Group3

DTM-130 and DTM-141 DIGITAL TESLAMETERS with IEEE-488 GPIB Interface

USER'S MANUAL

For units supplied with software DTMG V5.0

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1. GENERAL DESCRIPTION

The DTM-130-_G and DTM-141-_G Digital Teslameters offer precision measurement of magnetic flux densities, with direct digital readout in tesla or gauss, and IEEE-488 GPIB interfacing for system applications. The instruments are light and compact, and the probes are easy to use.

This description includes features of the serial communications option which is an alternative to the IEEE-488 option. If your teslameter is the serial version, refer to the DTM-130-_S and DTM-141-_S User's Manual.

FEATURES

Measures magnetic fields over four ranges up to 3 tesla with polarity indication; resolution up to 1 part in 60,000.

Used with special miniature Hall probe - easy to attach to magnet pole or other hardware. Probe holders are available as optional accessories.

Precision and temperature specifications include performance of probe.

Probe is calibrated, with field and temperature characteristics stored in memory chip contained in cable plug.

Available in two precision specifications - 0.03% and 0.01% of reading.

Microprocessor reads probe calibration data stored in probe connector to compute corrected field reading, using cubic spline curve-fitting technique.

Temperature coefficient options: 80ppm/°C and 10ppm/°C.
Lower tempco is achieved using temperature sensor in probe.
Microprocessor calculates corrected field reading (DTM-141).

Precision is verified against nuclear magnetic resonance (NMR) standard.

Calibration is verified at many field points on every probe, and a printed calibration table is supplied with every probe.

AC mode measures and displays time-varying fields between 8 Hz and 3000 Hz.

Front panel keys set the display to read the desired field range, to read the peak value of the field using the peak hold function, to show the ac field component, and to display the probe temperature (141 only).

Peak hold is implemented digitally, has zero sag.

Digital filtering of the displayed field reading suppresses short-term fluctuations. The filtering characteristic is non-linear; small field variations within a narrow window centered on the currently displayed value are filtered; large field changes are displayed immediately. Filter window and time-constant may be changed by remote command. Filtering is controlled by an internal switch.

Two digital communication options: serial (RS-232C and fiber optic) and IEEE-488 General Purpose Interface Bus.

With the serial option, a single teslameter may be connected to standard RS-232C equipment, or up to 32 units may be interconnected on Group 3 Communication Loop (G3CL) and driven from computer or terminal.

Fiber optic ports duplicate functions of RS-232C signals, for electrical noise immunity and voltage isolation. Fiber optic links may be up to 60 meters in length, using Hewlett-Packard HFBR-3500 series fiber optic cables.

The IEEE-488 option fully supports all relevant GPIB functions and commands, including full talker-listener capability, serial and parallel polling, service request, and talker-only.

ASCII control commands are accepted to modify the output data format, to change the rate of data transmission or to request transmission of a single field reading. Other commands set scaling and offset, select the field range, select ac and peak hold functions, turn on and off digital filtering and modify the filter characteristics. System status may be determined remotely.

The system can be operated in triggered mode where field measurements by one or more teslameters are triggered in synchronism with each other by external command.

Internal switches select serial data format and baud rate, device address, string terminators, filtering, field units in gauss or tesla, data format, service request action, EOI action, and perform system reset.

Two analog outputs are available: instantaneous field value (0 to 3 kHz), rectified time-varying (ac) component of field, response 8 Hz to 3 kHz.

All model variations are available also without display and keys for true 'black box' magnetic-field-to-computer interfacing.

A panel mount model with display is available.

2. SPECIFICATIONS OF SYSTEM

Specifications include LPT-130 or LPT-141 Hall Probe.

Measurements	field value and time-varying (ac) component of field
Field ranges	0.3 0.6 1.2 3.0 tesla full-scale, 3 6 12 30 kilogauss full-scale, with polarity indication maximum calibrated field ±2.2 tesla, ±22 kilogauss
Resolution	1 in 60,000 of full-scale: 50 microtesla (0.5 gauss) on 3.0T range 20 microtesla (0.2 gauss) on 1.2T range 10 microtesla (0.1 gauss) on 0.6T range 5 microtesla (0.05 gauss) on 0.3T range 16-bit digitizing of field
Precision	DTM-130 with LPT-130 probe: ±0.03% of reading ±0.006% of full-scale max. at 25°C DTM-141 with LPT-141 probe: ±0.01% of reading ±0.006% of full-scale max. at 25°C
Temperature stability	DTM-130 with LPT-130 probe: calibration: -80ppm of reading/°C max. zero drift: ±(8 microtesla + 0.0015% of full-scale)/°C max. DTM-141 with LPT-141 probe: calibration: ±10 ppm of reading/°C max. zero drift: ±(1 microtesla + 0.0003% of full-scale)/°C max. add -3ppm/°C for each meter of probe cable
Time stability	±0.1% max. over 1 year
Measurement rate	10 measurements per second
Response time	Full-scale change of displayed field reading settles to within resolution in less than 0.3 second (filtering off - see below)
Peak hold mode	Displays maximum field since mode entered or reset. Peak hold is implemented digitally with zero sag or decay.

AC mode	Displays time-varying (ac) component of field; frequency response: 8 Hz to 3 kHz at -3dB points. response time-constant: 0.2 seconds. average responding, reads rms value of sinusoidally-varying field.
Display	7-character 7-segment alphanumeric display.
Indicators	8 back-lit legends for: 0.3 0.6 1.2 3.0 tesla range selected, peak hold mode on, digital filtering on, tesla/gauss field units.
Display modes	magnetic field, peak hold field, ac field, peak ac field, temperature (141 only)
Digital filtering	field value filtering smooths out small fluctuations in the reading; large, rapid field changes are not filtered; internally switch selected.
Keys	2 keys for range selection, access to display modes, zeroing field display, peak hold reset.
Digital interfacing	serial option: RS-232C and fiber optic. parallel option: IEEE-488 General Purpose Interface Bus.
Digital data format	ASCII input commands and output responses.
Commands	requests for field values, setting and inspection of display and control modes, field measurement triggering, entry of numerical values, setting units, output data format, and filter characteristics, test commands.
Output responses	field value in tesla or gauss followed by optional T or G and string terminator(s), system status, numerical data requested by commands, messages.
Serial bit rate	16 rates, switch selected, 50, 110, 134.5, 150, 200, 300, 600, 900, 1050, 1200, 1800, 2000, 2400, 4800, 9600, 19200 baud.
System orientation	Group 3 Communication Loop (G3CL) using serial ports, simple loop for 32 devices, no multiplexer required; GPIB with IEEE-488 option.
Fiber optic cable	Hewlett-Packard HFBR-3500, 60 meters max.

On-board switches	serial baud bit rate selection, system reset, device address, filtering, string terminators, data format, service request enable, EOI enable.
Analog outputs	dc output - instantaneous field analog: full-scale output: ±3V nominal source impedance: 1000Ω zero offset: ±10mV max. accuracy: ±5% residual noise: 0.5mV peak approx. bandwidth: 3kHz at -3dB, rolloff 3-pole 60dB/decade
	ac output - rectified analog of time-varying (ac) field: frequency response: 8Hz to 3kHz at -3dB points time-constant: 0.2 seconds average responding, delivers rms value of sinusoidal field full-scale output: 3V nominal source impedance: 1000Ω accuracy: ±7% zero offset: ±10mV max.
IEEE-488 functions	SH1 source handshake capability AH1 acceptor handshake capability T5 talker (basic talker, serial poll, talk-only mode, unaddressed to talk if addressed to listen) TE0 no address extension talker capability L4 listener (basic listener, unaddressed to listen if addressed to talk) LE0 no address extension listener capability SR1 service request capability RL0 no remote local capability PP1 parallel poll capability (configured by controller) DC1 device clear capability DT1 device trigger capability C0 no controller capability
GPIB connector	standard Amphenol 57-20240 with metric standoffs
Microprocessor	6809
Memory back-up	user-entered data storage for 30 days with power off.
Power source	9 to 12 V 900 mA ac/dc; ac input plug pack supplied. L option: 115/208/230 V ac power input.

Enclosure	aluminum, 217 x 125 x 50 mm, textured finish, light tan color, tilt stand fitted to bench models.
Ambient field	Maximum operating field for instrument: 10 millitesla with single-range probe, 0.5 millitesla with multi-range probe.
Temperature range	0 to 50°C operating, absolute maximum temperature of probe 60°C.
Instrument weight	1.2 kg, shipping weight 2.5 kg.
Probes	LPT series, transverse types, sensitive area 4 x 1.6mm, probe head size: LPT-130 and LPT-230: 13 x 10.5 x 2.5 mm LPT-141 and LPT-231: 14 x 14 x 2.5 mm MPT series, miniature transverse types, sensitive area 1 x 0.5mm, probe head size: MPT-132 MPT-230 MPT-141 MPT-231: 14 x 5 x 2 mm Standard cable length: 2 meters. Special cable lengths to 30 meters. Shielded probe cable is available for electrical noise rejection.

ORDER CODES

Basic teslameters,
capable of four measurement ranges 0.3, 0.6, 1.2, 3.0 tesla full scale,
support all LPT and MPT series probes, plugpack supplied except for option -L.

DTM-130 supports LPT-130, LPT-230, MPT-132, MPT-230 probes
DTM-141 supports LPT-141, LPT-231, MPT-141, MPT-231 probes

Options

Bench style instrument with display: add suffix **-D** |
Panel-mount version: add suffix **-P** | one of these options
Without display, plugpack powered: add suffix **-N** | must be specified
Without display, line voltage power: add suffix **-L** |
Serial data input/output, RS-232C & fiber optic: add suffix **S** | must select
IEEE-488 GPIB capability: add suffix **G** | one option

Example: DTM-141-DS

Probes

Four ranges, standard 2 meter cable

LPT-130 |
LPT-141 | standard sensitivity
MPT-132 | probes
MPT-141 |

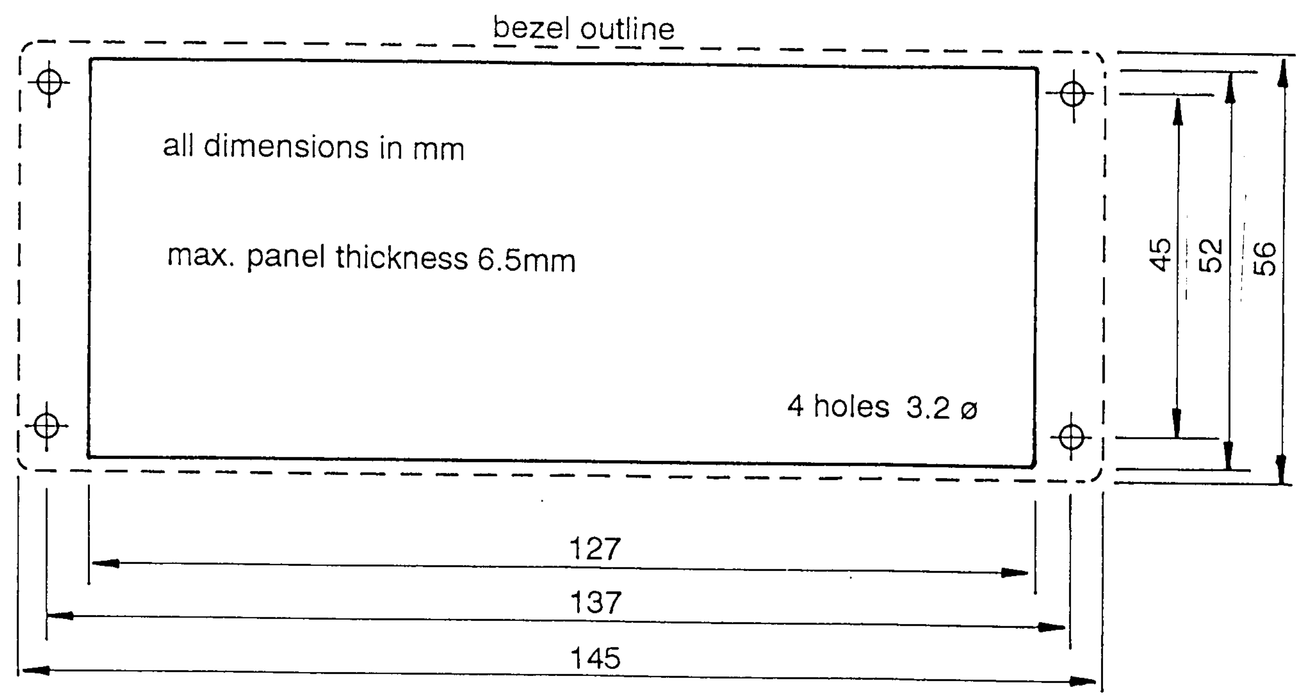
LPT-230 |
LPT-231 | high sensitivity
MPT-230 | probes
MPT-231 |

Single range probes: add range suffix **-03, -06, -12, -30**.
Special probe cable lengths: add length suffix **-Xm** or **-Xs**,
for **X** substitute cable length in meters, 30 max.
m denotes unshielded cable, **s** denotes shielded cable.

Example: LPT-141-2m

Accessories

fiber optic cable fitted with connectors, standard length 5 meters.
fiber optic cable fitted with connectors, special lengths to 60 meters.
probe holders.
fiber-optic to RS-232C adaptor, model **FTR**.
serial/GPIB adaptor, model **COM-488**.
digital display for remote control & readout of field values, model **DPM**.
rack panels, 3.5 inches high (2U), for rack mounting 1, 2, or 3 DTMs or DPMs.


bezel outline
all dimensions in mm
max. panel thickness 6.5mm
4 holes 3.2 ø
45
52
56
127
137
145

3. SETTING UP

3.1 INTRODUCTION

This manual provides operating instructions for all members of the DTM-130-_G and DTM-141-_G family of digital teslameters with IEEE-488 interfacing, and their companion LPT series of Hall probes. For a summary of all current members of the product family, see page 2-4.

Users of teslameters without the front panel display and keys should ignore sections of this manual referring to these features. All other aspects of operation are identical.

Before using your teslameter for the first time, please read through sections 3.2, 3.3, 4.1, 4.2, and 4.3 of this manual. This will give a quick introduction to basic operation of the instrument. If you have a DTM without display, also read sections 3.4 and 4.5.

3.2 CONNECTING THE HALL PROBE

Before handling the probe, please read section 4.2, page 4-2.

Your DTM is used with a Group 3 LPT series Hall probe. The probe may be one supplied with your teslameter, or it may have been obtained separately. In any case, calibration is preserved when probes are exchanged between instruments.

All LPT series probes will operate with all DTM series instruments. However, in order to obtain specified performance, the LPT-130 and LPT-230 probes should be used with a DTM-130. Similarly, LPT-141 and LPT-231 probes should be used with a DTM-141.

The standard probe cable length is 2 meters. Probes with non-standard cable lengths may be ordered from your Group 3 supplier.

With the DTM unpowered, plug the probe connector into the instrument. The pin side of the plug is inserted into the large opening in the rear of the DTM, with the plug's label uppermost when the instrument is standing right way up. It is easy to find the correct mating position for the plug, and then push it fully home, but if any difficulty is experienced at first, remove the DTM's top cover by loosening the central screw and lifting the cover off. Now it is possible to see when the plug is centrally located and its overhang slides over the card-edge receptacle, ensuring that its pins engage correctly. Tighten the connector retaining screws finger tight.

The teslameter should always be used with both covers attached.

Always disconnect power from the teslameter before connecting or disconnecting the probe. If the probe connector is inserted or withdrawn with power on, data stored in memory may be corrupted, leading to erroneous field readings. If this happens, the teslameter should be reset by switching S2-8 ON then OFF while power is applied. See Fig. 3 and pages 3-4 and 3-5.

When a probe is not connected to the DTM, the display reads "noProbE".

3.3 CONNECTING THE POWER SOURCE

All teslameter versions, except for the L option, are supplied with a plug-pack. Connect the plug-pack to a convenient ac power source, first checking the voltage marked on the plug-pack, and insert the cable connector into the power receptacle on the DTM rear panel.

Instead of the plug-pack, the unit can be powered by any floating source of ac or dc (either polarity), 9 to 12 volts, capable of supplying 800 milliamperes average current. AC sources should be capable of 1.6 amps rms. The cable connector required for power connection to the DTM is generally available from electronics parts suppliers.

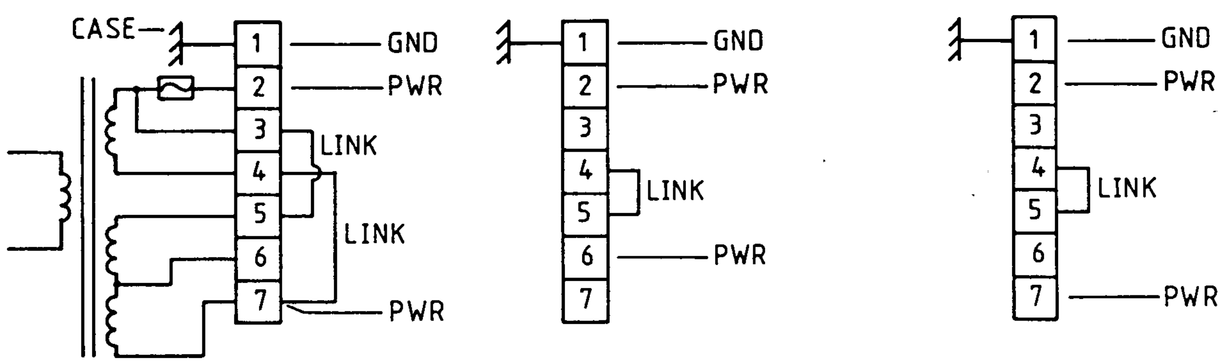
The L option will accept mains power input.

Access to the power input terminals of the L option is obtained by taking off the orange cover; remove the 3 fixing screws to release the cover.

Use 3-conductor power cord. For safety from electrical shock it is essential to provide a reliable ground connection to the DTM case. Make sure the ground wire is connected as shown in Fig. 1. Strip about 60 mm (2.5 in) of outer jacket from the cord, and strip 5 mm (3/16 inch) of insulation from the 3 wires. Pass the cord through the grommetted hole in the cover. Loosen the screw securing the cable clamp and pass the cord through the clamp. Tighten the clamp on the outer jacket. Terminate the wires and fit links according to the supply voltage as set out in Fig. 1 below.

Replace the orange cover, making sure that wires are not pinched in the process. For safety reasons, do not operate the unit with the cover off.

Note that input power protection is provided by a thermal fuse wound into the power transformer. This fuse will open in the event of transformer overheating rather than on excess current. The power input must be connected as shown to include the thermal fuse in the circuit correctly. If a fault causes transformer overheating and subsequently the fuse opens, the transformer must be replaced with the genuine Group 3 part.



115V	link 4 and 7 link 3 and 5 power 2 and 7 ground 1	208V	link 4 and 5 power 2 and 6 ground 1	230V	link 4 and 5 power 2 and 7 ground 1

Fig. 1. Power Input Connections

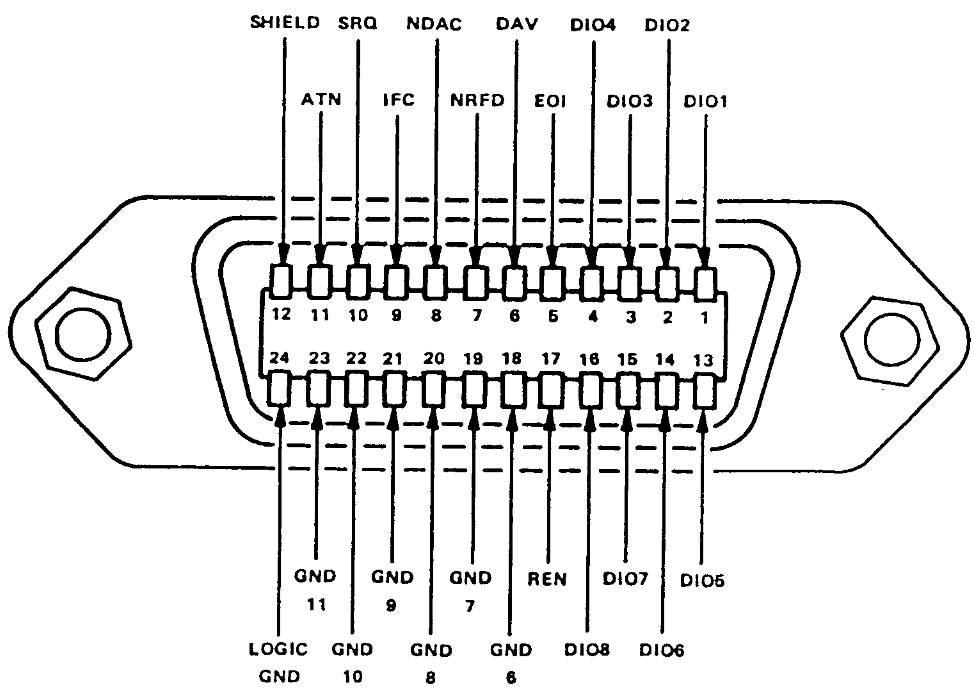


Fig. 2. IEEE-488 Standard Connector.

If desired, the wiring may be protected by installing an external fuse in the ac power feed. Suggested fuse ratings are 200 mA for 115 volts, or 100 mA for 208 and 230 volt operation.

When the unit is first powered up, the display shows "Group 3" for 2 seconds before field measurements appear.

If the Hall probe is not plugged in, the field reading display is replaced with "noProbE".

3.4 GPIB CONNECTION

Connection to the GPIB connector on the rear of the DTM is made using cables as specified in the IEEE-488-1978 standard document. Briefly, the cable has 24 conductors with an outer shield. The connectors at each end are 24-way Amphenol 57 series or similar with piggy-back receptacles to allow daisy-chaining in multiple device systems. The connectors are secured in the receptacles by a pair of captive locking screws with metric threads.

The total length of cable allowed in a system is 2 meters for each device on the bus, or 20 meters maximum. A system may be composed of up to 15 devices.

Fig. 2 shows the GPIB connector pin location and signal names as viewed on the teslameter rear panel. Table 1 is a listing of the pin assignments.

pin	symbol	description
1	DIO1	Data Input Output line 1
2	DIO2	Data Input Output line 2
3	DIO3	Data Input Output line 3
4	DIO4	Data Input Output line 4
5	EOI	End Or Identify
6	DAV	Data Valid
7	NRFD	Not Ready For Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Cable shield - connects to teslameter case
13	DIO5	Data Input Output line 5
14	DIO6	Data Input Output line 6
15	DIO7	Data Input Output line 7
16	DIO8	Data Input Output line 8
17	REN	Remote Enable - not used in teslameter
18	GND 6	Ground wire of twisted pair with DAV
19	GND 7	Ground wire of twisted pair with NRFD
20	GND 8	Ground wire of twisted pair with NDAC
21	GND 9	Ground wire of twisted pair with IFC
22	GND 10	Ground wire of twisted pair with SRQ
23	GND 11	Ground wire of twisted pair with ATN
24	GND	teslameter logic ground

Table 1. GPIB Connector Pin Assignments

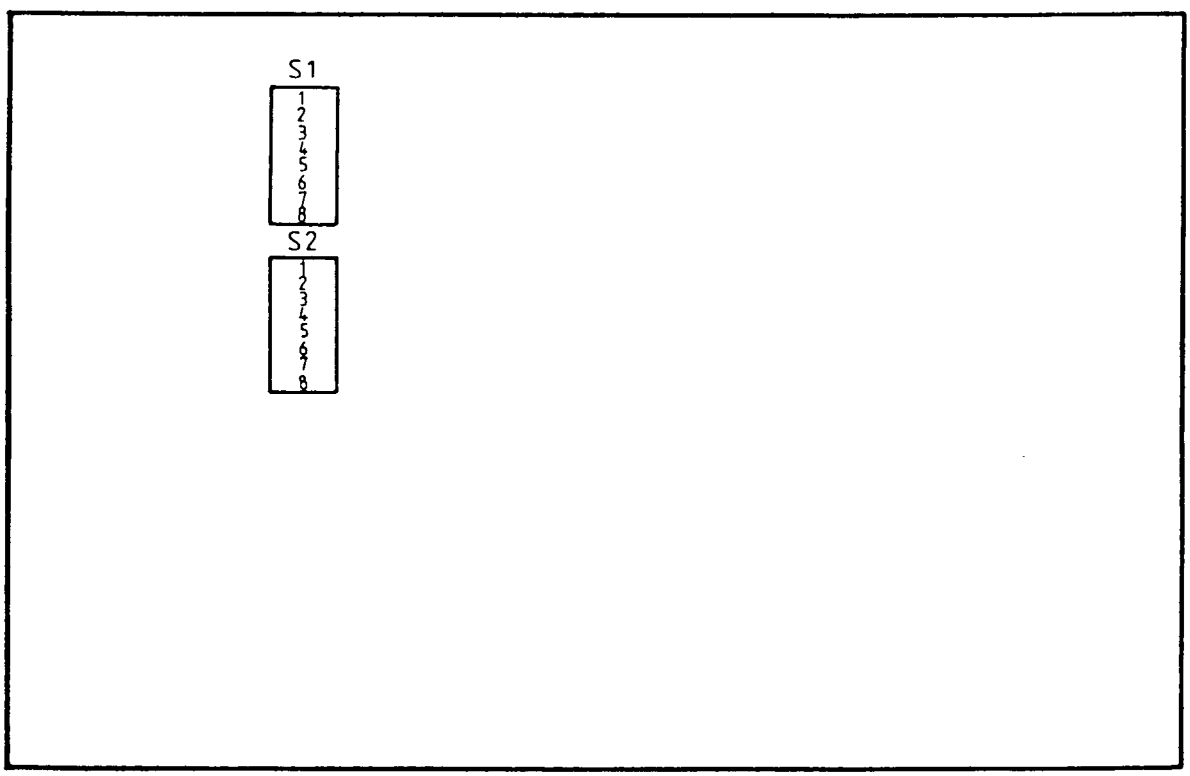


Fig. 3. Location of Processor Board Switches.

useful in systems without a controller, where the teslameter readings are continuously sent to a listening device, such as a printer.

S2-1 through S2-7 are set according to the GPIB system requirements.

S2-1 is normally ON, which allows the teslameter to assert the SRQ line and the SRQ bit of the serial poll response. However, if the GPIB system controller routines are to run without interrupts, S2-1 should be switched OFF, thus disabling all SRQ action.

S2-2 controls the operation of the EOI bus management line. Normally the switch is ON, so EOI is asserted each time the teslameter sends a string terminator character on the bus, indicating the end of a response. With S2-2 OFF, the teslameter does not assert the EOI line.

S2-3 selects the character sent as a string terminator. With the switch OFF, the terminator is the line feed character. When the switch is ON, carriage return is used.

S2-4 when ON introduces a pre-terminator character before the final string terminator selected by S2-3. The pre-terminator is the character not selected by S2-3. The terminator sequence as selected by S2-3 and S2-4 is as follows:

		S2-3	
		OFF	ON
S2-4	OFF	lf	cr
	ON	cr/lf	lf/cr

Check which terminator characters are required by the system controller and/or other devices in your GPIB system, and set the switches accordingly.

S2-5 selects the field units used, OFF for tesla, ON for gauss.

S2-6 when ON causes the field units character T or G to be sent on the bus following numerical field values.

S2-7 enables digital filtering of the field value when switched ON.

S2-8 allows the user to perform a system reset, where all the numerical values entered by the operator are reset to their default values, and switch-selectable functions are instated as set on the switches. To perform the reset, switch S2-8 ON, then OFF again. If the switch is left ON, a system reset will occur each time the teslameter is powered up. The display shows the message "rESEt" each time a reset occurs. When a reset occurs on power up, the reset message follows the Group 3 power up message.

The functions of S2-1,2,5,6,7,8 can be selected remotely on the bus by DTM commands. See page 4-13. To revert to switch control, change the switch setting, and then place it in the desired position.

3.6 ANALOG OUTPUTS

3.6.1. Two output signals are available at the rear of the teslameter. These signals are referred to as the dc and ac outputs, and are described below. The cable connector required is a Molex receptacle type M5051-4 fitted with M2759 terminals. It carries both outputs. Pin assignments are given below.

The analog outputs are not corrected for linearity or temperature errors.

pin	signal
1	ground
2	ac output
3	ground
4	dc output

Table 3. Analog Output Connector Pin Assignments.

3.6.2. DC Output.

The dc output is the Hall probe signal amplified to 3 volts full-scale, and gives an indication of the instantaneous field value from dc to 3kHz (-3dB), with a roll-off of 60dB/decade. Field direction is indicated by the output voltage polarity. There is a small zero offset of 10 millivolts maximum, arising from the probe zero-field output and amplifier offsets. The output impedance is 1000 ohm with a 10nF capacitor to common for noise filtering.

3.6.3 AC Output.

The ac output is a positive voltage analog of the time-varying or ac field component. To generate this output the instrument removes the dc component of the analog output described above, then full-wave rectifies any remaining ac component. The overall response to varying fields is 8Hz to 3kHz, and the rectified output has a time constant of 0.2 seconds. The rectifier circuit responds to the average value of the ac waveform, but is calibrated such that if the waveform is sinusoidal, the reading corresponds to its rms value. The output impedance is the same as for the dc output.

3.7 GROUNDING

All parts of the DTM case are connected together to form an integral electic shield around the circuitry inside. The internal circuitry is not connected to the case. Circuit common and the case are electrically isolated from each other.

The case is connected to pin 12 of the GPIB receptacle.

Circuit common is connected to pins 18 through 24 of the GPIB receptacle.

Sometimes it is desirable to ground the case in order to reduce pickup of electrical interference and transients. A ground connection may be made via the GPIB cable shield when the cable is connected to other grounded instruments.

For electrical safety, the case of the L version must be grounded through the third wire of the power input cord.

Unlike the main instrument case, the Hall probe connector is connected only to circuit common. Do not ground this the connector.

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4. OPERATING INSTRUCTIONS

4.1 ZEROING

The DTM series digital teslameters have very stable zero field readings. Nevertheless, it is good practice to zero the instrument on all ranges immediately prior to making critical field measurements. The zeroing process takes out residual zero errors in the Hall probe and the instrument's preamplifier "front-end".

The instrument must be zeroed if it has not been powered for 30 days or more, as there is a possibility that its memory back-up may have failed.

Zeroing is mandatory if a different probe is to be used since the instrument was last zeroed. You should also zero the instrument when using it for the first time. The ac ranges must also be zeroed individually.

Before zeroing the system, connect up and apply power as described in sections 3.2 and 3.3. Allow 30 minutes for the instrument and probe to stabilize.

For absolute zeroing, place the probe in a zero-field region, either in a zero field chamber or inside a suitable magnetic shield, so that the probe is shielded from the earth's magnetic field and other stray fields.

If desired, a relative zero setting may be done; the instrument is zeroed after the probe is placed in its measurement position. Thus any ambient field is automatically subtracted from subsequent measurements. The probe should not be moved once zeroing is complete. About 5% of full-scale may be zeroed out without reducing full-scale span below specification.

The zero field reading is affected slightly by the presence of metal against the probe's back surface. If the probe is to be used clamped to a metal surface, or in a probe holder, it should be zeroed in the same situation.

Ambient temperature also has an effect on the probe zero. With the DTM-130 teslameter the probe should be zeroed at a temperature as close as possible to the temperature during service. With the DTM-141 the actual temperature is not important, but allow the probe to stabilize thermally for a minute or two before zeroing.

A range is selected by pressing the RANGE key. The four range indicators show the selected range. The RANGE key selects the ranges in turn in the sequence 0.3, 0.6, 1.2, and 3.0 tesla. If a single-range probe is in use, the RANGE key will have no effect.

The zeroing process is implemented by pressing and releasing both keys together. The display will read "ZEro" for a moment, indicating that zeroing has occurred.

The zeroing process should now be repeated for all the remaining ranges. Press the RANGE key to select another range, and zero this range by pressing both keys together, as above. After changing ranges, wait 1 or 2 seconds before zeroing. Continue until all the ranges have been zeroed.

To zero the ac ranges, first select the ac mode by pressing the MODE key once. "A" will appear at the left of the main display.

Now perform the zeroing function on all ranges, as described above.

Because the ac measurement circuitry has a 0.2 second time constant, allow the display to settle after changing ranges before zeroing.

Return to normal dc field display by pressing the MODE key 4 times (3 times with the DTM-130).

Once the zeroing process has been completed, the internal processor will apply the appropriate correction to whichever range is selected. It is recommended that the instrument be re-zeroed if the ambient temperature has changed significantly.

4.2 INSTALLING THE PROBE

Group 3 Hall probes are built to be as robust as possible for a small, precision device. However, it is most important that certain precautions be taken when handling and installing probes so that they are not damaged or destroyed, and to preserve their accurate calibration.

Mount the probe head so there is no pressure which will tend to bend or depress its ceramic rear surface. If the probe head is clamped, make sure the surface in contact with the ceramic is flat and covers the whole of the ceramic surface. Do not apply more force than is required to hold the probe in place. Any strain on the ceramic will alter the probe's calibration, and excessive force will destroy the Hall element inside.

When the probe head is mounted, the cable should be clamped firmly nearby so it cannot be torn away from the probe head if accidentally pulled. The flexible section adjacent to the probe head can be carefully folded to allow the cable to come away in any direction, but avoid repeated flexing of this section.

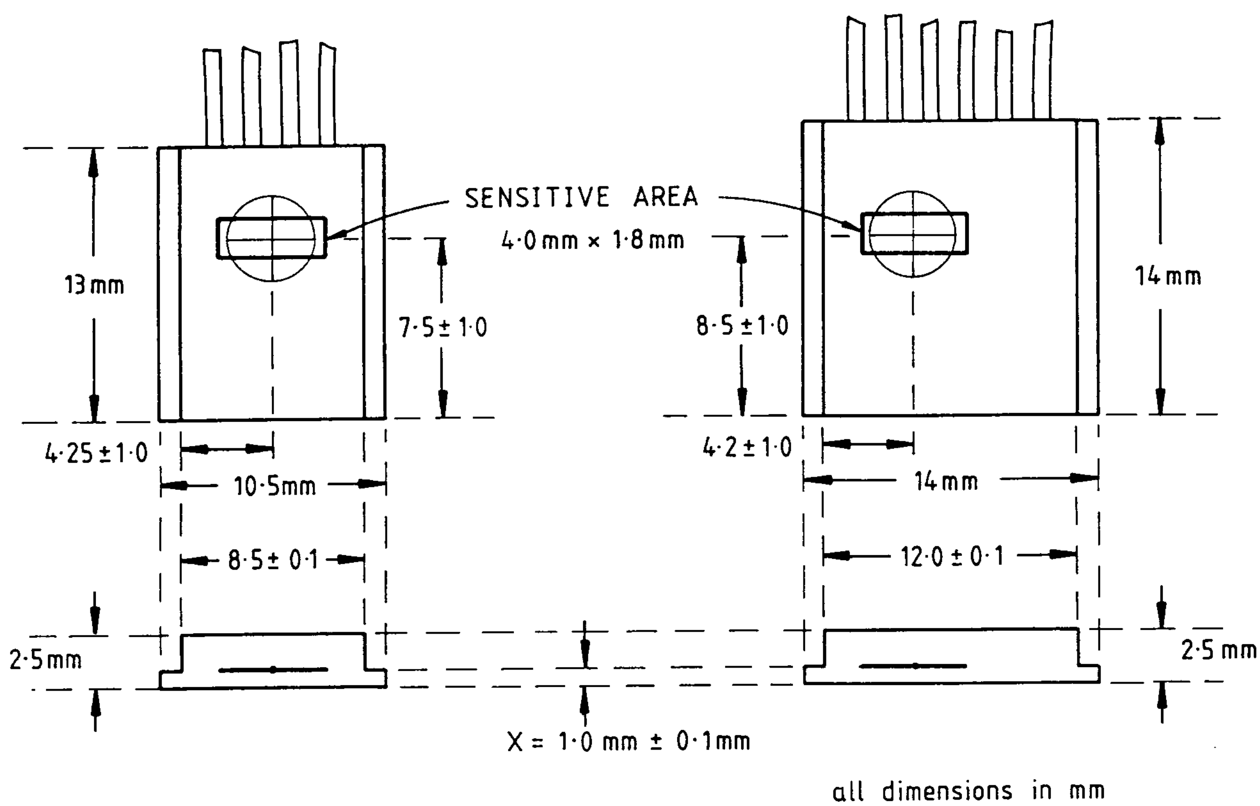
Keep the cable out of the way of foot traffic. Do not pinch the cable, or drop sharp or heavy objects on it. A severed cable cannot be re-joined without altering the probe's performance, and requires factory repair and re-calibration.

The probe can be fitted to a Group 3 probe holder, part no.17000049 for the LPT-130, part no.17000050 for the LPT-141. The holders protect probes and provide additional cable strain relief. Alternatively, the probe can be clamped using the machined detail in each side of the metal cap.

The probe will measure the component of the field which is normal to the flat surface of the probe case. The point of maximum sensitivity is marked by a target printed on the top of the probe case. A positive indication will be obtained when the magnetic field vector enters this side of the probe. The target represents the tail of the vector arrow. Magnetic field convention is that field lines are directed from an N pole to an S pole.

Fig. 6 gives the dimensions of the two styles of probe, and shows the position of the most sensitive point.

If the exact direction of the magnetic field is unknown, its magnitude can be measured by putting the DTM in the peak hold mode, and slowly rotating the probe. As the probe turns and the measured field rises and falls, its maximum value is held on the display. See section 4.4.2 page 4-4.



Dimension X is the distance from the rear ceramic surface to the sensitive element of the Hall probe. The center of the sensitive area is marked on the probe cap to a tolerance of ±0.3mm.

Fig. 6. Probe Dimensions.

4.3 READING THE FIELD VALUE

The field value is read directly off the display. A negative sign indicates that the field direction is opposite to that described insection 4.2. For maximum resolution, select the lowest range which will display the field value. See sections 4.1 and 4.4 for range selection instructions. If the field reading is greater than full-scale, the message "o'rAnGE" will be displayed. Change to a higher range until the message clears.

The field may be displayed in tesla or gauss, with the appropriate indicator showing the units in use. To change the units, see section 3.5 page 3-4.

4.4 DISPLAY MODES, USING THE FRONT PANEL KEYS

4.4.1 The Keys.

Two front panel keys are used to control the teslameter.
Changes of state occur as a key is released, not as it is depressed.

The MODE key, used on its own, rolls the instrument through the various operating modes in sequence: dc field, ac field, peak hold field, peak hold ac field, and probe temperature (DTM-141 only), as described in 4.4.2 below.

The RANGE key selects the range without changing the display mode.

The keys are pressed together to zero the display. The keys must be pressed close to simultaneously for zeroing to take place.

The same action is used to reset the display in the peak hold mode.

4.4.2 Operating Modes.

a. Field (dc) display.
   Four ranges, 0.3, 0.6, 1.2, and 3.0 tesla full-scale, are selected in sequence by pressing the RANGE key.
   Four range indicators show the range in use.
   The magnetic field measurement is displayed with up to seven digits.
   A minus sign is added to indicate reverse polarity fields.
   Press the keys together to zero the display. The display shows "ZEro".
   Field reading is filtered if selected by the internal switch - see p.3-4.

b. AC field measurement, ranges and zeroing as above.
   Shows the value of time-varying component of field.
   This mode is indicated by A appearing in the left-hand display character.

c. Peak hold display, ranges as above.
   Displays maximum field measurement taken, either polarity, since entering the mode, or since last reset.
   "HOLD" indicator shows peak hold mode is operating.
   If filtering is on, the filtered field value is held.
   Reset is performed by pressing both keys together.
   The peak value is also reset if the field polarity changes.

d. Peak ac measurement. Combination of b. and c. above.

e. Probe temperature display (DTM-141 only) in degrees celsius.

4.4.3 No Probe, Over-range, and Overflow Display Messages

a. No Probe.

The message "noProbE" is displayed if the Hall probe is disconnected from the instrument. While the message is visible, all key functions are disabled.

b. Over-range.

The message "o'rAnGE" appears when the DTM is displaying dc or ac field or is in peak hold, if the field measurement exceeds the instrument's input capacity.

To clear the over-range message, select a higher range or reduce the magnetic field at the probe, or both if necessary.

During over-range, all key operations are locked out, except for range selection.

c. Overflow.

The message "o'FLo" is displayed in dc or ac field modes, or in peak hold mode, if the computed value of the field reading exceeds the capacity of the display, that is, if the number to be displayed is outside the range ±99999.9.

In overflow, the instrument is not over-ranged, but rather the computed reading is too large to be displayed. However, if over-ranging occurs at the same time as overflow, then the over-range message is displayed preferentially.

The usual cause of overflow is a large calibration factor, scale factor, or offset entered through the IEEE-488 interface. See section 4.5.

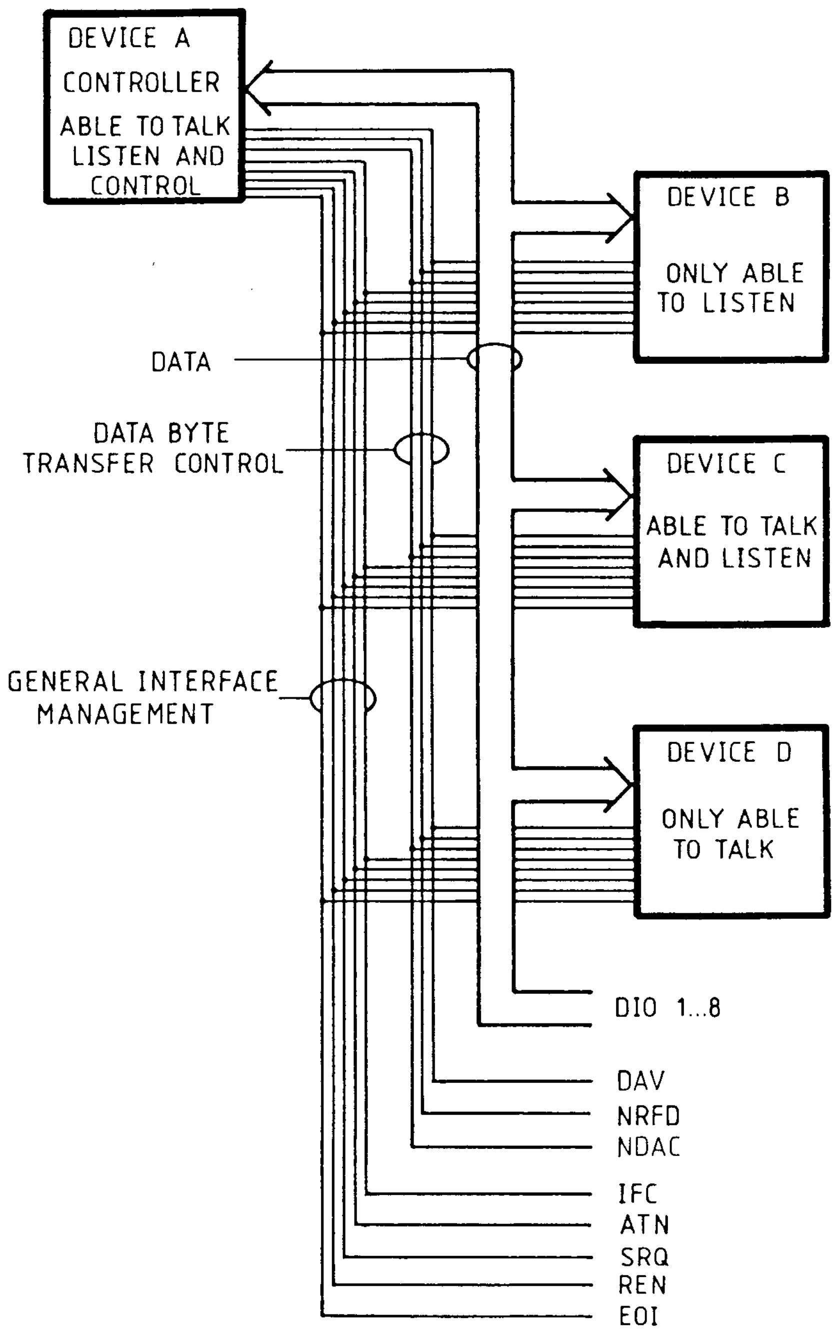


Fig. 5. A Typical GPIB System.

4.5 USING THE IEEE-488 GPIB INTERFACE

4.5.1 General Purpose Interface Bus - Overview

The IEEE-488 standard describes a means of communication to and from programmable instruments through a standard bus and associated protocol called the General Purpose Interface Bus (GPIB). Any instrument manufactured to this specification will be able to communicate on the bus. Up to 15 instruments may be connected on the bus at any one time, and they are considered to be listeners (able to receive data), talkers (able to transmit data) or controllers (able to control and configure the bus).

A typical GPIB setup is shown in Fig. 5. This system contains a controller and a selection of talkers and listeners. However, a wide range of system complexity is possible, from systems with just one talker-only and one listener-only and no controller, to systems including several controllers linked with many talker/listener devices.

The GPIB interconnection cable contains 16 signal lines in three groups:

a) 8 data lines
b) 3 handshake lines
c) 5 bus management lines.

All these lines connect to all the instruments on the bus. The logic sense on the actual bus wires is low true.

The 8 data lines allow bit-parallel, byte-serial data transmission between units on the bus. The data lines are used to send data from talkers to listeners, and to send data and commands from controllers to talkers and listeners.

The three handshake lines are: Data Valid - DAV
Not Ready For Data - NRFD
Not Data Accepted - NDAC.

NRFD is high (false) to indicate that all devices on the bus are ready for the next data transmission. If any device is not ready, it pulls NRFD low (asserted) which inhibits data transmission. When a talker is ready to send data it places the data on the 8 data lines and asserts the DAV line. As each listener on the bus accepts and reads the data, it removes its assertion of the NDAC line. Thus the NDAC line stays asserted until the slowest unit on the bus has accepted the data and releases the line. Now the talker can take the data off the bus which becomes available for the next transaction.

There can be only one System Controller on the bus. However the System Controller can pass control to another controller which is then called the active controller. It is the responsibility of the active controller to determine which device can next talk and which can listen. At any time there can be only one active talker, but as many active listeners as desired. The speed of data transmission between talker and listener will be limited by the speed of the slowest listener.

Each device on the bus is assigned a unique address in the range 0 to 30. The address is usually set by switches on the device. The switches may be located on the back panel or internally.

When the controller wishes to designate the talker and listeners for the next sequence of bus transmissions, it asserts the bus management line called Attention (ATN) and then sends the appropriate talker and listener address commands to assign the desired talker and listener(s) required for the next transaction. The controller then releases the ATN line, thus allowing the talker to start sending its data on the bus. The ATN line distinguishes commands from data. When a controller is about to set up such a transaction, it is normal practice first to send a single command which causes all devices to unlisten.

Devices which have not been addressed to listen simply ignore the data being sent and so have no effect on the transmission.

When configuring a system, the controller can send commands to the other devices in one of three ways:

a) a command can be sent by asserting one of the 5 bus management lines; for example, asserting the Interface Clear (IFC) line resets the bus to an idle state irrespective of bus activity at the time;

b) a command can be sent by asserting the ATN line and placing the command on the data lines; the command is read by every device on the bus, with normal handshaking, as described above; an example of this is the Device Clear command which resets all devices on the bus to their specific predefined device-dependant states;

c) a command can be sent to specific devices. First the controller sends the listen address command of the devices which are to receive the command. Then the command itself is sent, to be received only by the devices addressed to listen.

Command messages are sent on the data bus using 7-bit ASCII codes, and are distinguished from data messages by the state of the ATN line - ATN is asserted for commands. Command messages fall into four groups as shown in Table 4 below. The groups are the Primary Command Group, the Listen Address Group, the Talk Address Group, and the Secondary Command Group.

Address Commands

When the controller wants to make a device behave as a listener, it places the appropriate listen address command on the bus. The command is given by

listen address command = decimal 32 + device address.

For example, if the device address is decimal 18 (hex 12), then the decimal number 50 (hex 32, ASCII 2) is placed on the data lines as a binary coded 7-bit number, while the ATN line is held asserted. This causes the device whose address is decimal 18 to become a listener. In GPIB parlance, the device is said to be "selected". Any or all devices on the bus which have listener capability may be in the selected state simultaneously.

decimal value	hex value	ASCII character	GPIB mnemonic	description
			PCG	**Primary Command Group**
1	01	SOH	GTL	Go To Local
4	04	EOT	SDC	Selected Device Clear
5	05	ENQ	PPC	Parallel Poll Configure
8	08	BS	GET	Group Execute Trigger
9	09	HT	TCT	Take Control
17	11	DC1	LLO	Local Lockout
20	14	DC4	DCL	Device Clear
21	15	NAK	PPU	Parallel Poll Unconfigure
24	18	CAN	SPE	Serial Poll Enable
25	19	EM	SPD	Serial Poll Disable
			LAG	**Listen Address Group**
32-62	20-3E	sp thru >		Listen addresses 0 through 30
63	3F	?	UNL	Unlisten
			TAG	**Talk Address Group**
64-94	40-5E	@ thru ^		Talk Addresses 0 through 30
95	5F	underscore	UNT	Untalk
			SCG	**Secondary Command Group**
96-126	60-7E	' thru ~		Secondary Commands 0 through 30
96-111	60-6F	' thru o	PPE	Parallel Poll Enable (SC0 through SC15)
112	70	p	PPD	Parallel Poll Disable (SC16)
127	7F	DEL		ignored

Table 4. GPIB Command Codes.

When the controller wants to make a device into a talker, it places the device's talk address command on the bus. This command is given by

talk address command = decimal 64 + device address.

For example, a device whose address is decimal 18 has a talk address of decimal 82 (hex 52, ASCII R). At any time, only one device may be a talker.

To cause all listeners to stop listening, the controller sends the Unlisten command, decimal 63 (hex 3F, ASCII ?).

To stop the talker being a talker, the Untalk command is sent, i.e. decimal 95 (hex 5F, ASCII _).

Bus Management Lines

ATN Attention - asserted when the controller is sending commands. Not asserted while data is on the bus. Also used with EOI - see EOI below.

IFC Interface Clear - when asserted by the controller, all bus activity is unconditionally terminated and the System Controller regains active control if control has previously been passed to another controller. Any talkers or listeners are unaddressed.

REN Remote Enable - if asserted while a device listen address is on the bus, then the device will go into its remote mode.

EOI End Or Identify - dual function.
1) when output from a talker, indicates the end of a multi-byte message when asserted during transmission of the last byte.
2) during parallel polling, the controller asserts EOI and ATN simultaneously. This causes each device which has been configured for parallel poll to place its status on the appropriate status line.

SRQ Service Request - asserted by a device when it requires attention from the controller. The controller responds by servicing the device in an appropriate way. Often the service request is used to indicate that the device has data ready to be sent. The controller is not obliged to respond to the service request, but the device will hold the line asserted until it has been serviced.

Service Requests

Often GPIB compatible devices have the ability to generate a service request when they require some action on the part of the active controller. A service request is usually issued when the device has completed a task, or if an error condition has occurred. To request service, the device asserts the SRQ line. This usually causes an interrupt in the active controller, so it enters an interrupt service routine which services the event. In general, the service routine will take the following actions:

1) determine which device is requesting service (parallel poll)

2) ascertain the action required (serial poll)

3) execute the required action

4) re-enable interrupts

5) return to the task in hand before being interrupted.

The SRQ line is released by the device when the serial poll is performed.

Serial Polling

When a serial poll is done on a device, it causes the device to output a byte which indicates its status or condition. Each bit indicates the status of some device dependant parameter. Usually data line 7 reflects the status of the SRQ line.

Parallel Polling

The fastest way for the active controller to ascertain the status of several devices on the bus is to perform a parallel poll. The devices to be polled must have parallel poll capability and must have been previously configured by the controller. During a parallel poll each configured device responds by placing its status on its own designated bus data line. More than one device can respond on each data line.

The data line assigned to a device and the logic sense of the response is configured by a PPOLL CONFIGURE sequence, as follows:

1) the device is addressed to listen

2) the Parallel Poll Configure command PPC, hex 05, is sent

3) the Parallel Poll Enable code is sent. This code belongs to the Secondary Command Group, decimal 96 to 111. In this code bits 6 and 7 are always set. Bits 1, 2, and 3 carry a binary code to specify which of the 8 data lines the device will use to send its status, and bit 4 is used to determine the logic sense of the status. For example, if bits 1 through 4 were all 0, the device would place 0 on data line 1 during a parallel poll if its status response were in the affirmative.

4) the Unlisten command is sent

Now if the controller executes a parallel poll by asserting the ATN and EOI lines simultaneously, the configured device(s) respond as described above and the controller reads the data lines.

The parallel poll response can be disabled in two ways:

a) a Parallel Poll Unconfigure (PPU) command from the controller will cause all devices on the bus to ignore subsequent parallel polling. The devices are not addressed to listen before this command.

b) the PPC command followed by Parallel Poll Disable (PPD) will disable parallel polling only in devices which have been selected (addressed to listen).

Device Clear and Selected Device Clear

A device on the bus is cleared by sending a Device Clear Command. The device is then initialized to a pre-defined, device dependant state. There are two forms of this command; the Device Clear command (decimal 20) causes all devices on the bus to be cleared, whereas the Selected Device Clear command (decimal 4) clears only devices selected to listen.

Talker-Only Mode

If a device is set to be a talker-only, it will output data on the bus, using normal handshaking, whenever it has data to send. This mode is useful in simple systems where a talker-only is connected to one or more listener-only devices without the need for a controller. A talker-only cannot receive data and it cannot be programmed through the bus.

Listener-Only Mode

A listener-only can only receive data. It cannot be programmed through the bus, nor can it output data. For example, a printer as a listener-only will continuously print all data it receives.

For full details on the GPIB, see the IEEE standard 488-1978.

4.5.2 DTM-130-_G and DTM-141-_G GPIB Capability

The IEEE-488 Standard defines ten interface functions, some with as many as 28 allowable subsets. The DTM-130-_G and DTM-141-_G teslameters support the interface functions as listed below. See also Appendix C of the IEEE-488-1978 Standard.

SH1 source handshake capability

AH1 acceptor handshake capability

T5 talker (basic talker, serial poll, talk-only mode, unaddressed to talk if addressed to listen)

TE0 no address extension talker capability

L4 listener (basic listener, unaddressed to listen if addressed to talk)

LE0 no address extension listener capability

SR1 service request capability

RL0 no remote local capability

PP1 parallel poll capability (configured by controller)

DC1 device clear capability

DT1 device trigger capability

C0 no controller capability

In general, the teslameter may act as a listener to receive commands from a system controller, and as a talker to send field readings and other responses to the controller and other listening devices in the bus system.

The teslameter may be set by means of an internal switch to act as a talker-only. See page 3-4. This mode is used in systems which have no system controller, in which the teslameter continuously sends field readings on the bus to listener-only devices, for example printers, terminals, or the Group 3 COM-488 GPIB to Serial Adaptor which converts the bus traffic to serial data format.

The teslameter responds to the following command messages on the bus. This is a subset of the complete repertoire of bus commands given earlier.

decimal value	hex value	ASCII character	GPIB mnemonic	description
4	04	EOT	SDC	Selected Device Clear
5	05	ENQ	PPC	Parallel Poll Configure
8	08	BS	GET	Group Execute Trigger
20	14	DC4	DCL	Device Clear
21	15	NAK	PPU	Parallel Poll Unconfigure
24	18	CAN	SPE	Serial Poll Enable
25	19	EM	SPD	Serial Poll Disable
32-62	20-3E	sp thru >		Listen addresses 0 through 30
63	3F	?	UNL	Unlisten
64-94	40-5E	@ thru ^		Talk Addresses 0 through 30
95	5F	underscore	UNT	Untalk
96-111	60-6F	' thru o	PPE	Parallel Poll Enable (SC0 through SC15)
112	70	p	PPD	Parallel Poll Disable (SC16)

Table 5. Teslameter GPIB Command Codes.

The Device Clear and Selected Device Clear commands perform device specific functions. In the teslameter these commands cause the following to occur:

a) normal field display selected
b) 3 tesla range selected if 4 range teslameter
c) peak hold value reset
d) triggered mode cancelled
e) GPIB I/O buffers cleared
f) GPIB software reinitialized
g) serial poll byte and SRQ cleared
h) parallel poll unconfigured

4.5.3 DTM Commands

In addition to the GPIB commands listed in the previous section, the teslameter responds to a set of DTM commands which are listed in Table 6 below. These commands are in the form of ASCII coded data which are sent to the teslameter by the system controller on the bus. Note that DTM commands are data as far as the bus is concerned and are not to be confused with GPIB commands. The distinguishing feature is that with GPIB commands the controller asserts the ATN line.

The commands are in the form of one to three characters, in some cases followed by a decimal number represented by n in the table. If no number is entered where one is expected, the command is ignored.

If an error message is returned, the command must be re-entered.

The default values apply after system reset command CTRL X or if switch S2-8 has been switched ON. The processor automatically executes a reset if the memory back-up has failed after more than 30 days without power applied.

For switch-selectable defaults, see Table 2, page 3-4.

Commands involving temperature apply to the DTM-141-_G series only.

Table 6. DTM Commands.

command	description
B<text>	Displays ASCII text on DTM display; 7 characters maximum.
B	Cancel text mode, return to normal display.
Cn	Calibrate - calls up the calibrate function and defines the current field measurement as equal to the entered value n. This command applies to the selected range only. Separate calibration factors are stored for each range. Default: field measurement not modified (calibration factor = 1).
D0	Turns OFF digital filtering.
D1	Turns ON digital filtering. Default set by S2-7.
EC	Erase calibration - sets calibration factor to 1 on current range.
EL	Erase scale factor - sets scale factor to 1 (all ranges).
EO	Erase offset - sets offset to 0 (all ranges).
EP	Erase (reset) peak hold field value.
EZ	Erase zero - cancels zero correction on current range.
F	Field reading - requests a field reading from the DTM.

GA General function AC - puts DTM in ac field measurement mode.

GD General function DC - puts DTM in dc field measurement mode.

GC General function Continuous - DTM measures continuously.

GV General function Triggered - DTM measures only when triggered by V.

IC Inspect calibration factor -
returns calibration factor as mantissa and exponent.

ID Inspect digital filtering status - returns 0 for OFF, 1 for ON.

IG Inspect general function - returns two letters:
D for dc field mode or A for ac mode, followed by
C for continuous or V for triggered measurements.

IJ Inspect filter factor - returns filter factor as mantissa and exponent.

IK Inspect sampling interval - returns interval in seconds between output field readings in SM1 mode (see below).
0 implies readings sent at maximum rate.

IL Inspect scale factor - returns current scale factor.

IN Inspect display mode - returns H for hold display
N for normal field display
T for temperature display

IO Inspect offset - returns current value of offset.

IR Inspect range - returns 0 for 0.3 tesla range
1 for 0.6 tesla range
2 for 1.2 tesla range
3 for 3.0 tesla range

IY Inspect window - returns current value of window within which digital filtering operates.

IZ Inspect zero - returns current zeroing offset added to field values.

Jn Filter factor - enters filter factor n. Default n =
n = 0 or 1, no filtering
n > 1, filtering more severe as n increases, max. 65534.
0 < n < 1, reading overshoots.

Kn Sampling interval - enters interval between output field values in SM1 mode (see below).
Default n = 0, every reading sent, rate is 2.34 samples/second;
n = any integer, time in seconds between output field values
maximum n = 65534 (approx. 18 hours).

Ln Scale - computes a scale factor to make the field reading equal to the entered value n. The one scale factor applies to all ranges. The computed scale factor may be in the range -9.9999 to 9.9999. Default: field measurement not modified (scale factor = 1).

NH Display mode: hold - DTM display shows peak dc or ac field.

NN Display mode: normal - DTM display shows field value.

NT Display mode: temperature - DTM display shows temperature.

On Offset - calls up offset mode and enters offset which is added to all field readings. Default = 0. n in range -79999.9 to +79999.9. The one offset applies to all ranges.

P Peak hold field - requests a peak field reading from the DTM.

Q Test DTM front panel display.

R0 Range selection, selects 0.3 tesla range.
R1 Range selection, selects 0.6 tesla range.
R2 Range selection, selects 1.2 tesla range.
R3 Range selection, selects 3.0 tesla range.
Default is 3.0 tesla range or range of single range probe.

SCn Set calibrate - enters calibration factor n for the selected range; similar to Cn, but enters factor rather than desired field reading. Default n = 1.

SE0 Turns OFF EOI line assertion when string terminator is sent.
SE1 Turns ON EOI line assertion when string terminator is sent.
Default set by S2-2.

SLn Set scale - enters scale factor n for all ranges; similar to Ln, but enters factor rather than desired field reading. Default n = 1.

SM0 Send mode: field readings sent when requested by F command only.
SM1 Send mode: field readings sent at intervals defined by Kn command.

SS0 Turns OFF service request line assertion when data is available.
SS1 Turns ON service request line assertion when data is available.
Default set by S2-1.

SU0 Turns OFF units symbol sent after field and temperature readings.
SU1 Turns ON units symbol sent after field and temperature readings.
Default set by S2-6.

SZn Set zero - enters zero offset n for the selected range; useful when the DTM must be zeroed but using Z command is inconvenient; the correct zeroing offset must be known; can be obtained after Z command by using IZ, and should be noted for future use with SZ.

T	Temperature reading - requests a temperature reading from the DTM.
UFG	Units: field values displayed and sent in gauss)) default set by S2-5
UFT	Units: field values displayed and sent in tesla)
V	Triggers field measurement after triggered operation selected by GV.
WA	Raw field - returns uncalibrated field reading direct from the ADC.
WE	Returns raw field after DTM internal calibration has been applied.
WZ	As WE, but field reading has user-entered zero offset applied.
Yn	Window - enters n = window within which digital filtering occurs. Default 10 gauss. Maximum n = 65534.
Z	Zeroing - calls up zeroing mode and defines current field reading as zero for selected range only. The ranges are individually zeroed. Default sets zeroing offset to zero.
CTRL D	returns a 16-bit binary number representing the states of the 16 DIP switches, 0 = OFF, 1 = ON; once the command has been given, changing the switches does not alter the DTM operating mode until some other command is sent.
CTRL U	restarts operating software as if DTM had been freshly powered up.
CTRL X	System reset - all default values reinstated. The message RESET is returned.

Table 6. DTM Commands.

4.5.4 DTM Error Messages

The following error messages are returned to the controller as a result of bad command entries:

"INVALID COMMAND ENTRY" indicates that the command entered did not fit the specifications in Table 6, or is not relevant to the teslameter model.

"NUMBER TOO BIG" indicates that the number entered in a command was too big.

"POSITIVE NUMBER REQUIRED" indicates erroneous entry of minus sign.

"DIVIDE BY ZERO" indicates that a calibration was attempted while the raw field value was zero.

"FIXED RANGE PROBE" indicates that an attempt was made to change the range when a single range probe was connected to the DTM.

The messages "NO PROBE", "OVERFLOW", and "OVER RANGE" duplicate the functions of these messages on the DTM display.

4.5.5 GPIB Handshaking

Once a handshake sequence has begun on the bus it should always be allowed to finish in a normal fashion. If it is stopped part way through by an asynchronous bus take-over, then an IFC uniline command should be issued before another handshake sequence is initiated. If the second handshake starts with ATN false before the IFC, while the teslameter is in the listener state, the device will not read from the bus correctly and will have to be reset. When the controller performs a serial poll on the teslameter, it must ensure completion of the handshake for the status byte. If it does not do this the device's ability to function as a talker is adversely affected until such time as the controller places the teslameter into the SPAS (serial poll active state) and completes the handshake for the serial poll status byte.

4.5.6 Serial Poll

A serial poll is performed on a device, in this case a teslameter, for two reasons:

a) to check on its status by decoding the byte output in response to the serial poll

b) to reset the SRQ line.

In systems employing interrupts (SRQ function is enabled), the serial poll will usually be performed after a parallel poll has indicated which device issued the SRQ.

Performing the serial poll will immediately reset the SRQ line. Data must be read from the teslameter by the bus before the device is able to assert the SRQ line again.

The status byte from the teslameter in response to the serial poll has 2 bits assigned to indicate its status:

a) the least significant bit, which appears on bus line DIO1, indicates that the device has data available if asserted

b) the next to most significant bit, on line DIO7, reflects the status of the SRQ line.

The status bit in the serial poll response will always be asserted if there is data available to be read. The SRQ bit is reset to the false state after the serial poll, and is only re-enabled when data is read from the teslameter.

4.6 DIGITAL FILTERING

The digital teslameter software includes a digital filtering algorithm which may be invoked by an internal switch or by remote command. See pages 3-4 and 4-13. Filtering is useful for smoothing out small fluctuations in the field reading.

In order to speed up the response to large field changes when filtering is on, a window can be set to define a band about the current displayed field value. Filtering will only occur while the unfiltered field value remains within the window. If the field value changes rapidly enough, the filtered field reading will not be able to follow fast enough to keep the unfiltered value within the window, and filtering is temporarily disabled. This allows the field reading to follow large rapid field changes, while providing good filtering of constant or slowly varying fields.

The window width can be set using the Y command. See page 4-16. The value entered is the half-window on either side of the current field reading. The default value on system reset is 10 gauss, for a total window width of 20 gauss.

The digital filter takes the field readings before processing by zero, calibrate, offset, and scale functions, and filters the values by performing the following computation:

$$F(new) = F(old) + \frac{F - F(old)}{J},$$

where F(old) is the previous field reading display
F(new) is the updated field reading display
F is the most recent unfiltered field reading
J is the filter factor.

The effective time constant of the filter is dependent upon both the rate at which field measurements are made and the value of J, according to the formula:

$$T = P/\{\ln[J/(J-1)]\}$$

where T is the filter time constant
and P is the period between field measurements.

Field measurements are made at a fixed rate of 10 per second, so P = 0.1. A default value of 41 for J is effective when the DTM is reset with the CTRL X command or S2-8. This gives an effective time constant of 4 seconds. The filter time constant may be changed by entering a new value of J using the Jn command. See page 4-14.

4.7 TRIGGERED OPERATION

Triggering allows one or more teslameters to make synchronized field measurements on demand.

The teslameter is set for triggered operation by entering the command GV.

Once the GV command has been entered, there are two ways of triggering a field measurement:

1) send the GPIB Group Execute Trigger (GET) command. This invokes the device trigger capability of the teslameter's GPIB interface, and is implemented by placing the GET code (decimal 8) on the data lines and asserting the ATN line.

2) enter the command V, as follows:

a) address as listeners all the teslameters which are to be triggered

b) send the teslameter command V. As with all other teslameter commands, the V is sent as ASCII data on the bus without the ATN line asserted.

The two triggering methods produce identical results, except that the GET command triggers all teslameters which have been set for triggering by GV, while V triggers only those units which have been addressed to listen.

The new measurement will immediately appear on the teslameter display, and can be read out via the bus by entering the F command. Alternatively, if the teslameter is set for continuous transmission with the SM1 command after being set for triggered operation, then following V or GET the device will issue a service request (if service request is enabled). The device can then be parallel polled and the field value read without needing the controller to send the F command.

The following sections describe details of triggered operation.

4.7.1 Digital filtering with triggered operation

If filtering is ON, then each time a measurement is triggered the filtering algorithm will calculate a new field value for display and transmission, as described in section 4.6.

The effective time-constant will depend on the timing of the V commands.

If the field values obtained on triggering are required to reflect only the field at the time of triggering and not contain any history, then filtering should be turned OFF.

4.7.2 Triggered operation timing

The teslameter stores a new field value zero to 10ms after the V is received.

After storing, computations are done, taking about 100ms.

The new field value is ready for transmission no later than 120ms after the V.

Do not request transmission of the value (using F) sooner than 120 ms after the V command, or the old field value may be transmitted.

4.7.3 When the trigger command is ignored

The trigger command is ignored by teslameters which have not been initialized for triggering by the GV command.

The trigger command is ignored by teslameters which have been initialized for triggering, if the command is received while the device is still in the process of making a measurement in response to a previous trigger command.

4.7.4 Zeroing while in triggered mode

If the teslameter is zeroed, either with the keys or by remote command, while in the triggered mode, a new zero offset will be calculated and stored, using the last field measurement made. The effect of the zero operation will be reflected in the next field measurement, when the trigger command is given.

To ensure the most accurate zero, it is best to place the teslameter in continuous mode with filtering on, allow time for the display to settle, then give the zero command.

The unit will zero correctly in triggered mode if first the trigger command is given while the probe is in zero field with filtering off; then the Z command (or pressing both keys together) will zero the instrument.

GROUP 3 TECHNOLOGY LTD

LIMITED WARRANTY

Group 3 Technology Ltd. (hereinafter called the Company) warrants instruments and other products of its manufacture to be free from defects in materials and workmanship that adversely affect the product's normal functioning under normal use and service for a period of one year from the date of shipment to the purchaser.

The obligation of this warranty shall be limited to repairing or replacing, at the discretion of the Company and without charge, any equipment which the Company agrees is defective as set out above within its warranty period.

The Company will reimburse lowest freight rate two-way charges on any item returned to the Company's factory or any authorized distributor or service center, provided that prior written authorization for such return has been given by the Company.

This warranty shall not apply to any equipment which the Company determines to have become defective owing to mishandling, improper installation, alteration, negligence, inadequate maintenance, incorrect use, exposure to environmental conditions exceeding specifications, or any other circumstance not generally acceptable for equipment of a similar type.

The Company reserves the right to make changes in design without incurring any obligation to modify previously manufactured units.

No other warranties are expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The Company is not liable for consequential damages.