Optidrive Applications Support Library

Application Note	AN-ODV-2-027
Title	Master-Slave Network Operation
Related Products	Optidrive HVAC
Level **1**	1 – Fundamental - No previous experience necessary 2 – Basic – Some Basic drives knowledge recommended 3 – Advanced – Some Basic drives knowledge required 4 – Expert – Good experience in topic of subject matter recommended

Overview

The Optidrive HVAC has an on-board Master Slave function, which allows up to 63 drives to be connected together on a communications network, using their RJ45 connectors and the required number of splitters and cables. Drive Address Number 1 acts as the Master, whilst all the remaining drives can be configured as Slaves. The Master drive then outputs its operating state (e.g. Stopped, Running) and output frequency every 30ms. The slave drives will follow the Running / Stopped status of the Master drive, and the Master drive's output frequency becomes the setpoint frequency for all the slave drives. This can then be further scaled as described below to allow speed ratios and offsets to be programmed.

This document describes how to set up a Master-Slave drive network and how to setup the parameters to implement a 'digital gear box' type function.

Connecting the Network

The RJ45 connector on the Optidrive is used to connect the Master-Slave network. Details of the connector configuration can be found in the User Guide. Invertek drives can supply connection cables in various lengths and splitters to allow a network to be quickly and easily connected together. Depending on the overall length of the network cables and number of slaves connected, it may be necessary to install RS485 repeaters in the network.

Each drive requires a unique address to be configured in Parameter P5-01. In the case of the Master drive this <u>must</u> always be address 1. The slave drives can take any address greater than 1, and it is not necessary for the addresses to be consecutive numbers, e.g. a network of three drives can be Address 1 (Master), Address 7 (Slave), and Address 12 (Slave).

Configuring the Master Drive

The Master drive should be configured as required by the application. The drive can operate in any mode except slave mode, e.g. P1-12 can be any value except 5.

Configuring the Slave Drive(s)

Drive Address

Each connected slave drive must have a unique Slave communications address set in P5-01. The range of slave addresses available is 2 – 63.

Note - The Communications address Parameter P5-01 also affects the communication address used by the drive on any connected Fieldbus networks (e.g. Modbus, CAN Open, Profibus, DeviceNet or Ethernet) and the communications address used with Optitools Studio and Optiport / Optipad remote keypads.

Operating Mode

Each Slave must also be configured to operate in Slave Mode using P1-12 = 5.

Minimum and Maximum Speeds

The Slave drive operating speed will always be limited by the programmed Minimum and Maximum Speeds. This means that if the Minimum Speed programmed in the Slave drive is greater than the Minimum Speed programmed in the Master drive, the Slave speed will not follow the Master Speed once operating below the Slave drive minimum speed.

In general, where it is intended for the Slave drive to operate at the same frequency as the Master drive, the minimum speed can simply be left at zero in the Slave drive, and the Slave will then follow the Master drive Minimum Speed.

Acceleration and Deceleration Ramp Times

During Acceleration and Deceleration, the Slave drive operation will be limited by it's own internal ramp times, whilst following the Master drive. This means that if the ramp times in the Slave are longer than those in the Master, the Slave speed will briefly lag behind the Master. When setting Slave ramp times, it is advisable to set as follows :-

$$\text{Slave Ramp Time} \quad = \quad \frac{\text{Master Ramp Time x 100\%}}{\text{Slave Speed Scaling (P2-29)}}$$

Slave Drive Speed Scaling and Offset

Each Slave drive receives the output frequency reference from the Master drive, and this is then used as the Slave drives frequency setpoint. The drives internal parameters then allow an offset and scaling factor to be applied to this reference. This is controlled using parameters P2-28 and P2-29.

P2-28 – Digital Speed Scaling Source & P2-29 Digital Scaling Factor

P2-28	Function	
0	Disabled – No scaling applied.	Slave Output Frequency = Master Output Frequency
1	Fixed digital scaling.	Slave Output Frequency = Master Output Frequency x P2-29
2	Fixed digital scaling with an analog offset.	Slave Output Frequency =(Master Output Frequency x P2-29) + Analog Input 1 Reference
3	Digital and Analog Scaling.	Slave Output Frequency = Master Output Frequency x P2-29 x Analog Input 1 Reference

Analog Input 1 Reference = P0-01 = (Applied Analog Signal Level (%) - P2-32) x P2-31
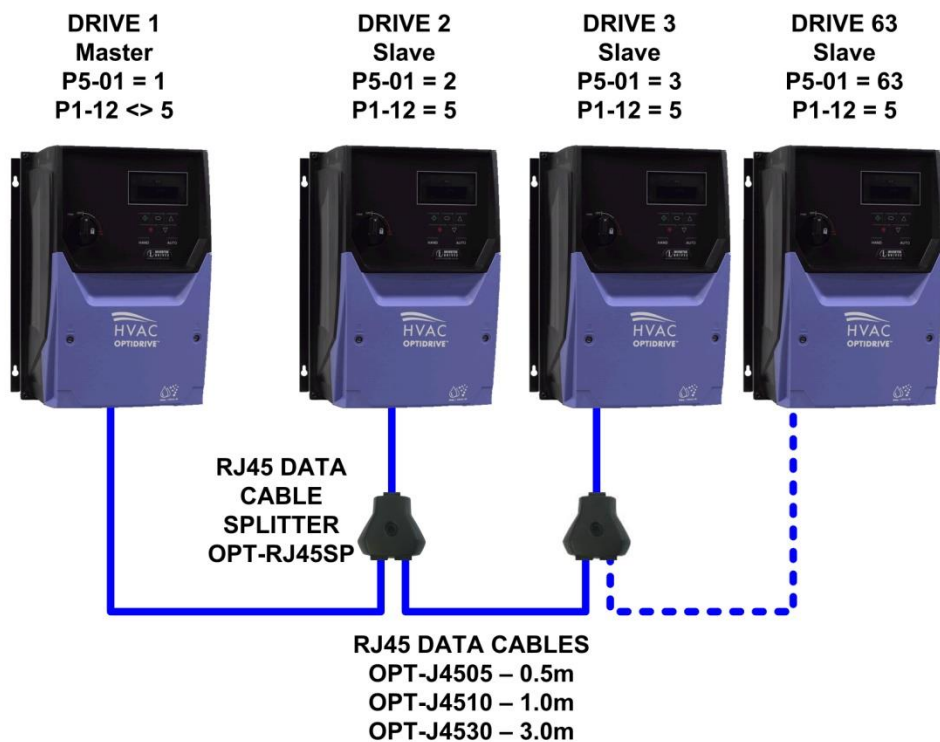
Note: P0-01 cannot be > 100.0%

Master Slave Operation Notes

All Slave drives require an enable signal, e.g. Digital Input 1 (terminal 2) must be closed in order for the Slave to operate. This means that individual Slave drives can be disabled if required by switching off Digital Input 1.

If Digital Input 1 opens during operation, the Slave drive will ramp to standstill at the rate set in P1-04, hence this parameter should be set to a suitable value to ensure correct Master Slave operation, but still allowing adequate stopping time to prevent any nuisance trips.

Master Slave operation can be used in conjunction with other drive functions (e.g. Dynamic braking can be used on all Slaves), and can be combined with Droop Control to provide a very simple load sharing system – see AN-ODP-2-039 for further information.

DRIVE 1
Master
P5-01 = 1
P1-12 <> 5

DRIVE 2
Slave
P5-01 = 2
P1-12 = 5

DRIVE 3
Slave
P5-01 = 3
P1-12 = 5

DRIVE 63
Slave
P5-01 = 63
P1-12 = 5

RJ45 DATA
CABLE
SPLITTER
OPT-RJ45SP

RJ45 DATA CABLES
OPT-J4505 – 0.5m
OPT-J4510 – 1.0m
OPT-J4530 – 3.0m

Note: RJ45 cables and splitters are not IP certified and need to be installed into a suitable enclosure in order to maintain the IP rating of the drive / system.

Practical Examples

Example 1 – Simple Master Slave Operation for Speed Matching

If two or more identical conveyers are required to operate at the same speed, and also to be controlled (e.g. started and stopped) together, the following system can be used.

- Connect the external control circuit or enable signal to the first drive, this will be used as the Master drive.
- Ensure P5-01 = 1 on this drive only
- On each Slave drive, set a unique Slave address in P5-01, e.g. First Slave = set to 2, Second Slave = set to 3 etc.
- On each Slave drive, set P1-12 = 5.
- On each Slave drive, ensure the acceleration (P1-03) and deceleration (P1-04) Ramp Times are set equal to those in the Master drives.
- Connect the RJ45 connectors on all the Optidrives together using the required RJ45 cables and splitters

Example 2 – Scaled Slave Speed

Some applications can require two motors to operate with a scaled offset between the two speeds. This could be required in an Air Handling application with supply and extract fans where a positive pressure is required in the room, hence the extract fan must operate slower than the supply fan, e.g. Extract Fan Speed = 90% of Supply Fan Speed. In this case

- Connect the external control circuit or enable signal to the first drive, this will be used as the Master drive for the Supply Fan.
- Ensure P5-01 = 1 on the Master drive only.
- On the Slave drive, set a unique Slave address in P5-01, e.g. First Slave = set to 2, Second Slave = set to 3 etc.
- On the Slave drive which will be used to control the Extract Fan, set P1-12 = 5.
- In this case, since the Slave drive output speed is intended to be 90% of the Master drive speed, the ramp times of the Slave drive must be set to 90% or less than those of the Master drive.
- On the Slave drive, set P2-28 = 1 and P2-29 = 90.0%
- Connect the RJ45 connectors on all the Optidrives together using the required RJ45 cables and splitters.

When operating the Extract fan will always operate at 90% of the Supply Fan speed, hence if the Master speed is 40Hz, the Slave speed = 40Hz x 90% = 36Hz

Example 3 – Master Slave with Manual Slave Speed Trim (Hz)

Where an application requires the operator to be manually able to adjust a small speed offset between 2 pieces of machinery, this can be very easily achieved using the Master Slave function and a trim pot connected to the Slave drive. For example, the slave speed should follow the Master speed, with the operator being able to trim the speed by + / - 2Hz. This would mean that if the Master drive were to operate at 20Hz, the Slave speed would be 18 – 22Hz depending on the trim pot setting.

- o Connect the external control circuit or enable signal to the Master drive.
- o Ensure P5-01 = 1on the Master Drive only
- o On the Slave drive,
  - o set a unique Slave address in P5-01, e.g. 2.
  - o Select Slave Mode by settting P1-12 = 5
  - o Ensure the acceleration (P1-03) and deceleration (P1-04) Ramp Times are set equal to or less than those in the Master drives.
  - o Assuming a pot is being used to trim the speed, and the pot is connected to terminals 5, 6, & 7 on the slave drive, set P2-28= 2.
  - o Adjusting the possible range of offset is achieved using the offset and scaling parameters for anlog input 1. These can be determined as follows :-
    - ▪ If a negative speed offset is required (e.g. + / - 2Hz), ensure the analog input mode is set for bipolar signals by setting P2-30 = -10 – 10 Volt
    - ▪ Calculate the required value of P2-31 as follows :-
      - • Decide on the trim bandwidth, e.g. if a + / - 3Hz trim is required, the bandwidth will be 6Hz.
      - • P2-31 = Trim Bandwidth / P1-01 (%), e.g. if P1-01 = 80Hz, and a trim of + / - 5Hz is required, P2-31 = 10 / 80 = 12.5%
    - ▪ Set P2-32 = 50%
- o Connect the RJ45 connectors on all the Optidrives together using the required RJ45 cables and splitters.

Example 4 – Master Slave with Manual Slave Speed Trim (%)

In this example, it is desired that the Slave will follow the Master speed reference, but with an adjustable offset as a percentage of the speed reference controlled from a potentiometer connected to Analog Input 1 of the Slave drive.

For example, Slave Speed = Master Speed with +10% / -10% adjustment range.

- o Connect the external control circuit or enable signal to the Master drive.
- o Ensure P5-01 = 1on the Master Drive only
- o On the Slave drive, set a unique Slave address in P5-01, e.g. 2.
- o On the Slave drive, set P1-12 = 5
- o On the Slave drive, ensure the acceleration (P1-03) and deceleration (P1-04) Ramp Times are set equal to or less than those in the Master drives.
- o In this case, the scaling and offset of Analog Input 1 needs to be set to allow the correct adjustment range. When P2-28 = 3, the Slave drive output Frequency is defined as follows :-
  - o Slave Output Frequency = Master Output Frequency x P2-29 x P0-01
  - o P0-01 = (Applied Analog Signal Level % - P2-32) x P2-31
  - o Note : P0-01 cannot be > 100.0%!)
- o From the above formulas, we must determine settings of P2-29, P2-31 and P2-32 to achieve the desired final scaling. This is done as follows :-
  - o Firstly, determine the value required in P2-29. In our example, Slave Speed = Master Speed + 12% / - 25%
  - o P2-29 = 100 + Maximum Scaling required, e.g. for +10%, P2-29 = 110%
  - o From this, we can determine the range for P0-01 (Analog Input 1 Scaled Result) required to achieve the target speed range
  - o When Analog Signal Level = 0%, Slave Speed should be 100 – 10 = 90% of Master Speed
  - o When Analog Signal Level = 100%, Slave Speed should be 100 + 10% = 110% of Master Speed
  - o Since P2-29 = 110%, the required range of P0-01 is
  - o Minimum Level : 90 / 110 (%) = 81.8% (Maximum 1 Decimal Place)
  - o Maximum Level : Always 100%
  - o Then calculate the value of P2-31 as follows :-
  - o P2-31 = P0-01 Maximum – P0-01 Minimum, e.g. 100 – 81.8 = 18.2%
  - o Now determine the value for P2-32 as follows :-
  - o P2-32 = <u>P0-01 Minimum Level</u> x -1, e.g. <u>81.8% x -1</u> = -449.5%
  - o P2-31   18.2%

Note

The possible setting ranges of P2-31 and P2-32 are limited, which will determine the scaling limits possible in any application, e.g.

P2-31 Range = 0.0 to 500.0%

P2-32 Range = -500.0 to + 500.0%

Appendix

Revision History			
Issue	Comments	Author	Date
01	New Application Note Created	JP	02/03/12
02	Updated to new version	KB	28/04/14