M4020

EFA427  630D1192

GENERAL DESCRIPTION:

The model M4020 is a linear bipolar DC amplifier. It requires a bus voltage of +/- 40V DC and is capable of motor currents to 20A peak and 5A continuous. It has 3 inverting variable gain inputs and one non-inverting variable gain input. The unit requires an external bus power supply to operate. It typically is used with a TA3-OEM baseplate (EFA451) which supplies the +/- 40V DC to the amplifier. The baseplate also is the interface for external connections to the amplifier.
FIG 3: M4020 BLOCK DIAGRAM
BLOCK DESCRIPTION:

BLOCK 1: TA3-OEM

This is the baseplate for the M4020. It is capable of handling up to 3 amplifiers. When connected to a center tapped 56V transformer, it generates the +/- 40V DC bus voltage for the amplifier. It also requires 115V AC for the cooling fan. It has the interface for motor connections to the amplifier as well as the interface to the amplifier input connections.

1TB1 - AC neutral input
1TB2 - fan AC input
1TB3 - AC input fuseblock
1TB4 - motor interface connector
BR1 - power supply bridge rectifier
C1,C2 - bus voltage filter capacitors
BLOCK 2: LOGIC POWER SUPPLY

This section develops the +/- 15V DC power supplies for the amplifier from the +/- 40V DC bus.

DZ3,DZ4 - +/- 15V zener diode regulators
C9,C10 - +/- 15V filter capacitors
C11,C12,C13,C14 - +/- 40V filter capacitors
BLOCK 3: INPUTS & PREAMP

This section is the "user interface" of the amplifier. With an input voltage applied to it, a current command for the output stage is generated.

Input 1 - variable gain input network (typically TB1-1 is command input and TB1-5 is connected to ground)
Input 2 - variable gain resistor network typically not used
Input 3 - variable gain resistor network typically used for tach input.
A3 - input 1 preamp
A2 - amplifier preamp
R7,R8,C4 - variable AC gain feedback network of preamp
R11,R12,R13 - DC gain feedback network of preamp
R10 - preamp balance pot
D1,D2 - external motor current limiting diodes
BLOCK 4: DRIVER STAGE

This stage takes the current command from the preamp and controls the drive transistors for the output stage.

- Q7, Q8: constant current source generator
- Q4, Q5: pre drive transistors for output stage
- Q3, Q9, Q14, Q15: drive transistors
- R25, C8: output stage AC feedback network
- R24: motor current feedback resistor
- Q1: amplifier shutdown transistor
BLOCK 5: OUTPUT STAGE

This section is made up of two banks of transistors. As each bank is turned on, it creates a path for current flow through the motor causing it to rotate.

Q10, Q11, Q12, Q13 - output transistors for current flow from 1TB4-2 to 1TB4-1
Q16, Q17, Q18, Q19 - output transistors for current flow from 1TB4-1 to 1TB4-2
D7, D8 - flyback diodes
F1 - load fuse
R49 - current sense resistor
1TB4-2 (TB2-1) - load hi motor connection (motor -)
1TB4-1 (TB2-2) - load lo motor connection (motor +)
BLOCK 6: CURRENT LIMIT

This section senses motor current and limits it to a level determined by the current limit adjustment pots.

- **R51** - 1TB4-2 to 1TB4-1 current limit pot
- **Q20, Q2** - 1TB4-2 to 1TB4-1 current limit transistor
- **R54** - 1TB4-1 to 1TB4-2 current limit pot
- **Q21** - 1TB4-1 to 1TB4-2 current limit transistor
BLOCK 7: SHUTDOWN CIRCUIT

This circuit will shutdown the amplifier if the logic supply levels drop or if commanded by an external shutdown. Jumper 3-4 is installed for SD-N input and jumper 4-5 is installed for SD input.

J2-8,TB1-8 - external shutdown input
Q22 - mosfet (used for inverting signal for shutdown input)
A1 - logic supply shutdown comparator
DZ1,DZ2 - reference voltage generator for A1
Q6 - amplifier shutdown transistor
RATE LOOP THEORY:

A rate loop consists of an input command to a DC amplifier driving a DC motor that generates negative tach feedback.

The rate loop block diagram shows the typical rate loop configuration. Input 1 being a velocity command input, input 3 used as a tach feedback input. The positive lead of the motor is connected to load 10 and the negative lead is connected to load high. As an input is applied to the amplifier, the preamp will output a current command that will command one side of the output transistors to come on. This will start current flow in the motor causing it to rotate. As the motor rotates, a tach voltage will be generated. The tach is then fed back to input 3. The tach voltage, being of equal and opposite polarity as the command input (negative feedback), will cancel it as they are summed in the preamp stage. This will decrease the current command on the preamp output.

Without tach feedback, any input command would cause the preamp to saturate. The current command would then be at maximum, causing the output transistors to fully turn on. The amplifier would be saturated and the motor in a runaway condition. Even though the current command would be at maximum, the actual motor current would be low. This is because as the motor rotates, a back EMF voltage is generated by the motor. The actual motor current would be determined by the following formula:

\[
\frac{\text{APPLIED MOTOR VOLTAGE} - \text{BACK EMF VOLTAGE}}{\text{MOTOR RESISTANCE}}
\]

With the amplifier saturated, the full bus voltage would be across the motor. With the motor resistance being constant, the motor current would be a factor of the difference in applied motor voltage to back EMF voltage. This would limit the current to whatever it takes to to overcome internal motor friction which would cause the motor to slow down. This slowing of the motor causes less back EMF voltage to be generated. With less back EMF voltage than applied motor voltage, a motor current will result.
SECTION 2: STEPPING DRIVES
SECTION 3: CONTROLLERS