

Load Sharing with the Altivar ATV71

Application Guide



Load Sharing with the Altivar ATV71

Contents

Overview	3
Typical DOL Motor Performance	3
DOL load sharing performance	3
Variable Speed Drives - load sharing performance	3
Load sharing using Motor slip	4
Operating principle	4
Set-up Guidelines	4
Load balancing	5
Operating principle	5
Set-up guidelines	6
Master - Slave	7
Operating Principle	7
Master / Slave Set-up Example	8
Master ATV Set-up	8
Slave ATV Set-up	9
Additional Considerations	12
Fault Interlock Set-up	12
Mechanical Brake Control	12
Reference Documentation/Manuals	12



The examples in this Guideline are shown using PowerSuite Software. The Configuration is also straight forward using the provided HMI. Please refer to the programming manual for detailed instructions.

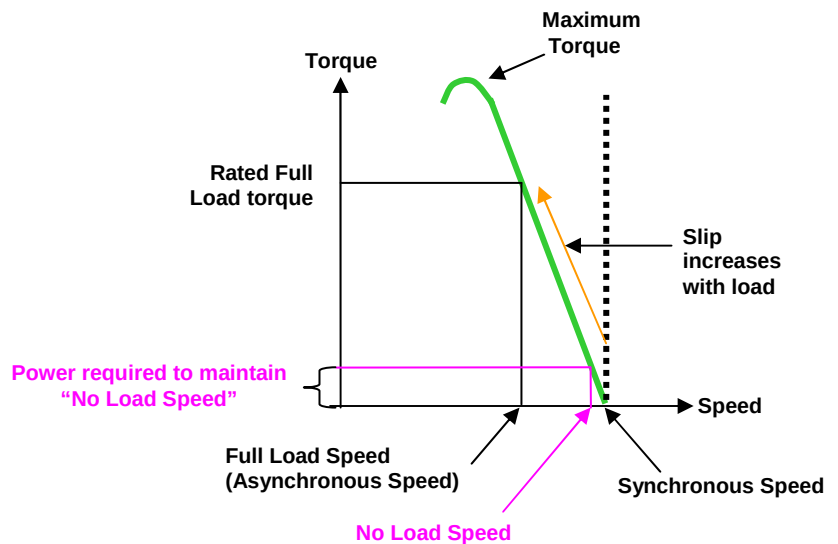
Overview

Many industrial applications require multiple drives mechanically coupled to a common load

When designing a new or retrofitting a multi-motor system, several choices of drive configurations and technologies need to be considered.

Typical DOL Motor Performance

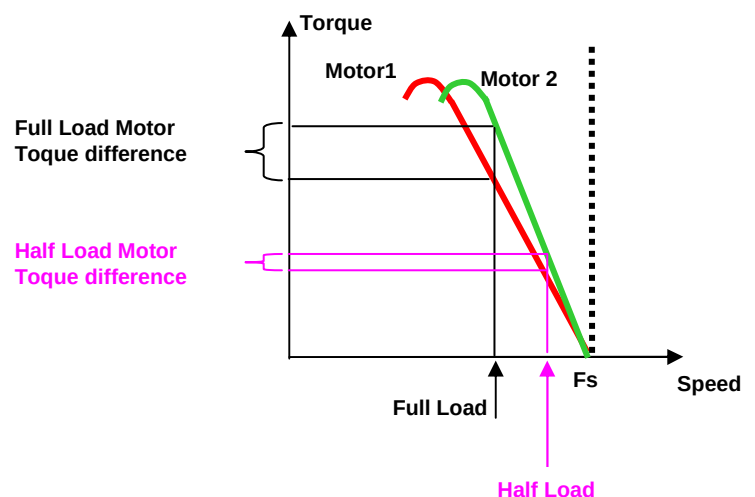
On a fixed frequency supply, motor speed will vary with the connected load. The amount of variation is dependent on the motor slip, which is dependent on the motor design and manufacture.



DOL load sharing performance

If a single load is driven by two motor's, individual motor performance and hence loading, may be different - This is most evident and problematic at maximum load.

As Torque is directly proportional to Current, this could result in one motor running in an overload condition, while the other motor is not yet fully loaded.



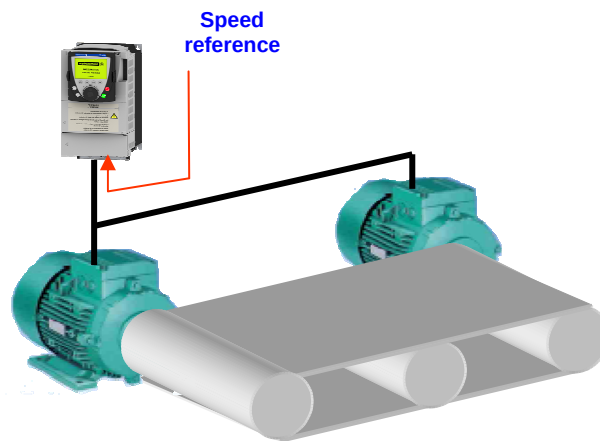
Variable Speed Drives - load sharing performance

This document discusses three different methods of load sharing using the inbuilt functions of the Altivar ATV71

- ❑ Load sharing via natural motor slip.
- ❑ Load balancing.
- ❑ Load sharing in a master/slave configuration.

Load sharing using Motor slip

If two motors are soft-coupled and controlled by one drive, “natural” load sharing can be achieved by disabling slip compensation.



Operating principle

The principle is that as one motor is loaded, the slip increases causing it to slow down, which causes the second motor to load up and also slow. Effectively, the motors are load sharing by varying their slip to cope with the change in load with similar load sharing performance to DOL Systems.

Advantages

- Low Cost
- Simple

Disadvantages

- Optimal performance is only achieved using identical motors.
- The load balance between mismatched motors will deteriorate with increasing loads
- Individual motor protection devices needed
- No possibility to adjust for mechanical equipment

Applications

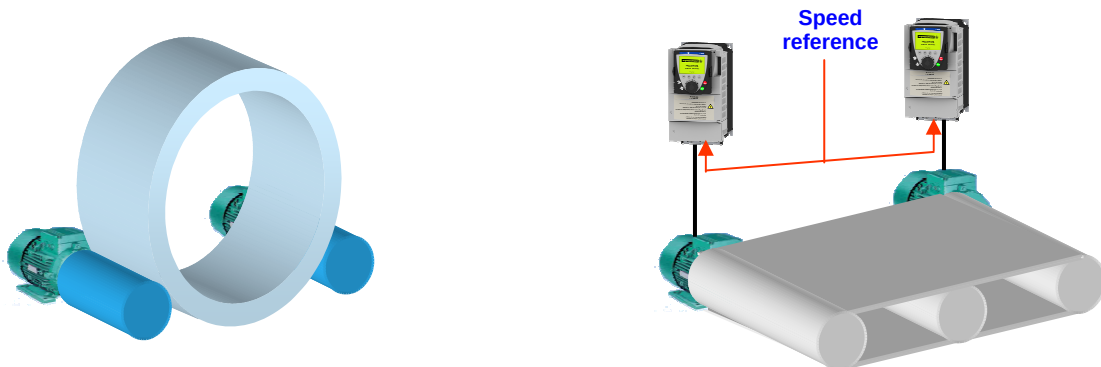
- Conveyors etc

Set-up Guidelines

- Operation only possible in the following motor control modes:
 - V/Hz (No slip compensation is applied when in V/Hz Mode)
 - SVC U (with slip compensation disabled)

Load balancing

When multiple motors are soft-coupled and each is controlled by a VSD, the load sharing function on ATV71 can be used to improve load sharing between the motors.



Operating principle

Load balancing works similar to load sharing via slip compensation discussed in the previous section. However, instead of using the natural slip of the motors, load balancing utilises “artificial” slip generated by the drives.

The load balancing method also provides an effective means for load sharing between different motors as the user is essentially creating customised slip curves.

Advantages

- No interconnection between drives required
- Individual Motor performance is adjustable.

Disadvantages

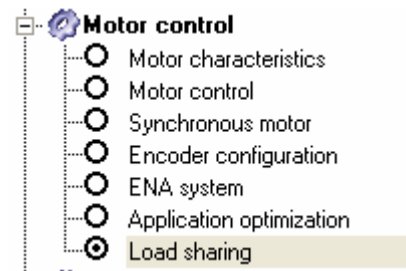
- The load balance between mismatched motors will deteriorate with increasing loads
- No automatic compensation between motors
- Limited adjustments for mechanical equipment

Applications

- Conveyors
- Centrifuges

Set-up guidelines

- Operation possible in all open loop motor control modes
 - Except for V/Hz 2points and V/Hz 5points.
- From the Motor Control menu, select Load Sharing
- When **Load Sharing** is selected to “Yes” the following parameters are accessible



LBA	Load sharing		Yes
LBC	Load correction	Hz	0.0
LBC1	Correction min speed	Hz	0.0
LBC2	Correction max speed	Hz	0.1
LBC3	Torque offset	%	0
LBF	Sharing filter	ms	100

LBC: Load Correction

Enter the desired amount of motor Slip (artificial) required at rated torque.

eg: Increase this value to decrease the amount of load on the motor.

□ LBC1: Minimum Speed to apply Correction

Below this speed no motor slip corrections are made. Slowly increase from 0Hz if unstable operations occur at low speeds

□ LBC2: Max Speed to apply Correction

Above this speed the maximum load corrections are applied.

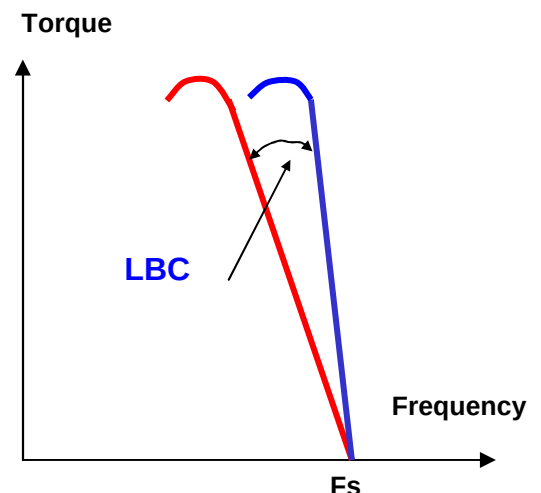
Typically set at the maximum operating speed of the system

□ LBC3: Torque Offset

Minimum motor torque value before any corrections are made
Used to avoid torque instability when torque direction changes.

□ LBF: Sharing Filter

Refers to the time it takes for the motors to reach equilibrium in the event that the load changes. Increase to dampen oscillations caused by flexibility in the mechanical system.



Master - Slave

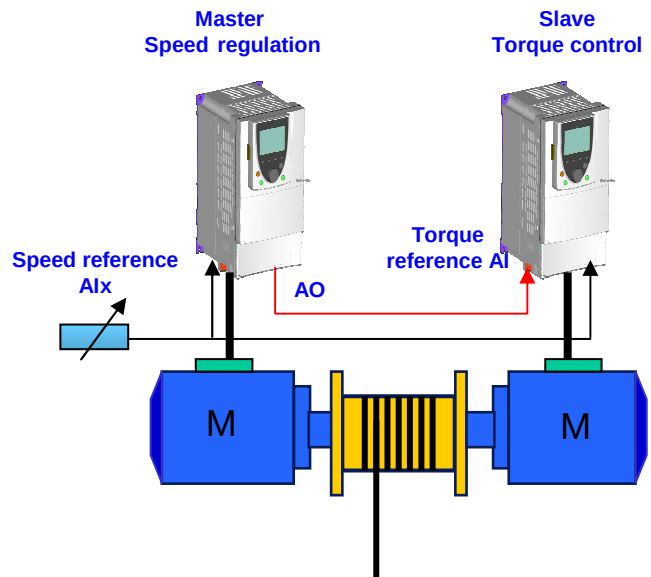
This system is essential for torque sharing applications where two or more motors have their shafts directly coupled together. It is also suitable for soft-coupled motors that require high performance.

Operating Principle

The slave drive is configured to adjust its output to allow for the actual "motor torque" difference between itself and the master to balance the load between each drive.

To achieve this, all Drives receive an identical Speed Reference. The slave drive also receives a Torque reference signal from the master drive. (In case of more than one slave drive, a signal splitter is required suitable for 0-20mA).

The slave drive will then adjust its output to balance the load evenly between the drives. The slave utilises this along with its speed reference (identical for both drives) to adjust its speed, within the specified tolerance,



Advantages

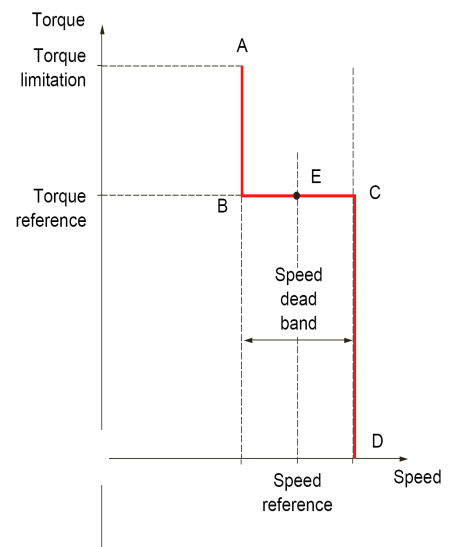
- Fast and Accurate load sharing
- Fully adjustable

Disadvantages

- Interconnection of VSD's required

Applications

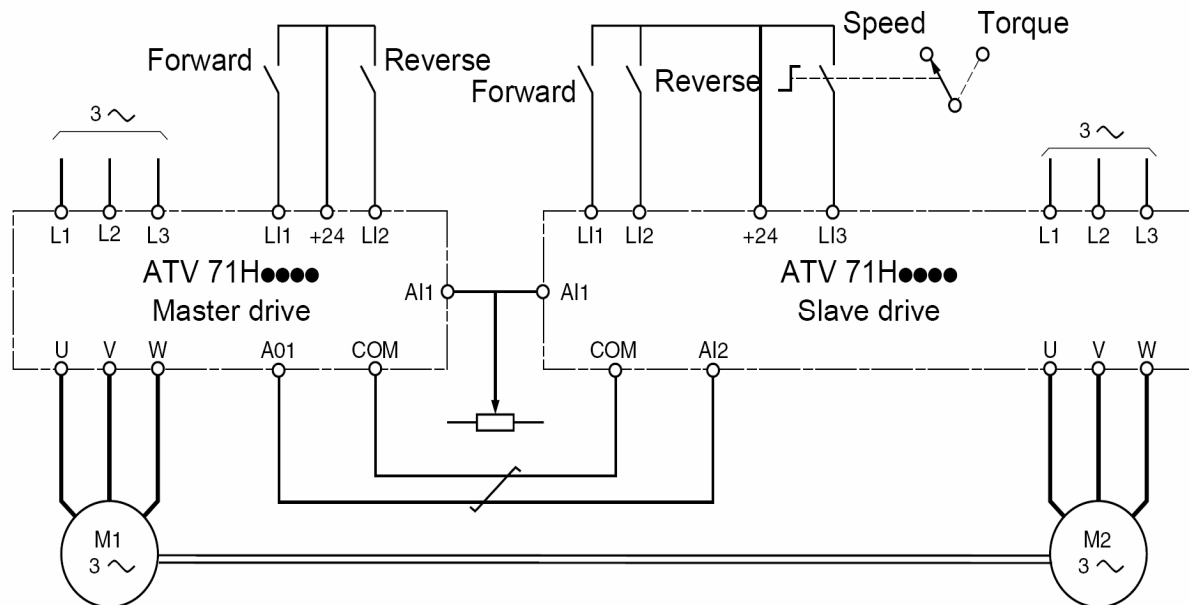
- Hoists
- Winches
- Over-Land Conveyors
- Elevators
- Piggy – back motors eg pumps and crushers.
- Trolleys
- **Any application where two (or more) motors are used to drive a common load**



- AB and CD: "Fallback" to speed regulation
- BC: Torque control zone
- E: Ideal operating point

Master / Slave Set-up Example.

The example is based on a typical application as outlined below.



Notes:

- Ensure that both ATV71's are version 1.2 or greater.
- Both ATV71's require the same Speed Reference as well as Start / Stop Commands.
- Wire between AO1 of the Master and AI2 of the Slave as per the ATV71 catalogue.

Master ATV Set-up

- ❑ Complete standard Drive set up in simple start menu.
Assign the master drives torque to AO1.

Configuration AO1		
A01	A01 assignment	Master / Slave torque
A01T	Configuration of A01	AI in current selected
A0L1	A01 min output value mA	0.0
A0H1	A01 max output value mA	20.0
U0L1	A01 minimum output V	0.0
U0H1	A01 maximum output V	10.0
ASL1	Scaling A01 min	% 0.0
ASH1	Scaling A01 max	% 100.0
A01F	A01 filter	sec 0.00

This signal is transmitted to the slave drive as the "Torque Reference".

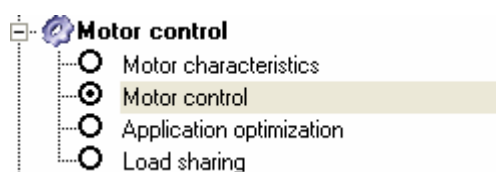
This signal allows for operation in all four motor operating quadrants.

Note: if selecting from the drive HMI, select 4Qt as the output

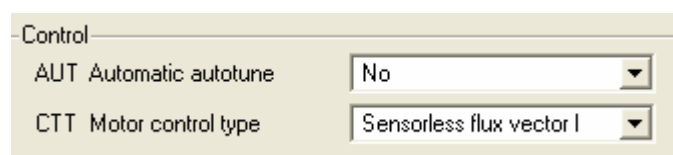
Slave ATV Set-up

1/ Configure the Motor Control

- From the Motor Control Menu, Select Motor Control Type.



- The Slave torque control is only possible in either:
 - Sensorless Flux Vector I, or
 - Closed loop Vector Control with the use of a motor encoder

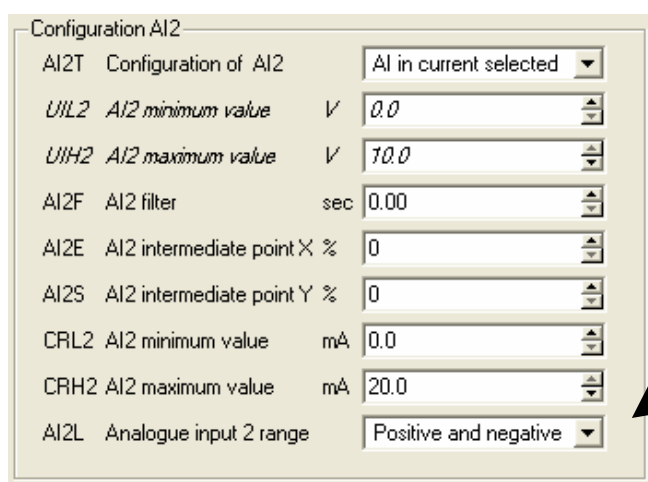
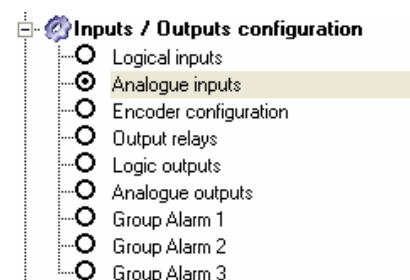


Note: If closed loop Flux Vector Control is used, please refer to the programming manual for required configuration

- Complete standard Drive set up in the “Simply Start” menu.

2/ configure the Inputs

- From the Input / Output Menu, Select Analogue inputs
And then select AI2



- Select and Configure AI2 input.

Only AI2L requires modification.
Change to “Positive and Negative”.
This now matches the output of the Master.

3/ Configure the Torque Control Function

- ❑ From the Application Functions Menu,
- ❑ Select “Torque Control

The following parameters need to be adjusted to suit the individual application

- ❑ **TSS: Torque / Speed Switching.**
Used to select torque or speed control.

Select “yes” for permanent master/slave configuration

If required this can be allocated to a digital input on the drive. This allows for simple selection to allow the drive to run in Speed mode for maintenance purposes.

If an Input is selected to activate his function then an input of:

- ❑ 0 = Speed Mode
- ❑ 1 = Torque Mode

- ❑ **TR1: Torque Reference Channel.**
Used to select torque reference, leave at AI2.

- ❑ **TRT: Torque Ratio.**
Used to apply a coefficient to the torque reference when different mechanical equipment is used.

Adjustable from 0% to 1000%.

The default of 100% is used for equipment with similar ratings

- ❑ **TSD: Torque Reference Sign.**
Used to change the sign of the torque reference, Leave default of “No” unless required for a specific application needing specific control.

- ❑ No = Function Not Active

If Input is selected to activate this function then an input of:

- ❑ 0 = Torque sign is the same as reference
- ❑ 1 = Torque sign is the opposite to the reference

- ❑ **TRP: Torque Ramp Time.**
Sets the rise and fall times based on a 100% torque

The screenshot displays a configuration window for torque control with the following sections and parameters:

- Torque control/Torque reference**
 - TSS Torq/Speed switching: Logic input LI3
 - TR1 Torque ref. channel: Analog input AI2
 - TRT Torque ratio: 100%
 - TSD Signed torque reference: Not assigned
- Torque control stop**
 - TRP Torque ramp time: 3.00 sec
 - SPT Spin time: 1.0 sec
 - TST Torque control stop type: Speed
- Deadband and Time Out**
 - DBP Torque reg + deadband Hz: 10.0
 - DBN Torque reg - deadband Hz: 10.0
 - RTO Torque control time out: 60.0 sec
 - TOB Torque control fault mgt: Alarm

□ **TST: Torque Control Stop.**

Select different methods of how the slave drive will stop when in torque control mode.

- Speed (SPD): Speed regulation stop, in accordance with the stop type configuration
- Freewheel (YES): Freewheel stop
- Spin (SPN): Zero torque stop, but maintaining the flux in the motor. This type of operation is only possible when using Closed loop Flux Vector Control

□ **SPT: Spin Time.**

Spin time, activated if “spin” is chosen for “torque control stop” as per TST above.

Spin method can only be employed when using Closed loop Flux Vector Control.

This sets the time the motor remains fluxed after a “Torque Controlled Spin Stop”

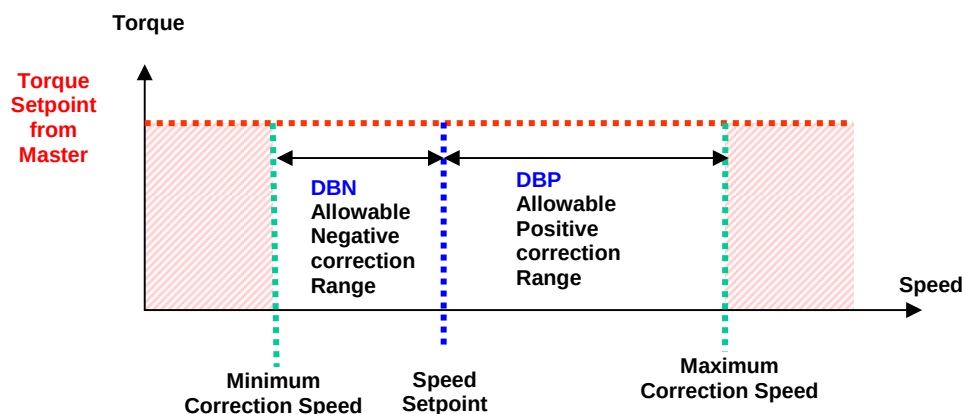
□ **Torque Regulation Limits**

DBP: Torque Regulation +ve Deadband.

&

DBN: Torque Regulation -ve Deadband

This sets the allowable amount of speed limit allowable for Torque correction around the speed set point.



RTO: Torque Control Time Out.

Sets the time that the positive or negative dead band is at limit before an alarm occurs.

Once the speed tolerance has been reached one of the following scenarios will occur:

- 1 The torque returns to within the limits set and then torque control will resume;
- Or
- 2 The torque does not return to the required value and an adjustable time elapses, causing a fault or alarm condition depending on which is configured

□ **TOB: Torque Control Fault Management.**

Drives response in the event that the “Torque Control Time Out” elapses.

Selectable between: Alarm, Freewheel to stop etc,

Additional Considerations

Fault Interlock Set-up

Most applications require an external fault interlock to be set-up between the two VSD's when load sharing.

This is simply set up by wiring a signal from each drive to the other,

On each drive

- Wire a relay output that has been configured as a Fault output to an unused input of the other drive.
- These inputs are then configured as an "External Fault" input.
- This trips each drive if one drive is in a fault condition.

Mechanical Brake Control

If each motor has an individual mechanical brake, or a common brake is used, all brakes should be controlled from the Master Drive Output.

A delay equal to "Opening Time" of the brakes should be programmed into the slave drives run command.

Refer to the ATV71 programming manual for more information on Brake control logic.

Reference Documentation/Manuals

ATV71 Simplified Manual

The main manual required for basic ATV71 installation, programming and fault finding.

ATV71 Installation Manual

A comprehensive description of the installation and wiring of the ATV71

ATV71 Programming Manual

A comprehensive description of all the ATV71 functions and parameters.

ATV71 Communication Parameters

Contains a list of the ATV71 parameter addresses and describes the various operating modes specific to serial communications.

Not required if the start/stop and reference controls are achieved via the standard digital and analogue I/O.

ATV71 Communication Manuals

Contains useful information on the connection and diagnostics of the drives over various Networks.

These manuals are not required unless the corresponding protocol is required for remote control and Supervision of the system.