

TC6400/6401

User Manual

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1. TC6400/6401 Features

The **TECHNA-CHECK® TC6400/6401** is a computerized device developed for the single purpose of Machine Tool Monitoring.

The **TC6400** implements a 1 to 8 channel Tool Monitoring System. The TC6400 interfaces to the external world through a number of communication channels: TTBUS (a Sensor Bus), Profibus (an optional Sensor Bus), USB Master & Device and Ethernet (future option).

The **TC6401** is a single channel **TC6400** unit solution.

The **TC6400/6401** has been exclusively developed for the **supervision of cutting tools on single spindle automatic machine tools. It is capable of detecting missing, blunt, and broken or damaged tooling.** The **TC6400/6401** measures, from external measurement transducer(s), either electrical power consumption or vibration of the spindle motor.

The Key Benefits of the **TC6400/6401** Tool Monitoring are:

Improved part quality

The detection of missing or broken tools helps insure that the proper machining is being performed. Detection of tool wear and damage can help improve surface finish and tolerances.

Maximized tool life

By detecting for tool wear and damage, expensive tooling can be changed before the damage gets too severe. This detection also reduces dependence on hit or miss part counting schemes.

Protection of spindle and feed mechanism

By detecting catastrophic tool failures, the **TC6400/6401** can prevent serious damage to your head and feed mechanisms, not just at the station being monitored, but at down-stream stations where "chain reaction" effects can occur.

Improved up time

By creating the process improvements listed above, **TC6400/6401** keeps your machine running longer.

Easy installation

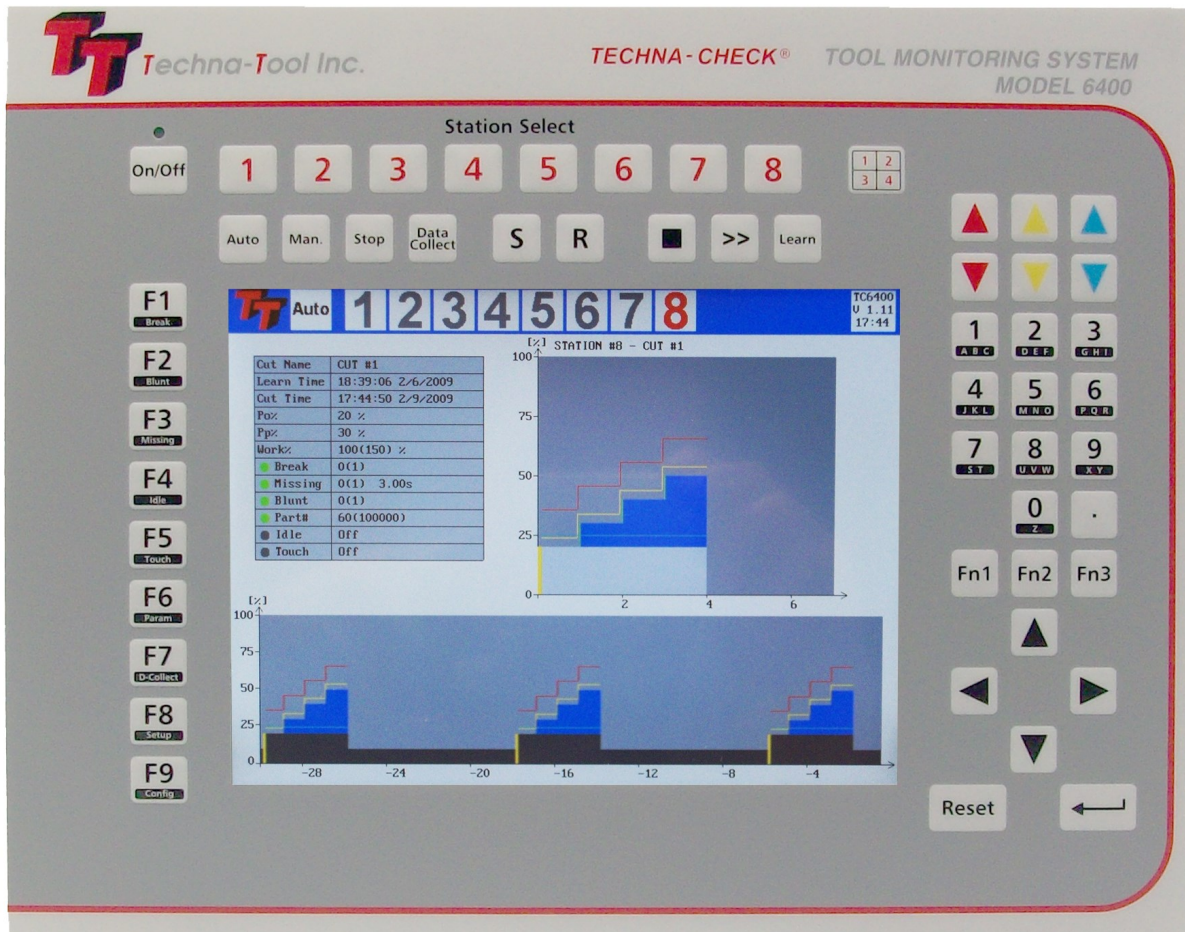
No mechanical modification of the machinery is necessary. The entire system mounts easily in your electrical cabinet.

1.1 Technical Specifications

Technical Specifications:

CPU	:	ARM9 family, 200 MHz
Keyboard	:	54 Folio Key Panel
Graphics	:	800 x 600 pixel TFT
Backlight	:	LED type. 70.000 Hours Life
RAM Memory	:	64 MB
Flash Memory	:	256 MB
Operating System	:	Proprietary
TTBUS	:	Proprietary Sensor Bus
Profibus	:	Optional Sensor Bus
USB Device	:	PC Interface
Micro SD Card	:	Data Collection (Future Optional)
Protection Class	:	IP 60
Dimensions	:	See appendix H.

1.2 Operating the TC6400/6401



The TC6400 is operated from the 54-Key front folio.

The station keys are used to select the current station and the 1,2,3,4 key is used for simultaneously displaying multiple channels.

1.3 Auto mode

The TC6400 screen dump below shows an example of the TC6400 function operating in **Auto Mode**.

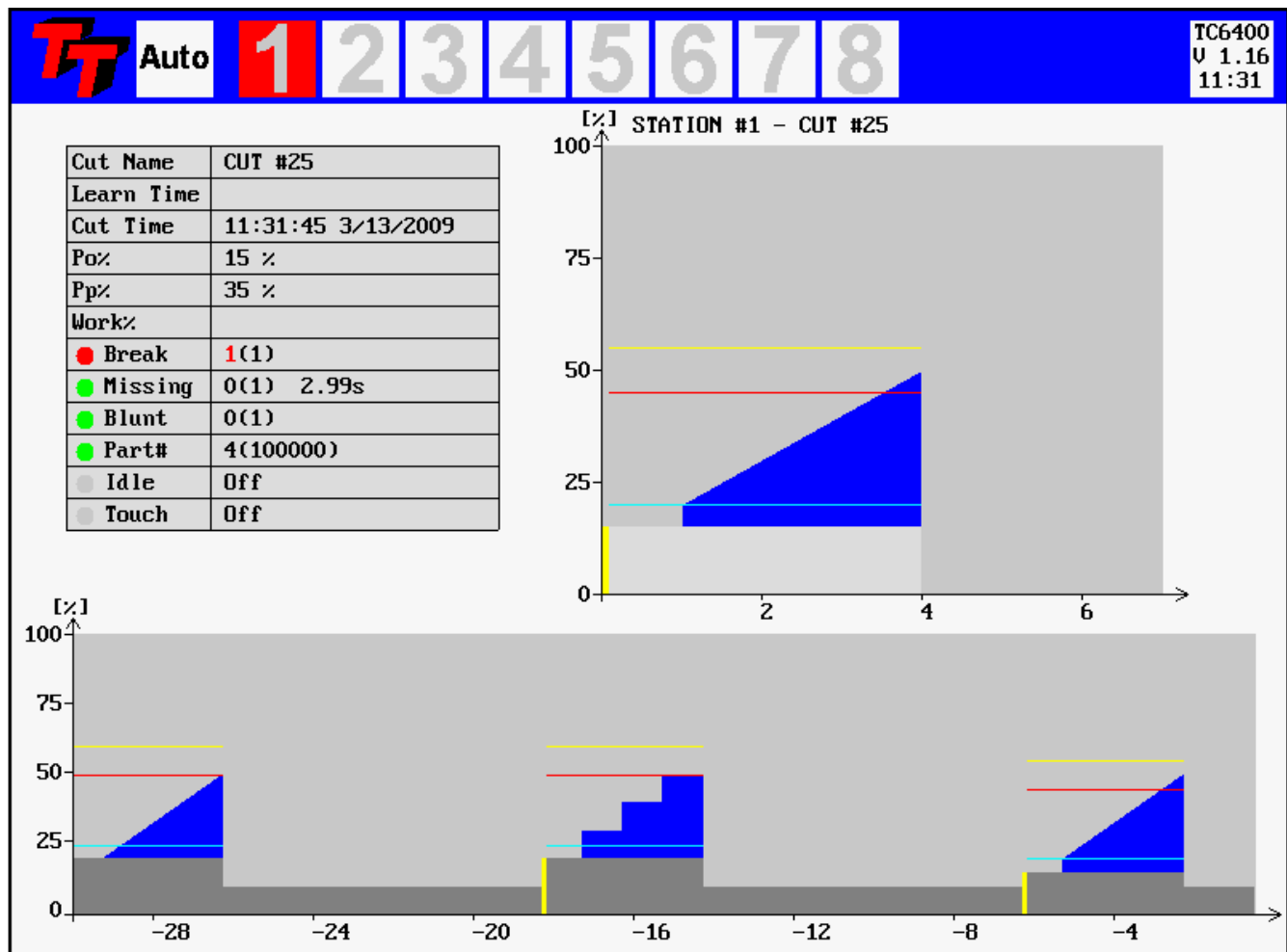


Figure 1—Auto Mode

When the Auto key is activated Auto-Mode is entered.

In this mode the upper half of the screen tracks the current machining cycle on the station that has been selected. The lower part of a screen works as a rolling window where all measurement and all cycle are shifted from right to left. It is possible to store the rolling and to restart the rolling from the keyboard.

The Break Limit is shown in red color. The Blunt Limit is Yellow and the Missing Limit is light Blue. The gray area of the curve is the Idle Measurement. The blue color represents the actual load (torque) from the current cycle.

1.4 Manual Mode

The TC6400 screen dump below shows an example of the TC6400 function operating in **Manual Mode**.

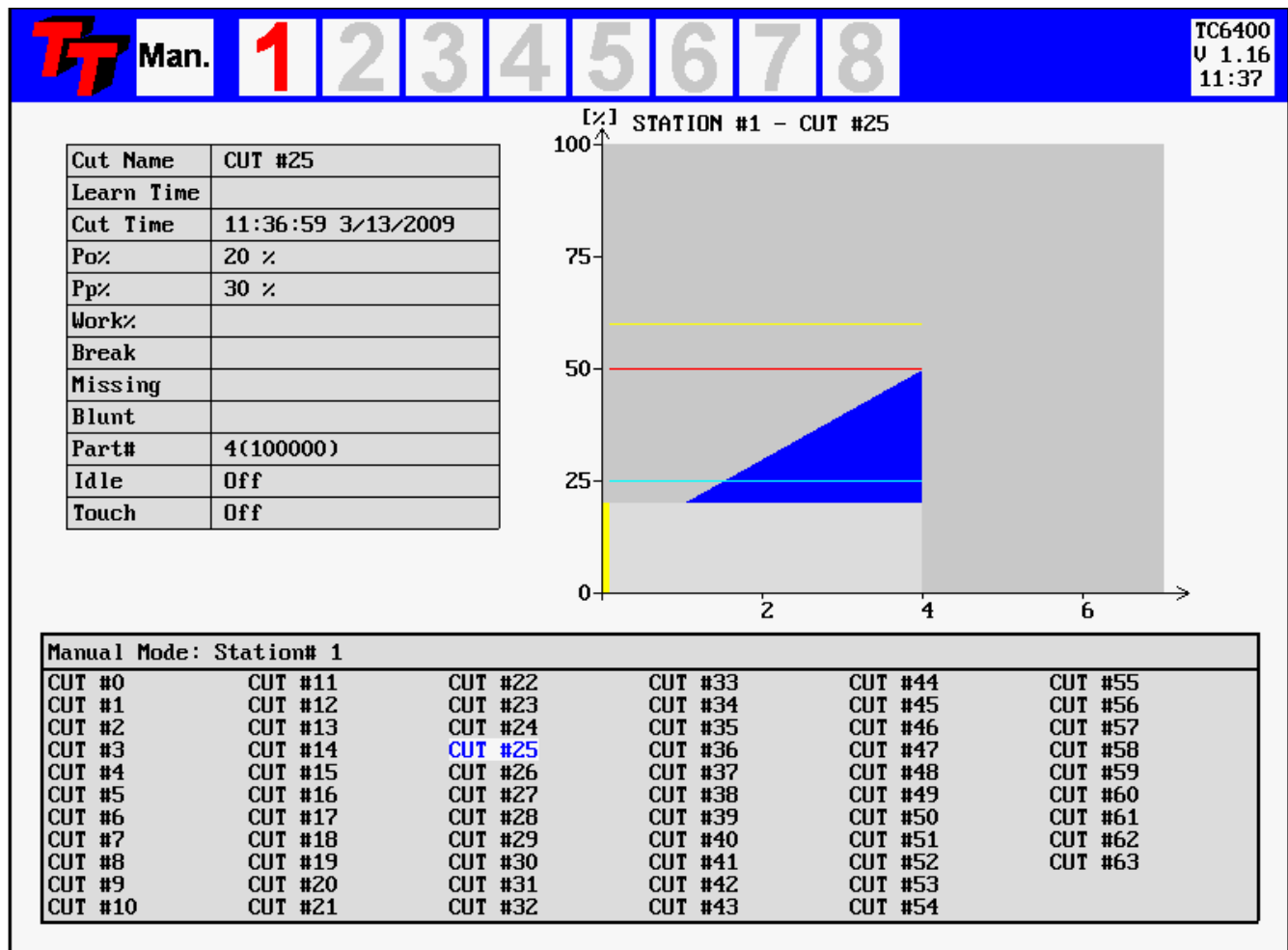


Figure 2—Manual Mode

.When the Man. Key is activated Manual Mode is selected.

1.5 Stop Mode

The TC6400 screen dump below shows an example of the TC6400 function operating in **Stop Mode**.

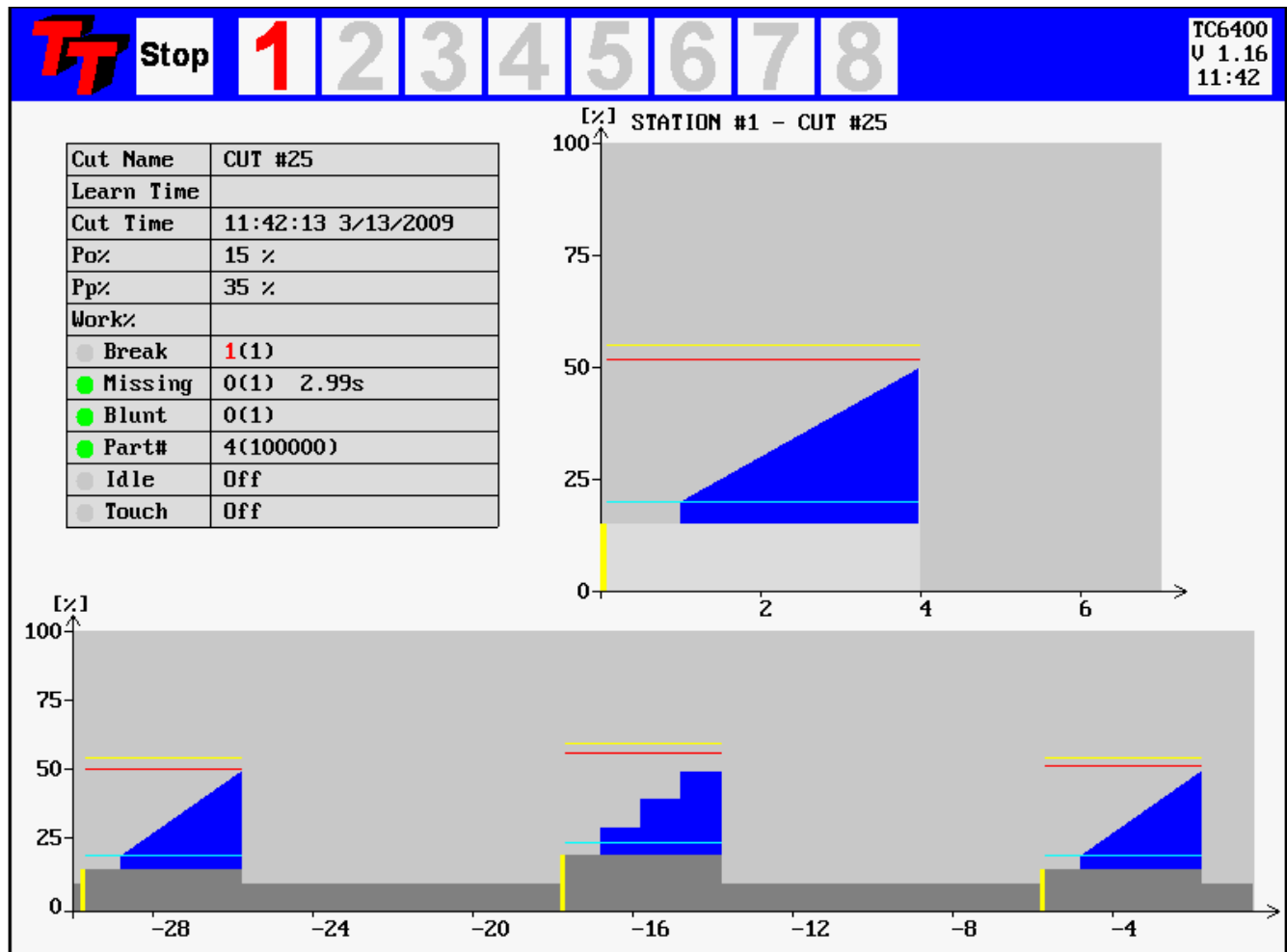


Figure 3—**Stop Mode**

When the Stop-key is activate Stop Mode is entered.

1.6 Full Spindle Window

The TC6400 screen dump below shows an example of the TC6400 function operating in **Full Spindle Window**.

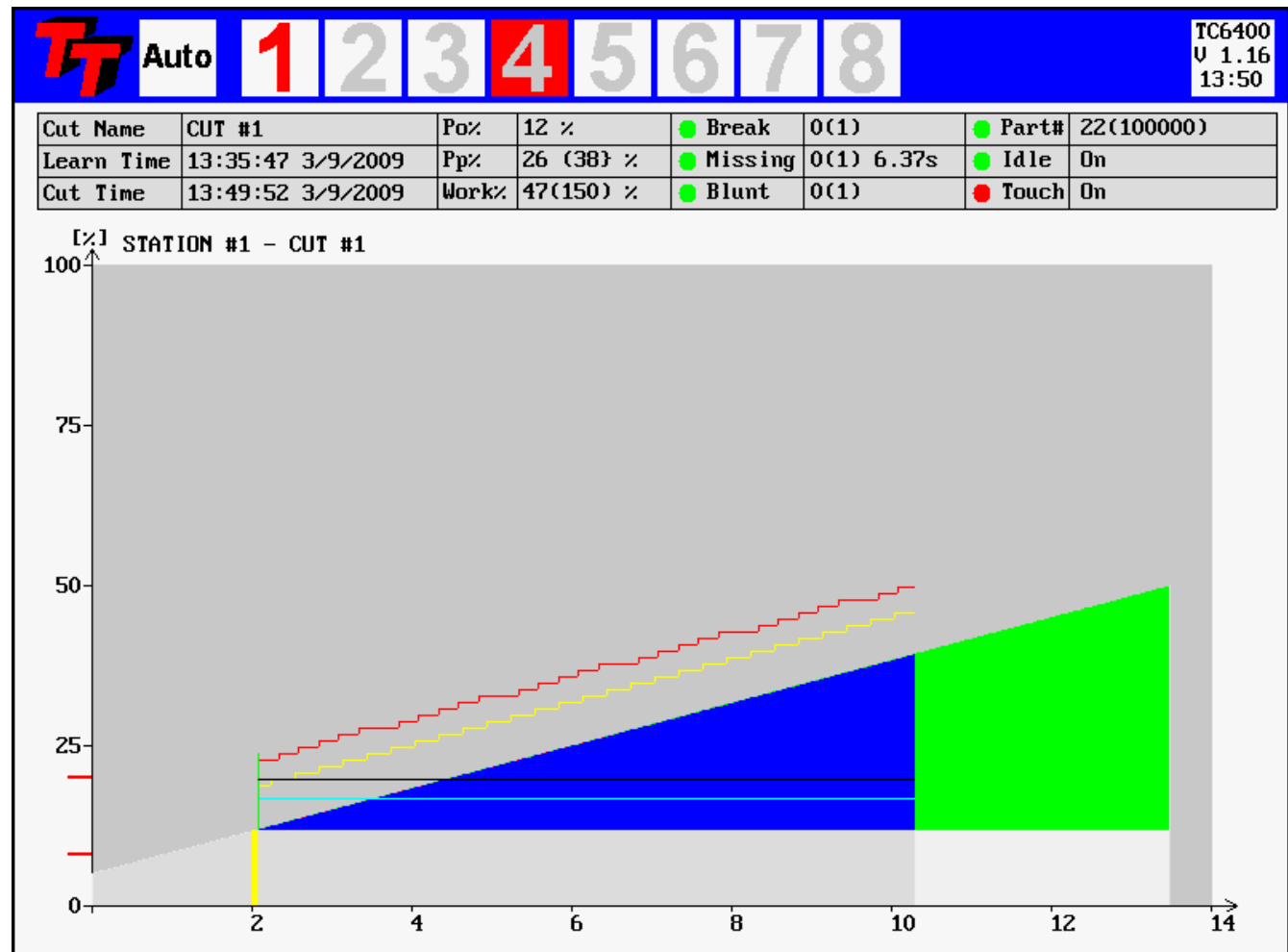


Figure 4—Full Spindle Window

When the S key is activated the current cycle (spindle) takes up the whole screen.

2. Function

2.1 General

The figure below shows a typical measurement cycle on a machine spindle during a machining cycle. The first measurement peak, which is caused by a change in motor speed or a motor start, is not monitored at all. Only the portion of the cut where the spindle speed is constant and the tool is actually in cut is monitored by the unit. When the machine head begins to move towards the part, a **"Start" Signal** is generated by the machine which tells the TECHNNA-CHECK® **TC6400/6401** that a new cycle is beginning. When the unit receives the start signal, the user-defined **Start Delay, T_s** , is activated.

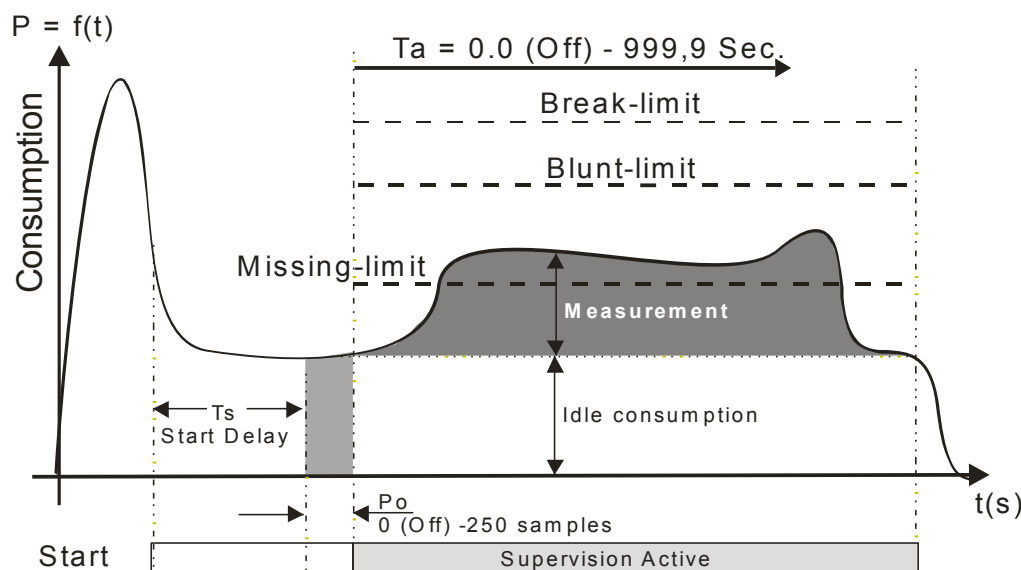


Figure 5—Function

When the start delay ends, the unit initiates the idle measurement. It is very important to measure the idle **before** the tool begins cutting the part. The **idle measurement, P_o** , is the portion of work done by the machine not going into the cut. Idle measurement will vary normally during the course of the day due to such factors as friction, temperature, oil and grease viscosity, etc. The idle measurement is calculated as an average of a certain programmable number (**P_o Averaging**) of measurements.

After the idle measurement has completed, the tool monitoring becomes active. The duration of monitoring may be limited through the use of the monitoring timers, **T_a and T_w** , in order to avoid monitoring undesired events, such as motor speed changes. In many cases, these timers may be turned off, allowing monitoring for as long as the start signal is present. The TECHNNA-CHECK® TTBUS transducers includes a user programmable **Measurement Averaging** feature, which sets the number of individual measurements which are averaged into one calculated value (again, the number of measurements are related to the actual transducer type). This averaging can be used to "smooth" very noisy electrical signals, but it should be set as low as possible in order not to filter out very short duration measurement surges caused by tooling problems. The TECHNNA-CHECK® TC6400/6401 includes a unique **Analog Zoom Function**, which greatly improves the monitoring of small tools. Refer to the section on "Analog Zoom Function" for details.

The TECHNA-CHECK **TC6400/6401** is capable of monitoring 64 completely different cutting operations on each of the max. 8 channels available. This feature is useful when making multiple machining passes with the same machine head, or when making several different parts on the same machine. Prior to the Start Signal being received, the machine signals the cut# select, which cause the appropriate parameters to be used in monitoring the subsequent machine operation.

2.2 Learn Signal

For each type of monitoring (Missing, Break, and Blunt), there are one or more "Learn" modes available. The Learn modes allow the monitoring to take into account variations in tool grind from one tool to the next. In most applications, when using Learn modes, a Learn cycle should be initiated whenever the tool is changed. A Learn cycle may be initiated in three ways, as described below. It should be noted that during a Learn cycle, only Idle Power monitoring is taking place.

2.2.1 Learn Cycle Initiation -- Machine Controlled

A Learn cycle may be initiated by the machine controller. If the Start signal is made active while the Reset signal is being held active, the cycle will be a Learn cycle. If an Idle Power fault would occur during the Learn cycle, the reset signal must be taken low, then brought back high again to reset the fault. The Profibus interface also implements a function for initiating a Learn Cycle.

2.2.2 Learn Cycle Initiation -- TC6400/6401

A Learn cycle may be initiated from the TC6400 front panel by pressing the appropriate function key (the Learn Button at the top of the Window)..

2.3 Fault Signals and Resetting of Faults

All faults generated by the TC6400/6401 are signaled to the machine controller by normally closed dry contact relays (refer to the section on "Electrical Connection") or via the Profibus interface. The Tool Break and Tool Missing faults share a common relay. It is typical that the machine will be programmed to stop its present cycle immediately and retract the machine head on detection of a Tool Missing or Tool Break condition. The Blunt Tool fault is signaled by a second relay. It is typical that the machine will be programmed to finish the current cycle before stopping the machine on a Blunt Tool fault.

All faults may be reset by using the RESET button located on the front panel of the unit, or through the use of the external Reset input (refer to the section on "Electrical Connection"). The fault relays will remain in their active (open) condition until a reset is received.

Profibus implements a separate bit for signaling the various types of alarms.

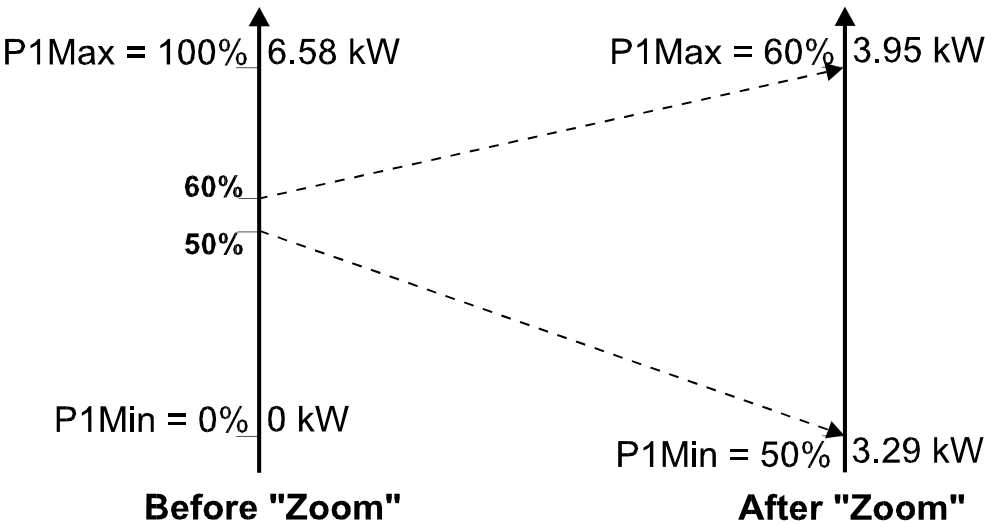
2.4 The Analog Zoom Function

Prior to setting the monitoring parameters, it is desirable to set up the **Analog Zoom Function** parameters. The Analog Zoom Function enables **TTMON** to monitor even very small tools by "focusing" the unit's full analog to digital conversion resolution into a narrow band of measurement. Note that the Analog Zoom Function should be set up prior to setting monitoring parameters, as the monitoring parameters will be "re-scaled" if changes are made to the Analog Zoom.

The transducer **measurement range** must first be set. Once the measurement range has been set, then any large idle powers may be subtracted from the display by adjusting P1Min so that the idle is only 5% to 10% of the full load. P1Max may then be adjusted so that the cutting torque is a rise of 10% to 20% above idle.

The figure below shows a hypothetical application to highlight the power of the Analog Zoom Function. In this application, a 380 VAC, three phase motor is being monitored. If the Current Range is set to 10 A, then 100% power is equivalent to 6.58 kW. If a small tool with a high spindle speed is being used, it is entirely possible that the idle power may be as high as 50% of the scale, while the cutting torque may only rise 2% or 3%. In order to maximize the ability to monitor this application, P1Min is "zoomed" to 50%, while P1Max is "zoomed" to 60%. The entire resolution of the unit is now concentrated in a 10% band. The unit is now only monitoring between 3.29 kW and 3.95 kW. The cutting torque will appear to be 10 times bigger.

Figure 6. Analog Zoom Function



3. TTBUS Networking

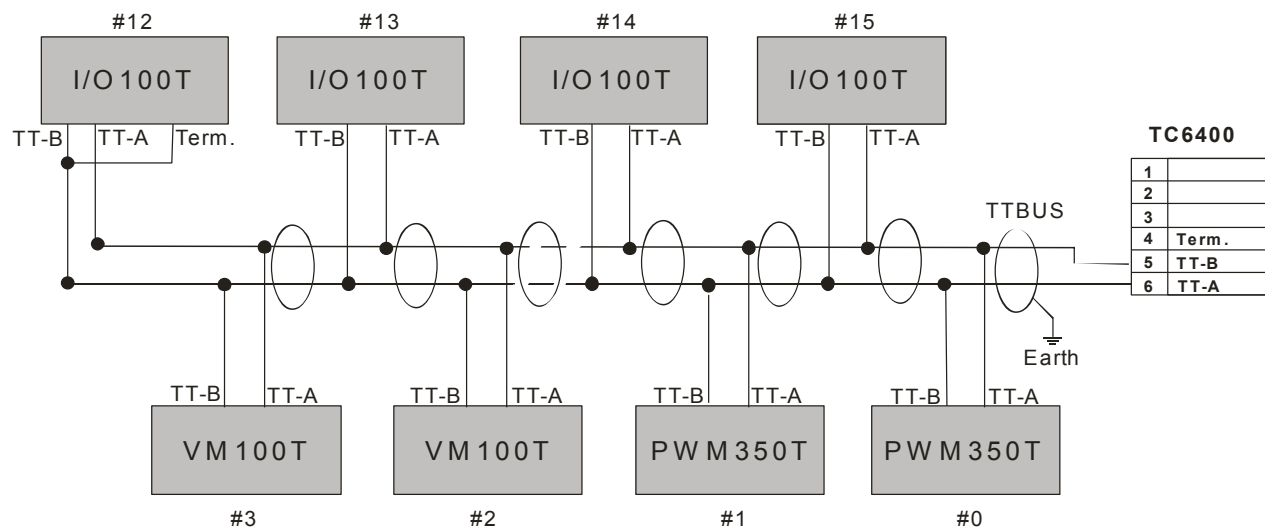
The TTBUS is a Proprietary Sensor Bus designed to interface multiple Measurement Transducers and/or Digital I/O units to the Tool-Monitoring-System. The TTBUS is based upon traditional RS485 hardware.

Today 4 different TTBUS devices have been developed.

PWM350T	:	3-Phase Analogue Power Transducer
PWM3100T	:	3-Phase Digital Power or Current Transducer
VM100T	:	Vibration Sensor Interface Unit
I/O100T	:	Digital I/O Unit.

In the future other type of sensors may be added.

Detailed specifications of the TTBUS units are found in the appendices of this manual. Each TTBUS unit is assigned a unique address on the network. The address is programmed by 2 BCD switches located on the front of the transducers. The Tool Monitoring System automatically locates transducers on the TTBUS. A Channel Mapping menu in the TC6400 is used to map the different transducers to the different channels.



Important note:

Use good-quality twisted pair and shielded cable.
 Connect shield to Earth in one or both ends.
 Last module in chain **must** be terminated.
 Termination possible in all units by adding external wire.
 Make the stubs as short as possible.

Figure 7—TC6400 Networking

Important note:

Please use **good-quality** low-resistance twisted and shielded cable earth-connected at one or both ends for the TTBUS network.
 Last unit in the TTBUS network chain **must** be terminated.
 Termination is possible in all units by adding external wire.
 Make the stubs as short as possible.

3.1 TTBus Communication Analysis

The TC6400 screen dump below shows the function of the **TTBUS Communication Status** mode.

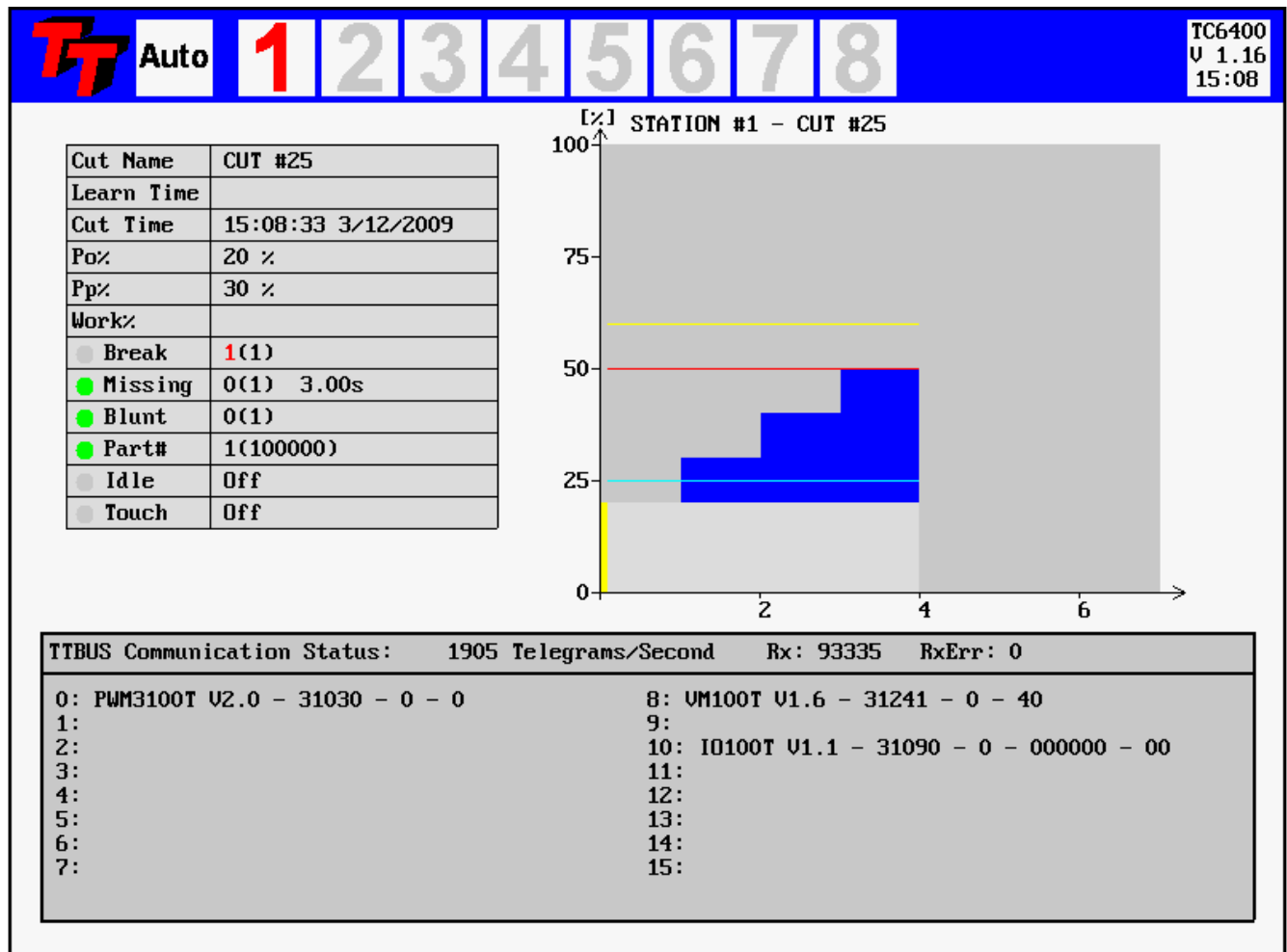


Figure 8—TTBUS Communication Status Window

The screen is activated from the key combination F9 followed by Fn1. The arrow up and down keys are used to switch between the various debug screens.

The screen dump shows three TTBUS slaves found. A maximum of 16 TTBUS slaves may be connected to the TC6400.

The screen shows that 1905 TTBUS telegrams are transferred each second. After the TTBUS transducer type is shown the number of telegrams for each slave is shown. This is followed by the number of erroneous telegrams. The last item is relevant to the data transferred and may be a measurement or digital IO.

4. Profibus Networking

Profibus is an option and requires an insertion of a special Profibus Communication board (PCB) into the TC6400.

4.1 Profibus Cycle-Time Considerations

The Profibus cycle time should be a maximum of 10 -15 ms (milliseconds) equal to 67 – 100 profibus telegram transfers per second. To achieve this a Profibus transmission speed (baud rate) of 1Mb and higher is probably required. If this requirement is not met the synchronization from cycle to cycle is affected and also measurement accuracy may be lost (if the measurement value is supplied from the Profibus network).

4.2 The output telegram from the Profibus Master to the TC6400

The output telegram length is 32 bytes. Data is always sent for 8 channels no matter how many channels are actually used. Data sent for channels not present should be zero. The purpose of the output telegram is to supply control signals, cut number and possibly measurement value to the TC6400 Tool Monitoring System.

Telegram Format:

BitFlags#1, Measurement#1, CutNumber#1, BitFlags#2, Measurement#2, CutNumber#2, BitFlags#8, Measurement#8, CutNumber#8

Telegram Data-Byte Numbering:

Byte No		
0	BitFlags#1	Channel #1 – 8 bits
1, 2	Measurement#1	Channel #1 – 16 bits
3	CutNumber#1	Channel #1 – 8 bits
4	BitFlags#2	Channel #2 – 8 bits
5, 6	Measurement#2	Channel #2 – 16 bits
7	CutNumber#2	Channel #2 – 8 bits
.....		
28	BitFlags#20	Channel #8 – 8 bits
29, 30	Measurement#20	Channel #8 – 16 bits
31	CutNumber#20	Channel #8 – 8 bits

Measurement# - 2 Byte MSB, LSB

16 bit measurement value 0 - 1000 decimal = 0.0 - 100.0%

CutNumber# - 1 Byte

8 bit cut number range 0 - 63 decimal

BitFlags# - b7b6b5bb3b2b1b0

#define PROFIBUS_MODE_MASK

(PROFIBUS_MODE1 | PROFIBUS_MODE2 | PROFIBUS_MODE3) // b6b5b4
(Profibus Mode is current not used should be set to 0)

// PROFIBUS - bit_signals -

Externally Generated Signals - Inputs

#define START_SIGNAL_ACTIVATED	0x01	// b0 = Start Signal
#define LEARN_SIGNAL_ACTIVATED	0x02	// b1 = Learn Signal
#define RESET_ALARM_SIGNAL_ACTIVATED	0x04	// b2 = Reset Signal
#define PROFIBUS_SPARE	0x08	// b3 = not used
#define PROFIBUS_MODE1	0x10	// b4 = Profibus mode

```
#define PROFIBUS_MODE2          0x20    // b3 = Profibus mode
#define PROFIBUS_MODE3          0x40    // b2 = Profibus mode
#define PROFIBUS_UNIT_PRESENT   0x80    // b1 = Channel Present
```

CutNumber# - 1 Byte

8 bit cut number range 0 - 127 decimal

(Please not that cut number zero is not monitored)

4.3 The input telegram from TC6400 to the Profibus Master

The input telegram (data sent from the TC6400 to the Profibus Master) is always 8 bytes long – 1 byte for each channel.

Channel #1 is first and Channel #8 is the last byte. The purpose of the inputs is to report Alarms and other status information to the master (NC controller).

Telegram Format:

InputFlags#1, InputsFlags#2 InputFlags#8

InputFlags - b7b6b5bb3b2b1b0

```
#define ACTIVE_READY          0x01    // b0 = Po Measured
#define SPARE1                 0x02    // b1 = bit not used
#define TOUCHED                0x04    // b2 = Touched
#define IDLE_ALARM             0x08    // b3 = IDLE_ALARM
#define BLUNTCOUNT_ALARM       0x10    // b4 = BLUNTCOUNT_ALARM
#define MISSING_ALARM          0x20    // b5 = MISSING_ALARM
#define BLUNT_ALARM            0x40    // b6 = BLUNT_ALARM
#define BREAK_ALARM            0x80    // b7 = BREAK_ALARM
```

ACTIVE_READY

This bit is set when the Tool Monitoring becomes active.

Example: Start Signal has been activated and Idle Power calculated.

SPARE1

Not used.

TOUCHED

Is used with the Touch-Limit function and set when the tool touches the part – signal reaches the touch-limit.

IDLE_ALARM

Signals the presence of an IDLE_ALARM.

BLUNTCOUNT_ALARM

Signals the presence of a BLUNTCOUNT_ALARM.

MISSING_ALARM

Signals the precense of a MISSING_ALARM.

BLUNT_ALARM

Signals the precense of a BLUNT_ALARM.

BREAK_ALARM

Signals the precense of a BREAK_ALARM.

4.4 The Profibus GSD File TC64000A0C.GSD

```

; =====
; Techna Tool Inc.
;
; File : TC64000A0C.GSD
; Revision : 1.0
; Last Modification : 14/01/2009
; =====
;
#Profibus_DP
; General device information
GSD_Revision          = 1
Vendor_Name           = "Techna Tool Inc."
Model_Name            = "TC6400"
Revision              = "V1.0"
Ident_Number          = 0x0A0C
Protocol_Ident        = 0          ; 0 = PROFIBUS-DP only
Station_Type          = 0          ; 0 = DP-Slave
FMS_supp              = 0          ; FMS is not supported
Hardware_Release      = "A1"
Software_Release      = "V1.0"

; Supported baudrates
9.6_supp              = 1
19.2_supp             = 1
45.45_supp            = 1
93.75_supp            = 1
187.5_supp            = 1
500_supp              = 1
1.5M_supp             = 1
3M_supp              = 1
6M_supp              = 1
12M_supp             = 1

; MaxTsdr default values for supported baudrates
MaxTsdr_9.6           = 60
MaxTsdr_19.2          = 60
MaxTsdr_45.45         = 60
MaxTsdr_93.75         = 60
MaxTsdr_187.5         = 60
MaxTsdr_500           = 100
MaxTsdr_1.5M          = 150
MaxTsdr_3M            = 250
MaxTsdr_6M            = 450
MaxTsdr_12M          = 800

; General supported features
Redundancy             = 0          ; Redundancy not supported
Repeater_Ctrl_Sig      = 2          ; RTS Signal with TTL level
24V Pins              = 0          ;
Implementation_Type    = "ASIC_solution, VPC3+"

.; DP Slave related information
Freeze_Mode_supp       = 0          ; Freeze-Mode not supported
Sync_Mode_supp         = 0          ; Sync.-Mode not supported
Auto_Baud_supp         = 1          ; Automatic baud control supported

```

```
Max_Diag_Data_Len      = 6
Set_Slave_Add_supp     = 0           ; Set Slave address not supported
User_Prm_Data_Len      = 05          ;
Min_Slave_Intervall    = 5           ; 500us
Slave_Family           = 1@TT@TC

; Modules information
Modular_Station        = 0
Max_Module             = 1
Max_Input_Len          = 8
Max_Output_Len         = 32
Max_Data_Len           = 40

Module = "32 Byte out/ 8 Byte In" 0x2f,0x2f,0x17

EndModule
```

4.5 Profibus Communication Analysis

The TC6400 screen dump below shows the function of the **Profibus Communication Status** mode.

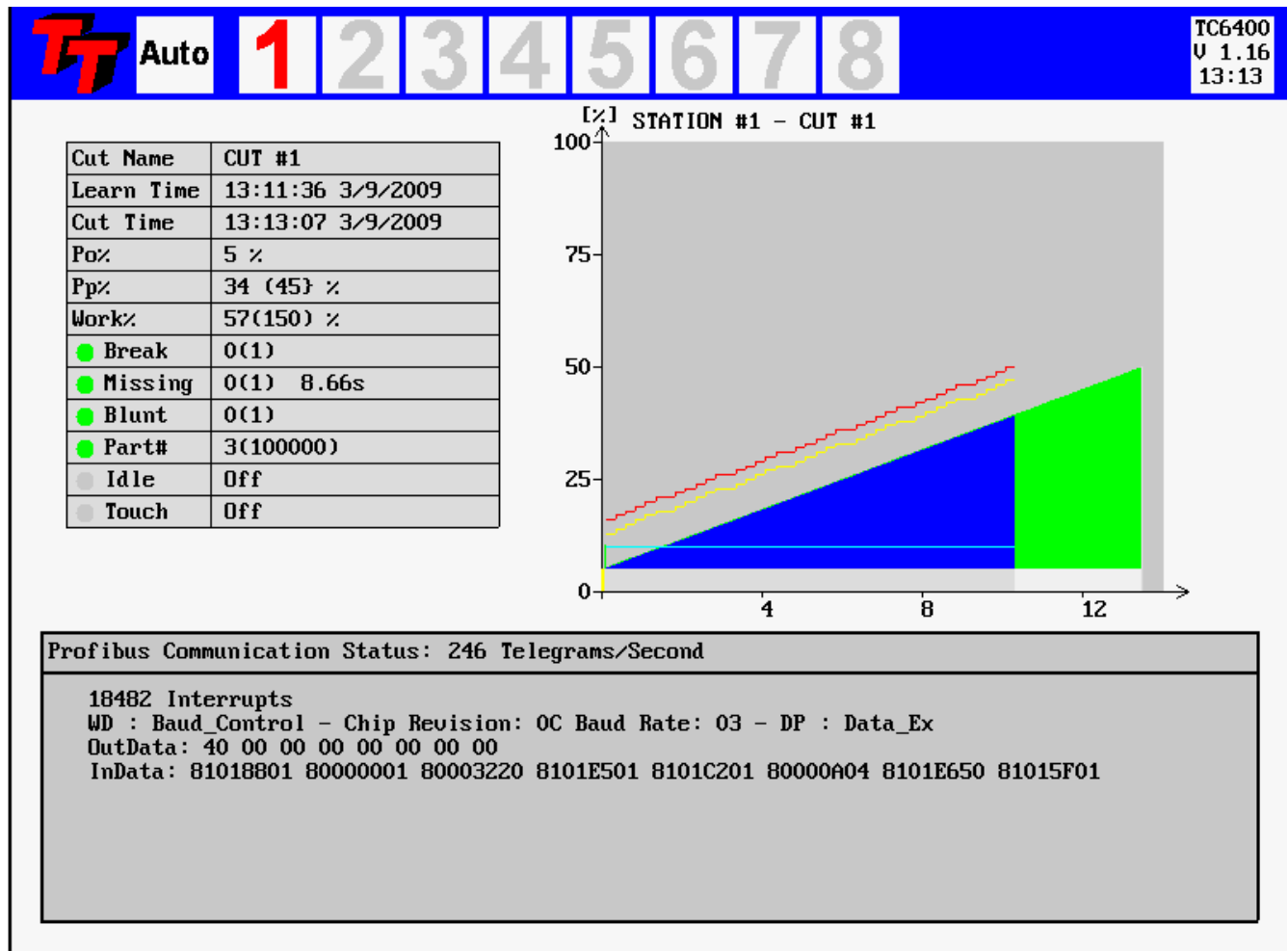


Figure 9—Profibus Communication Status Window

The screen is activated from the key combination F9 followed by Fn1. The arrow up and down keys are used to switch between the various debug screens.

5. F1 Key - Break

5.1 Break Mode Selection

When a tool breaks while it is machining a part, it is typical to notice a sharp, short duration "spike" of torque in the motor. This torque spike is the extra energy being used by the machine to actually break the tool. The TECHNNA-CHECK® TC6400 can detect this spike, and indicate a broken tool. (It should be noted that not all tools break the same way every time, and that a torque spike may not necessarily be generated in the process of breaking the tool. In this case, a missing tool condition should be noticed on the same or following cycle.) There are four **Break Modes** available, which are described below.

5.2 Tool Break -- Absolute Peak Mode

The TC6400 screen dump below shows the function of the Break Limit in **Abs. Peak** mode.

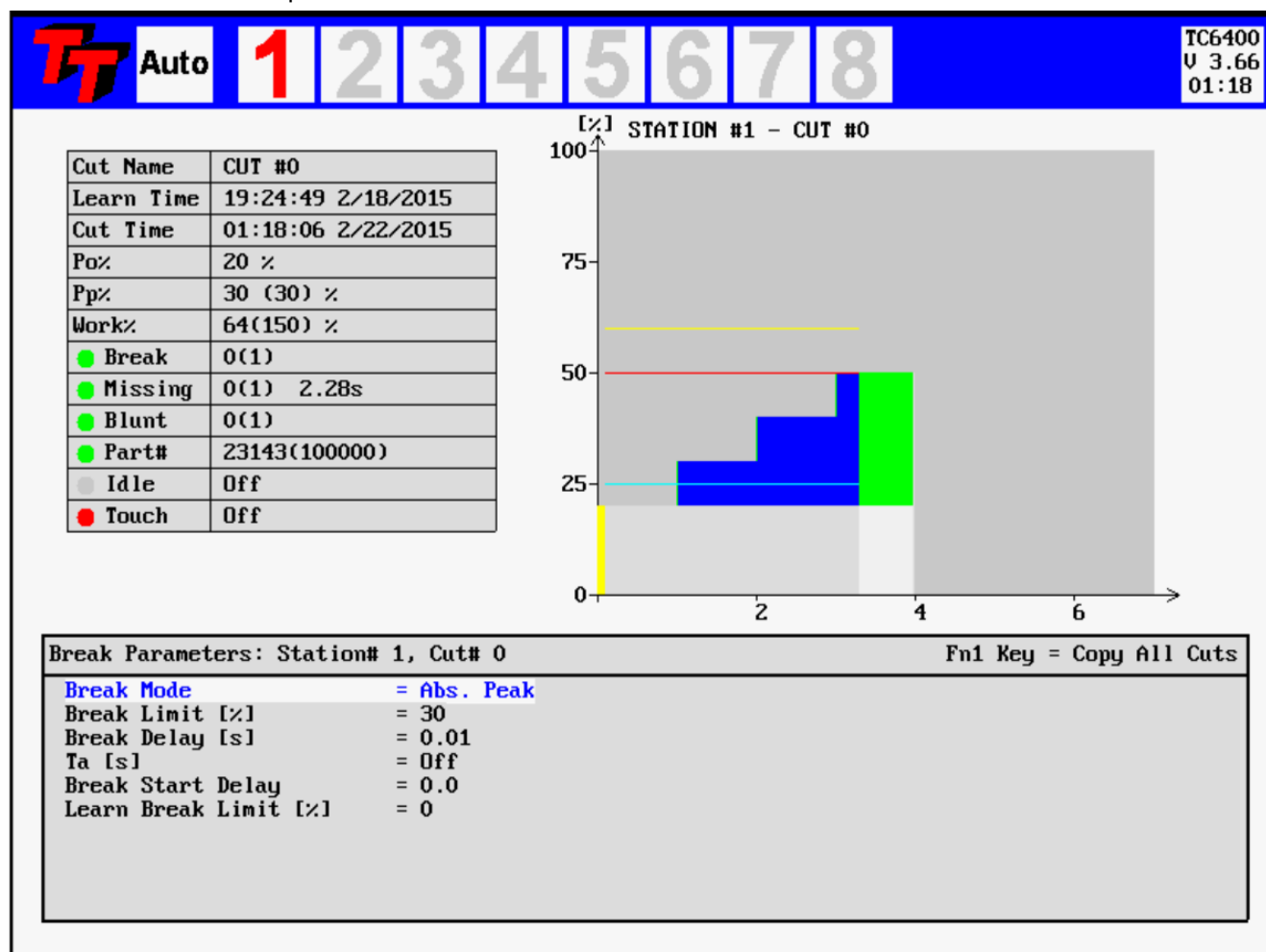


Figure 10—Tool Break Absolute Peak Mode

The break-limit is shown in red color. The break limit is placed as an absolute percentage above the idle power Po%. In this mode the Break Limit is not related to a previously learned item. If the Break Limit is exceeded for a cumulative time greater than the user-defined **Break Delay**, then a tool break fault will be generated. When determining the Break Limit and Break Delay, more aggressive monitoring is achieved by setting a lower limit and shorter delay. However, setting these parameters too aggressively will result in increased nuisance trips. In typical applications, the Break Limit is set fairly high (between 20 and 30%), but with a very short Break Delay (often the minimum 0.01 second). When a tool break occurs, the rise in torque is often quite dramatic, so a high limit and short delay are best to eliminate nuisance faults.

5.3 Tool Break -- Learn Peak Mode

The TC6400 screen dump below shows the function of the Break Limit in **Learn Peak** mode.

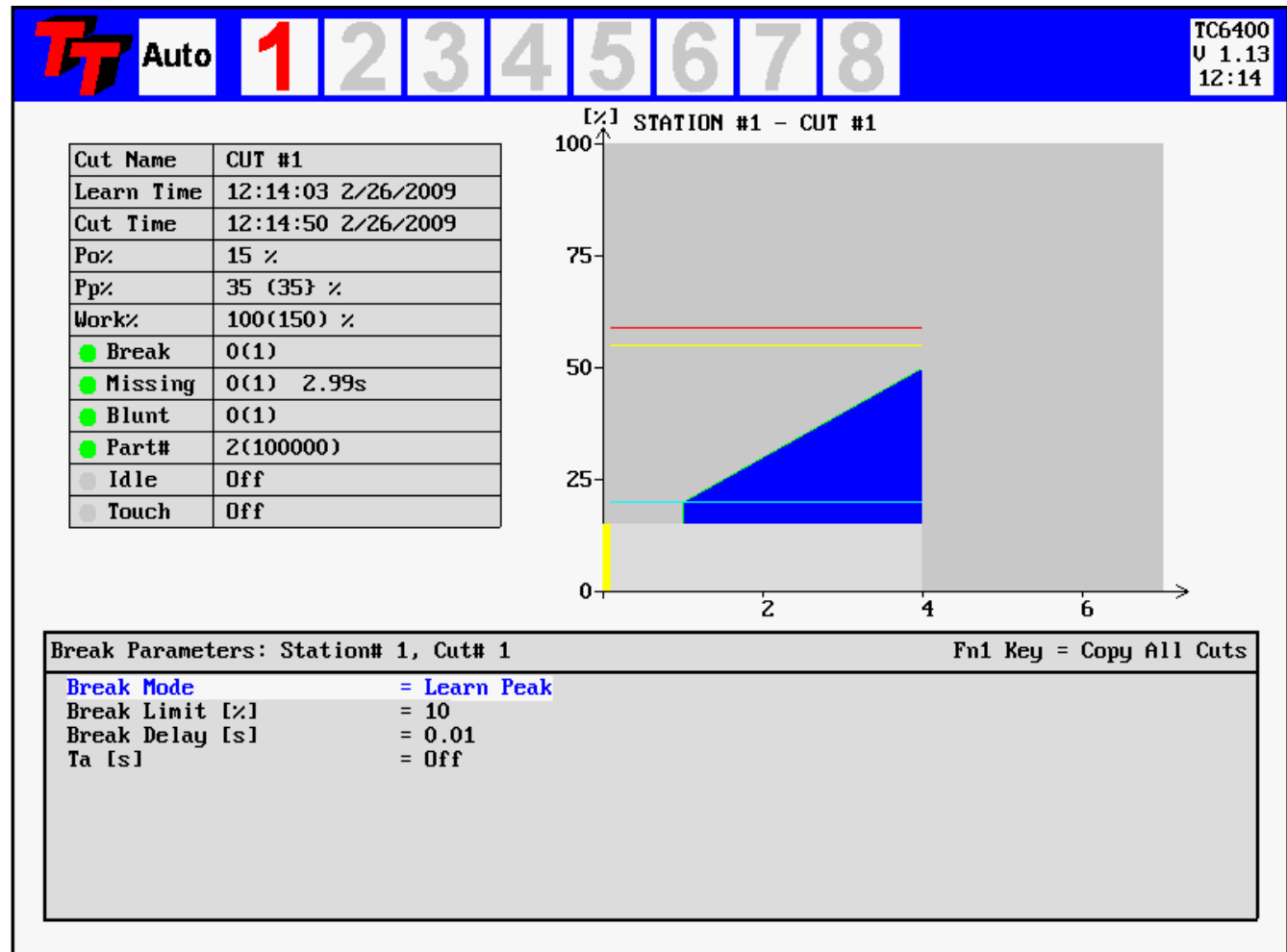


Figure 11—Tool Break Learn Peak Mode

The break-limit is shown in red color. The break limit is placed as a percentage increase above the previously learned Peak value. If the Break Limit is exceeded for a cumulative time greater than the user-defined **Break Delay**, then a tool break fault will be generated. When determining the Break Limit and Break Delay, more aggressive monitoring is achieved by setting a lower limit and shorter delay. However, setting these parameters too aggressively will result in increased nuisance trips. In typical applications, the Break Limit is set fairly high (between 20 and 30%), but with a very short Break Delay (often the minimum 0.01 second). When a tool break occurs, the rise in torque is often quite dramatic, so a high limit and short delay are best to eliminate nuisance faults.

Setting the Break Limit and Break Delay in Learn Mode is much the same as in the Absolute Peak Mode, except that the Break Limit in Learn Mode will “move” with respect to the learned cut. This adaptation allows the unit to adjust to changes in grind from one tool to the next, when the profile is re-learned.

5.4 Tool Break -- Absolute 3 Step Curve Mode

The TC6400 screen dump below shows the function of the Break Limit in **Absolute 3 Step Curve** mode.

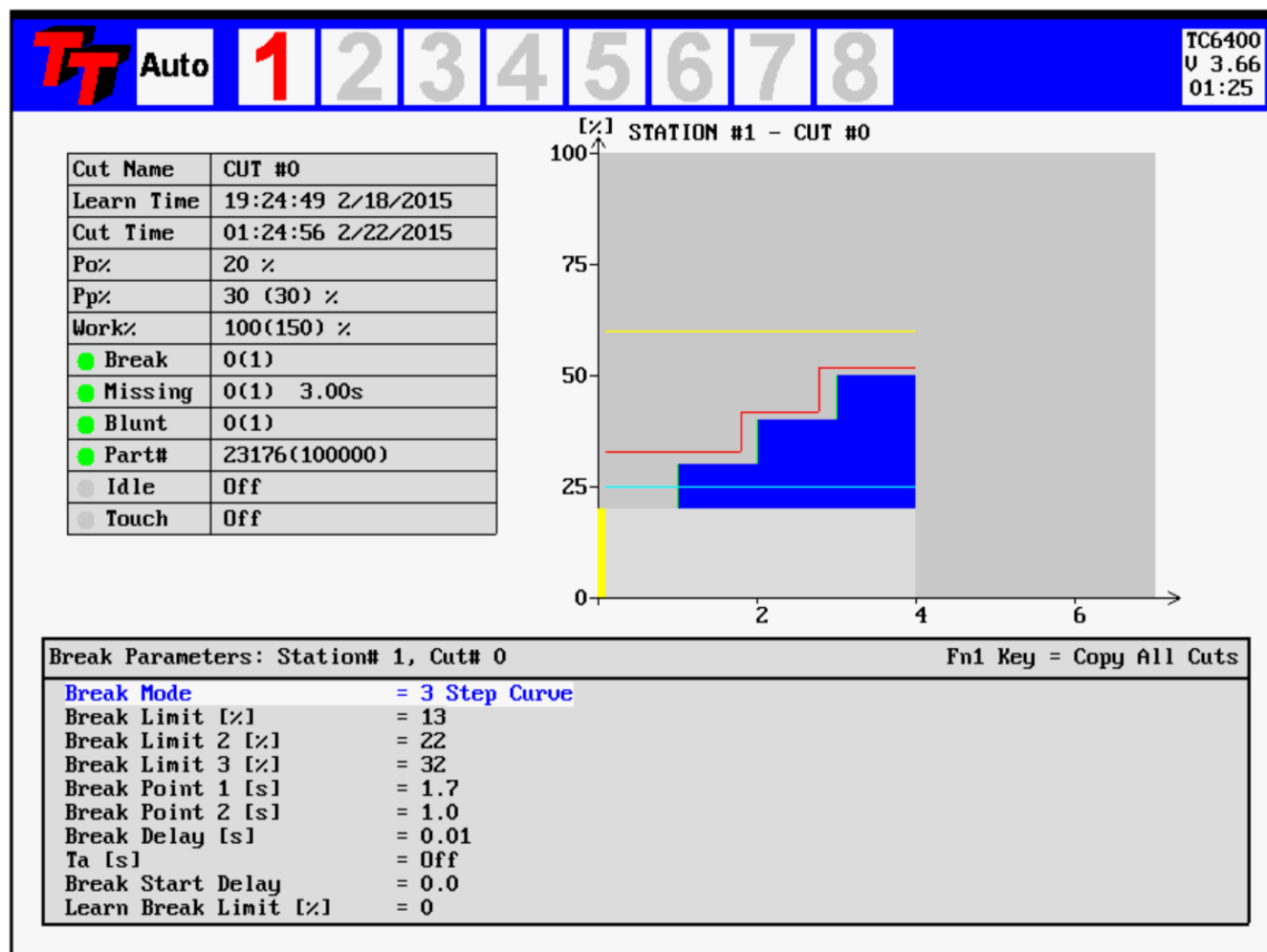


Figure 12—Tool Break Absolute 3 Step Curve Mode

The Absolute Peak Curve mode works just like Absolute Peak Mode, but the limit changes in a **step** fashion as a function of time. This mode may well be used to supervise step tools. If the Break Limit is exceeded for a cumulative time greater than the user-defined **Break Delay**, then a tool break fault will be generated. Tool Break supervision remains active for the entire time, following the Start Delay and idle power measurement, that the Start Signal is present on the unit if monitoring timer Ta is turned off, or for the duration of Ta if it is enabled. Three steps are available and if a step limit is set to zero it is not monitored at all.

The Tool-Break Limit is shown in red color. No learn cycle is needed for this mode of Tool-Break monitoring.

If a step is set to zero it is not monitored at all. This feature may be used in monitoring tapping operations. The second step of the curve is the set to zero and used to switch-off the monitoring when the spindle changes direction. The first step is then used to monitor the forward (tapping) operation and step three is then used to monitor the reversal (tap getting out).

5.5 Tool Break -- Learn Step Curve Mode

The TC6400 screen dump below shows the function of the Break Limit in **Learn Step Curve** mode.

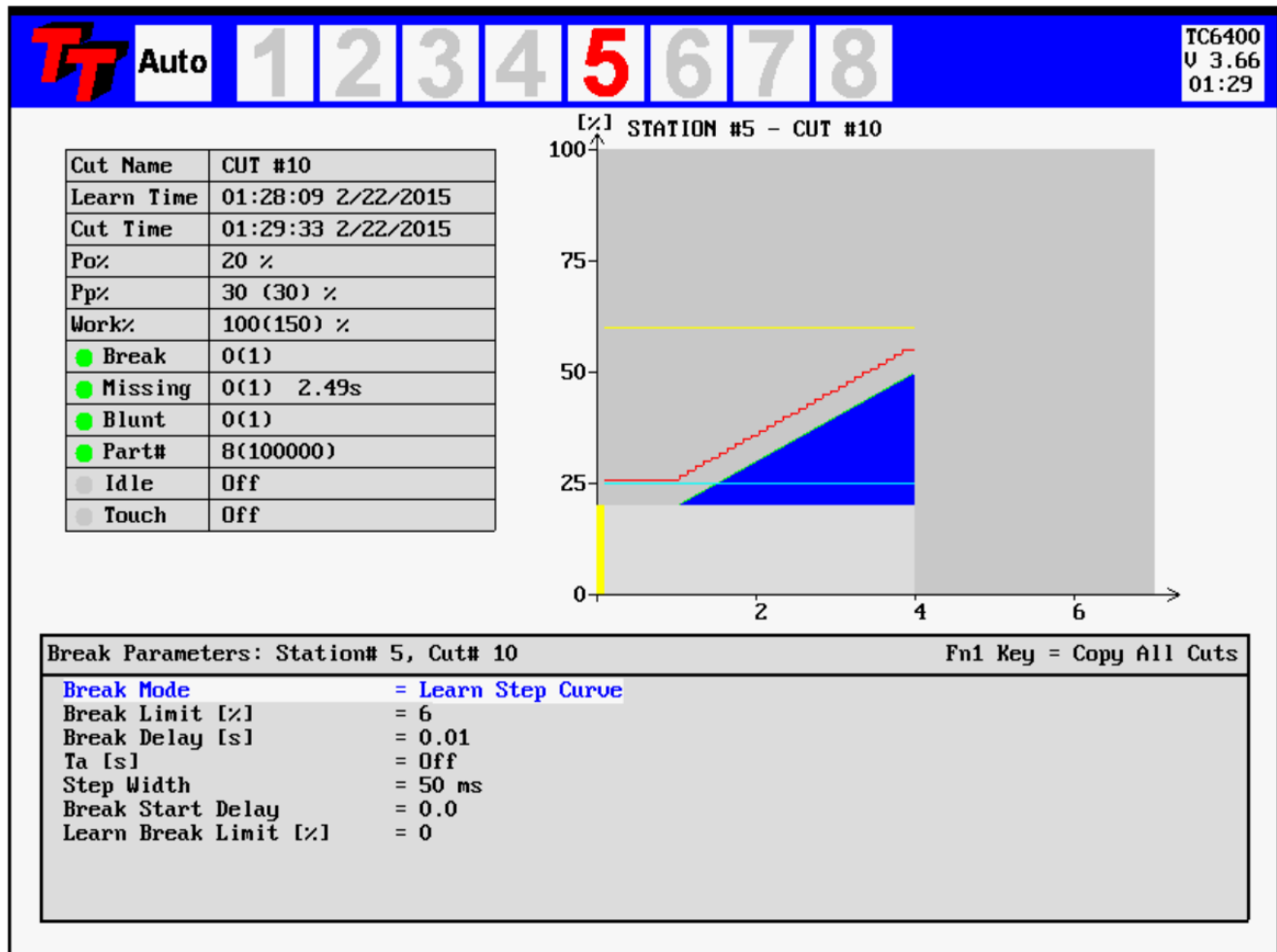


Figure 13—Tool Break Learn Step Curve Mode

The figure above shows the Learn Step Curve break mode. In this mode the Break Limit is calculated as a step-curve from the original learned curve. The Break Limit is a percentage increase from this learned curve. This makes the break limit follow the curve and may result in better monitoring for break detection of step-tools. Even multiple spindle heads may be monitored successfully for single breaking tools with this monitoring mode. The Step-Width is programmable and a new learn cycle is not necessary when the Step-Width is modified. If synchronization problem exists between the learned and the monitor cycle the Step-Width should be increased in order to avoid false alarms.

The Tool-Break Limit is shown in red color. A learn cycle is needed for this mode of Tool-Break monitoring.

6.0 *Blunt Tool Supervision*

6.1 Blunt Mode Selection

As a tool wears, it is normal for its cutting surfaces to become less efficient, and thus it requires more torque to cut the part. The TECHNA-CHECK® **TC6400/6401** is designed to look for this rise in torque, and to stop the machine when a tool has reached a point where it would be desirable to change it.

There are four **Blunt Modes** available. If **Absolute Peak Mode** is selected, the detection of blunt tools is based on the value of the instantaneous torque measurement above idle. In **Work Mode**, the detection of blunt tools is based on the area under the torque curve for the duration of the cutting cycle, which is proportional to the work or energy used to cut the part. Peak Mode is recommended for most simple machining operations. Work Mode may be used when there are multiple or changing load levels observed during the cycle, such as when a step tool or complicated boring tool is used. Additionally, there are two Blunt Modes representing **Learn** versions of the two modes already described. They allow the system to automatically adjust to changes in grind from one tool to the next.

Also in any blunt mode, the **Blunt Counter** feature is available. In order to reduce the number of undesired nuisance trips, the Blunt Counter may be set to require a number of consecutive blunt tool faults to be detected before the machine is signaled to stop. For example, a hard part or temporary chip build up may cause a blunt fault to occur in one cycle, but the condition may not be present again in the next cycle. In this case, a Blunt Counter setting of, for example, three would require this condition to occur three cycles in a row before a blunt trip stops the machine. In typical applications, a Blunt Counter setting from 2 to 5 is generally used, depending on material consistency and chip build-up, but higher settings may be used.

6.2 Blunt Tool – Absolute Peak Mode

The TC6400 screen dump below shows the function of the Blunt Limit in **Abs. Peak** mode.

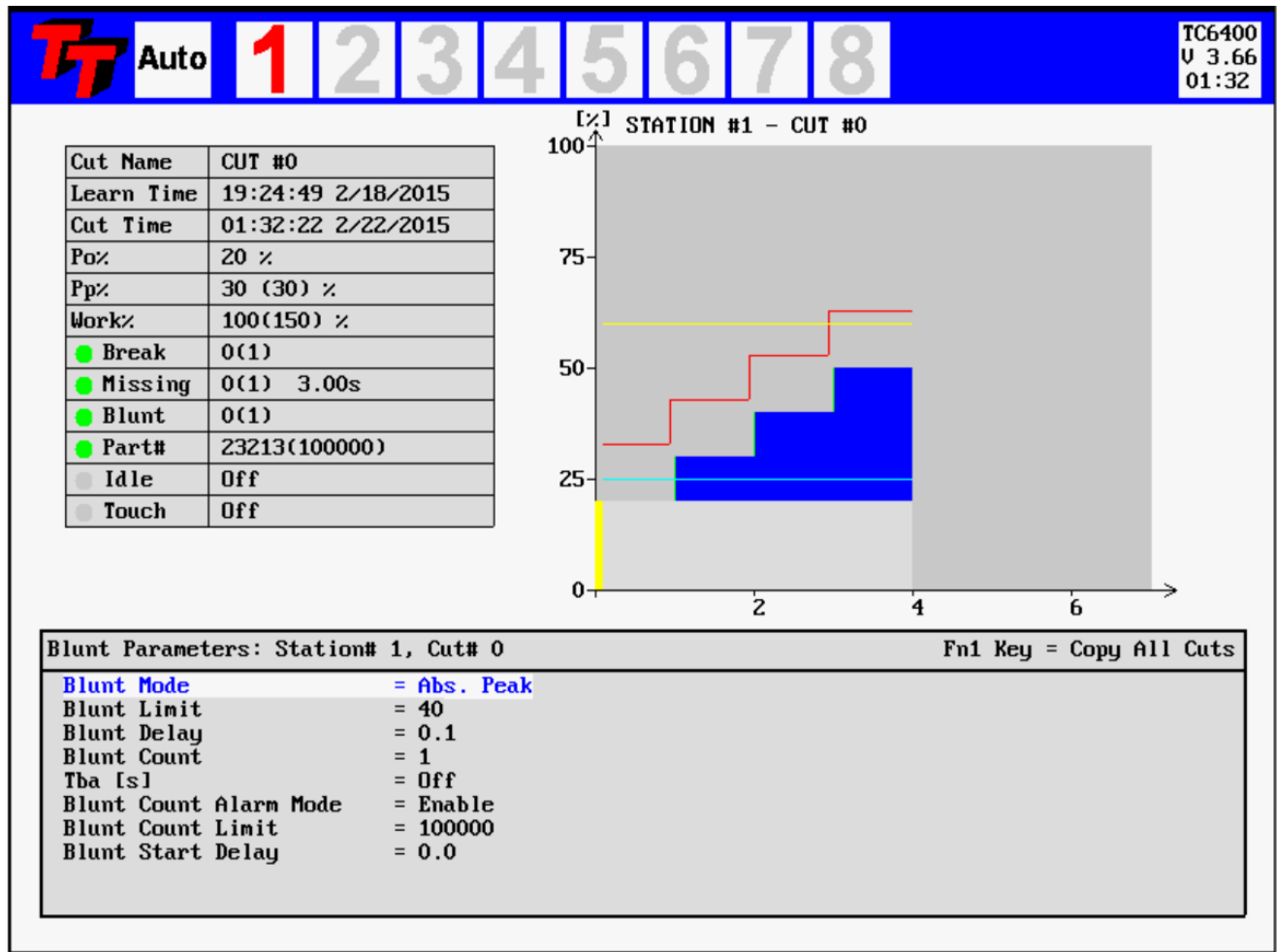


Figure 14—Tool Blunt Abs. Peak Mode

The blunt-limit is shown in yellow color. The blunt limit is placed as an absolute percentage above the idle power Po%. In this mode the Blunt Limit is not related to a previously learned item. If the Blunt Limit is exceeded for a cumulative time greater than the user-defined **Blunt Delay**, then a tool blunt fault will be generated.

In setting the Blunt Limit and Blunt Delay, more aggressive monitoring is achieved by setting a lower limit and shorter delay. However, setting these parameters too aggressively will result in increased nuisance trips. As a tool wears, the load will gradually increase, and will eventually stay at a higher level for the entire duration of the cut. In typical applications, the Blunt Limit is set fairly low (between 10 and 25%), but with a fairly long Break Delay (often around 75% of the total duration of the cut).

6.3 Blunt Tool - Learn Peak Mode

The TC6400 screen dump below shows the function of the Blunt Limit in **Learn Abs. Peak** mode.

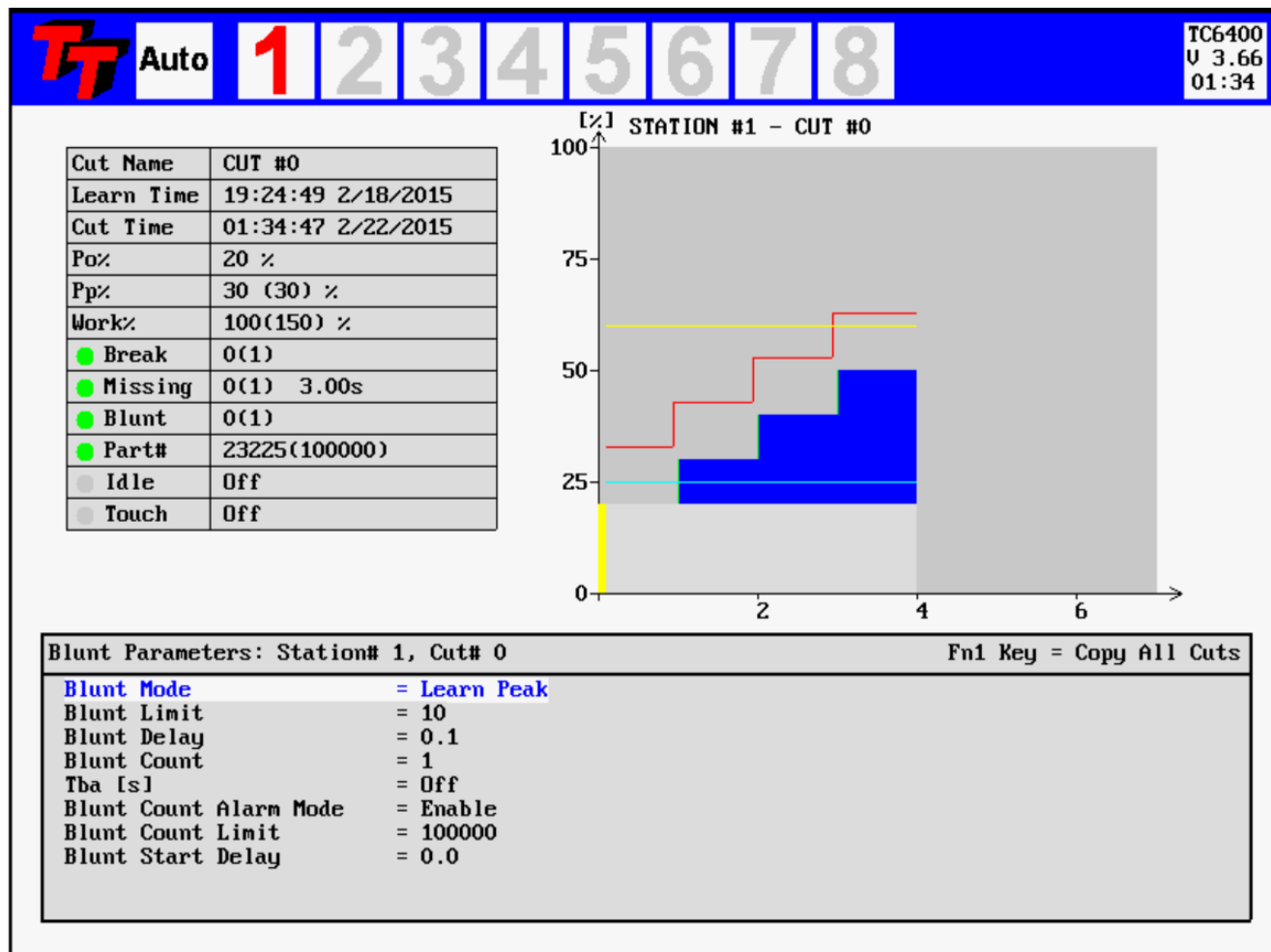


Figure 15—Tool Blunt Learn Peak Mode

The blunt-limit is shown in yellow color. The blunt limit is placed as a percentage increase above the previously learned Peak value. If the Blunt Limit is exceeded for a cumulative time greater than the user-defined **Blunt Delay**, then a tool blunt fault will be generated.

In setting the Blunt Limit and Blunt Delay, more aggressive monitoring is achieved by setting a lower limit and shorter delay. However, setting these parameters too aggressively will result in increased nuisance trips. As a tool wears, the load will gradually increase, and will eventually stay at a higher level for the entire duration of the cut. In typical applications, the Blunt Limit is set fairly low (between 10 and 25%), but with a fairly long Break Delay (often around 75% of the total duration of the cut).

6.4 Blunt Tool - Learn Work Mode

The TC6400 screen dump below shows the function of the Blunt Limit in **Learn Work Peak** mode.

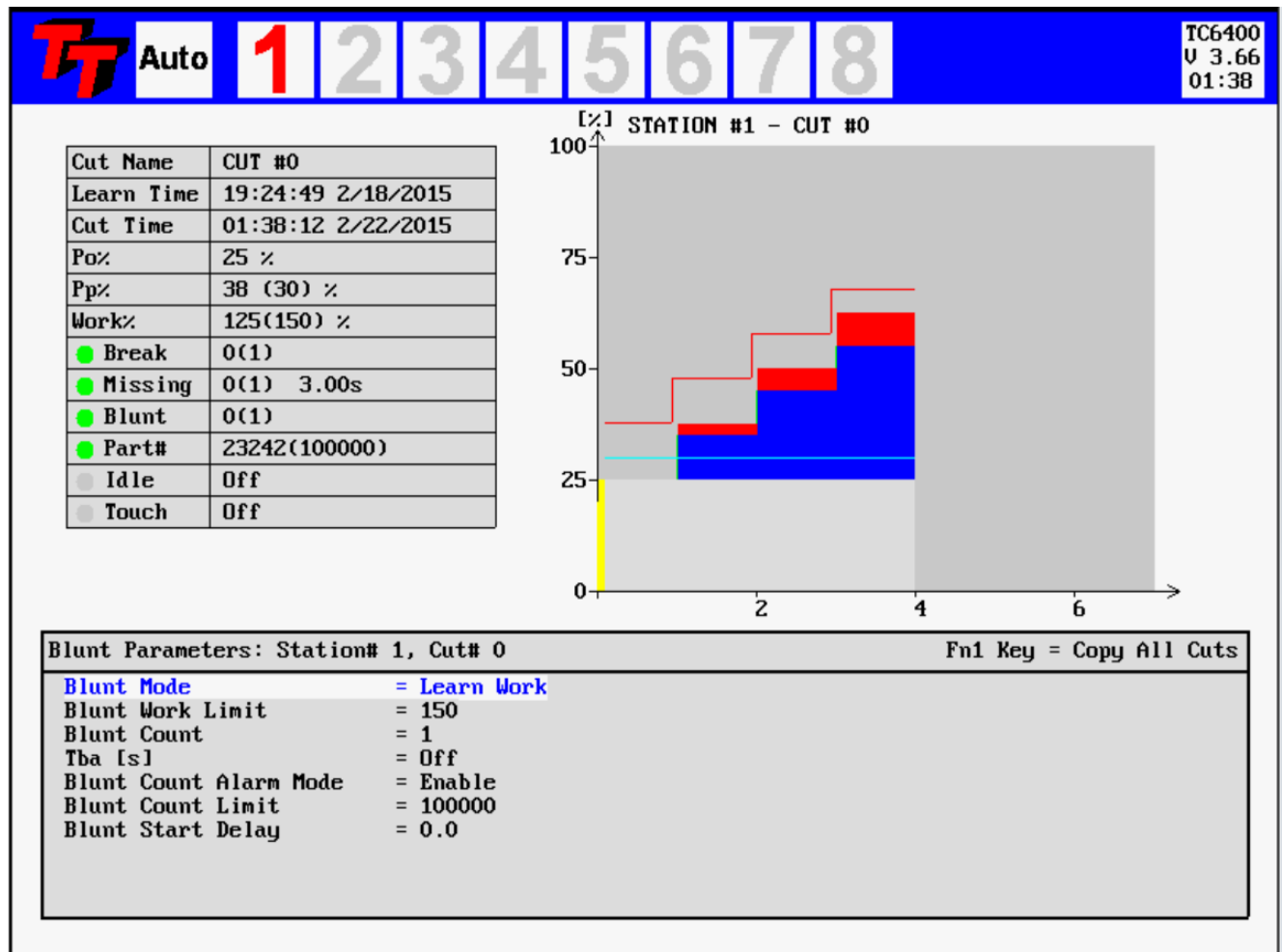


Figure 16—Tool Blunt Learn Work Mode

The figure above shows a typical blunt tool situation using **Learn Work Mode** monitoring, including the setting of the tool **Blunt Limit**. The work, or energy consumed, during the cutting cycle is proportional to the blue area in the figure. The Blunt Limit is a user-defined percentage increase above the Learned Work. A fault is generated if the measured work exceeds the percentage increase over the Learned Work (note that the Blunt Delay becomes inactive in Work Mode). In the event of a blunt tool fault, a red number will appear in the blunt window and the particular station number will flash red. Blunt Tool supervision remains active for the duration of **Tba**, if **Tba** is enabled. If **Tba** is turned off, Blunt Tool supervision remains active the entire time the start signal is present, following the **Start Delay** and the idle power measurement. Because Work Mode monitoring calculates total energy used in the entire cycle, any faults will always be signaled at the end of the cycle. The Tool-Blunt Limit is not actually shown but the green area in the above figure represents 100% in the Work calculation. A learn cycle is needed for this mode of Tool-Blunt monitoring.

6.5 Blunt Tool - Blunt On Part Count

Each cut is counted by the **TC6400**. This part count may even be used to generate a Blunt Alarm. The number of parts to generate a Blunt Alarm is programmable from the **TC6400**. The 'Blunt Count Alarm Mode' function must be enabled as well.

6.6 Blunt Tool - Learn Step Curve mode

The TC6400 screen dump below shows the function of the Blunt Limit in **Learn Step Curve** mode

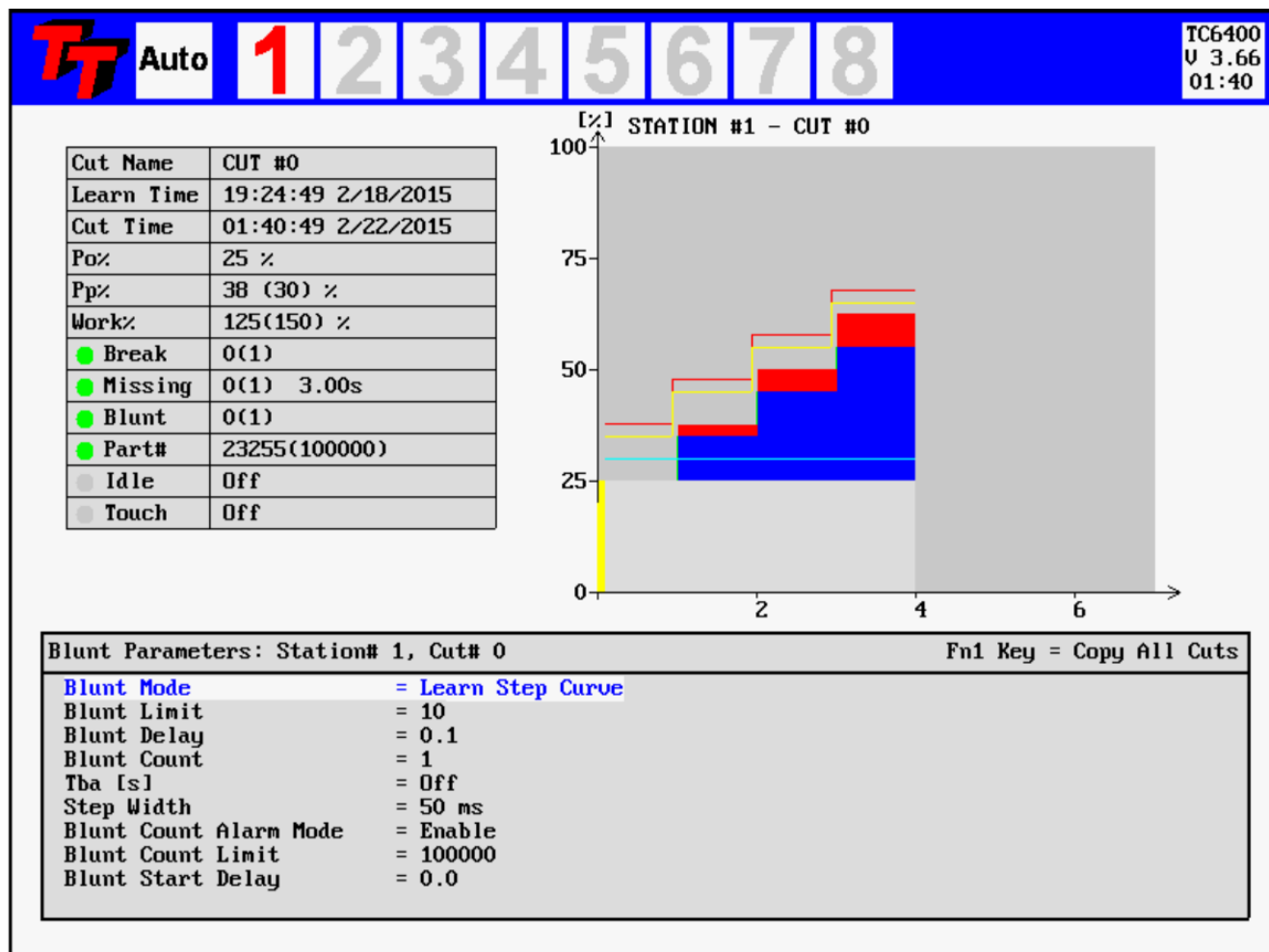


Figure 17—Tool Blunt Learn Step Curve Mode

The figure above shows the Learn Step Curve blunt mode. In this mode the Blunt Limit is calculated as a step-curve from the previous learned curve. The Blunt Limit is a percentage increase from this learned curve. This makes the blunt limit follow the curve and may result in better monitoring for blunt detection of step-tools. Even multiple spindle heads may be monitored successfully for blunt tools with this monitoring mode. The Step-Width is programmable and a new learn cycle is not necessary when the Step-Width is modified. If synchronization problem exists between the learned and the monitor cycle the Step-Width should be increased in order to avoid false alarms.

The Tool-Blunt Limit is shown in yellow color. A learn cycle is needed for this mode of Tool-Blunt monitoring.

7. Missing Tool Supervision

7.1 Missing Tool -- Absolute Mode

The TC6400 screen dump below shows the function of the Missing Limit in **Abs. Peak** mode.

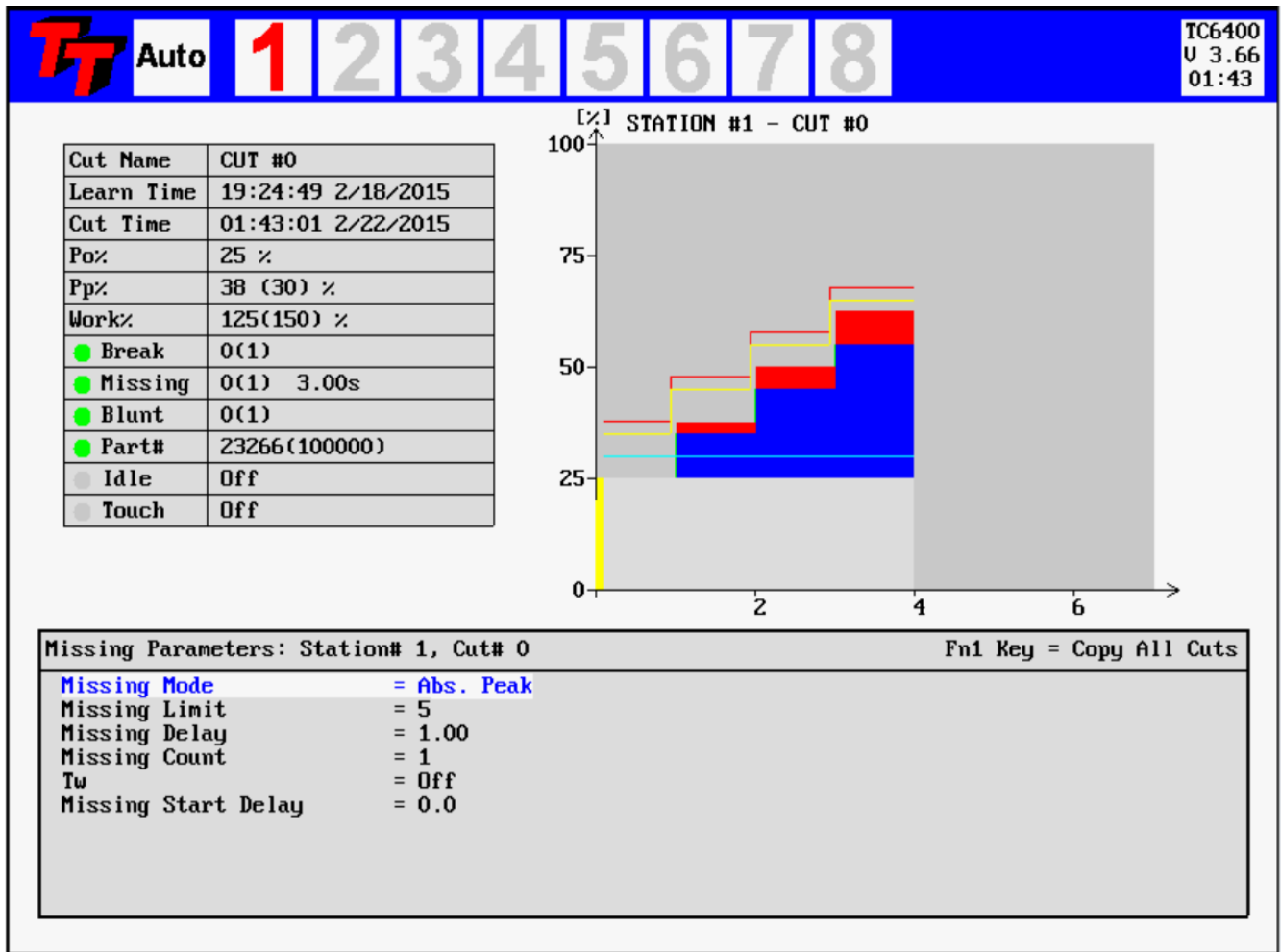


Figure 18—Tool Missing Absolute Peak Mode

The measurement during the machining cycle must remain above the **Missing Limit** for a cumulative time longer than the **Missing Delay**. (Note that the cumulative nature of this measurement means that brief power dips below the **Missing Limit** will not cause a fault as long as the **TOTAL** amount of time spent above the **Missing Limit** is greater than the **Missing Delay**). In the event of a missing tool fault, a red indicator will appear in the text-table in the missing row. Missing Tool supervision remains active for the duration of **Tw**, if **Tw** is enabled. If **Tw** is turned off, Missing Tool supervision remains active the entire time the start signal is present, following the **Start Delay** and the idle power measurement. In this mode the **Missing Limit** is not based on a previously learned tool. The **Learn Time** field in the table at the left is blank indicating no Learn Cycle was performed.

The **Missing Limit** is shown as the light blue colored line in the graphics above. The **Time-Over-Missing** is calculated for each cycle and it is displayed in the table at the left (3.00 seconds). The **Missing Delay** may be set as close to the **Time-Over-Missing** value as possible without generating nuisance trips. If a Tool-Break is not detected for some reason it is important to catch a Tool-Missing in the same or at least the following machining cycle.

7.2 Missing Tool -- Learn Work Mode

The TC6400 screen dump below shows the function of the Missing Limit in **Learn Work** mode.

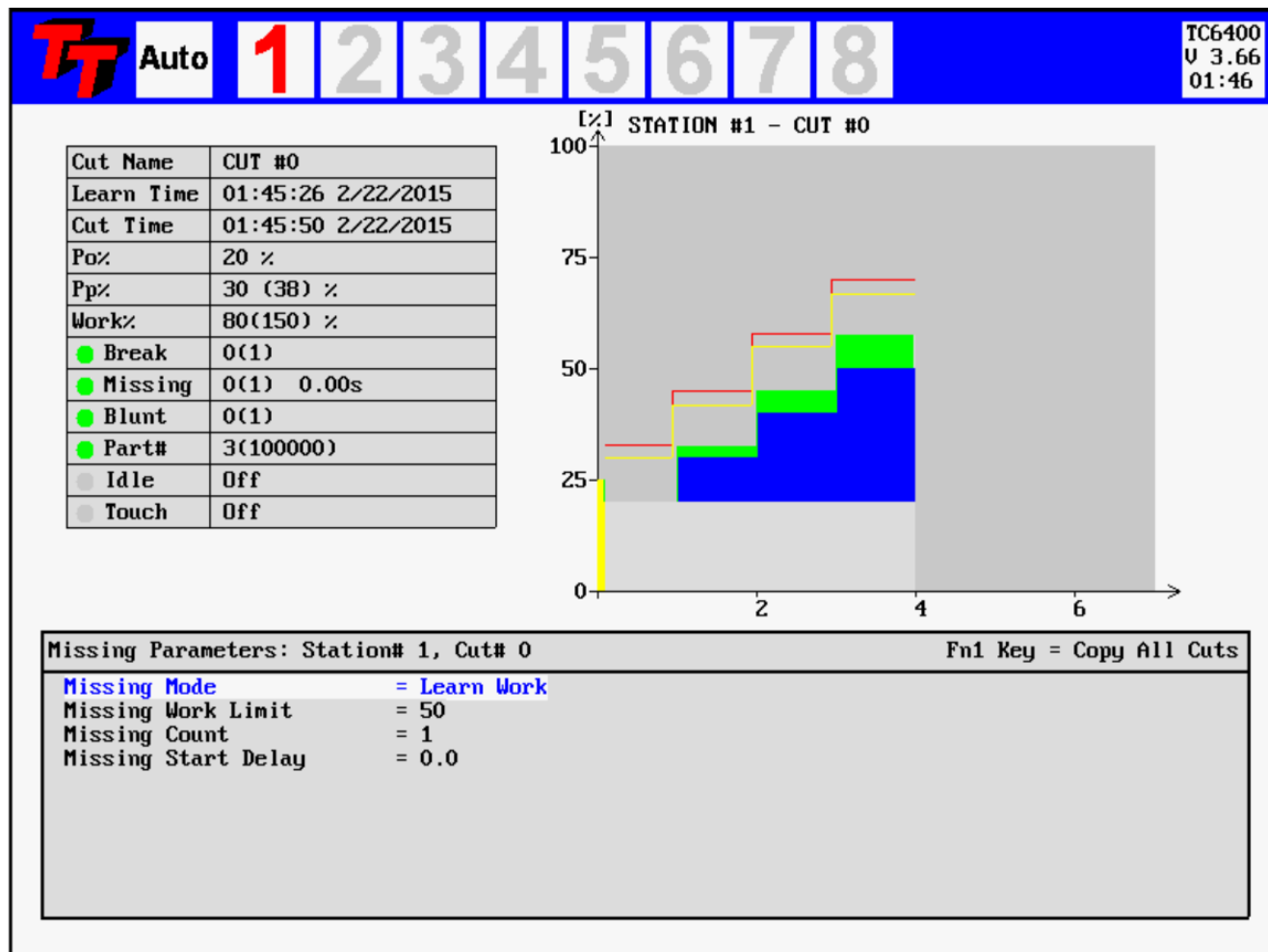


Figure 19—Tool Missing Learn Work Mode

The figure above shows how the missing tool detection, in Learn Work mode, is set up relative to a typical machining cycle. In the **Learn Work mode**, the Missing Tool Limit is a user-defined relative percentage of the work calculated during the Learn cycle. If the work calculated during a cycle does not exceed this percentage of the learned work, then a Missing alarm is generated. In the event of a missing tool fault, a red 1 will appear in the missing window and the particular station number will flash red. Missing Tool supervision remains active for the duration of **Tw**, if **Tw** is enabled. If **Tw** is turned off, Missing Tool supervision remains active the entire time the start signal is present, following the **Start Delay** and the idle power measurement.

Setting these parameters too aggressively can result in more frequent nuisance trips. A good compromise and starting point for adjustment seems to be to set the Missing Limit fairly low, around 30 - 50 % (since if the tool is missing, there will be NO rise above idle).

In the figure above the green color represents the learned area and the blue represents the measurement in the current cycle. In the above example the blue area represents 92% of the learned (green) area. When the measurement is higher than the learned value it is shown as red. The more red the more blunt the tool should be.

7.3 Missing Tool -- Learn Step Curve

The TC6400 screen dump below shows the function of the Missing Limit in **Learn Step Curve** mode.

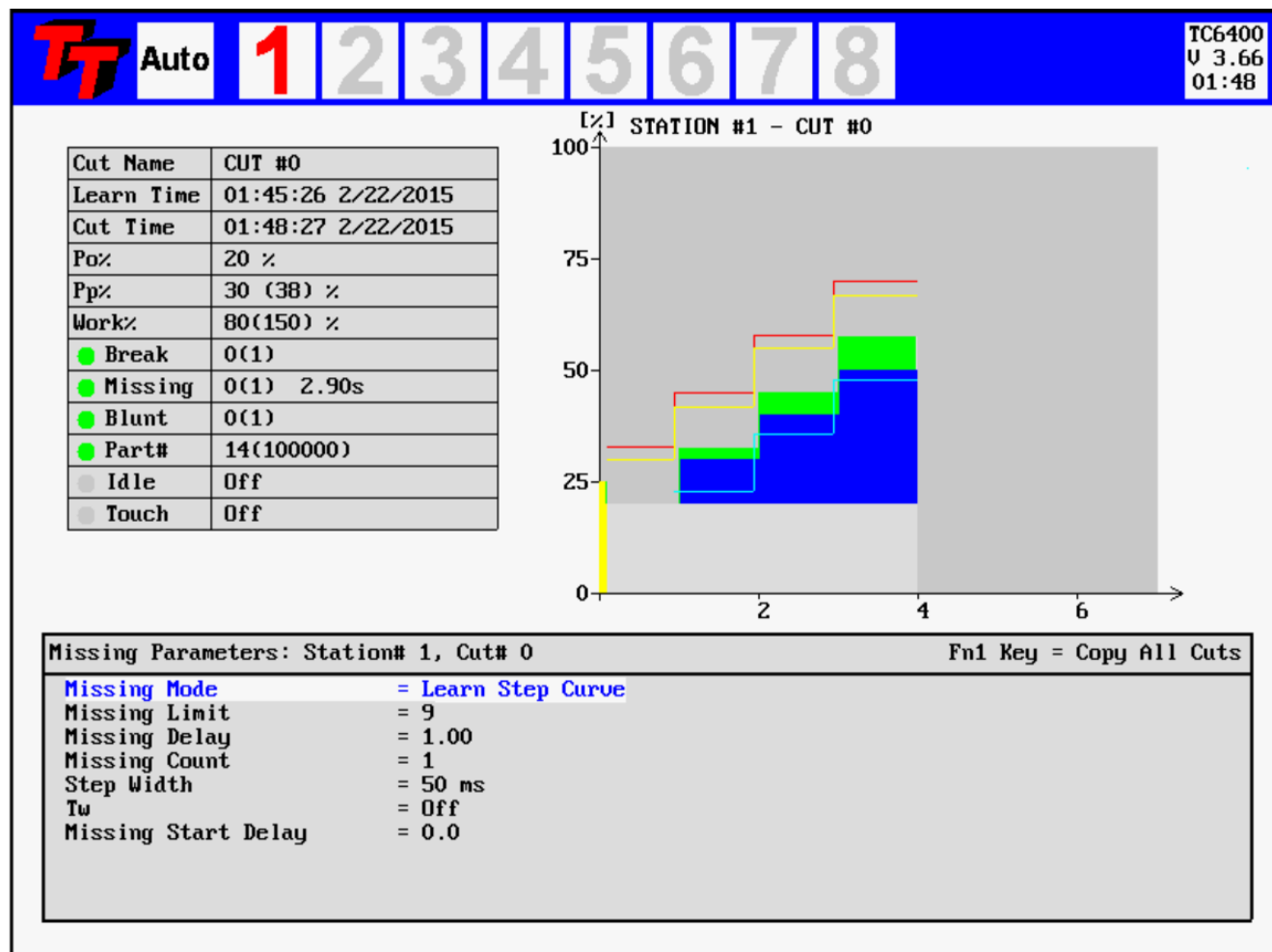


Figure 20—Tool Missing Learn Step Curve Mode

In this mode the Missing Limit is calculated as a step-curve from the original learned curve. The Missing Limit is a percentage decrease from this learned curve. This makes the missing limit follow the curve and may result in better monitoring for missing detection of step-tools. Even multiple spindle heads may be monitored successfully for single missing tools with this monitoring mode, especially if the Time-Over-Missing is placed as close to the normal value as possible. The Step-Width is programmable and a new learn cycle is not necessary when the Step-Width is modified. If synchronization problem exists between the learned and the monitor cycle the Step-Width should be increased in order to avoid false alarms.

The missing limit is drawn as the cycle proceeds and is shown in blue color.

8. Idle Limit Supervision

The TC6400 screen dump below shows the function of the Idle Limits.

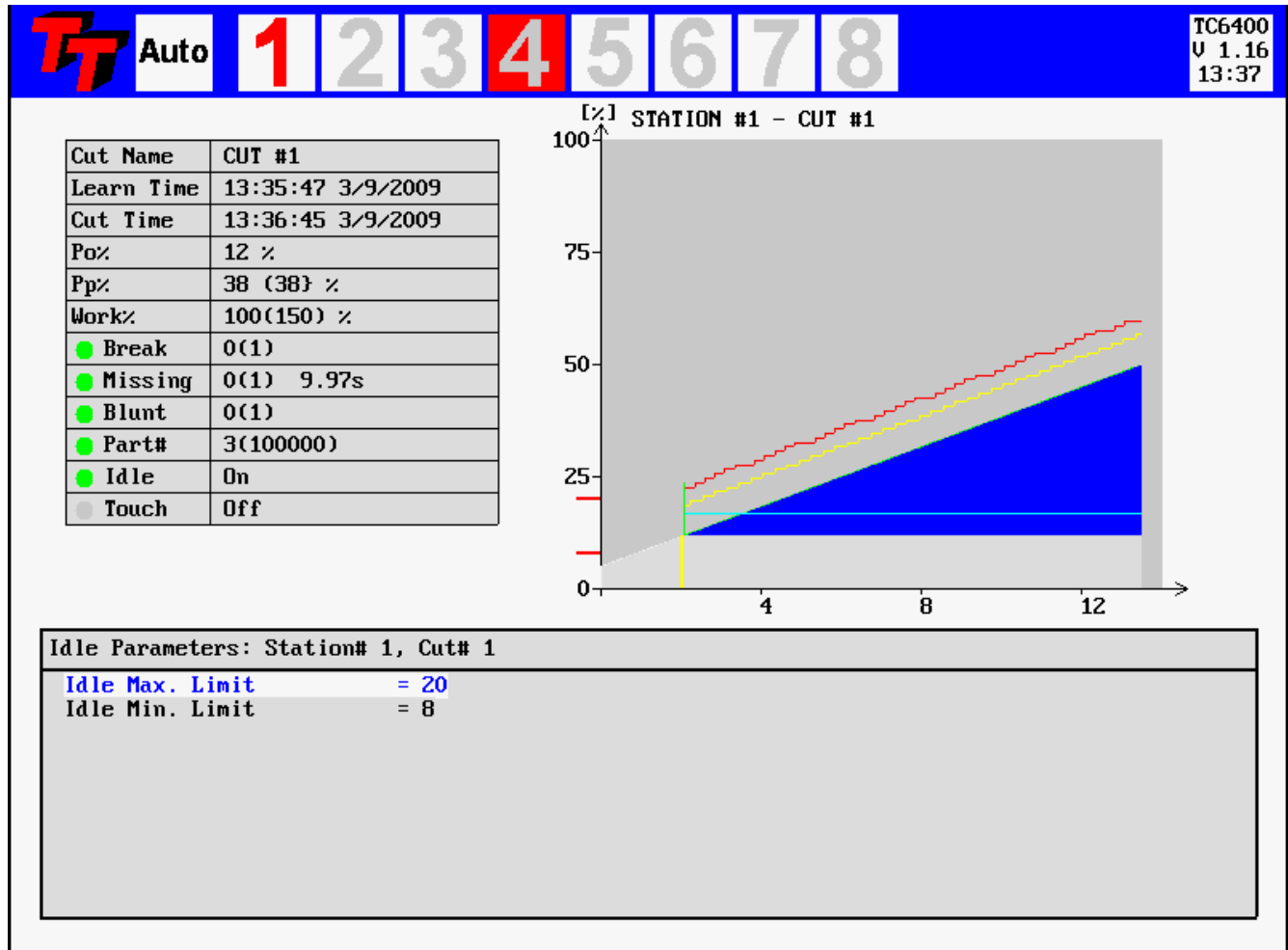


Figure 21—Idle Limits

In some applications, it may be necessary to check that the machine idle power is within certain boundaries. For example, a very low idle power may indicate that a belt is broken or that there is no power to the motor. A very high idle power may also indicate belt problems, or problems with lubrication or bearings. In these cases, a high and low limit, IdleMax and IdleMin, for the idle power may be set. After the idle power is measured and Po is calculated, the value is compared with IdleMax and IdleMin. If it is not within the limits, then a Tool Break fault occurs immediately.

Each of the Idle Power Monitoring limits may be disabled by turning them all the way down to zero.

9. Touch Point Limit Function

The TC6400 screen dump below shows the function of the Touch Point Limit.

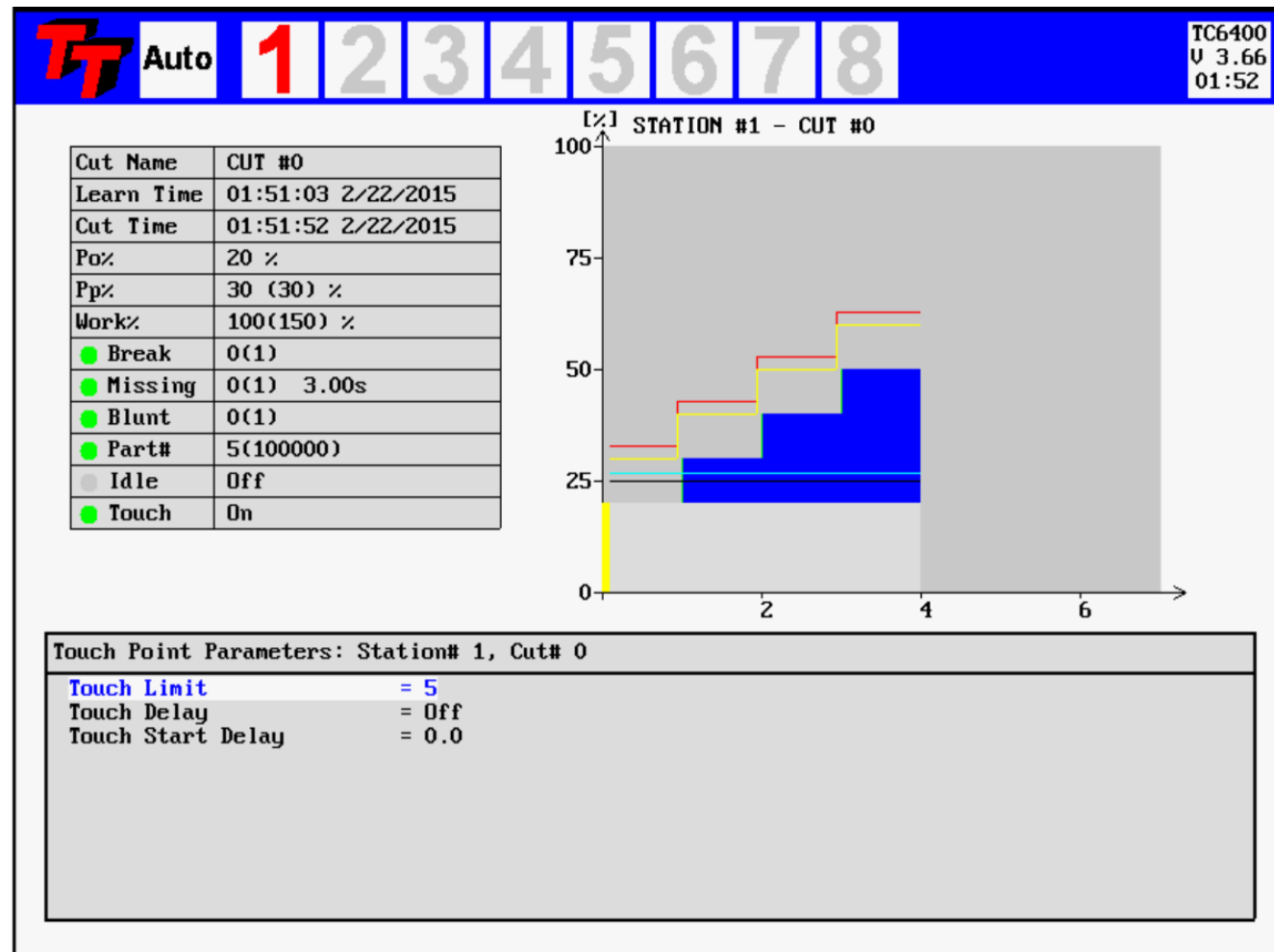


Figure 22—Touch Point Limit

If a Touch Point Limit greater than zero has been programmed the relay no. 3 contacts of IO100T are closed when the power consumption reaches a threshold equal to $P_o + \text{Touch Point Limit}$. The relay #3 contacts are released again when the start signal is removed.

This function may be used in some systems to tell the tool feed mechanism that a tooling operation has begun and the feed rate needs to be decreased. The tooling cycle may be shortened if a different, faster feed rate, can be used until the tool touches the target.

If the Profibus interface is used a separate bit signals the Touch Point Limit reached.

The Touch-Point Limit is shown in black color.

10. F6 Key - Parameters

The TC6400 screen dump below shows the function of **Param Function key F6**.

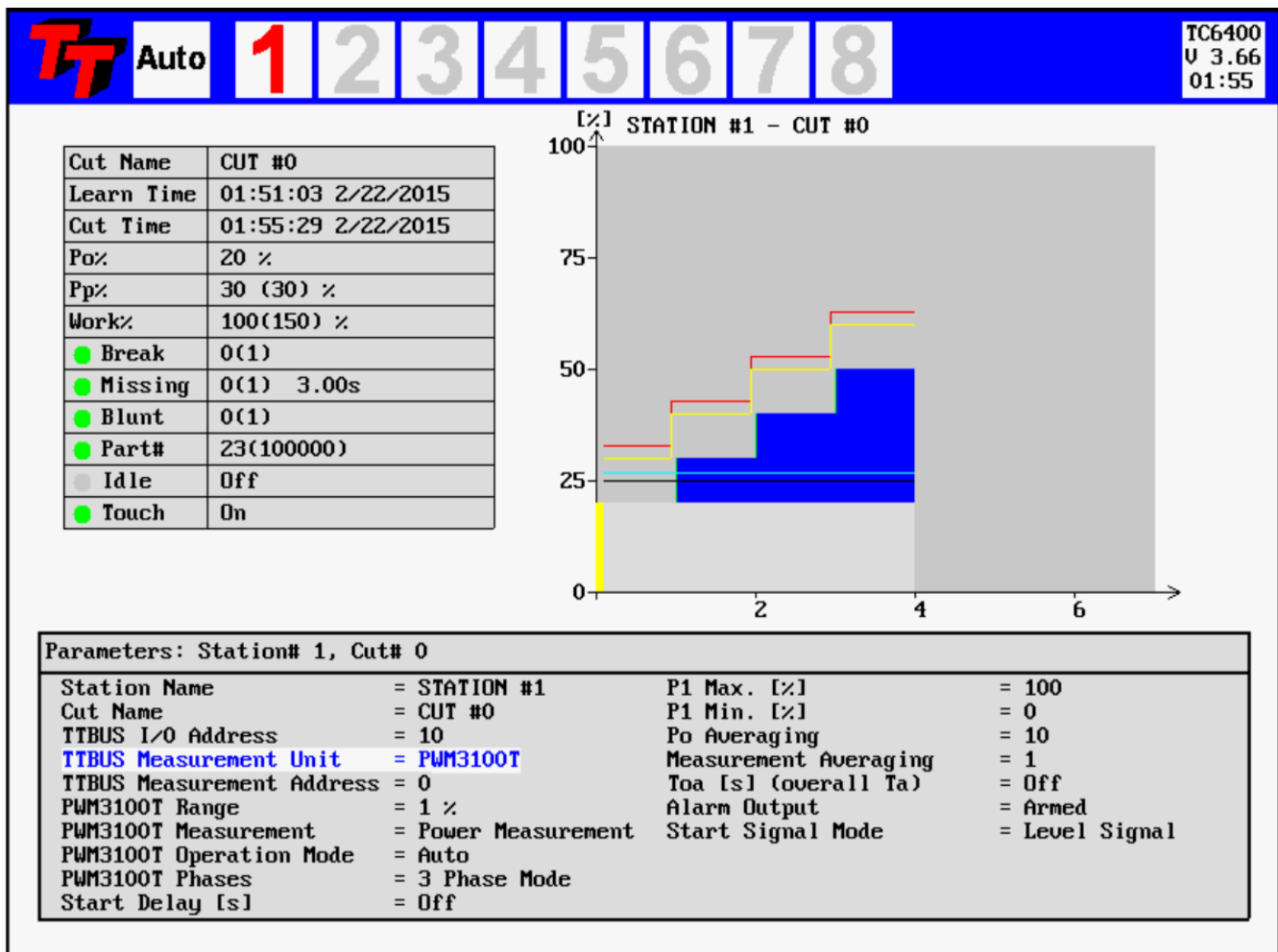


Figure 23—The Parameters Window

The Parameter menu is used to set a number of variables related to measurement and digital IO transducers.

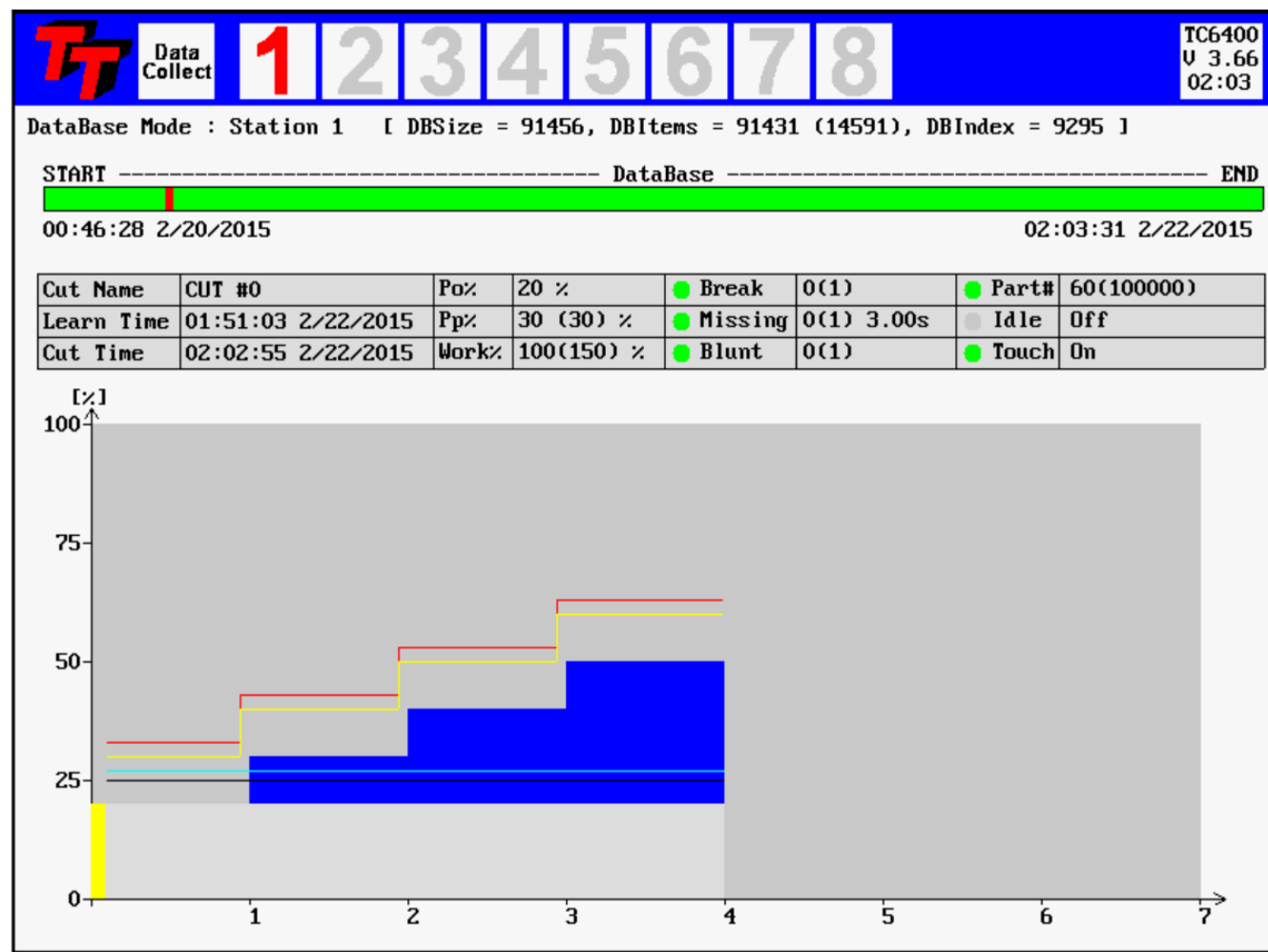
Parameters: Station# 1, Cut# 0			
Station Name	= STATION #1	Measurement Averaging	= 1
Cut Name	= CUT #0	Toa [s] (overall Ta)	= Off
TTBUS I/O Address	= 10	Alarm Output	= Armed
TTBUS Measurement Unit	= PWM350T	Start Signal Mode	= Level Signal
TTBUS Measurement Address	= 0		
PWM350T Range	= 5%		
Start Delay [s]	= Off		
P1 Max. [%]	= 100		
P1 Min. [%]	= 0		
Po Averaging	= 10		

The parameters menu shows only parameters relevant to the type of transducer selected. In the above menu the PWM350T is selected as measurement transducer.

Parameters: Station# 1, Cut# 0			
Station Name	= STATION #1	P1 Max. [%]	= 100
Cut Name	= CUT #0	P1 Min. [%]	= 0
TTBUS I/O Address	= 10	Po Averaging	= 10
TTBUS Measurement Unit	= VM100T	Measurement Averaging	= 1
TTBUS Measurement Address	= 0	Toa [s] (overall Ta)	= Off
VM100T Range	= 5%	Alarm Output	= Armed
VM100T RMS Averaging	= 1 ms	Start Signal Mode	= Level Signal
VM100T LP-Filter	= none		
VM100T HP-Filter	= none		
Start Delay [s]	= Off		

The parameters menu shows only parameters relevant to the type of transducer selected. In the above menu the VM100T is selected as measurement transducer.

11.F7 Key - D-Collect



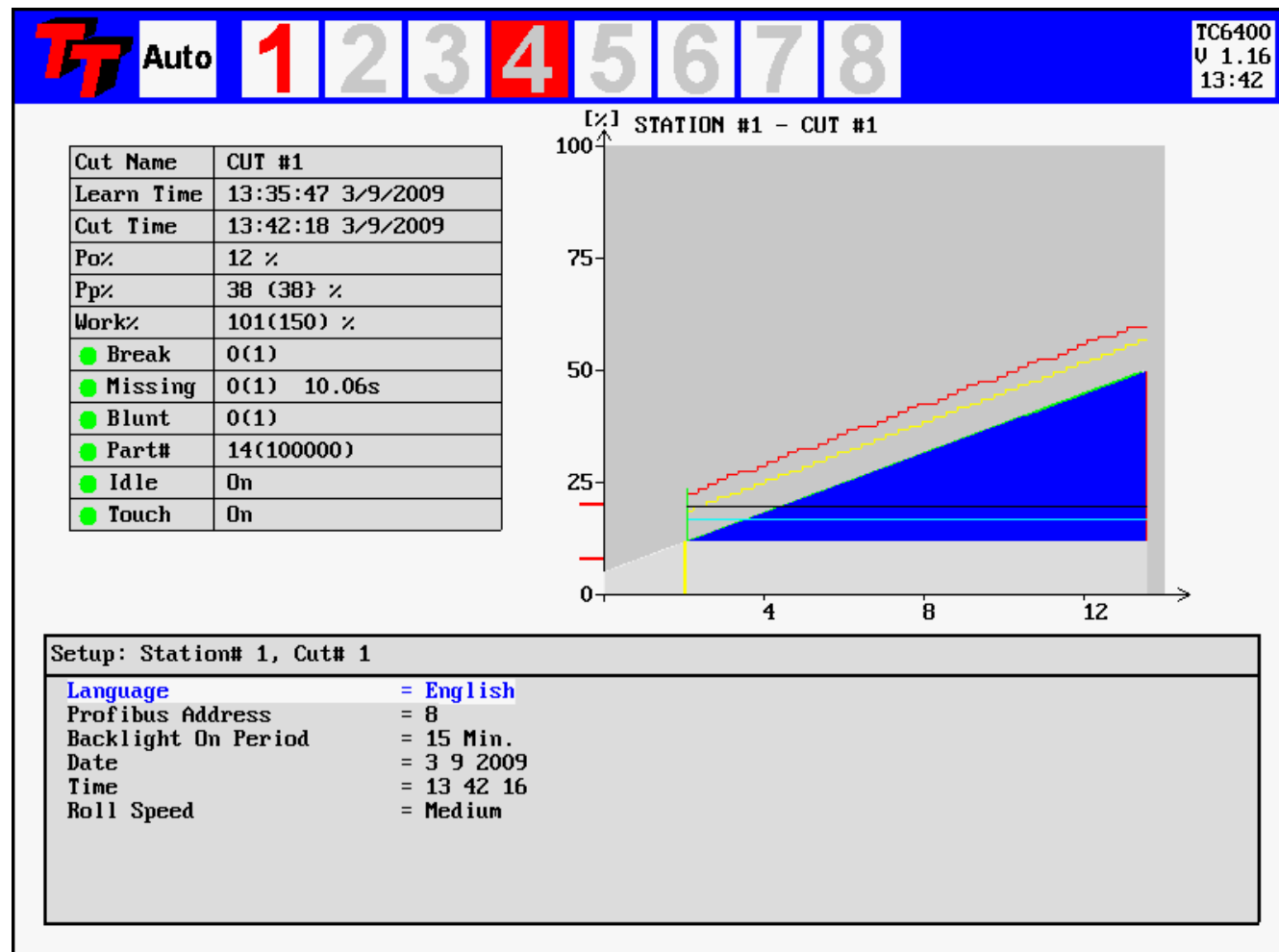
The TC6400/6401 records the last 91000 tooling cycles in a First-In/First-Out fashion. The exact number of cycles recorded may vary and is shown as DBSize above.

It is possible to use the arrow keys to move around in the history. The red arrow keys are used to show the next or previous Alarm cycle.

In the future even more sophisticated Data-Collection may be introduced.

12. F8 Key - Setup

The TC6400 screen dump below shows the function of the **Setup F8** menu.



.Figure 26—Setup Menu Display

The menu is used to set variable that are related to general setup and appearance of the display.

13. F9 Key - Config

The TC6400 screen dump below shows the function of the **Config F9** menu.

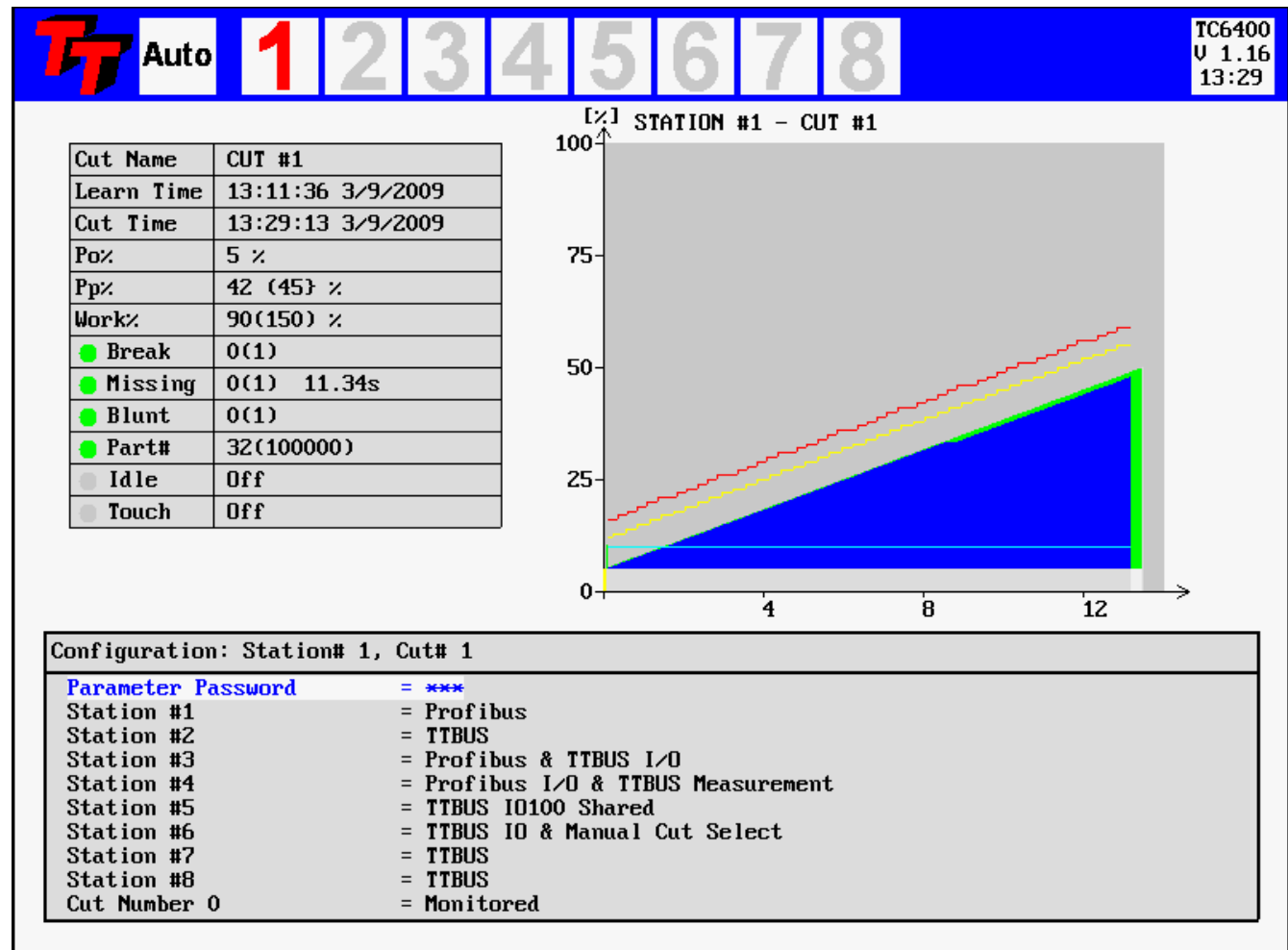


Figure 27—Config Menu Display

Profibus	:	Digital IO and Measurement comes from Profibus
TTBUS	:	Digital IO and Measurement comes from TTBUS
Profibus & TTBUS I/O	:	Measurement from Profibus and Digital IO from TTBUS
Profibus I/O & TTBUS Measurement	:	Digital IO from Profibus and Measurement from TTBUS
TTBUS IO100 Shared	:	Digital IO Shared among channels. Measurement from TTBUS
TTBUS IO & Manual Cut Select	:	Digital IO from TTBUS. Cut number manually selected
Cut Number 0	:	Monitored

14. 1-2-3-4 Key - Displaying Multiple Channels

The TC6400 screen dump below shows the function of the dual channel display.

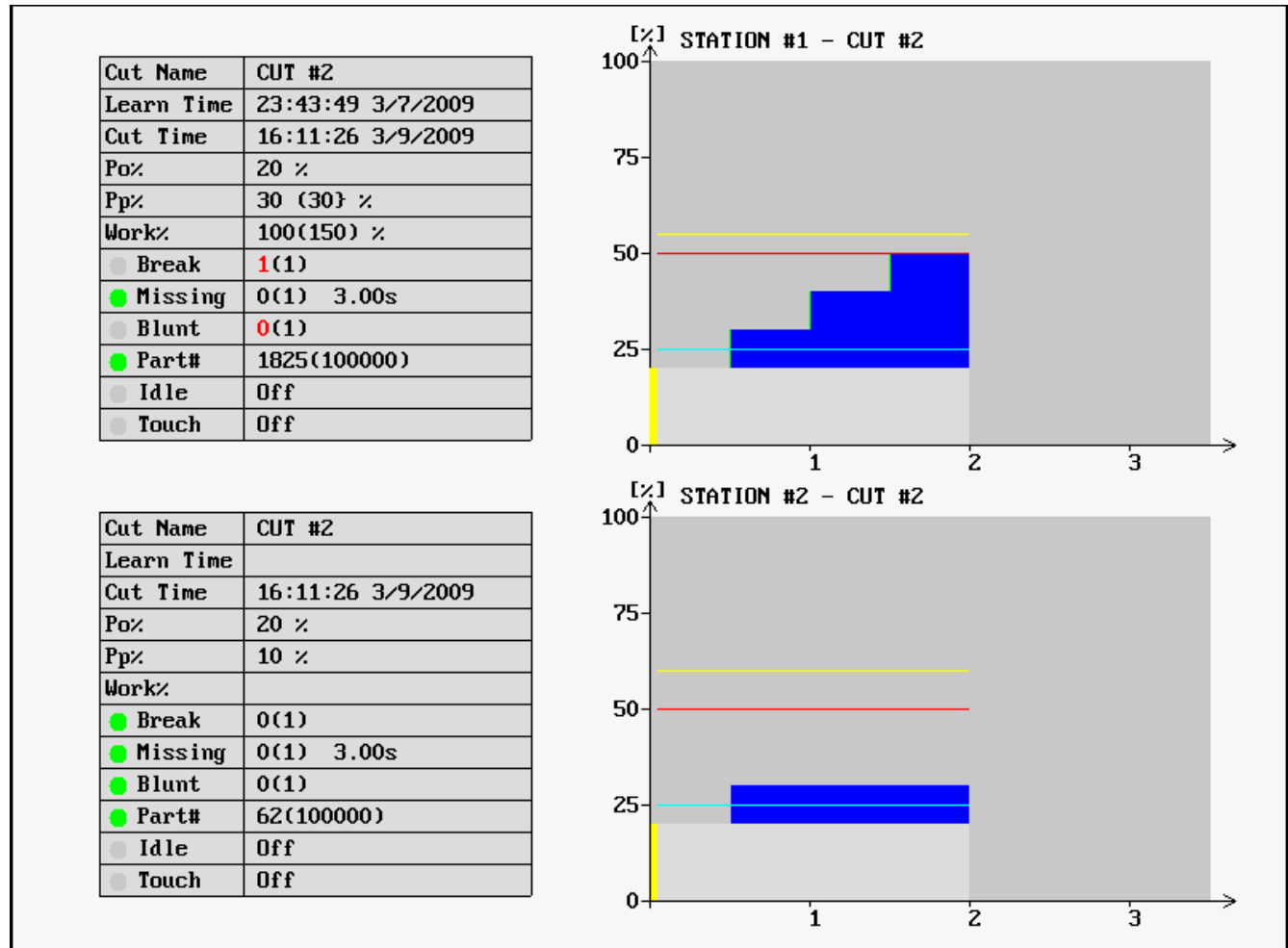
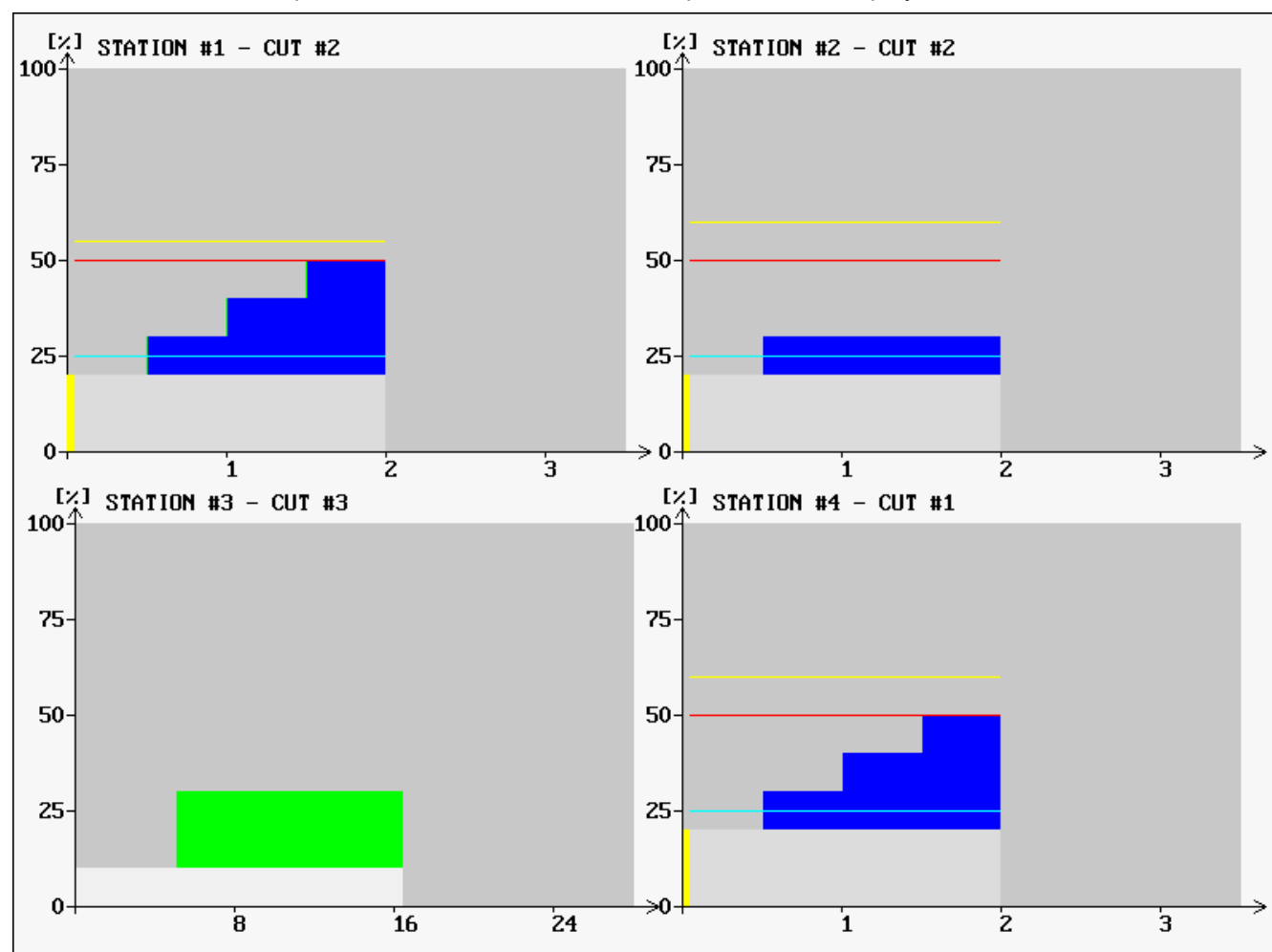


Figure 28—Dual Channel Display

It is possible to show multiple channels simultaneously by activating the 1-2-3-4 key. It is possible to display 2, 4 or even 8 channels simultaneously. Multiple activation of the 1-2-3-4 key switches among the various display modes.

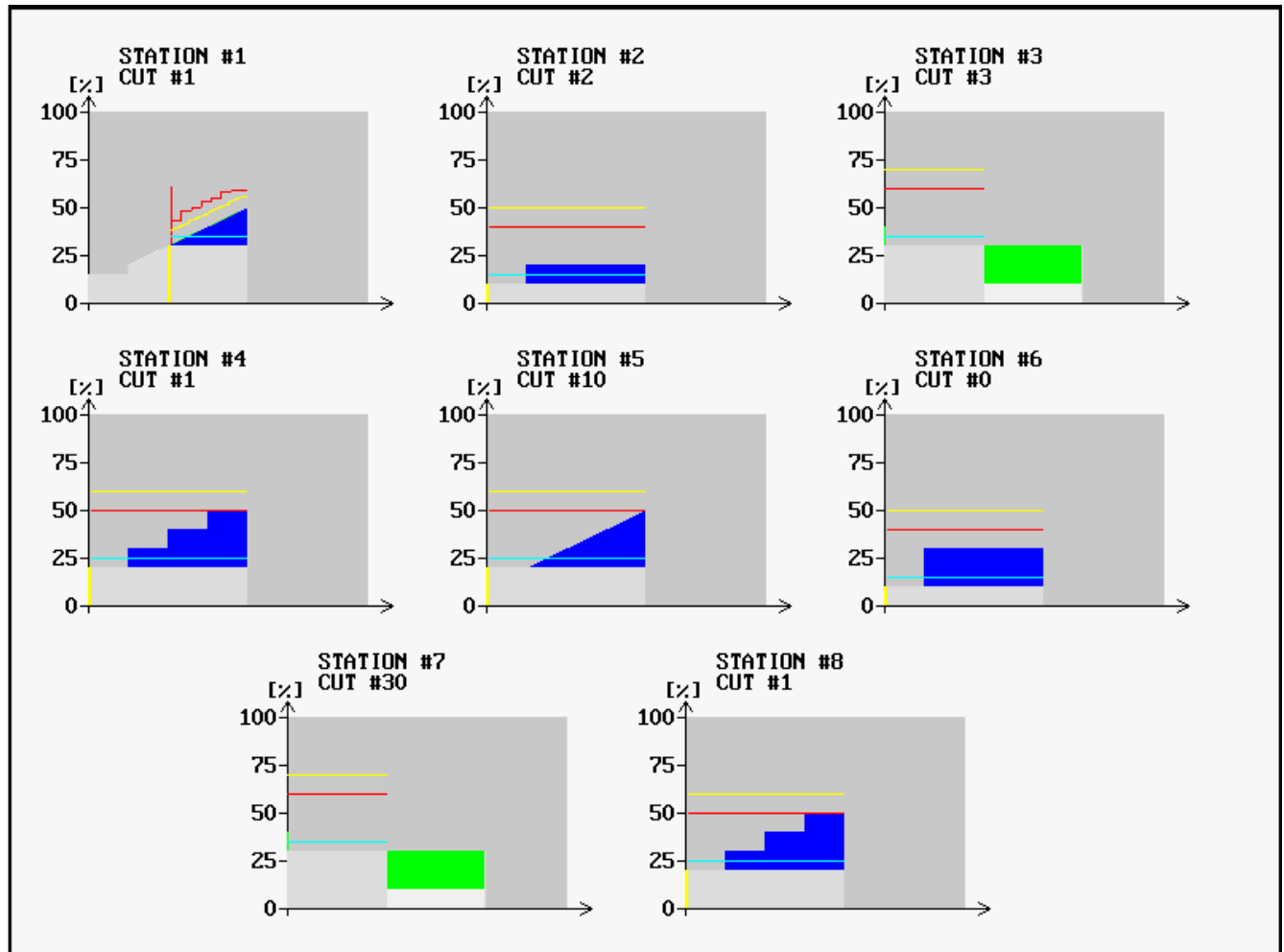
The TC6400 screen dump below shows the function of the quad channel display.



.Figure 29—Quad Channel Display

4 Channels shown simultaneously.

The TC6400 screen dump below shows the function of the octal channel display.



.Figure 30—Octal Channel Display

8 Channels shown simultaneously.



PWM3100T Load Transducer

Load Transducer for 1- or 3-phase AC & DC Loads

An ultra-fast measurement transducer specifically developed for Machine Tool Monitoring applications.

PWM3100T measures motor power [kW] or motor current [A].

◆ TTBUS Output

RS485 type Sensor Bus

◆ 8 Programmable Measurement Ranges

1, 2.5, 5, 10, 15, 25, 50 or 100 % of full scale.

Digital Design

4 quadrant digital multiplication.

Measures power or current *before or after* variable frequency inverter.

Ultra Compact DIN rail mount

Less than 2" of rail space.

External Hall-Sensor(s) for Current Measurement

1 or 3 external 100 Amp. custom designed current sensors (Hall-Effect Sensors).

Additional sensors ranges to be introduced.



Technical Specification

Mechanical

Housing:	Polycarbonate.
Mounting:	35 mm DIN-rail.
Protection Class:	IP40.
Temp. Range:	-15 to + 50 C.
Weight:	App. 250g.
Dimensions:	D 118 x B 45 x H 137,5 mm.
Connections:	Max 2.5 mm ² (AVG 24).

Electrical

Voltage Input:	3 x 0-500 VAC/VDC max.
Current Input:	3 x 100 Amp. 0 Hz - 35kHz
Power Range:	0 - 86.5 kW AC. 0 - 50 kW DC.
Supply:	18-36 V DC max. 2.0 Watt.
TTbus output:	RS485 - proprietary protocol.
CE marked to:	TBD

Range Select:

The measurement-range is selected from the Tool Monitoring Application TTMON.

Range	% of full-scale
0	1 %
1	2.5 %
2	5 %
3	10 %
4	15 %
5	25 %
6	50 %
7	100 %

Features

The PWM3100T is designed primarily for measuring AC or DC power or current delivered to motors by variable frequency inverters. AC power is measured from the formula:

$$P = \sqrt{3} \times U \times I \times \cos\phi$$

DC power is measured from the formula:

$$P = U \times I$$

The PWM3100T Power or Current Transducer is specifically developed to function as a load transducer for the **TECHNA-CHECK®** Range of Machine Tool Monitors.

The transducer interface to Tool Monitor Applications via the TTBUS interface.

The three motor wires **must** pass through the external hall sensors in the **same direction** to the motor either from Top-Bottom or from Bottom-Up.

TECHNA-CHECK® is a registered trade mark by Techna-Tool Inc., Hartland, Wisconsin USA.

Using the PWM3100T

The operating modes is selected from the Tool Monitoring Device in this case the TC6400.

Parameters are accessed from the Param Menu (**F6**-key).

Parameters: Station# 1, Cut# 25			
Station Name	= STATION #1	P1 Max. [%]	= 100
Cut Name	= CUT #25	P1 Min. [%]	= 0
TTBUS I/O Address	= 10	Po Averaging	= 10
TTBUS Measurement Unit	= PWM3100T	Measurement Averaging	= 1
TTBUS Measurement Address	= 0	Alarm Output	= Armed
PWM3100T Range	= 1 %	Start Signal Mode	= Level Signal
PWM3100T Measurement	= Power Measurement		
PWM3100T Operation Mode	= Auto		
PWM3100T Phases	= 3 Phase Mode		
Start Delay [s]	= Off		

TTBUS Measurement Unit : PWM3100T selected
 TTBUS Measurement Address : 0
 PWM3100T Range : 1% (8 ranges available)
 PWM3100T Measurement : Power Measurement or Current Measurement
 PWM3100T Operating Mode : Auto
 PWM3100T Phases : 3 Phase Mode

Operating Mode:

Auto = This is the default AC-measurement mode. The PWM3100T measures the current frequency and uses this as a time base for the measurement. The measurement speed and reaction speed of the unit increases as the spindle speed increases. This mode cannot be used in DC-measurement mode.

10ms = Fixed measuring interval 10 ms (millisecond). May be used in both AC- and DC-mode

25 ms = Fixed measuring interval 25 ms (millisecond). May be used in both AC- and DC-mode

100ms = Fixed measuring interval 100 ms (millisecond). May be used in both AC- and DC-mode

No. of phases:

3 Phases = 3 phase measurement

Single Phase = Single phase measurement—usually used with DC-measurement

Power/Current Measurement.

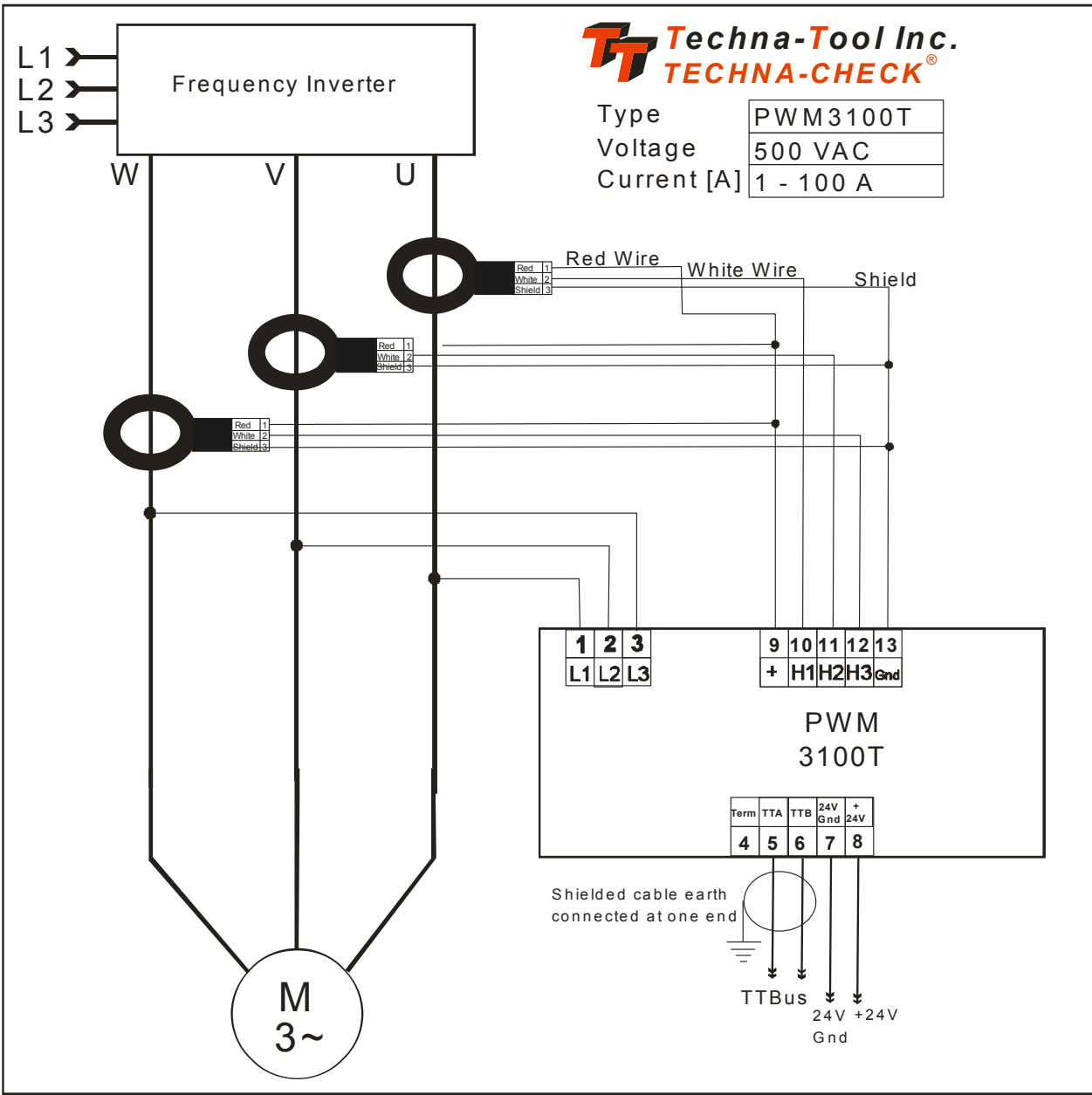
Power or Current measurement may be selected from the dialog box above. When power is measured after a variable frequency inverter a certain amount of noise is introduced. The noise comes from the high frequency voltage switching (PWM Voltage). In some applications the noise can be eliminated by measuring current only. Measuring current after a frequency converter often has similar sensitivity as power-measurement, but the noise is significantly reduced. The current measurement may be used for monitoring smaller dimension tools. When current is measured the voltage connection terminals 1, 2 and 3 are not used and may be left open.

Offset Zeroing:

Offset zeroing is a function that calibrates the Hall-Sensors to the unit. Offset zeroing **must be done once** after the Hall Sensors are connected and the spindle (motor) is **NOT** running. The offset button must be activated for 5 seconds and the green on-led flashes for 5 seconds during the offset adjustment. Calibration values are maintained after power off (saved in EEPROM).



PWM3100T 3-Phase AC-Connection with Frequency Inverter.



Note!
Please use good-quality twisted and shielded cable earth-connected at one or both ends for the TTBUS-network.
The last unit in the TTBUS network **must** be terminated.
Please connect a wire between terminal 4 and 6 on the PWM3100T (the TTBUS slave) when termination is required.



TECHNA-CHECK®

IO100T Digital I/O Interface

Parallel Digital I/O Interface

An interface unit which interfaces traditional parallel I/O to the **TECHNA CHECK®** TC6400 unit.

IO100T features.

- ◆ TTBUS Networked Unit
- ◆ 3 Relay Alarm Outputs
- ◆ 7 Digital Inputs for Cut-Number
- ◆ Digital Input for START and RESET

Technical Specification

Mechanical

Housing: Polycarbonate.
 Mounting: 35 mm DIN-rail.
 Protection Class: IP40.
 Temp. Range: -15 to + 50 C.
 Weight: App. 300g (1 lb).
 Dimensions: D 118 x B 45 x H 137,5 mm.
 Connections: Max 2,5 mm² (AVG 24).

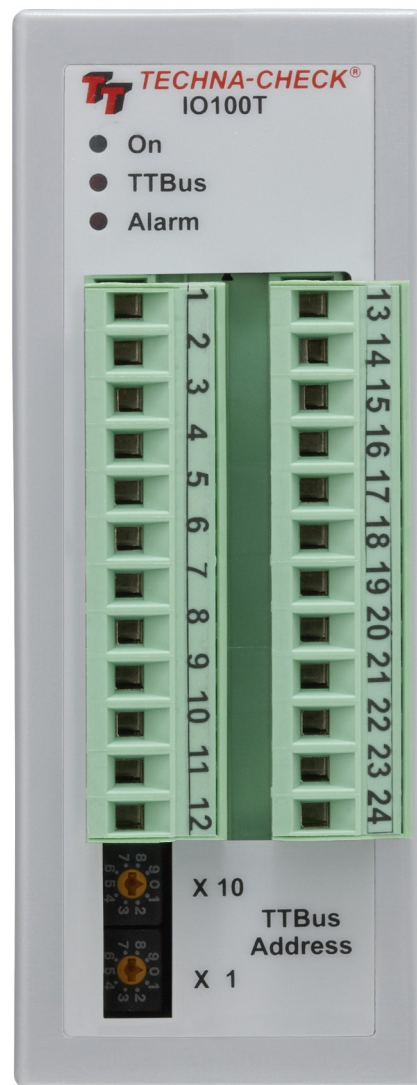
Electrical

Digital Inputs: 10-30 VDC.
 Relay Outputs: 250 VAC max, 5 A max.
 Sensor Input: Proprietary. Sensor supplied with unit.
 Supply: 18-24 V DC max. 2.5 Watt.
 TTBUS: RS485.

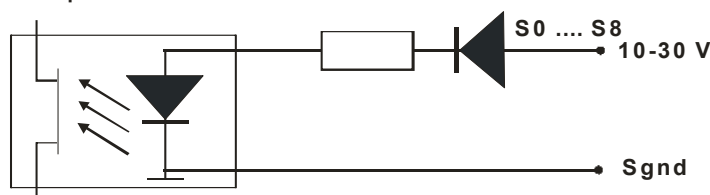
The IO100T interfaces traditional NC-controllers, which are not Profibus capable, to the **TECHNA CHECK®** TPC1120 and TC6400 Tool-Monitor-System.

It is possible for multiple channels (spindles) to share a single IO100T. Could be a round-table machine where all stations changes operation (production change) simultaneously. In this case the alarms outputs is the logical OR of alarms generated by the channels. Thus if one channels makes an alarm the corresponding alarms relay is activated.

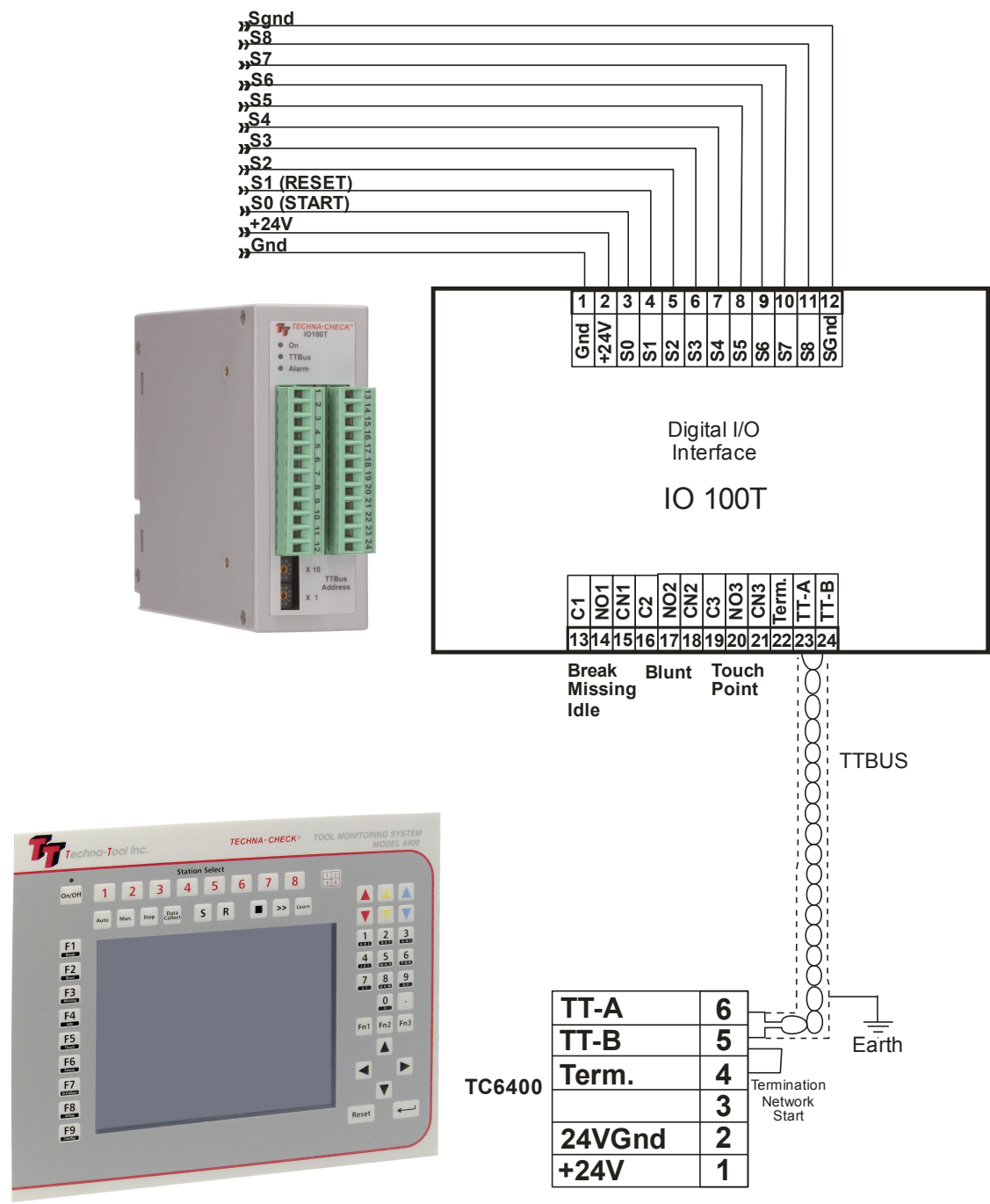
TECHNA CHECK® is a registered trade mark by Techna- Tool Inc., Hartland Wisconsin USA.



Digital inputs S0 - S8



IO100T Connection to the TC6400



Note!
Please use good-quality twisted and shielded cable earth-connected at one or both ends for the TTBUS-network.
The last unit in the TTBUS network **must** be terminated.
Please connect a wire between terminal 22 and 24 on the IO100T (the TTBUS slave) when termination is required.

TECHNA-CHECK® VM100T Vibration Interface

Vibration Sensor Interface

A measurement transducer, which provides Vibration Monitoring for the **TECHNA CHECK®** units.

VM100T measures vibration (acceleration).

- ◆ TTBUS Networked Unit
- ◆ 4 Remotely Programmable Measurement Ranges
- ◆ 4 Remotely Programmable RMS averaging periods
- ◆ Remotely Programmable filters

Technical Specification

Mechanical

Housing: Polycarbonate.
Mounting: 35 mm DIN-rail.
Protection Class: IP40.
Temp. Range: -15 to + 50 C.
Weight: App. 300g (1 lb).
Dimensions: D 118 x B 45 x H 137,5 mm.
Connections: Max 2,5 mm² (AVG 24).

Electrical

Sensor Input: Proprietary. Sensor supplied with unit.
Vibration Range: +- 0.5G, 0 - 1000 Hz
Supply: 18-24 V DC max. 2.5 Watt.
TTBUS: RS485.

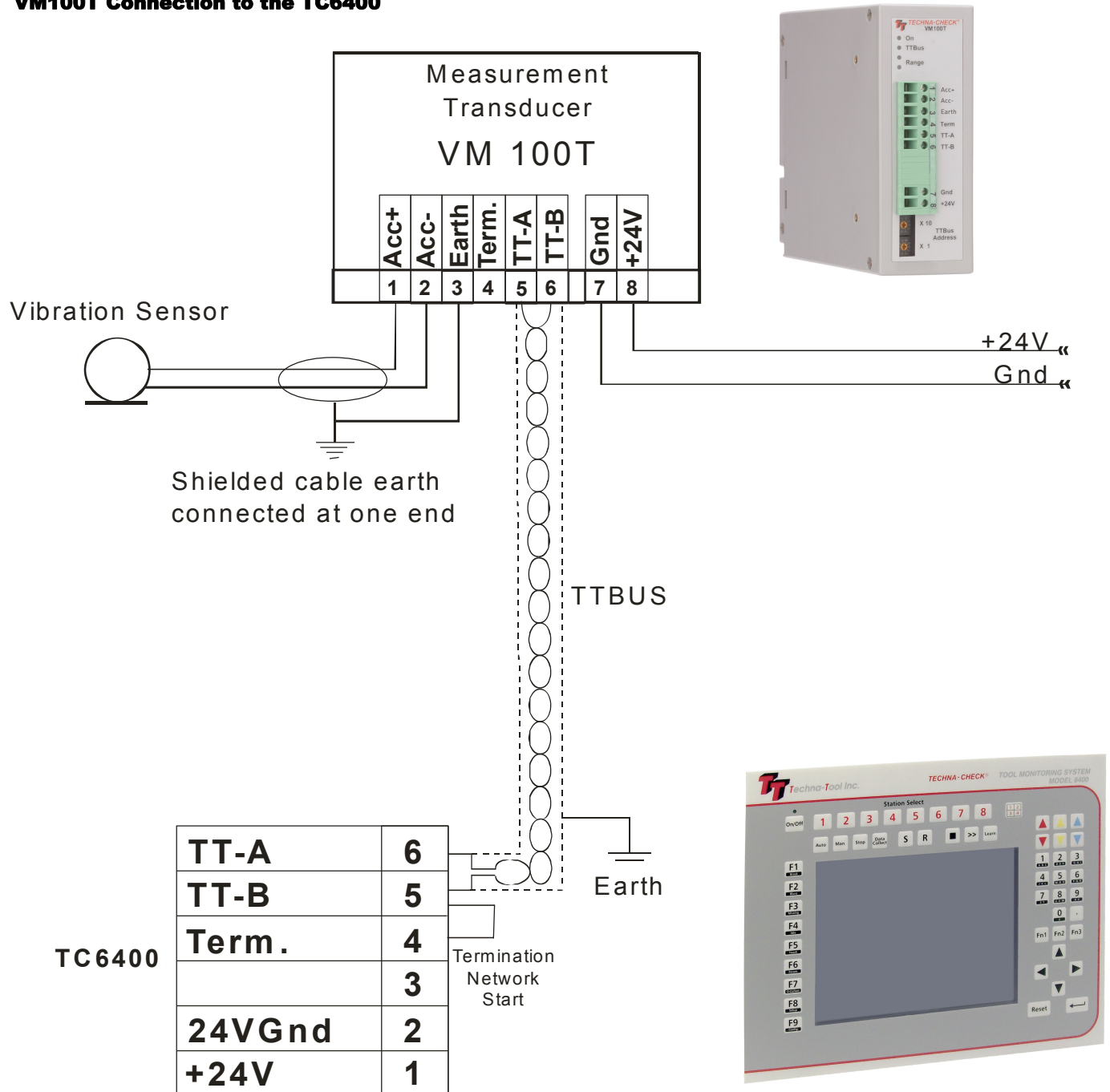


The VM100T interfaces a propriety acceleration sensor to the existing **TECHNA CHECK®** range of Machine Tool Monitors.

The purpose of the vibration monitoring is to catch for instance the damage of a tool like for instance a miller, which has damaged one of its inserts. When one insert is broken the next insert is forced to cut twice the amount of material, which will generate machine vibrations to be picked up by the VM100T.

Another application is to protect high-speed spindles against operation with an unbalanced tool, which may lead to a rapid wearing and destruction of the spindle bearings.

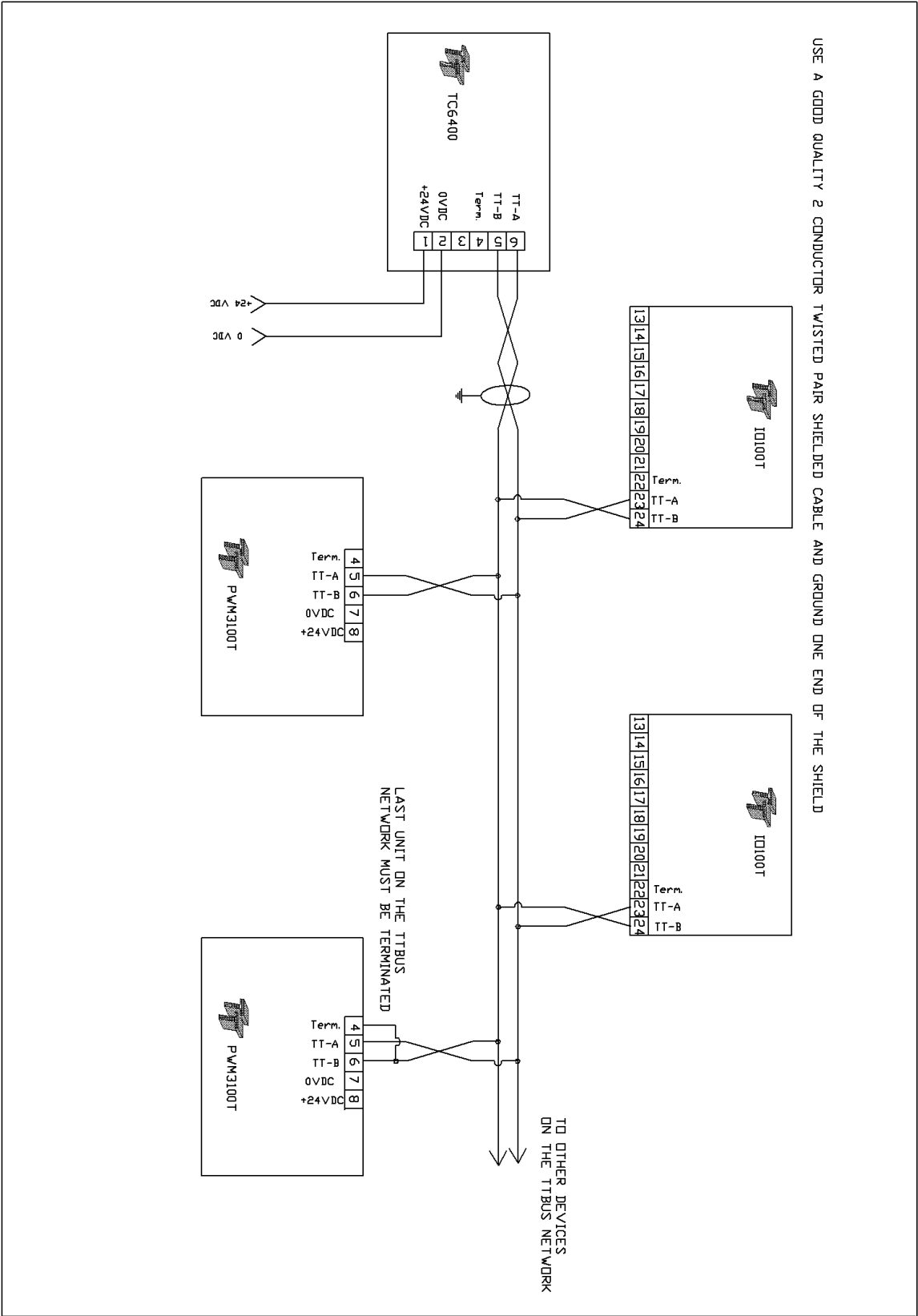
TECHNA CHECK® is a registered trade mark by Techna- Tool Inc., Hartland Wisconsin USA.

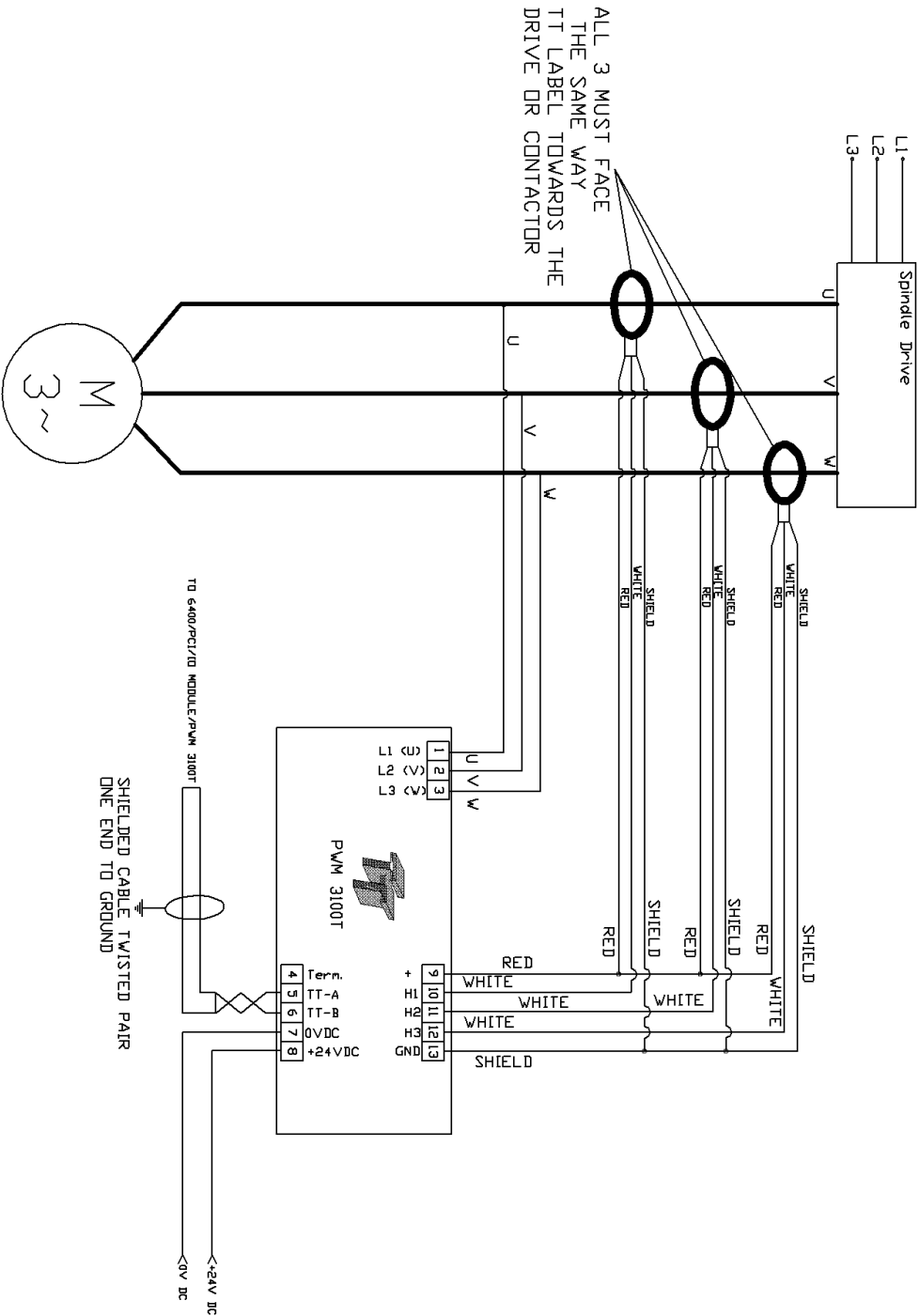
VM100T Connection to the TC6400**Note!**

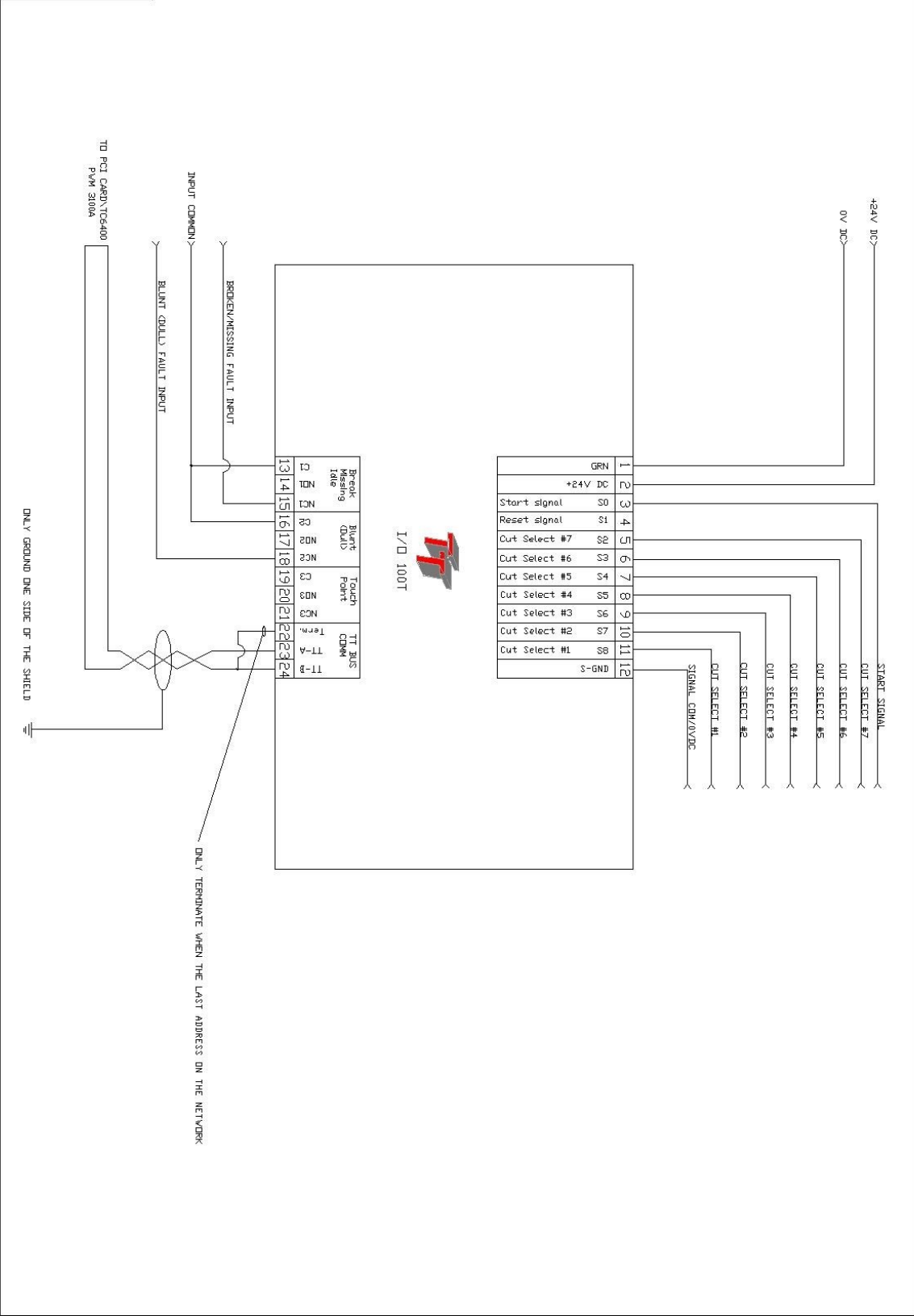
Please use good-quality twisted and shielded cable earth-connected at one or both ends for the TTBUS-network.

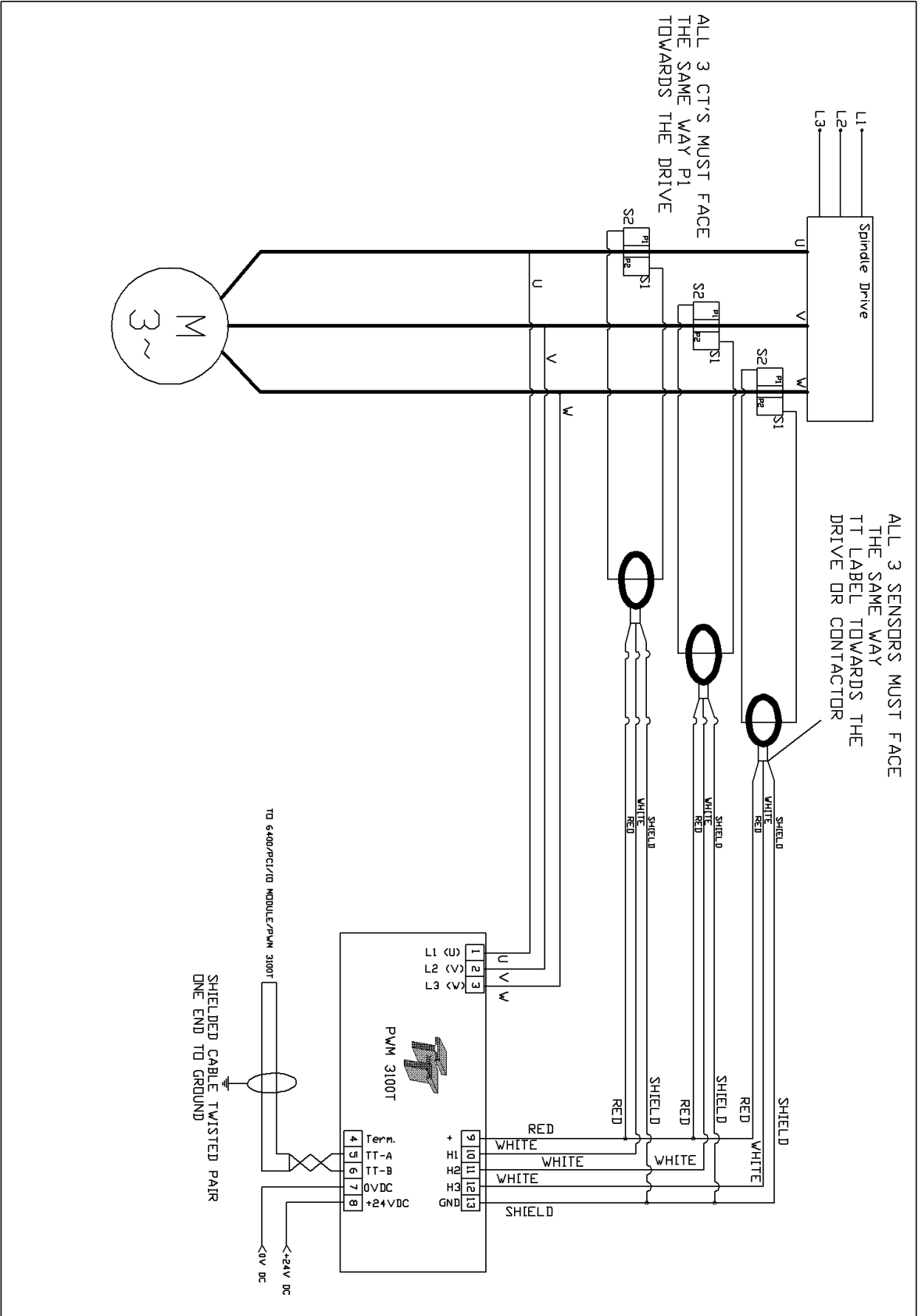
The last unit in the TTBUS network **must** be terminated.

Please connect a wire between terminal 4 and 6 on the VM100T (the TTBUS slave) when termination is required.









Setting the number of channels

The TC6400 screen dump below shows the **No Of Channels** dialog.

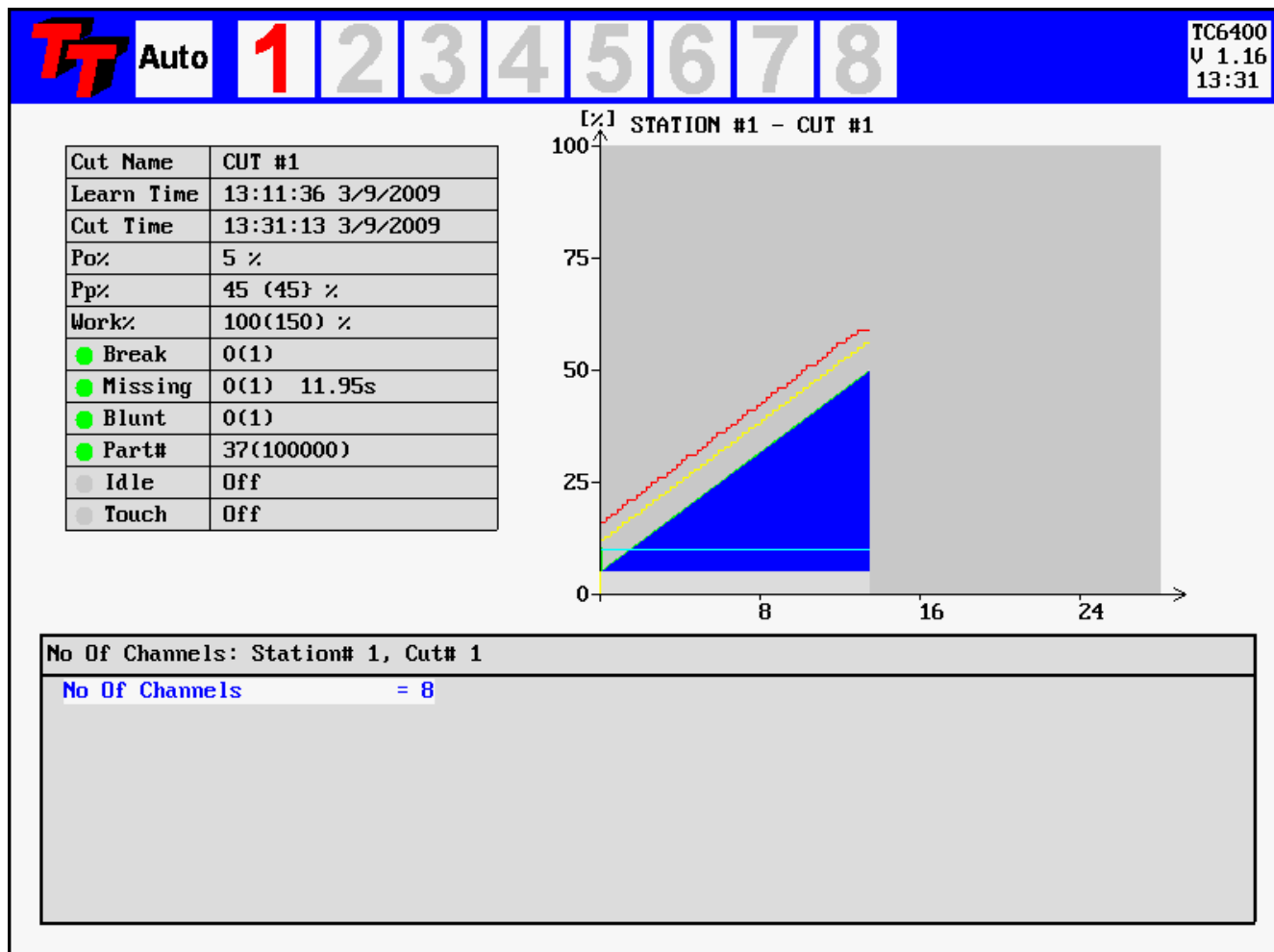


Figure 31—No Of Channels dialog

The dialog is shown after pushing the **F9**-key followed by the **Fn3**-key.

This dialog is protected by a master password only known to Techna-Tool Inc. and service personnel.

