MOTOR CONTROLLER SPECIFICATION

APACHE 120 / 240V

1. Scope

This specification defines the basic characteristics for a motor controller Apache 120 / 240V, originally develop for laundry applications. This motor controller will run Fisher & Paykel Technologies motors using Sensorless Vector control and provides the features listed in this specification.

2. Motor Controller Operation

Control Features

- Spin control of speed, acceleration and direction.
- Agitation control with a profile defined by acceleration, plateau speed, plateau time and pause time

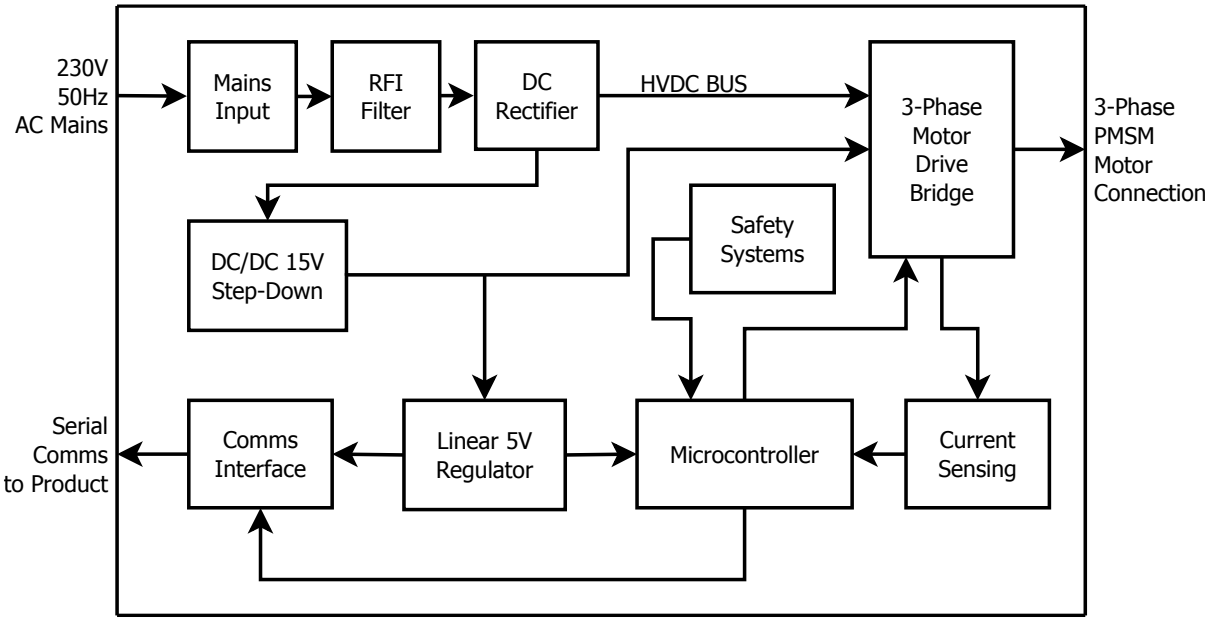
Feedback Features

The controller can measure and report the following quantities during operation:

- Fault Registers – fault status of the controller and connected motor
- Bridge Temperature – the measured temperature of the power section of the controller
- DC-link bus voltage
- Instantaneous and Average motor current
- Motor status – what mode of operation the motor is currently in (Idle, Spinning, Agitation etc.)
- Motor Temperature – the estimated motor temperature using the built-in thermal model and motor winding resistance measurement during startup.
- Motor Speed – the current motor speed in RPM

3. Specification – Motor Controller

Functional Block Diagram



Functional block diagram of the Motor Control Module and external connections

Absolute Maximum Ratings (240V operation)

Use of the control outside of these maximum ratings may cause irreversible damage or improper operation of the controller.

Rating	Symbol	Minimum	Maximum	Units
Utility Mains Input Voltage	V_{MAINS}	160	264	V
RMS Motor Output Current (per motor phase)	I_{MOTOR}	-	5	A
Motor Output Power*1	P_{MOTOR}(Av)	-	800	W
Supply Voltage for Communications Interface	V_{CC}(COMMS)	0	13	V
Ambient Temperature of Surrounding Air	T_{AMB}	0	50	°C
Ambient Humidity of Surrounding Air *2	RH_{AMB}	20	95	%RH

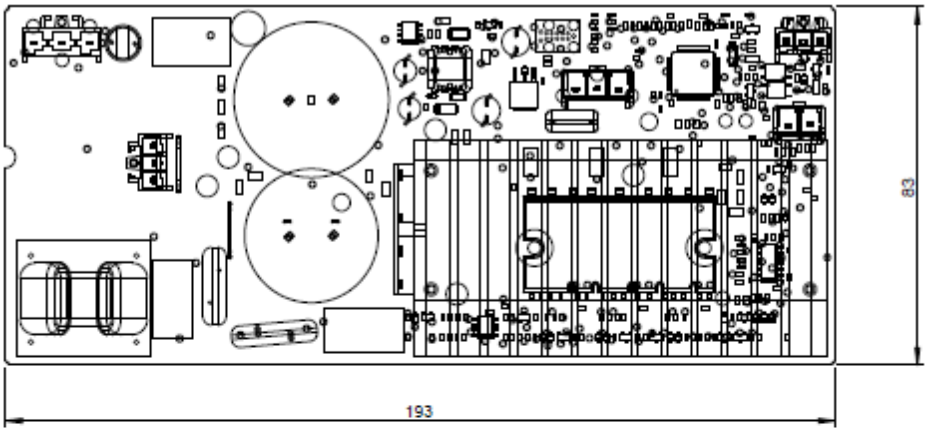
*1 – Averaged over a 10 second period

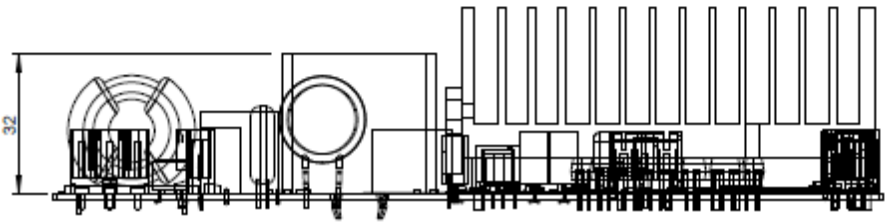
*2 – Ambient temperature and humidity conditions should be maintained such that condensation does not form on or inside the controller module

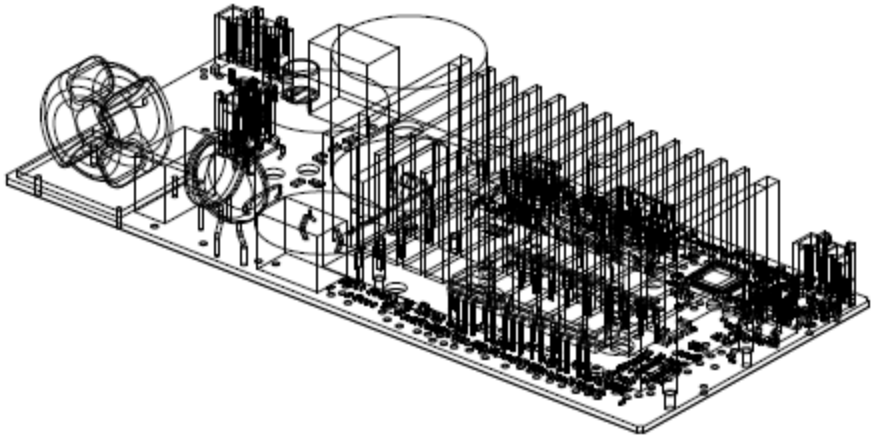
Connector Pin Description

Connector	Pin	Name	Function
P101 Mains Input	1	EARTH	Earth connection to the RFI Filter (not used)
	2	NEUTRAL	Utility mains voltage input connection – Neutral line
	3	PHASE	Utility mains voltage input connection – Phase / Active line
P171 Motor Connection	1	MTR_A_OUT	Output connections to the motor. It is important that these are connected in the correct polarity or the motor may not spin in the correct direction when driven
	2	MTR_C_OUT	
	3	MTR_B_OUT	
P231/P233 Isolated Comms	1	0V	0V reference connection for the isolated comms bus
	2	Rx/Tx	Serial communications signal
	3	+9V/+12V	+9V/+12V power supply for the isolated comms bus

Physical Dimensions







Serial Communications Interface

The serial communications interface is implemented as a single-wire open-collector half-duplex serial communications link. The signaling rate is 4800bps, using UART communications signaling standard with 8 Data bits, No Parity, 1 Stop bit.

The open-collector interface is non-inverting, NPN output with the open-collector pulling down to 0V. Nominal input/output impedance is 10KΩ.

The communication protocol for the motor control is the F&P protocol

4. Compliance and Standards

This controller has been evaluated to UL 60730 4th edition and IEC 60730 4th edition. This section contains the conditions of usage that are required to maintain this compliance in the end-use installation.

Temperature Limits

The following parts of the assembly have temperature limitations imposed by compliance with UL/IEC 60730. These temperatures are end-use dependent and it is the responsibility of customer (application manufacturer) to ensure that these components do not exceed these limits during ***normal operation*** (as defined by IEC 60335 Cl.11).

- Temperatures should be measured with a thermocouple (K-type or T-type) with the thinnest possible wire gauge to ensure that the heatsinking effect of the thermocouple wire is minimised.

- The Performance Temp. Limit (if specified), is included to ensure reliable operation of the controller. Although a higher limit is allowed under UL/IEC 60730 4th edition requirements, Fisher & Paykel recommends that these components do not exceed these limits.

Number	Location	Location Description	Standards Temp. Limit	Performance Temp. Limit
1	P101	Nearest to pin P104	Reference	-
2	F101	Centred, on Top	85°C	-
3	C101	Centred, on Top	105°C	-
4	C106	Centred, on Top	105°C	95°C
5	L121	Centred, on Top	110°C (Class B)	-
6	P171	Centred, on pin 2	Reference	-
7	U251	Measuring air temperature 1.5mm above the top centre of the IC	Reference	-
8	L102	Centred in inner radius at the Bottom	110°C (Class B)	-
9	C103	Centred, on Top	105°C	-
10	R101	On lead, close to the PCB	130°C (PCB Limit)	110°C
11	C105	Centred, on Top	105°C	-
12	K101	Centred, on Top	105°C (Class E)	-
13	D101	Either of the middle two legs, close to the PCB	130°C (PCB Limit)	110°C
14	U171	On the side of the case, close to the heatsink at the end opposite D101	130°C	100°C *1
15	HEATSINK	Centred on the fin above D101 at the bottom	Reference	90°C
16	U121	Centred on the top	Reference	100°C

*1) IPM has an internal temperature sensor which limits the bridge temperature to 105°C. If the measured internal temperature reaches 105°C the motor drive will be disabled.

Safety Functions

The following safety functions of the controller are declared as part of this evaluation:

- Locked-Rotor protection – detects the motor locked-rotor condition and prevents operation under this condition
- Loss-of-Phase protection – detects an open-circuit condition in any of the motor winding circuits and prevents operation under this condition
- Motor Winding Over-Temperature protection – uses a thermal model to prevent over-temperature conditions in the motor windings
- Automatic Restart – the minimum automatic recovery period after a fault condition is detected is guaranteed

Rating	Symbol	Minimum	Typical	Maximum	Units
Locked Rotor Detection Time	t_{DETECT}(LR)	5	-	10	s
Loss of Phase Detection Time	t_{DETECT}(LOP)	0.5	-	10	s
Motor Winding Temperature Limit	$T_{OVERTEMP}$	-	170	200	°C
Automatic Restart Time	$t_{RESTART}$	1	-	10	s