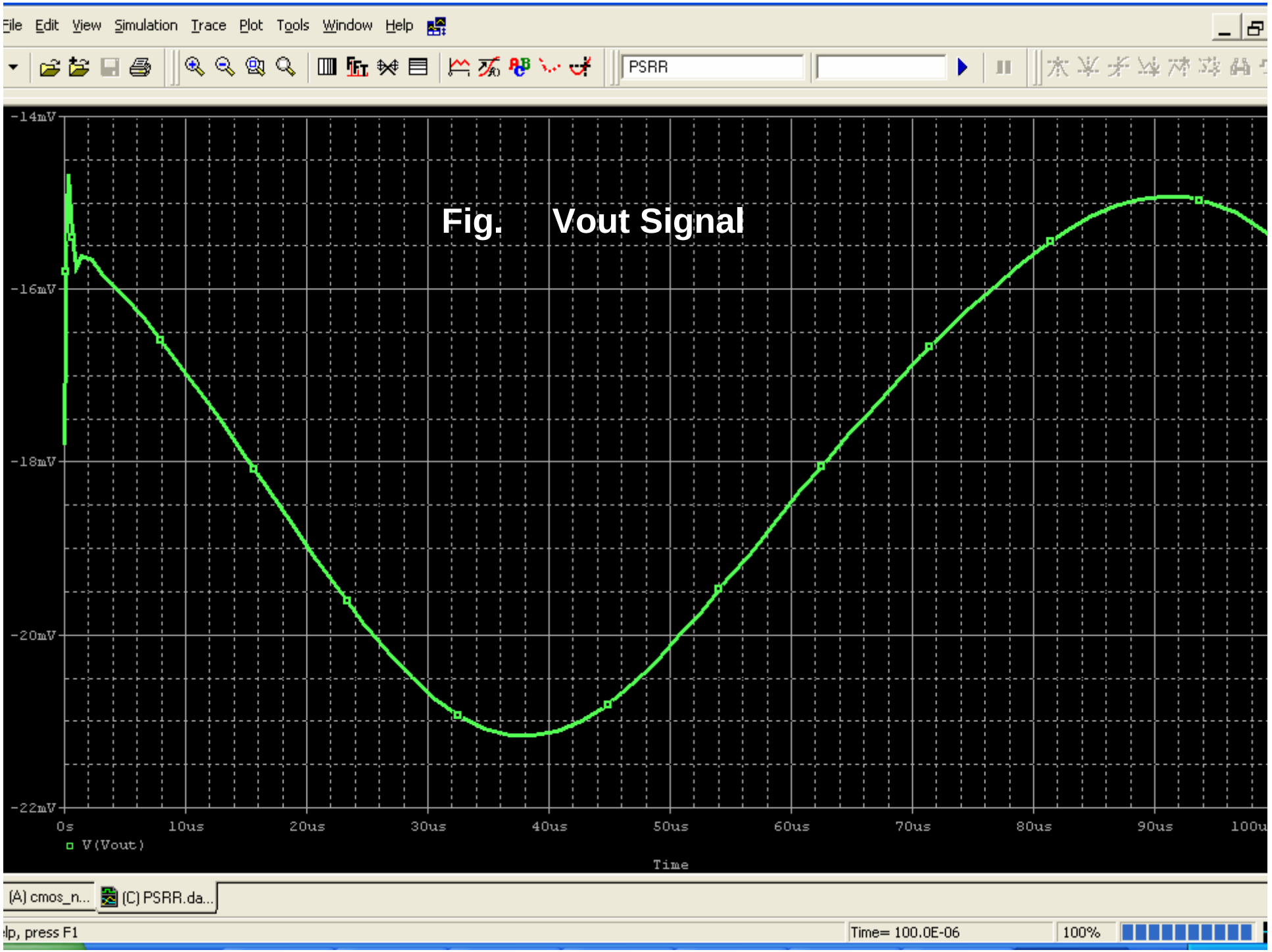


Fig. Vout Signal

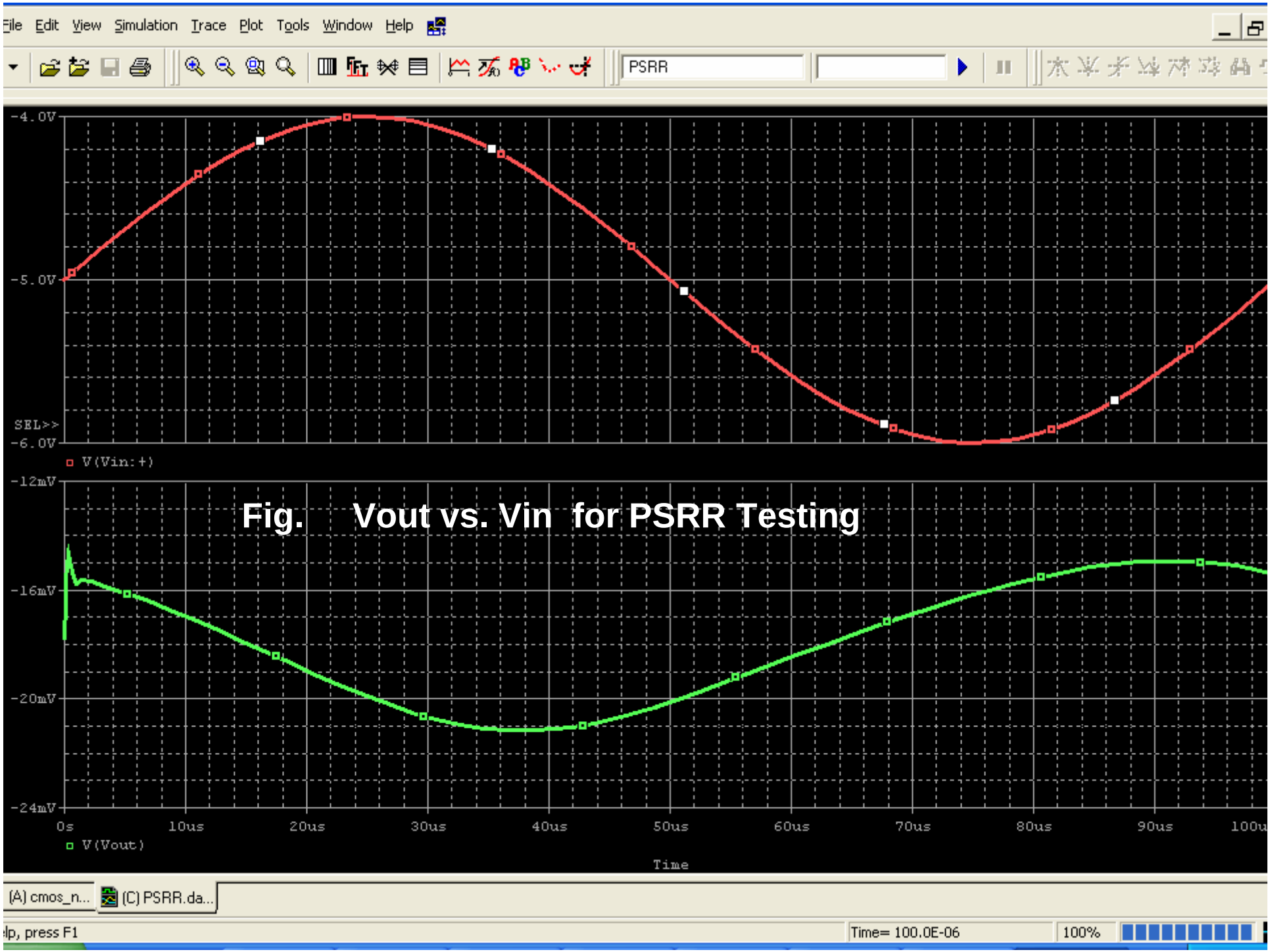


Fig. Vout vs. Vin for PSRR Testing

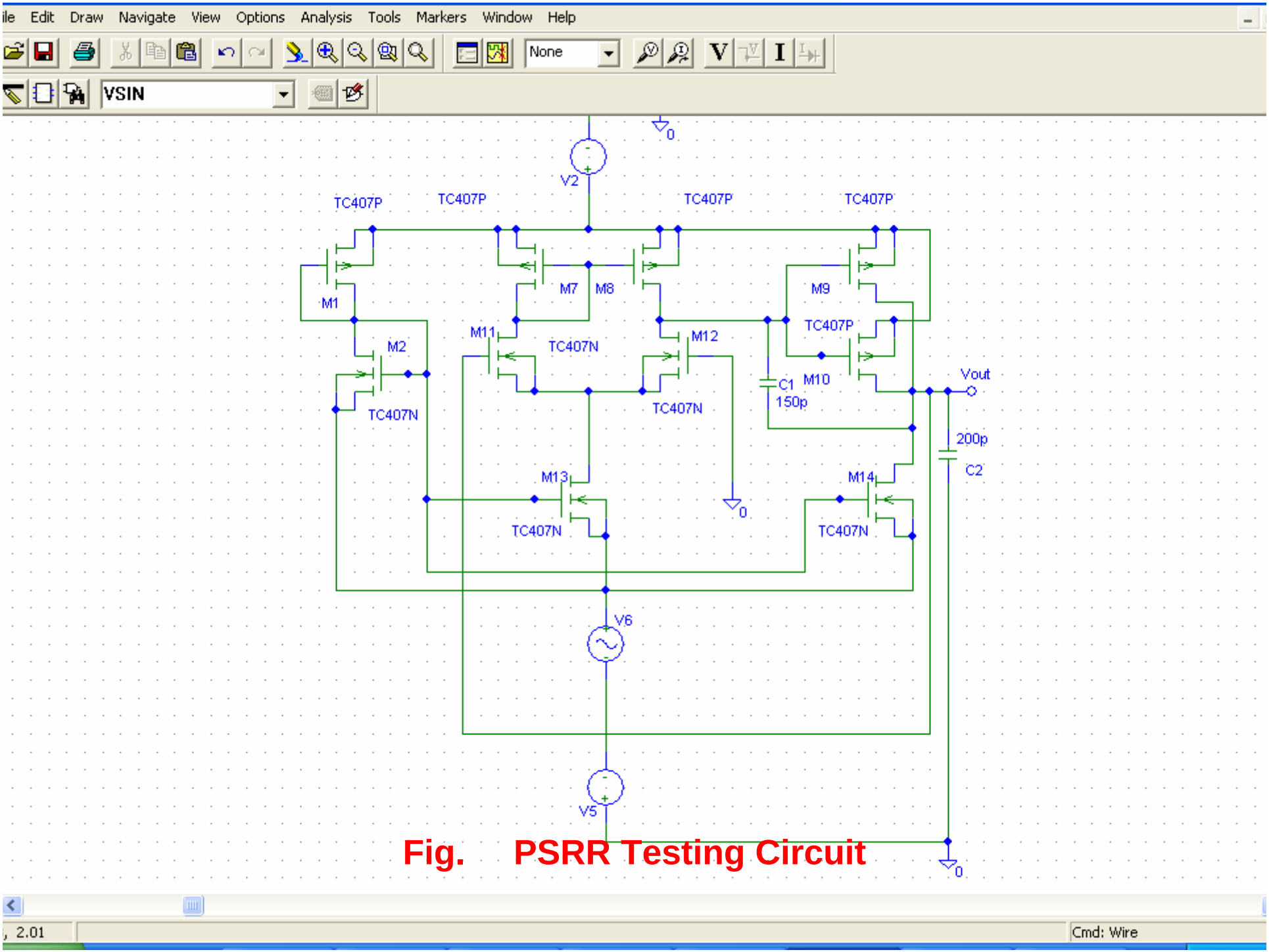


Fig. PSRR Testing Circuit

การทดลองที่ 3: คุณสมบัติในการขจัดสัญญาณรบกวนที่ผ่านเข้าทางไฟเลี้ยงของ Op Amp(PSRR)

ขนาดของสัญญาณ input(peak to peak) = ...*Volt*

ขนาดของสัญญาณ output(peak to peak) = ...*Volt*

ค่า PSRR(Vout/Vin) .....

Fig. Record Test for PSRR Testing

END