



# Optidrive Applications Support Library

<b>Application Note</b>	<b>AN-ODE-3-038</b>
<b>Title</b>	<b>Modbus RTU Control and Register Mapping</b>
<b>Related Products</b>	<b>Optidrive E3</b>
<b>Level</b> <b>3</b>	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

Optidrive E3 drives support Modbus RTU communication, allowing a network of drives to be controlled and monitored by any Modbus RTU capable PLC or control system. The Optidrive is always a Slave to an external Modbus RTU Master. This document describes the registers and functions available.

## Modbus RTU Protocol Specification

Protocol	Modbus RTU
Error check	CRC
Baud rate	9600bps, 19200bps, 38400bps, 57600bps, 115200bps (default)
Data format	1 start bit, 8 data bits, 1 stop bits, no parity.
Physical signal	RS 485 (2-wire)
User interface	RJ45

## Modbus Telegram Structure

The following Modbus RTU Commands are supported

- 03 Read Holding Registers
- 06 Write Single Holding Register

The telegram structure is as follows:-

Command 03 – Read Holding Registers				
Master Telegram			Slave Response	
	Length			Length
Slave Address	1	Byte	Slave Address	1 Byte
Function Code (03)	1	Byte	Function Code (03)	1 Byte
1 <sup>st</sup> Register Address	2	Bytes	Data Length	1 Byte
No. Of Registers	2	Bytes	1 <sup>st</sup> Register Value	2 Bytes
CRC Checksum	2	Bytes	2 <sup>nd</sup> Register Value	2 Bytes
			Etc...	
			CRC Checksum	2 Bytes

Command 06 – Write Single Holding Register				
Master Telegram			Slave Response	
	Length			Length
Slave Address	1	Byte	Slave Address	1 Byte
Function Code (06)	1	Byte	Function Code (06)	1 Byte
Register Address	2	Bytes	Register Address	2 Bytes
Value	2	Bytes	Register Value	2 Bytes
CRC Checksum	2	Bytes	CRC Checksum	2 Bytes

## RJ45 Data Connection Pin Configuration

1	CAN-
2	CAN+
3	0 Volt
4	Optibus / Remote Keypad / PC Connection -
5	Optibus / Remote Keypad / PC Connection +
6	+24 Volt Remote Keypad Power Supply
7	RS 485- Modbus RTU
8	RS 485+ Modbus RTU
Data Format is Fixed at:	
1 start bit, 8 data bits	
1 Stop bit, No parity	
Baud rate and address set in P-36	

## Modbus RTU Register Map

**Table 1: Control and status registers**

Note : All registers are Holding Registers

Register Number	Parameter Number	Upper byte	Lower Byte	Format	Min	Max	Command	Type	Scaling
1	-	Control Word		WORD	-	-	03,06	R/W	See Below
2	-	Frequency Setpoint		S16	-5000	5000	03,06	R/W	1dp, e.g. 100 = 10.0Hz
3	-	Reserved		-	-	-	03,06	R/W	No function
4	-	Modbus ramp control time		U16	0	60000	03,06	R/W	2dp, e.g. 500 = 5.00s
5	-	High Resolution Frequency Setpoint		S16	-30000	30000	03	R	See Below
6	-	Error code	Drive status	WORD	-	-	03	R	See Below
7	-	Output Frequency		S16	0	5000	03	R	1dp, e.g. 100 = 10.0Hz
8	-	Motor Current		U16	0	-	03	R	1dp, e.g. 100 = 10.0A
9	-	Motor Torque		S16	0	2000	03	R	1dp, e.g. 100 = 10.0%
10	-	Motor Power		U16	0	-	03	R	2dp, e.g. 100 = 1.00kW
11	P00-04	Digital Input Status		WORD	-	-	03	R	See Below
12	P00-20	Rating ID		U16	-	-	03	R	Internal Value
13	P00-20	Power rating		U16	-	-	03	R	2dp, e.g. 37 = 0.37kW / HP
14	P00-20	Voltage rating		U16	-	-	03	R	See Below
15	P00-18	IO processor software version		U16	-	-	03	R	2dp, e.g. 300 = 3.00
16	P00-18	Motor control processor software version		U16	-	-	03	R	2dp, e.g. 300 = 3.00
17	P00-20	Drive type		U16	-	-	03	R	Internal Value
18	P00-48	Scope Channel 1 Data		S16	-	-	03	R	See Below
19	P00-48	Scope Channel 2 Data		S16	-	-	03	R	See Below
20	P00-01	Analog 1 input result		U16	0	1000	03	R	1dp, e.g. 500 = 50.0%
21	P00-02	Analog 2 input result		U16	0	1000	03	R	1dp, e.g. 500 = 50.0%
22	P00-03	Pre Ramp Speed Reference Value		S16	0	5000	03	R	1dp, e.g. 500 = 50.0Hz
23	P00-08	DC Bus Voltage		U16	0	1000	03	R	600 = 600 Volts
24	P00-09	Drive Power Stage Temperature		S16	-10	150	03	R	50 = 50°C
25	P00-30	Drive Serial Number 4		U16	-	-	03	R	See Below
26	P00-30	Drive Serial Number 3		U16	-	-	03	R	
27	P00-30	Drive Serial Number 2		U16	-	-	03	R	
28	P00-30	Drive Serial Number 1		U16	-	-	03	R	
29	-	Relay Output Status		WORD	0	1	03	R	Bit 0 Indicates Relay Status 1 = Relay Contacts Closed
30	-	Reserved		-	-	-	03	R	No Function
31	-	Reserved		-	-	-	03	R	No Function
32	P00-26	kWh Meter		U16	0	9999	03	R	1dp, e.g. 100 = 10.0kWh
33	P00-26	MWh Meter		U16	0	-	03	R	10 = 10MWh
34	P00-10	Running Time – Hours		U16	-	-	03	R	1 = 1 Hour
35	P00-10	Running Time – Minutes & Seconds		U16	-	-	03	R	100 = 100 Seconds
36	P00-14	Run time since last enable – Hours		U16	-	-	03	R	1 = 1 Hour
37	P00-14	Run time since last enable – Minutes & seconds		U16	-	-	03	R	100 = 100 Seconds
38	-	Reserved		U16	-	-	03	R	No Function
39	P00-20	Internal Drive Temperature		S16	-10	100	03	R	20 = 20C
40	-	Speed Reference (Internal Format)		U16	0	P-01	03	R	3000 = 50Hz
41	-	Reserved		-	-	-	03	R	No Function

Register Number	Parameter Number	Upper byte	Lower Byte	Format	Min	Max	Command	Type	Scaling
42		Digital Pot / Keypad Reference		U16	0	P-01	03	R	3000 = 50Hz
43	P00-07	Output Voltage		U16	0	-	03	R	100 = 100 Volts AC RMS
44	-	Parameter Access Index		U16	1	60	03	R	See Below
45	-	Parameter Access Value		S16	-	-	03	R	See Below

**Format**

WORD = WORD Format, functions assigned to individual bits

S16 = Signed 16 Bit Integer

U16 = Unsigned 16 bit Integer

**Control and Status Register Descriptions****Read-Write Registers****Register 1: Drive Control Word**

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
High byte								Low byte							

Bit 0: Run/Stop command: Set to 1 to enable the drive. Set to 0 to stop the drive.

Bit 1: Fast stop request. Set to 1 to enable drive to stop with 2<sup>nd</sup> deceleration ramp.

Bit 2: Reset request. Set to 1 in order to reset the drive if drive is under trip condition.

User must clear this bit when drive is under normal condition to prevent un-expected reset.

Bit 3: Coast stop request. Set to 1 to issue a coast stop command.

For normal operation, Bit 3 has the highest priority, bit 0 has the lowest priority (bit 3>bit 1>bit 0). For example if user set command as 0x0009, drive will do a coast stop rather than run. For normal run/start, just set this register to 1.

Note that stat/stop (bit 0), fast stop (bit 1) and coast stop(bit 3) only works if P-31= 0 or 1. Otherwise, start/stop function is controlled by drive control terminals. Reset function (bit 2) works all the time as long as drive is operated under Modbus control mode (P-12=3 or 4).

**Register 2: Speed Reference**

This register holds the speed reference value with one decimal place (200 = 20.0Hz). The maximum speed reference value is limited by P-01. Either register 2 or register 5 can be used for speed reference control, however only one reference should be used in any control system, otherwise unexpected behaviour can result.

**Register 4: Acceleration / Deceleration Ramp Time**

Active only when P-12 = 4, this register specifies the drive acceleration and deceleration ramp time. The same value is applied simultaneously to the acceleration and deceleration ramp times. The value has two decimal places, e.g. 500 = 5.00 seconds.

**Register 5: High Resolution Speed Reference**

This register allows the user to set the speed reference value in the internal format, e.g. 3000 = 50.0Hz. This allows control resolution to 1 RPM with a 2 pole motor . The maximum allowed value is limited by P-01.

Either register 2 or register 5 can be used for speed reference control, however only one reference should be used in any control system, otherwise unexpected behaviour can result.

**Read Only Registers****Register 6: Drive status and error code**

High byte gives drive error code. (Valid when the drive is tripped, see Appendix E – Drive Fault Code and Information for further details)

Low byte gives drive status information as follows :-

Bit 0: 0 =Drive Stopped, 1 = Drive Running

Bit 1: 0 = OK, 1 = Drive Tripped

Bit 5: 0 = OK, 1 = In Standby Mode

Bit 6: 0 = Not Ready, 1 = Drive Ready to Run (not tripped, hardware enabled and no mains loss condition)

**Registers 18 & 19 : Scope Channel 1 & Scope Channel 2 Data Values**

These registers show the scope present data sample value for the first two scope channels. The channel data source selection is carried out through Optitools Studio.

**Registers 25 - 28: Drive Serial Number**

The drive serial number may be read using these four registers. The serial number has 11 digits, stored as follows:-

Register 28		Register 27				Register 26		Register 25		
x	x	x	x	x	x	x	x	x	x	x

e.g.

Register 25	1										
Register 26	1										
Register 27	8745										
Register 28	57										
Drive Serial Number	5	7	8	7	4	5	0	1	0	0	1

**Indirect Parameter Access Registers**

Optidrive E3 allows Read / Write access to all user adjustable parameters using a simple method as detailed below. This is achieved using the following two Modbus registers.

**Register 44: Drive parameter index**

This index value will be used by register 45 to carry out parameter read and write function. The valid range of this parameter is from 1 to 60 (maximum number of drive user adjustable parameters)

**Register 45: Drive parameter value**

When reading this register, value represents the drive parameter value which index is specified by register 44.

When write to this register, value will be written to the drive parameter which index is specified by register 44.

**Parameter Read Method**

In order to read a parameter, firstly write the parameter number to register 44, then read the value from register 45, e.g. to Read the Value of P-01

- Write 1 to Register 44
- Read the Value of Register 45

**Parameter Write Method**

Writing parameter values can be achieved by the same method, however Register 45 is used to write the parameter value after the parameter number has been selected using Register 44, e.g. to Write a Value of 60.0Hz to parameter P1-01

- Write 1 to Register 44
- Register 45 will return the present value of P-01, which can be Read if required
- Referring to the parameter table shown in Appendix A: Parameter Registers and Scaling, apply any scaling necessary
  - In this case, 60.0Hz = 3600
- Write the scaled value to Register 45. P-01 now changes to 60.0Hz, or an exception code may be returned.

## Appendix A: Parameter Registers and Scaling

All user adjustable parameters within the drive are accessible by Modbus, and can be Read or Written to. For further information regarding the parameter functions and specific settings, please refer to the User Guide.

Register	Parameter	Description	Format	Min	Max	Data format / scaling
129	01	Max speed limit	U16	0	5*P-09	Internal value (3000 = 50.0Hz)
130	02	Min speed limit	U16	0	P-01	Internal value (3000 = 50.0Hz)
131	03	Accel ramp time	U16	0	60000	2dp, e.g. 300=3.00s
132	04	Decel ramp time	U16	0	60000	2dp, e.g. 300=3.00s
133	05	Stop Mode	U16	0	2	0: Ramp to stop + Mains Loss Ride Through 1: Coast to stop 2: Ramp to stop + Fast Stop 3 : AC Flux Braking + Fast Stop
134	06	Energy Optimiser	U16	0	1	0: Disabled 1: Enabled
135	07	Motor rated voltage	U16	0	250 500	400 = 400 Volts
136	08	Motor rated current	U16	0	Drive Rating Dependent	1dp, e.g. 100 = 10.0A
137	09	Motor rated frequency	U16	25	500	Data unit is in Hz
138	10	Motor rated speed	U16	0	30000	Maximum value equals to the sync speed of a typical 2-pole motor
139	11	Boost Value	U16	0	Drive Rating Dependent	1dp, e.g. 100 = 10.0%
140	12	Control mode	U16	0	6	0: Terminal Control 1: Keypad forward only 2: Keypad forward and reverse 3: Modbus control mode 4: Modbus control with ramp control 5 : PID control 6 : PID control with analog speed sum 7 : CAN Open 8 : CAN Open + Ramp Control 9 : Slave Mode
141	13	Application Mode	U16	0	2	0 : Industrial Mode 1 : Pump Mode 2 : Fan Mode
142	14	Access code	U16	0	9999	No Scaling
143	15	Digital input function	U16	0	17	See user guide for function details
144	16	Analog input format	U16	0	7	0: 0...10V 1: b 0...10V 2: 0...20mA 3: t 4...20mA 4: r 4...20mA 5: t 20...4mA 6: r 20...4mA 7 : 10...0V
145	17	Effective switching frequency	U16	0	5 (Drive Rating Dependent)	0 = 4KHz 1 = 8KHz 2 = 12KHz 3 = 16KHz 4 = 24KHz 5 = 32KHz
146	18	Relay Output Function	U16	0	9	See user guide for function details
147	19	Digital Threshold	U16	0	1000	100 = 10.0%
148	20	Preset Speed 1	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
149	21	Preset Speed 2	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
150	22	Preset Speed 3	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
151	23	Preset Speed 4	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
152	24	2 <sup>nd</sup> Ramp	U16	0	2500	2dp e.g. 250 = 2.50s
153	25	Analog Output Function	U16	0	10	See user guide for function details
154	26	Skip Frequency Centre	U16	0	P-01	Internal value (3000 = 50.0Hz)
155	27	Skip Frequency Band	U16	0	P-01	Internal value (3000 = 50.0Hz)
156	28	V/F Adjust Voltage	U16	0	P-07	100 = 100V
157	29	V/F Adjust Frequency	U16	0	P-09	50 = 50Hz
158	30	Start Mode Select	U16	0	6	0: Edgr-r 1: Auto_0 2...6: Auto_1 to Auto_5
159	31	Keypad restart mode	U16	0	7	See user guide for details
160	32	DC Injection	WORD	See Below		
161	33	Spin Start Enable	U16	0	2	See user guide for function details
162	34	Brake circuit enable	U16	0	4	See user guide for function details
163	35	Analog Input / Slave Scaling	U16	0	20000	1000 = 100.0%
164	36	Communication Settings	WORD	See Below		

Register	Parameter	Description	Format	Min	Max	Data format / scaling
165	37	Access code definition	U16	0	9999	
166	38	Parameter lock	U16	0	1	0: Unlocked 1: Locked
167	39	Analog input offset	U16	-5000	5000	1dp, e.g. 300=30.0%
168	40	Display Scaling Function	WORD	See Below		
169	41	User PI P gain	U16	1	300	1dp, e.g. 10 = 1.0
170	42	User PI I time constant	U16	0	300	1dp, e.g. 10 = 1.0s
171	43	User PI mode select	U16	0	1	See user guide for more information
172	44	User PI reference select	U16	0	1	See user guide for more information
173	45	User PI digital reference	U16	0	1000	1dp, e.g. 100 =10.0%
174	46	User PI feedback select	U16	0	3	See user guide for more information
175	47	Analog Input 2 Format	U16	0	6	0: 0...10V 1: 0...20mA 2: t 4...20mA 3: r 4...20mA 4: t 20...4mA 5: r 20...4mA 6: Ptc-th
176	48	Standby Mode Timer	U16	0	250	1dp, e.g. 250 = 25.0s
177	49	PI Wake Up Error Level	U16	0	1000	1dp, e.g. 50 = 5.0%
178	50	User Relay Output Hysteresis	U16	0	1000	1dp e.g. 100 = 10.0%
179	51	Motor Control Mode	U16	0	4	0 : IM Vector 1 : V/F 2 : PM Motor 3 : BLDC Motor 4 : SynRM Motor
180	52	Motor Parameter Autotune	U16	0	1	
181	53	Vector Mode Gain	U16	0	2000	1dp, e.g. 500 = 50.0%
182	54	Maximum Current Limit	U16	0	1750	1dp, e.g. 1000 = 100.0%
183	55	Motor Stator Resistance	U16	0	65535	2dp, e.g. 100 = 1.00R
184	56	Motor Stator d-axis Inductance (Lsd)	U16	0	65535	1dp, e.g. 1000 = 100.0mH
185	57	Motor Stator q-axis Inductance (Lsq)	U16	0	65535	1dp, e.g. 1000 = 100.0mH
186	58	DC Injection Speed	U16	0	P-01	3000 = 50.0Hz
187	59	DC Injection Current	U16	0	1000	1dp, e.g. 100 = 10.0%
188	60	Thermal Overload Retention	U16	0	1	

## Additional Information

### Register 160 : DC Injection Configuration

The parameter value is stored as a combined 16 bit word which is constructed as follows :-

High Byte								Low Byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DC Injection Mode								DC Injection Duration : 1dp, e.g. 0 – 250 = 0.0 – 25.0s							
0 : DC Injection on Start															
1 : DC Injection on Stop															
2 : DC Injection on Start & Stop															

### Register 164 – Communications Configuration

This Register entry contains multiple data entries, as follows:-

High Byte								Low Byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Trip Configuration				Baud Rate				Drive Address							

Data values can be interpreted as follows :-

Drive Address	1 to 63	
Baud Rate	0	115k2
	1	115k2
	2	9k6
	3	19k2
	4	38k4
	5	57k6
	6	115k2
	7	115k2
	8	115k2
	9	115k2
	10	115k2
Trip Time Set-up	0	Comms Loss Trip Disabled
	1	30ms Watchdog, Trip on Comms Loss
	2	300ms Watchdog, Trip on Comms Loss
	3	1000ms Watchdog, Trip on Comms Loss
	4	3000ms Watchdog, Trip on Comms Loss
	5	30ms Watchdog, Ramp To Stop on Comms Loss
	6	300ms Watchdog, Ramp To Stop on Comms Loss
	7	1000ms Watchdog, Ramp To Stop on Comms Loss
	8	3000ms Watchdog, Ramp To Stop on Comms Loss

### Register 168 : Display Scaling

The parameter value is stored as a combined 16 bit word which is constructed as follows :-

High Byte								Low Byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Display Scaling Source								Display Scaling Factor : 3dp, e.g. 0 – 16000 = 0.000 – 16.000							
0 : Motor Speed															
1 : Motor Current															
2 : Analog Input 2 Signal															
3 : PI Feedback															

## Appendix B - Modbus Exception Response Telegrams

Under some circumstances, the drive may reply with an Exception Response (error) in response to a request telegram sent from the network master, for example where the master tries to read a register which does not exist. Exception Responses which can be generated by the drive are listed below:-

### ***Exception Code 1: Invalid Request***

Returned under the following conditions

- Network Master sends an unsupported Modbus command (e.g. Read Coils).
- Run command issued to drive whilst the drive is not set for Modbus Control Mode (e.g. P1-12 <>4).
- Run command issued to drives whilst the drive is not enabled (e.g. Digital Input 1 is open).
- Run command issued to drive whilst the drive is in a tripped condition.

### ***Exception Code 2: Invalid Modbus register***

Returned under the following conditions

- Network Master attempts to read or write a register that does not exist within the drive.

### ***Exception Code 3: Register Value Out of Range***

Returned under the following conditions

- Network Master attempts to write a holding register with a value outside the range of the register

### ***Exception Code 6: Drive Busy***

Returned under the following conditions

- Drive busy due to internal data transfer. The Network Master should re-send the message after a delay



**Appendix C : Dataflow example:*****Read data from register 6***

Request: [01] [03] [00] [05] [00] [01] [94] [0B]  
 (Drive Addr) (Command) (Reg start addr) (No. of Registers) (Checksum)

Reply: [01] [03] [02] [00] [00] [B8] [44]  
 (Drive Addr) (Command) (No of data bytes) (Data) (Checksum)

Note: The actual start address of register 6 is 5. All data in [ ] is in 8bits Hex format.

Write start command to the register 1 (suppose P-12 = 3, P-15 =0 and digital input 1 is closed):

Request: [01] [06] [00] [00] [00] [01] [48] [0A]  
 (Drive Addr) (Command) (Reg addr) (Data value) (Checksum)

Reply: [01] [06] [00] [00] [00] [01] [48] [0A]  
 (Drive Addr) (Command) (Reg addr) (Data value) (Checksum)

Note: The actual address of register 1 on the data link is 0. All data in [ ] is in 8bits Hex format.

Reply can be error message depending on drive parameter settings and digital input status.

## Appendix D - Register Changes for Single Phase Output Drives

The Single Phase Output drive has some registers that are different to the standard three phase output drive, as listed below :-

Register Number	Parameter Number	Upper byte	Lower Byte	Format	Min	Max	Command	Type	Scaling
2	-	Frequency Setpoint		S16	0	5000	03,06	R/W	1dp, e.g. 100 = 10.0Hz
9	-	Reserved		-	-	-	-	-	-
10	-	Motor Power		U16	0	-	03	R	2dp, e.g. 100 = 1.00kW
40	-	Speed Reference (Internal Format)		U16	0	P-01	03	R	3000 = 50Hz

Register	Parameter	Description	Format	Min	Max	Data format / scaling
134	06	Reserved	-	-	-	No Function
139	11	Boost Value	U16	0	Drive Rating Dependent	1dp, e.g. 100 = 10.0%
141	13	Reserved	U16	-	-	No Function
148	20	Preset speed 1	U16	0	P-01	3000 = 50Hz
149	21	Preset speed 2	U16	0	P-01	3000 = 50Hz
150	22	Preset speed 3	U16	0	P-01	3000 = 50Hz
151	23	Preset speed 4	U16	0	P-01	3000 = 50Hz
160	32	Boost Frequency	U16	0	1500	1dp, e.g. 100 = 10.0s
161	33	Boost Period Duration	U16	0	2	See user guide for function details
179	51	Thermal Overload Retention	U16	0	1	-

Registers above 179 are not present in Single Phase Output Drives

## Appendix E – Drive Fault Code and Information

Error Codes may be returned in the High Byte of Register 6 as below. Note that this list is a generic list, applicable to all Inverter drives. Not all codes listed may be returned by E3, where the hardware and / or software does not support that feature.

Fault Code	No.	Description	E3	Fault Code	No.	Description	E3
no-Flt	00	No Fault	Yes	AtF-01	40	Measured motor stator resistance varies	Yes
OI-b	01	Brake channel over current	Yes	AtF-02	41	Measured motor stator resistance is too large.	Yes
OL-br	02	Brake resistor overload	Yes	AtF-03	42	Measured motor inductance is too low.	Yes
O-I	03	Software Instantaneous over current	Yes	AtF-04	43	Measured motor inductance is too large.	Yes
I.t-trp	04	Motor Thermal Overload (I2t)	Yes	AtF-05	44	Measured motor parameters not convergent	Yes
PS-trp	05	Power stage trip		Ph-Seq	45	Reserved	
O-Volt	06	Over voltage on DC bus	Yes	Fb-Err	46	Reserved	
U-Volt	07	Under voltage on DC bus	Yes	Fb-Loc	47	Reserved	
O-t	08	Heatsink over temperature	Yes	Pr-Lo	48	Reserved	
U-t	09	Under temperature	Yes	Out-Ph	49	Reserved	
P-dEF	10	Factory Default parameters have been loaded	Yes	SC-F01	50	Modbus comms loss fault	Yes
E-trip	11	External trip	Yes	SC-F02	51	CANopen comms loss trip	Yes
SC-ObS	12	Optibus comms loss	Yes	SC-F03	52	Reserved	
FLt-dc	13	DC bus ripple too high	Yes	SC-F04	53	Reserved	
P-LOSS	14	Input phase loss trip	Yes	SC-F05	54	Reserved	
h O-I	15	Hardware Instantaneous over current	Yes	SC-F06	55	Reserved	
th-Flt	16	Faulty thermistor on heatsink.	Yes	SC-F07	56	Reserved	
dAtA-F	17	Internal memory fault. (IO)	Yes	SC-F08	57	Reserved	
4-20 F	18	4-20mA Signal Lost	Yes	SC-F09	58	Reserved	
dAtA-E	19	Internal memory fault. (DSP)	Yes	SC-F10	59	Reserved	
U-dEF	20	User parameter default	Yes	OF-01	60	Reserved	
F-Ptc	21	Motor PTC thermistor trip	Yes	OF-02	61	Reserved	
FAN-F	22	Cooling Fan Fault (IP66 only)	Yes	OF-03	62	Reserved	
O-hEAt	23	Drive internal temperature too high	Yes	OF-04	63	Reserved	
O-torq	24	Reserved		OF-05	64	Reserved	
U-torq	25	Reserved		OF-06	65	Reserved	
Out-F	26	Drive output fault	Yes	OF-07	66	Reserved	
Err-01	27	Reserved		OF-08	67	Reserved	
Err-02	28	Reserved		OF-09	68	Reserved	
Sto-F	29	STO circuit fault		OF-10	69	Reserved	
Enc-01	30	Reserved		PLC-01	70	Reserved	
Enc-02	31	Reserved		PLC-02	71	Reserved	
Enc-03	32	Reserved		PLC-03	72	Reserved	
Enc-04	33	Reserved		PLC-04	73	Reserved	
Enc-05	34	Reserved		PLC-05	74	Reserved	
Enc-06	35	Reserved		PLC-06	75	Reserved	
Enc-07	36	Reserved		PLC-07	76	Reserved	
Enc-08	37	Reserved		PLC-08	77	Reserved	
Enc-09	38	Reserved		PLC-09	78	Reserved	
Enc-10	39	Reserved		PLC-10	79	Reserved	

## Appendix E

Revision History			
Version	Comments	Author	Date
01	First Release	KB	2/12/15