



GE Druck

**Pressure measurement
for research & industry**

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Technical Note

DPI 104

Communications protocol

TN0610

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1 INTRODUCTION

This document details the communications protocol used by DPI 104. The DPI 104 pressure measurement firmware and hardware is based on the RTX-DPM. However since the DPI 104 responds to DUCI commands (please see TN326 for further details) it is not compatible with RTX-DPM commands. There is a set of calibration commands that DPI 104 utilises, which are only accessible when the DPI 104 is placed into calibration mode. All slave mode communications are at 9600 baud-rate; however, in master mode (communicating with IDOS UPM) the baud-rate is 19200. The DPI104 uses 8 data bits, 1 stop bit with no parity. Each command that does not have an immediate response associated with it (e.g. enter cal mode) will cause the DPI104 to send an “acknowledge” response consisting of the start character, the command characters and the terminator characters once the command has been received.

Message frames have the following basic structure:

Byte Function	Character Sent	Number of Bytes
Start Character	‘*’ or ‘#’ or ‘!’	1
DD	Destination Address	2
SS	Source Address	2
XX	Command. This can be followed by additional data	2+x
Separator	:	1
CS	Checksum	3
Terminator	<CR><LF>	2

Start Character: The start character ‘*’ causes all command block data to be echoed around the daisy chain. The ‘#’ character will suppress the echoing of block data. The ‘!’ character indicates a response from an instrument.

DD: A 2 digit destination address from 00 - 99

SS: A 2 digit source address from 00 - 99

XX: A 2-character command. This can be followed by additional data as required by the specific command being transmitted.

CS: Checksum is a block checksum and takes the format: NN, Where NN is a 2-digit checksum. This is the modulo 100 sum of all the ASCII codes of the characters in the message string including the start character

An error is reported if an incorrect checksum is received.

Terminator: Is the string termination characters <CR><LF>

For brevity, the start, addressing and termination characters have been removed from the following examples.

In direct mode (using the '#' start character), DDSS will be omitted. So the minimum command will be of the format #XX<CR><LF>, where XX is the command.

2 CALIBRATION MODE COMMANDS

Several commands have been added to the original DUCI protocol (version 4) to cater for in-house testing of the DPI 104 hardware.

2.1 ACCESS DPI 104 DICTIONARY ENTRY, AD

This command is used to read/write to the DPI 104 Dictionary. It has been modified from the RTX-DPM command and converted to DUCI format. NB this command will only operate in download mode, a configuration error will occur if it is used outside of download mode – please see section 3.6, page 14. A partial dictionary is listed in Appendix 1, page 19

Command: AD

Read Format: AD<location>,<length>?:<CS>

Write Format: AD<location>,<length>=<value>:<CS>

Valid values for <location> are from 0x00 to the end of the data area for read commands and from 0x80 to the end of the write data area. <location> is sent in ASCII hex format. <length> is the size (in bytes) of the variable to be read. If a message is sent with <location> outside the range defined above the PARAMETER error flag is set, which can be read with the RE command. The response is in ASCII hex format.

Example read command: AD3B,4?: <CS>
read full-scale pressure range, 4 bytes (float)

Example read response: AD3B=41A00000: <CS>
pressure range is 20.0 bar

Example write command: AD3B,4=41A00000: <CS>
write full-scale pressure range, 4 bytes (float)

There is no response to this command.

2.2 TEST ALARM MODE, AL

This command is used to test the alarm output port. *Note, that the alarm mode is not functional in calibration mode; hence the only way to toggle this port is via this command.*

Command: AL

Format: AL=<on/off>:<CS>

Valid values for <on/off> are:

'0'	off
'1'	on

Example: AL=1:<CS> turn alarm on.

2.3 READ BOOTSTRAP LOADER PASSWORD, BP

This command is used to read the password for the bootstrap loader.

Command: BP

Format: BP? :<CS>

DPI 104 will respond with the 32 bytes of the vector table, which is used as the password for access to the protected functions for the bootstrap loader. For a programmed microcontroller, this password must be read from the device before the bootstrap mode is entered. The data is returned in ASCII hex format.

Example response: BP=FF(32 times):<CS>

2.4 ACCEPT CALIBRATION, CA

This command is used to accept the calibration pressures supplied via the CP1 and CP2 commands and perform a straight line fit between the two points. The gain and zero offset registers will be updated after this. On calibration exit, the pressure correction will be seen in the pressure readings.

Command: CA

Format: CA:<CS>

No response to this command

2.5 ENTER CALIBRATION POINT, CP

This command is used to enter a calibration point to perform a zero/span operation.

Command: CP

Format: CP<n><value>:<CS>

<n> = 1 or 2. 1 refers to the zero point for gauge transducers or first point for absolute transducers.
Point 2 refers to the full-scale point.

<value> is the desired pressure *in mbar*

Once DPI104 has received both pressure points and the CA command it will perform straight line fit between the two points. If the pressure is not stable at either point the calibration will not be performed and the calibration error flag will be set.

No response to this command

2.6 EXIT CALIBRATION MODE, CX

This command is used to exit calibration mode and download mode.

Command: CX

Format: CX :<CS>

There is no response to this command, DPI 104 will perform a system restart after this command.

2.7 LOAD FACTORY DEFAULTS, LD

Command: LD

Example: LD:<CS>

DPI 104 will load the factory defaults for the calibration data and the user set up data. This command is only available in download mode, and is intended to be used for in-house testing.

2.8 TEST LCD MODE, LS

Command: LS

Format: LS=<on/off>:<CS>

Valid values for <on/off> are:

'0'	off
'1'	on

Example: LS=1:<CS> turn LCD test mode on.

DPI 104 will begin lighting all segments in sequence one at a time. (Lighting segments individually ensures there are no segment shorts – remember that the bar graph scale marks are *one* segment!). Once all segments have been lit individually, entire display is lit for 10 seconds. Once the 10-second period is over the display will return to normal mode. *Note that in calibration mode the LCD is not lit, hence once calibration mode is entered the display should become blank.*

2.9 SET PRESSURE CHANNEL GAIN, SG

Sets and stores the amplifier gain for the pressure bridge (positive pressure).

Command: SG

Format: SG=P:<CS>

Once completed, the command replies with the gain chosen (as stored in the ADC7718_PRESS_RANGE dictionary entry). The gain value should lie between 1 and 3 (inclusive).

example reply:

SG=P, 03:<CS>

2.10 DIAGNOSTIC (DEBUG) FACILITIES, TD

This command is also used in IDOS but indices 2 and 4 have been modified for DPI 104. Some additional parameters used in IDOS have been removed.

Command: TD

Format: TD< n, x, y, z >?:<CS>

Valid values for <n> are:

- 1 bridge output (ADC count)
- 2 Vbat (ADC count)
- 3 bridge temperature (ADC count)
- 4 Vout (ADC count)
- 5 reserved
- 6 2-point cal data (uses x & y parameters, please see below)

Note that commands 1-5 use only the n parameter; command 6 uses x and y (<z> is not required):

Valid values for <x> are:

- 1 = Pressure fit 1 There is only 1 pressure fit for DPI 104

Valid values for <y> are:

- 1 = Gain gradient for straight line fit
- 2 = Zero offset y-intercept for straight line fit

Response examples:

TD1=4096:<CS> bridge ADC output is 4096 counts.
TD6,1,2=0.0:<CS> zero offset for pressure fit 1 is 0.0

ADC count values are returned as unsigned integers.

2.11 TEST KEYBOARD MODE, TK

This command is used to test the keyboard. The DPI 104 will wait for all keys to be pressed, and respond when all keys have been pressed.

Command: TK

Format: TK? :<CS>

DPI 104 will respond with TK=1,00:<CS> once all four key presses have been detected.

NB There is a timeout period of 10 seconds for this test, if the user does not press all four keys within this time period, the DPI 104 will respond with TK=0,n:<CS> to indicate the key that was NOT pressed and the process must be repeated.

“n” is returned in hex format as follows:

Bit number							
7	6	5	4	3	2	1	0
0	0	0	0	“Enter”	“Down”	“Up”	“Menu”

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e.g. if TK=0,08:<CS> is returned, it means that the “Menu” key was not pressed.

2.12 WRITE DATA TO DAC, WD

Command: WD

Format: WD=<value>

<value> is sent in ASCII hex format (unsigned short)

Example: WD=0FFF:<CS> write FS (4095) to DAC.

Since the DAC is only 12-bit the upper 4 bits are stripped from <value>

3 OPERATIONAL MODE COMMANDS

In normal operational mode, the DPI 104 complies with the DUCI protocol for a limited set of commands. Please see TN0326 for further details of the DUCI protocol. Additionally, it can utilise an external IDOS (UPM) as a pressure sensor (at 19200 baud). Hence it can send DUCI commands also.

3.1 AUTOMATIC DEVICE ADDRESS, AA

This command can only be used with the # command header block. The effect of this command is to automatically set the addresses of the instruments on the daisy chain to sequentially increasing addresses.

Command: AA

Format: AA=<device address>

Description: Automatic Addressing.

Example: AA=10:<CS>

For, say, 3 instruments on the daisy chain this command will set the instruments to have addresses 10,11, and 12.

First in chain receives command (# means don't echo), it sets its address to 10

First in chain echoes with #AA11 (it increments passed address), second in chain receives command, and sets its address to 11.

Second in chain echoes with #AA12 (it increments passed address), third in chain receives command, and sets its address to 12.

The whole process continues, if a device receives #AA98, it does not increment, as only 99 devices are allowable. 99 is the generic code for ALL devices in the chain.

There is no query for this command

3.2 READ INPUT CHANNEL READING, IR

This command allows reading the following channels.

Command: IR

Format: IR[n]? :<CS>
[n] = Channel #

If [n] is omitted, a value of 1 is assumed

Description: Get Input channel Reading. This is a query only command.

Example:

IR1? :<CS> Read channel #1 for pressure
IR2? :<CS> Read channel #2 for switch input
IR3? :<CS> Read channel #3 for captured pressure on switch
change
IR4? :<CS> Read channel #4 for Peak High pressure reading
IR5? :<CS> Read channel #5 for Peak Low pressure reading
IR6? :<CS> Read channel #6 for voltage output reading

The DPI 104 replies with:

IR1=<value>:<CS> Value ranges from -9999 to 99999 as shown on the front panel LCD display.

Note: If the measured pressure is out of display range, the DPI 104 will set the "Display Error" flag (please see section 3.8, page 15) when the command is sent.

IR2=<value>:<CS> Switch test returns 0 when contact is open and 1 when the contact is closed.

IR3=<value>:<CS> Value ranges from -9999 to 99999 as displayed on the front panel LCD during a captured pressure reading resulting from a change of state of the test switch.

IR4=<value>:<CS> Value ranges from -9999 to 99999 as shown on the front panel LCD during a PEAK High display.

IR5=<value>:<CS> Value ranges from -9999 to 99999 as shown on the front panel LCD during a PEAK Low display.

IR6=<value>:<CS> Value ranges from 0.000 to 5.000 (V)

Notes:

All pressure values returned are expressed in the currently set engineering units.

If an item is selected on a device that does not have the correct hardware, (e.g. '6' for a unit without Option C present), then PARAMETER ERROR will be set.

3.3 SET ENGINEERING UNITS, IU

This command sets the current pressure units

Command: IU

Format: IU[n]=<index>:<CS>

Description: Set up the units for the specified input channel. The units are specified as <index>, as defined below and in Appendix B of TN326.

Valid variables are:

[n] = 1 (Input Pressure Channel).

Any other parameter specified will result in a 'Syntax Error' response message.

mbar	< index> = 00
bar	< index> = 01
kPa	< index> = 04
MPa	< index> = 05
kg/cm ²	< index> = 06
mmHg	< index> = 08
mmH ₂ O	< index> = 11
mH ₂ O	< index> = 13
psi	< index> = 16
inHg	< index> = 18
inH ₂ O	< index> = 19

Example:

IU1=16:<CS> Set measured pressure units to psi

3.4 SET ZERO REFERENCE, IZ

Sending this command has the same effect as pressing the front panel ZERO button. Subtracts current pressure reading from all subsequent pressure readings. The command has no effect if the Zero (Tare) function is disabled.

Command: IZ

Format: IZ=<value>:<CS>

Description: Zero (Tare) the pressure input channel.

If <value> and '=' are omitted, a value of 0.0 is assumed.
<value> is passed in mbar, and must satisfy the following:

lower pressure range \leq value \leq upper pressure range

Pressure values outside this range will result in a "Zero Error"

Example:	IZ:<CS>	Zero pressure
	IZ=1000.0:<CS>	Set tare value to 1000 mbar

The value parameter can be used to adjust the barometric reading of an absolute transducer.

The command also has a query version:

Example:	IZ=?:<CS>	Query current tare value
	IZ=1026.0 mbar:<CS>	DPI104 response <i>in mbar</i>

3.5 OUTPUT CHANNEL SETPOINT, OP

This command is for in-house calibration use, to verify that the voltage output mode has been correctly calibrated.

Command: OP

Format: OP=<value>:<CS>

Description: Sets the output channel to <value>

Valid variables are:

<value>= from 0.0 to 100.0 %

Example: OP=50.0: <CS>

If the particular DPI 104 does not have the voltage output hardware, then the 'Parameter' error flag will be set.

Once this command has been issued the following settings will be modified on the DPI 104:

Voltage output mode is changed to user mode
The voltage output scale factor is forced to 1.0

In this manner confusion will be avoided between the previous output mode and the mode set by the command. The colon appears at the end of the command to differentiate between <value> and the checksum.

3.6 PIN PROTECTION COMMAND, PP

This is included to enable certain parameters to be changed.

Command: PP

Format: PP=<pin>:<CS>

Description: PIN protection command.

Example: PP=151264:<CS> enter download mode
PP=123:<CS> enter calibration mode

The query form of this command can be used to test calibration mode. For example:

PP? :<CS>
PP=0:<CS> not in calibration mode
PP=1:<CS> in calibration mode

3.7 READ BATTERY VOLTS, RB

This command allows reading the battery voltage measured by the DPI 104 and used in updating the battery symbol on the front panel LCD.

Command: RB

Format: RB? :<CS>

Description: Read battery voltage. This is a query only command.

Example: RB? :<CS> Queries the battery voltage

The DPI 104 replies with:

RB=<voltage>:<CS>

e.g. RB=9.0:<CS> battery voltage is 9.0V

3.8 READ ERROR STATUS, RE

This command allows reading the last error code issued by the DPI 104. This is a query only command and reports errors that occurred since the last RE? command. After issuing this command, all non-fatal* errors are cleared.

Command: RE

Format: RE? :<CS>

Description: Read Error Code. This is a query only command.

The DPI 104 replies with:

RE=<code>:<CS>

<code> is returned in 16 bit ASCII hex format and the bit definitions are as follows:

Syntax error	Set if the command syntax was not understood
Parameter error	Set if the parameters in the command were out of range or not valid
Configuration error	The configuration parameters can only be altered if the configuration PIN number is sent along with the commands. If the PIN number is not sent or is incorrect, then this error is reported
Not Implemented	Not Implemented
Checksum error	The received command checksum did not match with the calculated checksum. In this case, the command is not executed and this error bit is set
Zero error	An error occurred whilst trying to zero a measurand, probably because the zero offset is too large
Calibration error	Error in the instrument's calibration procedure, e.g. not enough calibration points
Sequence error	A valid command is received, but can not be processed because the instrument is not in the appropriate state to execute it.
Command not available	The requested function is not available on this instrument
Range error	Reading outside range
Sensor error	Invalid or no reading from internal pressure sensor
Power-up error	Power up self-diagnostic failure
Gain error	Unable to set pressure gain within desired range
Display error	Unable to display the pressure value due to the units chosen and the display range.
Read error	EEPROM read error (checksum failure)

	Write error	EEPROM write error (verification failure)
--	-------------	---

* non-fatal errors are all errors with the exception of the following:
Read EEPROM error, Gain error, Power up error and Sensor error

3.9 READ INSTRUMENT TYPE AND VERSION NUMBER, RI

This command returns the instrument type on the ring including the version of the software code.

Command: RI

Description: Read Device Equipment. This is a query only command.

Example: RI? :<CS> Query Instrument model and version number

The DPI 104 replies with:

RI=DPI104,V1.00.00:<CS>

V1.00.00 indicates software version number.

3.10 SET INSTRUMENT ADDRESS, SA

Set instrument address to <nn>. Changes the daisy chain address of the instrument. The value can be in the range of 0 – 98. Address 99 is reserved for global communication commands only. Data can be queried at any time, but changing the data can only be performed with the configuration PIN number included in the command.

Command: SA

Format: SA=<nn>:<CS>

Description: Set instrument to address = <nn>.

Example: PP=151264:<CS> Puts instrument into download mode.
SA=10:<CS> Set the instrument address to 10.

The reply is of the form:

SA=<nn>:<CS> where <nn> is in the range of 0 – 98.

e.g. SA=10:<CS> current address setting is 10

3.11 ENTER SLEEP MODE, SI

Forces the DPI104 into sleep mode. This is identical to the IDOS command with the exception that only the “sleep indefinite” form is implemented.

Command: SI

Format: SI=inf:<CS>

There is no reply to this command. The DPI104 will wake up on the next DUCI message sent or the next key press.

3.12 SET FUNCTION REGISTER, SF

This command is utilized to load function registers within the DPI 104

Command: SF

Format: SF[nn]=<value>:<CS>

Description: Load Function Registers.

Valid variables are:

[nn]	parameter	<value>
0	Voltage Mode	0 → 2
1	Zero (Tare) function	0 - 1
2	Peak Monitor function	0 - 1
3	Alarm Monitor function	0 - 1
4	Auto Off function	0 - 1
5	Menu Lock	0 - 1
6	Switch Mode	0 - 1
13	Voltage Output (%)	000.0 → 100.0
14	Voltage Scale	0.00 → 9.99
11	Scan Rate	02 → 10
12	Menu Lock Code	000 → 999
15	Alarm Low Register (%)	000.0 → Alarm High
16	Alarm High Register (%)	Alarm Low → 100.0%
17	FSO Low Register	Cal Low → FSO High
18	FSO High Register	FSO Low → Cal High

Any value out of range or other parameters specified will result in a ‘Parameter Error’ response message.

Example:

SF00=0:<CS>

Output Voltage Mode Disabled

SF13=050.0:<CS>

Output Voltage set to 50.0% FSO

SF14=1.00:<CS>	Output Voltage Scale Factor set to 1.00
SF11=2:<CS>	Scan Rate set to 2x per second
SF12=123:<CS>	Menu Lock code set to 123
SF16=75.0:<CS>	Alarm Register High set to 75.0% FSO
SF15=25.0:<CS>	Alarm Register Low set to 25.0% FSO

SF[nn]?:<CS>	Queries the status of the register
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The reply is of the form:

SF[nn]=<value>:<CS>

3.13 SET/READ INSTRUMENT SERIAL NUMBER, SN

Set instrument serial number to <serial number>. Data can be queried at any time, but changing the data can only be performed in download mode. Serial number information is maintained in EEPROM memory in the DPI 104.

Command: SN

Format: SN=<serial number>:<CS>

Description: Set instrument serial number to <serial number>.

Example:	PP=151264:<CS>	Puts instrument into configuration mode.
	SN=123456:<CS>	Set the instrument serial number to 123456.

Query: SN? Report serial number

The reply is of the form:

SN=<serial number>:<CS>

e.g. SN=123456:<CS>	DPI 104 returns serial number of 123456
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Appendix 1. DPI104 Dictionary.

Index(Dec)	Read Entry	Write Entry	Description	Type
12	C	8C	PressureMaxADC	ULONG
13	D	8D	PressureMinADC	ULONG
14	E	8E	TemperatureMaxADC	ULONG
15	F	8F	TemperatureMinADC	ULONG
17	11	91	ADC7718_Press_Range	UCHAR
18	12	92	ADC7718_Temp_Range	UCHAR
21	15	95	LastCalibration_Year	UCHAR
22	16	96	LastCalibration_Month	UCHAR
23	17	97	LastCalibration_Day	UCHAR
24	18	98	Span_Year	UCHAR
25	19	99	Span_Month	UCHAR
26	1A	9A	Span_Day	UCHAR
28	1C	9C	PressureOffset	FLOAT
29	1D	9D	Vout_gain	FLOAT
30	1E	9E	Vout_intercept	FLOAT
31	1F	9F	DPI104_MinPressure	FLOAT
32	20	A0	DPI104_MaxPressure	FLOAT
34	22	A2	SensorType	UCHAR
45	2D	AD	Lower (50 mV) voltage value for Vout	FLOAT
46	2E	AE	Full scale (5V) voltage value for Vout	FLOAT
47	2F	AF	Lower (50 mV) ADC value for Vout	ULONG
48	30	B0	Full scale ADC (5V) value for Vout	ULONG
49	31	B1	DAC lower value (50 mV)	USHORT
50	32	B2	DAC FS value (5V)	USHORT
51	33	B3	Option Present	UCHAR
52	34	B4	NumberOfPressCoefficients	UCHAR
53	35	B5	NumberOfTempCoefficients	UCHAR
54	36	B6	X_Adjustment	FLOAT
55	37	B7	Y_Adjustment	FLOAT
56	38	B8	Coeff[0][0]	FLOAT
57	39	B9	Coeff[0][1]	FLOAT
58	3A	BA	Coeff[0][2]	FLOAT
59	3B	BB	Coeff[0][3]	FLOAT
60	3C	BC	Coeff[0][4]	FLOAT
61	3D	BD	Coeff[0][5]	FLOAT
62	3E	BE	Coeff[1][0]	FLOAT
63	3F	BF	Coeff[1][1]	FLOAT
64	40	C0	Coeff[1][2]	FLOAT
65	41	C1	Coeff[1][3]	FLOAT
66	42	C2	Coeff[1][4]	FLOAT
67	43	C3	Coeff[1][5]	FLOAT
68	44	C4	Coeff[2][0]	FLOAT
69	45	C5	Coeff[2][1]	FLOAT
70	46	C6	Coeff[2][2]	FLOAT
71	47	C7	Coeff[2][3]	FLOAT
72	48	C8	Coeff[2][4]	FLOAT
73	49	C9	Coeff[2][5]	FLOAT

DPI104 Dictionary (continued)

Index(Dec)	Read Entry	Write Entry	Description	Type
74	4A	CA	Coeff[3][0]	FLOAT
75	4B	CB	Coeff[3][1]	FLOAT
76	4C	CC	Coeff[3][2]	FLOAT
77	4D	CD	Coeff[3][3]	FLOAT
78	4E	CE	Coeff[3][4]	FLOAT
79	4F	CF	Coeff[3][5]	FLOAT
80	50	D0	Zero_offset	FLOAT
81	51	D1	Gain	FLOAT
92	5C	DC	FSO_Low	FLOAT
93	5D	DD	FSO_High	FLOAT