

### 3. Generic Definition

This section will define the protocol in generic terms.

#### 3.1 Data Packets

Data is transferred between devices within variable length data packets. The format of a data packet is shown in Figure 1.

HEADER_1	HEADER_2	CLASS	DATA_LEN	DATA	CHECKSUM
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**Figure 1. Data Packet Format**

The fields in a data packet are described in Table 4 below.

Field	Length (bytes)	Value	Description
HEADER_1	1	0xAA	Packet Header byte # 1
HEADER_2	1	0x55	Packet Header byte # 2
CLASS	1	0x00 to 0xFF	The packet classifier. This indicates the type of data carried within the packet. This is also referred to as the payload classifier.
DATA_LEN	1	1 to 250	The length of the data in the Data field of the packet.
DATA	1 to 250	0x00 to 0xFF for every byte.	The actual data (payload) carried in the packet.
CHECKSUM	1	0x00 to 0xFF	An 8-bit, 1's complement checksum, calculated over the CLASS, DATA_LEN and DATA fields.

**Table 4. Data Packet Field Description**

##### 3.1.1 Example

An example of a data packet is as follows:

0xAA	0x55	0x27	0x02	0xC3, 0x12	0x01
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The checksum in this example is calculated as follows:

$$\begin{aligned}
 \text{CHECKSUM} &= \sim(0x27 + 0x02 + 0xC3 + 0x12) \\
 &= \sim(0xFE) \\
 &= 0x01
 \end{aligned}$$

## 4.1 Motorscope: Controller Operational Data

Byte #	Identifier	Value/Contents/Comments
0	Header 1	See section 3.1
1	Header 2	See section 3.1
2	Class	0x00
3	Data length	29
4	Data byte 0	Controller Model <sup>1</sup>
5	Data byte 1	Minimum phase angle config (degrees)
6	Data byte 2	CT ratio config
7	Data byte 3	Motor startup time config (seconds)
8	Data byte 4	Overload allow time config (seconds)
9	Data byte 5	Underload allow time config (seconds)
10	Data byte 6	Maximum current config (A/D current in ampere)
11	Data byte 7	Underload auto restart timer config (4 minute intervals) <sup>2</sup>
12	Data byte 8	Assisted Calibration Maximum current (A/D current in ampere)
13	Data byte 9	General Info Bit-Field (See Note 2 below section 4.19)
14	Data byte 10	Auxiliary contact type (N/O or N/C)
15	Data byte 11	Underload auto restart / Temperature timer state config (enabled/disabled) <sup>3</sup>
16	Data byte 12	Minimum power config low byte
17	Data byte 13	Minimum power config high byte
18	Data byte 14	Maximum power config low byte
19	Data byte 15	Maximum power config high byte
20	Data byte 16	Temperature timer config (minutes)
21	Data byte 17	V1 measurement
22	Data byte 18	V2 measurement
23	Data byte 19	V3 measurement
24	Data byte 20	Phase angle measurement
25	Data byte 21	Current measurement
26	Data byte 22	Underload auto restart timer measurement <sup>4</sup>
27	Data byte 23	Instantaneous power measurement (low byte)
28	Data byte 24	Instantaneous power measurement (high byte)
29	Data byte 25	Lowest recorded power (low byte)
30	Data byte 26	Lowest recorded power (high byte)
31	Data byte 27	Highest recorded power (low byte)
32	Data byte 28	Highest recorded power (high byte)
33	Checksum	See section 3.1

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Model Name	Model ID	Comments
B110M	0	Underload auto-restart timer implemented by means of analog potentiometer on the Controller. Calibrate button on Controller.
B110M10	1	Underload auto-restart timer set via Optimiser and stored in calibration configuration on the Controller. No calibrate button on Controller.
COOLSCOPE	2	Underload auto-restart timer implemented by means of analog potentiometer on the Controller. Calibrate button on Controller. No Overload Auto-Restart. Works differently to normal Motorscope.
C115	3	Underload auto-restart timer set via Optimiser and stored in calibration configuration on the Controller. No calibrate button on Controller. Checks the system voltage at each power-up. Either 525Vpp or 1000Vpp.

2. Contains meaningful data for B110M10 model only.

3. Format ( $\Phi$  = don't care):

Timer ID	Enabled	Disabled
Underload auto restart timer	0x5 $\Phi$	0xC $\Phi$
Temperature timer	0x $\Phi$ A	0x $\Phi$ 3

4. Contains meaningful data for B110M model only.

## 4.2 Motorscope: Controller Error Data

Byte #	Identifier	Value/Contents/Comments
0	Header 1	See section 3.1
1	Header 2	See section 3.1
2	Class	0x01
3	Data length	2
4	Data byte 0	Current error indication (See notes below)
5	Data byte 1	Additional error information (See notes below)
6	Checksum	See section 3.1

**Notes:**

The current error indication may have one of the following values:

Current Error Indication Value	Error type
0	Phase sequence
1	V1
2	V2
3	V3
4	Maximum power (overload)
5	Maximum current
6	Minimum phase angle (overload)
7	Minimum power (underload)
8	Phase imbalance
9	Auxiliary inhibit
10	No Current
11	Controller
12	Temperature Timer
13	Voltage Frequency
14	Earth Leakage
15	Back-EMF
16 to 255	Unknown

The additional error information is as follows

Error Type	Additional Information
Temperature Timer	Minutes remaining before timer timeout.
Controller	Controller error identifier (error specifics)
Minimum power (underload)	0x00: No additional info 0x01: Phi > 60° during calibration 0x02 to 0xFF: Reserved (no additional info)
Insulation Test	The cycle in which the insulation error occurred: 0x00: Pre-run Test 0x01: Self-Test Active 0x02: Self-Test Inactive 0x03: Continuous 0x04: Idle

## 4.23 Level Controller: Operational Data

Byte #	Identifier	Value/Contents/Comments
0	Header 1	See section 3.1
1	Header 2	See section 3.1
2	Class	0x30
3	Data length	52
4	Data byte 0	Low Pressure Warning On Config LB
5	Data byte 1	Low Pressure Warning On Config HB
6	Data byte 2	Low Pressure Warning Off Config LB
7	Data byte 3	Low Pressure Warning Off Config HB
8	Data byte 4	Low Pressure Control Config LB
9	Data byte 5	Low Pressure Control Config HB
10	Data byte 6	Medium Pressure Control Config LB
11	Data byte 7	Medium Pressure Control Config HB
12	Data byte 8	High Pressure Control Config LB
13	Data byte 9	High Pressure Control Config HB
14	Data byte 10	High Pressure Warning Off Config LB
15	Data byte 11	High Pressure Warning Off Config HB
16	Data byte 12	High Pressure Warning On Config LB
17	Data byte 13	High Pressure Warning On Config HB
18	Data byte 14	Pressure Sensor Offset Config LB
19	Data byte 15	Pressure Sensor Offset Config HB
20	Data byte 16	Pressure Sensor Gain Config LB
21	Data byte 17	Pressure Sensor Gain Config HB
22	Data byte 18	Pressure Sensor Temperature Coefficient Config LB
23	Data byte 19	Pressure Sensor Temperature Coefficient Config HB
24	Data byte 20	Controller Version LB
25	Data byte 21	Controller Version HB
26	Data byte 22	Temperature Sensor Offset Config LB
27	Data byte 23	Temperature Sensor Offset Config HB
28	Data byte 24	Temperature Sensor Gain Config LB
29	Data byte 25	Temperature Sensor Gain Config HB
30	Data byte 26	Low Temperature Warning On Config LB
31	Data byte 27	Low Temperature Warning On Config HB
32	Data byte 28	Low Temperature Warning Off Config LB
33	Data byte 29	Low Temperature Warning Off Config HB

Byte #	Identifier	Value/Contents/Comments
34	Data byte 30	Reserved 1 LB
35	Data byte 31	Reserved 1 HB
36	Data byte 32	Reserved 2 LB
37	Data byte 33	Reserved 2 HB
38	Data byte 34	Reserved 3 LB
39	Data byte 35	Reserved 3 HB
40	Data byte 36	High Temperature Warning Off Config LB
41	Data byte 37	High Temperature Warning Off Config HB
42	Data byte 38	High Temperature Warning On Config LB
43	Data byte 39	High Temperature Warning On Config HB
44	Data byte 40	User Controller Settings Word LB <sup>2</sup>
45	Data byte 41	User Controller Settings Word HB <sup>2</sup>
46	Data byte 42	Instantaneous Pressure Measurement LB
47	Data byte 43	Instantaneous Pressure Measurement HB
48	Data byte 44	Instantaneous Temperature Measurement LB
49	Data byte 45	Instantaneous Temperature Measurement HB
50	Data byte 46	Instantaneous Operational Parameters LB <sup>3</sup>
51	Data byte 47	Instantaneous Operational Parameters HB <sup>3</sup>
52	Data byte 48	Reserved 4 LB
53	Data byte 49	Reserved 4 HB
54	Data byte 50	Reserved 5 LB
55	Data byte 51	Reserved 5 HB
56	Checksum	See section 3.1

**NOTES:****1. Controller Version Word:**

B15	B14	B13	B12	B11	B10	B09	B08
Main Version Number				Bug Fix Number			
B07	B06	B05	B04	B03	B02	B01	B00
Sub Version Number							Type: 1=Release 0=Debug

Controller Version Example: Main.Sub.BugFix.Type = 1.001.000.1

**2. User Controller Settings Word:**

B15	B14	B13	B12	B11	B10	B09	B08
Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	DelayOn Timer Bit5	DelayOn Timer Bit4	DelayOn Timer Bit3	DelayOn Timer Bit2	DelayOn Timer Bit1
B07	B06	B05	B04	B03	B02	B01	B00
DelayOn Timer Bit0	Pump Relay CFG: 01-A only; 10-B only; 11-Both		Controler Type	HT Warn Alarm	LT Warn Alarm	HP Warn Alarm	LP Warn Alarm

The Delay On Timer consists of 6 bits, and has a maximum value of 60 minutes.

**3. The Operational Parameters Word:**

B15	B14	B13	B12	B11	B10	B09	B08
Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0
B07	B06	B05	B04	B03	B02	B01	B00
Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Alarm Relay State	Relay B State	Relay A State	Mode of Operation	

A list of the possible modes of operation is given below.

Mode of Operation	B01:B00
Initialization Mode	00
Normal Running Mode	01
User Calibration Mode	10
Device Non-Functional (After MEM_ERR or SECURITY_BREACHED_ERR)	11

**4.24 Level Controller: Error Data**

Byte #	Identifier	Value/Contents/Comments	
0	Header 1	See section 3.1	
1	Header 2	See section 3.1	
2	Class	0x31	
3	Data length	1 (LC ← Any device)	3 (LC → Any device)
4	Data byte 0	See Note 2	Error Word Low Byte <sup>1</sup>
5	Data byte 1	N/A	Error Word High Byte <sup>1</sup>
6	Data byte 2	N/A	Additional Error Information <sup>3</sup>
7	Checksum	See section 3.1	

Notes:

1. The Error Word consists of the following flags (higher value: higher priority):

B15	B14	B13	B12	B11	B10	B09	B08
Security Breached Error Flag	Controller Error Flag	EEPROM Corrupted Error Flag	RAM Error Flag	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0
B07	B06	B05	B04	B03	B02	B01	B00
Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	Reserved: R/W 0	VCC Low Error Flag	Sensor Output H Error Flag	Sensor Output L Error Flag	Error Recovery

## 2. Value of Data byte 0

Value of Data byte 0	Controller Side Actions
ACK	Switch the alarm relay OFF (if it is ON)
Any other value	Send the Error Array data to the requesting device.

3. If ONLY the Error Recovery bit is set, the Additional Error Information contains the number of minutes until next restart attempt, ELSE it contains the number of minutes the error is active.