Programme Controller **TC S2**

Bedienungsanleitung

Operating Instructions

bentrup

Erläuterung Anzeige

1 - Zeiger auf aktuellen Programmabschnitt

2 - Programmlaufanzeige und gewählte Programmnummer

3 - Aktuelle Temperatur, Sollwert und Ausgangsleistung *

4 - Programmtabelle mit Segmentnummer, Zeit, Temperatur und ggf. weiteren Werten *

5 - aktuelles Segment und Restzeit im Segment

6 - Zustand der ersten fünf Schaltausgänge

7 - Echtzeituhr (Zeit / Datum) *

8 - zusätzlicher Prozesswert (z.B. Werkstück) *

9 - Funktion der Softkeys X und Y (16)

** Darstellung von Konfiguration abhängig*

Erläuterung Tastatur

10 - Cursortasten (Tastenkreuz)

11 - Programmwahltaste

12 - Plus/Minustaste zur Werteverstellung

13 - Manuell Modus und Konfiguration

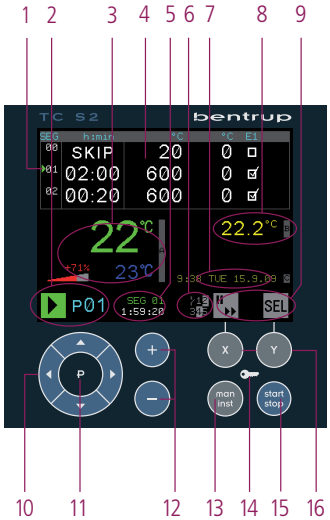
14 - Tastaturverriegelung

15 - Programmstart bzw. -stopp

16 - Softkeys X und Y (Funktion s. Symbol in 9)

Bedienungsanleitung vor der Benutzung aufmerksam durchlesen

Please read through this booklet carefully before using your controller



Explanation of the Graphical Screen

1 - pointer to the current programme segment

2 - programme run indicator and selected programme number

3 - current temperature, setpoint and power output percentage *

4 - programme table with segment number, dwell time, temperature and further parameters *

5 - current segment no. and remaining time

6 - status of the first five control outputs

7 - real time clock (time / date) *

8 - additional process indicator (e.g. kiln item) *

9 - function of the softkeys X and Y (13 or 17)

** appearance depends on configuration settings*

Explanation of the keypad

10 - cursor keys (up/down/left/right)

11 - programme selection key

12 - plus/minus keys to adjust values

13 - manual mode and configuration

14 - keypad lock

15 - programme start or -stop

16 - softkeys X and Y (functions see symbol in 9)

Vorwort

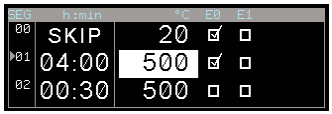
Der bentrup TC-S2 vereint modernste Regelungstechnik bei einfachster Handhabung. Er ist ein leistungsfähiger, Multikanal-Kompaktregler der höchste Ansprüche an Sicherheit und Genauigkeit erfüllt.Die Reglerstruktur wird werksseitig auf Ihre Anwengung konfiguriert. Sehen sie die Technische Anleitung auf www.bentrup.de zur Installation.

Programmeingabe

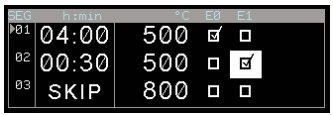
Das Temperaturprofil wird als Folge von Zeit/-Temperaturwerten (Segmenten) eingegeben. Je nach Anwendung werden für jedes Segment weitere Werte angegeben (z.B. Abluftklappe auf/zu). SKIP (=Sprung) steht für ungeregeltes Aufheizen.

Nebenstehende Programmtabelle Bild A zeigt ein Temperaturprofil mit sofortigem Start (SEGment 0, 20°C) in 4 Stunden auf 500°C (Segment 1) und anschließendem 30 Minuten Halten auf 500°C (Segment 2). Wählen Sie über die Cursortasten den Wert in der Programmtabelle aus und ändern Sie ihn über die Plus/Minustasten. Für größere Werteänderungen halten Sie die Taste gedrückt.

Beispiel in Bild B zeigt eine Konfiguration mit Klappensteuerung über Events. In jedem Programmsegment kann der Zustand der Abluftklappe voreingestellt werden (im Beispiel wird Event 1 (E1) in Segment 2 eingeschaltet).



(A)



(B)

Introduction

Your bentrup TC-S2 combines the latest controller technology with very simple operation. It is a powerful multi loop compact controller which complies to the highest level of accuracy and safety. The controllers is preconfigured from your supplier to fit your application. For details please refer to the Technical Manual available on www.bentrup.com.

Entering a Programme

The temperature profile is entered as a sequence of time/temperatures per segment. Depending on the application additional parameters are required per segment (e.g. damper open/close. SKIP stands for uncontrolled heating/cooling.

Programme table depicted in fig. A shows a profile with immediate start (SEGment 0, 20°C) heating up in 4 hours to 500°C (segment 1) followed by a 30 minutes dwell at 500°C (segment 2). Navigate using the cursor keys in the programme table and change the value pressing the plus/minus keys. For major value changes keep the key pressed.

Example fig. B shows a configuration with a controlled damper using events. For every segment you can programme the status open/close of the damper (the example given shows event 1 (E1) in segment 2 turned on).

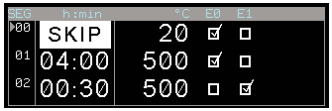
In Segment 0 kann (ausschließlich) eine Programmstartverzögerung eingeben werden. Segment 0 muss in jedem Fall eingegeben werden (Zeit auf SKIP), weil dadurch auch die Anfangstemperatur der folgenden Rampe festgelegt wird (siehe Beispiel A, Segment 1 "Aufheizen von 20°C auf 500°C in 4 Stunden").

Geben Sie das gesamte Temperaturprofil ein. Die maximale Anzahl Segmente wir in der Konfiguration festgelegt. Am Programmende wird als Zeit "END" eingestellt. HOLD bedeutet, dass der Regler bei Erreichen des Segments anhält, bis der Benutzer auf Tastendruck den Ablauf fortsetzt. Drücken Sie die Plustaste während der Zeitangabe lang, wechselt der Regler nach Überlaufen der Maximalzeit (Standardwert 99 Stunden 59 Minuten) in den Eingabemodus Temperatur pro Zeit (siehe Bild B für alle Beispiele).

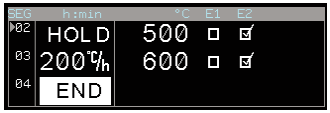
Einfügen und Löschen von Segmenten

Ermöglicht das schnelle Ändern von bestehenden Programmen, ohne die hinterliegenden Segmente neu von Hand eingeben zu müssen.

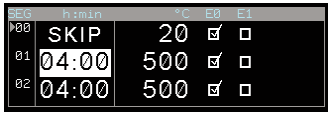
Zum Einfügen wählen Sie mit den Cursortasten das entsprechende Segment an. Drücken **und halten** sie nun die **Programmtaste** gefolgt von der Cursortaste **rechts**. Das aktuelle Segment wird verdoppelt und folgenden Segmente um eins nach hinten verschoben (Bild C).



(A)



(B)



(C)

Segment 0 is to be used for a delayed programme start ONLY. However, segment 0 needs always to be entered (set time to SKIP) to define the starting temperature of the ramp in segment 1 (see fig. A, segment 1 "heating up from 20°C to 500°C in 4 hours").

Now enter the entire temperature profile. The maximum number of segments is set in the configuration. At the end of the programm set the time to 'END'.

The setting 'HOLD' causes the controller to hold when reaching the segment until the operator continues the programme by pressing a key.

Keep the plus key pressed to change from time to gradient (°C/h) once it overruns the maximum time of 99 hours 59 seconds (refer to fig. B for all examples)..

Inserting and Deleting Segments

Allows quick changing of existing programmes without having to re-enter all segments.

To insert a segment navigate to the segment using the cursor keys. Now press **and hold** the programme key followed by the key **to the right**. The current segment is doubled and segments behind are moved by one segment towards the end (fig. C).

Zum Löschen eines Segmentes drücken **und halten** sie die Programmtaste gefolgt von der Cursortaste **links**. Das aktuelle Segment wird gelöscht und die folgenden Programmsegmente verschieben sich nach vorne (Bild A).

(A)

Werte der Programmtabelle

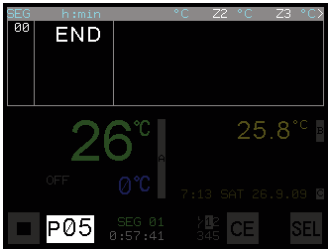
Je nach Anwendung ist die Programmtabelle für Ihre Anwendung vorkonfiguriert. Beispielsweise könnte diese bei einem 3-Zonenofen mit Zu- und Abluftklappe wie in Bild B gezeigt aussehen. Die Marke oben rechts zeigt, dass ein Teil der Programmtabelle erst beim scrollen mit dem Cursor anzeigt wird.

In nebenstehenden Beispiel ist für die dritte Zone während Segment 1 eine Temperaturminderung von 10°C vorgegeben, d.h. diese Zone wird beim Aufheizen auf 10°C bis 390°C geführt.

(B)

Programmspeicher

Je nach Konfiguration werden bis zu 99 Programme gespeichert. Drücken sie die Programmwahltaste und wählen die gewünschte Programmnummer mit den Plus/Minustasten aus. Die Programmtabelle zeigt das gewählte Programm (Bild C, werksseitig leer). Während des Programmlaufs kann kein neues Programm gewählt werden (zuerst Programmlauf stoppen).



(C)

To delete a segment press **and hold** the programme key followed by the key to the left. The current segment is deleted and the segments behind area shifted towards to the programme beginning (fig. A).

Values of the Programme Table

The programme table is preconfigured depending on your application. On a three zone kiln with air let and exhaust air damper, for instance, the programme table might appear as shown in fig. B. The marker in the upper right hand corner indicates a part of the table visible once the cursor is scrolled to the right hand side.

Example shows a temperature drop of 10°C for zone no. three during segment 1, ie. this zone is controlled by 10°C to 390°C.

Programme Memory

Depending on Configuration up to 99 temperature profiles are saved as programmes. Press the programme selection key and choose the programme no. using the keys plus and minus. The programme table shows the selected programme (fig C, programmes are empty ex factory). To change a programme no. when a programme is in progress you have to stop the current prog. first.

Programmlauf

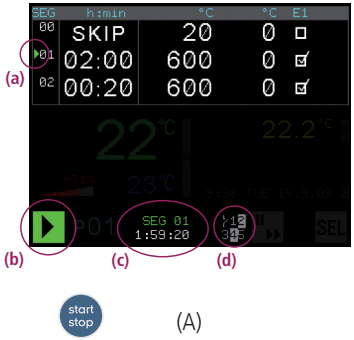
Durch Betätigen der Taste Start/Stop wird das aktuell gewählte Programm gestartet (Bild A). Symbol (b) zeigt 'Programmlauf' an, das aktuell abgearbeitete Segment und die berechnete Restzeit im Segment wird in (c) angezeigt. (a) zeigt in der Programmtabelle ebenfalls auf das aktuelle Segment. Der Zustand der ersten fünf Schaltausgänge wird in (d) angezeigt (invertiert = an). Die Bedeutung der Schaltausgänge (z.B. 'Heizen Zone 1') wird in der Konfiguration festgelegt.

Über die Softkey-Taste X kann der Programmlauf angehalten werden; hierbei wird die Zeit (und damit in Rampen auch die Temperatur) angehalten werden, der Regler bleibt aber aktiv. Dieser HOLD-Modus wird durch ein entsprechendes Symbol angezeigt und erst durch erneutes Drücken der Softkey-Taste X verlassen (Bild B).

Halten sie die Softkey-Taste X drei Sekunden gedrückt, um sofort ins nächste Programmsegment zu springen (Bild C).

Bei Programmende erscheint in der Segmentanzeige "finished" und links in der Anzeige wird das entsprechende Symbol angezeigt (Bild D).

Die Funktion der Softkeys wechselt je nach aktueller Erfordernis.



start stop

(A)

(B)

(C)

(D)

Programme Run

Press the key start/stop to commence the current selected programme (fig. A). Icon (b) indicates active programme run, the segment currently processed and the remaining segment time is shown in (c). (a) points to the current segment in the programme table. The status of the first five control outputs is shown in (d), invers = active. The control outputs are assigned in the controllers configuration.

To hold the programme press softkey X; this stops time count and therefore temperature increase in ramps. Controlling operation, however, stays active. The hold mode is shown by the corresponding yellow icon and is released by pressing the softkey X again (fig. B).

Hold the softkey X pressed for 3 seconds to immediate skip into the next programme segment (fig C).

When the programme is completed segment display changes to "finished" and the grey icon for IDLE is shown (fig D).

The function of the softkey changes depending on the current demand.

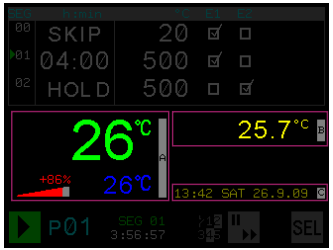
Anzeige der Prozesswerte

Anordnung, Größe, Farbe und Art der Darstellung wird in der Konfiguration festgelegt. Bild A zeigt ein Beispiel mit Anzeige von 3 Prozesswerten:

(a) eines Regelkanals mit Istwert (grün), Sollwert (blau) und Heizleistung (rot für Heizen und blau für Kühlen). Falls die Isttemperatur nicht nachgeregelt werden kann, wechselt die Anzeige auf rot.

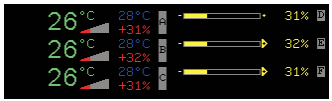
(b) einer zusätzlich gemessener Temperatur (z.B. einer Werkstücktemperatur (gelb)

(c) der aktuellen Uhrzeit und dem Datum (braun)



(A)

Beispielsweise könnte die Prozesswertanzeige eines für einen 3-Zonen-Gasofen wie in Bild B aussehen. Links sind die 3 Regelkanäle dargestellt, auf der rechten Seite die Aktivität der angesteuerten Gasventile (+ = Öffnen/ - = Schliessen).



(B)

Anzeige bei Messfehler

Bei nicht oder falsch gepolt angeschlossenem Messfühler erscheinen Fehleranzeigen (Bild C). 'over' wird bei Messbereichsüberlauf (z.B. offener Eingang), 'under' / 'udr' wird bei Unterschreiten des Messbereichs (z.B. Thermolement falsch gepolt) und 'inval' bei anderen Problemen (z.B. kein CJC-Wert) angezeigt. Die Meldung verschwinden nach Behebung der Ursache.

(C)

Display of the Process Values

Arrangement, size, colour and kind of appearance is determined in the configuration. Fig. A shows a typical display providing 3 process values:

(a) control loop value with current process temperature (green), setpoint (blue) and control output (red on heating, blue on cooling). If the temperature gets out of control range it is shown in red.

(b) an additional process temperature (ie. the temperature of a kiln item (yellow)

(c) current date and time (brown)

For example on a 3 zone gas kiln the process value display could look as appears in fig. B. On the left hand side the control loops are shown, on the right the position and activity of the servomotors (+ = open, - = close).

Readings on Errors

If a probe is not (or wrongly) connected to the controllers input an error message is shown (fig. C). 'over' stands for signal range overflow (e.g. open input), 'under' / 'udr' is shown if the signal range is undershoot (e.g. a bad polarized thermocouple), 'inval' points to various causes (e.g. no CJC temperature). The message disappears automatically once the cause is solved.

Anzeigen im Regelkanal

Bild A links zeigt einen auf Heizen/Kühlen konfigurierten Regelkanal (aktuelle Kühllleistung 74%).

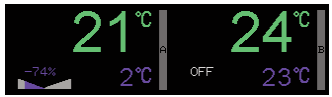
Der Regelkanal in **Bild A rechts** ist trotz Programmlauf deaktiviert ('OFF'), z.B. wenn bei einem Gasofen die Brenner nicht freigegeben sind (über C-PID-Funktion, siehe Konfiguration).

Bild B links zeigt einen Regelkanal im Fehlerzustand (OVER), verursacht durch einen Fehler des Prozesswertes (z.B. Thermoelement defekt).

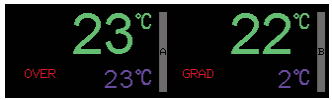
Der Regelkanal in **Bild B rechts** meldet Gradientenfehler, d.h. die konfigurierte Aufheizkontrolle hat abgeschaltet. In beiden Fällen wird der Kanal erst wieder aktiv, wenn der Fehler über Softkey-X (CE) quittiert oder das Programm neu gestartet wurde.

Über den Softkey Y (SEL) wird zu weiteren Seiten mit Prozesswerten geblättert. Der in Bild C dargestellte Zustand aller Ein/Ausgänge ist z.B. bei Inbetriebnahme eines Ofens interessant. Links wird für jeden digitalen Ein/Ausgang an/aus angezeigt (rot=Fehler, grau= unbestückt), Rechts der Messwert für alle analogen Ein/Ausgänge (rot=Fehler, grau=unbestückt /unbenutzt).

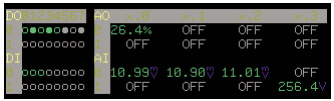
Weitere Fehleranzeigen: **ov.ld** = Spannungsausgang Überlast, **open** = Stromausgang offen, **offli** = IO-Karte offline/defekt, **unrel** = Messwert unsicher (z.B. nach booten).



(A)



(B)



(C)

Readings of a control loop

Fig. A left hand side reads a control loop configured for heating and (currently 74% cooling).

The control loop **Fig. A right hand side** is deactivated ('OFF') although a programme is active, e.g. since the burners of a gas kiln are disabled (for details see configuration of C-PID feature).

Fig. B left hand side reads a control loop in error state (OVER), caused by an error of the process value (e.g. a broken thermocouple).

The control loop **Fig. B right hand side** reports gradient error, ie. the configured gradient check failed. The control loop is turned off, to reactivate the control loop the error must be cleared pressing softkey X (CE) or the programm restarted.

Use the softkey Y (SEL) to browse to further process value pages. Fig. C reads the entire Input/Output status of the controller, very helpful for commissioning a kiln. On the left hand side on/off is shown for every digital I/O (red=error, grey=not physically existing), right hand side the signal value for all analogue I/Os (red=error, grey not physically existing or disabled by the config).

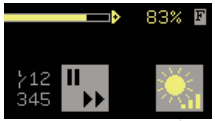
Additional error readings: **ov.ld** = voltage output mode overload, **open** = current output mode open circuit, **offli** = IO-board offline/broken, **unrel** = signal unreliable (e.g. during booting).

Weitere Bedienoptionen

Zum Schutz gegen unbefugtes Bedienen halten sie die **Schlüsseltaste** gedrückt, bis das Verriegelungssymbol erscheint (3 Sekunden). Nun können nur noch über Softkey Y (SEL) Werte abgefragt werden, alle weiteren Eingaben sind gesperrt. Die Fernsteuerung über die RS485 Schnistelle ist weiterhin möglich (Bild A).

(A)

Zur Veränderung der **Helligkeit der Anzeige** halten Sie den **Softkey Y** gedrückt. Nach 3 Sekunden wechselt das Icon und es kann durch wiederholtes Drücken die Helligkeit in 3 Stufen eingestellt werden (Bild B).

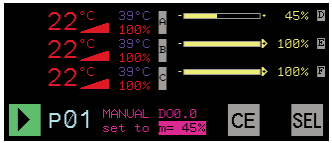


(B)

Y

Manuelle Steuerung der Ausgänge

Drücken Sie die Taste **man/inst** um in den manuellen Modus zu gelangen. Mit den Cursortasten rechts/links wird der zu verändernde Parameter ausgewählt (Restzeit im Segment/aktuelles Segment/digitale Ausgänge/analoge Ausgänge). Bei den Ausgängen wird über die Cursortasten up/down noch der genaue Ausgang angewählt; mit den Plus/Minustasten können Sie einen Wert vorgeben, der den Reglerwert überschreibt. Durch "CE" wird wieder der Reglerwert verwendet (Anzeige "aut"). Erst nach Verlassen des manuellen Modus (über man/inst) übernimmt der Regler wieder die komplette Kontrolle (Bild C).



(C)

man inst

Additonal Operating Features

To prevent unauthorized controller operation hold the **key button** pressed until the key icon appears (3 seconds). Now, only softkey Y (SEL) is in function to display values, all other operations are locked. Remote control via RS485 is not affected. Press and hold key button again for 3 seconds to unlock the controller (Fig C).

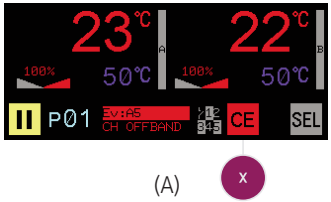
To adapt the **brightness of the screen** hold the **softkey Y** pressed until the softkey icon changes (fig B). Now press the softkey multiple times to change screen brightness (3 levels).

Manual Operation of the Outputs

Press the key **man/inst** to enter manual mode. Use the left/right arrow keys to select the parameter to change (possible choices are remaining segment time/segment no./digital outputs/analogue outputs). When selecting outputs the actual output number is chosen by the up/down arrow keys; use the plus/minus keys to operate the output manually (fig C). Press softkey X (CE) to release the selected output back to automatic ('aut') or key man/inst to quit manual mode (releases all outputs to automatic).

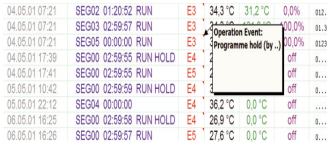
Ereignis- und Fehlermeldungen

Bestimmte in der Konfiguration festzulegende Probleme werden vom TC-S2 erkannt und per Ereignis- oder bei schweren Problemen - Fehlermeldung angezeigt. Je nach Einstellung führen diese zum Programmhalt (Bild A) oder Programmabbruch. Nebenstehend wird ein Event A5 dargestellt, der mit dem Stoftkey-X (CE) quittiert werden muss (die aktuellsten 5 Meldungen).



(A)

Wichtige Ereignis- und Fehlermeldungen werden im Regler geloggt und bleiben auch nach dem Ausschalten erhalten. Die letzten ca. 50 Meldungen können z.B. über WinConfig in EXCEL eingelesen werden und ermöglichem dem Servicetechniker effiziente und schnelle Hilfe (Bild B).



(B)

Ein überwachter Regelkanal hat wegen Fehler des Prozesswertes abgeschaltet. Rücksetzen des Regelkanals über 'CE'. Überprüfen sie den Messfühler bzw. die Zuleitung zum Messfühlers, den Anschluß oder den konfigurierten Messbereich.

```
Ev:A1
CHAN FAIL
```

Aufgrund eines schweren Fehlers wurde das aktuelle Programm beendet, d.h. der Regler ist direkt ins Abkühlsegment gesprungen. Die Kriterien für einen Programmabbruch werden in der Konfiguration festgelegt. Überprüfen sie die Einträge im Event- und Fehlerlog zur Festellung der Ursache.

```
Ev:A2
END PROG
```

Event and Error Messages

Certain conditions are defined in the configuration and are recognized by the TC-S2 and cause an event message or - on more severe problems - an error message to be displayed. Depending on configuration they cause a programme hold or termination of programme run. Fig A shows event message A5, press softkey X (CE) to clear. Five most recent messages are kept.

Important event and error messages are logged in the controller and kept also after power off. The 50 most recent event- or error messages can be downloaded via bentrup WinConfig to EXCEL and allow detailed examination of even well hidden technical problems (fig B).

A monitored control loop has turned off due to an error of the process value. Reset by pressing softkey X ('CE'). Check the temperature sensor or all wiring and connections and make sure the input value range is configured properly.

Due to a severe error the programme run has been terminated,ie. the controller jumped straight into the cooling segment. The process criteria to terminate a programme are set in the configuration. Check the event/error log to determine the cause of the problem.

Im Master / Slave Betriebsmodus hat ein Slave-Regler ein schweres Problem gemeldet. Details sind am Slave zu erkennen und zu beheben.

Ev:A3
ERR SLAVE

During master / slave operation a slave controller has reported a severe problem. Check the slave controller to identify and solve the cause.

Ein überwachter Regelkanal hat Gradientenfehler gemeldet (zu geringes Aufheizen trotz maximaler Heizleistung oder Problem durch Betriebseingriff). *Diese Meldung weist eindeutig auf ein Problem am Ofen hin!* Überprüfen sie Heizspiralen, Netzphasen, alle Schützkontakte auch nach längerem Betrieb. Stellen sicher, dass das Thermoelement korrekt der Tempeartur ausgesetzt ist und die Zuleitung nicht kurzgeschlossen ist.

Ev:A4
CHAN GRAD

A monitored control loop has reported a gradient error (temperature increasing too slow despite full power heating or kiln interrupted). *This error message points clearly to a kiln problem!* Carefully check heating elements, mains supply/lines, contactor (also when warm). Make sure the thermocouple is exposed properly to the temperature and the thermocouple leads are not short circuited.

Wenn die Temperatur nicht dem vom Progamm vorgegebenen Anstieg folgt, geht der Regler in HOLD und zeigt diese Meldung an. Hiedurch wird dem System Zeit gegeben, die Temperatur aufzuholen. Sowohl die Kriterien als auch das Verhalten des Reglers, falls die Temperatur nicht innerhalb einer einstellbaren Zeit aufgeholt wird, werden in der Konfiguration festgelegt. Hinweis für Mehrzonensysteme: Physikalisch bedingt können die Temperaturen aller Zonen nur ausgeglichen werden, wenn alle Kanäle im Regelbereich sind. Hierfür ist diese Funktion besonders hilfreich.

Ev:A5
CH OFFBAND

If the temperature does not follow the programmed rate the controller enters HOLD state and shows this event message. This gives the system time to catch up with the temperature. The criteria for holding, as well as the reaction if the situation is not solved during hold, can be determinend by the configuration. Note for multi zone controllers: The temperature in the different zones can only be equalized if all zones are within control range. The holding feature is to ensure this physical limitation can be observed as long as possible.

Nach einem Ev A5 hat das System erfolgreich Temperatur aufgeholt, daher wurde der Programmlauf fortgesetzt. Diese Meldung wird zur Information für eine Minute angezeigt.

Ev:A6
CHAN CONT

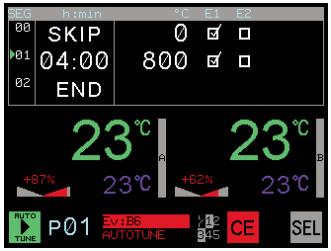
After entering Ev A5 holding the system has successfully caugth up with the temperature, therefore programme run has been continued. This message is displayed for one minute.

Nach einem Ev A5 hat das System den Temperaturrückstand nicht aufgeholt, darauf wurde der Programmlauf gemäß Konfiguration abgebrochen.	Ev:A7 CHAN BREAK	After entering Ev A5 holding the system failed to catch up the temperature, therefore programme run has been terminated according to the configuration.
Nach einem Ev A5 hat das System den Temperaturrückstand nicht aufgeholt, gemäß Konfiguration wurde der Programmlauf trotzdem fortgesetzt. Diese Meldung wird für eine Minute angezeigt.	Ev:A8 CHAN OB/C	After entering Ev A5 holding the system failed to catch up the temperature, however, as requested by configuration the programme is continued. This message is displayed for one minute.
Ein Segment wird erst normaler Weise erst beendet, wenn die Temperatur aller überwachten Zonen den Endwert erreicht hat. Um ein Hängenbleiben zu vermeiden überprüft der Regler, ob die Temperaturen sich noch annähern, andernfalls beendet der Regler das Segment trotzdem ('Emergency Exit')	Ev:A9 CHAN EM/E	Usually a segment is terminated if the temperature of all monitored zones matches the final value. However, to avoid a deadlock the controller enters next segment if it finds zone temperatures are not approaching any more ('Emergency Exit').
Reglerneustart trotz ausreichender Versorgungsspannung. Prüfen Sie korrekte Erdung und externe Störsignale.	Ev:B1 PWG CONT	Controller restart although power supply is good. Check proper grounding of the controller and verify no noisy electrical environment.
Nach Wiederkehr der Netzspannung wurde der Programmlauf automatisch forgesetzt. Kriterien werden in der Konfiguration eingestellt.	Ev:B2 PWF CONT	Programme is continued automatically after power failure. Criteria are to be set in the configuration.
Trotz Wiederkehr der Netzspannung wurde das Programm nicht fortgesetzt, weil 1=durch Konfiguration verboten, 2=DO war inaktiv, 3=Maximalzeit überschritten, 4=Temperaturabfall zu groß	Ev:B3.x PWF BREAK	After power was reestablished the program is not continued due to 1=disabled by configuration 2=DO not active, 3=maximum period expired, 4=Temperature dropped too much

Autotune kann nicht durchgeführt werden, weil der konfigurierte Regelalgorithmus hierfür ungeeignet ist.	Ev:B5 AT BADP	Unable to perform autotune since the configured control algorithm is not suitable (must be PID / C-PID)
Autotune (Selbstoptimierungszyklus) aktiv. Details siehe Kapitel weiter hinten in dieser Anleitung	Ev:B6 AUTOTUNE	Autotune self optimization in progress. For details see chapter further on in this booklet
Autotune wurde abgebrochen, weil während des Vorgangs ein Regelkanal in Fehlerzustand gegangen ist. Hierdurch ist kein aussagekräftiges Ergebnis möglich.	Ev:B7 AT FAILED	Autotune was cancelled due to one control loop entered error state. All control must work properly to get a reasonable result.
Autotune wurde zu Ende geführt, die ermittelten Parameter wurden nach Evaluierung jedoch als nicht geeignet befunden. Sicherheitsfeature zur Vermeidung von Fehlfunktion.	Ev:B8 AT INV RUN	Autotune was completed but the calculated parameters were evaluated as unsuitable. This safety relevant feature avoids bad control results on strange parameters.
Autotune wurde erfolreich zu Ende geführt und die ermittelten Parameter für aussagekräftig bewertet und in die Konfiguration geschrieben.	Ev:B9 AT SUCCESS	Autotune was completed successfully, the results are considered valid and the new PID parameters were saved to the configuration.
Internes technisches Problem: Mess-Signalverstärker defekt. Wenden sie sich an den Kundendienst.	Ev:C1 AD FAIL	Internal technical problem. Signal converter broken. Service required.
Internes technisches Problem: Mess-Signalverstärker ungenau. Wenden sie sich an den Kundendienst.	Ev:C2 AD INACCUR	Internel technical probelm. Signal converter self validation failed. Service required.
Die Ein/Ausgabeeinheit in Slot Nr. # hat ein Problem gemeldet. Überprüfen Sie den korrekten Sitz und Installation.	Ev:C3.# IO EXP ERR	The Input/Output extension in slot no. # failed. Check proper installation and possible IO board error indicator.
Die interne PLC (optionales, sehr leistungsfähiges Feature) hat ein Problem gemeldet. Verbinden sie den Regler zur Diagnose mit der bentrup PLC-download-Utility.	Ev:C5 PLC ERROR	Integrated PLC (a very smart and powerful feature) reported a problem. Use the bentrup PLC download utility to further diagnose the cause of the problem.
Hardwareproblem des Reglers, konsultieren sie den Kundendienst (# steht für 1=CPU, 2=RAM, 3=I2C Bus, 4=I2C Device, 5=Kalibrierungsdaten Prüfsummenfehler)	Ev:D# PLC ERROR	controller hardware problem, service required (# stands for 1=CPU, 2=RAM, 3=I2C bus, 4=I2C device, 5=calibration data checksum error)

Autotune

Zur automatischen Optimierung der PID-Parameter kann ein spezieller Autotune-Vorgang gestartet werden. In diesem werden durch ein absichtliches oszillieren nach dem Ziegler-Nichols-Verfahren die Parameter ermittelt und in der Konfiguration abgelegt. Durch die permanente Optimierung ist dieser Vorgang eigentlich entbehrlich. Falls sie ihn trotzdem starten wollen, stellen sie in Segment 1 die Optimierungstemperatur ein und starten sie Autotune über **Softkey-X** und gleichzeitig **start/stop**.



Autotune

To tune in the PID parameters of the control loop a self optimization firing can be started. During this procedure the controller oscillates the temperature and calculates the PID parameters according to the Ziegler-Nichols algorithm and saves them into the configuration. Due to the permanent self tune of TC-S2 this autotune is actually not required. If you still want to do an autotune set segment 1 to the target temperature and start autotune by pressing simultaneously **softkey X** followed by **start/stop**.

Neustart eines Programmes

Ein Programm wird nach Anwahl immer bei Segment 0 gestartet. Bei stoppen und wieder starten wird der Vorgang jedoch im zuletzt abgearbeiteten Segment ausgeführt. Falls sie das Programm von Anfang an gestartet haben wollen, wählen sie kurz ein anderes Programm an.

Restarting a Programme

If you select and start a programme it will always start at segment 0. If you stop and start a programme again, it continues the segment. If you want to restart a programme from segment 0 select a different programme for a moment and then start the requested programme.

Verhalten bei Netzausfall

Bei Ausfall der Stromversorgung wird das Programm unterbrochen und nach Wiederkehr im entsprechenden Segment fortgesetzt. In einer Haltezeit wird ab einem gewissen Temperaturabfall die Rampe davor angesprungen, um das Brenngut bestmöglich zu schützen.

Reaction on Power Failure

After the power is reestablished the programme continues automatically (check configuration for details). During a dwell the preceeding ramp is repeated if the temperature dropped essentially during the power breakdown period. This ensures the quality of the firing goods.

Technical Manual (english only)

Mechanical Installation

Electrical Installation

Configuration

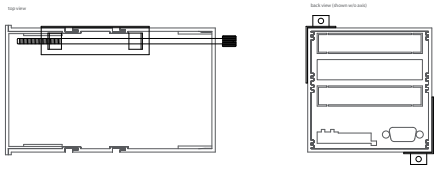
Programme Controller **TC S2**

Mechanical Installation

TC-S2 comes in a standard 96x96mm DIN case for panel mounting. The recommended panel cutout dimension is 92x92mm, the controllers depth is 155mm (175mm space for leads etc.).

Use the two stainless steel brackets to fix the controller into the panel. Do not overtighten the screws to avoid case distortion.

If you need to build an array of TC-S2 close together (e.g. master / slave operation) ask us for the specially designed "narrow brackets". These brackets allow very close arrangement of TC-S2 as well as they have long knurled screws to allow tool-free assembly / disassembly.



Ambient Conditions

Make sure that the ambient temperature does not exceed 50°C (122°F). Maximum power dissipation of TC-S2 is 18 W only.

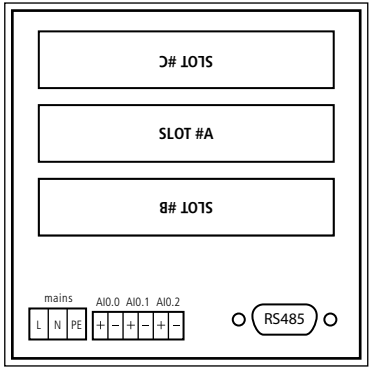
TC-S2 is tolerant to humidity as long it is non-condensing. If enviromental conditions might cause this issue install climatization in your control panel. Especially during winter, allow controller to warm up to room temperature before powering up. This allows condensing water which builds up on cold surfaces to evaporate before electrical damage occurs.

Although TC-S2 complies to highest passive EMC levels we recommend - as a basic rule - to keep away from high noise emitting components like contactors or lines driven by frequency inverters. The use of noise suppressing devices is always recommended. Note that even if such noise does not affect controller operation it will cause induction to all signal lines. TC-S2 is fitted with intelligent filters, however, compensation is limited by physical laws.

Electrical Installation

All electrical links to the TC-S2 are pluggable screw type connectors (PHOENIX or similar). Please refer to the sketch on the right. Depending on the configuration, expansion boards are installed in slots A, B and C. The connections of the TC-S2 basic model are as follows:

mains - power supply 85-264V AC/DC (on request 24V AC/DC)
AI0.0, AI0.1, AI0.2 - thermocouple input or 0-20mV/50mV input. non-isolated signal inputs
RS485 - communication interface. Use bentrup passive converter cable to directly connect to standard serial port (RS232), to use bentrup WinConfig configuration utility.

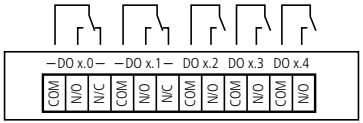


Expansion Boards

Your TC-S2 can be fitted with expansion boards to suit your application. Up to 3 expansion boards can be inserted in slot A, B and C *(Note: Slot B and C are upside down!)*. The TC-S2 automatically assigns the input/output signals according to the board sequence in the slots.

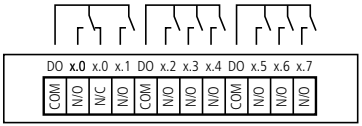
Switching Outputs SW5

SW5 provides 5 switching outputs for maximum 6A/250V each. They are designed to drive contactors or small resistive loads. In most configurations TC-S2 is fitted with a SW5 in Slot #A



Switching Outputs SW8

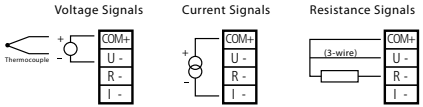
SW8 provides 8 switching outputs for maximum 6A/250V each. They are designed to drive contactors or small resistive loads. For easier wiring some of the outputs have common outlets



Analogue Inputs AI4

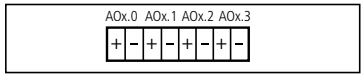
AI4 provides 4 electrical isolated high accuracy inputs for generic use. Input signal type is for thermocouples, PT100, 0-20mV/50mV, 0-5V, 0-10V, 0/4-20mA, resistive types (2 or 3 wire). Selection is done by the configuration automatically.

See sketch on the right for individual signal connections.



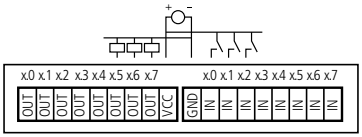
Analogue Outputs AO4

AO4 module expands your TC-S2 with 4 electrically isolated outputs to drive power devices (such as thyristors) or to output process values.. Depending on configuration the output provides a 0-10V or 0/4-20mA signal. In voltage mode the max load is limited to 50mA each output, in current mode a burdon <600 Ohms is required. Overload or open output failure is detected and reported. An AUTO-restart takes place every 2 seconds (output LED on AO4 flashes).



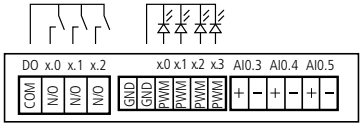
Digital Inputs / Outputs DIO8

DIO8 provides 8 digital inputs and outputs each. The outputs are designed to directly drive DC relays (max. load 1A per output). The outputs are short circuit proof and contain thermal protection. Overload condition is reported to the TC-S2. The inputs directly connect to any actuator sensor (input current threshold 5mA). Both inputs and outputs are optically isolated from the TC-S2 and designed for 24V DC operation (voltage GOOD is reported to the TC-S2). However, the actual operating range is from 10 to 30V DC.



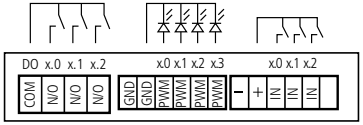
Combined IO 'COMBI a'

'COMBI a' provides 4 PWM outputs, 3 switching outputs 6A / 250V and 3 analogue inputs which can be used for either additional thermocouple inputs or for 3-wire inputs together with mainboard inputs. PWM outputs are desgined to drive solid state relays (SSR) at adjustable speed (1/2/5/10 Hz). The outputs are activated one after the other for best mains load pattern and provide a short circuit protection with auto restart. An overload is indicated on the TC-S2.



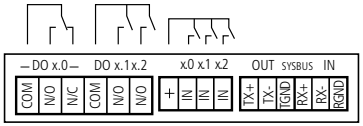
Combined IO 'COMBI b'

'COMBI b' is the same as 'COMBI a' but has 3 digital inputs instead of the analogue inputs.



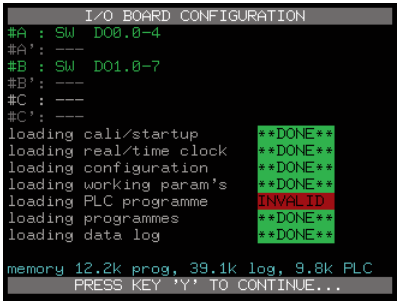
Combined IO 'COMBI c'

'COMBI c' provides 3 switching outputs 6A / 250V, SYSBUS and 3 digital inputs. SYSBUS is used to chain multiple TC-S2 for master slave operation which is similar to multizone operation with one TC-S2, but provides extended graphical illusion of the chain as well as the option to split the chain into several sub chains simply by the operator. It also provides electrical isolation of the inputs. Typical application are heat treatment systems for welding. Daisy chain the OUT to the IN signal of the following TC-S2 and the OUT of the last in chain to the first (Bus-Master).



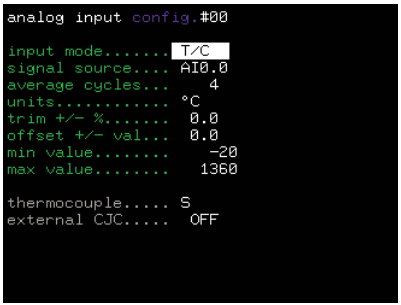
Assignement of the input and output ports

Depending on the expansion boards fitted the input and output designators (e.g. DO1.0) are assigned automatically only depending on the sequence of each type in the slot. Example: SLOT A holds SW5 (becomes DO0.0 to 5), SLOT B an AI4 (becomes AI2.0-3 since AI0.x and AI1.x are on mainboard) and SLOT C a SW8 (becomes DO1.0 to 7). Press 'Y' during power up to display current assignment and other relevant internal information (refer to the sketch).



Configuration

The configuration defines the entire TC-S2 structure. TC-S2 is more a highly flexible computer for control applications than an ordinary controller. As a consequence, even minor changes might affect the basic controller operation. Your system builder will have preconfigured the TC-S2 according to your application so normally it is not required to enter configuration. Get yourself familiar with the meaning of the parameters before you start adjusting the configuration. See next page for a detailed explanation of all TC-S2 parameters.

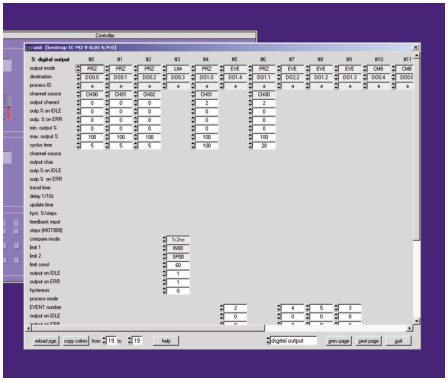


Configuration via keypad

All configuration parameters can be changed by the keypad. Enter the configuration by holding the 'inst' key pressed for 3 seconds. Now you can navigate through the parameters using the cursor keys and modify if necessary. Use the keys 'X' res. 'Y' to directly change between the configuration tables. Press and hold key 'inst' again to save and leave configuration.

Note: If TC-S2 re-enters configuration automatically it has detected an illegal setting (ie. an input mode which is not available physically or a servomotor indication on a switching output).

Configuration and Reading Controller Logs via PC software



Download the free of charge configuration utility "WinConfig" from www.bentrup.com. This utility allows easy setting, saving and restoring configuration. Use WinConfig to download the controllers error log which - like a flight recorder - contains all relevant process values of the last 50 controller events (even after power down). The offline created data log of TC-S2 can be also downloaded. All data shown is easily understood in Microsoft EXCEL.

TC-S2 with Integrated PLC (Option)

Configuration allows even complex input output control including logical functions; if your applications require even more complex networks (including timers etc.) check out the corresponding application note on www.bentrup.com.

bentrup TC-S2 Configuration Table Version 7.40

Table 0: clock / calender

The controller uses its real time clock / calender for different purposes. It allows the automatic commencing of programmes at predefined times as well the real time clock / calender is used to time stamp logged data and events. When configuring the controller using bentrup WinConfig / WinControl the controller is automatically updated with the PCs time / date information, Therefore manually changeing time / date is disabled

00: time (hours)	*(value range 00 to 23)*
current time (hours) of the real time clock	
01: time (minutes)	*(value range 00 to 59)*
current time (minutes) of the real time clock	
02: DST auto adj.	*(value range ADJ OFF to USA/CAN)*
Selects daylight saving time algorithm	
03: date (day)	*(value range 01 to 31)*
current date (day) of the real time calendar	
04: date (month)	*(options JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC)*
current date (month) of the real time calendar	
05: date (year)	*(value range 00 to 99)*
current date (year) of the real time calendar	
06: cfg.lock level	*(value range 0 to 5)*
reserved for future used	

Table 1: misc. adjustments

The following miscalleneous adjustments determine general operation parameters of the controller

00: max. segments	*(value range 5 to 98)*
maximum number of segments per programme. Entering a smaller number increases the number of programmes you can save in your controller. In most applications a maximum of 20 segments is suitable. Note: After changing this value all programmes must be reentered because of the required reorganisation of the controllers memory	
01: log rate (sec)	*(value range 0 to 120)*
All important process values will be sampled to the controllers log memory for further examination by the operator. Since the log memory is quite limited adjust the **log rate** to the highest value suitable for your application. The log rate (specified in seconds) determines the time between two recordings. The actual size of the log memory depends on the configuration	
02: manual enable	*(options OFF, ON)*
The **manual mode** allows the user to individually operate the control outputs (digital outputs and analog outputs) manually. This feature is very helpful for kiln commissioning. Caution: For safety reasons only enable this MODE if the operator is familiar with it !	
03: auto P. starts	*(options OFF, ON)*
This feature allows automatic commencing programmes by the weekly switching clock. Depending on configuration up to 99 real time clock / weekdays controlled jobs can be entered. Enable this feature only if necessary to avoid unintentional programme commencing	
04: lock programs	*(options OFF, ON)*
Allows locking of all programmes (temperature curves) to avoid any unauthorized changes	
05: communicat. ID	*(value range OFF to 62)*

Sets the communication ID of the controller. Affects external communication only. Make sure that this ID fits the setting in the communcation software (e.g. bentrup WinControl). Each ID must be unique on the communication network	
06: Slaves in Chain	*(value range 0 to 15)*
no explanation available	
07: fctn.on pow.up	*(value range 0 to 3)*
Verhalten nach dem Einschalten: **0**=Regler aus (IDLE), **1/2**=automatischer Programmstart wenn alle Bedingungen erfüllt sind (**1**=Zeit-Limit in Sekunden / **2**=Zeit-Limit in Minuten). **3**=automatischer Programmstart	
08: ..only if DOxx	*(value range OFF, DO0.0 to DO2.3)*
Programme is continued only if the selected output was ON before power breakdown. When selecting and output controlled by a programme EVENT, this feature can be used to enable programme continuation after a power breakdown for each segment	
09: only if t<time	*(value range OFF to 240)*
Programme is continued only if the duration of the power failure was less than this parameter. Depending on the selection of "fctn. on pow. up" this time limit is seconds or minutes	
10: dT input sel	*(value range OFF, IN00 to IN19)*
Selects the process value check for drop in temperature during a power breakdown	
11: ..only if dT<x	*(value range -9999 to 9999)*
Programme is continued only if the selected process value did not drop more than a the given value during power breakdown	
12: p.time MIN:SEC	*(options OFF, ON)*
Set to 1 for fast programme cycles to enter segment time as minutes : seconds (MIN:SEC) instead of hours : minutes	

Table 2: analog input

Specifies the analog input signals for the controller. Analog inputs are used to connect sensors like thermocouples, resistors, voltage/current signals to the controller. You can exactly define signal type (voltage, resistance, current) as well as signal range, signal conversion and correction, unit etc. The most common signal types are predefined. Each column of the table defines one process value which are named IN00, IN01 etc. The maximum number of analog input depends on the hardware.

00: input mode	*(options END, T/C, LIN, ATMS, RES, FLOW, FUN)*
type of the analog input signal. Choose the appropriate kind of signal conversion from the given options:	
T/C: Thermocouple input type. Selection of thermocouple and compensation mode see parameter below	
LIN: Linear input type for generic use. This mode is used to convert any kind of linear input signal (as defined in the corresponding parameters) into its process parameter. An example for a typical application is to convert a 4-20mA signal from a pressure transducer into 0 to 100 Pa process parameter	
ATMS: Atmosphere signal conversion. Use this selection to convert the typical signal of a circonoxyde probe into the kiln atmosphere reading. The controller uses the equation of Nerntzsch to convert the probe signal into % of oxygen. The probe temperature required for oxygen calculation is specified in the corresponding parameters as well as the kind of gas required for the carbonmonoxyde calculation. Note below on temperatures below 650°C no oxygen calculation is done (no reliable probe signal)	
RES: Resistance temperature sensor conversion. Converts the resistance characteristic of most commonly used resistance sensors (like Pt100) into temperature reading	
FLOW: Flow measuring device signal conversion. Use this selection of obtail the actual flow of devices based on the method of acquring difference in pressure on an orifice valve. The controller converts the signal using the common physical laws with the optional compensation of media temperature and absolute media pressure	
FUN: Non linear signal conversion. Use this selection to convert any signal which	

complies to the options given in the corresponding parameters (like logarithmic etc.) to its proper process value. The controller uses the formula **process value = (FUNC + constant val) / divisor val** replacing the terms with the given parameters

01: signal source	*(value range AI0.0 to AI5.3)*

Specifies a physical input (AI..) of the controller. The process parameter is created from the signal on this physical input. To create two different process parameters from one physical input make sure that both signal types and ranges equals

02: average cycles	*(value range 1 to 11)*

Specifies the low pass signal filter. This options is used to smoothen the input signal. Can be used to eliminate signal interference as well as to improove signal quality. Setting this option to "1" disables the filter. A higher setting causes higher smoothening (low pass frequency is 1/n Hz). A setting of 4 suits most applications.

03: units	*(options °C, °F, °K, dg, mV, mA, O2, CO, %, ev, mb, m³, m³h, kh, kwh, Pa, AT, lda)*

Specifies the unit of the process value

04: trim +/- %	*(value range -10.0 to 10.0)*

Allows full scale input signal correction. In certain applications it is required to compensate for any deviations of the installation. Example: Setting this parameter to -5.0% will cause the process value to be trimmed to 95°C instead of 100°C. **Note**: This parameter should be used with care since on most applications deviations errors should to be compensated by eliminating the real cause of the deviation rather then compensating on the controller

05: offset +/- val	*(value range -10.0 to 10.0)*

Allows zero offset signal correction. Adjust this parameter if you need to adjust the input offset value. **Note**: This parameter should be used with care since on most applications deviations errors should to be compensated by eliminating the real cause of the deviation rather then compensating on the controller

06: min value	*(value range -10000 to 10000)*

Minimum value of the process value. Specifies the lower value limit of the process parameter. Any lower value is respected as underrun (causing an error)

07: max value	*(value range -10000 to 10000)*

Maximum value of the process value. Specifies the upper value limit of the process parameter. Any higher value is respected as overrun (causing an error)

following parameters apply on selection **T/C** only:

08: thermocouple	*(options S, R, K, J, B)*

Select the IEC code of the thermocouple used

09: external CJC	*(value range OFF, IN00 to IN19)*

Could junction compensation temperature. Set to "OFF" for internal compensation (recommended). Make sure that the proper compensating wire is used

following parameters apply on selection **LIN** only:

18: signal type	*(options OFF, 0-20mV, 0-50mV, 0-5V, 0-10V, 0-20mA, 4-20mA, -500R2, -500R3)*

Type of input signal. Set this parameter to fit the signal of the device connected to the physical input. **Note:** Adapt the jumper settings of the physical input accordingly (done automatically on some devices)

19: val.@zeropoint	*(value range -3000.0 to 3000.0)*

Process value at lower reference of input value. Example: A pressure transducer supplying 4 to 20mA at -250 to +250 Pa. Set this parameter to "-250" since this is the process value at the lower reference of 4mA

20: val.@fullscale	*(value range -3000.0 to 3000.0)*

Process value at upper reference of input value. Example: A pressure transducer supplying 4 to 20mA at -250 to +250 Pa. Set this parameter to "250" since this is the process value at the upper reference of 20mA

following parameters apply on selection **ATMS** only:

28: temp. source	*(value range IN00 to IN19)*

Selects the process value representing the temperature of the atmosphere sensor. The temperature is required for the calculation of the oxygen

29: press.source	*(value range OFF, IN00 to IN19)*
Selects the process value representing the over pressure of the reference air. This is used to supervise the referece air for the oxygen probe. Set to "OFF" if not used	
30: min. pressure	*(value range 0 to 120)*
Minimum pressure limit of reference air. Oxygen process value is set to "INVALID" if reference over pressure falls below this limit	
following parameters apply on selection **RES** only:	
38: resist.type	*(options PT100)*
Kind of the resistance sensor used	
39: signal type	*(options -500R2, -500R3)*
Type of input signal. Set this parameter to fit the signal of the device connected to the physical input. **Note:** Adapt the jumper settings of the physical input accordingly (done automatically on some devices)	
following parameters apply on selection **FLOW** only:	
48: signal type	*(options OFF, 0-20mV, 0-50mV, 0-5V, 0-10V, 0-20mA, 4-20mA, -500R2, -500R3)*
Type of input signal. Set this parameter to fit the signal of the device connected to the physical input. **Note:** Adapt the jumper settings of the physical input accordingly (done automatically on some devices)	
49: sig.@ max.flow	*(value range 0.0 to 1000.0)*
Process value at upper reference of input value (at maximum flow)	
50: media tmp.sens	*(value range OFF, IN00 to IN19)*
Selects the process value representing the media temperature. Used to compensate the flow information for the media temperature. Set to "OFF" if not used	
51: media std.temp	*(value range -100 to 100)*
Temperature that has been used as "standard temperature" on orifice calculation	
52: media prs.sens	*(value range OFF, IN00 to IN19)*
Selects the process value representing the media over pressure. Used to compensate the flow information for the media over pressure. Set to "OFF" if not used	
53: media std.ov.p	*(value range 0 to 120)*
Pressure that has been used as "standard pressure" on orifice calculation	
following parameters apply on selection **FUN** only:	
58: signal type	*(options OFF, 0-20mV, 0-50mV, 0-5V, 0-10V, 0-20mA, 4-20mA, -500R2, -500R3)*
Type of input signal. Set this parameter to fit the signal of the device connected to the physical input. **Note:** Adapt the jumper settings of the physical input accordingly (done automatically on some devices)	
59: function sel	*(options ----, EXP, EXP10, LN, LOG, SIN, COS)*
Select the kind of function see term "FUNC" in formula)	
60: constant val	*(value range -30.000 to 30.000)*
Value "constant val" of the formula)	
61: divisor val	*(value range -30.000 to 30.000)*
Value "divisor val" of the formula)	

Table 3: digital input

Digital inputs can be used for different purposes. First they are used to create a process value depending on a frequency or number of pulses. Second they are used to control programme execution in different ways. Third, they are used by the optional PLC. **Note:** PLC provides you with total flexibility of the controller. If you are using the PLC of the controller you must **not** do any adjustments in this digital input section since all features are programmed by PLC networks

00: input mode	*(options END, CNT, PRC)*

Sets the operation mode of the digital inputs. Set to END when using the PLC	
CNT: Pulse signals supplied to this input are converted into a process value. Obsolete feature	
PRC: Used to control the programme flow externally. See below for a list of available control commands	
01: signal source	*(value range DI0.0 to DI8.0)*
Physical input used for the function	
following parameters apply on selection **CNT** only:	
02: units	*(options °C, °F, °K, dg, mV, mA, O2, CO, %, ev, mb, m³, m³h, kh, kwh, Pa, AT, lda)*
no explanation available	
03: min value	*(value range -10000 to 10000)*
no explanation available	
04: max value	*(value range -10000 to 10000)*
no explanation available	
05: count unit x /	*(value range -2000.0 to 2000.0)*
no explanation available	
06: count unit / x	*(value range -2000.0 to 2000.0)*
no explanation available	
following parameters apply on selection **PRC** only:	
12: process mode	*(value range 0 to 15)*
Defines the procedure to be commenced when the selected inputs is activated: 0=programme starts all over again / 1=programme starts / 2=programme stops 3=ON:programme starts all over again OFF:programme stops / 4=ON:programme stops OFF:programme stops / 5=programme HOLD	
13: process ID	*(value range a to a)*

Table 4: analog output

Analog outputs are used to drive of analog devices like steady power control units (thyristor controls), voltage controlled frequency converters or any kind of recorders. The analog output can be any kind of voltage (0 to 10V etc.) or current (0-20mA etc.) signal. The controller can be configured to drive an analog output by any kind of process value (control channel output, process value output etc.)

00: output mode	*(options END, PRZ, ANA)*
Sets the operation mode of the analog output:	
PRZ: Sets the analog output to be used to send the channel output value for controlling the heating resp. cooling device. Example: Use this mode to provide a 4-20mA steady output signal (according to 0 to 100% heating) for driving a thyristor	
ANA: Sets the analog output to send any internal process value as analog signal within adjustable boundaries. Example: Use this mode to create a 0 to 10V output signal according to 0°C to 1000°C programme setpoint	
01: output type	*(value range OFF to PWM 8Hz)*
no explanation available	
02: destination	*(value range AO0.0 to AO3.3)*
Selects the physical output of the signal	
03: process ID	*(value range a to f)*
following parameters apply on selection **PRZ** only:	
04: channel source	*(value range CH00 to TA19)*
Selects the control channel (loop) used to drive the output. The options MX../A resp. MX../G are the outputs of the air / gas mixer (for combustion units)	
05: output charact	*(value range 0 to 5)*
Specifies the operation range of the output. Used to limit an output assigned to a heating / cooling loop (range +100% to -100%) to the physical range of operation. In an typical application one output (eg. controlling the heating elements) is set to "0 to	

+100%" and a 2nd output (eg. controlling a fan) is set to "0 to -100%" (both outputs assigned to the same control channel). The available settings are 0=0% to +100% / 1=+100% to 0% / 2=0% to -100% / 3=-100% to 0% / 4=-100% to +100% / 5=+100% to -100%. The further settings will repeat the choices but use the motor characteristic for non-linear devices: 6 to 11: motor char.#0 / 12 to 17: motor char.#1 18 to 23: motor char#3 etc.

06: outp.% on IDLE	*(value range 0 to 100)*

Whenever the controller is IDLE the output is fixed to this value

07: outp. % on ERR	*(value range 0 to 100)*

Whenever the entire controller is in ERROR status the output is fixed to this value. Note that this only applies on system errors and not an operation error on a single channel

08: min. output %	*(value range 0 to 100)*

Lower output signal limit. The output will never drop below this limit. Can be used for instance to obtain permanent minimum heating. Care should be taken since high settings might interfere with the control loop

09: max. output %	*(value range 0 to 100)*

Upper output signal limit. The output will never exceed this limit. Can be used for instance to limit the maximum heating of a kiln. Note that limiting can cause problems if the applications lacks of heating power (gradient check errors etc.)

following parameters apply on selection **ANA** only:

14: outp. param.	*(value range SP00 to CH19)*

Selects a process value sent to the analog output. The output is driven according to to the process value in the range given by the following parameters "lower base value" and "upper base value". Example: Assuming a signal type 0 to 10V / lower base value 0°C / upper base value 1000°C the output provides 7,5 V on a process value of 750°C

15: lower base val	*(value range -9999 to 9999)*

Sets the lower base value for a process value output. For details refer to the example given at "outp. param."

16: upper base val	*(value range -9999 to 9999)*

Sets the upper base value for a process value output. For details refer to the example given at "outp. param."

Table 5: digital output

Digital outputs are used to switch any kind of ON/OFF devices as well as motorized valves (using 2 digital outputs in sequence). Depending on controller hardware the output is either a switching relay output (8A / 250V) or a logic output (OFF=0V / ON=12V). The following parameters select the kind of operation (control outputs, alarms, events etc.). Digital outputs used by the PLC must **not** be assigned in this section

00: output mode	*(options END, PRZ, MOT, LIM, PRC, EVE, TAB, CMB)*

Selects an operation mode of the digital outputs:

PRZ: Used to provide the output value of a control channel (loop) to an ON/OFF device. The most common application is to control a contactor used for heating

MOT: Used to provide the output value of a control channel (loop) to a servomotor device. A typical application when controlling a motorized butterfly valve on a gas kiln. A servomotor is controlled by 2 digital outputs (OPEN and CLOSE). The physical output CLOSE is automatically assigned to the output following OPEN

LIM: Output works as limit switch (commonly called ALARMs). Any kind of comparison of process of constant values can be done

PRC: Indication of selectable process conditions. Can be used to activate an output on programme end, process errors, process holds etc.

EVE: Used to configure the output as programme event. Can be programmed to ON or OFF for each segment. During programme run the output is set accordingly

TAB: Used to control a group of outputs according to the bit pattern provided in the corresponding column of the programme table. Typically used in combination with a PLC

CMB: Output is driven according to the result of the network defined by the following

parameters. Used to create simple logic networks, ie. output do0.2 is only if do1.0 and do1.1 is active. For more complex networks ask for the optional, integrated PLC

01: destination	*(value range DO0.0 to DO8.0)*

Selects the physical output of the signal

02: process ID	*(value range a to f)*

following parameters apply on selection **PRZ** only:

03: channel source	*(value range CH00 to TA19)*

Selects the control channel (loop) used to drive the output. The options MX../A resp. MX../G are the outputs of the air / gas mixer (for combustion units)

04: output charact	*(value range 0 to 5)*

Specifies the operation range of the output. Used to limit an output assigned to a heating / cooling loop (range +100% to -100%) to the physical range of operation. In an typical application one output (eg. controlling the heating elements) is set to "0 to +100%" and a 2nd output (eg. controlling a fan) is set to "0 to -100%" (both outputs assigned to the same control channel). The available settings are 0=0% to +100% / 1=+100% to 0% / 2=0% to -100% / 3=-100% to 0% / 4=-100% to +100% / 5=+100% to -100%. The further settings will repeat the choices but use the motor characteristic for non-linear devices: 6 to 11: motor char.#0 / 12 to 17: motor char.#1 18 to 23: motor char#3 etc.

05: outp.% on IDLE	*(value range 0 to 100)*

Whenever the controller is IDLE the output is fixed to this value

06: outp. % on ERR	*(value range 0 to 100)*

Whenever the entire controller is in ERROR status the output is fixed to this value. Note that this only applies on system errors and not an operation error on a single channel

07: min. output %	*(value range 0 to 100)*

Lower output signal limit. The output will never drop below this limit. Can be used for instance to obtain permanent minimum heating. Care should be taken since high settings might interfere with the control loop

08: max. output %	*(value range 0 to 100)*

Upper output signal limit. The output will never exceed this limit. Can be used for instance to limit the maximum heating of a kiln. Note that limiting can cause problems if the applications lacks of heating power (gradient check errors etc.)

09: cyclus time	*(value range 1 to 100)*

Cyclus time (seconds) of the digital output. The output value is converted into an ON and OFF period accordingly (T on + T off = T cyclus). Decreasing the cyclus time improves accuracy but might decrease lifetime of the heating device. A typical value for contactors on kilns is 30. Set to 0 for the Logic Output Option (different hardware). A signal 1 Hz PWM 0-100% for solid state relays is provided on the output

following parameters apply on selection **MOT** only:

13: channel source	*(value range CH00 to TA19)*

Selects the control channel (loop) used to drive the output. The options MX../A resp. MX../G are the outputs of the air / gas mixer (for combustion units)

14: output char.	*(value range 0 to 30)*

Specifies the operation range of the output. Used to limit an output assigned to a heating / cooling loop (range +100% to -100%) to the physical range of operation. In an typical application one output (eg. controlling the heating elements) is set to "0 to +100%" and a 2nd output (eg. controlling a fan) is set to "0 to -100%" (both outputs assigned to the same control channel). The available settings are 0=0% to +100% / 1=+100% to 0% / 2=0% to -100% / 3=-100% to 0% / 4=-100% to +100% / 5=+100% to -100%. The further settings will repeat the choices but use the motor characteristic for non-linear devices: 6 to 11: motor char.#0 / 12 to 17: motor char.#1 18 to 23: motor char#3 etc.

15: outp.% on IDLE	*(value range 0 to 100)*

Whenever the controller is IDLE the output is fixed to this value

16: outp.% on ERR	*(value range 0 to 100)*

Whenever the entire controller is in ERROR status the output is fixed to this value.

Note that this only applies on system errors and not an operation error on a single channel

17: travel time	*(value range 0 to 120)*

Enter the time (in seconds) for the servomotor to move over the entire actual operation range (fully close to fully open)

18: delay 1/10s	*(value range 0 to 120)*

Delay time of the servomotor on direction changes. This parameter (given as 100ms units) is used to compensate for gearbox lags etc.

19: update time	*(value range 0 to 120)*

Rate in seconds the servomotor position is updated. Decreasing this rate causes more stress to the servomotor

20: hyst. %/steps	*(value range 0 to 100)*

Hysteresis for updating the servomotor position. Decreasing this rate causes more stress to the servomotor. However, in most application a hysteresis of 1% is recommended

21: feedback input	*(value range OFF, IN00 to IN19)*

The position feedback option is used for best tracking of the actual servomotor position. Typically a position potentiometer is connected to an analog input (configured as linear resistance input 0-100%). Enter the process parameter number of this input here. Set to OFF is unused

22: steps (MOT808)	*(value range -10000 to 10000)*

no explanation available

following parameters apply on selection **LIM** only:

23: compare mode	*(options 1>2+c, 1<2+c, dif<c, dif>c, 1>2+c/S, 1<2+c/S, dif<c/S, dif>c/S)*

Selects the kind of equation of the formula given as **limit 1 ? limit 2 + limit const**. The "?" is replaced depending on this parameter: 0 stands for ">=", 1 stands for "<=", 2 means "limit 1 - limit 2 less then limit const", 3 means "limit 1 - limit 2" more than limit const. Add 4 to disable sigal during SKIP. The digital output is ON when the equation is true. Example: To activate the output whenever the actual temperature exceeds the setpoint more than 30°K (= overtemperature alarm) set the parameters as follows: compare more = 0 / limit 1 = IN00 / limit 2 = SP00 / limit const = 30

24: limit 1	*(value range OFF, SP00 to CH19)*

Selects the process value used as "limit 1" in the formula. This can be a setpoint, an actual temperature, a channel (loop) output or "OFF" to insert "0" in the formula. For detailed explanation including an example refer to "compare mode"

25: limit 2	*(value range OFF, SP00 to CH19)*

Selects the process value used as "limit 2" in the formula. This can be a setpoint, an actual temperature, a channel (loop) output or "OFF" to insert "0" in the formula. For detailed explanation including an example refer to "compare mode"

26: limit const	*(value range -10000 to 10000)*

The constant value used as "limit const" in the formula. For detailed explanation including an example refer to "compare mode"

27: output on IDLE	*(value range 0 to 2)*

Defines the state of the digital output when the controller is IDLE: 0 = same as during programme run / 1 = OFF / 2 = ON

28: output on ERR	*(value range 0 to 2)*

Defines the state of the digital output when the controller enters a system error: 0 = same as during programme run / 1 = OFF / 2 = ON

29: hysteresis	*(value range 0 to 10000)*

The Hysteresis defines the difference between ON and OFF switching. Example: switch at a temperature of 100°C, hysteresis 10°K: ON at 105°C, OFF at 95°C. Set to 0 if not used

following parameters apply on selection **PRC** only:

33: process mode	*(value range 0 to 22)*

Selects the process state the digital output is indicating: 0=programme run (also ON

during segment 0 and at the end of the firing) / 1=programme run (also ON during segment 0) / 2=programme run / 3=end of the firing / 4=any channel error / 5=programme HOLD / 6=OFF / 7=ON / 10/11/12=mixer in air excess/stochiometric/cooling mode / 13=programme continues after power breakdown / 14=do0.6 and not do0.7 / 15=do0.6 and do0.7 / 16=not do0.6 and do0.7 / 17=control channel off band / 18=programme interrupted due to off band / 19=any monitored channel error / 20=final temperature matches in all monitored channels / 21=any monitored channel in control range / 22=any monitored channel out of control range

following parameters apply on selection **EVE** only:

43: EVENT number	*(value range 0 to 10)*

Digital output works as programme EVENT number #. This number must fit the EVENT number specified in the programme table

44: output on IDLE	*(value range 0 to 1)*

Defines the state of the digital output when the controller is IDLE: 0 = OFF / 1 = ON

45: output on ERR	*(value range 0 to 1)*

Defines the state of the digital output when the controller enters a system error: 0 = same as during programme run / 1 = OFF / 2 = ON

following parameters apply on selection **TAB** only:

53: table dat.src	*(value range TA00 to TA19)*

Select the column number of the programme table the programme value is taken

54: outp. width	*(value range 0 to 8)*

number of digital outputs in sequence used for this function

following parameters apply on selection **CMB** only:

63: combinat. type	*(options OR, NOR, AND, NAND, XOR, XNOR)*

Select the type of combinatoric operator applied to the selected bits

64: output on IDLE	*(value range 0 to 2)*

Defines the state of the digital output when the controller is IDLE: 0 = same as during programme run / 1 = OFF / 2 = ON

65: output on ERR	*(value range 0 to 2)*

Defines the state of the digital output when the controller enters a system error: 0 = same as during programme run / 1 = OFF / 2 = ON

66: 1. DOxx sel.	*(value range DO0.0 to DO8.0)*
67: 2. DOxx sel.	*(value range OFF, DO0.0 to DO8.0)*
68: 3. DOxx sel.	*(value range OFF, DO0.0 to DO8.0)*
69: 4. DOxx sel.	*(value range OFF, DO0.0 to DO8.0)*
70: 5. DOxx sel.	*(value range OFF, DO0.0 to DO8.0)*
71: 6. DOxx sel.	*(value range OFF, DO0.0 to DO8.0)*
72: 7. DOxx sel.	*(value range OFF, DO0.0 to DO8.0)*
73: 8. DOxx sel.	*(value range OFF, DO0.0 to DO8.0)*

Selects the bits (digital outputs) used in the combinatoric network. Set to "OFF" when unused

Table 6: programme table

The programme table determines the parameters and the sequence to be entered for each programme segment. The first programme parameter is always a time followed by a temperature. Depending on the application the following programme segment parameters could be for instance offset temperatures (for multizone kilns), programme events etc. The parameter sequence after the 1st temperature is variable; however, keeping all programme EVENTs togather saves programme memory

00: value type	*(options END, TIME, VAL-L, ---, VAL-S, EVENT, ATMS)*

Select the kind of value in each column of the programme table:

TIME: The very first column of the programme table holds the segment time

VAL-L: Programme value in the range of -10000 to 10000. Typically used for any kind of absolute value (like kiln temperature etc.)

---: selection not used

VAL-S: Programme value in the range of -127 to 128. Typically used for any kind of relative values (like offset temperature for zones)

EVENT: EVENT value, ie. holds ON or OFF. When requiring multiple events defining them one after the other saves programme memory

ATMS: Programme value to define an atmosphere

01: designator 1	*(alphanumerical characters)*
02: designator 2	*(alphanumerical characters)*
03: designator 3	*(alphanumerical characters)*

Used to give each programme table column an individual name (consisting of up to 3 alphanumeric letters)

following parameters apply on selection **TIME** only:

04: lower time lim	*(value range -101 to -2)*

Limits the value range entered as a time. Note that the values smaller than minus 2 enable the programme link feature (-3 = allow linking to programme number 1, -4 = allow linking to programme number 2 etc.)

05: upper time lim	*(value range 1 to 6998)*

Upper limit when adjusting the time. The 1000 steps beyoind this limit stand for setting the gradient as centigrade kelvin per period

following parameters apply on selection **VAL-L** only:

14: value unit	*(options °C, °F, °K, dg, mV, mA, O2, CO, %, ev, mb, m³, m³h, kh, kwh, Pa, AT, lda)*

Specifies the unit of the programme table value

15: lower val. lim	*(value range -9999 to 9999)*

Lower limit of the programme table value. Used for instance to ensure the values entered by the user stay within the operation limits of the kiln

16: upper val. lim	*(value range -9999 to 9999)*

Upper limit of the programme table value. Used for instance to ensure the values entered by the user stay within the operation limits of the kiln

following parameters apply on selection **---** only:

24: value unit	*(options °C, °F, °K, dg, mV, mA, O2, CO, %, ev, mb, m³, m³h, kh, kwh, Pa, AT, lda)*

Specifies the unit of the programme table value

25: lower val. lim	*(value range -9999 to 9999)*

Lower limit of the programme table value. Used for instance to ensure the values entered by the user stay within the operation limits of the kiln

26: upper val. lim	*(value range -9999 to 9999)*

Upper limit of the programme table value. Used for instance to ensure the values entered by the user stay within the operation limits of the kiln

following parameters apply on selection **VAL-S** only:

34: value unit	*(options °C, °F, °K, dg, mV, mA, O2, CO, %, ev, mb, m³, m³h, kh, kwh, Pa, AT, lda)*

Specifies the unit of the programme table value

35: lower val. lim	*(value range -99 to 99)*

Lower limit of the programme table value. Used for instance to ensure the values entered by the user stay within the operation limits of the kiln

36: upper val. lim	*(value range -99 to 99)*

Upper limit of the programme table value. Used for instance to ensure the values entered by the user stay within the operation limits of the kiln

following parameters apply on selection **EVENT** only:

44: EVENT number	*(value range 0 to 15)*

This unique number identifies the EVENT in the programme table for the digital output

following parameters apply on selection **ATMS** only:

54: atmosphere cde	*(options AT, lda)*

Wählt die Einstellungsart des Atmosphären-Sollwertes aus. Wert nicht veränderbar

Table 7: process flow setup

The parameters of this section specify the reaction of the controller to any kind of unusual conditions that might happen during a programme run. Examples for unusual conditions are broken temperature sensors, heat up problems of the kiln, control channel errors etc. As well the conditions to enter the next segment during a running programme can be adjusted as required

00: time in ramps	*(options KEEP, UPDAT)*

If the temperature of the pilot input (IN00) is higher than the start temperature of the ramp the time of the ramp can be either kept or reduced accordingly

KEEP: Segment time is kept, setpoint begins as programmed

UPDAT: Segment time is reduced accordinly. Example: Segment 0 is 0°C, segment 1 is "in 2 hours to 500°C". Assuming a kiln temperature of 250°C when starting the firing, the time is reduced to 1 hour (causing a setpoint of 250°C)

01: monitor ch	*(value range -CH45 to CH45)*

Only the channels specified are monitored for process problems. This setting allows to include only the channel(s) which are important for the process. Either a single channel can be selected (e.g. on single zone kilns) or a range of channels (e.g. ch00 to ch02 on a 3 zone kiln). A range is entered as minus channel (e.g. "-ch02" stands for ch00 to ch02)

02: temp match %o	*(value range 0.0 to 100.0)*

An uncontrolled ramp (SKIP) the end of the segment is determined by match of actual temperature and final segment temperature. Since the controller slows down temperature move at the end to avoid over/undershoot it might take some time to finally reach the temperature althought it is not required by the process. This parameter allows to specify a window to earlier complete the segment. Example: 2.0 ppm of 1320°C (max. channel temperature) = 2.64°C, SKIP segment ends at 997.36°C assuming a final ramp temperature of 1000°C

03: num of matches	*(value range 1 to 250)*

An uncontrolled ramp (SKIP) is only completed if the temperature matched the specified number of cycles. The check is done each 0.5 seconds. This is used to avoid leaving the segment if the temperature only overshoots for a short time. Example: The setting of 6 lets the controller to complete the current segment if the temperature matched for at least 3 seconds

04: end of SKP seg	*(options DISR, WAIT.X, INFIN)*

no explanation available

DISR: Causes the controller to disregard the temperature, ie. to leave a SKIP segment immediately

WAIT.X: Causes the controller to wait for temperature match, but maximum for the specified time (see next parameter). This option is strongly recommended on multi zone kilns, e.g. at a time of 10 minutes. Otherwise the process might lock up itself. For instance in a cooling SKIP, the thermocouple of zone 2 has a little deviation an therefore zone 2 is heated 4°C higher; if the heating affects zone 1 this zone will never cool down as neccessary. The time begins to count if the first zone starts to control. If the time is elapsed the segment is finished disregarding the temperature of the zones matches

INFIN: Causes the controller to wait for temperature match for infinite time

05: chk rate (sec)	*(value range 0 to 9999)*

no explanation available

06: act.on CH unco	*(options DISR, WAIT.BR, WAIT.CO, INFI)*

In a controlled ramp it might happen that the kiln temperature can not follow the requested increase although the controller asks for maximum heating (resp. the requested decrease in a cooling segment). The following actions can be selected:

DISR: Causes the controller to disregard this situation

WAIT.BR: Causes the controller to hold the firing to give the kiln temperature time to catch up. If the kiln couldn't catch up within the specified time (see next parameter) the firing is interrupted (break). The hold mode (same as hold used during programme run) can also be released manually by pressing the hold skip button

WAIT.CO: Causes the controller to hold the firing but - after the time has elapsed - continues the firing disregarding the temperature

INFI: Causes an immediate break if the temperature can not follow.

07: uncontr = ..CH	*(options ALL, ANY)*

Selects the criteria the controller judges to the kiln as non following the temperature increase:

ALL: all channels out of control (maximum or minimum heating)

ANY: any channel out of control

08: max hold (sec)	*(value range 0 to 9999)*

wait time in seconds for the feature specified previously

09: act.on error	*(options DISR, WAIT.BR)*

If any error in the control channels happens (e.g. overtemperature because of break of thermocouple) the reaction of the controller can be adjusted:

DISR: Causes the controller to disregard this event and to continue the process with the remaining channels

WAIT.BR: Causes the controller to hold for a specified time (see next parameter). This delay time can be used to notify the user (e.g. by a process alarm of the controller) and to fix the problem. When the time is elapsed the firing is terminated. Set time to "0" if the process is to be finished after channel error immediately

10: max hold (sec)	*(value range 0 to 9999)*

wait time in seconds for the feature specified previously

Table 8: programme setpoint

The programme setpoints are calculated according to the programme resp. temperature curve entered by the operator. Some adjustments are possible for easy operation. Automatic setpoint calculation required for cascade control systems is also entered by the following settings

00: setpoint type	*(options END, CON, MOD, CHA)*

The following basic types creating a setpoint can be selected:

CON: Use initial value of the programme segment only. Typical applications are offset values for zone temperatures or flap positions

MOD: Programme setpoint modulated by the segment time. This is the common setting causing the programme setpoint to count upwards resp. downwards over the segment time (e.g. within 2:00 hours from 0°C up to 1000°C)

CHA: Setpoint calculated by cascade control algorithm - for details refer to the example below

01: process ID	*(value range a to a)*

following parameters apply on selection **CON** only:

02: table source	*(value range TA01 to TA19)*

Selects the column of the programme table used for setpoint calculation. TA01 is the 1st column, ie. usually the primary temperature

03: offset src SP	*(value range OFF, SP00 to SP09)*

Defines a setpoint which refers to an existing setpoint, ie. the setpoint is calculated by adding another setpoint to it. Used e.g. for the setpoint of the slave zones of a multizone kiln. Using this option allows the operator to enter the temperature of the slave zones as offset (temperature difference) relative to the master zone setpoint. In this example the master zone setpoint is entered in this option

04: idle setpoint	*(value range -10000 to 10000)*

Setpoint whenever the controller is not in a programme run (IDLE). Can be used to ensure a certain temperature is maintained without a programme run. Entering "0"

switches off this feature

05: error setpoint	*(value range -10000 to 10000)*

Setpoint whenever the controller is not in a programme run (IDLE). Can be used to ensure a certain temperature is maintained without a programme run. Entering "0" switches off this feature

following parameters apply on selection **MOD** only:

12: table source	*(value range TA01 to TA19)*

Selects the column of the programme table used for setpoint calculation. TA01 is the 1st column, ie. usually the primary temperature

13: offset src SP	*(value range OFF, SP00 to SP09)*

Defines a setpoint which refers to an existing setpoint, ie. the setpoint is calculated by adding another setpoint to it. Used e.g. for the setpoint of the slave zones of a multizone kiln. Using this option allows the operator to enter the temperature of the slave zones as offset (temperature difference) relative to the master zone setpoint. In this example the master zone setpoint is entered in this option

14: idle setpoint	*(value range -10000 to 10000)*

Setpoint whenever the controller is not in a programme run (IDLE). Can be used to ensure a certain temperature is maintained without a programme run. Entering "0" switches off this feature

15: error setpoint	*(value range -10000 to 10000)*

Setpoint whenever the controller is not in a programme run (IDLE). Can be used to ensure a certain temperature is maintained without a programme run. Entering "0" switches off this feature

following parameters apply on selection **CHA** only:

22: based on SP	*(value range SP00 to SP09)*

Selects the programme setpoint used for the cascade control, ie. the programme setpoing for the target

23: charg.ctrl.CH	*(value range CH00 to TA19)*

Selects the master control channel (loop). The basic idea of a cascade control is as follows: An application requires a large target (e.g. a piece of aluminium) to follow a temperature curve. An appropriate solution is using an air convection kiln. Using an ordinary control it will give different problems depending on the position of the thermocouple: When sensing the ambient temperature the actual temperature of the target (aluminium) will be far (might be even hundreds of degrees centigrade) behind since it is very lag. Sensing the target temperature might cause damage to the kiln since the controller does not pick up the temperature of the heaters. Additionally, temperature oscillations are likely when the target temperature is getting close. **A cascade control eliminates these problems and works as follows:** Two control channels are combined. The master control channel is configured as normal, ie. using the programme temperature as setpoint and the target temperature as actual temperature. The output of this channel is used to create a 2nd temperature setpoint according to the settings in this section. This setpoint and the actual ambient temperature are assigned to the slave control channel driving directly the heating device of the kiln. Note that the master control channel is configured as heating/cooling loop with a wide proportional range and slow integral time (P/I/D = 10.0% / 400 s / 0 s)

24: max. temp.diff	*(value range -10000 to 10000)*

Limits the maximum difference in temperature between the target and the ambient temperature. Used to avoid damage of the target if sensitive. A high limit, however, speeds up the process of the target reaching the programme setpoint

25: max envir.temp	*(value range -10000 to 10000)*

Limits the maximum ambient temperature. Used to avoid damage of the target if sensitive. A high limit, however, speeds up the process of the target reaching the programme setpoint

Table 9: control channel

The control loops are designed to operate in totally different modes. Each operation mode can be tuned individually

00: ctrl.algorithm	*(options END, PID, C-PID, D-HYS, P-DIR)*

Depending on your application different control algorithms are available

PID: Default control algorithm suitable for most applications

C-PID: As before, but provides independent disable feature for heating and cooling range. Important on heating/cooling applications where heating and cooling depends on external conditions. Also used to avoid heating and cooling ranges chasing each other. Activation is done by any bit (e.g. a digital output). Typical applications are gas kilns where heating range (0 to +100%) is disabled once the burner control bit goes OFF

D-HYS: Hysteresis control for heating devices which require either temperature deviation or do not allow short cyclic activation (e.g. discontinuous burners)

P-DIR: Direct control. The setpoint is directly converted into a control value refering to the given value boundaries. Typical application is setting a flap position directly (e.g. 0 to 100%)

01: setpoint chn	*(value range SP00 to CH19)*

Selects the setpoint used for this control channel

02: input chn	*(value range SP00 to CH19)*

Selects the process value used for this control channel

03: power % on ERR	*(value range -100 to 100)*

Predefined process output if an error occurs in the control channel. The control channel enters error state if a.) the process value fails (overrun, underrun, invalid), b.) the process value exceeds the process value limit specified in the channel configuration or c.) the gradient check indicates failure

04: maximum value	*(value range 0 to 10000)*

Maximum process value. Used to limit the process input value for safety reasons as well as setting the operation range. If the process value exceeds the limit the control channel enters error state which can only be cleared by re-starting the programme. Set this value above the actual operation range to allow overshooting

05: grdnt check s	*(value range 0 to 3600)*

The gradient check is used for safety reasons. Prevents the unit from damage if the feedback signal (e.g. the thermocouple) fails. Checking the increase of the process value is performed on maximum output (typically +100%). This parameter defines the checking period in seconds. Set to "0" to disable checking. If the gradient check determines an error the channel is switched off (gradient error state)

06: grdnt chk dif	*(value range 0 to 10000)*

Increase of the process value required per checking period on maximum heating

07: ctrl charact	*(value range 0 to 3)*

Depending on the application select the operation range of the control channel to one of the following options: 0 = 0% to 100% / 1 = 100% to 0% / 2 = -100% to +100% / 3 = +100% to -100%

following parameters apply on selection **PID** only:

08: prop. band %	*(value range 0.0 to 1000.0)*

Control parameter "proportional band" in % of the maximum value

09: integral time	*(value range 0 to 10000)*

Control parameter "integral time" in seconds

10: derivat. time	*(value range 0 to 10000)*

Control parameter "derivative time" in seconds

11: prop. shift ¬	*(value range 0 to 4)*

Determines the operating range of the proportional band: 0 = prop. band below setpoint / 1 = prop. band one quarter above setpoint / 2 = .. half above setpoint / 3 = .. three quarters above setpoint. In most applications a setting of "1" ensures best results (ie. fast reaching the setpoint with minimum overshoot)

following parameters apply on selection **C-PID** only:

18: prop. band %	*(value range 0.0 to 1000.0)*
Control parameter "proportional band" in % of the maximum value	
19: integral time	*(value range 0 to 10000)*
Control parameter "integral time" in seconds	
20: derivat. time	*(value range 0 to 10000)*
Control parameter "derivative time" in seconds	
21: prop. shift ¬	*(value range 0 to 4)*
Determines the operating range of the proportional band: 0 = prop. band below setpoint / 1 = prop. band one quarter above setpoint / 2 = .. half above setpoint / 3 = .. three quarters above setpoint. In most applications a setting of "1" ensures best results (ie. fast reaching the setpoint with minimum overshoot)	
22: + activat. DOx	*(value range OFF, DO0.0 to DO8.0)*
Selects the bit (digital output) which activates the positive operation range (heating). When the bit is off the channel enters OFF status as long as heating applies	
23: - activat. DOx	*(value range OFF, DO0.0 to DO8.0)*
Selects the bit (digital output) which activates the negative operation range (cooling). When the bit is off the channel enters OFF status as long as cooling applies	

following parameters apply on selection **D-HYS** only:

28: hyster. units	*(value range 0.0 to 100.0)*
Hysteresis of the control channel. The hysteresis is specified as absolute value. A small value results in higher accuracy but causes higher switching rates. A large value causes less accuracy due to larger oscillations of the process value	
29: derivat. time	*(value range 0 to 10000)*
Control parameter "derivative time" in seconds	
30: min. ON time	*(value range 0 to 120)*
Minimum time for output activation specified in seconds. Used to supress short time output activation. A typical application is when driving certain types of burners which need a minimum startup time for ignition	
31: min. OFF time	*(value range 0 to 120)*
Minimum time for output deactivation specified in seconds. Used to supress short time output deactivation. A typical application is when driving certain types of burners which should not be interrupted for short periods	

following parameters apply on selection **P-DIR** only:

38: lower val.base	*(value range -10000 to 10000)*
Sets the lower base value which corresponds to 0% control channel output	
39: upper val.base	*(value range -10000 to 10000)*
Sets the upper base value which corresponds to 100% control channel output	

Table 10: infobox

Defines the process parameters displayed on the controller front panel. Each infobox defines one process parameter to show. The number of process parameters to be displayed simultanuously depends on the controller model. Pressing the *select* button shows one infoboxes after the other

00: infobox type	*(options END, SPACER, VALUE, C.LOOP, MOTOR, IOSTAT, TIMDAT, KW/KWH, FLOW, MIXER)*
Selects the kind of information shown on the infobox	
SPACER: Inserts a space to seperate or better arrange the infobox window	
VALUE: Displays a process value	
C.LOOP: Displays all significant process parameters of an control loop	
MOTOR: Displays position and movement of a servomotor output	

IOSTAT: shows the entire input output status of the controller (covers entire infobox)

TIMDAT: Displays real time / date

KW/KWH: Displays the power and consumption

FLOW: Displays all relevant parameters of the atmosphere controller

01: infobox color	*(value range BLUE to WHITE)*

select the color the information is shown. Note that on some infobox types the colors are fixed (e.g. control loop)

following parameters apply on selection **SPACER** only:

02: spacer size	*(value range SMALL to HUGE)*

size of the space. SMALL uses 1/6, MEDIUM 1/3, LARGE=1/2 and HUGE 1/1 of the column

following parameters apply on selection **VALUE** only:

12: process value	*(value range SP00 to VT19)*

process value to be shown

13: infobox size	*(value range SMALL to HUGE)*

Size of the Infobox. SMALL uses 1/6, MEDIUM 1/3, LARGE=1/2 and HUGE 1/1 of the column

14: decimal places	*(value range 0 to 3)*

number of decimal places

following parameters apply on selection **C.LOOP** only:

22: control loop	*(value range CH00 to TA19)*

control loop no. to be displayed

23: infobox size	*(value range MEDIUM to LARGE)*

Size of the Infobox. SMALL uses 1/6, MEDIUM 1/3, LARGE=1/2 and HUGE 1/1 of the column

following parameters apply on selection **MOTOR** only:

32: servomotor	*(value range DO0.0 to DO7.7)*

servomotor to be displayed

following parameters apply on selection **IOSTAT** only:

42: page number	*(value range 0 to 7)*

page number of the IO status. Page 0 shows DI/DO 0/1 and AI/AO 0/1, page 1 DI/DO 2/3 etc.

following parameters apply on selection **TIMDAT** only:

52: date only	*(options OFF, ON)*

set to disable display date only (no time)

following parameters apply on selection **KW/KWH** only:

62: power calc.CH	*(value range -CH45 to CH45)*

Selects either a single control channel of a range of control channels used for calculating power pickup. Negative channel number stands for CH00 to CH.. *Example:* "-CH02" will add up control channels CH00, CH01 and CH02

63: power ratng.kw	*(value range 0 to 250)*

Enter the total power of the kiln. The calculation assumes all zones having the same amount of power

following parameters apply on selection **FLOW** only:

72: flow source	*(value range P¥ç to IN19)*

no explanation available

73: infobox size	*(value range SMALL to HUGE)*

Size of the Infobox. SMALL uses 1/6, MEDIUM 1/3, LARGE=1/2 and HUGE 1/1 of the column

74: decimal places	*(value range 0 to 3)*

number of decimal places

Table 11: infograph

Applies only if the controllers is capable of displaying graphs (like TC M2). Different kind of display modes are available

00: graph type	*(options END, TIM/S, VALUE, CHAN, DOx, AOx)*

Selects the kind of graphic used to show process parameters

TIM/S: Displays a time axis (including real time and programme segment information)

VALUE: Displays a process value as chart. Up to 4 process values can be shown in one chart togather. Colors are assigned automatically

CHAN: Displays a channel output value as chart. Up to 4 channel output values can be shown in one chart togather. Colors are assigned automatically

DOx: Displays up to 8 digital outputs. Note that depending on time scale short switching cycles disappear

AOx: Displays up to 4 analog outputs as chart

01: time scale	*(value range 0 to 18)*

Select the grafic moving rate according to the speed of the process. The width of one grafic screen equals to 1=2.5 min / 2=5min / 3=10min / 4=20min / 5=40min / 6=1h / 7=2h / 8=4h / 9=8h / 10=16h / 11=1 day / 12=2 days / 13=4 days / 14=8 days / 15=16 days / 16=1 months / 17=2 months / 18=3 months

following parameters apply on selection **TIM/S** only:

02: time axis type	*(value range 0 to 1)*

no explanation available

following parameters apply on selection **VALUE** only:

12: vertic. scale	*(value range 1 to 11)*

Vertical extension of the graph. "1" equals to 10% of the total window height, "2"=20% etc. On some kind of graphs (e.g. digital outputs) the vertical extension of the graph is determined by the number of informations only. **Note:** Multiple graphs are shown togather on the screen if they are adjusted to the same time scale as well as vertical display space is sufficient

13: grph.lower lim	*(value range -10000 to 10000)*

Sets the value representing the lower display border

14: grph.upper lim	*(value range -10000 to 10000)*

Sets the value representing the upper display border

15: 1. graph val	*(value range SP00 to CH19)*
16: 2. graph val	*(value range OFF, SP00 to CH19)*
17: 3. graph val	*(value range OFF, SP00 to CH19)*
18: 4. graph val	*(value range OFF, SP00 to CH19)*

Selects the process value shown as a graph

following parameters apply on selection **CHAN** only:

22: vertic. scale	*(value range 1 to 10)*

Vertical extension of the graph. "1" equals to 10% of the total window height, "2"=20% etc. On some kind of graphs (e.g. digital outputs) the vertical extension of the graph is determined by the number of informations only. **Note:** Multiple graphs are shown togather on the screen if they are adjusted to the same time scale as well as vertical display space is sufficient

23: CH graph range	*(value range 0 to 2)*

Selects the display range of the channel output: 0=0 to +100% / 1=-100 to 0% / 2=-100 to +100%

24: 1. graph CH	*(value range CH00 to TA19)*
25: 2. graph CH	*(value range OFF, CH00 to TA19)*
26: 3. graph CH	*(value range OFF, CH00 to TA19)*
27: 4. graph CH	*(value range OFF, CH00 to TA19)*

Selects the channel output shown as a graph

following parameters apply on selection **DOx** only:

32: 1. graph DOx	*(value range DO0.0 to DO8.0)*
33: 2. graph DOx	*(value range OFF, DO0.0 to DO8.0)*
34: 3. graph DOx	*(value range OFF, DO0.0 to DO8.0)*
35: 4. graph DOx	*(value range OFF, DO0.0 to DO8.0)*
36: 5. graph DOx	*(value range OFF, DO0.0 to DO8.0)*
37: 6. graph DOx	*(value range OFF, DO0.0 to DO8.0)*
38: 7. graph DOx	*(value range OFF, DO0.0 to DO8.0)*
39: 8. graph DOx	*(value range OFF, DO0.0 to DO8.0)*

Selects a digital output shown as a graph

following parameters apply on selection **AOx** only:

42: 1. graph AOx	*(value range AO0.0 to AO4.0)*
43: 2. graph AOx	*(value range OFF to AO4.0)*
44: 3. graph AOx	*(value range OFF to AO4.0)*
45: 4. graph AOx	*(value range OFF to AO4.0)*

Selects an analog output shown as a graph

Table 12: virtual input

Virtual inputs allow very flexible control loops. Depending to the configuration setup process parameters are automatically assigned to the virtual input

00: select type	*(options END, AVG, MIN, MAX, SEL)*

Selects the kind of algorithm used to create the virtual input:

AVG: Virtual input is calculated by averaging all specified inputs. If one of the inputs is in error state (overrun etc.) it is not considered

MIN: Virtual input is created by picking the input representing the lowest value of all specified inputs. An input in error state is not considered

MAX: Virtual input is created by picking the input representing the highest value of all specified inputs. An input in error state is not considered

SEL: Virtual input is created by picking the input selected according to the specified bits (ie. virtual input operates as multiplexer)

01: input A	*(value range SP00 to CH19)*
02: input B	*(value range OFF, SP00 to CH19)*
03: input C	*(value range OFF, SP00 to CH19)*
04: input D	*(value range OFF, SP00 to CH19)*

Selects the process parameters to be used for calculation. Set unused process parameters to "OFF"

following parameters apply on selection **AVG** only:

05: value offset A	*(value range -9999 to 9999)*
06: value offset B	*(value range -9999 to 9999)*
07: value offset C	*(value range -9999 to 9999)*
08: value offset D	*(value range -9999 to 9999)*

This value is added to the corresponding process parameter before calculation. Can be used for example to make selection of thermocouple dependant on temperature deviations

following parameters apply on selection **MIN** only:

15: value offset A	*(value range -9999 to 9999)*
16: value offset B	*(value range -9999 to 9999)*
17: value offset C	*(value range -9999 to 9999)*

18: value offset D	*(value range -9999 to 9999)*

This value is added to the corresponding process parameter before calculation. Can be used for example to make selection of thermocouple dependant on temperature deviations

following parameters apply on selection **MAX** only:

25: value offset A	*(value range -9999 to 9999)*
26: value offset B	*(value range -9999 to 9999)*
27: value offset C	*(value range -9999 to 9999)*
28: value offset D	*(value range -9999 to 9999)*

This value is added to the corresponding process parameter before calculation. Can be used for example to make selection of thermocouple dependant on temperature deviations

following parameters apply on selection **SEL** only:

35: output sel.A	*(value range DO0.0 to DO8.0)*

Sets the bit (digital output) to be used for the selection of the thermocouple. Can be used to change the temperature sensor used for controlling automatically during programme run (e.g. using an EVENT)

36: output sel.B	*(value range OFF, DO0.0 to DO8.0)*

As before, but selects between options 0/1 and 2/3. Set to "OFF" if not used

Table 13: motor char.

Some output devices have a non-linear characteristic. A typical example is a butterfly valve. Each motor characteristic is a list of value pairs **controller percentage output vs. required (true) percentage output**. Missing values are interpolated. A motor characteristic can be selected as "output char." in "digital output - motorized valve

00: outp % on 0%	*(value range 0 to 100)*
01: outp % on 7%	*(value range 0 to 100)*
02: outp % on 14%	*(value range 0 to 100)*
03: outp % on 21%	*(value range 0 to 100)*
04: outp % on 29%	*(value range 0 to 100)*
05: outp % on 36%	*(value range 0 to 100)*
06: outp % on 43%	*(value range 0 to 100)*
07: outp % on 50%	*(value range 0 to 100)*
08: outp % on 57%	*(value range 0 to 100)*
09: outp % on 64%	*(value range 0 to 100)*
10: outp % on 71%	*(value range 0 to 100)*
11: outp % on 79%	*(value range 0 to 100)*
12: outp % on 86%	*(value range 0 to 100)*
13: outp % on 93%	*(value range 0 to 100)*
14: outp % on 100%	*(value range 0 to 100)*

Enter the actual position which equals to the this control output

Table 14: atmosph. mix. setup	
The atmosphere mixer allows the controller to operate the core of a smart complex control system for any gas fired kiln. The basic operation modes are **air excess, stochiometric, cooling**. In **air excess** mode the heat up power controls the amount of gas (gas leads air by a ratio control). In **stochiometric** mode the heat up power controls the amount of air (air leads gas). In **cooling** mode the cooling power controls inverted the amount of air (gas closed)	
00: tempCtrl 0 CH	*(value range OFF, CH00 to CH09)*
01: tempCtrl 1 CH	*(value range OFF, CH00 to CH09)*
02: tempCtrl 2 CH	*(value range OFF, CH00 to CH09)*
Selects the control channel which controls the temperature for this zone	
03: atmosphere SP	*(value range AIR/DRV to SP09)*
Selects the setpoint representing the atmosphere	
04: atmosphere AI	*(value range OFF, IN00 to IN19)*
no explanation available	
05: air vol.0 SP	*(value range OFF, SP00 to SP19)*
06: air vol.1 SP	*(value range OFF, SP00 to SP19)*
07: air vol.2 SP	*(value range OFF, SP00 to SP19)*
Selects the process parameter representing the actual air flow for this zone	
08: gas vol.0 SP	*(value range OFF, SP00 to SP09)*
09: gas vol.1 SP	*(value range OFF, SP00 to SP09)*
10: gas vol.2 SP	*(value range OFF, SP00 to SP09)*
Selects the process parameter representing the actual gas flow for this zone	

Table 15: atmosph. mix. adj.	
Fine tune parameters for the stochiometric mode of the atmosphere mixer	
00: max pwr AIR	*(value range 0.1 to 3000.0)*
01: max pwr GAS	*(value range 0.1 to 3000.0)*
02: low pwr lim %	*(value range 10 to 100)*
03: combust. Cx	*(value range 1.00 to 100.00)*
04: combust. Hy	*(value range 1.00 to 100.00)*
05: combust. inert	*(value range 0.00 to 50.00)*
06: min tune range	*(value range 0.00 to 1.00)*
07: max tune range	*(value range 0.00 to 2.00)*
08: atms.integral	*(value range 10 to 10000)*
integral time for the atmosphere control loop	
09: feedback lim %	*(value range 0.0 to 12.5)*

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operating instructions bentrup TC-S2 V1.1

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