Operational Strategy for FFD MPC DIFF controller

Specification Overview

Inputs
- Diff control pressure
- Pump Pressure
- Throttle Position
- Foot brake Pressure
- Hand brake Switch
- Lock Switch
- Rear Prop shaft Speed
- Front Prop shaft Speed
- Boost Pressure

Outputs
- Rexroth Valve Drive

Serial Comms for reprogramming and data logging

ECU
- Connection 16 way CPC
- Box size 120 x 100 x 35 mm

Strategies

Lock input / calibration selection

The system has four selectable calibrations and a full pressure setting for fully locking the diff under fault conditions.
The calibrations are selected via the lock input:
- If the lock input is open circuit then full pressure (LOCK mode) will be selected.
- If the lock input is shorted to 0v then calibration 1 is selected.
- If there is a resistance of 1 Kohm between the lock input and 0v calibration 2 is selected
- If there is a resistance of 2 Kohm between the lock input and 0v calibration 3 is selected
- If there is a resistance of 3 Kohm between the lock input and 0v calibration 4 is selected

The system can run with a simple on / off lock switch allowing calibration 1 and LOCK mode only , or using a 5 position rotary switch and 3 1 Kohm resistors to have four fully selectable calibrations and LOCK mode . (See fig 1).

There are 7 programmable options which have an overall effect and are not individually selectable for each calibration:

Lock Pressure

This sets the control pressure when lock is selected

Min value 0 bar
Max value 25.5 bar

Proportional constant, integral constant and dead band
These control the current feed back for the valve

- Proportional Constant should be set to 100
- Integral Constant should be set to 100
- Dead Band should be set to 2

Frequency
Sets the frequency of the control signal to the Valve

- Frequency =1950/Value
- Current value = 13 (150 Hz)
- Min value = 7
- Max value = 255

P-I multiplier and P-I offset
These set the relationship between the demanded control pressure and the control valve current

- Valve current = Control Pressure x P-Im + P-Io
- P-Im x amps /bar
- Current value =.0675
- Min value 0
- Max value .18
- P-Io amps
- Current value 0.5
- Min value 0
- Max value 2.55

Calibration selectable strategies
Each calibration has 5 modes of operation:

- Start
- Hand brake
- Braking
- Accel
- Deccel

The entry and exit for each mode and the control pressure is defined by a set of single value constants and / or one of two look up tables.

Start mode
Priority level 2, can be overridden by LOCK and Handbrake only.
Entry conditions:

- Start mode is enabled if the Front Prop Speed is 0 for 5 seconds
- Exit conditions Front Prop Speed > Start RPM
- Start Rpm
    - Min value = 0
    - Max value = 2550

- Control Pressure = Start Control Pressure
- Start Control Pressure
    - Min value = 0 bar
    - Max value = 25.5 bar
- Mode Code 0 CAL 1
    - 1 CAL 2
    - 2 CAL 3
    - 3 CAL 4

Hand Brake Mode
Priority level 1, can be overridden by LOCK only.
Entry condition:
- Hand Brake switch on

Exit condition:
- Hand Brake switch off

Control pressure set by
Hand Brake Control Pressure
Fixed value 0 bar

Brake Mode
Priority level 3, can be overridden by Start LOCK and Hand Brake
Entry conditions:
- Brake pressure > Foot Brake Pressure Threshold (Option 6)
    - Min Value 0
    - Max value 100 bar

  AND
- Throttle Position < Option 9

  OR
- Left foot braking override
- Foot brake pressure < Option 8 }
- Control Pressure = Option 10
    - Min Value 0 bar
    - Max Value 25.5 bar

Active mode

Entry conditions:
- Filtered Throttle Position - Current Throttle Position > -ve Delta TPS Threshold
    - Min value 0
    - Max Value 255

Exit Conditions:
- Brake pressure < Foot Brake Pressure Threshold
    - Min Value 0
    - Max value 100 bar

  AND
- Filtered Throttle Position - Current Throttle Position > +ve Delta TPS Threshold

    - Min value 0
    - Max Value 255

  OR
- Start or Hand brake mode being selected.
- Control Pressure

The control is set either by the Prop shaft Speed Difference if Foot Brake Pressure / Step = 0 or by the Brake pressure if Foot brake Pressure / Step > 0

If the Foot Brake Pressure / Step = 0 then the Control Pressure is set by a lookup table using Front Speed - Rear Speed as the controlling input.

The scope of the table is defined by:
- Step Size RPM
    - Min value 0
    - Max Value 255 RPM

  AND
- Steps / Arm
    - Min value 0
    - Max Value 25

E.G. If Step Size RPM = 100, Steps/arm = 10, then Control pressure table will have 21 locations covering a speed difference of -1000 RPM to + 1000 RPM.

At each location the Control Pressure can be set
Min value 0
Max value 25.5 bar

If the Foot Brake Pressure / Step >0 then the Control Pressure is set by a look up table using Brake Pressure as the controlling input.

The scope of the table is defined by:
- Front Brake Pressure / Step bar

  AND
- Steps / Arm

E.g. If Front Brake Pressure / Step =2, Steps / Arm = 10, then Control pressure table will have 21 locations covering a Brake Pressure of 0 to 40 bar.
At each location the Control Pressure can be set
Min value 0
Max value 25.5 bar

Run mode
Priority 4, can be overridden by any other mode
Entry conditions:
- No other mode selected

Exit conditions:
- No other mode selected

Control Pressure

The control is set by the Prop shaft Speed Difference with a lookup table using Front Speed - Rear Speed as the controlling input.

The scope of the table is defined by

- Step Size RPM
  - Min value 0
  - Max Value 255 RPM

  AND
- Steps / Arm
  - min value 0
  - Max Value 25

E.G. If Step Size RPM = 100, Steps/arm = 10, then Control pressure table will have 21 locations covering a speed difference of -1000 RPM to + 1000 RPM

At each location the Control Pressure can be set

Min value 0
Max value 25.5 bar

Logging

The Diff control unit can be linked to a data logger via the serial link.
15 parameters are sent to the logger every 20 mSecs allowing a maximum logging rate of 50Hz.

The 15 parameters are:

- Diff speed /100
- Diff speed -100 to +100
- Control Pressure
- Valve current (demanded)
- Valve control Mark Space Ratio
- Diff mode
- Filtered Diff pressure
- Filtered Valve amps
- Front Prop shaft Speed
- Rear Prop Shaft Speed
- Diff Pressure
- Pump Pressure
- Throttle Position
- Valve amps
- Error