LDU 78.1 Load cell Digitizing Unit

PROGRAMMER'S MANUAL

Relating to Firmware Version 78.183 v 2.46 (CHECKWEIGHER)

CONTENTS:

1. INTRODUCTION & SPECIFICATIONS

The LDU 78.1 load cell digitizing unit is a high performance device that can form the "front end" of weighing systems intended for either "approved" or industrial applications. The device feature full multi-drop communications capability and can be programmed via a straightforward ASCII command set.

The technical specifications of the unit are tabulated below:

Driving Capability	80-2000 Ohm (12-14V supply voltage)
	350-2000 Ohm (14-24V supply voltage)
Load Cell Connection	Six-wire
Input Signal Range	±2.2 mV/V nominal
Polarity	Bipolar
Maximum read out	± 99999
Sample rate	600 readings/second transmitted
Internal Resolution	Up to ±260,000 parts (18-bit)
Analogue Filter	17Hz 3rd.order (i.e. 60 dB/decade)
Digital Filter	18 - 0.25Hz 2nd.order (i.e. 40 dB/decade)
Calibration	Software calibration and set up
Communication	RS422 or RS485 full duplex
Baudrate	9k6, 19k2, 38k4, 57k6,115k2
Bus	Up to 32 devices on one bus (RS485)
Temperature Effect on Zero	< 7 ppm/°C
Temperature Effect on Span	< 6 ppm/°C
Temperature Range	-15°C to +55°C
Storage Temperature Range	-30°C to +70°C
Housing	Metal shield
Dimensions (L x W x H)	82 x 31 x 6 mm
Weight	Approx. 30g
Power Supply	12-24 V DC

2. COMMUNICATIONS & GETTING STARTED

Communicating with the LDU 78.1 digitiser is performed via the RS422/RS485 port. The data format is the familiar 8/N/1 structure (8 data bits, no parity, and 1 stop bit)

Available data rates are:

Baud Rate
9600
19200
38400
57600
115200

Point-to-point or multi-drop connections are supported.

Protocol Summary

The LDU 78.1 digitiser are intended for use with standard PC or PLC systems, and require no special interfacing hardware and no special software adapters. The command set is based on a simple ASCII format, as per the example below:

Master (PC or PLC) sends:	OP 1	(Open the device # 1)
Slave (LDU) sends:	OK	(acknowledging device #1 active)
Master sends:	GG	(Get the gross weight result)
Slave sends:	G+123.45	(the gross weight with sign and Decimal point information)

This protocol is standard across the whole range of H&B instrumentation, so it is possible to mix different types of H&B devices on the same bus.

Multi-Drop Support

A connection to the required device is opened by sending the OP xxx command, where xxx is the address of the relevant slave device, in decimal notation. The relevant device responds by acknowledging that it is active, and will then respond to any other command sent along the bus, until another OP xxx with a different address value is detected, or until a “Close Connection” command (CL) is detected.

Baud rate Settings

The LDU 78.1 has a jumper SW3 for enabling a special configuration mode used for altering the baud rate and the device address. When this jumper is closed the LDU will enter a special baud rate search mode after power on – waiting for a space character (0x20) to be received. The time duration of this character will be measured by the LDU and its baud rate timing will be set accordingly – i.e. the baud rate of the terminal used will be the baud rate used by the LDU subsequently. The default factory setting is 9600 baud.

Address Settings

It is possible to set the network address of the device using the AD command. (Address range between 0 and 255). Setting the device address to 0 will set the continuously active mode, where the device becomes permanently active, and will listen and respond to any command on the bus, without the need for an OP xxx command. The default factory setting is 0.

Check Weigher Functions

This software has the following check weigher functions added: The falling or rising edge (TE) of a pulse on logic input 0 will start a timer SD, adjustable between 0 and 500ms. After this time has elapsed, an average of the actual load (Net. value) will be derived over another adjustable time frame MT (0-500ms). This average result will be available to the user (GA) until overwritten by a new result. A new trigger pulse will only be accepted after the end of the measuring period. The timers are derived from the LDU's update rate so the highest time resolution will be obtained at 600 samples / sec. (1 / 600 = 1.67ms)

Getting Started

You will require a:

- PC or PLC with either a RS422 or RS485 communication port ;
- RS232 to RS422/485 converter - necessary if it is intended to use communication driven from the master which has only a RS232 port available;
- Interconnecting cabling - confirm that all of the relevant pins are in use - check against the wiring diagram that follows this section ;
- A load cell with test weights, OR a load cell simulator ;

- A DC power supply capable of delivering 12-24 VDC. Current capacity dependent on the number of device and the number of load cells to be connected. (One device plus one load cell requires less than 100 mA) ;

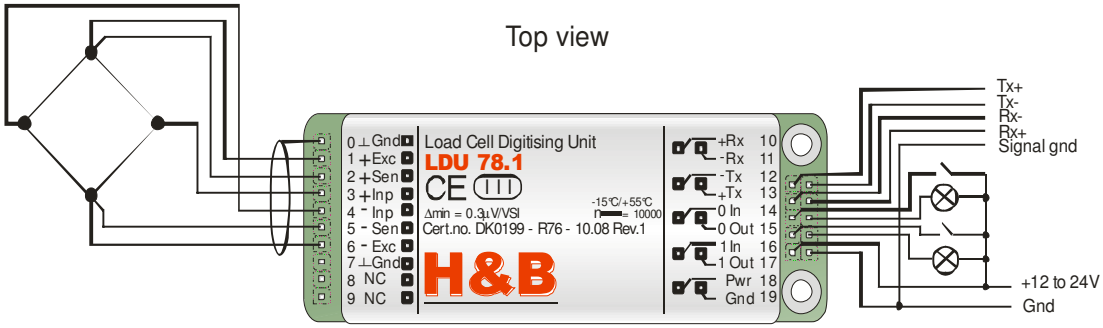
- One or more LDU 78.1;

- A suitable ASCII communication software (HyperTerminal etc)

Refer to the following wiring diagram

3. HARDWARE & CONNECTIONS

Top view



Connectors Not Shown for Clarity

Bottom view

Sw1 & Sw2 : Close for 4-wire loadcell
Sw3 : Close to enter configuration mode
Sw4 : Do NOT close - used for program download

4. COMMAND PROTOCOL - LONG DESCRIPTIONS

For ease of interpretation, the commands have been grouped together and will be described in the following sequence:

4.1 System Diagnostics Commands

4.2 Set up Commands

4.3 Calibration Commands

4.4 Motion Detection Commands

4.5 Filter Setting Command

4.6 Weigher Control Commands

4.7 Output Commands

4.8 Auto-Transmit Commands

4.9 Remote I/O Commands

4.10 Setpoint Operation Commands

4.11 Communication set-up commands

4.12 Save set-up Parameters Command

4.1 SYSTEM DIAGNOSTICS COMMANDS – ID, IV, IS, SR, RS

The following three commands provide a means of interrogating the device to confirm the type of device present, the software version of that device and the status. The commands require no parameters and are used as follows:

ID Determine the device ID code - this is a code which identifies the type of device which is currently open for communications. Issuing the ID command, which has no parameters, will return the code **D:7810** This code is useful when mixed devices may be present on the bus.

IV Determines the device software version - this identifies the release of software that is installed in the device. This is useful when determining the availability of special commands or features that may have been requested for special applications. Issuing the IV command, which has no parameters, will return the software identification code in the format **V:0246**

IS Determine the device status - Issuing the ID command, which has no parameters, will return a result in the format **S:000000** . This result comprises two 3-digit decimal values, which can be decoded according to the table below:

Leftmost 3-digit value:		Rightmost 3-digit value:	
1	Signal stable	1	not used
2	Zero action performed	2	not used
4	Tare active	4	not used
8	not used	8	not used
16	Input 0 active	16	not used
32	Input 1 active	32	not used
64	Output 0 active	64	not used
128	Output 1 active	128	not used

Therefore, the example result **S:001000** decodes as signal stable (no-motion) no zero action and no tare.
The unsupported bits are reserved for use on other members of the H&B instrument family and in the case of the LDU 78.1 are always set at zero.

SR Software Reset – this command will respond with 'OK' and after maximum 400ms perform a complete reset of the LDU.

RS Read device serial number - this command is currently being implemented in the H&B product range. Units which have not been programmed with serial number will show serial number 0 (zero) or -1 (minus one) when using new firmware.

4.2 SET UP COMMANDS – SD, MT, TE, TR, TL, RW, TT, HT, TW, TI, DT, TS

SD Start Delay (0-500ms). Set the delay between falling/rising edge of trigger pulse and start of measurement. Issuing the **SD** command without any parameters will return the current delay setting. Factory default setting: 0.
NOTE: Remember to store the setting using the **WP** command before turning off the power.

MT Measuring Time (0-500ms). Set the time over which the average value will be build. Issuing the **MT** command without any parameters will return the current measurement time setting. **Factory default setting: 0 which disables the trigger/average functions completely. NOTE:** Remember to store the setting using the **WP** command before turning off the power.

TE Trigger Edge – this command selects rising or falling edge trigger. Parameter = 0 select falling edge and parameter = 1 select rising edge. Issuing the **TE** command without any parameters will return the current edge trigger setting. Factory default setting: 0.
NOTE: Remember to store the setting using the **WP** command before turning off the power.

TR Trigger, this command will start the measuring cycle in the same way as the hardware trigger input.

TL Trigger level (0-99999). Set the level for rising edge start of measurement. Issuing the **TL** command without any parameters will return the current trigger level setting. Factory default setting: 99999.
NOTE: Remember to store the setting using the **WP** command before turning off the power.

RW Set the re-trigger window in counts (digits) without decimal point (0-65535). If the weight relative to the current average value changes by more than the RW value the average cycle will be restarted using TT as measure time. To automatically issue the re-trigger command, the time period over which an increase of weight average is measured has to be defined by using the command DT. Factory default setting: 65535.

TT Set the re-trigger time in milliseconds [ms] (0-65535). Re-trigger time is the average time used by the re-trigger function. If set to zero the re-trigger function is disabled.
Factory default: 0.

HT Set the Hold Time in milliseconds [ms] (0-65535). During the Hold Time the weight value must be over set-point that a digital output can be switched. This means that a short signal peak will not lead to the switching of a digital output. Factory default: 0.

TW Set the Tare Window in counts (digits) without decimal point (0-65535).
Tare window (TW) allows an automatic Tare update.
If TW = 0 this function is not active.
If TW = 100, this means a new tare value will be taken when the net average weight of an empty scale is within 100 counts or division of zero. The new average tare value is calculated over the average tare time defined by TI. If the tare average is outside tare window, the tare will not be updated. Factory default: 0.

TI Set the Tare Time in milliseconds [ms] (0-65535). During the Tare Time a "tare-average" will be calculated by the system. Factory default: 0.

DT Set the Delta Time in milliseconds [ms] (0.65535). During MT and TT timeframes "sub-averages" will be calculated by the system over the time DT. If a sub-average is outside the re-trigger window, the re-trigger function is automatic started. Factory default: 50.

TS Set the re-trigger stop in counts (digits) without decimal point (0-65535). In case of a (TS) decrease in weight relative to the current average value the re-trigger function is stopped. Factory default: 65535.

4.3 CALIBRATION COMMANDS – CE, CM, DS, DP, CZ, CG, ZT, FD, IZ, ZR, ZI, WT, CS

CE Set the calibration functions to the enabled state. This command must be issued PRIOR to any attempt to set the calibration parameters CM, DS, DP, CZ, CG, ZT, FD, IZ, ZR, ZI, WT or CS. Issuing the command without any parameters results in the response **E+XXXXX** where **XXXXX** is the Traceable Access Code (TAC). This is an internal code that is used to record any changes in the calibration settings of the device. This is a critical feature that is required for "approved" applications, as it provides for the control of access to any command that has the potential of changing the weigher calibration value. For further information, please refer to section 7, "USE IN APPROVED APPLICATIONS".

CM Set the maximum allowable output value. Lower limit 1, upper limit 99999. Issuing the command without any parameters returns the current CM value. This value will determine the point at which the output will change to **oooooo**, signifying over-range. To set a new value for CM, the command must be preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC. The new CM value required is then input as a parameter of CM, in the format **CM 4010** . For further information, please refer to section 6, "CALIBRATION PROCEDURE". Factory default setting: 99999.

DS Set the display step size - this allows the output to step up or down by a unit other than 1. Permitted values are 1, 2, 5, 10, 20, 50, 100 and 200. To set a new value for DS, the command must be preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC. The new DS value required is then input as a parameter of DS, in the format **DS 100** . For further information, please refer to section 6, "CALIBRATION PROCEDURE". Factory default setting: 1.

DP Set the decimal point position - this allows the decimal point to be positioned anywhere between leftmost and rightmost digits of the 5-digit output result. Permitted values are 0 for the rightmost position, and 5 for the leftmost position. To set a new value for DP, the command must be preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC. The new DP value required is then input as a parameter of DP, in the format **DP 2** . For further information, please refer to section 6, "CALIBRATION PROCEDURE". Factory default setting: 0.

CZ Set the calibration zero point - this is the reference point for all weight calculations, and is subject to TAC control. The command returns **ERR** and has no action unless it is preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC. Confirmation of action is provided by the return **OK**. For further information, please refer to section 6, "CALIBRATION PROCEDURE". Factory default setting: approx. 0mV/V input.

CG Set the calibration gain (span) value - this is the reference point for the calibration under load, and is subject to TAC control. The lower limit for CG is 1, the upper limit is 99999. The weight signal used for calibration should be as close as possible to the maximum allowable display value (CM) so as to ensure optimum calibration accuracy. A feature provided is the ability to recall the value of the calibration weight used for the current calibration by the issue of a CG command without any parameters. This is useful information for future calibration purposes or for diagnostics. When calibrating the span, the actual value of the calibration weight must be entered as a parameter of the CG command, for example if the output 25000 is required for the weight placed on the load cell, then the calibration command becomes **CG 25000**. The command returns "**ERR**" and has no updating action unless it is preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC. **If the load applied to calibrate the span is less than 1% of full scale (2mV/V), the gain calibration will fail and 'ERR' will be returned.** For further information, please refer to section 6, "CALIBRATION PROCEDURE". Factory default setting: 20000 at approx. 2mV/V input.

ZT Zero tracking - this command enables or disables the zero tracking. Parameter = 0 disables the zero tracking and parameter = 1 to 255 enables the zero tracking and set the zero track range (1 => Zero track range = +/-0.5d; 2 => Zero track range = +/-1.0d …..255 => Zero track range = +/-127.5d). Issuing the command without any parameters returns the current ZT value. The command returns **ERR** and has no updating action unless it is preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC. Zero tracking

will be performed only on results within the zero track range at a rate of 0.4 d/sec where d = display step size - see the DS command. The zero can only be tracked within the zero range – see the ZR command. Factory default setting: 0.

FD Factory default settings – this command put the LDU back to a known state. The data will be written to the EEPROM and the TAC will be incremented by 1.
NOTE : All calibration and setup information will be lost by issuing this command . The command returns **ERR** and has no updating action unless it is preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC.

IZ Move the calibration zero point - this is used after installation of an otherwise calibrated load cell. When installed, the installation may add a bias to the load cell. This function can be used to move the CZ zero point without further calibration. IZ is subject to TAC control. The command returns ERR and has no action unless it is preceded by the CE XXXXX command, where XXXXX is the current TAC. Confirmation of action is provided by the return OK.

ZR Set the zero range - this is the range in increments within which the weighing scale can be zeroed. Issuing the ZR command without any parameter will return the current value. Set a new value by issuing the ZR command followed by the desired value, in the format ZR 5. Permitted values are between the lower limit of 0 and the upper limit of 99999.
Factory default setting: 0. A value of zero enables the standard zero range of +/-2% of max.
NOTE: Setting the zero range is protected by the CE sequence and the value is stored using the CS command.

ZI Defines the initial zero range (0-99999). If ZI is non-zero the device will perform an automatic Set-Zero when the weight stabilizes with the No-motion settings and the weight is within the ZI range. Factory default: 0.

WT Set the warm up time - this command defines a time interval between 0 and 65535 seconds after power on where the output value will be set to **"uuuuu"** to avoid false readings during the initial stabilisation period. To set a new value for WT, the command must be preceded by the **CE XXXXX** command, where **XXXXX** is the current TAC. The new WT value required is then input as a parameter of WT, in the format **WT 20**. Factory default setting: 0.

CS Save the calibration values - this command results in the calibration values being saved to EEPROM, and causes the TAC to be incremented by 1. The CS command saves all of the calibration group values, as set by CM, DS, DP, CZ, CG, ZT, IZ, ZR, ZI and WT. The command returns **ERR** and has no updating action unless it is preceded by the

CE XXXXX command, where **XXXXX** is the current TAC. For further information, please refer to section 6, "CALIBRATION PROCEDURE".

4.4 MOTION DETECTION COMMANDS – NR, NT

The Motion Detection facility provides a means of disabling certain functions whenever a condition of instability, or "motion", is detected. The "no-motion", or "stable" condition is achieved whenever the signal is steady for the period of time set by NT, during which it cannot fluctuate by more than NR increments. The stable condition activates the relevant bit of responses to "Info Status" (IS - see section 4.1, "SYSTEM DIAGNOSTICS COMMANDS")
The functions which are disabled whenever motion is detected are "Calibrate Zero" (CZ) "Calibrate Gain" (CG) "Set zero" (SZ) and "Set tare" (ST).

NR Set the "no-motion" range - this is the range within which the weighing signal is allowed to fluctuate and still be considered as "stable". Issuing the NR command without any parameter will return the current value. Set a new value by issuing the NR command followed by the desired value, in the format **NR 5**. Permitted values are between the lower limit of 0 and the upper limit of 65535. Factory default setting: 1.

NT Set the stabilisation time for the "in motion" band. This is the time parameter that defines the period during which the output must not fluctuate more than NR increments in order to be considered "stable". Set a new value by issuing the NT command followed by the desired value in milliseconds, in the format **NT 1000** . Permitted values are between the lower limit of 0 and the upper limit of 65535. Factory default setting: 1000.

4.5 FILTER SETTING COMMAND – FL, FM, UR

The facility exists for the setting of a digital filter via the command parameters FL, FM, and UR. This filter can be adjusted to eliminate most unwanted disturbances. Note that this filter is positioned immediately after the A/D Converter, and will therefore have an effect on all aspects of weigher operation.

FL Set the filter cut off frequency - permitted values are between 0 and 8, see tables below. A setting of 0 will disable the filter in both mode 0 and 1. Issuing the FL command without any parameters will return the current filter value. Set a new value by issuing the FL command followed by the desired value, in the format **FL 4**. Factory default setting: 3.

NOTE: Remember to store the setting using the **WP** command before turning off the power.

FM Set the filter mode - permitted values are between 0 and 1, see tables below. Mode 0 uses a 2.order low pass Gaussian IIR filter and mode 1 uses a combination of FIR filters. Issuing the FM command without any parameters will return the current filter mode. Set a new value by issuing the FM command followed by the desired value, in the format **FM 1**. Factory default setting: 0.

NOTE: Remember to store the setting using the **WP** command before turning off the power.

Mode 0 characteristics:

FL	Settling time to 0.1% in ms.	3db Cut-off frequency in Hz.	Damping in dB at 300Hz.	Update-rate in samples/sec.
1	55	18	57	600
2	122	8	78	600
3	242	4	96	600
4	322	3	104	600
5	482	2	114	600
6	963	1	132	600
7	1923	0.5	149	600
8	3847	0.25	164	600

Mode 1 characteristics:

FL	Settling time to 0.1% in ms.	3dB Cut-off frequency in Hz.	20dB damping at frequency in Hz.	40dB damping at frequency in Hz.	Damping in dB in the stopband	Stopband in Hz.	Update-rate in samples/sec.
1	47	19.7	48	64	>90	>80	600
2	93	9.8	24	32	>90	>40	300
3	140	6.5	16	21	>90	>26	200
4	187	4.9	12	16	>90	>20	150
5	233	3.9	10	13	>90	>16	120
6	280	3.2	8	11	>90	>13	100

7	327	2.8	7	9	>90	>11	85.7
8	373	2.5	6	8	>90	>10	75

UR Set the update-rate. This command will define over how many measurements, from the preceding IIR or FIR filter, an average will be calculated. Permitted values are between 0 and 7, see table below. Issuing the UR command without any parameters will return the current update rate. Set a new value by issuing the UR command followed by the desired value, in the format **UR 2**. Factory default setting: 0.

NOTE: Remember to store the setting using the **WP** command before turning off the power.

Update rates:

UR	0	1	2	3	4	5	6	7
Number of samples	1	2	4	8	16	32	64	128

4.6 WEIGHER CONTROL COMMANDS – SZ, ZA, RZ, ST, RT

The following commands provide the means to control the setting and resetting of the zero and tare points. The availability of net weighing depends on these functions. The zero point which is set at calibration time, remains the “true” zero, but the “current” zero will be the basis for the output result. Remember that the “current” zero can be influenced by the “zero tracking” function, and this should be taken into account when designing the application. A basic system control is the disabling of the “set zero” and “set tare” functions whenever the weighing signal is not stable, as defined by the “no-motion” function.

SZ Set the system zero - this command will create a “current” zero point which will become the basis for all weigher operation, until further updated by the zero tracking function, or another SZ command or the “reset zero” command (RZ). Any attempt to zero a drift of more than the zero range (ZR) will result in the SZ command being rejected (**ERR**). The SZ command is also rejected if the weighing signal is fluctuating, as defined by the “no-motion” function parameters (NR and NT). The “signal stable” bit in the responses to the “info status” (IS) command must therefore be active before a SZ command can be accepted. Issuing the SZ command, which has no parameters, will return the **OK** or **ERR** response. If **OK** is returned, then the “zero action performed” bit in the response to the “info status” (IS) command will be activated.

ZA Set system Zero. This will set new system Zero as SZ, but using an average over the TI period.

RZ Reset the zero point to the "calibration" zero - this command will return the zero point to that which was stored during the calibration procedure. Issuing the RZ command, which has no parameters, will return the **OK** or **ERR** response. If **OK** is returned, then the "zero action performed" bit in the response to the "info status" (IS) command will be de-activated.

ST Set the tare point - this command will activate the net weighing function, by storing the current weighing signal output value as a tare value. The ST command is rejected if the weighing signal is fluctuating, as defined by the "no-motion" function parameters NR and NT. The "signal stable" bit in the "info status" return must therefore be active before a ST command can be accepted. Issuing the ST command, which has no parameters, will return the **OK** or **ERR** response. If **OK** is returned, then the "tare active" bit in the response to the "info status" (IS) command will be activated.

RT Reset the tare - this command cancels the net weighing mode, and restores the current zero. The weighing signal output returns to the gross mode. Issuing the RT command, which has no parameters, will return the **OK** or **ERR** response. If **OK** is returned, then the "tare active" bit in the response to the "info status" (IS) command will be activated.

4.7 OUTPUT COMMANDS – GG, GN, GT, GS, GW, GA, GL

The following command provides the means of obtaining an output results from the device.

GG Get the gross value - returns the current gross weight value. Issuing the GG command, which has no parameters, will return the gross weight value in the format **G+01.100** .

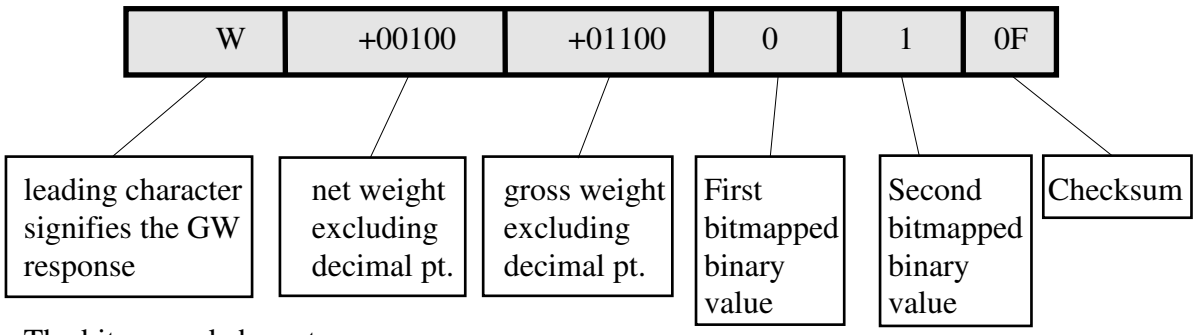
GN Get the net value - returns the current net weight value. Issuing the GN command, which has no parameters, will return the net weight value in the format **N+01.100** .

GT Get the tare value - returns the current tare weight value. Issuing the GT command, which has no parameters, will return the tare weight value in the format **T+01.100** .

GS Get the A/D sample value – returns the current output result of the A/D converter (ADC). This facility is useful when developing the application, or when calibrating the system, as it allows a check to be made of the operating range of the ADC. Issuing the GS command, which has no parameters, will return the ADC output value in the format

S+100000.

GW Get the "long" weight values - returns the current net, gross and status values. Issuing the GW command, which has no parameters, will return the net weight, the gross weight, the status and the checksum values, all combined into one single string in the format **W+00100+01100010F**. The first two sections of the return string comprise the net weight and gross weight results, followed by two hexadecimal characters, which represent two bitmapped status indicators. The last two hexadecimal characters represent the checksum, which is the inverse of the sum of all the ASCII values of the string, not including the checksum characters.



The bitmapped characters are:

First Bit value	description	Second Bit value	description
1	Input 0 active.	1	No motion.
2	Input 1 active.	2	Zero action performed.
4	Output 0 active.	4	Tare active.
8	Output 1 active.	8	Not used.

The checksum is derived as follows:

a. Add the ASCII values (in hex) of all the 15 characters in the string
b. Invert the hexadecimal value
c. Add one to the value
d. Use only the last two digits
e. Convert the hexadecimal value to characters

GA Get Average - returns the current average weight value. Issuing the GA command, which has no parameters, will return the average weight value in the format: **A+01.100.** **Please note that during the time between the trigger condition being accepted and the average value being updated, the GA command will return the value 99999**

GL Get the "long" weight values - returns the current average, gross and status values. Issuing the GL command, which has no parameters, will return the average weight, the gross weight, the status and the checksum values, all combined into one single string in the format **L+00100+01100010F**. The first two sections of the return string comprise the net weight and gross weight results, followed by two hexadecimal characters, which represent two bitmapped status indicators. The last two hexadecimal characters represent the checksum, which is the inverse of the sum of all the ASCII values of the string, not including the checksum characters – see the GW command.

4.8 AUTO-TRANSMIT COMMANDS – SG, SN, SW, SA ,SL

The following command provide the means to output the weight results in a continuous stream, which starts upon the issue of the relevant command, and ends upon the issue of any other command.

SG Auto-transmit the gross weight value - continually returns the current gross weight value. Issuing the SG command, which has no parameters, will continually return the gross weight value in the format **G+01.100** , until interrupted by any other command.

SN Auto-transmit the net weight value - continually returns the current net weight value. Issuing the SN command, which has no parameters, will continually return the net weight value in the format **N+01.100**, until interrupted by any other command.

SW Auto-transmit the "long" weight values - continually returns the current net, gross and status values. Issuing the SW command, which has no parameters, will continually return the "long" weight values in the format **W+00100+01100010F**, until interrupted by any other command – see the GW command for details.

SA Auto-transmit the measured weight value - continually sends measured weight values. When a measurement is trigged the value 99999 is sent, if re-trigged 88888 are sent and on measurement completion the actual measured weight.
Issuing the SA command, which has no parameters, will continually return the measurement values in the format **A+01.100**, until interrupted by any other command.

SL Auto-transmit the "long" weight values - continually returns the current average, gross and status values. Issuing the SL command, which has no parameters, will

continually return the "long" weight values in the format **L+00100+01100010F**, until interrupted by any other command – see the GL command for details.

4.9 REMOTE I/O COMMANDS – IN, IO, IM

The LDU 78.1 includes 2 independent logic input channels and 2 independent logic output channels together with control features which provide the user with total control over the configuration and action of each output channel. The inputs can be read directly by the host application, allowing for such uses as machine status indication, and the outputs can be driven internally, from fully flexible setpoint controls, or can be driven directly by the host application. The following group of commands provides for reading the status of logic inputs, outputs and for configuring the outputs as internally or externally controlled.

IN Read the status of the two input channels – returns the status in the form of a bitmapped four-digit value where 0 corresponds to "false" and 1 corresponds to "true" (inputs are active "high"). Issuing the IN command, which has no parameters, returns the input status in the form **IN:0001**, where Input 0 status is given by the Least Significant Digit (in this example 1) and so on.

IO Read/Modify the status of the two output channels – returns the status in the form of a bitmapped four-digit value where 0 corresponds to "false" and 1 corresponds to "true" (outputs are open drain MOSFET's, normally open) and modifies the status if enabled by the IM command. Issuing the IO command without any parameters returns the output status in the form **IO:0011**, where Output 0 status is given by the Least Significant Digit and so on. Change the status of the outputs by issuing the IO command with the appropriate four-digit value in the form **IO 0001**, where in this example, output 0 will be activated (FET in conducting mode). Note that in normal operation, the status of the output channels is determined by the status of the internal setpoints (see section 4.9, "SETPOINT COMMANDS"), therefore setting the output channel status by means of the IO command is inhibited. However, if the IM command is used (see following), the status of the output channels can be set by the host application, through the use of the IM or IO commands.

IM In order to control the outputs from the host application the outputs must be configured using the IM command. A "1" bit in the mask will open the corresponding output channel for outputs from the IO command and a "0" bit will leave the channel controlled by the setpoint. Issuing the IM command without any parameters returns the current mask in the form **IM:0011**. Change the mask by issuing the IM command with the appropriate four-digit value in the form **IM 0001.** NOTE: When reading back the output status using the IO command the setpoint status will be read regardless of the setting of IM.

4.10 SETPOINT COMMANDS – S0, S1, H0, H1, A0, A1

S0 (S1) Set the setpoint value for channel 0 (1) – sets the value which will trigger the required action of the output channel transistor, in conjunction with the settings of the other controls H0 (H1) and A0 (A1). Issuing the S0 (S1) command without any parameters will return the current value in the form **0+00200.**, signifying that setpoint number 0 is set to trigger at value +200, and in so doing will set output 0 "ON". The source to be monitored for the purpose of setpoint action is determined by the setpoint ACTION command A0 (A1). After the setpoint has been reached, the action of the setpoint, and the status of the relevant output channel, is dependent on the setting of the HYSTERESIS command H0 (H1).

H0 (H1) Set the hysteresis value for channel 0 (1) – sets the value and polarity by which the output value must change in order to release the setpoint. Issuing the H0 (H1) command without any parameters will return the current value in the form **0+00100.** , signifying that setpoint 0 must hold it's "ON" status until the source value drops by 100. If H0 returns a negative value, then this signifies that the source value must increase beyond 100, after which point the setpoint will release, and the relevant output channel will change to the "OFF" condition. This command therefore allows the setpoint to be inverted.

A0 (A1) Set the action for channel 0 (1) – sets the source for the value which will trigger the required action of the output channel relay, according to the settings of the other controls S0 (S1) and H0 (H1). Issuing the A0 (A1) command without any parameters returns the current value in the form **0+00001**

An = 0	Gross weight as setpoint source
An = 1	Net weight as setpoint source

4.11 COMMUNICATION SET-UP COMMANDS – AD, BR, DX, TD

AD Set the address of the LDU for networking (0-255). Setting the device address to 0 will set the continuously active mode, where the device becomes permanently active, and will listen and respond to any command on the bus, without the need for an **OP** xxx command. Issuing the AD command without any parameters will return the current address. Factory default setting: 0.

NOTE: this setting will take effect after power on reset (remember to store the setting using the **WP** command before turning off the power)

BR Set the LDU baud rate. Issuing the **BR** command without any parameters will return the current baud rate. Set a new value by issuing the **BR** command followed by the desired value, in the format **BR 115200**. Factory default setting : 9600.

NOTE: this setting will take effect after power on reset (remember to store the setting using the **WP** command before turning off the power)

DX Half or full duplex – this command select half or full duplex communication. Parameter = 0 select half duplex communication and parameter = 1 select full duplex communication - use half duplex setting when using two wire RS485.

TD Transmit delay – this command allow delays from 0 to 255ms before any response from the LDU. This delay is necessary in some two wire applications. Issuing the **TD** command without any parameters will return the current value. Set a new value by issuing the **TD** command followed by the desired value, in the format **TD 20**. Factory default setting : 0.

4.12 SAVE SET-UP PARAMETERS COMMAND – WP, SS, PI, GI

The configuration parameters can be considered as three distinct groups, namely:

- Calibration Parameters (CM, DS, DP, CZ, CG, ZT, IZ, ZR, ZI, WT) ;
- Indicator Parameters (FL, FM, UR, NR, NT, AD, BR, DX, TD, SD, MT, TE, TL, RW, TT, HT, TW, TI, DT, TS) ;
- Setpoint Parameters (S0, S1, H0, H1, A0, A1);

The alteration and amendment of the calibration parameters is subject to the control procedure that is described in section 6, "CALIBRATION PROCEDURE". This procedure includes the use of the "Calibration Save" (CS) command. All other settings can be saved using the save commands WP and SS.

WP Save the "indicator" set-up parameters - saves the settings of the "Filter" (FL, FM and UR), the "No-Motion" settings (NR and NT), the communication settings (AD, BR, DX and TD) and the check weigher settings (SD, MT, TE, TL, RW, TT, HT, TW, TI, DT and TS) in the EEPROM

SS Save the "setpoint" set-up parameters - saves the settings of the setpoints (S0 and S1), the "Setpoint Hysteresis" settings (H0 and H1) and the "Setpoint Action" settings (A0 and A1). Issuing the SS command, which has no parameters, will return OK or ERR response. The OK response signifies the "setpoint" parameters group settings have been saved to EEPROM.

PI Put EEPROM image. Download a HEX-INTEL formatted EEPROM image to the unit.

The image contains all stored information except the calibration data.
The unit must have same firmware type and revision as the source.

GI Get EEPROM image. Get a HEX-INTEL formatted EEPROM image of the unit.
The image contains all stored information except the calibration data.
This image can be downloaded to any unit with same firmware type and revision as this unit.

5. COMMAND PROTOCOL - SHORT DESCRIPTIONS

Command	Short Description	Usage	Parameter Values	Typical Response
An	Get/set setpoint n action	Read/modify setpoint action 0 or 1	0..1 and 0..2	An:+00000
AD	Network address	Read/modify network address	0..255	A:014/OK/ERR
BR	Baud rate	Read/modify baud rate setting	9600..115200	B 9600
CE	Calibrate enable	Open legal parameters (CE 'TAC')	0..65535	E+00001/OK/ERR
CG	Calibrate gain (TAC protected)	Calibrate gain at some load >> zero	0..99999	G+20000/OK/ERR
CL	Close all connections	Close all devices (OP XXX implies CL)	none	none
CM	Calibrate max (TAC protected)	Read/modify max	0..99999	M+30000/OK/ERR
CS	Calibrate save (TAC protected)	Save CM,DS,DP,CZ,CG,ZT,IZ,ZR,ZI,WT to EEPROM	none	OK/ERR
CZ	Calibrate zero (TAC protected)	Calibrate zero - no load on platform	none	OK/ERR
DP	Decimal point (TAC protected)	Read/modify decimal point position	0..5	P+00005/OK/ERR
DS	Display step size (TAC protect)	Read/modify the display step size	1,2,5,10,20,50,100,200	S+00001/OK/ERR
DT	Delta time	Read/modify delta time	0..65535	T+00050/OK/ERR
DX	Duplex	Select half (0) or full (1) duplex	0..1	X:001/OK/ERR
FD	Factory default (TAC protected)	Load factory defaults into EEPROM	none	OK/ERR
FL	Filter setting	Read/modify filter setting	0..8	F+00007/OK/ERR
FM	Filter mode	Read/modify filter mode	0..1	M+00001/OK/ERR
GA	Get Average weight	Returns the current average weight value	none	A+00000/OK/ERR
GG	Get gross value	Get gross value	none	G+01100.
GI	Get image	Get EEPROM image as an Intel hexfile	none	Intel hexfile
GL	Get long weight	Get average, gross and status	none	L+00100+01100010F
GN	Get net value	Get net value	none	N+00000.
GS	Get A/D sample	Get A/D sample	none	S+100000
GT	Get tare value	Get tare value	none	T+00500.
GW	Get long weight	Get net, gross and status	none	W+00100+01100010F
Hn	Get/set setpoint n hysteresis	Setpoint hysteresis 0 or 1	-99999..99999	Hn:+00000
HT	Hold time	Read/modify hold time	0..65535	H+00100
ID	Inform. Device ID	Information - device identification	none	D:7810
IM	Read /modify manual status	Read /modify manual status	0000..0011	IM:0000
IN	Read input status	Read input status	none	IN:0011

IO	Read/modify output status	Read/modify output status	0000..0011	IO:0001
IS	Inform. on device status	Information	none	S:000000
IV	Inform. version number	Information - software version number	none	V:0246
IZ	Installation zero (TAC protected)	Readjust zero calibration	none	OK/ERR
MT	Measuring Time	The time over which the average value is derived	0..500 ms	M+00000/OK/ERR
NR	No-motion range	Read/modify No-motion range	0..65535	R+00010/OK/ERR
NT	No-motion time	Read/modify No-motion time in milliseconds	0..65535	T+00500/OK/ERR
OP	Open connection	Open device XXX	0..255	O:002/OK
PI	Put image	Put EEPROM image as an Intel hexfile	Intel hexfile	OK/ERR
RS	Read serial number	Read the serial number of the device	none	S+12345678
RT	Reset tare	Restores current zero point	none	OK/ERR
RW	Retrig window	Read/modify retrig window	0..65535	R+00100/OK/ERR
RZ	Reset system zero	Restores the calibration zero point	none	OK/ERR
Sn	Get/set setpoint n	Setpoint 0 or 1	-99999..99999	Sn:+00000
SA	Start auto-transmit average	Start auto-transmitting average results	none	A+01000
SD	Start Delay	Start delay between trigger and start of measurement	0..500 ms	S+00000/OK/ERR
SG	Start auto-transmit gross	Start auto-transmitting gross weight result	none	G+01100.
SL	Start auto-transmit long weight	Start auto-transmitting average, gross and status	none	L+00100+01100010F
SN	Start auto-transmit net	Start auto-transmitting net weight result	none	N+00000.
SR	Software reset	Responds with OK and then resets the LDU	none	OK/ERR
SS	Save setpoint parameters	Save S0, S1, H0, H1, A0, A1 to EEPROM	none	OK/ERR
ST	Set tare	Set tare point	none	OK/ERR
SW	Start auto-transmit long weight	Start auto-transmitting net, gross and status	none	W+00100+01100010F
SZ	Set system zero	Set system zero point	none	OK/ERR
TD	Transmit delay	Read/modify transmit delay	0..255	T+00020/OK/ERR
TE	Trigger Edge	Selects trigger on a falling (0) or rising (1) edge	0..1	E:000/OK/ERR
TI	Read/modify tare interval	Read/modify the tare time interval	0..65535	T+00100/OK/ERR
TL	Read/modify trigger Level	Set value of the rising or falling trigger edge	0..99999	T+99999/OK/ERR
TR	Trigger	Software trigger to start measuring cycle	none	OK/ERR
TS	Retrigger stop	Read/modify the retrigger stop level	0..65535	T+00500/OK/ERR
TT	Retrigger time	Read/modify retrigger time	0..65535	T+00200/OK/ERR
TW	Tare window	Read modify the tare window	0..65535	W+00050/OK/ERR
UR	Read/modify the update rate	Read/modify the update rate	0..7	U+00001/OK/ERR
WP	Save set-up parameters	Save parameters to the EEPROM	none	OK/ERR

WT	Warm up time (TAC protected)	Read/modify the warm up time delay	0..65535	W+00030/OK/ERR
ZA	Set system zero - average	Set system zero point using TI	none	OK/ERR
ZI	Initial zero (TAC protected)	Set initial zero range	0.99999	R+01000/OK/ERR
ZR	Zero range (TAC protected)	Set zero range	0..99999	R+00500/OK/ERR
ZT	Zero track (TAC protected)	Zerotrack off (0) or zerotrack on (1..255)	0..255	Z:001/OK/ERR

6. CALIBRATION PROCEDURE

The calibration interface features a "**TRACEABLE ACCESS CODE**" (**TAC**), as is required for use in "Approved" applications (see section 7, "USE IN APPROVED APPLICATIONS" for more details). This feature also ensures that access to the calibration functions is protected from inadvertent or unauthorised change. The following parameters are considered as CALIBRATION commands:

CE : Calibration Enable - returns the current TAC value.
CZ : Calibrate zero - sets the system zero point.
CG : Calibrate gain - sets the system gain.
CM : Calibrate maximum - sets the maximum allowable display value.
DS : Display step size - sets the output incremental step size.
DP : Display decimal point - sets the position of the output decimal point.
ZT : Zero track enable.
FD : Factory default setting (return to)
CS : Calibration save.

To make an enquiry as to the setting of any of these commands requires the issue of the command with no parameters attached. The responses are explained in section 4.2, "CALIBRATION COMMANDS".

To make a change to the settings of any of these commands **REQUIRES THE ISSUE OF THE CE COMMAND FOLLOWED BY THE CURRENT TAC VALUE (CE XXXXX).**
For example, if the output step value needs to be changed from 1 to 5, the following steps would be required:

Master sends : **CE**
Slave returns : **E+00016**
Master sends : **CE 16**
Slave sends : **OK**
Master sends : **DS 5**
Slave sends : **OK**

The output will now increment in steps of 5 divisions. It will then be necessary to SAVE the calibration parameters to non-volatile memory, by issuing the CS command. The CS command, which has no parameters and must be preceded by the **CE XXXXX** command, will return **OK** to signify successful update. The TAC is then incremented by 1.
An example of the recommended calibration procedure follows:

To set the system zero and the system gain:

With the device selected, a suitable load cell in place, with known test weights available, (the example uses 5000 as a test weight value):

Step 1	Master sends	:	**CE**	Query the current TAC value
	Slave returns	:	**E+00017**	
Step 2	Master sends	:	**CE 17**	Enables the calibration sequence
	Slave returns	:	**OK**	
Step 3	Master sends	:	**CZ**	Ensure that the weigher is unloaded
	Slave returns	:	**OK**	
Step 4	Master sends	:	**CE 17**	Enables the calibration sequence
	Slave returns	:	**OK**	
Step 5	Master sends	:	**CG 5000**	Where 5000 is the weight value added
	Slave returns	:	**OK**	
Step 6	Master sends	:	**GG**	To confirm the calibration is correct
	Slave returns	:	**G+05000.**	
Step 7	Master sends	:	**CE 17**	Enables the calibration sequence
	Slave returns	:	**OK**	
Step 8	Master sends	:	**CS**	Writes the calibration data to memory
	Slave returns	:	**OK**	

The system zero and system gain value will have been updated and written to EEPROM, and the TAC will have been incremented.

7. USE IN "APPROVED" APPLICATIONS

The term "approved" applies whenever the weighing application is intended to be used for "legal-for-trade" weighing - that is, money will change hands according to the weight result. Such applications are bound by the legal metrology regulations of the relevant governments around the World, but most countries will comply with either the relevant EN's (Euro Norms) or the relevant OIML (Organisation Internationale de Metrologie Legale) recommendations.

- The LDU 78.1 has been approved as a component for use in weighing systems according to OIML recommendation R76, the highest performance level approved being Class III, 10000 division. The approval Authority was the Danish Electronics, Light & Acoustics (DELTA), and the approval certificate number was
- DK0199-R76-02.02 Revision 1, dated xx.yy.zz. This approval will allow the use in approved weighing systems throughout Europe, and in many other countries of the World.

To achieve approval on a particular application, it will be necessary to satisfy the relevant Governmental Trading Standards Authority that the requirements of the various rules and regulations have been satisfied. This task is greatly simplified if the key components of the weighing system, namely the load cells and the weighing indicator or digitiser, are already approved as “components”.

Usually, a discussion with the Weighing Equipment Approvals Officers at the relevant National Weights & Measures Office will then reveal the extent of any pattern testing that may be necessary to ensure compliance.

Restrictions upon usage when in “Approved” applications

A number of performance restrictions must come into force. These restrictions are the number of display divisions, which become limited to 10000 divisions, and the sensitivity per display division, which becomes 0.3uV per division.

Once installed in the application, an “approved” application will require “stamping” by an Officer of the relevant Governmental Trading Standards Department. This certifies the equipment or system as being in accordance to the relevant regulations and within calibration limits.

The Traceable Access Code (TAC)

The user software must then provide a guard against improper access of the calibration commands (see the “Calibration Commands” section). The LDU 78.1 digitiser features the “Traceable Access Code” or TAC method of controlling the access to the calibration commands group. This means that a code is maintained within the device, and is incremented whenever any change to any of the calibration commands is saved.

When performing the “stamping” test, the Trading Standards Officer will make a note of the TAC, and advise the user that any change to this code which occurs prior to the regular re-inspection by the Trading Standards Office, will result in legal prosecution of the user.

The user software is required as a condition of approval, to make the TAC available to the weight display indicator or console, on demand.

8. DOWNLOADING CUSTOM SOFTWARE

For downloading customized software or updates the LDU must be connected to

a PC running Windows through a suitable RS485/RS422 converter using 4 wire connection. The jumper SW4 must be closed before powering up the LDU to enter this special download mode.
The download is done using the program PROG78 available from H&B. The program will prompt for the COM-port used (1 to 4) and for the name of the new software distributed as a file in Motorola S format.