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# ***HYCAL***

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Hycal Mini User Manual V2.0



Certificate No. 469

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## Declaration of Conformity

We, EMC Hycal Ltd., declare under our sole responsibility, that the Hycal Mini Analyser, to which this declaration relates, is in accordance to the European EMC Directive 89/336/EEC, being compliant with the following:

**EN 50081-2:1993 Electromagnetic Compatibility Generic Emission**

**Standard. Part 2: Industrial Environment**

**EN 50082-2:1995 Electromagnetic Compatibility Generic Immunity**

**Standard Part 2: Industrial Environment**

We, also declare that same is in accordance with European Low Voltage Directive 73/23/EEC, being compliant with the following:

**EN 61010-1:1993 including Amendment A2:1995 Safety Requirements for Electrical Equipment for measurement, control and laboratory use. Part 1: General Requirement.**

The undersigned, hereby declares that the equipment designated herein conforms to the Directives and Standards shown above.



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Mark Henson

EMC Hycal Limited

Director

Date: 25<sup>th</sup> January 2017

## 1 Introduction

The HYCAL Mini hydrogen measurement system provides rapid, accurate measurement of hydrogen dissolved in molten aluminium and its alloys. The system can be used to:

1. Perform spot measurements to check melt hydrogen levels prior to casting
2. Continuously monitor dissolved hydrogen levels
3. Monitor a melt treatment to achieve a desired hydrogen level e.g. degassing
4. Monitor the dissolved hydrogen in a Low Pressure Die Casting furnace

The probe provides simultaneous measurement of dissolved hydrogen and temperature. Hydrogen sensing is achieved by an electrochemical hydrogen sensor located in the probe tip. Calibration is assured through individual calibration of each sensor in a precisely controlled hydrogen atmosphere, and through testing of each probe prior to shipment. The HYCAL Mini analyser is a battery powered lightweight unit built with ease of use in mind. The analyser automatically detects when the probe signal has stabilised. An integrated data logger allows recording of up to 100 readings. Sophisticated On-Board Diagnostics (OBD) continuously monitor the condition of the probe and inform the operator if a problem is detected.

## 1.1 Post shipment checking procedure

The components supplied with a Hycal Mini kit are listed below. Please use this list to check the shipment has arrived intact.

Item	Quantity	Item	Quantity
Packing case	1 off	Probe adaptor	1 off
Analyser	1 off	Probe connection cable	1 off
Analyser protective cover	1 off	Probe adaptor cable	1 off
Probe extension cable	1 off	Quick-release plug 4 - 6 mm	1 off
DC Power supply unit	1 off	Clear nylon tube 6 x 4 mm	5 m
USB cable	1 off	[Refer to Figure 2]	
SD memory card	1 off		
Probe	[as ordered]		
[Refer to Figure 1]			

Table 1: Shipment checklist

## 2 Hycal components

### 2.1 Analyser packing case

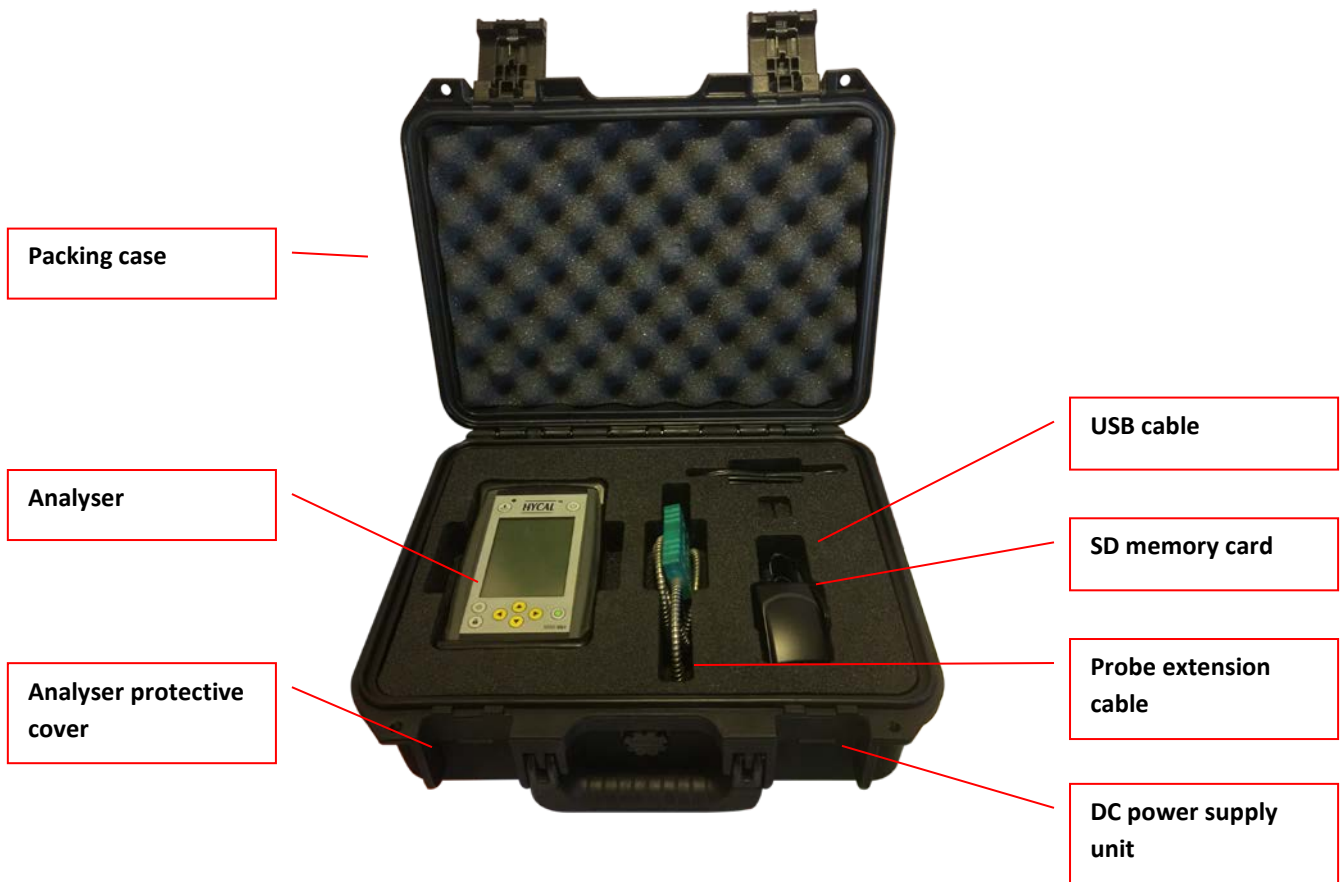


Figure 1: Hycal Mini analyser packing case

## 2.2 Probe adaptor

The purpose of the probe adaptor is to deliver gas to the Hycal probe.

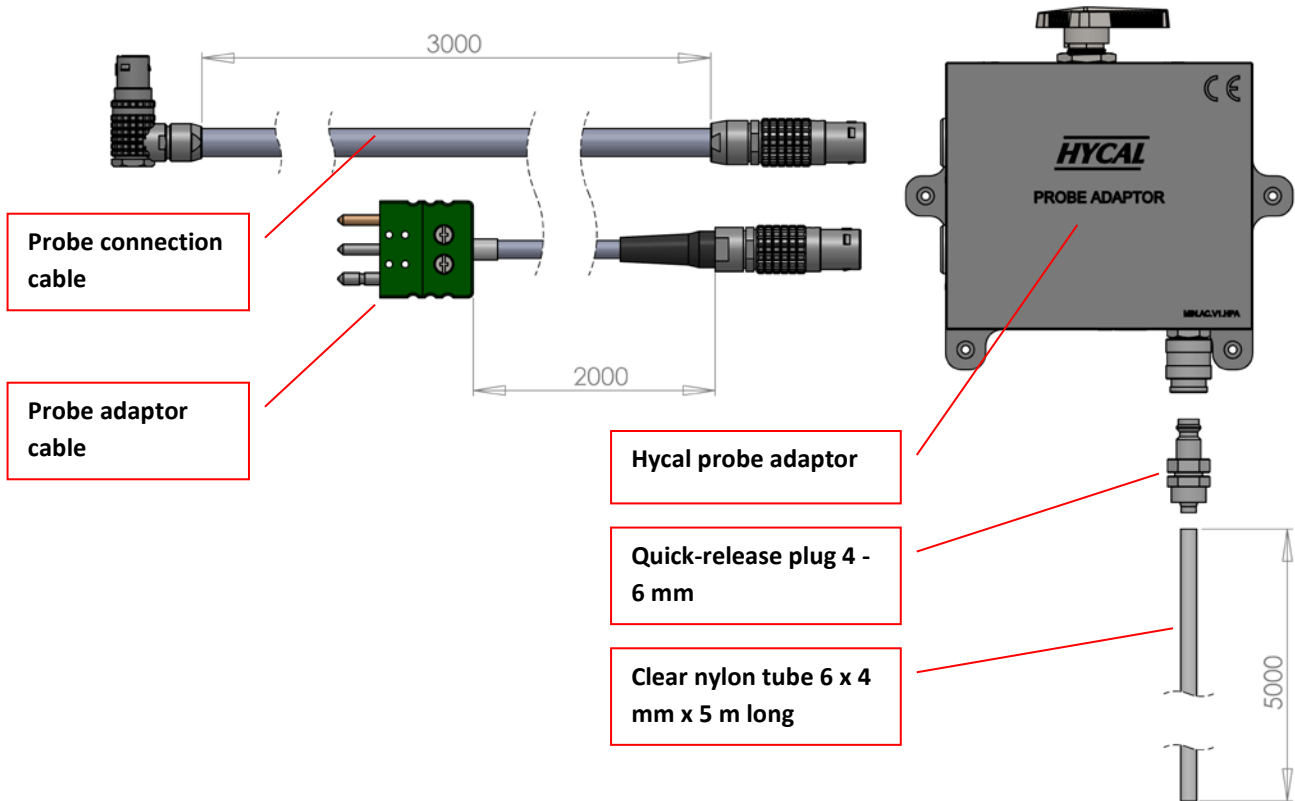


Figure 2: Probe adaptor parts (dimensions are in mm)

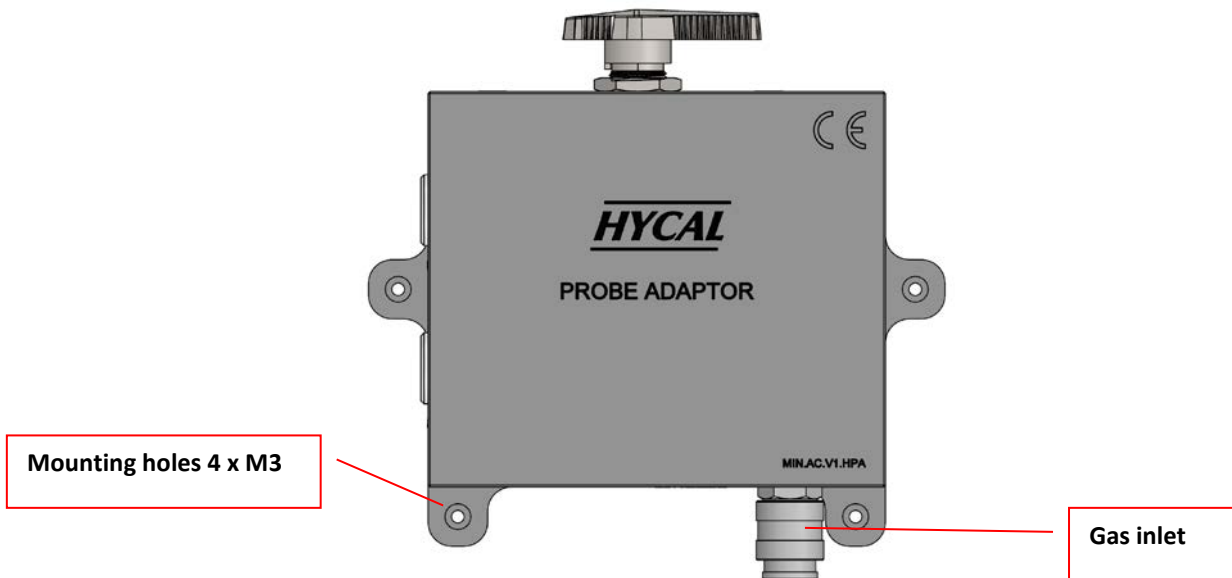


Figure 3: Hycal probe adaptor front view

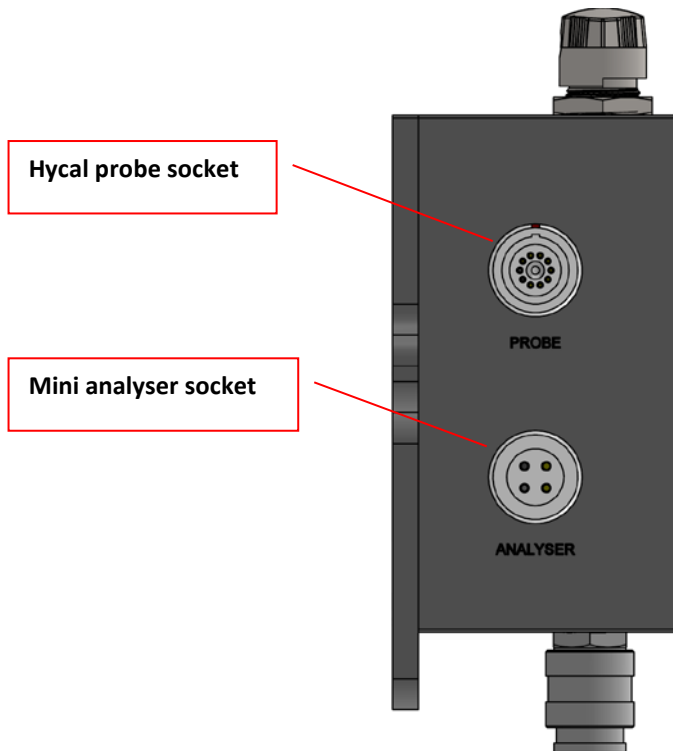


Figure 4: Hycal probe adaptor side view

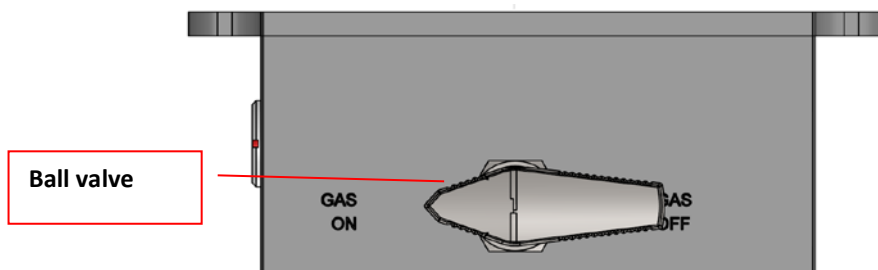


Figure 5: Hycal probe adaptor top view

### 2.2.1 Setup

Set up the probe adaptor as follows:

1. Mount the probe adaptor close to the melt using the 4 x M3 mounting holes (Figure 3). Choose location to ensure that probe adaptor temperature does not become hot to the touch (max. 60°C).
2. Connect the quick-release plug to the clear nylon tube.
  - a. On the quick-release plug, unscrew the metal ring.
  - b. Slide the metal ring onto the nylon tube.

- c. Push the nylon tube securely onto the quick-release plug.
  - d. Screw the metal ring into the quick-release plug until the nylon tube is fully clamped.
3. Connect the quick-release plug to the gas inlet of the probe adaptor (Figure 3) .
  4. Connect the other end of the nylon tube to a supply of nitrogen (or argon). Ultra-high gas purity is not necessary, however gas purity must be sufficient for degassing .
  5. Pressurise the gas line to 3 - 10 bar.

## 2.3 Probe types

The Hycal Mini analyser is compatible with the following probes:

- Mini probe
- Hycal probe (when used with the probe adaptor).

### 2.3.1 Mini probe

The Mini probe is fitted with green 3 pin connector and consists of a length of Mineral Insulated (MI) metal cable with a glass coating to protect against molten aluminium (Figure 6). There are no gas connections to the Mini probe.

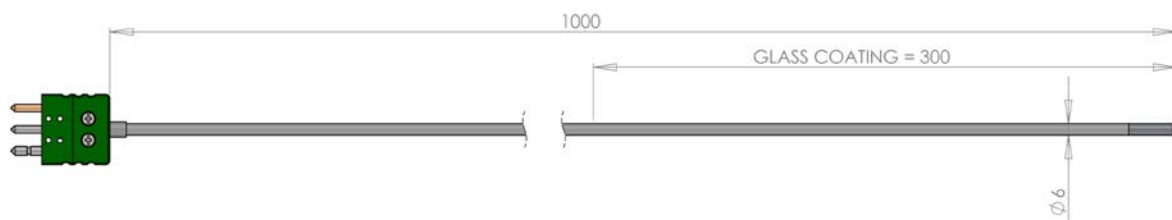


Figure 6: Mini probe (dimensions are in mm)

### 2.3.2 Hycal probe

The Hycal probe is fitted with a LEMO connector and consists of a ceramic tube joined to a metal tube (Figure 7). It is possible to pass gas through the Hycal probe; inert purge gas (N<sub>2</sub> or Ar) is used to improve probe performance, and a hydrogen gas mixture may be used to check probe calibration in situ. It is necessary to use a probe adaptor (section 2.2) when using Hycal probes with the Mini analyser.



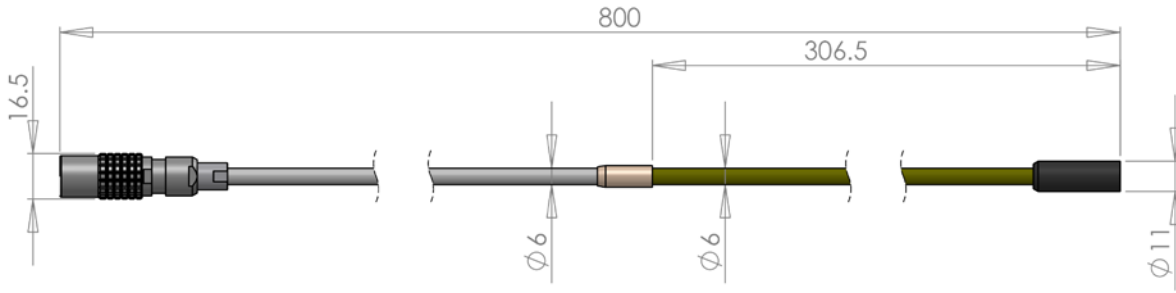


Figure 7: Hycal probe

## 2.4 Portable probe mount (Optional Accessory)

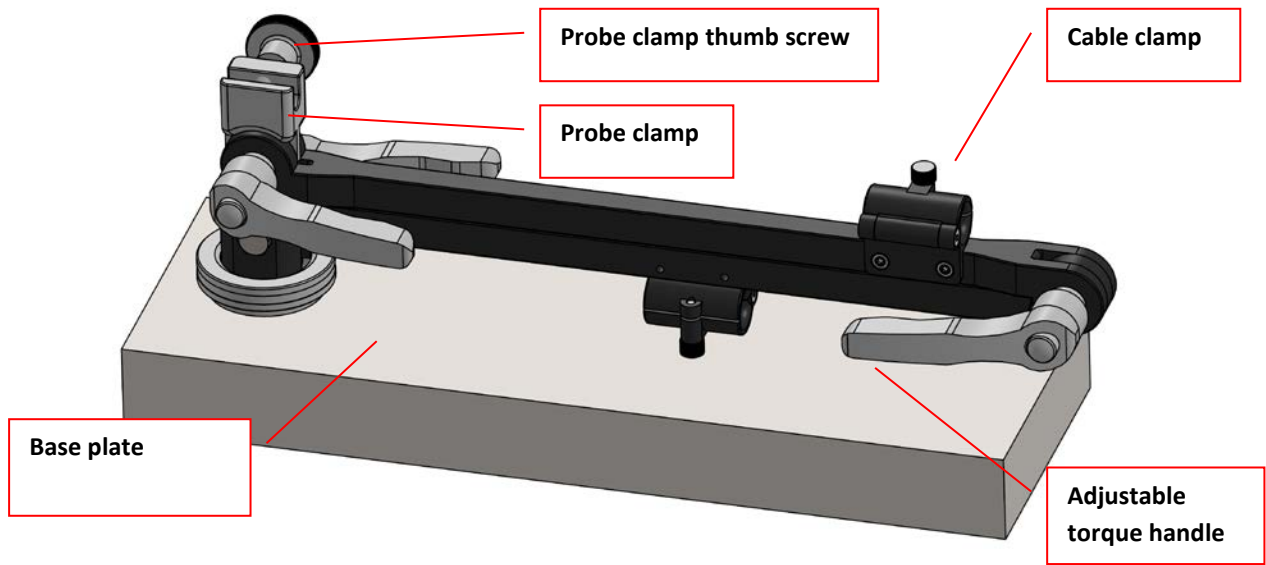


Figure 8: Portable probe mount

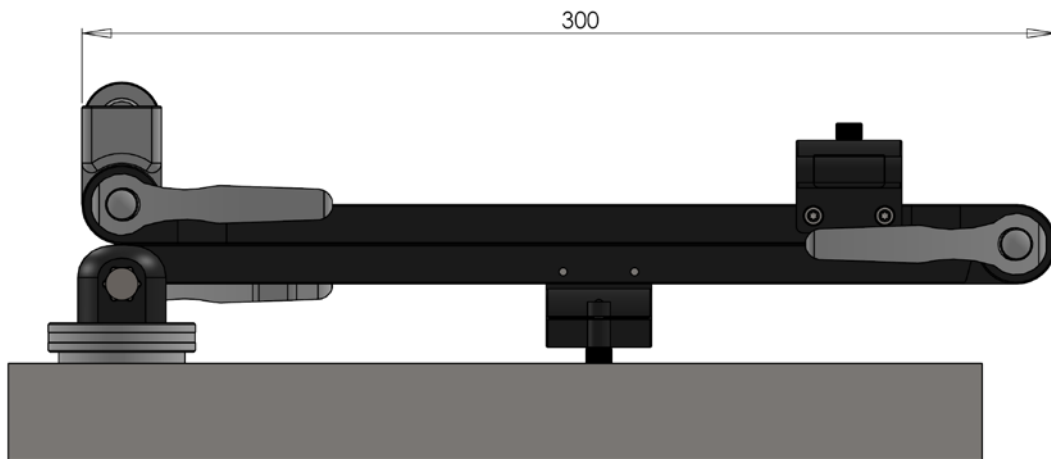


Figure 9: Portable probe mount dimensions

### 3 Analyser Operation

#### 3.1 Buttons & icons

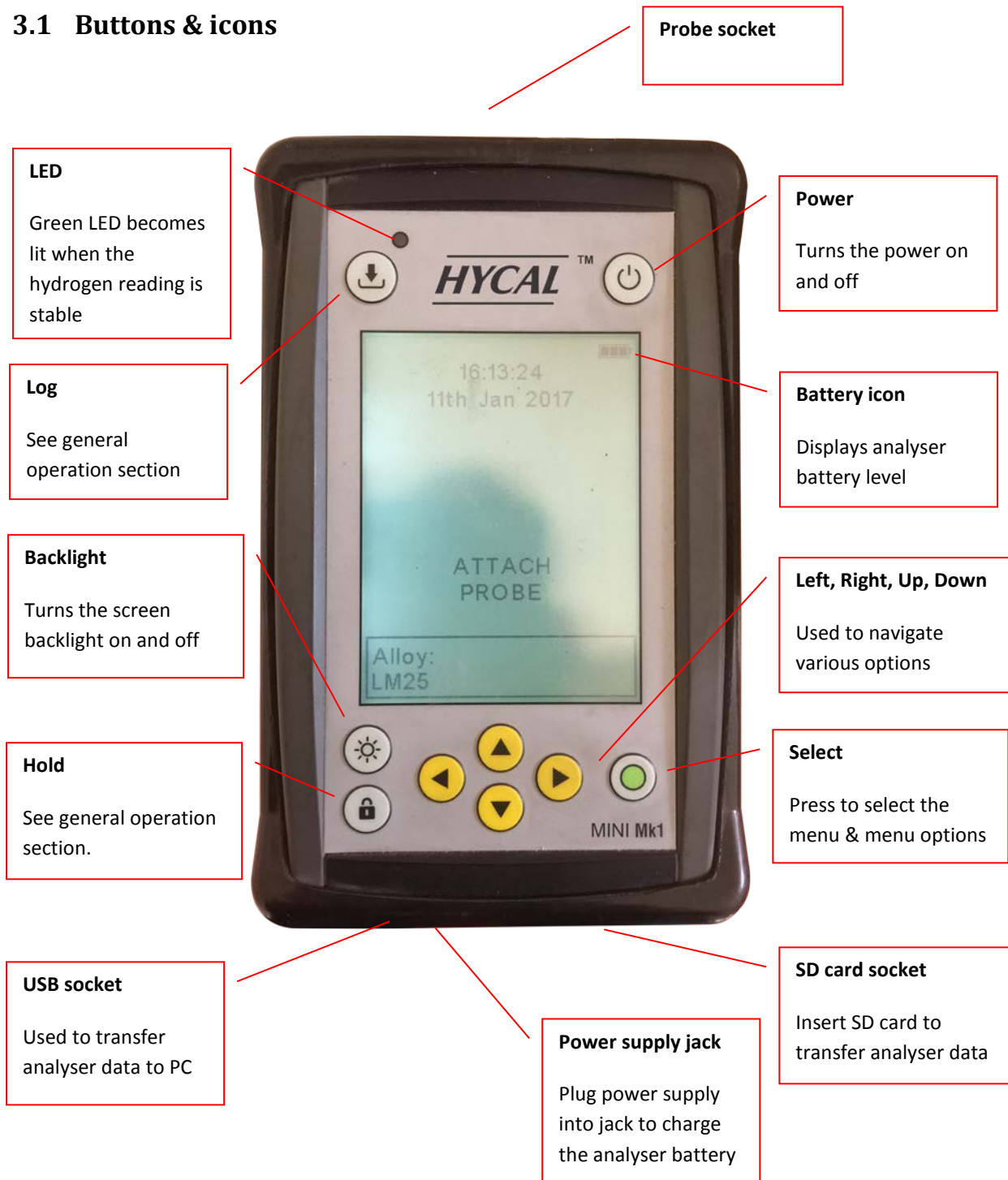


Figure 10: HYCAL Mini analyser

## 3.2 Measurement

The analyser's main default screen (pictured) is the measurement screen. The top right of the screen displays the current battery level, time and date. The bottom of the screen displays the currently selected alloy. This may be altered using the "Left" and "Right" buttons.

Above this the analyser displays the live measurement results:

### Message

Attach Probe

T = [probe temperature] °C

H = No Data

H = Wait...

H = [hydrogen level] ml/100g

Probe Failure

### Detail

The probe is not connected

The probe temperature

The probe temperature is not yet above 600°C required for the hydrogen sensor to function

The hydrogen level is being analysed and has not yet stabilised

The hydrogen level of the melt

There is a fault with the probe

### 3.2.1 Alloy Selection

Hydrogen solubility depends on alloy composition. The HYCAL Mini analyser must therefore be set to the correct alloy prior to measurement. When on the main default screen (pictured), use the "Left" and "Right" buttons to scroll through and select the correct alloy. The analyser is pre-programmed with the following 4 preset UK alloys: LM2, LM5, LM6, and LM25. A 5<sup>th</sup> "Custom" alloy is available which may be programmed by the operator via the analyser menu (see Set Custom Alloy Option).

### 3.2.2 Hold Function

Once the hydrogen level is displayed the readings may be frozen by pressing the "Hold" button. The current measurements are then held until it is pressed again. The screen displays HOLD to indicate the function is active.

### 3.2.3 Log Function

If a valid hydrogen reading is displayed, then pressing the "Log" button causes the current time stamped readings to be saved as a new entry in the log memory. Each log entry records the following: Date, Time, Hydrogen, Temperature, Temperature units, Alloy name, Alloy constant C, Alloy constant D, Melt Code, Probe Number.

#### 3.2.3.1 Melt Code

A set of logged hydrogen readings may be associated with a particular batch of aluminium using the Melt Code facility. After pressing the "Log" button the analyser will ask if a Melt Code is required. If "Yes" is selected the analyser will prompt for a melt code. Use the "Up" and "Down" buttons to scroll through the available characters. Any alpha numeric character (including blank spaces) may be selected and the Melt Code may be up to 5 characters long.

#### 3.2.3.2 Probe Number

Logging the probe number (etched onto the side of the ALSEPEK H Mini probe near the connector) is useful for associating logged hydrogen readings with a particular probe. After entering the Melt

Code, the analyser will ask if a Probe Number is required. If "Yes" is selected the analyser will prompt for a probe number. Use the "Up" and "Down" buttons to scroll through the numbers 0 – 9. The Probe Number may be up to 8 numbers long.

Logging of Melt Code and Probe Number can be turned on or off via the Data Logger menu, section 2.3.1. By default, both are enabled.

*Note: If the log function is used whilst the Hold function is active, the currently held readings will be stored to the log, regardless of what the readings may have subsequently changed to.*

### 3.2.4 Backlight

The analyser includes a backlight for reading the screen in conditions of poor lighting. The backlight will automatically turn off after a period of inactivity. The default is 30 seconds; this can be adjusted via the menu (section 2.3.10).

## 3.3 Main Menu

Press the "Select" button to display the menu. The following options are then displayed:

- Exit
- Calibrate probe
- Data Logger
- Set Custom Alloy
- Set Time
- Set Date
- Buzzer
- Stabilisation
- Set Language
- Set Temperature Units
- Set Backlight Timer

Use the "Up" and "Down" buttons to highlight the required option then press the "Select" button.

### 3.3.1 Calibrate probe

Each probe is supplied with calibration constants A and B, and these must be programmed into the analyser. After selecting the "Calibrate probe" option, the A and B calibration constants are displayed. Use the "Up" and "Down" buttons to change the value, and the "Left" and "Right" buttons to switch between constants. When complete, press the "Select" button to store the values.

### 3.3.2 Data Logger

After selecting the "Data Logger" option, the following menu is displayed:

- Exit
- View Log
- Delete Log
- Auto Logger
- Melt Code
- Probe Number
- Select Active Memory
- Select Data Format

#### 3.3.2.1 View Log

Displays each of the logged data entries, starting with the most recent. Use the "Left" and "Right" buttons to move between log entries. Press the "Select" button to return to the menu.

#### 3.3.2.2 Delete Log

Delete the entire log memory. Hold the "Up" and "Down" buttons for 3 seconds to delete or press the "Select" button to cancel and return to the menu.

#### 3.3.2.3 Auto Logger

This option allows the analyser to automatically log data entries at a regular time interval. After selecting "Auto Logger", the user selects the log time interval (5 – 5000 seconds) using the "Up" and "Down" buttons. Holding either of these buttons down causes the reading to accelerate; this saves time when changing the reading. After choosing the required time interval, press the "Select" button. The analyser will then prompt for a melt code and / or probe number if these options are enabled (see below).

The text "AUTOLOGGER" is displayed on the measurement screen when the Auto Logger is running. Each time a reading is logged, the text "LOGGED" is displayed. Similar to manual data logging, a reading will only be logged if a valid hydrogen reading is displayed.

If the "Select" button is pressed whilst the Auto Logger is running, then the analyser will ask if the user wishes to stop the logger. If "Yes" is selected, the logger is stopped and the analyser returns to

the measurement screen. If "No" is selected, the Main Menu is displayed and the Auto Logger continues to run in the background.

#### **3.3.2.4 Melt Code**

This option allows a melt code to be attached to each logged data entry. If selected, then the user will be given the option to enter a melt code after pressing the "Log" button. The user may then enter a melt code of up to 5 alpha numeric characters using the "Up", "Down", "Left", and "Right" buttons. If 5 characters are not required, then blank spaces may be selected. The analyser will remember the last melt code used when logging subsequent data entries.

#### **3.3.2.5 Probe Number**

This option allows the probe number to be attached to each logged data entry. If selected, then the user will be given the option to enter the probe number after pressing the "Log" button. The user may then enter a probe number of up to 8 digits using the "Up", "Down", "Left", and "Right" buttons. If 8 digits are not required, then blank spaces may be selected. The analyser will remember the last probe number used when logging subsequent data entries.

#### **3.3.2.6 Select Active Memory**

The analyser can log data to its internal memory, or directly to an SD card. Use the "Up" and "Down" buttons to highlight the required option then press the "Select" button.

##### **3.3.2.6.1 Internal Memory**

The analyser's internal memory can hold up to 100 readings. If the internal log memory becomes full, the analyser will prompt the user to overwrite the oldest entry, to delete the entire log memory before saving, or to cancel.

##### **3.3.2.6.2 SD Memory Card**

The analyser can log up to 10,000 readings to an SD card loaded into the SD card socket. If the SD card log memory becomes full, the analyser will prompt the user to delete the entire log memory, switch to internal memory, or cancel.

#### **3.3.2.7 Select Data Format**

The analyser can store data in either "Unprotected" format or "Protected" format. Use the "Up" and "Down" buttons to highlight the required option then press the "Select" button.

##### **3.3.2.7.1 Unprotected**

If this option is selected, then logged data will be stored in an unprotected file with file extension "CSV". This can be read on a PC using Microsoft Excel™, a text editor, or the HYCAL PC software.

##### **3.3.2.7.2 Protected**

If this option is selected, then logged data will be stored in a protected file with file extension "DAT". This can only be read using the HYCAL Mini PC software.

### **3.3.3 Set Custom Alloy**

The C and D constants for common aluminium alloys are given in the appendix. Use the "Up" and "Down" buttons to adjust the values of the C and D constants for the "Custom" alloy. Holding down

either the "Up" or "Down" button causes the reading to accelerate; this saves time when changing the reading. Use the "Left" and "Right" buttons to move between the 2 constants. Press the "Select" button to store and return to the menu.

### 3.3.4 Set Time

Set the current time in 24-hour format. Use the "Up" and "Down" buttons to adjust and the "Left" and "Right" buttons to move between hours and minutes. Press the "Select" button to store and return to the menu.

### 3.3.5 Set Date

Set the current date using the "Up" and "Down" buttons to adjust and the "Left" and "Right" buttons to move between the day, month and year. Press the "Select" button to store and return to the menu.

### 3.3.6 Buzzer

Use the "Up" and "Down" buttons to turn the buzzer on or off. Press the "Select" button to store and return to the menu.

### 3.3.7 Stabilisation

When immersing the probe into the melt, a short stabilisation time is required before the hydrogen sensor reaches equilibrium. The analyser's stabilisation function automatically determines when the reading is stable. If the reading is not stable then the analyser will display the text "Wait.." in place of the hydrogen reading. When the reading stabilises, a buzzer will sound and the analyser will display the melt hydrogen level.

Use the "Up" and "Down" buttons to turn stabilisation on or off then press the "Select" button to store and return to the main menu.

*Note: It is recommended to turn stabilisation off when monitoring dynamic processes such as degassing.*

### 3.3.8 Set Language

Set the desired language using the "Up" and "Down" buttons. Press the "Select" button to store and return to the menu. Available languages are: English, German, Italian, French, Spanish, Portuguese, Japanese, and Chinese.

### 3.3.9 Set Temperature Units

The analyser can display and record temperature in degrees Centigrade or Fahrenheit. Set the desired units using the "Up" and "Down" buttons. Press the "Select" button to store and return to the menu.

### 3.3.10 Set Backlight Timer

The backlight timer automatically turns the backlight off after a period of inactivity. Use the "Up" and "Down" buttons to adjust the backlight timer, or to turn the backlight timer off.

*Note: Prolonged use of the analyser's backlight will cause the battery to discharge more quickly.*

## 3.4 Data transfer

Data transfer depends on the type of memory in use i.e. Internal Memory or SD Card. The type of memory in use is indicated in the top left of the measurement screen.

*Note: When viewing the data in Microsoft Excel™, it may be necessary to increase the column width in order to view some of the data.*

### 3.4.1 Internal memory

#### 3.4.1.1 Data transfer by SD Card

Data from the analyser's internal memory may be transferred to a standard SD memory card. With the measurement screen visible, insert the supplied SD memory card into the slot at the bottom of the analyser. The analyser will detect the SD card and will prompt the user to copy the logged data onto the card. If there is already a data file on the card the analyser will prompt to overwrite the existing file. After the file has been copied, the SD card may be removed from the analyser and inserted into an SD card reader attached to a PC computer. If the "Unprotected" data format is selected, then this file will be named "HISTORY.CSV" and may be opened using a standard text editor or a spreadsheet application such as Microsoft Excel™. If the "Protected" data format is selected, then the data file will be named "HISTORY.DAT" and can only be opened using the Hycal Mini PC software.

#### 3.4.1.2 Data transfer by USB Connection

The USB Mini-B type connector on the bottom of the analyser may be used to connect it to a PC. With the analyser switched off, connect the analyser to the PC using the supplied USB A to 5 pin USB Mini B cable. Turn on the analyser by pressing the power button. The analyser will enter USB mode (indicated by the USB logo shown on its screen) and will appear as a new drive called "Analyser" in My Computer under Windows™. Opening this drive will reveal the data file stored in the analyser's memory. If the "Unprotected" data format is selected, then this file will be named "HISTORY.CSV" and may be opened using a standard text editor or a spreadsheet application such as Microsoft Excel™. If the "Protected" data format is selected, then the data file will be named "HISTORY.DAT" and can only be opened using the Hycal Mini PC software.

Notes:

1. *The analyser drive is read only – you cannot modify or delete the log file without copying it to another location first such as the PC's hard drive.*
2. *When Internal Memory is selected, it is not possible to access the SD card via the analyser's USB connection*



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## 3.4.2 SD card memory

### 3.4.2.1 Data transfer by SD card

Remove the SD card from the analyser and insert into an SD card reader attached to a PC computer. If the "Unprotected" data format is selected, then the data file will be named "HIST\_SD.CSV" and may be opened using a standard text editor or a spreadsheet application such as Microsoft Excel™. If the "Protected" data format is selected, then the data file will be named "HIST\_SD.DAT" and can only be opened using the Hycal Mini PC software.

*Note: The SD card supplied with the analyser is locked to help prevent accidental deletion. To delete the file, select the "Delete Log" option detailed in section 2.3.1.*

### 3.4.2.2 Data transfer by USB Connection

The USB Mini-B type connector on the bottom of the analyser may be used to connect it to a PC. With the analyser switched off, connect the analyser to the PC using the supplied USB A to 5 pin USB Mini B cable. Turn on the analyser by pressing the power button. The analyser will enter USB mode (indicated by the USB logo shown on its screen) and will appear as a new removable disk drive in My Computer under Windows™. If the "Unprotected" data format is selected, then the data file will be named "HIST\_SD.CSV" and may be opened using a standard text editor or a spreadsheet application such as Microsoft Excel™. If the "Protected" data format is selected, then the data file will be named "HIST\_SD.DAT" and can only be opened using the Hycal Mini PC software.

*Note: The file "HISTORY.DAT" may also be visible on the disk drive if the SD card has previously been used to make a copy of the analyser's internal memory (section 2.4.1).*

## 3.5 Power

The internal battery provides a Minimum of 8 hours operation between charges (with the backlight off). The battery may be charged using the 5V DC charger power supply (included) via the 2.1mm power connector on the bottom of the unit. When the charger is connected, the screen will show a battery charging animation, changing to a steady battery full icon once the battery is fully charged. During normal use an icon displays the battery state. When the battery level is nearing empty a warning message is displayed to the user<sup>1</sup>, and it is recommended that the unit is recharged at this stage. The user may continue measuring by acknowledging the warning message (press "Select"). If the battery level is insufficient to power the analyser, then the unit will automatically turn off.

*Note: The analyser may not be used whilst the charger is connected.*

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<sup>1</sup> If the buzzer is turned on then this will also sound to indicate very low battery level

## 4 Making Measurements

### 4.1 Procedure

#### 4.1.1 Mini probes

1. Press the "Power" button to turn on the analyser.
2. Press the "Left" or "Right" buttons to select the correct alloy.
3. Plug probe into probe extension cable and attach cable to analyser. The analyser will display the probe temperature.
4. Scrape the melt surface to remove dross.
5. Immerse the probe in the melt to a depth of 150 – 250 mm.
6. When the reading has stabilised, a buzzer will sound and the analyser will display the melt hydrogen level.

#### 4.1.2 Hycal probes

1. Ensure that the probe adaptor has been set up according to section 2.2.1.
2. Mount the probe in the probe clamp / mount. Do not immerse the probe at this stage.
3. Connect the Mini analyser to the probe adaptor using the probe adaptor cable.
4. Connect the Hycal probe to the probe adaptor using the probe connection cable.
5. Switch the probe adaptor ball valve to ON.
6. Scrape the melt surface to remove dross.
7. Immerse the probe into the melt to a depth of 100 - 200 mm (do not exceed 250 mm immersion depth).
8. Wait until temperature stabilises.
9. Wait until the H reading is less than 0.02 ml/100g.
10. Switch the probe adaptor ball valve to OFF.
11. Wait until the reading stabilises.
12. When measurements are complete, switch the probe adaptor ball valve to ON.
13. Remove probe from melt with gas ON.
14. When probe has cooled to <400C then switch the probe adaptor ball valve to OFF and allow to cool to room temperature.

## 4.2 Precautions

### 4.2.1 General

1. Do not immerse past the probe's protective coating (Mini probe) or deeper than 250 mm (Hycal probe).
2. Avoid impact with the probe's protective coating (Mini probe) or the ceramic tube (Hycal probe).
3. Do not exceed the probe's maximum rated temperature of 800°C. Damage will occur above 830°C.
4. Do not expose the analyser to temperatures above 50°C.
5. The Mini probe is not suitable for use in melts containing lithium or sodium (unstable readings).
6. Lifetime if the Mini probe is dramatically reduced in melts containing phosphorous due to a chemical reaction with the ceramic coating.

### 4.2.2 Moisture sensitivity

After opening the protective foil packaging, do not leave the probe exposed to ambient humidity for longer than 12h. If the probe will not be used for a long period of time then ensure probe tip is maintained at > 120°C e.g. stored above melt or probe tip placed in an oven.

## 4.3 Use with a degasser

Position the probe as far away as possible from the rotor, ideally 750 mm – 1m. Mounting too close to the rotor may result in damage to the probe due to collision, and erratic readings caused by bubbles of purging gas passing beneath the probe.

## 5 System Specifications

1. Analyser operating temperature range: 0° C to 50° C
2. Analyser battery: Internal lithium polymer battery. Battery provides a Minimum continuous running time before requiring recharging of 8 hours with the backlight off. DC Power Supply Unit (PSU) operates from 110V/240V mains supply
3. Measurement frequency: 2 seconds
4. Probe temperature range:
  - a. Calibrated operating temperature range of sensor: 650-800 deg C
  - b. Maximum temperature before sensor damage: 830C
5. Standard length of probe: 1m (Mini), 800mm (Hycal).
6. Accuracy +/-0.03 ml/100g or +/- 15% whichever is greater.
7. Reproducibility: +/- 0.02 ml/100g or +/- 10 % whichever is greater.
8. Analyser includes probe diagnostics which can detect a short circuit within the probe (e.g. due to aluminium ingress) or a high probe impedance, indicating sensor failure. If one of these conditions is detected the analyser displays a "Probe Failure" error message.
9. Analyser includes data logger capable of storing 100 readings (date, time, hydrogen, temperature, alloy name, alloy constant C, alloy constant D)
10. Analyser USB connection: USB Mini-B type
11. Analyser memory card slot: Standard SD card

## 6 Appendix A - Alloy Constants

Europe DIN EN 1676		UK	Germany DIN	France	USA	Japan		
Numeric	Chemical	BS1490	1725/6	C.T.I.F	AA/ASTM	JIS	C	D
	Pure Al						2692	1.729
	Al 99,5	LM 0		A 5	150.1		2692	1.703
21000	AlCu4MgTi		3.1372	A-5UGT	204.2		2692	1.603
21100	AlCu4Ti	LM 11	3.1842		224		2692	1.590
	AlCu10Si2Mg	LM 12		A-U10G	222		2692	1.394
41000	AlSi2MgTi						2692	1.705
42000	AlSi7Mg	LM 25		A-S7G	A356	AC4C	2657	1.622
42100	AlSi7Mg0,3		3.2335	A-S7G03	356.2	C4CV	2692	1.631
42200	AlSi7Mg0,6						2692	1.655
43000	AlSi10Mg(a)		3.2331	A-S9G	361.1	D3S	2692	1.595
43100	AlSi10Mg(b)	LM 9		A-S10G	A360	AC4A	2692	1.591
43200	AlSi10MG(Cu)		(233)	A-S9G	361.1	D3S	2692	1.575
43300	AlSi9Mg		3.2333	A-S10G	359.1	C4AV	2692	1.611
43400	AlSi10Mg(Fe)		3.2336		360.2		2692	1.580
44000	AlSi11		3.2212				2692	1.607
44100	AlSi12(b)	LM 6		A-S13	A413	AC3A	2632	1.460
44200	AlSi12(a)		3.2521				2692	1.556
44300	AlSi12(Fe)		(230)	A-S12	413.1	C3AS	2692	1.539
44400	AlSi9						2692	1.573
45000	AlSi6Cu4	LM 21	(225)	A-S5U2	308	AC2A	2692	1.481
45100	AlSi5Cu3Mg						2692	1.552
45200	AlSi5Cu3Mn	LM 4		A-S5U3	319	AC2A	2692	1.535
45300	AlSi5Cu1Mg	LM 16		A-S4UG	355	AC4D	2667	1.622
45400	AlSi5Cu3	LM 22		A-S5U3	319	AC2A	2692	1.534
46000	AlSi9Cu3(Fe)	LM 24	(226)	A-S9U3	380.1	ADC10	2692	1.472
46100	AlSi11Cu2(Fe)	LM 2		A-S9U3Y4	384	ADC12	2655	1.439
46200	AlSi8Cu3	LM 24	(226A)	A-S9U3Y	333.1	C4BS	2692	1.497
46300	AlSi7Cu3Mg						2692	1.508
46400	AlSi9Cu1Mg						2692	1.554
46500	AlSi9Cu3(Fe,Zn)	LM 24		A-S9U3A-Y4	A380	AC4B	2692	1.439
46600	AlSi7Cu2	LM 27				AC2B	2692	1.538
	AlSi9Cu3Mg	LM 26		A-S7U3G	332		2692	1.501
47000	AlSi12(Cu)	LM 20	3.2523	A-S12Y4	A413	C3AS	2632	1.460
47100	AlSi12Cu(Fe)	LM 2	231D	A-S12U	413.1		2692	1.520
48000	AlSi12CuNiMg	LM 13		A-S12UN	336	AC8A	2663	1.491

Europe DIN EN 1676		UK	Germany DIN	France	USA	Japan		
numerical	chemical	BS1490	1725/6	C.T.I.F	AA/ASTM	JIS	C	D
	AlSi17Cu4Mg	LM 30			390		2692	1.408
	AlSi191CuMgNi	LM 28		A- S18UNG	393.2		2692	1.547
	AlSi23CuMgNi	LM 29					2692	1.565
51000	AlMg3(b)						2692	1.903
51100	AlMg3(a)		3.3542	A-G3T	514.2		2692	1.907
51200	AlMg9		3.3293		518.2		2692	2.275
51300	AlMg5	LM 5	3.3562	A-G6	514	AC7A	2651	1.766
51400	AlMg5(Si)		3.3262	A-G6			2692	2.057
	AlMg6		(244)					
	AlMg10	LM 10			520.2	C7BV	2692	2.379
71000	AlZn5Mg	LM 31		A-Z5G	712		2692	1.635

## 7 Appendix B - Programming Standard Alloys

By default, the Hycal Mini is programmed with the following 4 pre-set UK alloys: LM2, LM5, LM6, and LM25. The pre-set alloys may be changed via the hidden Engineering menu. To access this, press the 'Hold', 'Up' and 'Right' buttons for 5 seconds. The following options are then displayed:

Exit

Set Constant C

Set Constant D

Set Alloy 1 Name

Set Alloy 2 Name

Set Alloy 3 Name

Set Alloy 4 Name

Use the "Up" and "Down" buttons to highlight the required option then press the "Select" button.

### 7.1 Set Constant C / Set Constant D

These two options allow each of these factory-set constant values to be altered. Use "Up" and "Down" buttons to adjust the value. Press the "Select" button to store and exit back to the Alloy Menu.

### 7.2 Set Alloy Name

These four options allow each of the factory set alloy names to be altered. Use "Up" and "Down" buttons to adjust each character. Press the 'Select' button to store and exit back to the Alloy Menu.