A Nidec Group Company Nidec All for dreams	Document Type	**TECHNICAL SPECIFICATION**
	Component	Washing Machine Bus Communication Protocol
	Customer	Elaraby
	Nidec Motor (Qingdao) Corporation	

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1. REVISED HISTORY

Rev	Date	Written by	Modification	Status
V01	2020/04/25	Gasel Qiu	First document release	Preliminary
V02	2020/05/09	Gasel Qiu	1. Redefined frame package 2. Added a NACK command 3. Deleted FRAME SPECIFIC HANDLING clause 4. Modified MASTER CONTROLS COMMUNICATION	Released
V03	2020/05/17	Gasel Qiu	1. Report inverter version # in Ping ACK 2. Added fault table	Revised
V04	2020/09/29	Gasel Qiu	1. Report Weight Value in Request ACK (5.2) 2. Added a clutching-declutching command (5.12)	Revised
V05	2020/10/12	Gasel Qiu	1. Added an Enable/Disable forced brake command (5.13)	Revised
V06	2021/4/25	Gasel Qiu	1. Modified clutching-declutching command to implement new tooth finding procedure. 2. Modified weight detection function, changing weight detection and request command frames content accordingly. 3. Added a motor free shaft spin command (5.14) 2. Added a FCT test command (5.15)	Revised
V07	2023/11/07	Gasel Qiu	1. Removed clutching-declutching command (5.12)	Revised

2. INTRODUCTION

A communication protocol is working as BUS transmitting and receiving information between master and slave nodes. It is a 'single master, multiple slaves' bus with one wire, where a master starts all transmissions and only one selected slave answers the requested information. The communication will always be half duplex. Periodically, the master has the bus control, transmits a communication frame towards one of the nodes, and waits to receive an answer. The slaves only reply messages from the master. They do not start a communication unless they receive a frame from the master.

In this application, the master is a machine control and the slave should be an inverter

3. TRANSMISSION PARAMETERS

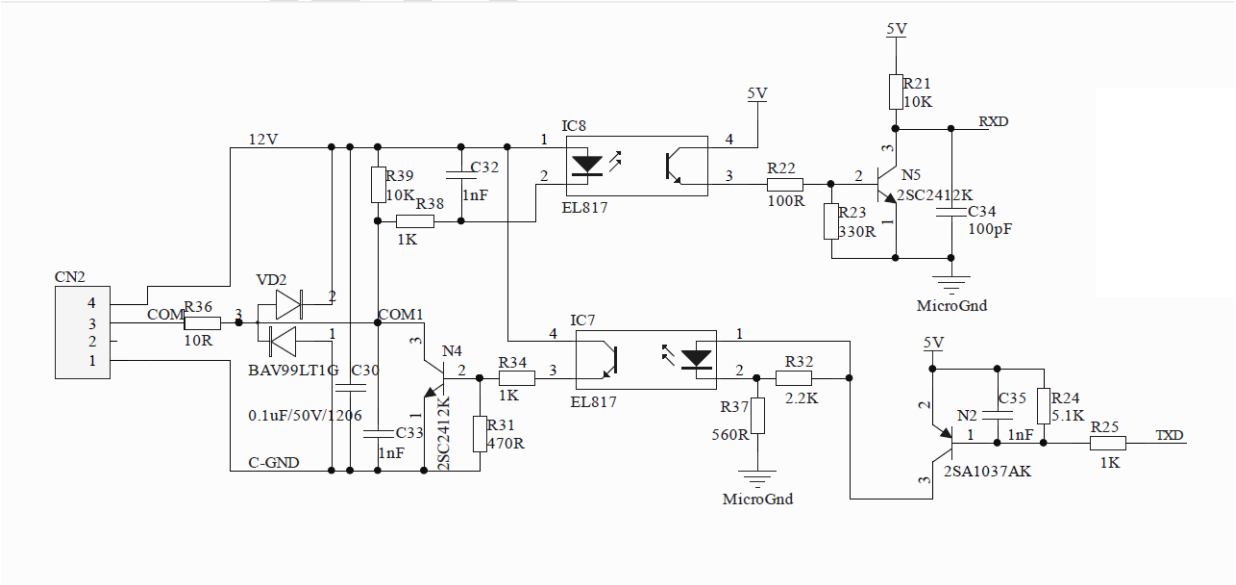
Communication connector

Inverter part

Pin	Definition
1	GND
2	*Reserved*
3	Data (TX/RX)
4	VCC

Typical circuit

Inverter part



Communication type	Asynchronous
Start Byte Transmission	One start bit
Stop Byte Transmission	One stop bit
Bit Check	Odd parity
Number of information bits	8
Bits order	LSB first
Communication	Half duplex
Baud Rate	4800
Checksum	CRC@

Note: @ A XOR result of all frame bytes.

4. GENERIC FRAME DEFINITION

4.1 Machine control to inverter

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8	Byte9	Byte10	Byte11
Header	Mode									CRC check byte
A5										*A XOR of all frame bytes*

The frame length is fixed and be 11 bytes (includes CRC byte)

Header: 10100101 (Hex A5)

Mode: refer to "5. TYPES OF FRAME"

CRC check byte: A XOR of all frame bytes

4.2 Inverter to machine control

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
Header	Mode					CRC check byte
A5 (or5A)						*A XOR of all frame bytes*

The frame length is fixed and be 7 bytes (includes CRC byte)

Header: 10100101 (Hex A5), or 01011010 (Hex 5A) as NACK

Mode: refer to "5. TYPES OF FRAME"

CRC check byte: A XOR of all frame bytes

5. TYPES OF FRAME

Item	Command	Description	Mode
1	**Ping**	Set up washer type	0x02
2	**Request**	Polling motor onsite	0x05
3	**CW rotation**	CW drive motor	0x09
4	**CCW rotation**	CCW drive motor	0x0B
5	**Agitation**	Wash tumble pattern	0x0C
6	**Spin**	Set specific speed as target	0X0D
7	**Stop**	Stop motor to 0 speed	0X27
8	**Brake**	Brake motor to 0 speed quickly	0X29
9	**Voltage detection**	Request DC bus voltage	0X2B
10	**Weight detection enable**	Enable load weight detection	0X2C
11	**Fabric detection enable**	Enable load fabric type detection	0x2D
12	**Clutching - declutching**	Slowly turn on motor in CW and CCW direction	0x19
13	**Enable/Disable Forced brake**	Force motor to stop in any situation	0x1B
14	**Motor free shaft spin**	Motor spin without machine's basket	0x1D
15	**FCT test**	FCT test Nidec inverter manufacturing	0x66

5.1 Ping command

Ping command intends to tell inverter the washer type of motor working with. Should be sent to inverter after power up every time before letting motor to work.

Platform is the related parameter. It can be a washer volume data as distinguishable parameter. For example, 6kg, 7kg, 8kg, etc. Corresponding platform should be 0x06, 0x07, 0x08, etc.

Empty raw weight data is this washer's empty basket raw weight data. If this data is 0, inverter will not do any adjustment on gotten weight raw data in weight detection process. If this data is not 0, inverter will adjust weight raw data by adding delta between this data and original table's empty basket raw data. This adding data maybe positive or negative.

A5	02	Platform	Empty raw weight data High byte	Empty raw weight data Low byte	00	00	00	00	00	CRC

Ping ACK

A5	02	Platform	Version number High Byte	Version number Low Byte	00	CRC

5.2 Request command

Request command is for holding communication continuous as a filling while no special command needs to be sent. Should be sent every one second at least. Since there is a communication fault handling, the fault will be reported while no communication for 6 seconds.

A5	05	00	00	00	00	00	00	00	00	CRC

Request ACK

A5	05	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	Weight Value (*100g)	CRC

If Weight Value has not detected, report 0

5.3 CW rotation command

CW rotation command intends to drive motor running in a clockwise direction at specific motor speed.

A5	09	Motor Speed High byte	Motor Speed Low byte	Time Accel High byte (*100ms)	Time Accel Low byte (*100ms)	00	00	00	00	CRC

CW ACK

A5	09	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	00	CRC

5.4 CCW rotation command

CCW rotation command intends to drive motor running in a counter clockwise direction at specific motor speed.

A5	0B	Motor Speed High byte	Motor Speed Low byte	Time Accel High byte (*100ms)	Time Accel Low byte (*100ms)	00	00	00	00	CRC

CCW ACK

A5	0B	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	00	CRC

5.5 Agitation command

Agitation command intends to drive motor running with a wash tumble pattern at specific motor speed.

A5	0C	Motor Speed High byte	Motor Speed Low byte	Time Accel (*100ms)	Time Decel (*100ms)	Time CW on (*100ms)	Time CW off (*100ms)	Time CCW on (*100ms)	Time CCW off (*100ms)	CRC

Agitation ACK

A5	0C	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	00	CRC

5.6 Spin command

Spin command intends to drive motor spin with specific acceleration time at specific motor speed.

A5	0D	Motor Speed High byte	Motor Speed Low byte	Time Accel High byte (*100ms)	Time Accel Low byte (*100ms)	00	00	00	00	CRC

Spin ACK

A5	0D	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	00	CRC

5.7 Stop command

Stop command intends to control motor to stop to 0 speed (close loop).

A5	27	00	00	00	00	00	00	00	00	CRC

Stop ACK

A5	27	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	00	CRC

5.8 Brake command

Brake command intends to stop motor to 0 speed as fast as possible (open loop).

A5	29	00	00	00	00	00	00	00	00	CRC

Brake ACK

A5	29	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	00	CRC

5.9 Voltage detection command

Voltage detection command is for requesting present DC bus.

A5	2B	00	00	00	00	00	00	00	00	CRC

Voltage ACK

A5	2B	Error	DC bus High byte	DC bus Low byte	00	CRC

5.10 Weight detection enable command

Weight detection enable command intends to enable motor to start weight measuring process. This process will be complete in 35 seconds usually. And needs motor working at wash status (clutch be released).

In the beginning of machine cycle running, machine control will transfer this washer's empty raw weight data to inverter by sending the ping command.

After weight measurement has finished, detected weight raw data will be adjusted according to this washer's empty raw weight data. Then calculate the linear (physical) weight data by comparing with stored raw weight table which was gotten by testing on large number of washers. The report linear weight unit is 100g.

Empty raw weight data is this washer's empty basket raw weight data. If this data is 0, inverter will not do any adjustment on gotten weight raw data in weight detection process. If this data is not 0, inverter will adjust weight raw data by adding delta between this data and original table's empty basket raw data. This adding data maybe positive or negative

A5	2C	00	00	00	00	00	00	00	00	CRC

Weight detection ACK

A5	2C	Error	Raw weight data High byte	Raw weight data Low byte	Weight Value (*100g)	CRC

If Weight Value has not detected, raw weight data and weight value all report 0.

Weight value (linear data) and raw data will be reported at the same time.

Raw weight data can be gotten as this washer's empty raw data during washer manufacturing by sending this command with empty basket.

5.11 Fabric detection enable command

~~5.12 Clutching - declutching command~~

~~The clutch is in released status during wash agitation. On the contrary, the clutch is in pulled open during spin. To avoid the clutch gear working in a half clutch state, need to slowly turn the motor to make the clutch find tooth properly and can go to next step.~~

- ~~**NEW tooth finding procedure:**~~

1. ~~When switching from washing to spinning, the motor should rotate counter clockwise for 3 turns at a low speed (at least 1 turn, without shaking), if view from pulsator, it should be clockwise 3 turns. Then starts counterclockwise spinning.~~
2. ~~When spinning switching to washing, firstly rotate at right direction then rotate at left direction with low speed~~

~~This change is controlled by machine control through release clutch (or pull open clutch). Therefore, machine control can send a command to inverter to do slowly turn on (CW – CCW). This behavior is called Clutching – declutching movement.~~

~~A5~~	~~19~~	~~Wash2spin 1 /Spin2wash 0~~	~~00~~	~~00~~	~~00~~	~~00~~	~~00~~	~~00~~	~~00~~	~~CRC~~

~~Clutching - declutching ACK~~

~~A5~~	~~19~~	~~Error~~	~~Actual Motor Speed High byte~~	~~Actual Motor Speed Low byte~~	~~Movement has done or not? 1 – done 0 – not~~	~~CRC~~

5.13 Enable/Disable Forced brake command

Enable forced brake command intends to be able to force the motor to stop in any situation. And will hold the brake status until gets disable command to release. For example, can stop the motor immediately even if the motor is rotated by hand.

Disable forced brake command intends to release forced brake.

The byte 2 of this command if the parameter of “Enable” or “Disable”. 1 is enable and 0 is disable.

A5	1B	Enable/ Disable	00	00	00	00	00	00	00	CRC

Forced brake ACK

A5	1B	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	Enabled/ Disabled 1 – enabled 0 – disabled	CRC

5.14 Motor free shaft spin command

Motor free shaft spin command intends to drive motor standalone spin with specific acceleration time at specific motor speed.

A5	1D	Motor Speed High byte	Motor Speed Low byte	Time Accel High byte (*100ms)	Time Accel Low byte (*100ms)	00	00	00	00	CRC

Spin ACK

A5	1D	Error	Actual Motor Speed High byte	Actual Motor Speed Low byte	00	CRC

5.15 FCT test

FCT test need to get motor all related useful information as below ACK frame shows. This command only be used in Nidec inverter manufacturing process.

A5	66	12	00	34	00	56	00	78	00	CRC

FCT ACK

A5	66	Error High byte	Error Low byte	Actual Motor Speed High byte	Actual Motor Speed Low byte	IPM Temp High byte	IPM Temp Low byte	IPM Model + Bus Volt High byte	Bus Volt Low byte	Phase Current High byte	Phase Current Low byte	CRC

5.16 NACK

All above commands are from machine control send to inverter. Inverter will ack for each receiving. If the received frame is correct, inverter will ack with accordingly ACK above. And if

the received data CRC is incorrect or mismatching, inverter should ack a NACK frame for informing.

5A	00	FF	00	FF	00	CRC

6. MASTER CONTROLS COMMUNICATION

Periodically, master must transmit frame data to slaves. The periodicity is not fixed, but the recommendation is 500ms (1 second at least). It is meaning, if there is not any command need to send to inverter, main control needs to send request command to inverter as a polling to make sure the communication on duty. Slaves will not reply if there is not frame. Master needs resend previous frame after 100ms did not get replay from the slave. It is meaning, main control has sent a command then changed to received mode to get inverter reply. After 100ms has not received inverter reply, main control needs to resend last command again. This repeat can last for 6 seconds. After 6 seconds master can consider a communication fault occurred if there is still not reply from inverter.

7. SLAVES COMMUNICATION ERROR HANDLING

Slave is monitoring the bus all the time. If in 6 seconds does not see activity in the bus the motor will stop automatically and report communication fault to master.

8. FAULT TABLE

Fault Status Code	Fault Item	Time report to Main control	Motor Action	Fault Description
0x01	General fault	right now	Stop Motor to zero speed and then report fault code to main control, don't clear fault code except power off.	Micro related class B fault occurred
0x02	IPM over temperature	2s	Stop Motor to zero speed and then report fault code to main control, clear fault code after 4 seconds.	IPM temperature >= 95°C or IPM temperature circuit error
0x04	DC Bus voltage fail（>500V）	10ms	Stop Motor to zero speed and then report fault code to main control, clear fault code after 4 seconds.	DC Bus voltage fail（>500V）
0x04	Bus over voltage	200ms(477V), 2s(450V)	Stop Motor to zero speed and then report fault code to main control, clear fault code after 4 seconds.	DC Bus voltage >=470V in 200ms, or DC Bus voltage >=450V in 2s
0x08	Motor stall or tacho signal missing	4s	Stop Motor to zero speed and then report fault code to main control, clear fault code after 4 seconds.	Agitation - report to main control when detected motor stall 10 times in one minute. Spin - report to main control when detected motor stall one time.
0x10	Hardware over current	right now	Stop Motor to zero speed and then report fault code to main control, clear fault code after 4 seconds.	Agitation - report to main control when detected over current 5 times. Spin - report to main control when detected over current one time.
0x20	Bus under voltage	2s	Stop Motor to zero speed and then report fault code to main control, clear fault code after 4 seconds.	DC Bus voltage <=190V
0x40	Lost phase	4s	Stop Motor to zero speed and then report fault code to main control, clear fault code after 4 seconds.	Agitation - report to main control when detected lost phase 5 times in one minute. Spin - report to main control when detected lost phase one time.
0x80	Motor over temperature	right now	Stop Motor to zero speed and then report fault code to main control, clear fault code if temperature drop to 125°C or time last 20 seconds. 125°C or time last 5 minutes.	Detected winding temperature one time per 5 minutes (when motor stop), report fault when winding temperature > =140°C