OPERATING MANUAL

PSC-232 module   **PSC-488 module**
PSC-232   **PSC-488**
PSC-232 P148

PSC manual

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OPERATING MANUAL FOR POWER SUPPLY CONTROLLERS

External PSC module

Internal PSC card

1 Features

The PSC is an RS232 or IEEE488 interface, designed for an analog programmable power supply. The PSC sets output voltage and current and reads the voltage, current and status. The PSC also controls Remote/Local, Remote Shut Down etc. Up to 15 PSC's can be connected to only one RS232 port or IEEE488 bus. The analog voltages can be calibrated by software. The calibration settings can be saved in non volatile memory and recalled at power on.

2 Languages

The PSC allows three groups of commands:

- IEEE488.2 Common Commands
- SCPI (Standard Commands for Programmable Instruments)
- DPL (Delta Programming Languages) emulation mode of the PSC 44M

For communication with the PSC languages like Basic, Pascal, C, Visual Basic, Delphi, Testpoint or LabView can be used. Some free software examples are available on www.DeltaPowerSupplies.com. There is an external model for bench, rail or rack mounting and there are PSC card sets to use inside a power supply.

3 Models

MODELS	RS232	GPIB	USE
PSC-232 module	•		Bench/rail/rack
PSC-232	•		SM1500/6000 card set
PSC-232 P146			*Not Available after 2018.*
PSC-232 P148	•		ES150 card set
PSC-488 module	•	•	Bench/rail/rack
PSC-488	•	•	SM800/1500/6000 card set
PSC-232 P254	•	•	SM800 card set
PSC-488 P255		•	SM800 card set

4 Accessories supplied with the PSC

Accessories	PSC-232 module	PSC-232	PSC-232 P146	PSC-232 P148	PSC-488 module	PSC-488
RS232 cable	•	•	•	•	•	•
Analog cable	•				•	
Line cord	•				•	
Rail Mounting clip	•				•	

5 Dimensions

PSC-488 module and PSC-232 module:

89 x 85.5 x 118 mm, 0.8 kg

Enclosure: IP20
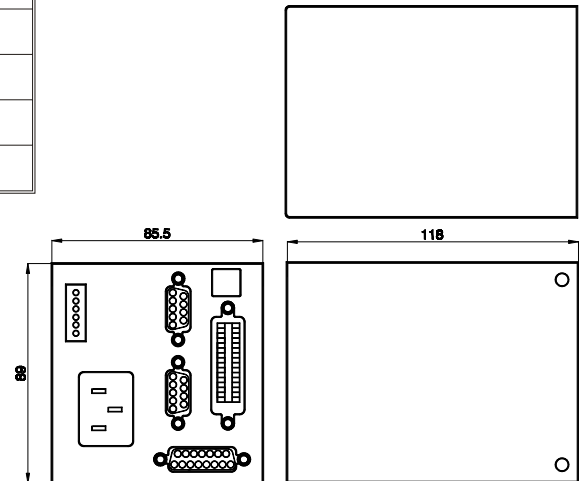
Dimensions PSC-232 and PSC-488 modules

6 Specifications

6.1 Power

Range: 98-264 VAC 48-62 Hz
          for DC-voltage contact factory

Power consumption: 10 W
Hold-up time: 300 ms, Vin = 230 VAC
                             80 ms, Vin = 110 VAC

6.2 EMC

Emission   : EN 61326-1

Immunity   : EN 61326-1

6.3 Isolation

Analog/logic in/outputs to case : 1000 V DC
GPIB or RS232 to case   : 1000 V DC
Line input to case   : 2500 V AC

6.4 Ambient temperature

Operating: 0 to 55 °C (Ext model)
Storage: -20 to +70 °C

6.5 Analog outputs

The analog outputs can be individually set on 0-5 V The settings can be reported. Calibration is by software. Settings can be saved in non-volatile memory. Analog in- and outputs have a common zero

- 2 analog outputs with buffered 14 bit D AC
- Output range 0 to 5 V
- Full scale software adjustment > 200 mV
- Offset software adjustment > 200 mV
- Resolution 0.33 mV / 5 V output
- Linearity error 1 LSB
- TC typical 30 ppm / °C
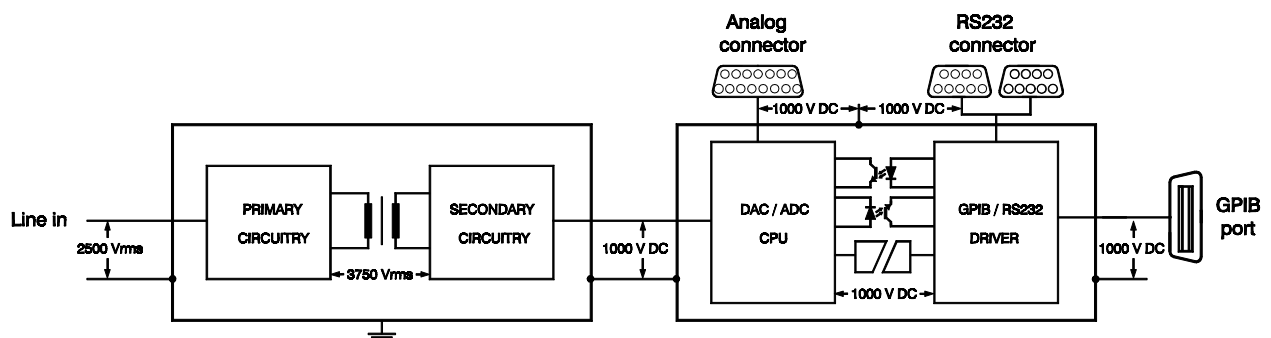
Isolation schematic diagram

6.6   Analog inputs

The analog inputs can be individually read. Calibration is done by software. Settings can be saved in non-volatile memory. Analog in- and outputs have a common zero

- Full scale software adjustment
- 2 x analog input channels with 16 bit ADC Input range 0 to 5 V
- Offset software adjustment
- Resolution 0.1 mV / 5 V input
- Linearity error +/- 2 LSB
- TC typical 5 ppm / °C

Read Back Resolution

The read back resolution depends on the voltage and current range of the power supply that is used with the PSC.

Range	Decimals
0 - 5.9999	4
6.000 - 59.999	3
60.000 - 599.99	2

Example with power supply SM52-30:

The voltage range is 52 V. After programming the unit to 50 V, the read back value has 3 decimals, see table; $V_{readback}$ = 50.000 V. The 3 digits after the decimal point give a resolution of 1 mV. This means that for 50 V the number of steps is 50000. From the next table it can be seen that the resolution is better than 15 bit.

Bit	Steps
12	4096
13	8192
14	16384
15	32768
16	65536

Analog in/ outputs
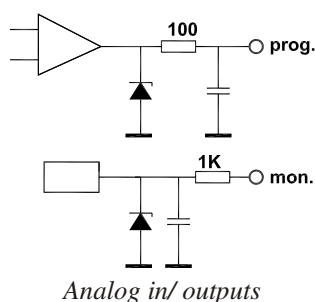
6.7   Status monitoring

The PSC provides TTL /CMOS compatible status inputs for monitoring signal changes and fail signals of the power-supply as CC mode, Current or Voltage Limit, DC Fail, AC Fail and Over Temperature. See power supply manual.

Status	Weight	Name
1	1	CC
2	2	LIM
3	4	DCF
4	8	ACF
5	16	OT
6	32	PSO
7	64	InpA
8	128	InpB

6.8   Logic inputs

The PSC-488 module and the PSC-232 module provide two 1000 V opto isolated logic inputs, InpA and InpB for custom use.
The inputs are 470 ohm, Logic high = 2.5 ... 8 V (15 mA max), Logic low = 0 V.
The two inputs have a common zero.
The maximum reverse voltage = 6 V.

6.9   Logic outputs

The PSC-488 module and the PSC-232 module also provide two opto isolated logic outputs for custom use: OutA and OutB.
The opto coupler outputs have an open collector and a common zero. The maximum voltage is 50 V and the maximum current is 5 mA.
Total power dissipation = 150 mW.

User logic in/outputs for external PSC-488 module and PSC-232 module
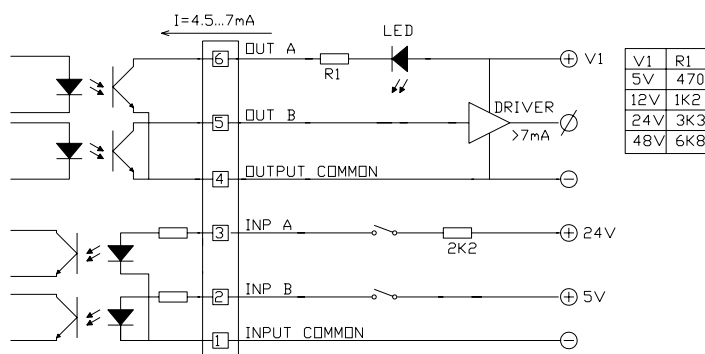
6.10   Led indicator

The PSC-232 module and the PSC-488 module have LEDs on the front panel.

LED	PSC-232 module	PSC-488 module	
PWR	•	•	Power on
LSN		•	Listener mode
TLK		•	Talker mode
ERR		•	Device in error
RDY	•		Device ready for command.

7   GPIB capabilities

The PSC-488 supports the following standard IEEE488.1-1987 capabilities.

ID code		Capability
T6	Basic talker, Serial poll, Un address if MLA	•
L4	Basic listener, Un addressed if MTA	•
SH1	Source handshake	•
AH1	Acceptor handshake	•
SR1	Service request	•
RL0	Remote / local	
PP0	Parallel poll	
DC1	Device clear	•
DT0	Device trigger	
C0	Controller	
E2	Three state driver	•

7.1   Restrictions

Up to 15 devices can be connected to the IEEE 488 instrument bus (can be increased by with a bus extender). The maximum cable length to connect a group of instruments is 2 meters x number of devices or 20 meters, whichever is less. Cable configurations may be star, linear or a combination of the two. Each of the devices must have a specific address code. The PSC-488 module has a device address code switch on the rear panel next to the GPIB connector. It has to be set to the appropriate binary code for the desired address.
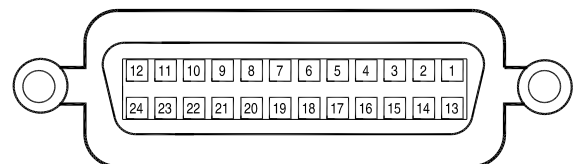
GPIB CONNECTOR

8   Switch settings

8.1   Address switch

When setting the address use any address from 1 up to 30.
The address is a 5 bit binary number which can be set with
switch A1 to A5.
Switch A1 is the LSB and switch A5 is the MSB.
For example address 1 is 00001 (A1 = on, A2-A5 = off) and
address 30 is 11110 (A1 = off, A2-A5 = on).
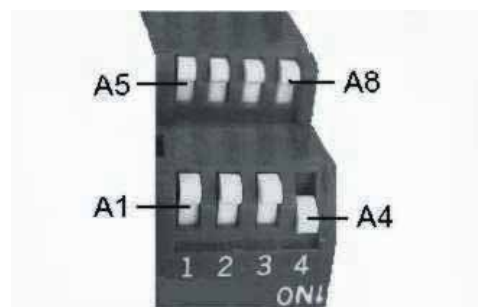
Address switch

8.2   PORQS switch

Only for DPL mode.
A8 is the PORQS switch. With switch POSRQ in the ON position, not only a SRQ at power-on
but also the request for service capability is enabled.

8.3   DPL command switch

A7 is the language switch on PSC-488 models.
When the DPL switch is ON, the PSC is in PSC 44M emulation mode.
The switch OFF means the PSC is in PSC-488 mode, SCPI language.

8.4   RS232 communication switch

A6 is used on PSC-488 models only.
When the RS232 switch is ON, the PSC is in RS232 mode.
The switch OFF means the PSC is in GPIB mode.

8.5   Baudrate

For PSC-232 models the switches A7 and A8 are baudrate switches.

Baudrate	A8	A7
2400	off	off
4800	off	on
9600	on	off
19200	on	on

8.6   Factory pre-settings

PSC-488:

Address 8
SCPI Language
RQS 0
A1, A2, A3, A5, A6, A7, A8 = off
A4 = on

PSC-232:

Channel 1
SCPI Language
9600 baud
A2, A3, A4, A5, A6, A7 = off
A1 and A8 = on

9   Connections

9.1   RS232 Interface

Connector from PC: Connector to next PSC:
D 9 F conn.   D 9 M conn.

Pin 2   TXD   Pin 2   RXD
Pin 3   RXD   Pin 3   TXD
Pin 5   GND   Pin 5   GND
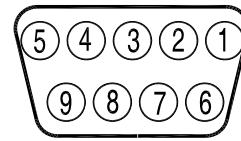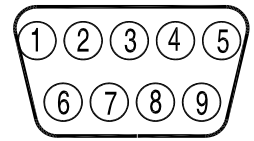
9F Pole D connector   *9M Pole D connector*

For connection to the PC or to the next PSC use a 1:1 cable with 1 female and 1 male connector.
Do not use a null modem cable.

Baudrate   : 2400 - 9600 baud
Databits   : 8
Stopbits   : 1
Paritybits   : none
Signal level   : -10 V to +10 V
Maximum cable length   : 15 m
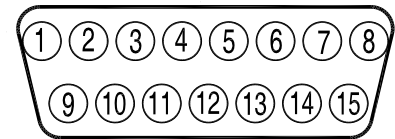
15 pole D connector

9.2   Pin assignment of the 15P connector

PIN	DESCRIPTION	PSC In/Output	Abbreviation
1	Analog common	Analog common	AGND
2	Current Monitor	Analog Input	I MON
3	Current Programming	Analog Output	I PROG
4	Constant Current status	Digital Input	CC
5	Remote Shut Down logic output	Digital Output	RSD
6	Power sink overload	Digital Input	PSO 1)2)
7	Not Connected		NC
8	Digital common	Digital common	DGND
9	Not Connected		NC
10	Voltage Monitor	Analog Input	V MON
11	Voltage Programming	Analog Output	V PROG
12	Over Temperature	Digital Input	O.T. 1)
13	Limit Status	Digital Input	LIM 1)
14	DC Fail	Digital Input	DCF 1)
15	AC Fail	Digital Input	ACF 1)

1) Check the power supply manual if the power supply supports the status.

2) If an SM7020-D or SM3004-D is used in combination with a
   PSC module, remove the jumper on P532 or otherwise the
   autoranging will not work properly.
   First remove the screws from the bottom and top of the PSC in
   order to remove the cover from the cabinet. Then remove the
   jumper on the PCB P532.
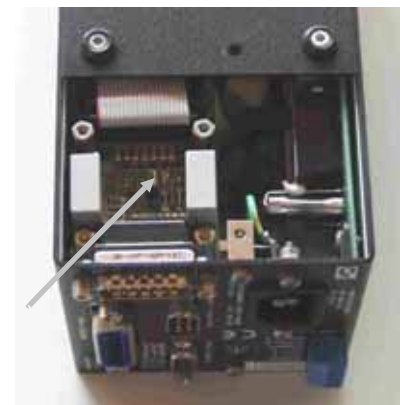
10   Conventions

Angle brackets < >   Indicate that words or characters enclosed in angular brackets
symbolize a program code parameter.

Brackets   { }   Brackets indicate one of the several parameters may be entered.
For example { 1|0|ON|OFF}.

Square brackets [ ]   All items between square brackets are optional.

Boldface   Boldface and computer font is used to show command syntax in the text.

Controller   A computer used to communicate with an instrument.

Instrument   A device that implements SCPI (PSC-488).

10.1   Frequently used ASCII symbols

Symbols	DEC	HEX	Codes Display	Description
EOT	4	04	\04	end of transmission
LF	10	0A	\n	line feed (command terminator)
CR	13	0D	\r	carriage return
ESC	27	1B	\1B	escape
WSP	32	20	\s	space

10.2   Summary of Data types

	Example	NDEC	Decimal
Digit	character 0....9		8
Hexadecimal	character 0..9 & A....F	#hFA	250
Binary	character 0 or 1	#b0101	5
String	character 0....9 and A....Z		

NDEC = Non-decimal HEX, OCT, BIN (Hexadecimal, Octal, Binary)

10.3   Booleans

A Boolean parameter is normally used to specify a binary condition which is either True or False.
Booleans can have one of the following values:
ON or 1 means condition is True.
OFF or 0 means condition is False.
Example: OUTputA ON or OUTputA 1.

10.4   Numerical data formats.

Symbol	Meaning	example
<NR1>	Signed integer value	1234
<NR2>	Floating point value without an exponent	12.345

11   Installation of the PSC

When the External PSC module is used for the first time, it must be configured and calibrated together with the power supply. The card set types are factory configured and calibrated.

11.1   PSC-488 module

This type of PSC is for rail or rack mounting, the unit can be mounted to the rear side of the power supply using a rail. Connect and install the PSC as follows:
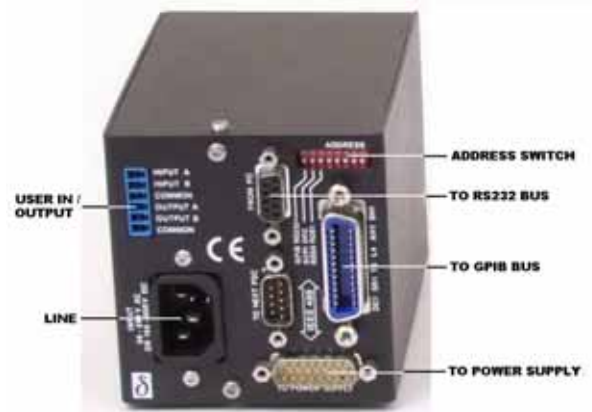
Connection of the PSC-488 module

- When used with a SM7020-D or with a SM3004-D
  remove the link on P532 (see comment 2 on page 8)
- Set the address switches to 8
  A1, A2, A3, A5 = OFF and A4 = ON.
- Set the GPIB communication switch A6 = OFF.
- Set SCPI language switch A7 = OFF.
- Set RQS switch A8 = OFF.
- Connect the 15 pole analog cable between the PSC and the power supply.
- Connect a GPIB cable between the PC and the PSC.
- Connect the line-cord.
- Switch the power supply to "programming" (see power supply manual).
- Go to section 12 of this manual.

11.2   PSC-488

This is a card set, mounted inside the power supply. Connect and install the PSC as follows:

- Set the address switches to 8
  A1, A2, A3, A5 = OFF and A4 = ON.
- Set the GPIB communication switch A6 = OFF.
- Set SCPI language switch A7 = OFF.
- Set RQS switch A8 = OFF.
- Connect a GPIB cable between the PC and the PSC.
- Switch the power supply to "programming" (see power supply manual).
- Go to section 12 of this manual.

11.3   PSC-232 module

This type PSC is for rail or rack mounting, the unit can be mounted to the rear side of the power supply using a rail. Connect and install the PSC as follows:

- When used with a SM7020-D or with a SM3004-D,
  remove the link on P532 (see comment 2 on page 8)
- Set the DIP switch to channel (address) 1. A2, A3, A4, A5 = OFF and A1 = ON.
- Set the Baudrate switch to 9600 baud. A6, A7 = OFF and A8 = ON.
- Connect the 15 pole analog cable between the PSC and the power supply.
- Connect the 9 pole RS232 cable between the PC comport and the PSC.
- Connect the line cord.
- Switch the power supply to "programming" (see power supply manual).
- Start the program Cal232.exe (on the CD) and follow the instructions on the screen.

11.4   PSC-232, P146 or P148

These are card sets, mounted inside the power supply.
Connect and install the PSC as follows:

- Set the DIP switch to channel 1. A2, A3, A4, A5 = OFF
  and A1 = ON.
- Set the Baudrate switch to 9600 baud. A6, A7 = OFF and
  A8 = ON.
- Connect the 9 pole RS232 cable between the PC comport
  and the PSC.

12   Calibration of the PSC

For easy calibration, a CD with a calibration program is supplied with the PSC-488 and PSC-232. You
can download the latest version from Internet www.DeltaPowerSupplies.com. First read the "ReadMe"
file supplied with the calibration program.

12.1   Configuration setting

- Switch on the power of the power supply.
- Run the LabView program "PSC488_v61.exe".
- Select "PSC488 Calibration.vi".
- Click "OK".
- Select tab "Start".
- Select "PSC address" 8.
- Set the "Power supply voltage range".
- Set the "Power supply current range".
- When password protected, enable "Reset calibration".
- Click "run continuously" in menu bar:
- Click "Config".
- If configuration fails, repeat from configure.
- When configuration is successful, the program.
  switches automatically to tab 1.

Start screen: Voltage and current configuration

12.2   Voltage DAC Offset calibration

- Connect a digital mV meter to the output terminals of
  the power supply.
- Click "Continue".
  The program sets the current and the voltage.
  The "Actual offset" will be displayed.
- Enter the DVM value in mV.
- Click "Continue".
- When calibration fails, repeat.
- When calibration is successful, the program switches
  automatically to tab 2.
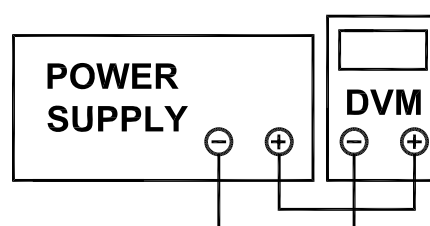
Voltage calibration connection

Screen 1:   Voltage DAC Offset calibration

12.3   Voltage DAC gain calibration

- Switch the digital voltage meter to the right range (maximum output voltage of the power supply).
- Click "Continue".
- Enter the DVM value.
- Click "Continue".
- When calibration fails, repeat.
- When calibration is successful, the program switches automatically to tab 3.
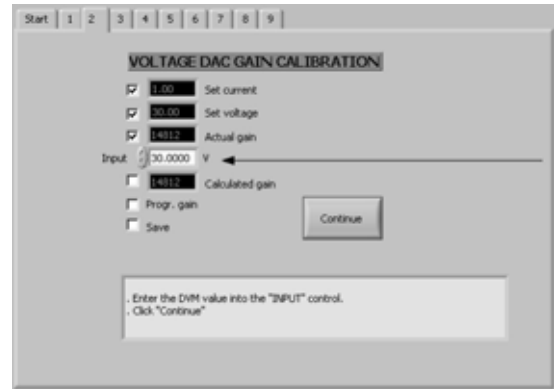
Screen 2:   Voltage DAC gain calibration

12.4   Voltage ADC Offset calibration

- Switch the digital voltage meter to the right range. See "Set voltage".
- Click "Continue".
- Enter the DVM value.
- Click "Continue".
- When calibration fails, repeat.
- When calibration is successful, the program switches automatically to tab 4.

Screen 3:   Voltage ADC offset calibration

12.5   Voltage ADC gain calibration

- Switch the digital voltage meter to the right range (maximum output voltage of the power supply).
- Click "Continue".
- Enter the DVM value into "Input" control.
- Click "Continue".
- Check "Measure new voltage".
- Click "Continue".
- When calibration fails, repeat.
- When calibration is successful, the program switches automatically to tab 5.

Screen 4:   Voltage ADC gain calibration

12.6   Current DAC Offset calibration

The program has set the voltage and current to zero, so you can safely change the connections of the power supply.

- Connect a shunt and a D.V.M. (or zero flux ampere meter) on the output terminals.
- Click "Continue".
- The program sets the current and the voltage.
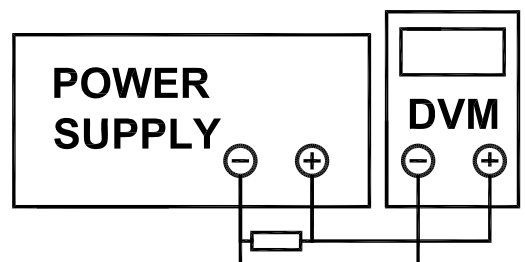
Current calibration connection

- Measure the shunt voltage with the D.V.M. and calculate the current.
  Enter the value.
- Click "Continue".
- Click "Continue" to set the output to zero.
- When calibration fails, repeat.
- When calibration is successful, the program switches automatically to tab 6.
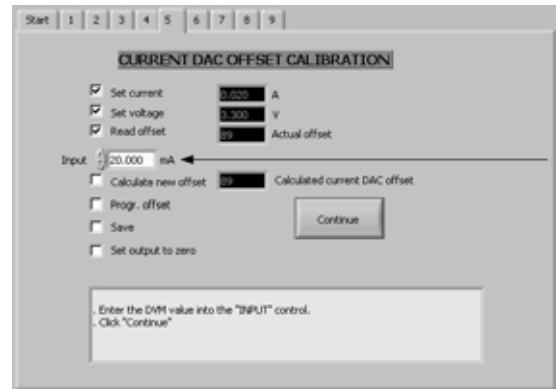
Screen 5:   Current DAC offset calibration

12.7   Current DAC gain calibration

The program has set the voltage and current to zero, so you can safely change the connections of the power supply.

- Connect a shunt and a D.V.M. (or zero flux ampere meter) on the output terminals.
- Click "Continue".
  The program sets the current and the voltage.
- Measure the shunt voltage with the D.V.M. and calculate the current.
- Enter the value.
- Click "Continue".
- Click "Continue" to set the output to zero.
- When calibration fails, repeat.
- When calibration is successful, the program switches automatically to tab 7.
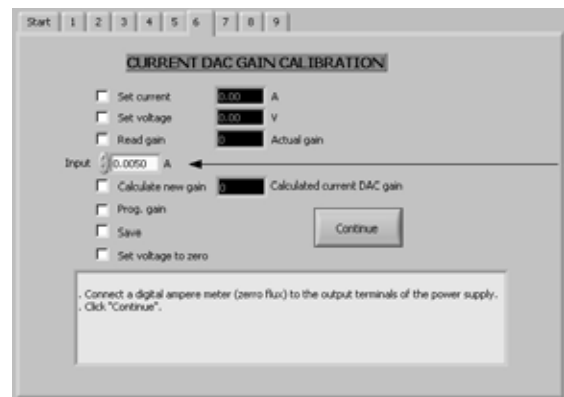
Screen 6:   Current DAC gain calibration

12.8   Current ADC offset calibration

- Switch the digital ampere meter to the right range. See "Set current".
- Click "Continue".
- Enter the DVM value.
- Click "Continue".
- Click "Continue" to set the output to zero.
- When calibration fails, repeat.
- When calibration is successful, the program switches automatically to tab 8.

Screen 7:   Current ADC offset calibration

12.9   Current ADC gain calibration

- Switch the digital ampere meter to the right range. See "Set current".
- Click "Continue".
- Enter the DVM value.
- Click "Continue".
- Check "Measure new current".
- Click "Continue".
- When calibration fails, repeat.
- When calibration is successful, the program switches automatically to tab 9.

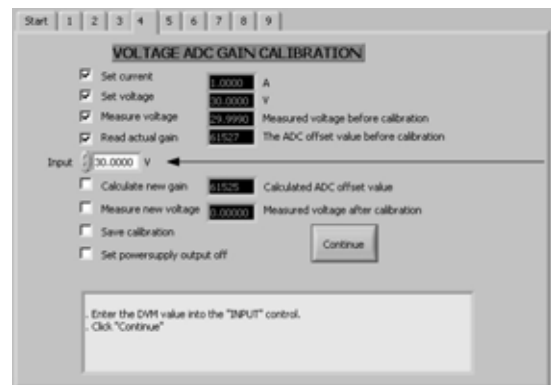*Screen 8:   Current ADC gain calibration*

12.10 Change IDN string

The IDN string can be changed. The suffix of the PSC is entered in field 2. Field 4 is reserved for a custom string. This calibration program enters the calibration date in this field.

- Select a button INT,EXT, P146 or P148. The red characters are the new IDN text.
- Click "Continue".
- Reset the PSC
  (Switch the power of the PSC off.
  Wait untill all LEDs are off
  Switch on the PSC power).
- Click "Continue".
- The new IDN string is displayed in the black indicator "New IDN string".

<u>End of calibration.</u>
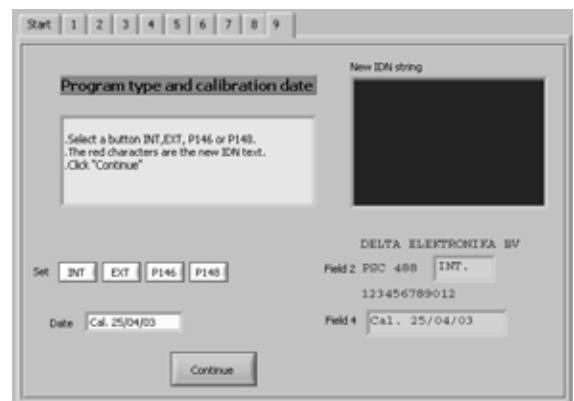
Screen 9:   Change IDN string

13   Power on Settings

When shipped, the PSC-488 module and the PSC-232 module are set to the configuration listed in table.
All configurable parameters can be changed and stored by the user.

Function	Command	Value
Voltage range	**SOurce:VOltage:MAximum**	5
Current range	**SOurce:CUrrent:MAximum**	5
Text field #2 in IDN string	**TYpe**	"EXT" | "INT" | "P146" | "P148"
Text field #4 in IDN string	**CUstom**	"Not Calibrate"
Password	**PAssword**	"Default"
Remote shut down		0
Remote		1

At power-on the Service Request Enable Register and the Standard Event Status Enable Register are cleared.

14   Languages

This section describes the operation of the three groups of commands.
The Groups are: Delta Programming Languages DPL, Standard Commands Programmable Instruments SCPI, and Common commands.

- Delta Programming commands is a PSC 44M compatible language. With the DIP switch A8 ON and A7 OFF the DPL is active. The DPL mode emulates the commands of the old PSC 44M and the 12 bit DAC and ADC.
- Common commands are mnemonic commands beginning with a star. The query commands are followed by a question mark. The common commands are defined in the IEEE488.2 standard and control status reporting, synchronization and conditions of the power supply and the PSC-488.
- Standard Commands for Programmable Instruments SCPI.
  These commands are used to configure and calibrate the PSC, to set voltage and current and to read back voltage,current and status of the Power Supply.

Note: Terminator for all commands is LF.

14.1   Delta Programming Commands

MNEMONICS	FUNCTION
SA	Step mode A channel (voltage)
SB	Step mode B channel (current)
FU	Input maximum voltage of the power supply
FI	Input maximum current of the power supply
U	Set output voltage of the power supply
I	Set output current of the power supply
ERR?	Report the last error
ID?	Report the Identify of the PSC
MA?	Read the measured output voltage of the power supply
MB?	Read the measured output current of the power supply
SCPI	Switch to the SCPI parser

PSC 44 emulating mode.

The PSC-488 emulates in this mode the PSC 44 language including the 14 to 12 bit conversion. The calibration is by the PSC-488 software. To calibrate the PSC-488 set the DIP switch A6 and A7 to OFF prior to using the calibrating program (See chapter calibration) and after the calibration the DIP switch must be set to A7 = ON (Delta Programming Languages).

For more details read the PSC 44M manual.

When in SCPI mode, the command "DPL" switches the PSC-488 to DPL mode.

14.2   IEEE488.2 Common Commands.

The mnemonic common commands have three letters and begin with a star, the query commands are followed by a question mark (?). Common commands are defined by the IEEE STD 488.2-1987 standard and control status reporting, synchronization, power-on conditions and stored operating parameters of the PSC-488.

The PSC-488 contains the following common commands.

MNEMONICS	Description	Only PSC-488
*IDN?	Identification query.	
*RST	Device Reset command.	
*TST?	Self test query.	
*OPC	Operation complete command.	•
*OPC?	Operation complete query.	•
*WAI	Wait to continue command.	•
*CLS	Clear status command.	•
*ESE	Standard event status enable command.	•
*ESE?	Standard event status enable query.	•
*ESR?	Standard event status register query.	•
*SRE	Service request enable command.	•
*SRE?	Service request enable query.	•
*STB?	Read status byte query.	•
*SAV	Save calibration values to non-volatile memory.	
*RCL	Recall values from non-volatile memory.	

14.2.1   Status reporting

The status structure of the PSC-488 is used to reflect the power supply condition and to report all kind of events that have happened. The various status models are ultimately reported in the Status Byte Register, giving a complete organized status of the power supply. Status model, registers and queues are reported in one of the summary bits of the Status Byte Register. The Service Request Enable Register selects which Status Byte bits will cause a Service Request (SRQ) on the GPIB.
From the Status Byte Register, which is returned as response to a serial poll from a controller, it is always possible to trace back the event that caused the corresponding summary bit to be set.
The diagram shows the interrelations.

14.2.2   *SRE

The Service Request Enable Command specifies the bit values of the Service Request Enable Register. This register determines which conditions from the Status Byte Register will cause a Service Request (SRQ) are summarized in the Master Summary Status -MSS- of the Status Byte Register.
A bit value 1 in the Service Request Enable Register selects the corresponding Status Byte Register condition. The bit value of bit 6 (RQS/MSS) is ignored. The command parameter is specified as a decimal using the <Nrf> format; when rounded to an integer value and expressed base 2 (binary), the parameter represents the bit value of the Standard Event status Enable Register. Alternatively, the command parameter may use a non-decimal numeric format (hexadecimal, octal or binary) to express the register's bit setting.

*SRE?

The Service Request Enable Query returns a decimal value, which expressed in base 2, reflects the bit values of the Service Request Enable Register. Bit 6 is always set to 0.

14.2.3 Register diagram
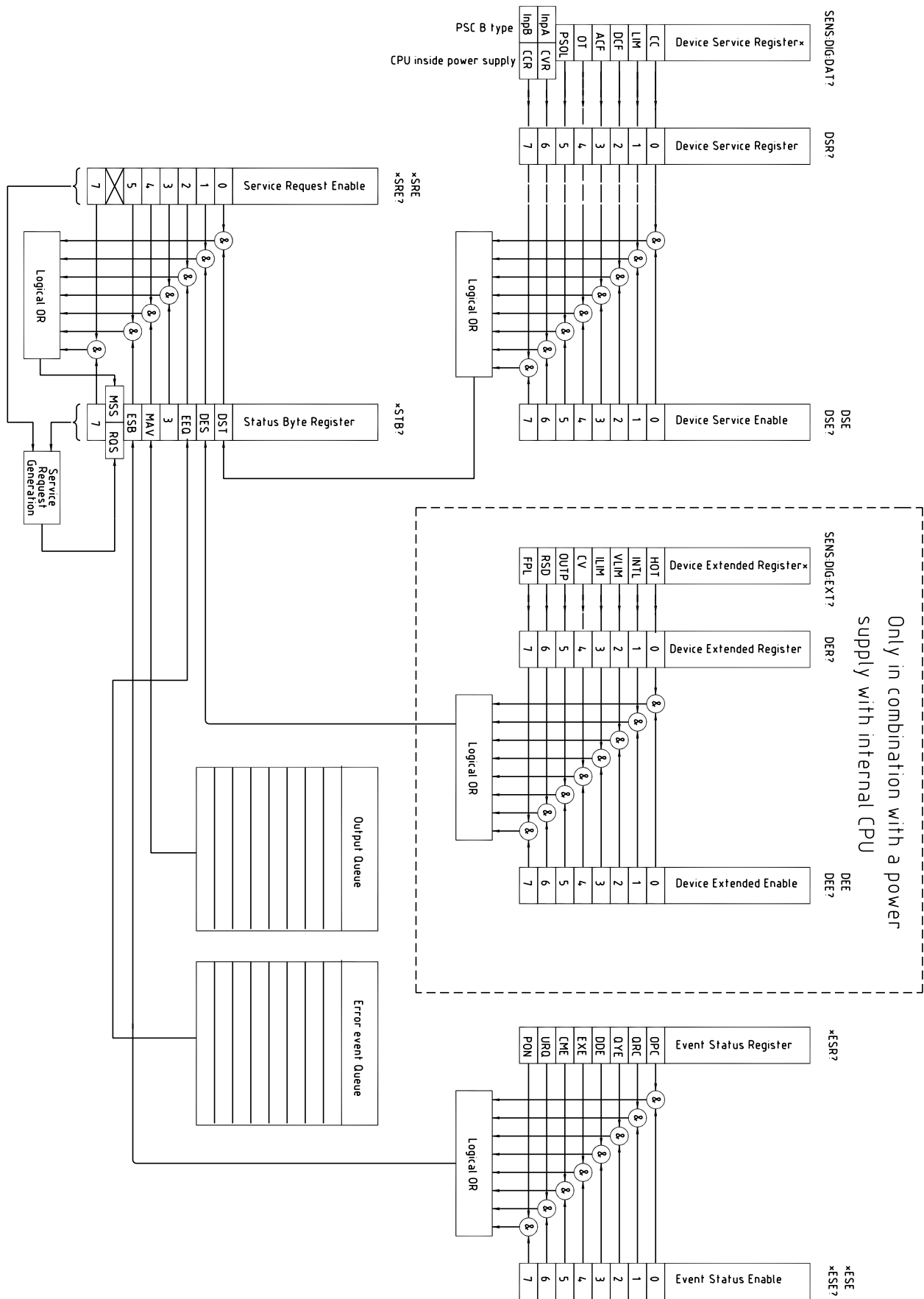
14.2.4 *STB?

The Read Status Byte Query reports the contents of the Status Byte Register. The register contains the summary status of all overlaying registers and status queues. When the Status Byte Register is read by a serial poll from the GPIB, the RQS bit is returned on bit position 6. The *STB? query returns the MSS bit on bit position 6. Reading the status byte by a serial poll or with the *STB? query does not affect its contents. The only exception to this rule is the RQS bit. This bit is always cleared after a serial poll. The other bits are cleared only when the overlaying status structure, which caused the summary bit or with *CLS.

Bit	MNE		Description Status Byte Register
0	DSB	Device Status	Contains the summary of the Device Status register.
1	DEB	Device Extended Status	Contains the summary of the Device Extended status register. Only used by power supply with internal CPU (SM6000)
2			Not used
3			Not used
4	MAV	Message Available	Indicates the 'non-empty' status of the Output Queue; this bit is set True when at least one byte is available in the queue. It is set to False when the Output Queue is empty.
5	ESB	Event Summary Bit	Contains the summary of the Standard Event Status register.
6	MSS	Master Summary Status.	Returned as a response to the *STB? query. Indicates that there is an event that caused the device to request for service. The MSS bit is cleared when the events in the overlaying status structure that caused the service request, are cleared.
6	RQS	Requested Service.	Sent as a response to a serial poll over the GPIB. Indicates that the device requested for service; this means that a SRQ message was issued on the GPIB. It differs from the MSS bit in the fact that the RQS bit is cleared after the serial poll. It is only set True again when a new event occurs that requires service.
7			Not used

For each status structure there is an Event register, that reflects the events themselves, and an Event x Enable

- Register. The Event Enable register selects which events are summarized into the Status Byte Register.
- The Status Byte Register can be read by either Serial Poll or by the *STB? query. The Status Byte Register is cleared only by clearing its overlaying structures.
- The Service Request Enable Register allows to select particular bits from the Status Byte to generate a Service Request (SRQ) on the GPIB.

14.2.5 *CLS

This Clear Status Command clears the device's status structures.

• All Event Registers summarized in the Status Byte.
• The Standard Event Status Register.
• Sets the device into the Operation Complete Command Idle State.
• Sets the device into the Operation Complete Query Idle State.

Note:
The *CLS command does not effect the Output Queue. However if there is data in the Output Queue and a *CLS command immediately followed by a Program Message Terminator is received, the Output Queue will cleared.

Standard Event status Register

This register contains the events that are standardized by IEEE488.2.
Common Commands are provided to access the values associated with the Standard Event Status.

14.2.6 *ESE

The Standard Event Status Enable Command specifies the bit values of the Standard Event Status Enable Register. This register determines which events from the standard Event Status Register are summarized in bit 5, the Event Summary Bit - ESB - of the Status Byte Register.

A bit value 1 in the Standard Event Status Enable Register selects the corresponding event bit in the Standard Event Status Register to be reported in the Event Summary Bit.

The command parameter is specified as a format, a decimal integer value from 0 to 255 and expressed base 2 (binary), the parameter represents the bit value of the Standard Event Status Enable Register.

*ESE?

The Standard Event Status Enable Query returns a decimal value, which expressed in base 2 reflects the bit values of the Standard Event Status Enable Register.

14.2.7 *ESR?

The *ESR? query causes the Standard Event Status Register is cleared.

Example:

send —-> *ESR?

read <—- 28   equals the binary value 00011100

The bits 4 (EXE), 3 (DDE) and 2 (QYE) are set. This means that an Execution Error, a Device Dependent Error and a Query Error has occurred since the last time this register was read.

Note:
The next *ESR? query will return a zero value, if no new events have occurred.

BIT	MNE	Name	Description of the standard Event Status Register
0	OPC	Operation complete	indicates whether an operation is completed or is still pending.
1	QRC	Request Control	Not implemented. Always set to 0.
2	QYE	Query Error	This error will occur when the Message Exchange Protocol is violated. For example, when a query was sent to the instrument and subsequently a new command is sent without first having read the entire response data from the previous query. Also trying to read data from the PSC-488 without first sending a query to the instrument will cause this error. In general a query error is reported because of: • incorrect query response handling. • an un terminated or interrupted action. • a buffer deadlock because the input buffer and output queue are overflown. • indefinite response from the PSC-488.
3	DDE	Device Dependent Error	This error indicates that the PSC-488 could not properly complete some device specific operations.
4	EXE	Execution Error	indicates that a syntactical valid program message is received that can not be executed due to some device specific conditions.
5	CME	Command Error	This error indicates that the instrument detected a syntax or semantic error.
6	URQ	User Request	Indicates that the user has requested for a service.
7	PON	Power-on	Indicates that the device's has been turned off and on since the last time that the register was read or cleared.

14.2.8 DSE

Device Status Enable

This command specifies the bit values of the Device Status Enable Register. This register determines which events from the Device are summarized in bit 7 of the Status Byte Register. A bit value 1 in the DSE selects the associated bit in the DSR (Device Status event Register) to be reported in Bit 0 of the Status Byte Register, the Device Summary Status bit 0.

DSE?

The Device Status Enable query returns a decimal value, which expressed in base 2, reflects the bit values of Device Status Enable Register. The returned value is a NR1 response data type.

14.2.9 DSR?

The Device event Status Register captures transitions in its condition register. An event bit becomes true when the associated condition bit makes a logical 0 to 1 or 1 to 0 transition. The command DSR? returns a decimal value, which expressed in base 2, reflects the bit values of the Device event Status Register. Execution of this query causes the Device Status Enable Register to be cleared. The returned value is a NR1 response data type.

14.2.10 DSC?

The Device Status Condition register contains the power supply's status, and returns a decimal value, which expressed in base 2, reflects the bit values of the Device Status. Execution of this query will not clear this register. The returned value is a NR1 response data type. See the power supply manual to check which statuses are available

BIT	MNE	Description Device Status Condition register
0	CC	Constant Current
1	LIM	Limit
2	DCF	DC Fail
3	ACF	AC Fail
4	O.T.	Over Temperature
5	PSO	Power Sink Overload
6	InpA (CCR)	User input A (CCR when used in a power supply with internal CPU)
7	InpB (CVR)	User input B (CVR when used in a power supply with internal CPU)

14.2.11 DEE

This register is only available when a power supply is used with an internal CPU.

Device Extended status Enable. This command specifies the bit values of the Device Extended status Enable Register. This register determines which events from the Device Extended status Register are summarized in bit 1 of the Status Byte Register. A bit value 1 in the Device Extended status Enable Register selects the corresponding bit in the Device Extended status Register to be reported in Bit 1 of the status byte, the Device Summary Extended status bit.

DEE?

The Device Extended status Enable query returns a decimal value, which expressed in base 2, reflects the bit values of Device Extended status Enable Register. The returned value is a NR1 response data type.

Bit	MNE	Description Device Extended status condition Register
0	HOT	High temperature
1	INTL	Interlock
2	VLIM	Voltage limit
3	ILIM	Current limit
4	CV	Constant voltage mode
5	OUTP	Output on
6	RSD	Remote shut down
7	FPL	Front panel lock

14.2.12 DER?

The Device Extended status Register contains the power supply Extended status change , and returns a decimal value, which expressed in base 2, reflects the bit values of the Device Extended status register. Execution of this query causes the Device Extended status Register to be cleared. The returned value is a NR1 response data type.

14.2.13 DEC?

The Device Extended status Condition register contains the power-supply status, and returns a decimal value, which expressed in base 2, reflects the bit values of the register. The returned value is a NR1 response data type. See the power supply manual to check which statusses are available.

14.2.14 *OPC

The Operation Complete Command allows for synchronization between a controller and several devices. It causes the instrument to set the Operation Complete Command -OPC- bit in the Standard Event Status Register to be set true when all selected pending operations have been finished. This implies that all device operations initiated by previous programming commands have been entirely completed or aborted.

Example:

    Send —->   MEAS:VOLT?

    Send —->   *OPC

The timing diagram related to the internal execution of these commands is shown in the following figure:

```
            ┌─ MEAS:VOLT? ────────┐
            ┌─────── *OPC ────────┐
OPC bit ____│      0              ┌──── 1
```
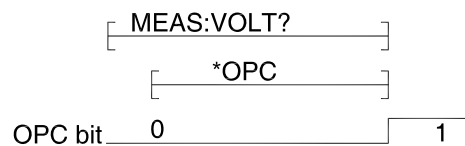
There are two methods of synchronization between application programs and the PSC-488:

*   Use the OPC event bit to generate a Service Request. During the instrument operation, the application program can perform other tasks if the Service Request is used as interrupt.
*   Read the *OPC bit (bit 0) from the standard event register using the common query *ESR?. Wait until the OPC bit becomes set to true.

*OPC?

The Operation Complete Query is a method for synchronization. The Operation Complete Query places an ASCII character"1" in the device Output Queue when all pending operations have been finished.

14.2.15 *RST

The ***RST** command resets the device dependent functions except for memorized configuration settings, protected settings and calibration data.

Voltage	0 V
Current	0 A
Output	Disable
RSD	off
REM	on
REM CV	on
REM CC	on
Front panel	Unlock

14.2.16 *TST?

The Self-Test Query causes the device to execute an internal self-test and reports detected errors.
The PSC-488 will output the ASCII character 0 (20 hex) when the test is passed without failures.

14.2.17 *WAI

The Wait-to-Continue Command is useful after an overlapped command to force sequential execution.
The ***WAI** command will prevent the instrument from executing any further command or query until it has finished the actions started by the overlapped command.

14.2.18 *SAV

Saves settings and calibration data in non-volatile memory registers. It is possible to protect the calibration data with a password. Normally the password is "DEFAULT" and not protected.
After the command **password<wsp>DEFAULT,<new_password>** the new password is active and the ***SAV** works only with the password parameter ***SAV <new_password> .**

14.2.19 *RCL

Recalls the settings and calibration data previously stored with the ***SAV** command.

14.2.20 *IDN?

The Identification Query is used to identify the PSC within a system. The response to the ***IDN?** is an <instrument_identifier> which is organized into four fields, mutually separated by commas (2C-hex).

Field 1	Manufacturer	DELTA ELEKTRONIKA BV	DELTA ELEKTRONIKA BV
Field 2	Model Version	PSC-488 module V 1.0.0,	PSC-232 V 1.0.0,
Field 3	Serial number	123456789012,	123456789012,
Field 4	Custom string	TST. 05\03\01	30 V / 10 A

The maximum number of characters is 72.

Note:
The syntax for the ***IDN?** response is Arbitrary ASCII Response Data. The IEEE488.2 standard requires this data type to be terminated with a Response Message Terminator. Therefore, controllers should send the ***IDN?** query as the last query message unit in a terminated program message. If not, the device will generate a Query Error and will not send the response to the subsequent queries.

The following documents will assist you with programming the IEEE488 interface:

Standard Codes, Formats, Protocols and Common Commands for use with IEEE Std 488.1-1987, IEEE Standard digital interface for programmable instrumentation, IEEE std 488.2-1992 , Published by the Institute of Electrical and Electronics Engineers),
345 East 47th street, New York, NY 10017-2394, USA
ISBN 1-55937-238-9

14.3   SCPI commands

14.3.1   SOurce:VOltage:MAximum

14.3.2   SOurce:CUrrent:MAximum

These commands are used to enter the maximum voltage and maximum current range of the used power supply. For example, the Delta power supply model SM35-45 has a range of 35 volt and 45 ampere. The **SOur:VOlt:MAx<wsp>35** and the **SOur:CUrr:MAx<wsp>45** have to be given before the voltage and current set commands. Save the configuration values in non-volatile memory with the ***SAV** command. The next time settings will automatically recalled at power on.
SOur:VOlt:MAx? and **SOur:CUrr:MAx?** read back the voltage and current settings.

14.3.3   CAlibration:CUrrent:OFfset
CA:CU:OF<wsp><NR1>

Used to calibrate the zero-offset of the current programming.

14.3.4   CAlibration:CUrrent:OFfset?

Reads-back the present offset calibration value of the current programming.

14.3.5   CAlibration:CUrrent:GAin

Used to calibrate the full-scale of the current programming.

14.3.6   CAlibration:CUrrent:GAin?

Reads-back the present full scale calibration value of the current programming.

14.3.7   CAlibration:VOltage:OFfset

Used to calibrate the zero-offset of the voltage programming.

CAlibration:VOltage:OFfset?

Reads-back the present offset calibration value of the voltage programming.

14.3.8   CAlibration:VOltage:GAin

Used to calibrate the full-scale of the voltage programming.

CAlibration:VOltage:GAin?

Reads-back the present full-scale calibration value of the voltage programming.

14.3.9   CAlibration:CUrrent:MEasure:OFfset

Used to calibrate the zero-offset of the current monitoring.

CAlibration:CUrrent:MEasure:OFfset?

Reads-back the present offset calibration value of the current monitoring.

14.3.10 CAlibration:CUrrent:MEasure:GAin

Used to calibrate the full-scale of the current monitoring.

CAlibration:CUrrent:MEasure:GAin?

Reads-back the present full scale calibration value of the current monitoring.

14.3.11 CAlibration:VOLTage:MEASure:OFFSet

Used to calibrate the zero-offset of the voltage monitoring.

CAlibration:VOltage:MEASure:OFfset?

Reads-back the present offset calibration value of the voltage monitoring.

14.3.12 CAlibrate:VOltage:MEasure:GAin

Used to calibrate the full-scale of the voltage monitoring.

CAlibrate:VOltage:MEasure:GAin?

Reads-back the present full scale calibration value of the voltage monitoring.

14.3.13 PAssword

From factory, the password is set to "DEFAULT" and *SAV can be used without parameter.
With the command **PAssword<wsp>DEFAULT,<New_password>** the protection is activated.
"DEFAULT" is the factory default string, <New_password> is the new password.
The string is maximum 8 characters and is not case sensitive. Execution of the *SAV command without valid password causes an execution error 15 (Illegal password).
A few examples:

PA DEFAULT,MYPASSW<LF>

Changes the factory default password into a new password.
After this command the *SAV command works only with a valid password as parameter.
The command:*SAV MYPASSW<LF>.

PA <current_password>,<new_password>

Changes the current password into a new password.

PA MYPASS,DEFAULT

Changes the current password into the factory default. Protection is disabled.

PAssword?

This query returns a 0 if the access is not protected. Otherwise a 1 is returned when the acces is protected with a password.

Forgotten password. With the command PAssword:Reset or abbriviated PA:R the PSC comming into a non calibrated state and the password are set to "DEFAULT".

14.3.14 SOurce:FUnction:RSD<wsp><boolean>

The command SOurce:FUnction:RSD<wsp>{ON|1}or abbreviated SO:FU:RSD<wsp>{ON|1} disables the output of the power supply. The command SOurce:FUnction:RSD<wsp>{OFF|0}or abbreviated SO:FU:RSD<wsp>{OFF|0} enables the output again.

SOurce:FUnction:RSD?

The query SOurce:FUnction:RSD? or abbreviated SO:FU:RSD? returns 1 when the power supply is disabled. Otherwise a 0 is returned.

14.3.15 SOurce:FUnction:OUtA<wsp><boolean>

The command SOurce:FUnction:OUtA<wsp>1 or abbreviated SO:FU:OUA<wsp>1 sets the open collector output A of the PSC-488 to 1.

The command SO:FU:OUtA<wsp>0 sets the open collector output A of the PSC-488 to 0.

SOurce:FUnction:OUtA?

The query SOurce:FUnction:OUtA? or SO:FU:OUA? returns 0 if the digital output A is set to 0. Otherwise , a 1 is returned.

14.3.16 SOurce:FUnction:OUtB <wsp> <boolean>

The command SOurce:FUnction:OUtB<wsp>1or abbreviated SO:FU:OUB<wsp>1 set the open collector output B of the PSC-488 to 1.

The command SO:FU:OUA<wsp>0 set the open collector output B of the PSC-488 to 0.

SOurce:FUnction:OUtB?

The query SOurce:FUnction:OUtB? or SO:FU:OUB? returns 0 if the digital output B is set to 0. Otherwise , a 1 is returned.

14.3.17 SOurce:FUnction:OUTP<wsp>{ON|OFF}

The command SOurce:FUnction:OUTP {on|off} or abbreviated SO:FU:OUTP {on|off} enables (on) or disables (off) the output of the power supply.

SOurce:FUnction:OUTP?

The query SOurce:FUnction:OUTP? Or SO:FU:OUTP? Returns O when the output is disabled, or 1 when the output is enabled.

14.3.18 SOurce:FUnction:FRontpanel Lock

The command SOurce:FUnction:FRontpanel<wsp>{Lock|Unlock} or SO:FU:FR<wsp> {L|U} locks or unlocks the front panel pushbuttons. See the power supply manual for details.

SOurce:FUnction:FRontpanel:Lock?

The query SOurce:FUnction:FRontpanel:Lock? Or SO:FU:FR:L? Returns 1 when the front panel is locked. Otherwise a 0 is returned.

14.3.19 REMote and LOCal

The command **REMote** switches the power supply to remote-control. The command **LOCal** switches the power supply back to manual control.

On some power supplies the selection Remote or Local is done by switches on the power supply itself. On these power supplies the commands REmote and LOcal have no effect.

REMote?

The query **REMote?** returns 0 when the power-supply in local mode. and in remote mode, a 1 is returned.

LOCal

Warning: After the command **LOCal**, the power supply will return to the potentiometers settings on the front panel.

Example: If the front-panel voltage potentiometer is set to 35 volt, the power supply output will go to 35V after the command **LOCal**. Set the potmeters for voltage and current on the front panel to a safe value prior to using the **LOCal** and **REMote** commands.

REMote:CV

When the programming switch 2 of 'SW A' are set to on, the command **REM:CV** switches the power supply to voltage remote-control. The command **LOC:CV** switch the power supply back to manual voltage control.

On some power supplies the selection Remote or Local is done by switches on the power supply itself. On these power supplies the command **REMote :CV** has no effect.

REMote:CV?

The query **REM:CV?** returns 0 when the power supply in voltage local mode and in voltage remote mode, a 1 is returned.

LOCal:CV

Warning: After the command **LOC:CV**, the power supply will return to the potentiometer setting on the front panel (Also see the **LOCal** command).

REMote:CC

The command **REM:CC** switches the power supply to current remote-control. The command **LOC:CC** switch the power supply back to manual current control.

On some power supplies the selection Remote or Local is done by switches on the power supply itself. On these power supplies the command **REMote :CC** has no effect.

REMote:CC?

The query **REM:CC?** returns 0 when the power supply in current local mode. and in current remote mode, a 1 is returned.

LOCal:CC

Warning: After the command **LOC:CC**, the power supply will return to the potentiometer setting on the front panel. (Also see the **LOCal** command).

14.3.20 SOurce:CUrrent <wsp>

This command sets the output current of the power supply. The mode of operation depends upon the load.

SOurce:CUrrent?

This query returns the present setting of the current.

14.3.21 SOurce:VOltage <wsp>

This command sets the output voltage of the power supply. The mode of operation depends upon the load.

SOurce:VOltage?

This query returns the present setting of the voltage.

Note that both voltage and current have to be programmed. It is necessary that the values of both current and voltage are non zero, otherwise the power supply can not function properly. If zero volts is programmed, then the current is limited to zero. If zero current is programmed, then the voltage will not rise!

14.3.22 MEasure:VOltage?

This query returns the voltage measured at the power supply sense terminals.

14.3.23 MEasure:CUrrent?

This query returns the current delivered by the power supply.

Wait for a response from the power supply because it needs time to collect data and send it to the computer.

Note:
When you write a program, you have to take care of the timing.
The ADC needs some time to measure the voltage or current.
See example programs on www.DeltaPowerSupplies.com.

14.3.24 CH

The channel command **CH<wsp>n** is the first command that should be executed to enable the PSC-232xxx type with that channel number. Each unit must have a unique channel number between 0 and 30. The channel can be set with the DIP switch on the front panel of the PSC-232 module or on the back side of an power supply.

CH?

The command **CH?** Reads the channel number of the active PSC-232 and communicates this back to the computer.

14.3.25 Help?

The query **HELP?** returns a list of PSC commands.

14.3.26 SEnse:DIgital:DAta?

The Device Status Condition register contains the power supply status and returns a decimal value, which expressed in base 2, reflects the bit values of the register. The returned value is a NR1 response data type. See the power supply manual if the status available.

14.3.27 SEnse:DIgital:EXtendeddata?

The Device Extended status Condition register contain the power supply status and returns a decimal value, which expressed in base 2, reflects the bit values of the register. The returned value is a NR1 response data type. See the power supply manual if the status available.

14.3.28 SEnse:DIgital:SWitch?

The Digital switch Condition register contain the power supply DIP switch status and returns a decimal value, which expressed in base 2, reflects the bit values of the register. The returned value is a NR1 response data type. See the power supply manual if the DIP switch status is available.

14.3.29 CU

With the CU command you can change the **custom string** of the identity string. See chapter 14.2.20.
The string must have 15 characters including the <lf> and is send via RS232.
Some examples:

CU<WSP>CAL. 01-02-2003   Calibration date

CU<WSP>SM 70-20 no 007   Power supply type and inventory number

After this command you can check it with query *IDN? to display the identify string.
With *SAV you can store the new information in non volatile memory.

15   Error numbers

There are four groups of standardized errors, which are reported in the Standard Event Status and in the Error/Event Queue, namely:

Classification	Standard Event Register
Command Error	bit 5 - CME
Execution Error	bit 4 - EXE
Device-Specific Error	bit 3 - DDE
Query Error	bit 2 - QYE

15.1   Command Error

This error indicates that the instrument detected a syntax or semantic error.

15.2   Execution Error

This error indicates that a syntactical valid program message is received that can not be executed due to some device specific conditions.

15.3   Device specific Error

This error indicates that the PSC-488 could not properly complete some device specific operations.

15.4   Query Error

This error will occur when the Message Exchange Protocol is violated.

For example, when a query was sent to the instrument and subsequently a new command is sent without first having read the entire response data from the previous query. Also trying to read data from the PSC-488 without first sending a query to the instrument will cause this error.

In general a query error is reported because of:

- Incorrect query response handling.
- An unterminated or interrupted action.
- A buffer deadlock because the input buffer and output queue are overflown.
- Indefinite response from the PSC-488.

Error number	
1	Syntax error
2	Channel-number error
3	Numerical-value error
4	Command without full-scale
5	Maximum voltage range error
6	Maximum current range error
7	Data out of range
8...12, 16	Non volatile memory error
13	Checksum error
14	Overflow

15	Illegal password
17	Invalid character
18	Not connected with PSU
19	Command not support, wrong configuration

16   Software examples and programs

Files on web site**:**

- Datasheet
- Manual
- RS232 and GPIB Calibration Program
- IBIC test scripts
- Labview VI for PSC-232 and for PSC-488

WEEE (Waste Electrical & Electronic Equipment)

Correct Disposal of this Product
Applicable in the European Union.

This marking shown on the product, its packing or its literature indicates that it should not be disposed with other wastes at the end of its working life, but should be collected separately to recycle it responsibly to promote the sustainable reuse of material resources.