EXPERIMENT NO.2

OBJECT: To test the performance of Micro-controller based reversible regenerative DC drive using 4-quadrant MOSFET based chopper.

APPARATUS:- 1) Reversible regenerative dc drive using MOSFET
2) CRO DUAL TRACE. (Unearthed)
3) DMM
4) 40 W – Source receptive Lamp

THEORY:-

When variable DC voltage is to be obtained from fixed DC voltage, DC chopper is ideal choice. Use chopper in traction systems is now accepted all over the world. A chopper is inserted in between fixed voltage DC source and the DC motor armature for its speed control below base speed. Chopper drive enables regenerative braking of dc motor and thus K. E. Of the system can be returned to the DC source. This result in overall energy saving which is must welcome feature bin transportation systems suffering heavy slopes and frequent stops. Chopper drive plays important in battery operated vehicles where energy saving is of prime importance.

Choppers can be used for regenerative braking, dynamic braking, combined regenerative and dynamic control of DC drive.

GENERATIVE/ BRAKING CONTROL:

Regeneration concept:

The fundamental torque can for motor load system is $T = T_L + J (dw_m /dt)$

Where, T = instantaneous value of developed motor torque N-m.

T_L = instantaneous value of load [opposing] torque, including function and wind age torque of motor refereed to motor shaft n-m.

J = polar moment of inertia of motor load system referred to the motor shaft, kg-m2

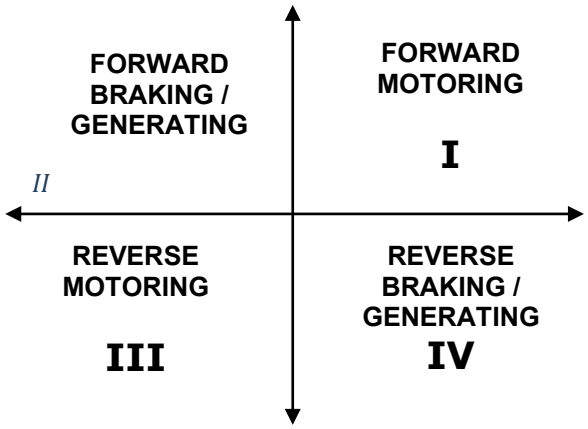
Wm = instantaneous angular velocity of motor shaft, rad / sec

Thus the torque developed by motor is counter balanced by a load torque T_L and a dynamic torque $J (dw_m / dt)$

torque component $J (dw_m /dt)$ is called the dynamic torque because it is present only during the transient operations.

Depending on whether T is greaten it or less than T_L drive operates as motoring [accelerates] or generating [braking / decelerates]

1. During motoring, motor should supply not only the load torque but an additional torque component J (dw_m /dt) in order to overcome the drive inertia. Energy associated with dynamic torque J (dw_m /dt) is stored in the from of K. E. Given by J (dw_m /dt).
2. During generating dynamic torque J (dw_m /dt) has negative sign. Therefore it assists the motor developed torque T and maintain drive motion by extracting energy from stored K. E.



An electric drives operates in three modes.

1. Steady state
2. Acceleration [including starting]
3. Braking [deceleration including stopping]

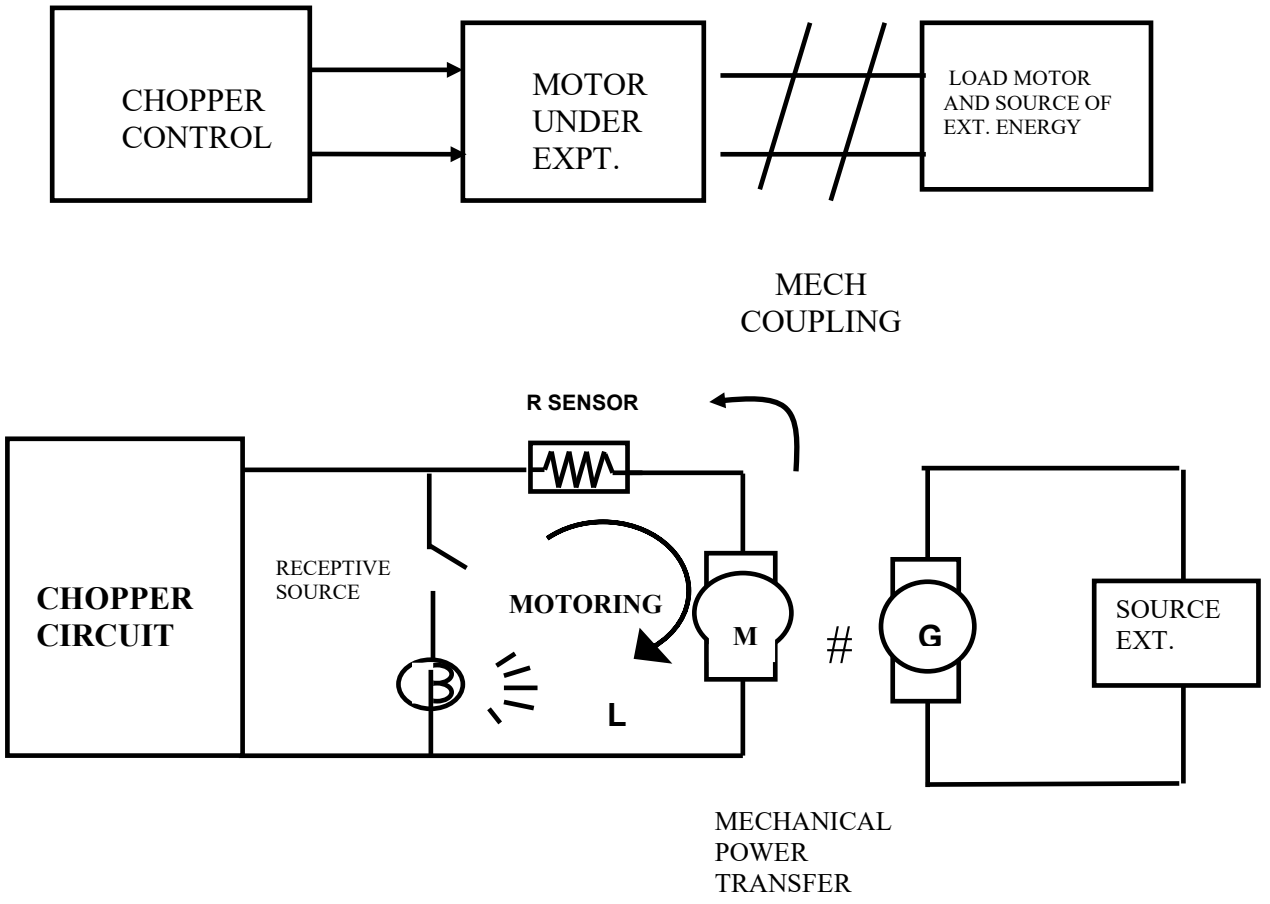
   Acceleration and braking is must for steady state operation. Steady state operation takes place when motor torque equals the load torque

There are two conditions for regenerative quadrant operation:-

Condition 1: The load n [motor] must be able to run due to stored K. E. Or any external source likes gravitational force i.e. it must be generative.

Condition 2: There should be any load for consuming generated energy or the source must be receptive is it must have a capacity to absorb energy generated by a load. When there two conditions are satisfied the regeneration is possible.

CIRCUIT DIAGRAM:-



PROCEDURE:-

MOTOR LOAD:-

1. Connect 230 V plug into mains.
2. Connect the motor generator set[1 HP (DC)] into the 8 pin output plug.
3. Keep direction switch (SW 1) in FWD position.
4. Switch ON the mains using Rocker switch,' FIELD ON' 'yellow LED' glows.
5. Press 'start button'. 'Motor ON''RED LED' glows.
6. Press the increment button and observe the motor speed increases slowly.
7. Observe the waveforms of TP1toTP 9 w.r.t GND with unearthed CRO only
8. Use divide by 10 probes to view this waveform.
9. Observe the o/p waveform TP10 w.r.t TP11 with unearthed CRO only.
10. Note the O/p voltage of DC voltmeter.
11. Measure the output voltage for each press of increment button. .

12. Measure the duty cycle at TP5 for each step of increment button. .
13. Plot the graph of O/P voltage v/s duty cycle.
14. Note the similar reading in a reverse direction by keeping the direction switch REV position.
15. Plot the graph o/p vol. v/s duty cycle on graph paper.
16. Observe the first & third quadrant operation R- sense is added between TP11 & TP12. So you can see the current waveform across these points)
17. Note the reading & fill the observation table.
18. Press the decrement button, the motor speed will decrease and press stop button.
19. Change the direction switch to REV position.

OBSERVATION TABLE:-

Duty Cycle (%)	Armature Voltage(V_{DC})
1	
5	
10	
20	
30	
40	
50	
80	
90	

RESULT:-

FOR ANALYSIS PURPOSE

TEST POINT

TP1: +5 power supply.

TP2: Start button signal

TP3: Stop button signal

TP4: Duty cycle

TP5: FWD direction signal (High when FWD position selected)

TP6 : REV direction signal (High when REW position selected)

TP7 : This signal is available at pin 8 of connector 1 . This INH signal changes when we change the direction of toggle switch .

TP8 : FWD signal is available at Q1 & Q4 of connector 2 Alpha is present at this point , When we select FWD direction.

TP9: REV signal is available at Q2 & Q3 of connector 2 .Alpha is present at this point . When we select REV direction

GND: Control circuit ground.

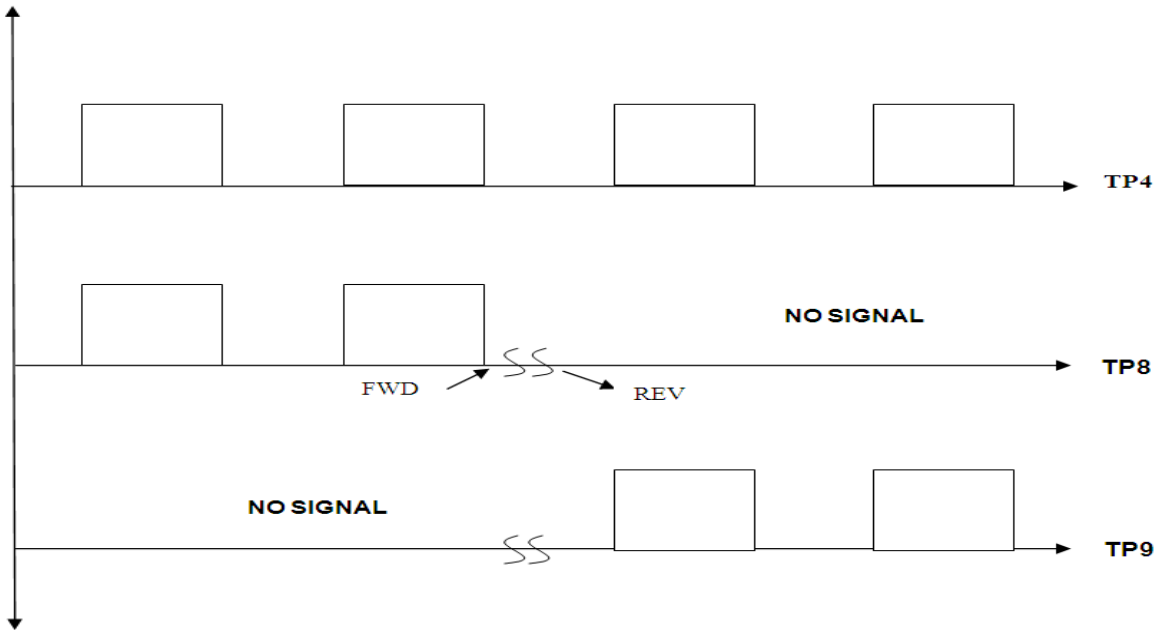
TP10 WRT TP11 : Armature Voltage.

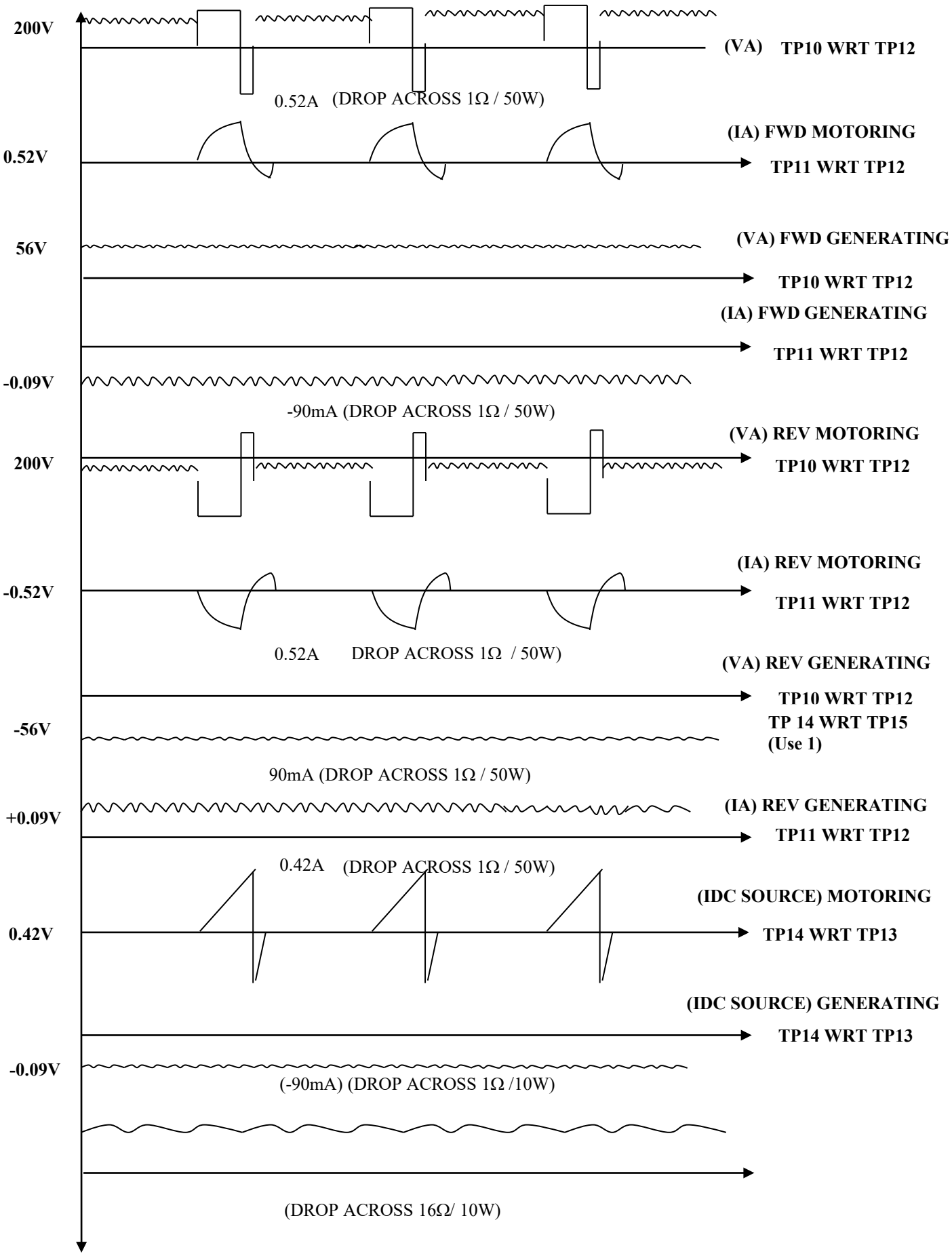
TP11 WRT TP12 : Armature current.

TP14 WRT TP15 : DC Link bus voltage.

TP14 WRT TP13 : DC Link bus Current.

WAVEFORMS




200V
(VA) TP10 WRT TP12
0.52A (DROP ACROSS 1Ω / 50W)
(IA) FWD MOTORING
0.52V
TP11 WRT TP12
56V
(VA) FWD GENERATING
TP10 WRT TP12
(IA) FWD GENERATING
TP11 WRT TP12
-0.09V
-90mA (DROP ACROSS 1Ω / 50W)
(VA) REV MOTORING
200V
TP10 WRT TP12
(IA) REV MOTORING
-0.52V
TP11 WRT TP12
0.52A DROP ACROSS 1Ω / 50W)
(VA) REV GENERATING
TP10 WRT TP12
-56V
TP 14 WRT TP15
(Use 1)
90mA (DROP ACROSS 1Ω / 50W)
(IA) REV GENERATING
+0.09V
TP11 WRT TP12
0.42A (DROP ACROSS 1Ω / 50W)
(IDC SOURCE) MOTORING
0.42V
TP14 WRT TP13
(IDC SOURCE) GENERATING
TP14 WRT TP13
-0.09V
(-90mA) (DROP ACROSS 1Ω /10W)
(DROP ACROSS 16Ω/ 10W)