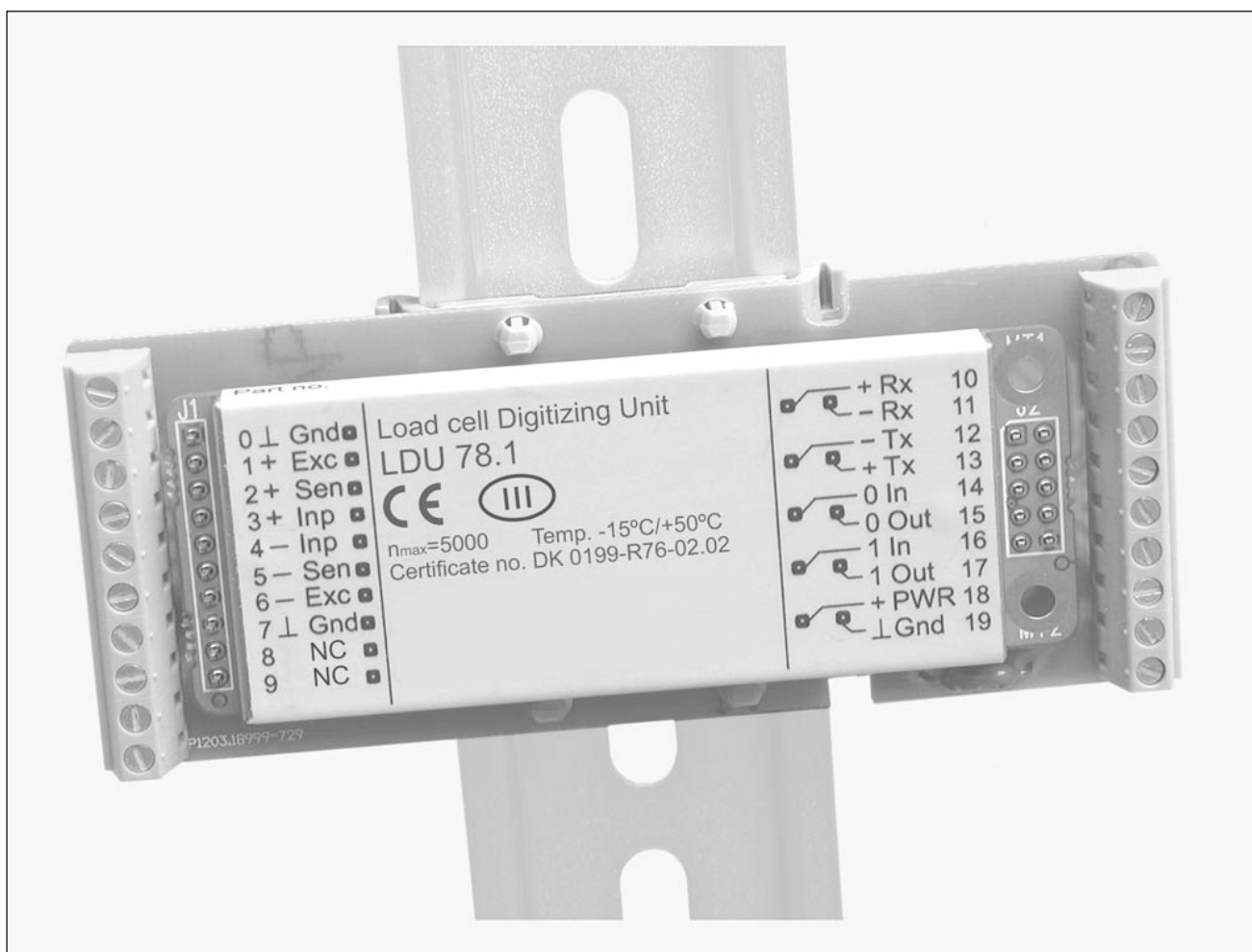


Load Cell Digitizing Unit Type LDU 78.1

MANUAL

Firmware Version 78.183 v2.XX



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1	INTRODUCTION & SPECIFICATIONS	3
2	COMMUNICATIONS & GETTING STARTED	4
2.1	Serial Interface	4
2.2	Command Language	4
2.3	Setup baud rate / device address	5
2.4	Getting Started	5
3	HARDWARE & WIRING	6
3.1	Load Cell Connections	7
3.2	Power Connections	7
3.3	Logic Inputs and Logic Outputs	7
3.4	Communication Connections	7
4	COMMANDS OVERVIEW	10
5	COMMANDS	13
5.1	System diagnostic Commands - ID, IV, IS, SR, RS	14
5.2	Check Weigher Set Up Commands - SD, MT, GA, TE, TL, TR, RW, TT, HT, TW, TI, DT, TS	16
5.3	Calibration Commands - CE, CI, CM n, DS, DP, CZ, CG, ZT, FD, IZ, ZR, ZI, WT, CS, TM, TN	20
5.4	Motion detection Commands - NR, NT	25
5.5	Filter setting Commands - FM, FL, UR	26
5.6	Set Zero/Tare and Reset Zero/Tare Commands - SZ, RZ, ST, RT, ZA, SP	28
5.7	Output Commands - GG, GN, GT, GS, GW, GA, GL, OF	30
5.8	Auto-transmit Commands - SG, SN, SA, SW, SL, SX	33
5.9	Commands for external I/O control - IN, IO, IM, TC	35
5.10	Setpoint Commands - Sn, Hn, An	37
5.11	Communication setup Commands - AD, CL, BR, DX, OP, TD	39
5.12	Save calibration, setup & setpoint parameters Commands - CS, WP, SS, PI, GI	41
6	CALIBRATION PROCEDURE	42
7	USE IN "APPROVED" APPLICATIONS	43
8	SOFTWARE (FIRMWARE) DOWNLOADS	44
8.1	Firmware updates for the LDU XX.X series	44
9	UNIT ADAPTOR CONNECTION DETAIL	45
9.1	UA 77.1 Unit Adaptor with built-in RS422 to RS232 converter	45
9.2	UA73.2 Standard Unit Adaptor	46
10	USB to RS422/485 CONVERTER WIRING (Multi-drop application)	47

1 INTRODUCTION & SPECIFICATIONS

The model LDU 78.1 is a precise, high speed digital amplifier for weighing and force measurements applications which use strain gauge (SG) based sensors. The LDU 78.1 can be used in legal for trade, as well as industrial applications. The device features full multi-drop communication capability and can be programmed using the straight forward ASCII command set.

The LDU XX.X series and the DAS72.1 amplifier with on-board digital display, use the same command set. So you can connect up to 32 SG amplifiers of either the LDU X.XX series or the DAS72.1 types onto a single RS 485 bus.

The LDU 78.1 with its high precision 18 bit A to D converter and a fast internal sample rate of up to 2400 measurements/second, is particularly suitable for high speed dynamic measurements and control.

Technical Specifications of the LDU 78.1:

Accuracy Class	III
EU Type approved	R76 10000 Divisions
Linearity	<0.002% Full Scale
Load Cell Excitation	5 V DC
Load Cell Drive Capability	Input impedance 80-2000 Ohms (12-14V DC Supply), 6-wire technique Input Impedance 350-5000 Ohms (14-24V DC Supply), 6-wire technique
Analogue Input Range	± 2.2 mV/V (bipolar, for push/pull weighing or tension/compression forces)
Minimum input per vsi	50nV per interval non-approved, 0.3 μ V per interval approved
Resolution	Internal max 260,000 counts, external max $\pm 99,999$ counts
Conversion rate	Up to 600 measurements per second
Digital filter IIR LP	0.25Hz -18Hz (i.e.40 dB/decade) selectable in 8 steps
Digital filter FIR LP	2.5Hz - 19.7Hz selectable in 8 steps
Calibration	Software calibration and set up
Computer Interface	RS485 or RS422 full duplex, 9600 ... 115200 Baud; up to 32 devices on a bus.
Weighing functions	Zero, gross, tare, net, filter etc.
Inputs	2 opto-isolated inputs, 10-30 VDC max. 3 mA
Outputs	2 open collector outputs, <30 V DC
Temperature effects	On zero:<7 ppm/°K On span:<6 ppm/°K
Temperature range	-15°C to +50°C (compensated); -30°C to +70°C (storage)
Enclosure	Tin plated steel enclosure sealed to IP 40
Dimensions	82 x 31 x 6 mm, weight approx. 30 g; with adaptor board 91 x 41 x 12 mm approx. 50 g
Power supply	12 ... 24 V DC $\pm 10\%$, <100mA, not galvanically isolated.
Options	Adaptor board UA73.2 (passive) or UA77.1 (RS422 to RS232)
EMC/Approvals	2004/22/EC MID Class E2 (Industrial Locations) passed

All dimensions in mm. Dimensions and specifications are subject to change without notice.

2 COMMUNICATIONS & GETTING STARTED

2.1 Serial Interface

Communication with the LDU 78.1 is via the RS422/RS485 port. The data format is the familiar 8/N/1 structure (8 data bits, no parity, 1 stop bit). The LDU 78.1 can communicate at the following baud rates: 9600, 19200, 38400, 57600, 115200 baud.

RS422

- ! Connection using a 4 wire technique.
- ! Point to Point connection for single units or multidrop connection for up to 32 LDUs on a bus.
- ! Full duplex (DX=1)

RS485

- ! Connection using 2 wire techniques
- ! Multi-drop connection possible with up to 32 LDU XX.X on a bus.
- ! Half duplex only (DX=0).

(RS232)

- ! An optional adaptor board model UA77.1 is available, which has a built-in RS422 to RS232 converter for point to point connection of single units.

(USB)

- ! An optional external adaptor model USB485i is available, which converts RS422/485 to USB for point to point or multi-drop connections of LDUs to a PC.

2.2 Command Language

The command set for the LDU XX.X series is based on a simple ASCII format. This consists of a 2 capital letter code which enables the user to setup the device, get results or check parameters.

Example:

An LDU XX.X with the address or channel number 1 is connected via the RS422 port to a bus system. You want to get the net weight from this device.

In this manual a space is represented by “_” and Enter (CR/LF) by “␣”

Master (PC / PLC) sends	Slave (LDU XX.X) responds	Status
OP_1␣		Open Device number 1
	OK	Device number 1 ready
GN_␣		Get Net weight value
	N+123.45	Net weight value with sign & decimal point

The command OP_2 opens the communication channel to device #2 and closes communication with device #1. Now device #2 acknowledges that it is active (OK) and responds to any commands on the bus. Communication with device #2 will be closed by another OP command (for another device on the bus e.g. OP_5) or by the close command e.g. CL_2.

Each OP_X command implies a CL command to all other devices on the bus except #X. This makes the address structure easier and improves system performance.

2.3 Setup Baud rate / Device Address

The factory default baud rate is 9600 baud. The factory default device address is 0. Under normal circumstances the baud rate can be changed or viewed using the BR command (Page 37). Similarly, the device address can be changed or viewed using the AD command (Page 37). If however you do not know the device baud rate or address, the LDU can be put into a special configuration mode which allows the baud rate and device address to be reset. On the under side of the LDU PCB are a set of special solder pads (SW3) - See diagram on page 6. If these solder pads are bridged (shorted together) then the LDU will enter the special configuration mode on power up.

Baud Rate (In Configuration Mode)

With SW3 pads bridged, the LDU XX.X will enter a special baud rate search mode on power up. This involves the LDU waiting for a space character (0x20) to be received. The time duration of this character is measured by the LDU and its baud rate will be set accordingly - i.e. the baud rate of the terminal sending the space character will be used by the LDU. The factory default baud rate is 9600 baud.

Address Settings (In Configuration Mode)

With SW3 pads bridged, the LDU XX.X will enter a special configuration mode on power up. It is possible to set the network address of the device using the AD command. (Address range between 0 and 255). Setting the address to 0 will set it into continuously active mode, where the device will listen and respond to any command on the bus without the need for an OP xxx command.

Factory default: Address 0

2.4 Getting Started

You will require a:

- ! PC or PLC with either a RS422 or RS485 communication port
- ! If you are using a PC or PLC with an RS232 port, you will require a RS422 to RS232 converter (optional unit adaptor UA77.1)
- ! If you are using a PC or PLC with an USB port, you will require a RS422/485 to USB converter (optional Model USB485i)
- ! Interconnecting cabling - See the wiring diagram on Page 6
- ! A load cell / scale with test weights or a load cell simulator
- ! A 12-24 V DC power supply capable of delivering approximately 100mA for each LDU and load cell
- ! One or more LDU 78.1
- ! The DOP 4 software*

Refer to the wiring diagram on Page 6

!*The DOP 4 software with graphical user interface and oscilloscope function is now available for Windows PCs. Download the latest version of the DOP 4 software from <http://www.haubac.com/haubac.asp?p1=167> together with Quick Start and Users Manuals

3.1 Load Cell Connections

The load cell(s) are connected to pins 0 to 6 of the LDU78.1.

Pins 1 & 6 provide excitation (5 V DC) to the load cell circuit, pin 1 being positive excitation (+Exc) and pin 6 negative excitation (-Exc).

Pins 3 & 4 are the signal inputs to the LDU78.1 from the load cell circuit, pin 3 being the positive signal (+Sig) and pin 4 being the negative signal (-Sig).

Pins 2 & 5 are the Sense connections for the LDU78.1, pin 2 being the positive sense (+Sen) and pin 5 the negative sense (-Sen). If your load cell has 6 wires (2 for Excitation, 2 for Signal and 2 for Sense) the sense connections provide the LDU78.1 with the voltage that reached the load cell(s) as opposed to the voltage that was sent. This enables the LDU 78.1 to correct for voltage drops on long cables.

If your load cell only has 4 wires you will need to link the positive excitation (+Exc) pin (Pin 1) and the positive sense (+Sen) pin (Pin 2) and similarly the negative excitation (-Exc) pin (Pin 6) and the negative sense (-Sen) pin (Pin 5). This can be achieved simply by solder bridging pads SW1 and SW2 on the underside of the LDU 78.1 pcb. (See diagram on Page 6)

Pin 0 provides a ground connection for the load cell cable screen or drain wire.

3.2 Power Connections

Power is provided to the LDU 78.1 via pins 18 & 19, pin 18 being the positive supply (Pwr) 12 - 24 VDC and pin 19 being the power supply ground (Gnd) 0 V.

3.3 Logic Inputs and Logic Outputs

The LDU 78.1 has 2 logic inputs on pins 14 & 16 and 2 logic outputs (Open Collector) on pins 15 & 17. The common for both the logic inputs and outputs is internally connected to the ground of the power supply so no separate common supply is required. Control signals (10 - 30 V DC) applied to the logic inputs can be used to trigger a variety of weighing processes such as check-weighing, filling etc. The status of the logic inputs can be read via the LDU 78.1 communication port. The logic outputs are effectively weight dependant switches. These can be used to control alarms or filling valves etc. The load to be controlled is wired between the positive supply and the appropriate logic output terminal on the LDU 78.1.

3.4 Communication Connections

3.4.1 RS422 Point to Point 4 wire connection half or full duplex.

The standard interface on the LDU 78.1 is RS422. The Tx+ connection from the host system is connected to +Rx (Pin 10) of the LDU 78.1. Similarly the Tx- from the host is connected to -Rx (Pin 11), the Rx- is connected to the -Tx (Pin 12) and the Rx+ is connected to the +Tx (Pin 13). The shield connection for the RS422 cable should be connected to the power supply ground Gnd (Pin 19)

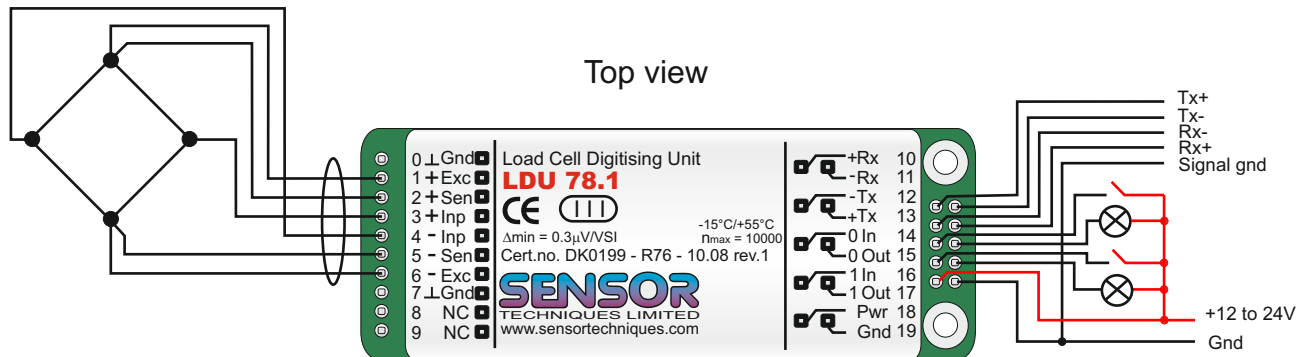
3.4.2 RS485 Multi-Drop 2 wire connection half duplex.

The LDU series can be wired in a multi-drop mode where up to 32 devices can be connected to one bus. The +Rx (Pin 10) and +Tx (pin 13) should be commoned together and should be connected to the B terminal of the host RS485 interface. The -Rx (Pin 11) and the -Tx (Pin 12) should similarly be commoned and connected to the A terminal of the host RS485 interface. The ground connection (GND) from the host RS485 should be connected to the power supply ground of the LDUs.

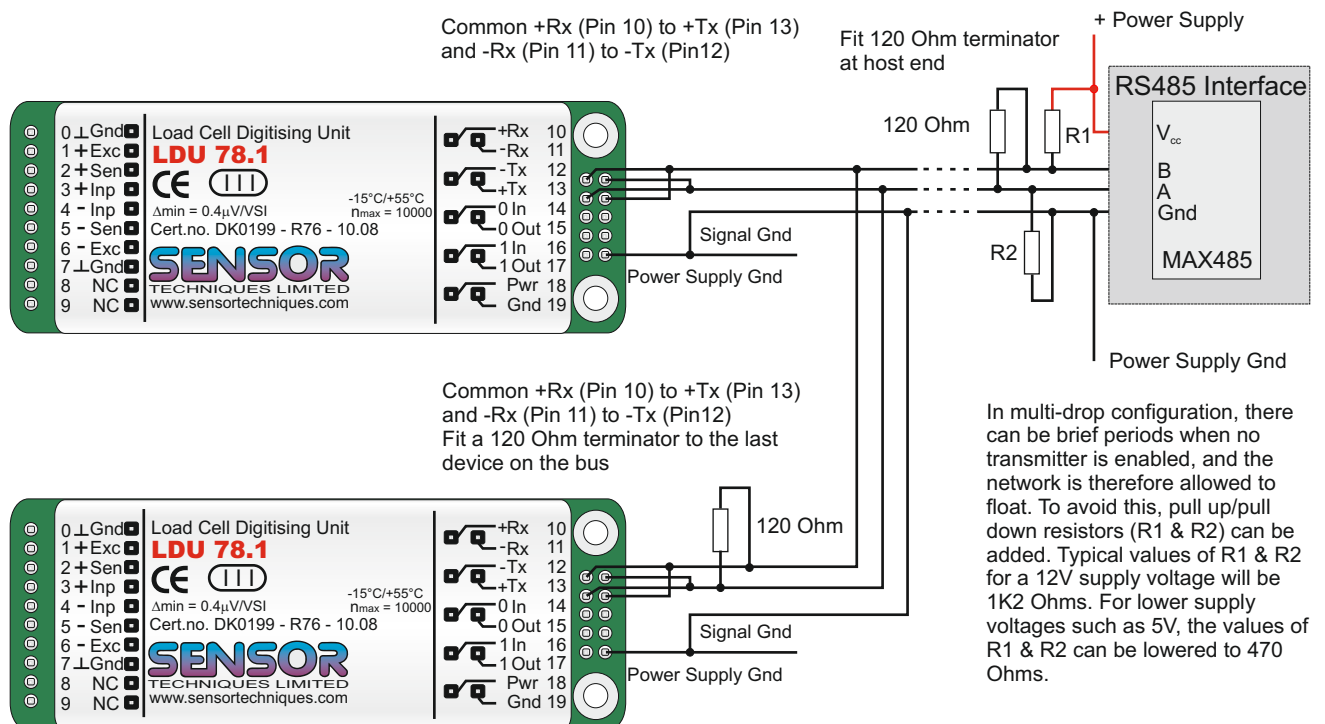
Termination resistors of 120 Ohm each should be placed across the A/B lines at host end of the bus and across the A/B lines of the last device on the bus. In addition it may be necessary to add pull up and pull down resistors (R1 & R2) to the A/B lines to prevent these lines 'floating' during periods of no transmission. Where the supply voltage to the RS485 line driver IC is typically 5V DC for example, the value of R1 & R2 can be 470 Ohms each. Where for example you are using a RS232 to RS485 converter with a supply voltage of 12 V DC, the value of R1 & R2 should be increased to 1K2 Ohms (1200 Ohms).

3 HARDWARE & WIRING DIAGRAMS

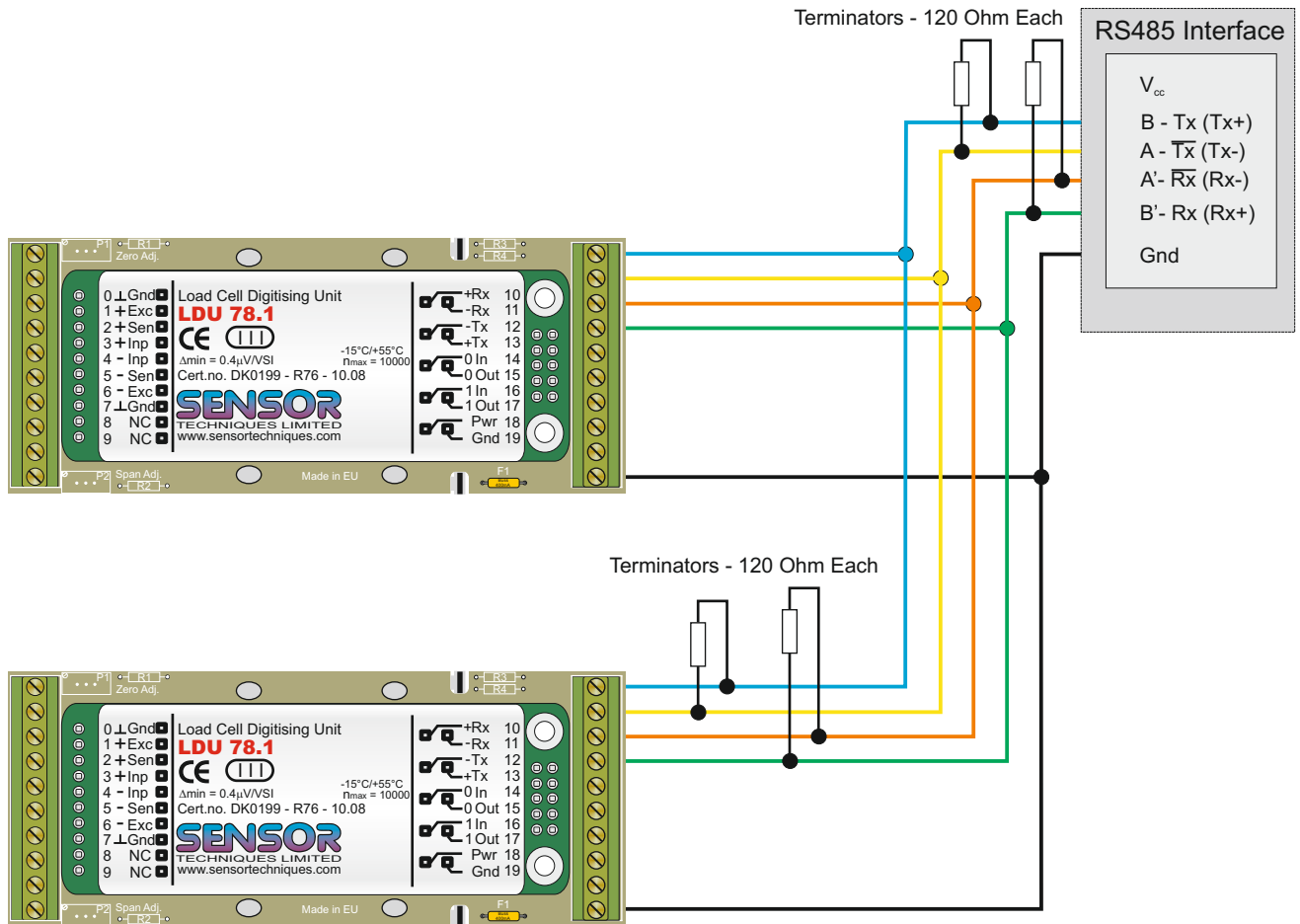
Standard Unit with RS422 Point to Point Connections



Standard Unit with RS485 Multi-drop Connections



3.4.3 RS485 4 Wire Multi-drop Connections Half Duplex (Recommended)



The LDU 78.1 can also be wired in a 4 wire multi-drop mode where up to 32 devices can be connected to one bus. To achieve this simply parallel up all connections. So all Rx + terminals are connected together and are connected to the B (Tx +) terminal of the host RS485 interface. All Rx - terminals are connected together and connected to the A (Tx -) terminal of the host RS485 interface. All Tx + terminals are connected together and are connected to the B' (Rx+) terminal of the host RS485 interface. All Tx - terminals are connected together and connected to the A' (Rx -) terminal of the host RS485 interface. All ground connections are connected together and connected to ground connection on the host RS485. Terminating resistors (120 Ohms each) should be connected across each pair of wires both at the host end and on the last device on the bus.

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4 COMMANDS OVERVIEW

Command	Short Description	Usage	Parameter Values	Full Description on
AD	Network Address	Read or Set the Network Address	0 to 255	Page 39
An	Get/Set Setpoint n action	Read or Change Setpoint Action	0 to 1 and 0 to 2	Page 38
BR	Baud Rate	Read or Change the Baud Rate	9,600 to 115,200	Page 39
CE	Calibrate Enable - TAC Code	Allows access to important Cal/Set up parameters	0 to 65,535	Page 20
CG	Calibrate Gain (TAC Protected)	Calibrate the weighing system span or gain	0 to 99,999	Page 22
CI	Calibrate Minimum (TAC Protected)	Read or modify the minimum output value	-99,999 to 0	Page 20
CL	Close 'Open' devices (Multi-drop)	Closes all open communication paths (Multi-drop)	None	Page 39
CM n	Calibrate Maximum (TAC Protected)	Read or modify the max. ranges (n=1, 2 & 3)	0 to 99,999	Page 20
CS	Calibrate Save (TAC Protected)	Save Calibration Parameters to EEPROM	None	Page 23
CZ	Calibrate Zero (TAC Protected)	Calibrate the weighing system zero	None	Page 21
DP	Decimal Point (TAC Protected)	Read or modify the decimal point position	0 to 5	Page 21
DS	Display Step Size (TAC Protected)	Read or modify the display step size or increment	1 to 200	Page 21
DT	Delta Time	Set the Delta Time in milliseconds	0 to 65,535	Page 19
DX	Duplex	Select half (0) or full (1) duplex	0 to 1	Page 39
FD	Factory Default	Reset to factory default settings	None	Page 22
FF	Filter Factor	Define time over which a rolling average is calculated	0 to 15	Page 22
FL	Filter Level	Read or modify the filter level (strength)	0 to 8	Page 26
FM	Filter Mode	Read or modify the filter mode	0 = IIR Filter / 1 = FIR Filter	Page 26
GA	Get Average Weight Value	Get the current 'average' weight value	None	Page 16 & 31
GE	Get Filtered Weight Value	Get the filtered net weight value	None	Page 26
GG	Get Gross Weight Value	Get the gross weight value.	None	Page 30
GI	Get Image	Get EEPROM Image as an Intel hexfile	None	Page 41
GL	Get 'Long' Weight	Get current Average, Gross and Status values	None	Page 31
GN	Get Net Weight Value	Get the net weight value	None	Page 30
GS	Get Sample (ADC value)	Get the ADC sample value.	None	Page 30
GT	Get Tare Value	Get the tare value	None	Page 30
GW	Get 'Long' Weight	Get the 'Long' weight value.	None	Page 30
Hn	Get/Set Hysteresis on Setpoint n	Read or modify the hysteresis value on Setpoint n	-99,999 to 99,999	Page 37
HT	Hold Time	Read/Modify the Hold Time	0 to 65,535	Page 19
ID	Get Device Identity	Read the device identity	None	Page 14
IM	Read/Modify Control of Outputs	Read or modify the control of the logic outputs	0000 to 0011	Page 35
IN	Read Status of Inputs	Read the status of the logic inputs	None	Page 35
IO	Read/Modify Output Status	Read or modify the status of the logic outputs	0000 to 0011	Page 35
IS	Get Device Status	Get the device status.	None	Page 14

4 COMMANDS OVERVIEW (Continued)

Command	Short Description	Usage	Parameter Values	Full Description on
IV	Get Firmware Version Number	Get the firmware version number	None	Page 14
IZ	Move Calibration Zero	Re-adjust calibration zero without affecting gain cal	None	Page 22
MR	Multi Range/multi-Interval	Select multi range or multi-interval	0 to 1	Page 21
MT	Measuring Time	The time over which the average value is derived	0 to 500 ms	Page 16
NR	No Motion Range	Read or modify the no-motion range	0 to 65,535	Page 25
NT	No Motion Time	Read or modify the no-motion time	0 to 65,535	Page 25
OF	Output Format	Selects if range/decimal point is include in long weight	0 to 3	Page 31
OP	Open Connection	Open a connection to a device number x	0 to 255	Page 40
PI	Put EEPROM image	Put EEPROM image as a Intel hexfile	Intel Hexfile	Page 41
RS	Read Serial Number	Read the serial number of the device	None	Page 15
RT	Reset Tare	Cancels tare value - unit reverts to Gross weighing	None	Page 29
RW	Re-trigger Window	Read/modify the re-trigger window	0 to 65, 535	Page 19
RZ	Reset System Zero	Restores the calibration zero point	None	Page 28
SA	Send Average Weight	Start auto transmitting the Average Weight	None	Page 33
SD	Start Delay	Read or set the delay between trigger & measurement	0 to 500 ms	Page 16
SP	Start auto transmit of filtered net value	Start auto transmitting the filtered net weight value	None	Page 7
SG	Start auto transmitting gross weight	Start auto transmitting the gross weight value	None	Page 33
SL	Start auto transmitting 'long' weight	Start auto transmitting the 'long' weight value	None	Page 34
Sn	Get/Set the setpoint values	Read or modify the setpoint values	-99,999 to 99,999	Page 37
SN	Start auto transmitting net weight	Start auto transmitting the net weight value	None	Page 33
SP	Set preset tare value	Set a preset tare value	0 to 99,999	Page 29
SR	Software reset	Causes the LDU to perform a software reset	None	Page 15
SS	Save Setpoint Parameters	Save Setpoint parameters to EEPROM	None	Page 41
ST	Set Tare	Sets a tare value and puts the LDU in net mode	None	Page 28
SW	Start auto transmitting 'Long' weight value	Start auto transmitting the 'long' weight values	None	Page 33
SX	Start auto transmitting ADC sample value	Start auto transmitting the ADC sample values	None	Page 34
SZ	Set Zero	Set a new system zero	None	Page 28
TD	Transmit Delay	Set delay between receiving command & responding	0 to 255	Page 40
TE	Trigger Edge	Selects trigger on a falling (0) or rising edge (1)	0 to 1	Page 17
TI	Tare Interval	Read or set the Tare Interval (Dynamic Tare)	0 to 65,535	Page 18
TL	Trigger Level	Set trigger level at which measurement cycle starts	0 to 99,999	Page 17
TM	Tare Mode	Set Tare Mode to R76 compatible (default 1)	0 to 1	Page 24
TN	Tare value volatile or non-volatile	Set tare mode to volatile (default 0) or non-volatile (1)	0 to 1	Page 24
TR	Trigger	Software trigger to start measurement cycle.	None	Page 17

4 COMMANDS OVERVIEW (Continued)

[illegible]

Please note that commands which are greyed out are not available on this model

5 COMMANDS

For better clarity, all commands are divided into groups as described on the following pages.

5.1	System diagnostic Commands - ID, IV, IS, SR, RS	14
5.2	Check Weigher Commands - SD, MT, GA, TE, TR, TL, TW, TI, RW, TT, HT, DT, TS	16
5.3	Calibration Commands - CE, CM n, CI, MR, DS, DP, CZ, CG, ZT, FD, IZ, ZR, ZI, WT, CS, TM, TN	20
5.4	Motion detection Commands - NR, NT	25
5.5	Filter setting Commands - FM, FL, UR	26
5.6	Set Zero/Tare and Reset Zero/Tare Commands - SZ, RZ, ST, RT, ZA, SP	28
5.7	Output Commands - GG, GN, GT, GS, GW, GA, GL, OF	30
5.8	Auto-transmit Commands - SG, SN, SA, SW, SL, SX	33
5.9	Commands for external I/O control - IN, IO, IM	35
5.10	Setpoint Commands - Sn, Hn, An	37
5.11	Communication setup Commands - AD, CL, BR, DX, OP, TD	39
5.12	Save calibration, setup & setpoint parameters Commands - CS, WP, SS, PI, GI	41

5.1 System diagnosis Commands – ID, IV, IS, SR, RS

Use these commands to get the LDU XX.X type, firmware version or device status. These commands are sent without parameters.

ID Request of device identity

Master (PC / PLC) sends	LDU XX.X responds
ID	D:7813

The response to this request gives the actual identity of the active device. This is particularly useful when trying to identify different device types on a bus.

IV Request of firmware version

Master (PC / PLC) sends	LDU XX.X responds
IV	V:0201

The response to this request gives the firmware version of the active device.

IS Request device status

Master (PC / PLC) sends	LDU XX.X responds
IS	S:067000 (example)

The response to this request comprises of 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	Centre of zero ($\pm 0.25d$)	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)

For example the result S:067000 decodes as follows:

Signal Stable (no-motion)	1
Zero action	2
Output 0 active	64
Total	67

Please note that the bits that are not used are set to zero.

SR Software Reset

Master (PC / PLC) sends	LDU XX.X responds
SR	OK

This command will respond with 'OK' and after a maximum of 400 ms perform a complete reset of the LDU. This has the same functionality as powering off and on again (hardware reset).

RS Read Device Serial Number

Issuing the RS command without any parameters will return the current serial number. Devices which have not been programmed with a serial number will show serial number 0 or -1 when using new firmware.

Master (PC / PLC) sends	LDU XX.X responds	Result
RS	S:12345678	Current Serial Number is 12345678

5.2 Check Weigher Commands SD, MT, GA, TE, TR, TL, TW, TI, RW, TT, HT, DT, TS

Note: All setups should be stored with the WP command before power off.

SD Start Delay 0 ... 500 milliseconds

Set the delay (in milliseconds) between the falling or rising edge of the trigger pulse and the start of the measurement cycle. Permitted values are 0 ... 500 ms. Factory default setting SD = 0 [Start Delay = 0 ms]. To check the current setting issue the command without any additional parameters. To change the setting issue the command with the additional parameter. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
SD	S+00100	Start Delay set to 100 milliseconds
SD_200	OK	Start Delay changed to 200 milliseconds

See check weighing timing diagram on page 18

MT Measuring Time. Range 0 ... 500 milliseconds

Set the time (in milliseconds) during which the weight average will be calculated. Permitted values are 0 ... 500 milliseconds. To check the current setting issue the command without any additional parameters. To change the setting issue the command with the additional parameter. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
MT	M+00100	Measuring Time set to 100 milliseconds
MT_200	OK	Measuring Time changed to 200 msec

Please note that if MT = 0 then the trigger and average functions are disabled. The factory default setting MT=0 [Measuring Time = 0]. See check weighing timing diagram on page 18

GA Get Average

Issuing the GA command, the LDU returns the current weight average calculated over the Measuring Time MT. The GA value is only updated after another measuring cycle is completed. the format of the response includes any decimal places etc. which may have been set.

Master (PC / PLC) sends	LDU XX.X responds	Result
GA	A+01.100	Weight average (over time MT) GA = 1.100g

Please note that during the period after the measuring cycle has been triggered but before the value of GA has been updated, the GA command will return a value 99999

See check weighing timing diagram on page 18. Also see the SA command under the Auto Transmit command section on page 31.

TE Trigger Edge

Using the TE command you can select whether the measuring cycle is triggered on a rising or falling edge. Permitted values are 0 [Falling Edge] or 1 [Rising Edge]. Factory default setting TE = 0 [Falling Edge]. To check the current setting issue the command without any additional parameters. To change the setting issue the command with the additional parameter. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
TE	E:001	Trigger Edge set on a rising edge
TE_0	OK	Trigger Edge changed to a falling edge

See check weighing timing diagram on page 18

TR Trigger

This command will start the measuring cycle immediately in the same way as the hardware trigger. The average value (see GA below) will be calculated over the Measuring Time (MT) after a Start Delay (SD). The GA value is only updated after a new measuring cycle has been completed.

Master (PC / PLC) sends	LDU XX.X responds	Result
TR	OK	Measuring cycle triggered

See check weighing timing diagram on page 18.

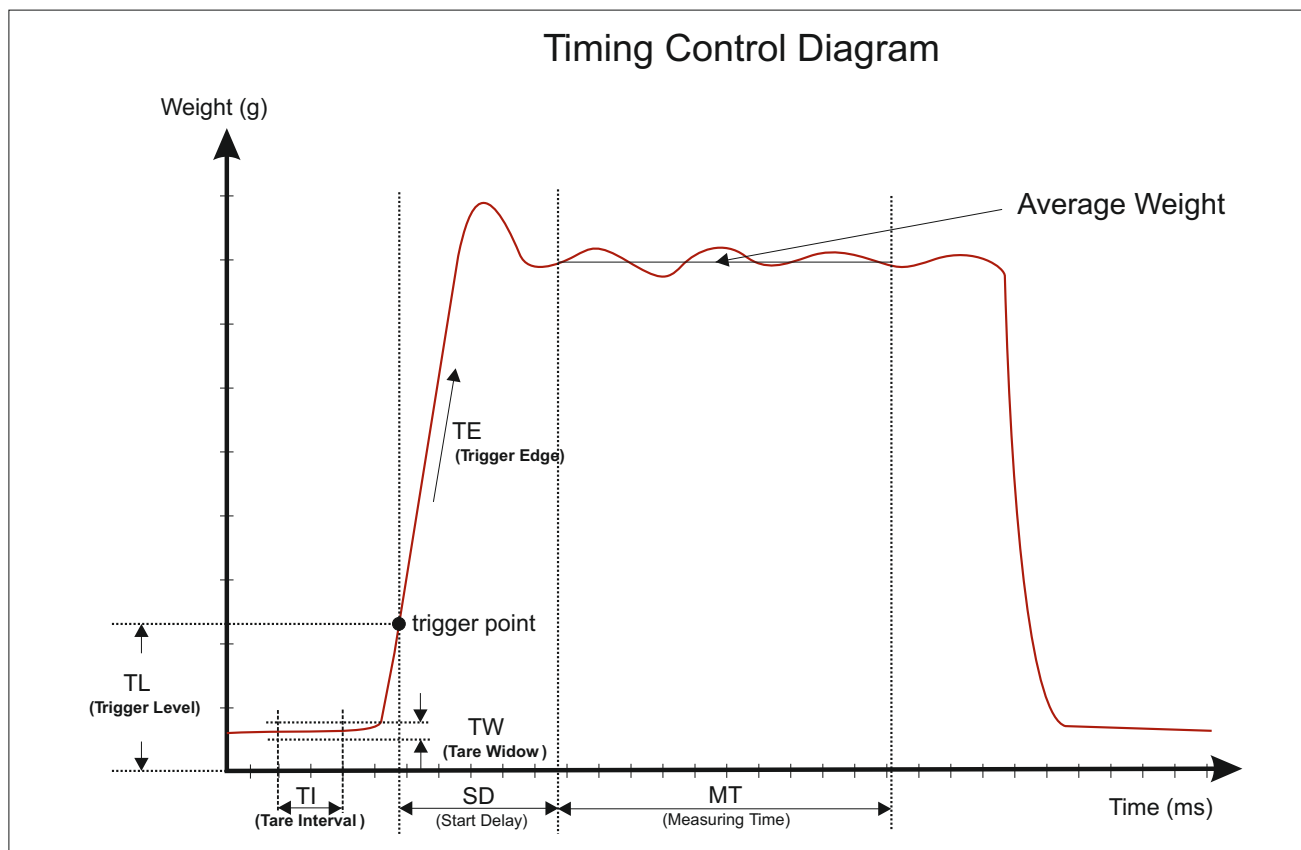
Please note that an electrical input (10 - 30V relative to the power supply 0V) on Logic Input 1 will act as a hardware trigger starting the measuring cycle. See Section 3.3 on page 7. The TE command also applies to this electrical input. So you can use a photo cell connected to Logic Input 1 and trigger the timing cycle off 'a falling edge' TE = 0 (trailing edge of the pack)

TL Trigger Level

This command sets the trigger level above or below which (depending if the Trigger Edge TE is set to a rising or falling edge) the measuring cycle starts. Permitted values 0 ... 99999. Factory default setting TL = 99999. To check the current setting issue the command without any additional parameters. To change the setting issue the command with the additional parameter. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
TL	T+99999	Trigger Level set to 99,999 divisions
TL_1000	OK	Trigger Level changed to 1,000 divisions

See check weighing timing diagram on page 18



Dynamic Tare

The Dynamic Tare feature allows a new tare value to be calculated over a time interval (TI) when the weight value is within a certain band or window (TW). If the weight value goes outside the Tare Window before the Tare Interval is complete, the newly calculated tare will be discarded and the previous tare value will be used. This is useful in checkweigher applications when you want to set a new tare value automatically during a “quiet period” when there is no product going down the belt.

TW Tare Window (Dynamic Tare)

Use this command to set or check the Tare Window value. To check the TW value issue the TW command without any parameters. To set a new TW value, issue the TW command followed by the required Tare Window value. Permitted values between 0 and 65535. Factory Default 0.

Master (PC / PLC) sends	LDU XX.X responds	Result
TW	W+00100	Tare Window set to 100 display divisions
TW_200	OK	Tare Window changed to 200 display divs.

TI Tare Interval (Dynamic Tare)

Use this command to set or check the Tare Interval value. To check the TI value issue the TI command without any parameters. To set a new TI value, issue the TI command followed by the required Tare Interval value. Permitted values between 0 and 65535. Factory Default 0.

Master (PC / PLC) sends	LDU XX.X responds	Result
TI	W+00100	Tare Window set to 100 milliseconds
TI_200	OK	Tare Window changed to 200 milliseconds.

RW Re-Trigger Window

This command sets the re-trigger window in counts (digits) without decimal point (0 - 65535). If the weight value relative to the current average value changes by more than the RW value, the average cycle will be restarted using the value of TT as the measuring 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

Master (PC / PLC) sends	LDU XX.X responds	Result
RW	R+65535	The re-trigger level is set at 65,535 counts
RW_1000	OK	Re-trigger level changed to 1000 counts

TT Re-Trigger Time

This command sets the re-trigger time in milliseconds [0 - 65535]. Re-trigger time is the average time used by the re-trigger function. If set to 0 the re-trigger function is disabled. Factory default 0

Master (PC / PLC) sends	LDU XX.X responds	Result
TT	T+00000	Re-trigger time set to 0 milliseconds
TT_100	OK	Re-trigger time changed to 100 milliseconds

HT Hold Time

This command sets the hold time in milliseconds [0 - 65535]. If during the hold time, the weight value exceeds the setpoint, the digital output will not switch. This can be useful to prevent digital outputs switching when the weight value temporarily exceeds the setpoint due to the kinetic energy of the product falling into the container etc. Factory default 0

Master (PC / PLC) sends	LDU XX.X responds	Result
HT	H+00000	Hold time set to 0 milliseconds
HT_100	OK	Hold time changed to 100 milliseconds

DT Delta Time

This command sets the delta time in milliseconds [0 - 65535]. During MT and TT time frames '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 automatically started. Factory default 50

Master (PC / PLC) sends	LDU XX.X responds	Result
DT	T+00050	Delta time set to 50 milliseconds
DT_100	OK	Delta time changed to 100 milliseconds

TS Re-Trigger Stop Level

This command sets the re-trigger stop level in counts without decimal point [0 - 65535]. When there is a (TS) decrease in weight, relative to the current average value, the re-trigger function is stopped. Factory default 65535

Master (PC / PLC) sends	LDU XX.X responds	Result
TS	T+65535	Re-trigger stop level set to 65535 counts
TS_100	OK	Re-trigger stop level changed to 100 counts

5.2 Calibration Commands CE, CM n, CI, MR, DS, DP, CZ, CG, ZT, FD, IZ, ZR, ZI, WT, CS, TM, TN

Note: TAC represents the Traceable Access Code (calibration counter) which increments every time new calibration data is stored. Calibration values are only stored in EEPROM when the CS command is issued (see CS command on Page 23)

CE TAC counter reading

With this command you can either read the current TAC value or enable a calibration command. To check the current TAC value issue the command without any additional parameters. To enable a calibration command, issue the CE command with the current TAC value. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled

This command MUST be issued PRIOR to any attempt to change calibration parameters such as CZ, CG etc. In legal for trade applications the TAC value can be used to check if any critical parameters have been changed without re-verification. After each calibration the TAC counter increases by 1.

CM n Set maximum output value

This command sets the maximum output value in interval or range n ($1 \leq n \leq 3$). Permitted values of CM n are between 1 and 999,999.. To check the current value issue the CM n command without any additional parameters. To change the value of CM n, issue the CE command with the current TAC value and then CM n and the new setting. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
CM_1	M+30000	Current output maximum is set to 30,000
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
CM_1_50000	OK	Output maximum changed to 50,000

The value of CM n will determine the point at which the output will change to “oooooo” signifying over-range. Factory default value CM 1 = 999999, CM 2 = 0, CM 3 = 0

CI Set minimum output value

This command sets the minimum output value. Permitted values are between 0 and -999,999. Factory default value CI = -9 for approved applications. To check the current value issue the CI command without any additional parameters. To change the value of CI, issue the CE command with the current TAC value and then CI and the new setting. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
CI	I-000009	Current output minimum is set to -9
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
CI_-10000	OK	Output minimum changed to -10,000

The value of CM will determine the point at which the output will change to “uuuuuuu” signifying under-range.

MR Set Multi Range or Multi Interval

This command allows you to select multi range or multi interval. 0 = Multi interval and 1 = Multi range. Factory default value 0. To check the current setting, issue the MR command without any additional parameters. To change the value of MR, issue the CE command with the current TAC value and then MR and the new setting. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
MR	M+00000	Multi Interval is selected
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
MR_1	OK	Multi Range is selected

DS Set output reading step size

This command allows you to set different output reading step sizes. Permitted values are 1, 2, 5, 10, 20, 50, 100, and 200. Factory default value DS = 1. For example, if the step size is set to 2, then the output value will go up or down in 2s. To check the current step size, issue the DS command without any additional parameters. To change the value of DS, issue the CE command with the current TAC value and then DS and the new setting. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
DS	S+00002	Display step size is set to 2
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
DS_50	OK	Display step size changed to 50

In multi range / multi interval applications DS will define the step size in the lowest range / interval. The higher ranges / intervals will use the next step size from the list of allowable step sizes. Factory default setting DS = 1.

DP Set decimal point position

This command allows the decimal point to be positioned anywhere between the most and least significant digits. To check the current position, issue the DP command without any additional parameters. To change the decimal point position, issue the CE command with the current TAC value and then DP and the new setting. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
DP	P+00002	Decimal point is set to 2 places (xxx.xx)
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
DP_0	OK	Decimal point set to no places (xxxxx)

CZ Set the calibration zero point

This command sets the calibration zero point which is a reference point for all weight calculations (TAC protected). To set a new calibration zero, issue the CE command with the current TAC value and then CZ (when there is no load applied). See table below. Factory default ~ 0mV/V input signal

Master (PC / PLC) sends	LDU XX.X responds	Result
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
CZ	OK	New zero point saved

CG Set calibration gain (Span)

This command sets the calibration span or gain which is a reference point for all weight calculations (TAC protected). To check the current gain calibration value, issue the CG command without any additional parameters. To change the calibration gain value, issue the CE command with the current TAC value and then CG (with the equivalent load applied). See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
CG	G+10000	Calibration gain set at 10000 counts
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
CG_15000	OK	Calibration gain set to 15000 counts

For the best system performance, calibrate the gain (span) as near to the display maximum (CM) as possible. A minimum calibration load of at least 20% is recommended. Factory default calibration gain setting 200000 counts = 2.0000 mV/V input signal. Permitted values 0 - 999999

ZT Zero tracking band

This command sets the zero tracking band in divisions. To check the current zero tracking band, issue the ZT command without any additional parameters. To change the zero tracking band, issue the CE command with the current TAC value and then ZT followed by the new setting.

Master (PC / PLC) sends	LDU XX.X responds	Result
ZT	Z+00001	Zero tracking band ± 0.5 divisions
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
ZT_2	OK	Zero tracking band changed to ± 1 division

Zero tracking will only be performed on values within the zero track band, at a rate of 0.4 d per second where d = display set size (see DS command). The zero will only be tracked if it is within the zero track range. See ZR command. If ZT is set to 0, zero tracking is turned off. Factory default: ZT = 0.

FD Factory default settings

This command restores the LDU back to the original factory settings. The data will be written back into EEPROM and the TAC will be incremented by 1. Please note: All calibration and set up data will be lost if the FD command is issued !

Master (PC / PLC) sends	LDU XX.X responds	Result
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
FD	OK	Factory default settings restored

IZ Adjust Calibration Zero Point

This command is used to adjust the calibration zero point after calibration has been complete. It allows you to set a new zero without having to redo the span calibration. To set a new calibration zero, issue the CE command with the current TAC value and then IZ. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
IZ	OK	Calibration Zero Adjusted

ZR Zero Range

This command sets the range in divisions, within which the unit can be zeroed. To check the current value, issue the ZR command without any additional parameters. To change the value, issue the CE command with the current TAC value and then ZR followed by the new setting.

Master (PC / PLC) sends	LDU XX.X responds	Result
ZR	R+00000	Zero range 0 divisions (default)
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
ZR_1	OK	Zero range changed to 1 division

ZI Initial Zero Range

This command sets an initial zero range on power up in divisions. If ZI is set to 0 (default value) an initial zero on power up is not performed. If ZI is set to something other than zero, the device will automatically perform a set zero on power up provided that the weight value is stable (within the No motion parameters) and the zero is within the ZI range. To check the current value, issue the ZI command without any additional parameters. To change the value, issue the CE command with the current TAC value and then ZI followed by the new value. See table below.

Master (PC / PLC) sends	LDU XX.X responds	Result
ZI	R+00005	Initial Zero range 5 divisions
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
ZI_1	OK	Initial Zero range changed to 1division

WT Warm Up Time

This command sets the warm up time between 0 and 65535 seconds. The warm up time is the period after power on when the output value will be set to 'uuuuuu' to avoid false readings during the initial stabilisation period. To check the current value, issue the WT command without any additional parameters. To change the value, issue the CE command with the current TAC value and then WT followed by the new value. See table below. Default value 0.

Master (PC / PLC) sends	LDU XX.X responds	Result
WT	W+00005	Warm up time set to 5 seconds
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
WT_1	OK	Warm up time changed to 1 second

CS Save the calibration values

This command stores the calibration values in EEPROM and causes the TAC code to be incremented by 1. **If the CS command is not issued and the power to the LDU fails or is turned off, all changes to the calibration values will be lost.**

Master (PC / PLC) sends	LDU XX.X responds	Result
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
CS	OK	Calibration values stored

The CS command saves all calibration group values as set by CZ, CG, CM, DS, DP, ZT, LC and LN. To do this issue the CE command with the current TAC code followed by CS.

TM Set Tare Mode

This command sets the tare mode to be compatible with R76 (TM = 1 default).

There are four possible settings (TM = 0 to 3). See table below. Clearing of preset tare value when returning to Range 0 refers to multi-range applications.

Parameter	Allow Tare of NegativeValues	Clear preset tare when returned to Range 0
0	YES	YES
1	NO	YES
2	YES	NO
3	NO	NO

To check the current tare mode, issue the TM command without any additional parameters. To change the tare mode, issue the CE command with the current TAC value and then TM followed by the new setting.

The tare mode value is saved using the CS command

Master (PC / PLC) sends	LDU XX.X responds	Result
TM	T+001	Tare Mode set to 1 (default)
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
TM_0	OK	Tare Mode changed to 0

TN Tare Mode Non Volatile

This command sets the tare mode to be either volatile (TN = 0 default) or non-volatile (TN =1). If set to non-volatile every set/clear tare will write the tare value directly to the EEPROM which is remembered even if the power fails. To check the current tare mode, issue the TN command without any additional parameters. To change the tare mode, issue the CE command with the current TAC value and then TN followed by the new setting. The tare mode non volatile value is saved using the CS command

Master (PC / PLC) sends	LDU XX.X responds	Result
TN	T+000	Tare Mode set to 0 (default)
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
TN_1	OK	Tare Mode changed to 1

5.4 Motion detection commands - NR, NT

The motion detection facility prevents certain functions from being performed if the weight value is unstable or 'in-motion'. This ensures that a new value cannot be set when the weight value is varying greatly over a short period of time. For a 'no-motion' or 'stable' condition to be achieved, the weight signal must not vary by more than NR divisions over the time period NT. If the weight signal is stable, the relevant bit of the 'Info status' (IS) response will be set.

The following functions are disabled if motion is detected:

Calibrate Zero (CZ), Calibrate Gain (CG), Set Zero (SZ), Set Tare (ST) and Set Preset Tare (SP)

NR No motion range

This command sets the range within which the weight signal can vary and still be considered 'stable'. Permitted values are between 0 and 65535. To check the current value, issue the NR command without any additional parameters. To change the value of NR, issue the NR command with the new setting. See table below. To save this change to EEPROM use the WP command.

Master (PC / PLC) sends	LDU XX.X responds	Result
NR	R+00010	No motion range set to 10 d
NR_2	OK	No motion range changed to 2 d
WP	OK	Write parameter to EEPROM

With NR = 2, the weight signal can vary no more than ± 2 d, in the time period NT in order to be considered stable. Factory default : NR = 1. If NR is set to 0 the no motion band will be set to 0.25 d where d = the display step size DS.

NT No motion time

This command sets the time (in milliseconds) over which the weight signal is checked to see if it is 'stable' or has 'no-motion'. The weight signal has to vary by less than NR divisions over the time period NT, to be considered 'stable'. Permitted values are between 0 and 65535. To check the current value, issue the NT command without any additional parameters. To change the value of NT, issue the NT command with the new setting. See table below. To save this change to EEPROM use the WP command.

Master (PC / PLC) sends	LDU XX.X responds	Result
NT	T+01000	No motion time set to 1000 ms
NT_500	OK	No motion time changed to 500 ms
WP	OK	Write parameter to EEPROM

With NT = 500, the weight signal can vary no more than \pm NR divisions, in the 500 ms in order to be considered stable. Factory default : NT = 1000 milliseconds.

5.5 Filter setting commands - FM, FL, UR

Using the commands FM and FL, a digital filter type and strength can be set which will eliminate most unwanted disturbances. Please note that these filters are positioned immediately after the A/D converter and therefore affect all aspects of the weighing operation.

FM Filter mode FIR / IIR

This command allows you to select the filter mode. Permitted values are 0 (IIR) or 1 (FIR). To check the current setting, issue the FM command without any additional parameters. To change the FM setting, issue the FM command with the new setting. See table below. To save this change to EEPROM use the WP command. Factory default FM = 0 (IIR)

Master (PC / PLC) sends	LDU XX.X responds	Result
FM	F+00001	Filter mode set to FIR
FM_0	OK	Filter mode changed to IIR
WP	OK	Write parameter to EEPROM

The digital IIR filter works as a 2nd order low pass filter with a Gaussian characteristic damping at 40dB/decade. This gives a slower response to a step input with little or no overshoot. See table - Mode 0. For this filter mode, the update rate is not affected by the filter level.

The digital FIR filter also works as a low pass filter which has a quick response with some overshoot. For damping characteristics see table - Mode1. With this filter mode the update rate is dependant on the filter level

FL Filter Level (Cut off frequency)

This command allows you to select the filter level or cut off frequency. Permitted values are between 0 to 8. To check the current setting, issue the FL command without any additional parameters. To change the FL setting, issue the FL command with the new setting. See table below. To save this change to EEPROM use the WP command. Factory default FL = 3

Master (PC / PLC) sends	LDU XX.X responds	Result
FL	F+00003	Filter level set to 3
FL_1	OK	Filter level changed to 1
WP	OK	Write parameter to EEPROM

If FL= 0 is selected in either filter mode 0 or 1, the digital filter will be disabled

Mode 0 Characteristic (IIR-Filter)

FL	Settling time to 0.1% (ms)	3dB Cut-off frequency (Hz)	Damping @300Hz (dB)	Update-rate (samples/s)
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 Characteristic (FIR-Filter)

FL	Settling time to 0.1% (ms)	3dB Cut-off (Hz)	20dB damping at frequency (Hz)	40dB damping at frequency (Hz)	Damping in the stopband (dB)	Stopband (Hz)	Update rate (samples/s)
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 defines how many of the measurements from the preceding IIR or FIR filter are used to calculate an average. Permitted values are between 0 and 7. See table below.

UR	0	1	2	3	4	5	6	7
SAMPLES	1	2	4	8	16	32	64	128

To check the current setting issue the UR command without any additional parameters. To change the setting issue the UR command with the additional parameter. See example below. Default value 0. Remember to save any changes to this parameter using the WP command.

Master (PC / PLC) sends	LDU XX.X responds	Result
UR	U+00001	Average calculated from 2 samples
UR_4	OK	Average will be calculated from 16 samples.

5.6 Set Zero/Tare and reset Zero/Tare commands - SZ, RZ, ST, RT, ZA, SP

The following commands allow you to set and reset zero and (preset) tare values. The zero set during calibration remains the 'true zero' but a new 'current zero' can be set using the SZ command. If the SZ command is issued and accepted then all weight values will be based in the new 'current zero'. Please remember that the zero value will be subject to the Zero Tracking function if enabled. If the weight signal is not stable (as defined by the No motion range NR and the No motion time NT) then both the set zero (SZ) and the set (preset) tare (SP & ST) commands will be disabled. Also the set zero (SZ) command is not allowed if the new zero value required and the 'calibration zero' differ by more than 2% of the CM value (maximum displayed value) and the ZR value is zero. Larger set zero range can be achieved using the ZR command. See Calibration Commands section 5.2. Also see chapter 8 "Legal for trade" applications

SZ Set Zero

This command sets a new "current zero" which is then the basis of all weight values until further updated by the zero tracking function, another SZ command or the "reset zero" command (RZ). If the zero range (ZR) is set to zero, the SZ command will fail (LDU responds with ERR) if the new "current zero" is more than 2% (of the CM value) higher or lower than the "true zero" set during calibration. The 2% range can be increased using the ZR command. The SZ command will also fail if the weight signal is not stable, as defined by the no motion range (NR) and no motion time (NT). If the weight signal is "stable", the response to the IS (device status) command will show the "signal stable" bit active and the SZ command will be accepted (OK). If the signal stable bit is not active, the SZ command will be rejected and the LDU will respond with ERR (error).

Master (PC / PLC) sends	LDU XX.X responds	Result
SZ	OK	New zero set

The SZ command is issued without any parameters and will return either the OK or ERR response. If the SZ command is accepted, the LDU responds with OK and the "zero action performed" bit of the device status (IS) response will be active (1).

RZ Reset Zero point

This command cancels the SZ command and the zero reading reverts to that set by the CZ command during calibration.

Master (PC / PLC) sends	LDU XX.X responds	Result
CZ	OK	Zero reverts to calibration zero (CZ)

The RZ command is issued without any parameters and will return either the OK or ERR response. If the RZ command is accepted, the LDU responds with OK and the "zero action performed" bit of the device status (IS) response (see page 11) will not be active (0).

ST Set Tare

This command will activate the net weighing function by storing the current weight value as a tare. The weight signal must be "stable" within the limits set by the no motion range (NR) and the no motion time (NT) for the set tare command to be accepted and the "signal stable" bit of the device status response (IS) to be active. (1)

Master (PC / PLC) sends	LDU XX.X responds	Result
ST	OK	New tare set

The ST command is issued without any parameters and will return either the OK or ERR response. If the ST command is accepted, the LDU responds with OK and the "zero action performed" bit of the device status (IS) response will be active (1).

RT Reset tare

This command cancels the tare and returns the weighing into gross mode.

Master (PC / PLC) sends	LDU XX.X responds	Result
RT	OK	Tare deactivated

The RT command is issued without any parameters and will return either the OK or ERR response. If the RT command is accepted, the LDU will respond with OK and the "tare active" bit of the Device Status (IS) response will be set to 0

ZA Set System Zero

This command sets a new system zero as SZ but using the average over the TI period.

Master (PC / PLC) sends	LDU XX.X responds	Result
ZA	OK	System Zero set to average over period TI

SP Set Preset Tare

This command will activate the net weighing function by storing a preset weight value as a tare. The weight signal must be "stable" within the limits set by the no motion range (NR) and the no motion time (NT) for the set tare command to be accepted and the "signal stable" bit of the device status response (IS) to be active. (1)

Master (PC / PLC) sends	LDU XX.X responds	Result
SP	T+100	Preset tare set to 100
SP_200	OK	Preset tare changed to 200

If the SP command is issued without any parameters the LDU will return the current preset tare value. To change the SP value, send SP followed by the new SP value. If the SP command is accepted, the LDU responds with OK and the "Tare active" bit of the device status (IS) response will be active (4).

5.7 Output commands GG, GN, GT, GS, GW, GA, GL, OF

The following commands “Get” the Gross, Net, Tare and ADC sample values from the LDU.

GG Get Gross weight value

This command gets the gross weight value.

Master (PC / PLC) sends	LDU XX.X responds	Result
GG	G+01.100	Gross weight value = 1.100 divisions

GN Get Net weight value

This command gets the net weight value.

Master (PC / PLC) sends	LDU XX.X responds	Result
GN	N+01.000	Net weight value = 1.000 divisions

GT Get Tare value

This command gets the tare weight value.

Master (PC / PLC) sends	LDU XX.X responds	Result
GT	T+0.100	Tare value = 0.100 divisions

In a multi-range application, optional parameters can be added to the command such as GT 1, GT 2 or GT 3 to make the tare value available rounded to the division size of the corresponding range.

GS Get ADC sample value

This command gets the actual Analogue to Digital Converter (ADC) value. This can be useful during development or when calibrating to see how much of the ADC range is being used.

Master (PC / PLC) sends	LDU XX.X responds	Result
GS	S+125785	ADC value = 125785 counts

For service applications it may be helpful to note the value of ADC at no load and full load.

GW Get the 'Long' weight value

This command gets the 'long' weight value. The GW command is issued without any parameters and the response is a single string in the format **W+00100+011005109** which contains the current net weight, the current gross weight, the status values and a checksum. The first two sections of the returned string contains the net weight and the gross weight values 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.

<div> <div>W</div> <div>+00100</div> <div>+01100</div> <div>5</div> <div>1</div> <div>09</div> </div>					
Leading character signifies response to GW command	Net Weight Excluding Decimal point	Gross Weight Excluding Decimal point	First bitmapped binary value	Second bitmapped binary value	Checksum
First bitmapped binary value:			Second bitmapped binary value:		
1	not used		1	Signal stable	
2	not used		2	Zero action performed	
4	Output 0 active		4	Tare active	
8	Output 1 active		8	not used	

The checksum is derived as follows:-

- Add together the ASCII values of all 15 characters in the string
- Convert the decimal result to hexadecimal.
- Remove the most significant digit from the hexadecimal result
- Invert the remaining hexadecimal value
- Convert the hexadecimal value to characters.

GA Get Average

Issuing the GA command, the LDU returns the current weight average calculated over the Measuring Time MT. The GA value is only updated after another measuring cycle is completed. the format of the response includes any decimal places etc. which may have been set.

Master (PC / PLC) sends	LDU XX.X responds	Result
GA	A+01.100	Weight average (over time MT) GA = 1.100g

Please note that during the period after the measuring cycle has been triggered but before the value of GA has been updated, the GA command will return a value 99999, See check weighing timing diagram on page 18. Also see the SA command under the Auto Transmit command section on page 33.

GL Get the 'Long' weight values

This command gets the 'long' weight values - the current average, gross and status values. The GL command is issued without any parameters will return the average weight, the gross weight and the status and checksum values all combined in one single string in the format **L+00100+01100010F**. The first two sections of the returned string contains the average weight and the gross weight values 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 for more details.

OF Output Format

Use the OF command to put range information into the weight result string and or to put a decimal point into the 'long' weight strings.

Parameter	Range Information	Decimal Point in GW/GL
0	NO	NO
1	YES	NO
2	NO	YES
3	YES	YES

To check the current value , issue the OF command without any additional parameters.. To change the value of OF, issue the CE command with the current TAC value and then OF and the new setting.

Master (PC / PLC) sends	LDU XX.X responds	Result
OF	F_0	Current OF setting 0
CE	E+00017 (example)	Current TAC value is 17
CE_17	OK	Calibration commands enabled
OF_3	OK	OF setting changed to 3

5.8 Auto-transmit commands SG, SN, SA, SW, SL, SX

The following commands allow the Gross, Net, Average and 'Long' weight values to be transmitted continuously. Transmission will start as soon as the relevant command has been received and will continue until another valid command is accepted by the LDU. The data output rate will depend on the baud rate being used e.g. with a baud rate of 9600 approximately 100 readings per second can be transmitted.

Note : The auto-transmit commands will only work if the LDU has been set to full duplex [DX=1]

SG Send the Gross weight value continuously

Master (PC / PLC) sends	LDU XX.X responds	Result
SG	G+01.100	Gross weight value = 1.100 divisions

SN Send the Net weight value continuously

Master (PC / PLC) sends	LDU XX.X responds	Result
SN	N+01.000	Net weight value = 1.000 divisions

SA Send Average Weight

Issuing the SA command, the LDU returns an "OK". It is then primed ready to automatically send the new average weight value when available. The LDU then wait for a trigger signal. As soon as the trigger signal is received the LDU immediately sends "A+99999" indicating that the measuring cycle has started. The value "A+99999" indicates to the host system that the Average Weight value is not valid and should not be used. After the Start Delay (SD) and Measuring Time (MT) have elapsed the new Average Weight is sent. The cycle is repeated each time the trigger signal is received. Thus the Average Weight is automatically sent to the host when a new value is available.

Master (PC / PLC) sends	LDU XX.X responds	Result
SA	OK	LDU is now waiting for a trigger signal
(TRIGGER)	A+99999	Measuring cycle started wait for Av. Weight
	A+1.1000	Average Weight = 1.1000
(TRIGGER)	A+99999	Measuring cycle started wait for Av. Weight
	A+1.1500	Average Weight = 1.1500

See check weighing timing diagram on page 18

SW Send the 'Long' weight value continuously

This command sends the 'long' weight value continuously. The SW command is issued without any parameters and the unit continually returns a string in the format **W+00100+011005109** which contains the current net weight, the current gross weight, the status values and a checksum. The first two sections of the returned string contains the net weight and the gross weight values 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 under section 5.7 for further details. Please note that the decimal point information is not transmitted.

SL Send the 'Long' weight value continuously

This command sends the 'long' weight value continuously. The SL command is issued without any parameters and the unit continually returns a string in the format **L+00100+01100010F** which contains the current average weight, the current gross weight, the status values and a checksum. The first two sections of the returned string contains the average weight and the gross weight values 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 GL command under section 5.7 for further details. Please note that the decimal point information is not transmitted.

SX Send the ADC Sample value continuously

This command send the ADC sample value continuously. The SX command is issued without any parameters and the unit then continually returns the ADC sample value.

5.9 Commands for external I/O control - IN, IO, IM

The LDU78.1 has 2 independent logic inputs and 2 independent logic outputs. The inputs and outputs can be configured and controlled completely via the LDU. The logic inputs can be read directly by the host application and the 2 logic outputs have additional control features which allow the user total control over the configuration and action of each output channel. The logic outputs are usually controlled internally via the setpoint commands but can be configured to be controlled externally by using the IM command.

The following group of commands allows the status of the 2 logic inputs to be read or modified and the logic outputs to be configured for internal or external control.

The use of the setpoint commands (Sn, Hn, An) are explained in the following chapter 5.10

IN Read the status of the two logic inputs

This command is sent without any parameters and reads the status of the two logic inputs. The response is in the form of a 4 digit code where 0= false and 1 = true (inputs are active 'high'), the least significant bit corresponding to logic input 0 etc .

Master (PC / PLC) sends	LDU XX.X responds	Result
IN	IN:0001	Input 0 active
IN	IN:0010	Input 1 active
IN	IN:0011	Input 0 & Input 1 active

IO Read/Modify the status of the output channels

With this command you can read the status of the two logic outputs. The outputs are normally internally controlled by the setpoint values (See section 5.10). The outputs can however be controlled by the host system **if they have been enabled by the IM command**. If the IO command is issued without any parameters the response shows the status of the logic outputs in the form of a four digit code where 0 = false and 1 = true (outputs are normally open, open drain MOSFETs), the least significant bit corresponding to Output 0 etc.

Request

Master (PC / PLC) sends	LDU XX.X responds	Result
IO	IO:0001	Output 0 active
IO	IO:0010	Output 1 active
IO	IO:0011	Output 0 & Output 1 active

(continues on the next page)

IO Read/Modify the status of the output channels (continued)

Please note that the status of the logic outputs is normally determined by the internal setpoint (see section 5.10) and therefore setting the logic output status using the IO command is not allowed **unless enabled by the IM command**. The status of the outputs can then be changed by issuing the IO command followed by the appropriate 4 digit code. For example if IO 0001 was sent to the LDU, the output 0 will be activated (FET conducting).

Setting

Master (PC / PLC) sends	LDU XX.X responds	Result
IO_0001	OK	Output 0 active
IO_0010	OK	Output 1 active
IO_0011	OK	Output 0+1 active

IM Control of the logic outputs by the host application

The logic outputs can be controlled by the host application (as opposed to the normal internal setpoints) if they are enabled by the IM command and the appropriate 4 digit code. If this command is issued without any parameters, the response shows which of the logic output are enabled. The response is in the form of a 4 digit code where 0= false and 1 = true (inputs are active 'high'), the least significant bit corresponding to logic input 0 etc .

Request

Master (PC / PLC) sends	LDU XX.X responds	Result
IM	IM:0001	Output 0 Enabled
IM	IM:0010	Output 1 Enabled
IM	IM:0011	Output 0 & Output 1 Enabled

To enable the logic outputs to be controlled by the host application the IM command must be issued together with a 4 digit code. A "1" bit in the code enables the corresponding logic output to be controlled by the host application using the IO command. A "0" in the code leaves the corresponding logic output controlled by the internal setpoint. Logic output 0 is again the least significant bit.

Setting

Master (PC / PLC) sends	LDU XX.X responds	Result
IM_0001	OK	Enable Output 0
IM_0010	OK	Enable Output 1
IM_0011	OK	Enable Output 0 & Output 1

Note: When reading the status of the logic outputs using the IO command, the setpoint status will be returned regardless of the IM setting. Sending IM 0000 disables the external logic output control.

Factory default:- IM= 0000

5.10 Setpoint Commands - Sn, Hn, An

The LDU78.1 has 2 logic outputs where the status is dependent on the weight value (setpoint). Each logic output can be assigned an independent setpoint value (Sn) with corresponding hysteresis/switch action (Hn) and base (An - switch on the gross or the next weight)

S0 Setpoint value for logic output 0

Request / Setting

Master (PC / PLC) sends	LDU XX.X responds	Result
S0	0+01500	Setpoint S0 set to 1500 d
S0_03000	OK	Setpoint S0 changed to 3000 d

Similarly, to read or change the setpoint value for logic 1, issue the commands as above but substitute S1 instead of S0.

H0 Hysteresis and switch action for logic output 0

Using the H0 command you can set the hysteresis on the setpoint value and define whether the logic output switches on or off when the setpoint value is reached. The numeric value of H0 sets the hysteresis and the polarity sets the action when the setpoint is reached.

Example

Setpoint	Hysteresis	Load	Output open	Output closed
S0 = 2000 kg	H0 = -100kg	increasing	2101 kg	0 . . . 2100 kg
S0 = 2000 kg	H0 = -100kg	decreasing	2000 kg	0 . . . 1999 kg
S0 = 2000 kg	H0 = 100kg	increasing	0 . . . 1999 kg	2000 kg
S0 = 2000 kg	H0 = 100kg	decreasing	1900 . . . 0 kg	1901 kg

An example of a negative hysteresis of 100 kg (H0= -100) on a setpoint (S0) of 2000 kg (see lines 1 & 2 of the table above):

When the weight is increasing between 0 kg and 2100 kg the logic output is "ON". Once the weight increases above 2100 kg, the logic output is "OFF". The logic output will come "ON" again when the weight drops below 2000 kg.

An example of a positive hysteresis of 100 kg (H0= +100) on a setpoint (S0) of 2000 kg (see lines 3 & 4 of the table above):

When the weight is increasing between 0 kg and 1999 kg the logic output is "OFF". Once the weight increases above 1999 kg, the logic output is "ON". The logic output will switch "OFF" again when the weight value drops below 1900 kg.

Request / Set Hysteresis value on logic output 0

Master (PC / PLC) sends	LDU XX.X responds	Result
H0	0-00100	Hysteresis on S0 set to -100 kg
H0_100	OK	Hysteresis on S0 changed to +100 kg

Setpoint range between ± 1 (minimum) and ± 99999 (maximum)

Similarly, to read or change the hysteresis value for logic 1, issue the commands as above but substitute H1 instead of H0.

A0 Request / Set the base for logic output 0

The A0 command defines the base on which the setpoint acts. If A0 is set to "0" then the setpoint acts on the unfiltered gross weight. So when the unfiltered gross weight reaches the setpoint, the logic output turns on/off. Similarly, if A0 is set to "1" then the setpoint acts on the unfiltered net weight or if A0 is set to "2" then the setpoint acts on the Average Weight (GA).

Request / Set base for logic output 0

Master (PC / PLC) sends	LDU XX.X responds	Result
A0	0+00000	Setpoint acts on the unfiltered gross weight
A0_1	OK	Setpoint acts on the unfiltered net weight

Similarly, to read or change the base for the setpoint of logic 1, issue the commands as above but substitute A1 instead of A0.

NOTE: All changes to the setpoint settings have to be stored in EEPROM using the SS command. See section 5.12

5.11 Communication setup Commands – AD, CL, BR, DX, OP, TD

NOTE: These settings will only take effect after a power on reset (remember to store the settings using the WP command before turning the power off)

AD Device address setup / request

Setting the device address to 0 will cause the device to be permanently active, listening and responding to every command on the bus without the need for an OP command.

Request / Set device address

Master (PC / PLC) sends	LDU XX.X responds	Result
AD	A:000	Address set to 0
AD_49	OK	Address changed to 49

Factory default: Address 0

Refer to section 2 (page 4) for details of how to carry out a manual setting of the address by soldering SW3.

CL Close Device address n

Master (PC / PLC) sends	LDU XX.X responds	Result
CL_3	OK	Device 3 closed

BR Request / Setup Baud Rate

With this command, the following Baud rates can be set up: 9600, 19200, 38400, 5760 and 115200 baud.

Master (PC / PLC) sends	LDU XX.X responds	Result
BR	B:9600	Baud rate set to 9600
BR_115200	OK	Baud rate changed to 115K2 baud

Factory default: 9600 Baud

Refer to section 2 (page 4) for details of how to carry out an automatic adjustment of the baud rate

DX Half or full duplex communication

With this command the communication can be set to half (DX=0) or full (DX=1) duplex.

Master (PC / PLC) sends	LDU XX.X responds	Result
DX	X:000	Half duplex set
DX_1	OK	Communication changed to full duplex

Half duplex communication can be used for 2 wire RS485 communication. The auto transmit commands SG, SN and SA will only work if full duplex (DX=1) is selected. Factory default DX=0

OP Device communication enable / request

This command, if sent without parameters, requests the address or device number of the device active on the bus. If sent with parameters, this enables the device defined by the parameters.

Request / Enable device communication

Master (PC / PLC) sends	LDU XX.X responds	Result
OP	O:0003	Device 3 open
OP_14	OK	Device 14 opened

The requested device acknowledges its readiness and responds to all bus commands until a further OP command arrives with a different device address or a CL command is received.

TD Transmit Delay

This command allows to set a delay between the LDU receiving a command and responding. You can set this delay anywhere between 0 and 255 milliseconds.

To read the current Time Delay setting issue the TD command without any parameters. To change the value of Time Delay issue the TD command followed by a space and then the value of the delay required in milliseconds e.g. TD 255 to set the delay to 255 milliseconds.

To save the new Time Delay setting, issue the WP command.

Request / Set Transmit Delay time

Master (PC / PLC) sends	LDU XX.X responds	Result
TD	D:0000	Transmit delay set to 0 milliseconds
TD_1	OK	Transmit delay changed to 1 millisecond

This command is particularly useful when LDUs are used on a 2 wire RS485 bus where the host PLC is unable to 'turn around' the transmit and receive lines quick enough to prevent missing part or all of the answer.

5.12 Save calibration, setup and setpoint parameters commands - CS, WP, SS, PI, GI

The setup and calibration parameters can be divided into 3 groups:

Calibration parameters: CZ, CG, DS, DP, ZT etc. are saved by the CS command.

Setup parameters (other than setpoint): FL, FM, NR, NT, BR, AD, DX etc. are saved by the WP command.

Setpoint parameters: S0, S1, H0, H1, A0, A1 are saved by the SS command.

Please note that the calibration parameters can only be saved if the TAC code is known and precedes the CS command. **See the CE and CS commands on pages 20 & 23 respectively.**

Both the setup parameters and the setpoint parameters are stored in EEPROM using the WP and SS commands respectively.

WP Save the setup parameters

With this command the settings of the Filter (FL, FM), the No-motion (NR, NT) and communication (AD, BR, DX) will be saved in the EEPROM.

Master (PC / PLC) sends	LDU XX.X responds	Result
WP	OK	Parameter saved

SS Save the Setpoint setup parameters

With this command the value of the setpoints (S0 & S1), the setpoint hysteresis (H0 & H1) and the setpoint action (A0 & A1) will be saved in the EEPROM.

Master (PC / PLC) sends	LDU XX.X responds	Result
SS	OK	Parameter saved

PI Put EEPROM Image

With this command you can download a HEX-INTEL formatted EEPROM image into the LDU. The image contains all stored information except the calibration data. The LDU must have the same firmware type and revision as the source.

GI Get EEPROM Image

With this command you can get a HEX-INTEL formatted EEPROM image from the LDU. The image contains all stored information except the calibration data. The image can be downloaded into any LDU 78.1 as long as it has the same firmware type and revision as this unit..

The PI and GI command must be handled by a host program able to read the hex data from the LDU and write it to a number of other LDUs for “cloning”. These commands are useful if you want to set up a large number of LDUs in the same way e.g. in some kind of production.

6 CALIBRATION PROCEDURE.

The calibration interface features a "TRACEABLE ACCESS CODE" (TAC), which is required for use in "Approved" applications (see section 7, "USE IN APPROVED APPLICATIONS" for more details). This feature also ensures that there is no inadvertent or unauthorized access to the calibration parameters. 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 settings (return to)
CS	Calibration save

Example: setup of zero point, gain and decimal point.

The chosen test weight has the value equivalent to 5000 increments. This could be 500 g, 5kg or 5000 kg. We will calibrate with a 500 g weight. The decimal point is set to 1 place using the DP command. So although the CG value (5000) does not contain a decimal place the final result does (500.0).

Master (PC / PLC) sends	LDU XX.X responds	Result
CE	E+00017	Request: TAC-counter CE = 17
CE_17	OK	Calibration sequence active
Scale no load !		
CZ	OK	System zero point saved
CE_17	OK	Calibration sequence active
Put calibration weight on (500 g) !		
CG_5000	OK	Setting span
CG	G+05000	Request: span 5000 d
CE_17	OK	Calibration sequence active
DP_1	OK	Setting: decimal point 0000.0
CE_17	OK	Calibration sequence active
CS	OK	Save calibration data in EEPROM

Zero point, gain and decimal point position were saved in the EEPROM; the calibration counter (TAC) is increased automatically by 1.

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 ENs (Euro Norms) or the relevant OIML (Organization Internationale de Metrologie Legale) recommendation

The LDU78.1 has been approved as a component for use in weighing systems according to OIML recommendations R76, the highest performance level approved being Class III, 10000 divisions. The approval authority was the Danish Electronics, Light & Acoustic (DELTA) and the approval certificate number is DK0199-R76-10.08. This approval will allow the use in approved weighing throughout Europe and many other countries in 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 0.4uV 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 SOFTWARE (FIRMWARE) DOWNLOAD

To download new firmware into the LDU XX.X, you will require a Windows PC with either an RS232 port or a USB port and an RS232 or USB to RS422/485 converter. The solder pad SW5 on the under side of the PCB has to be closed (linked across) before switching on the power. After downloading the new firmware the link has to be reopened.

8.1 Firmware update for LDU XX.X series

All files required to download new firmware (LduDownload.exe, prog78.a20 & LduXX.a20) must be stored in the same directory. The actual firmware to be downloaded is in the file LduXX.a20. These files will be provided by your local LDU supplier on request.

Remove the power to the LDU XX.X.

Link the solder pads SW5 on the back of the LDU XX.X with a solder bridge.

Power up the LDU XX.X

Start the "LduDownload" program.

Press the "Load" button and choose the "LduXX.a20" file

Press the "Program" button

When the message "Reset LDU before proceeding" appears, switch the LDU off and wait 5 seconds. Re-apply the power and press "OK"

The download will now proceed - When the download is complete the "Programming OK" message will be displayed.

Switch off the LDU and remove the solder bridge from the SW5 pads on the back of the LDU PCB

Now use the DOP program or a terminal program (such as Hyperterminal) to run the Factory Reset command (FD)

Please note that the FD command is TAC protected. You must issue the CE command with the relevant TAC code prior to the FD command otherwise the FD command will fail.

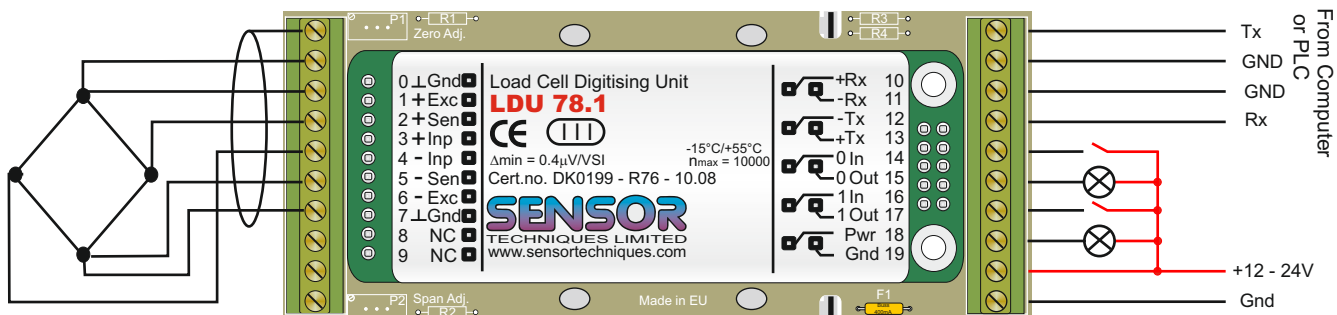
9 UNIT ADAPTOR CONNECTION DETAIL

9.1 UA77.1 Unit Adaptor with built-in RS422 to RS232 converter

External Connections

Pin No. LDU78.1	UA 77.1 Terminal	Function
0	Gnd (Shield)	Common Ground (Load cell cable shield)
1	+ Exc (to load cell)	Positive Load cell excitation voltage
2	+ Sen	Positive Load cell sense voltage
3	+ Inp (to LDU)	Positive Load cell signal voltage
4	- Inp (to LDU)	Negative Load cell signal voltage
5	- Sen	Negative Load cell sense voltage
6	- Exc (to load cell)	Negative Load cell excitation voltage
7	Gnd	Common Ground (Load cell cable shield)
8	Not Connected	
9	Not Connected	
10	RxD (RS232)	Receive Data RS232
11	Gnd (RS232)	RS232 Common Ground
12	Gnd (RS232)	RS232 Common Ground
13	TxD (RS232)	Transmit Data RS232
14	0 In	Logic Input 0 (relative to common ground)
15	0 Out	Logic Output 0 (relative to common ground)
16	1 In	Logic Input 1 (relative to common ground)
17	1 Out	Logic Output 1 (relative to common ground)
18	+ PWR	Power Supply 12-24 V DC
19	Gnd	Common Ground

With UA77.1 (Unit Adaptor with built-in RS422 to RS232 Converter)

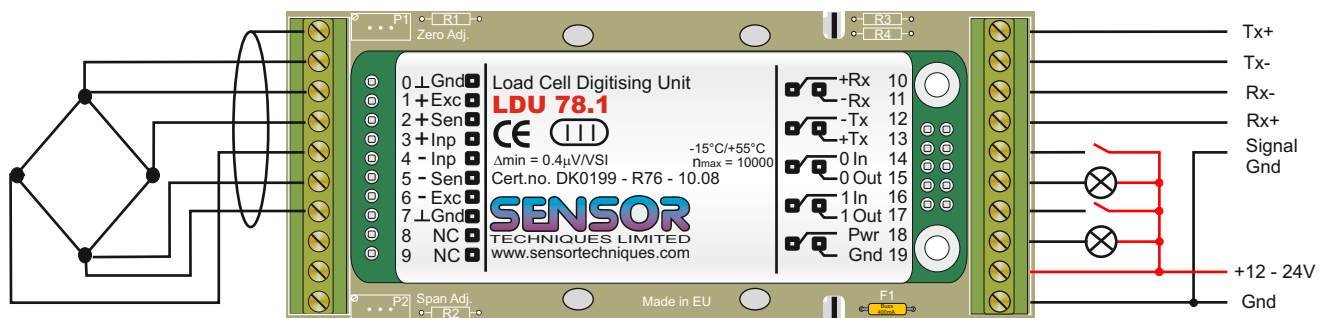


9.2 UA73.2 Standard Unit Adaptor

External Connections

Pin No. LDU78.1	UA 73.2 Terminal	Function
0	Gnd (Shield)	Common Ground (Load cell cable shield)
1	+ Exc (to load cell)	Positive Load cell excitation voltage
2	+ Sen	Positive Load cell sense voltage
3	+ Inp (to LDU)	Positive Load cell signal voltage
4	- Inp (to LDU))	Negative Load cell signal voltage
5	- Sen	Negative Load cell sense voltage
6	- Exc (to load cell)	Negative Load cell excitation voltage
7	Gnd	Common Ground (Load cell cable shield)
8	Not Connected	
9	Not Connected	
10	+Rx (RS422)	Receive Data +
11	-Rx (RS422)	Receive Data -
12	+Tx (RS422)	Transmit Data +
13	-Tx (RS422)	Transmit Data -
14	0 In	Logic Input 0 (relative to common ground)
15	0 Out	Logic Output 0 (relative to common ground)
16	1 In	Logic Input 1 (relative to common ground)
17	1 Out	Logic Output 1 (relative to common ground)
18	+ PWR	Power Supply 12-24 V DC
19	Gnd	Common Ground

With UA73.2 (Standard Unit Adaptor)



10 USB to RS422/485 CONVERTER WIRING (MULTI-DROP)

The following example shows how to wire up 2 or more LDU 78.1s in a multi-drop application to an USB port of a PC using a USB to RS422/485 converter. This circuit has been tested and is known to work correctly. The USB to RS422/485 converters can be purchased from Sensor Techniques Limited

