Black Star

4503
INTELLIGENT MULTIMETER

Instruction Manual

CORRECTIONS

P11 CLEAR. Delete section f)

P12 Add new paragraph

FILTER

The filter function provides an averaging filter with a time constant of approx 3 seconds. Select the function by pressing SHIFT then FILT.

SPECIFICATION

DC VOLTAGE

Range	Resolution	Accuracy
.2V	10uV	±0.03% rdg ±0.01% fs
2V	100uV	±0.03% rdg ±0.01% fs
20V	1mV	±0.03% rdg ±0.01% fs
200V	10mV	±0.03% rdg ±0.01% fs
2000V	100mV	±0.05% rdg ±0.01% fs

Maximum permissible input voltage: 1000V DC (.2V range 1000V DC 5 sec.)
Input impedance: 10MΩ ±0.25%
Normal mode rejection ratio: 60dB @ 50Hz
Common mode rejection ratio: 100dB @ 50Hz with 1kΩ imbalance

DC CURRENT

Range	Resolution	Accuracy	Voltage Burden	Max. Input
2mA	100nA	±0.1% rdg ±0.02% fs	10uV/count	0.5A (fused)
200mA	10uA	±0.15% rdg ±0.02%fs	10uV/count	0.5A (fused)
10A	1mA	±1% rdg ±0.02% fs	<15uV/count	20A (10 sec.)

AC VOLTAGE TRUE RMS

Range	Resolution	Accuracy (>10% fs)		
		45Hz-400Hz	400Hz-5kHz	5kHz-20kHz
.2V	10uV	±0.5% rdg ±0.1% fs	±1% rdg ±0.1% fs	±3% rdg ±0.1% fs
2V	100uV	±0.5% rdg ±0.1% fs	±1% rdg ±0.1% fs	±5% rdg ±0.1% fs
20V	1mV	±0.5% rdg ±0.1% fs	±2% rdg ±0.1% fs	±5% rdg ±0.1% fs
200V	10mV	±0.5% rdg ±0.1% fs	±2% rdg ±0.1% fs	±5% rdg ±0.1% fs
2000V	100mV	±1% rdg ±0.1% fs	±7% rdg ±0.1% fs	±15% rdg ±0.1% fs

Accuracy for .2V range at low levels:

Level	Max. Frequency for <1% Error	Max. Frequency for <10% Error
10mV	6kHz	15kHz
3mV	1kHz	8kHz
1mV	250Hz	2kHz

Maximum permissible input voltage: 750V AC (.2V range 1000V pk 10 sec.), 10^6VxHz
Common mode rejection ratio: 40 dB @ 50Hz with 1kΩ imbalance
Crest Factor: <5 @ fs for <3% increase in error

AC CURRENT TRUE RMS

Range	Resolution	Accuracy 45Hz-1kHz	Voltage Burden	Max. Input
2mA	100nA	±0.5% rdg ± 0.1% fs	10uV count	0.5A (fused)
200mA	10uA	±0.5% rdg ± 0.1% fs	10uV count	0.5A (fused)
10A	1mA	±1.5% rdg ± 0.1% fs	<15uV count	20A (10 sec.)

Crest Factor: <2 @ fs for <2% increase in error

RESISTANCE

Range	Resolution	Accuracy	Excitation Current
.2kΩ	10mΩ	±0.1% rdg ±0.02% fs	0.5mA
2kΩ	100mΩ	±0.1% rdg ±0.02% fs	0.1mA
20kΩ	1Ω	±0.1% rdg ±0.02% fs	10uA
200kΩ	10Ω	±0.15% rdg ±0.02% fs	1uA
2000kΩ	100Ω	±0.3% rdg ±0.03% fs	100nA
20MΩ	1kΩ	±1% rdg ±0.04% fs	100nA

Maximum permissible input voltage: 370V pk
Full scale voltage: 20MΩ 800mV; all other ranges 200mV

AUTORANGING CAPABILITY

Autoranging on all voltage and resistance ranges and 2mA/200mA (AC and DC) current ranges.

OTHER FUNCTIONS

NULL	Removes residual offset on DC voltage and resistance ranges
HOLD	Display hold
CONTINUITY	Audible continuity test
DIODE TEST	Diode forward voltage measured with excitation current 1mA, 1Vfs
FILTER	Averaging noise reduction filter
dB	Calculation error ± 0.02dB. User selectable reference impedance
DATA LOGGER	250 reading logger. User settable sample interval
% DEVIATION	Deviation in % from user selected nominal reference value
Ax + b	Scale and offset measurement. User selected scale factor and offset
REL	Allows user to make relative measurements

CALIBRATION

Closed case, fully automatic, via IEEE-488 or RS232 (except AC frequency response).

INTERFACING

Full IEEE-488/GP-IB talker/listener. Also RS232. Interfaces built-in.

IEEE-488/GP-IB SUBSET IMPLEMENTION

SH1	Source handshake — complete capability
AH1	Acceptor handshake — complete capability
T5	Basic talker + serial poll + talk only mode + unaddress if MLA
TE0	Extended talker — no capability
L4	Basic listener + unaddress if MTA
LE0	Extended listener — no capability
SR1	Service request — complete capability
RL1	Remote/local — complete capability
PP2	Parallel poll — remote configuration
DC1	Device clear — complete capability
DT0	Device trigger — no capability
C0	Not a controller

CONTROLLABLE FUNCTIONS

All ranges and functions (except 10A AC and DC) are settable and controllable via the built-in IEEE-488/GP-IB and RS232 interfaces. The string terminator may be selected, and the conditions under which an IEEE-488/GP-IB service request is initiated. Serial and parallel polling are supported. Instrument status, error messages and readings may be requested.

GENERAL

The accuracy specifications apply over a temperature of 18°C to 22°C typically for 1 year.
Accuracy Temperature Coefficient: Typically <0.1 x applicable accuracy spec. per °C (10°C to 18°C, 22°C to 35°C)
Maximum Common Mode Input Voltage: 500V DC or peak AC.
Mains Input Voltage: 220/240V (110V set internally) ± 10%
Display: 13mm LED, 6 digit
Scale Length: 4 ½ digit,.20999 counts max. Polarity: Automatic
Reading Rate: 3 per sec. Zero: automatic
Operating Temperature Range: 5°C to 40°C, 10% to 80% RH.
Supplied Accessories: Built-in IEEE-488/GP-IB and RS232 Interfaces, Instruction Manual, Spare Fuse, Test Lead Set.
Optional Accessories: Service Manual, Carry Case
Size: 219mm x 240mm x 98mm (product only) Weight: 2.3kg (product only) 2.6kg (packed)
300mm x 300mm x 116mm (packed)

Black Star reserve the right to alter specifications without notice

WARNING

THIS INSTRUMENT IS MAINS OPERATED. POTENTIALLY LETHAL VOLTAGES ARE PRESENT INSIDE THE CASE. BEFORE OPENING THE CASE, DISCONNECT THE SUPPLY BY REMOVING THE MAINS CABLE FROM THE REAR PANEL SOCKET.

N.B. THIS INSTRUMENT MUST BE EARTHED

INTRODUCTION

The Black Star 4503 is a 4½ digit auto-ranging digital multimeter with computing functions, and RS232/GP-IB systems capability built in.

Basic features include:
± 20999 counts scale length.
10uV, 10nA, 10mOhm sensitivity.
DC Volts, True-RMS AC Volts, DC Current, True-RMS AC Current, Ohms measurement, continuity check capability, and diode test.
Basic accuracy = 0.03%
Computing functions comprise:
dB, data logger (250 point with programmable timing), percentage deviation, Ax + b, multirange null, relative function, display hold, closed-case automatic calibration (via keyboard, RS232 or GP-IB).

SAFETY

The 4503 is protected against measurement overload, up to 1000V pk on voltage measurement, 370V pk on resistance, and 500mA pk on current ranges except 10A (max 20A, 10secs). Care should be taken when making measurements in high voltage and/or high energy circuits. In high voltage circuits, the circuit power should be removed, all voltages should be allowed to die away, then the correct instrument range and function should be selected and suitably insulated test probes should be applied to the measurement point. Power should then be re-applied, and the measurement results noted. Power should be removed BEFORE disconnecting the test leads. The test leads should never be removed from the instrument when high voltage measurements are being made. Note that if the instrument is used to measure current in a mains transformer primary winding, and if the secondary is unloaded, then removal of the test leads while power is applied may cause a hazardous high voltage transient. There are other circumstances under which hazardous voltages can be generated, and it is the responsibility of the user to ensure that suitable precautions are observed.

INSTALLATION

The instrument is fitted with an IEC mains connector, and is operated from either 220-240V 50Hz, or 110-120V 60Hz mains. The voltage to which the instrument is set is marked on the rear panel, and should be checked before power is applied.

The power on-off switch is located on the rear panel of the instrument. At switch on, the display shows all segments, followed by the software revision level, followed by IEEEnn where nn is the currently selected GP-IB address (selected by rear panel switch).

DEMONSTRATION SOFTWARE

The 4503 is supplied with 5¼" 360K floppy disk (for use with IBM and 100% compatible PC's) containing RS232 demonstration software.

DISPLAY

The display is a 6 digit LED display, with a maximum displayed count of ±99999.

The LED annunciators are grouped according to function:

There are two groups to the right of the main display — the upper group indicates GP-IB status, comprising TALK, LISTEN, and REMote operation. The lower group indicate the selected instrument function which can be one of ACV, DCV, ACmA, DCmA, ACA, DCA, KOhms, MOhms. AUTOranging is also indicated here.

The row of LEDS above the function/range buttons indicate the status of the corresponding computing function, thus the LED above the V function button indicates the status (running or not) of the FILTER function; the LED above the 20 range button is associated with the percentage deviation function, etc.

The two remaining LEDs in the top left of the display are REL on/off, and display HOLD on/off.

Negative indication

When a negative DC voltage or current is measured, the display will show a negative sign on the left hand side. No polarity indicator is displayed on positive.

MANUAL OPERATION

Manual measurements are performed by selecting the appropriate function (V, A, Ohms, AC), then selecting a range higher than the input to be measured. The range may also be selected by pressing the button marked AUTO. The selected function is indicated by the LED annunciators to the right of the main display, while the range is indicated by the position of the decimal point — note that the decimal point may be moved by some of the calculating functions. Under those circumstances, there is no direct way to tell which range is selected.

Caution

a) Do not raise the common socket more than 500V DC or pk AC above ground. Ensure that transient voltages cannot occur which violate this requirement.
b) Read the safety notes.
c) Do not exceed the rated maximum input values (see above).

OVERRANGE INDICATION

In the event of ADC overrange (± 20999 counts), the display will show 'OR'. If a computing function is used which causes the display to overrange (± 99999 counts), the display will show 'OFL'.

DC VOLTAGE MEASUREMENT

a) Connect the test leads to the VΩ and COM input terminals of the 4503, observing the polarity.
b) Select the DCV function (select V, and if the AC annunciator is on, press AC to toggle it to off).
c) Select a range consistent with the expected voltage. For automatic range selection, press the AUTO button.

Note

To prolong instrument life, manual ranging is recommended for routine measurements above 100V.

d) Connect the test leads to the source. If the positive terminal of the source is connected to the COM terminal of the instrument, the display will show a negative value. If the negative source terminal is connected to the instrument COM terminal, a positive reading will be displayed.
e) Observe the display; if the 'OR' message is shown, select a higher range until a normal display is shown, or select AUTO.
f) Take the reading from the display.

Note

In order to ensure full accuracy on 200mV and 200Ohms, residual offsets should be removed either by using the NULL function (see later), or by using the REL function as follows:

1. Short input high and COM test leads together.
2. Wait until the displayed reading stabilises.
3. Press the REL button.

TRUE-RMS AC VOLTAGE MEASUREMENT

The 4503 can make TRMS measurements between 10uV and 750V. To measure ACV, proceed as follows:

a) Connect the test leads to the VΩ and COM input terminals of the 4503.
b) Select the ACV function (select V, and if the AC annunciator is off, press AC to toggle it to on).
c) Select a range consistent with the expected voltage. For automatic range selection, press the AUTO button.
d) Connect the test leads to the source.

Note

There is a small amount of offset (typically less than 10 digits) when using AC. Do not REL this level out. It is caused by a combination of residual circuit noise, and DC offset in the RMS converter, but is small compared to the signal to be measured, and the calibration procedure takes it into account, ensuring good accuracy at levels greater than 10% of full scale. Below 10% of full scale, residual errors will cause inaccuracy.

e) Observe the display; if the 'OR' message is shown, select a higher range until a normal display is shown, or select AUTO.
f) Take the reading from the display.

CURRENT MEASUREMENTS (TRMS AC, DC)

The 4503 can make TRMS or DC measurements between 10nA and 10A (20A pk for 10 secs).

For measurements between 210mA and 20A:

a) Connect the test leads to the 10A and the COM socket of the instrument. Ensure that the test leads used are adequately rated to handle the current to be measured, and that they are as short as possible to minimise volt drops. If measuring high AC currents, twist the leads to reduce external induced fields.

b) Select the 10A range (autoranging is not possible on 10A). Note that when 10A is selected, the message '10A' appears on the display. When an input has been applied, if the range is changed, the numeric displayed value will remain the same, but the decimal point will move as dictated by the selected range — this will lead to erroneous readings, so care is required to ensure that 10A is only selected when the input is applied to the 10A socket. If the input is applied to the A socket, and 10A is selected on the switches, an erroneous reading will again be obtained.

Note

Ensure that the 10A range is selected when the input is applied to the 10A socket, and that the 10A range is NOT selected when the input is applied to the A socket. Note also that attempting to select a 2000mA range (invalid), will result in the 10A range being selected.

For measurements below 210mA:

a) Connect the test leads to the 'A' socket, and the COM socket of the instrument.
b) Select the ACA or DCA function.
c) Select a range consistent with the expected voltage. For automatic range selection, press the AUTO button.
d) Connect the test leads to the source.
e) Note that only 2mA and 200mA ranges are provided. If the .2mA range is selected, the instrument goes to the 2mA range. If the 20mA range is selected, the instrument goes to the 200mA range.
f) The 2mA and 200mA ranges are protected by the rear panel 500mA quick-blow fuse.

Note

The TRMS measurements are AC-coupled, so it is not possible to measure a combined DC + AC waveform. If this must be done, the AC component may be measured using the AC function, then the DC component may be measured using the DC function, and an RMS sum may be calculated thus:- if the ac = the AC voltage or current, the dc = the dc voltage or current, then the TRMS voltage or current = SQR(ac * ac + dc * dc) where SQR means 'square root of'.

FRONT PANEL PROGRAMMABLE FUNCTIONS

Note that the calculating functions can only be accessed via the front panel — they cannot be set up via the RS232 or GP-IB interfaces. The data logger cannot be set up via the interfaces, but the data may be recalled.

DATA ENTRY

The programmable functions are dB, data logger, percent deviation, Ax + b and keyboard calibration. These functions are grouped together because they all require input of numeric constants.

The keys used for entry of numeric constants are the function and range keys, and the key marked 'SHIFT' and ' + / − '. These keys together with the 'STORE' 'RECALL', 'ENTER', and 'CANCEL' keys are used in order to use the programmable functions.

The 'SHIFT' key allows access to the shifted functions, which are (reading left to right on the front panel): NULL, CONTinuity, DIODE TEST, FILTER, dB, DATA LOGGER, % DEV, AX + b, CAL, CLEAR, LOCAL.

The basic procedure for entering a numeric constant is used in all programs, so need only be learned once. It will be illustrated by means of the dB function.

To enter reference impedance for dB function:

Press the key marked 'SHIFT' (also marked ' + / − '). The LED above the key (the 'SHIFT' LED) will start to flash. This indicates that the next key pressed will give a shifted function, rather than a normal function, so if the '.2' range key is pressed, the shifted function above the key, in this case dB, will be selected. The message 'REF = ' will appear briefly, then the currently selected reference impedance (in Ohms) will appear, with the first character flashing. If the user wishes to change the value, a new number can be entered using the function and range keys which also double as numeric entry keys. As each digit is entered, the flashing prompt moves along, wrapping round to the start when it reaches the end. When the entered value is correct, the 'ENTER' key is pressed to accept the entry and run the program, or 'CANCEL' may be pressed to cancel the function.

Thus after editing the number, either 'ENTER' is pressed to accept the entry and run the program, or 'CANCEL' is pressed to throw the entry away, and to exit with the program not running.

dB FUNCTION

dB measurements are displayed with a resolution which varies with input between 1dB and 0.01dB.

On a Voltage range, the equation used to calculate dB is:

$$dB = 20 * LOG(Vin / Vref)$$

At small counts, each digit of change in Vin will correspond to a large change in the calculated dB value, so as the input voltage drops, the resolution of the dis-

played result is reduced, so that when Vin is almost zero, the displayed result changes in 1dB steps. As the input increases, the displayed resolution changes to 0.1dB, then to 0.01dB.

Vref is the voltage which when applied across Rref, will give a dissipation of 1mWatt, e.g. if Rref = 600 Ohms, the corresponding Vref will be 0.775V since 0.775V across 600 Ohms gives a dissipation of 1mW. The reference value entered in the dB function is always a reference impedance, and defaults to 600 Ohms (giving the function normally referred to as dBm).

Note that the 'REL' key may be used to further change the reference value as follows:

Apply the voltage (or current) which is to be the new 0dB reference, then press the 'REL' key to obtain a reading of 0dB. Further measurements will be made relative to the new reference value.

DATA LOGGER

The data logger is capable of holding 250 readings, with programmable time between samples. To use the logger, proceed as follows:

Entry of logging period:

Press the SHIFT key, giving a flashing SHIFT LED, then press the key marked 'DATA LOGGER'. This will elicit a brief 'PER =' (logger sample period =) message, followed by the currently selected period in seconds. The period can be set to give automatic logging at either 3 readings per sec, or any sample rate which is a whole number of seconds e.g. an entry of 0005 will cause logging every 5 seconds. An entry of 0000 will cause logging at 3 samples per sec, and an entry of −0001 will cause manual logging whereby a sample is stored every time the STORE key is pressed, and no automatic sampling takes place. Note that even when sampling automatically, a manual sample will still occur if STORE is pressed. If the sampling is manual, or if the sample period is slower than once every 5 secs, a message of the form 'ST nnn' is displayed on each sample, where nnn is the current store number (000 - 249).

When the data logger memory is full, i.e. 250 samples have been taken, the front panel display will periodically display the message 'FULL'.

Note that if the power is cycled, the logger continues to run, but will take a sample immediately following power-up.

Data may be recalled at any time. During the recall process, the logger is not updated, but its timer continues to run. To recall data, select the logger function (SHIFT then DATA LOGGER), giving a flashing DATA LOGGER LED, then press RECALL. The last sample taken will be recalled to the display, preceded by a brief 'ST nnn' message giving the store location. If RECALL is pressed again,

'ST 000' will be recalled, then 'ST 001' etc. As RECALL is pressed, the whole of the store currently in use will be recalled. The default direction of recall is up through the store i.e. location 0, then 1, then 2 etc. If the SHIFT (±) key is pressed, the message 'NEG' will appear, and data will be recalled in the negative direction i.e. location 2, then 1, then 0 etc. If '±' is pressed again, then message 'POS' will appear, and the direction will return to positive.

PERCENTAGE DEVIATION

The function allows the display of percentage change from some pre-defined reference value. Thus, if used on voltage, the display shows:

$$\text{reading} = (\text{Vin} - \text{Vref}) / \text{Vref} * 100$$

where Vref has been entered as follows:

Press SHIFT, followed by % DEV, and the message 'N=' will briefly appear followed by the currently selected value of Vref. (This function can also be used on current and resistance ranges, in which case the reference quantity will be Iref, Rref respectively.) When the 'N=' message disappears, it will be replaced by the currently selected reference quantity, with the first digit flashing. This entry should be edited as required, and the entry process terminated either with ENTER to accept the entry and run the program, or with CANCEL, to throw away the entry, and leave the program not running. During data entry mode, the RECALL key can be used to recall the display which was there before running the program — this allows percent deviation from the currently displayed value to be calculated, e.g. if the 2V range is selected, and the display is reading 1.5367V, then if the percent deviation program is selected, and the RECALL key pressed, the reference value will become 1.5367. This value can be then be edited, or the program can simply be run to yield a displayed value of 0.0000 i.e. no change from the reference value.

Ax+b

The Ax+b function allows a scale and offset calculation to be performed, where A and b are user-entered constants, and x is the result being operated upon. Thus if the reading is 1.0000, and Ax+b is run with A=1.5000, and B=0.0100, the result will be 1.5100.

To use the function, press SHIFT, then Ax+b. The instrument will briefly display the message 'A=', then will go into data entry mode, allowing you to enter a value for the constant 'A'. The CANCEL key causes the constant to be thrown away, and the instrument returns to normal operation with the program not running, the ENTER key causes the message 'b=' to appear, then the instrument goes into data entry mode, allowing the 'b' constant to be entered. If you press the ENTER key, the program will run using the entered constants; if you press CANCEL, the program will not run, and the constants will be discarded.

NON-PROGRAMMABLE FUNCTIONS

REL

Allows relative measurements to be made, e.g. if the negative lead (the COM terminal) is connected to the 0V rail in a circuit, and you want to make a measurement referred to the positive rail, then connect the positive lead to the circuit positive rail, and press the REL key. Further measurements will then be made with the supply voltage subtracted from the reading. This is a true relative measurement, i.e. if you establish a REL level of +5V on the 20V range, the REL is still +5V on the 2000V range.

HOLD

Allows the currently displayed value to be held, i.e. further display update is inhibited.

CLEAR

Selected by pressing SHIFT followed by CLEAR. The display shows the message 'CLEAR', and the following occurs:

a) The RS232 and GP-IB input and output buffers are cleared.
b) The Ax + b constants are set to 1.0, 0.0 respectively.
c) The percent deviation constant is set to 1.0.
d) The dB reference impedance is set to 600 Ohms.
e) The data logger period is set to −0001 (manual logging).
f) All constants stored for the multi-range NULL function are cleared.
g) The REL function is cleared.
h) The display HOLD function is cancelled.
i) The instrument is placed in DCV autoranging mode.

LOCAL

Pressing SHIFT then LOCAL returns the instrument to local control if it is in GP-IB remote mode.

NULL

This function zeroes all the DC V ranges, followed by the DC mA and 10A ranges, followed by the Ohms ranges. Use it when one or more of the ranges is showing a consistent permanent offset. Proceed as follows: Short the inputs together (if you wish the function to take out the residual resistance of the test probes, then short the inputs using the probes, otherwise make a short (less than 2 inches) lead with a 4mm plug on each end, and use that. Press SHIFT followed by NULL, and the display will show the message ENTER?. If you press the ENTER key, the nulling process will start. If you press any other key, the pro-

cess will be aborted. If you press ENTER, the display will show the message NULL13, then NULL12, then NULL11 etc., counting down to NULL00, as it nulls each range. The corresponding ranges are:

NULL13 — .2VDC
NULL12 — 2VDC
NULL11 — 20VDC
NULL10 — 200VDC
NULL09 — 2000VDC
NULL08 — 2mADC
NULL07 — 200mADC
NULL06 — 10ADC
NULL05 — .2KOhms
NULL04 — 2KOhms
NULL03 — 20KOhms
NULL02 — 200KOhms
NULL01 — 2000KOhms
NULL00 — 20MOhms

When completed, the instrument will remain on the 20MOhms range.

DIODE TEST

(Select by pressing SHIFT, then DIODE TEST.) In diode test mode, the instrument supplies approximately 1.5mA of current into the diode, and provides an accurate (spec as per the 2VDC range) measurement of the forward voltage drop. Note that the full-scale voltage is 1V, not 2.0999 as in the 2V range.

CONTINUITY TEST

(Select by pressing SHIFT, then CONT.) The continuity test function is basically the same as the .2KOhms range, except that if the resistance falls below approximately 100 Ohms, the buzzer sounds. The continuity tester does not use the converted result to indicate continuity, so it has a threshold which will vary from unit to unit, and it responds quickly. It operates by setting an internal latch whenever the input voltage falls below the threshold. Since the latch responds very quickly, it may be tripped spuriously when in use — this behaviour may be prevented by adding a capacitor of approximately 10uF across the input terminals to prevent spurious voltage excursions.

REMOTE OPERATION

RS232 INTERFACE

Accessed via the 9-way D connector on the rear panel. The baud rate is fixed at 9600 baud, and the format is 8 bits, no parity, 1 stop bit. The signal connections are:

Signal	Pin No.
RXD	3
TXD	2
CTS	7
RTS	8
GND	5

GP-IB INTERFACE

Accessed via the 24-way GP-IB socket on the rear panel. Each GP-IB device has an address which must be unique in the GP-IB system i.e. no two devices may normally share the same address. The address to which the instrument will respond is in the range 0 to 31, and is set via the address switches on the rear panel. Thus to set the instrument to address 5, set switches 1 and 4 to on, set all others to off. The TALK and LISTEN LEDs indicate the state of the 4503 when being operated remotely.

TALK-ONLY SWITCH

The instrument will normally be used with a GP-IB controller, and will require the talk-only switch (rear panel) to be off, thus allowing it to both talk and listen. If, however, you do not wish to use a controller — perhaps you want to connect the instrument to a listen-only device such as a printer — then set the talk-only switch to on. With talk-only selected the TALK LED illuminates.

REMOTE FACILITIES

The following remote facilities are provided:

Selection of instrument range, function(AC/DC, V/mA,Ohms, continuity, diode test, selection of end-of-string terminator, enable/disable calibration mode, perform calibration, enable/disable REFL function, instrument clear, continuous/triggered mode.

DATA

The following data can be requested:

Conversion result, current range, current function, selected terminator, data logger dump, instrument status, cal status (on/off), REL status (on/off), continuous/triggered mode status, error messages.

MAIN COMMANDS

Commands are executed only upon receipt of a valid terminator — they are held in a buffer within the instrument until then, thus the 'R1' command, etc., will be executed after receipt of a terminator which will be one of CR (ascii 13), LF (ascii 10), CRLF (ascii 13 followed by ascii 10), LFCR (ascii 10 followed by ascii 13), as set by the 'W' (set terminator) command. Returned data is terminated by the selected terminator sequence also. The terminators will not be shown in association with each command in the following discussion, but the command will not be executed until a terminator is received. Note also that there may be as much as 300-400mSec of delay from receipt of the terminator to the start of the response.

'R' COMMAND — SET RANGE

The measurement range may be set using the 'R' command as follows:

R0 — autorange
R1 — .2
R2 — 2
R3 — 20
R4 — 200
R5 — 2000
R6 — 20000
R? — request the current range.

If sent an invalid range, but one which is recognised, such as 20000V, the instrument will select the nearest available range (2000V in this case). Thus if sent .2 or 20 on AC or DC mA, the range selected will be 2 and 200 respectively. (.2mA and 20mA are not provided). On AC and DC mA, the 10A range can be selected via the R6 (or R5) command, but correct results will only be obtained if the 10A socket is used for the measurement — the instrument does not automatically switch the input. If autorange is selected on current, the instrument will select either the 2mA range or the 200mA range — it will not select 10A.

On Volts, the instrument will autorange between the .2V range and the 2000V range (1000V maximum input), and on resistance, between the .2KOhm range and the 20MOhm range.

If the selected range is requested using the 'R?' command, the string 'Rn' where n is as follows:

n=1 — .2 range, non-autoranging
n=2 — 2 range, non-autoranging
n=3 — 20 range, non-autoranging
n=4 — 200 range, non-autoranging
n=5 — 2000 range, non-autoranging

n=6 — 2000 range, non-autoranging
n=9 — .2 range, autoranging
n=A — 2 range, autoranging
n=B — 20 range, autoranging
n=C — 200 range, autoranging
n=D — 2000 range, autoranging
n=E — 20000 range, autoranging

'F' COMMAND — SET MEASUREMENT FUNCTION

The measurement function may be set using the 'F' command as follows:

F1 — DC Volts
F2 — AC Volts
F3 — Ohms
F4 — Continuity
F5 — DC mA
F6 — AC mA
F7 — Diode Test

If the command F? is issued, a string of the above form will be returned.

'S' COMMAND — DO A SAMPLE

The command 'S' will cause the instrument to send a sample result to the interface. The A/D converter runs continuously, and is not affected by the sample command; the command merely causes the current conversion result to be output — the command cannot therefore be used to precisely set the time at which a conversion is started — no facility is provided to allow the conversion to be synchronised to an external event.

'T' COMMAND — TRIGGER MODE

T1 — continuous mode.
T0 — triggered mode.
T? — return the trigger mode state.

The instrument normally powers on in triggered mode i.e. no data is sent by the interface. The interface will send readings continuously if the continuous trigger command (T1) is sent, or if the GP-IB talk-only switch is set to the talk-only position — this affects both the RS232 interface, and the GP-IB. When in continuous trigger mode, the instrument normally sends readings at conversion rate i.e. 3/sec, but this rate is reduced if the data logger is run, in which case readings are sent at the rate set by the data logger timer. This allows, for example, more economical paper usage if the instrument is connected to an RS232 printer. The command 'T?' causes a string (e.g. 'T0') to be returned, reflecting whether the continuous or triggered mode is selected.

'W' COMMAND — SET TERMINATOR

The 'W' command allows the end-of-string terminator to be set. Since this command affects the terminator, it does not itself need to be terminated. The selected terminator also affects the GP-IB, and some of the options (those involving EOI) are not relevant to the RS232 interface. The commands are as follows:

W0 — CR LF EOI, CR LF on RS232 (default)
W1 — CR LF only
W2 — CR EOI, CR on RS232
W3 — CR
W4 — LF EOI, LF on RS232
W5 — LF
W6 — EOI only, terminators disabled on RS232
W7 — terminators disabled
W? — return the currently selected terminator (e.g. 'W3')

Thus W0, W1 are identical on RS232, as are W2, W3 etc.

'Z' COMMAND — SET REL ON/OFF

If the command 'Z1' is sent, the front panel REL LED illuminates, and a new REL level is established, as it would be if the front panel REL key were pressed. 'Z0' cancels the REL function. 'Z?' returns the state of the REL function (returns 'Z0' or 'Z1').

'G' COMMAND — GET INSTRUMENT STATUS

The 'G' command causes a string of the form 'CnFnPnnRnWnZn' to be returned e.g. 'C0F1P00R3W0Z1' which would mean: 'C0' — Not in cal mode, 'F1' — DC V, 'P00' — service request disabled (GP-IB only), 'R3' — 20V, 'W0' — terminator = CR LF (EOI also on GP-IB), 'Z1' — REL function operating. This returned string is always of the same length, allowing convenient 'dissection' when used with a controlling computer.

'A' COMMAND — CLEAR THE INSTRUMENT

The 'A' command places the instrument in a known cleared condition, with all programs not running and program constants set as follows:

dB reference impedance = 600 Ohms.

Data logger sample rate is set to −0001 (manual sampling), stored data is cleared.

Percent deviation reference value is set to 1.0000.

Ax + b constants A and b are set to 1.0000 and 0.0000 respectively. The end-of-string terminator is set to CR LF EOI.
The RS232 and GP-IB data input and output buffers are cleared.
The instrument is placed in the DCV function, in autoranging mode.
The null values stored by the multirange NULL function are NOT cleared. The function is equivalent to the front panel CLEAR command.

'!' COMMAND — SEND ERROR MESSAGE

In response to a '!' command, a string of the form 'ERROR nn' will be sent by the 4503, where nn is a two digit number as follows:

ERROR 00 — no error
ERROR 01 — syntax error in command string
ERROR 02 — invalid argument to command e.g. R9
ERROR 03 — Use of 'H' or 'L' command in normal operation (only valid during auto-calibration).

'D' COMMAND — DATA LOGGER DUMP

The 'D' command causes the 4503 to return the contents of its data logging memory to the interface. The format of the returned data is:

nnn,sxxxxxt . . . . . ENDt

where:

'nnn'	is the store location number from 000 to 249.
's'	is the sign either a space for plus or ' – ' for minus.
'xxxxx'	is the value of the stored sample with decimal point.
't'	is the terminator (selected with the 'W' command).
'END'	indicates the end of the data.

GP-IB SPECIFIC COMMANDS

POLLING

The GP-IB interface built into the 4503 supports serial and parallel polling. When the instrument powers on, all polling is disabled. To enable polling the polling mask command 'P' must be used. There are four different situations in which the 4503 can request service:

1. Error in the command string.
2. Calibration point completed (auto-calibration mode only).
3. Range calibration successful (both cal high and low points accepted).
4. Calibration error (computed constants out of range).

The service request conditions are enabled by setting their corresponding bits in the service request mask:

CONDITIONS	SRQ MASK				COMMANDS
	bit-4	bit-3	bit-2	bit-1	
Command error	0	0	0	1	'P01'
Cal point completed	0	0	1	0	'P02'
Range cal successful	0	1	0	0	'P04'
Cal error	1	0	0	0	'P08'
SRQ disabled	0	0	0	0	'P00'

Example:
The command 'P07' (i.e. binary 0111) would enable service requests under the following conditions:

1. Error in the command string
2. Cal point complete
3. Range cal successful

Note: The 'P' command must have a 2-digit argument, e.g. 'P02' not 'P2'.

Please be careful to make a distinction between GP-IB bus commands (such as listen and talk addresses), and instrument-specific commands such as 'P00'. The bus commands are individual bytes sent with the ATN line true, whereas the instrument-specific commands are (so far as the GP-IB is concerned) data, sent with the ATN line false.

From power on, the 4503 does not respond to parallel polls — it returns zero. To make it respond, a service request mask must be sent ('P' command), so that the instrument will request service, and the GP-IB parallel poll configure sequence must be sent. If you are using a reasonably sophisticated controller, this will be straightforward, being typically accomplished by means of a command named something like CONFIGURE. The process entails sending the GP-IB bus commands (with ATN true) MLA (4503 GP-IB address) followed by PPC (parallel poll configure) followed by PPE (parallel poll enable), with the PPE command specifying both the line on which to respond, and the sense of the response: if sense is 1, then during a parallel poll, if the 4503 has requested service, and has not yet been serial polled, then respond by setting the response line true (where the response line is as specified by the PPE command). If the 4503 did not request service, do not set any response line true. If sense if 0, do the converse, i.e. if the 4503 requested service, do not set the response line true, and if the 4503 did not request service, then set the response line true.

GTL — GO TO LOCAL, LLO — LOCAL LOCK-OUT

The handling of remote-local issues is strictly according to the GP-IB standard (IEEE Std 488 — 1978) as follows:

When the 4503 is first addressed to listen, it goes into REMote mode, and the

REM LED comes on. This prevents front panel control of the instrument. If a front panel key is pressed, the instrument beeps, and the key is ignored. If GP-IB communication stops, and LLO (see later) has not been sent, then front panel (local) control may be regained by pressing the front panel keys SHIFT, then LOCAL. If the bus command LLO (local lock-out) has been sent, the front panel LOCAL key will not regain local control of the instrument — it will merely cause the message 'LLO' to be displayed.

If the controller sends the bus command GTL, the instrument will go into local mode, and the front panel will become active: however, if the controller addresses the instrument to listen again, it will again go into REMote mode, locking out the front panel once more. Note that if LLO has been sent, and if the instrument is addressed to listen, it will go into the locked-out state (the local key will not recover control), even after a GTL command, i.e. the LLO command is permanent — afterwards, the instrument will alternate between remote and local, but will remember the locked-out state, thus whenever it is in the remote state, the local key will not recover control. The only way to render the local key operative again is either to pulse the GP-IB REN (remote enable) line, or to power off the instrument.

DCL — DEVICE CLEAR, SDC — SELECTED DEVICE CLEAR

Device clear works on all the instruments on the bus, SDC works only on those devices which have been addressed to listen. The 4503 also responds to SDC when it has been addressed to talk. Action is to clear the RS232 and GP-IB input and output buffers. To clear the whole instrument, use the instrument-specific command 'A', described above.

GET — GROUP EXECUTE TRIGGER

If the 4503 is in 'T0' mode (triggered data transfer), a sample may be requested either by sending the instrument-specific command 'S' (described above), or by sending the bus command GET.

SPE — SERIAL POLL ENABLE, SPD — SERIAL POLL DISABLE

Read the section above on polling. In order to conduct a serial poll, the controller issues a SPE command, followed by a talk address (or a talk address followed by SPE). The device responds by sending a status byte which conveys information as to whether or not it requested service (bit 6 of 0 to 7 is set if the device requested service), and further information is provided in the other bits indicating why service was requested. The meaning of these bits is described above.

REAR PANEL INPUTS (BLANKED)

The four rear panel blanking plugs are used for the factory fitted option of rear panel mounted input sockets. Contact the factory or overseas agent for further details.

MAINTENANCE AND REPAIR

The manufacturer, or the appointed agents overseas, will repair and calibrate any instrument developing a fault.

Always observe the following points:

1. Clearly detail claimed fault.

2. Do NOT return **any** accessories.

3. Pack product very carefully. Whenever possible retain original packing for this purpose.

4. Enclose dated proof of purchase.

Where owners wish to undertake their own repairs and calibration, this should be carried out by skilled personnel, with access to precision equipment, working in conjunction with the Service Manual which can be purchased from the manufacturer or their overseas agents.

CALIBRATION

For optimum accuracy, the instrument requires calibration from time to time. How frequently will depend on the user and application but once every twelve months would normally be adequate.

Calibration of the multimeter is a complex procedure involving the use of precision equipment and should only be undertaken by those with specialist knowledge. However, for those users who wish to perform their own calibration, please refer to the Service Manual which can be purchased from the manufacturer or their overseas agents. **Note:** To avoid accidental re-calibration of the instrument a shorting plug must first be inserted into the rear panel 3.5mm jack socket before the instrument can be calibrated. **DO NOT** use this socket unless you intend to re-calibrate the multimeter.

GUARANTEE

BLACK STAR Ltd will undertake to repair, or replace free of charge, any product that fails within 12 months of the date of purchase provided that the equipment has not been modified or misused. Note this guarantee does not affect your statutory rights.