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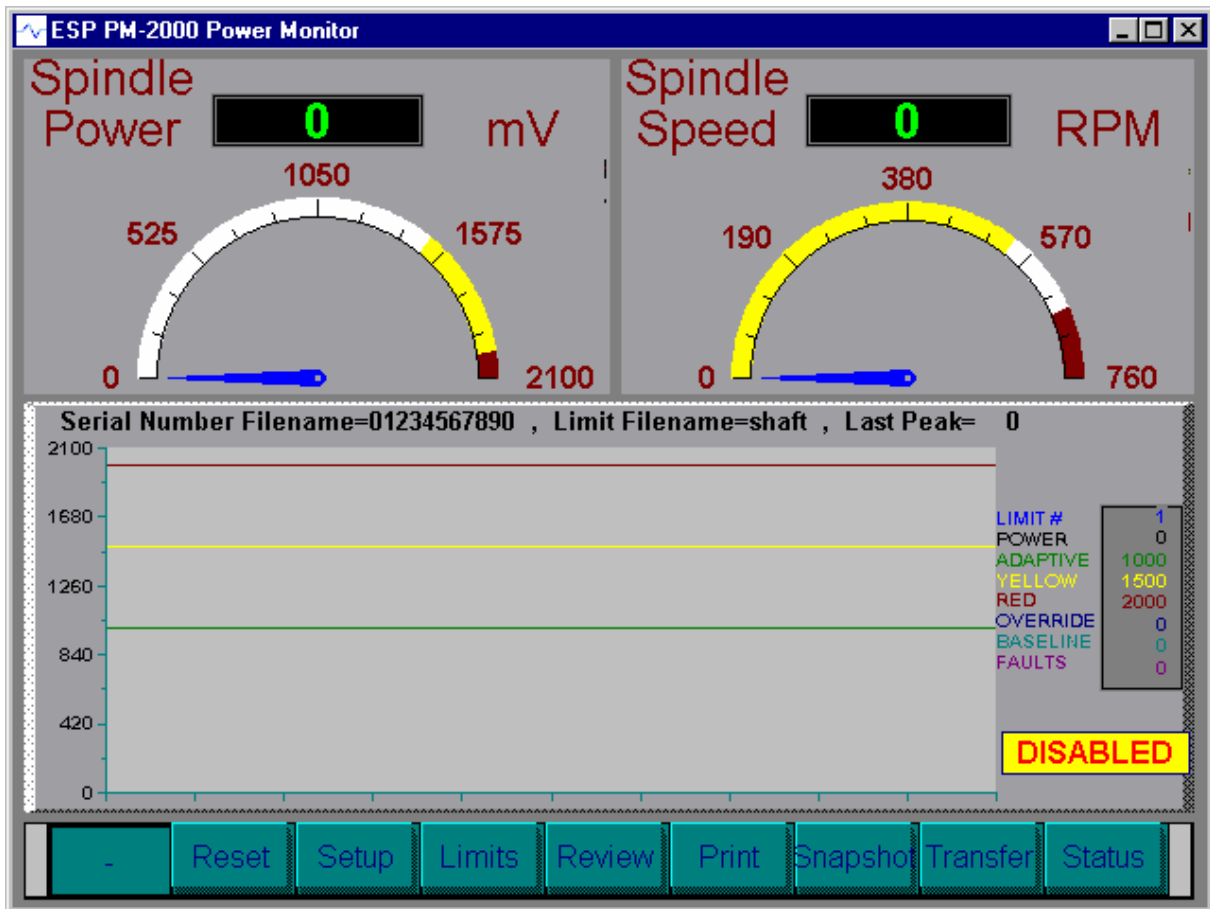
FANUC, VICKERS, AUTOCON, MDSI, ESP2000

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ESP PM-2000 POWER MONITOR FANUC 15 MB



ESP PM-2000

OVERVIEW

THE ESP PM-2000 POWER MONITOR SYSTEM WAS CREATED TO AID MACHINE TOOL OPERATORS IN PRODUCING QUALITY PARTS EFFICIENTLY BY MONITORING THE CUTTING POWER OF THE SPINDLE. THE BENEFITS INCLUDE LONGER TOOL LIFE, SHORTER CUTTING TIME, UNATTENDED OPERATIONS, AND LOWER STRESSES ON THE MATERIAL BEING MACHINED.

LONGER TOOL LIFE-

THE SYSTEM WILL STOP THE PROCESS WHEN A DULL TOOL IS SENSED, BEFORE TOOL BREAKAGE.

SHORTER PROCESS TIME-

HIGHER FEEDRATES CAN BE USED INSTEAD OF USING THE WORST CASE FEEDRATE BECAUSE THE SYSTEM WILL SHUT DOWN THE PROCESS WHEN A HIGHER THAN NORMAL LOAD IS HIT. IN ADDITION TO SHUTTING OFF ON LIMITS, THE ADAPTIVE OPTION WILL SLOW DOWN THE FEEDRATE AS REQUIRED SUCH AS WHEN MILLING INTO CORNERS OR SPEED UP WHEN TAKING A LIGHT CHIP OR CUTTING AIR.

UNATTENDED OPERATIONS-

WHEN LIMITS ARE PROPERLY SET, THE OPERATOR DOES NOT NEED TO CONSTANTLY WATCH THE MACHINE FOR DULL TOOL CONDITIONS.

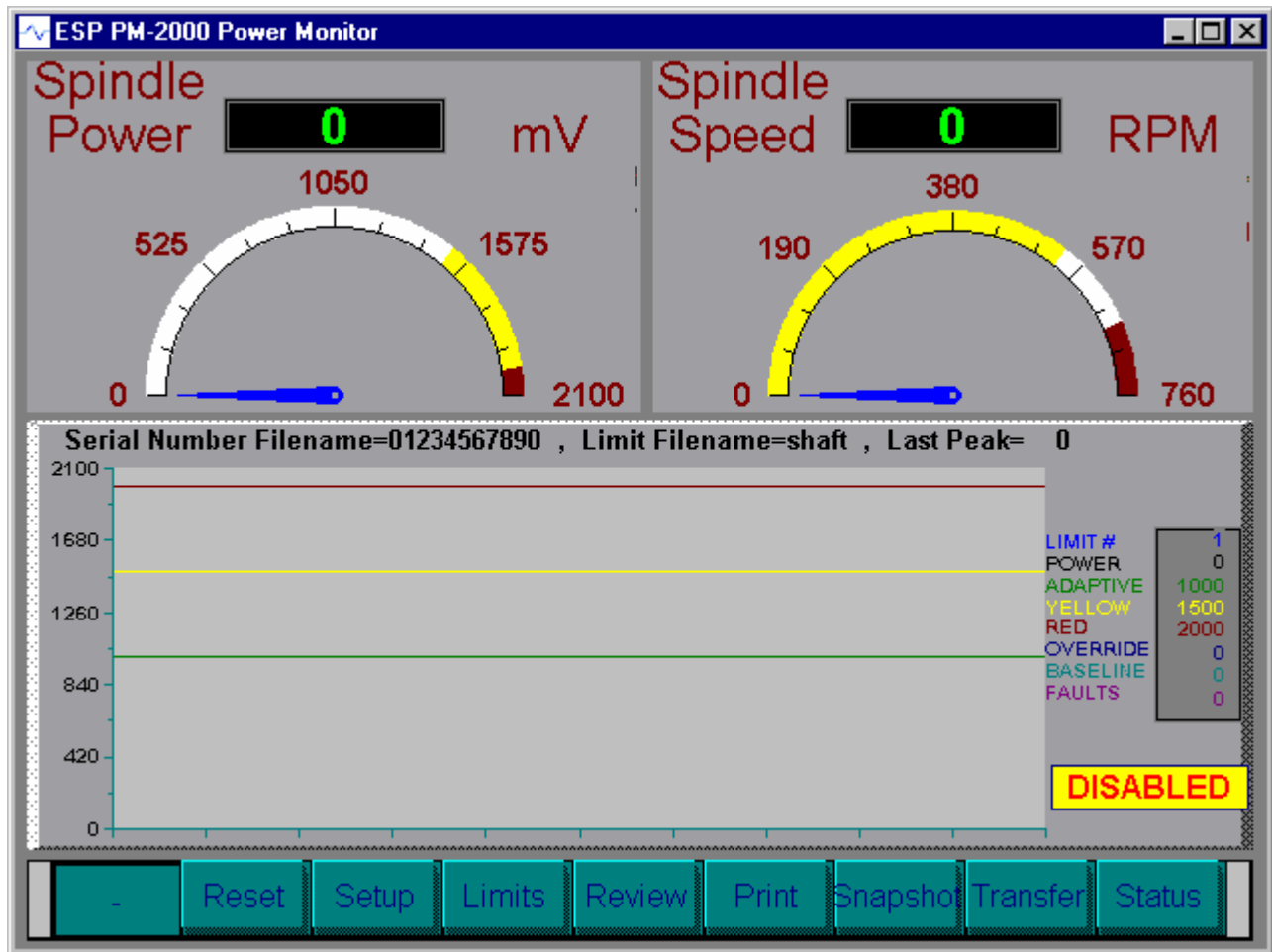
LOWER STRESSES ON MATERIAL BEING MACHINED-

AEROSPACE MANUFACTURERS ARE INCREASINGLY AWARE OF SUBSURFACE MATERIAL DEFECTS CAUSED BY HIGH TOOL PRESSURES ON EXOTIC NICKEL & TITANIUM ALLOYS. THE MONITORING AND LIMITING OF SPINDLE POWER ON THESE MATERIALS WILL PRODUCE A PART THAT HAS LONGER USABLE LIFE. SOME COMPANIES LIKE GENERAL ELECTRIC AIRCRAFT ENGINES ARE REQUIRING THIS TYPE MONITORING SYSTEM AS STATED IN THEIR P11TF12 SPECIFICATION.

ESP PM-2000

POWER MONITOR

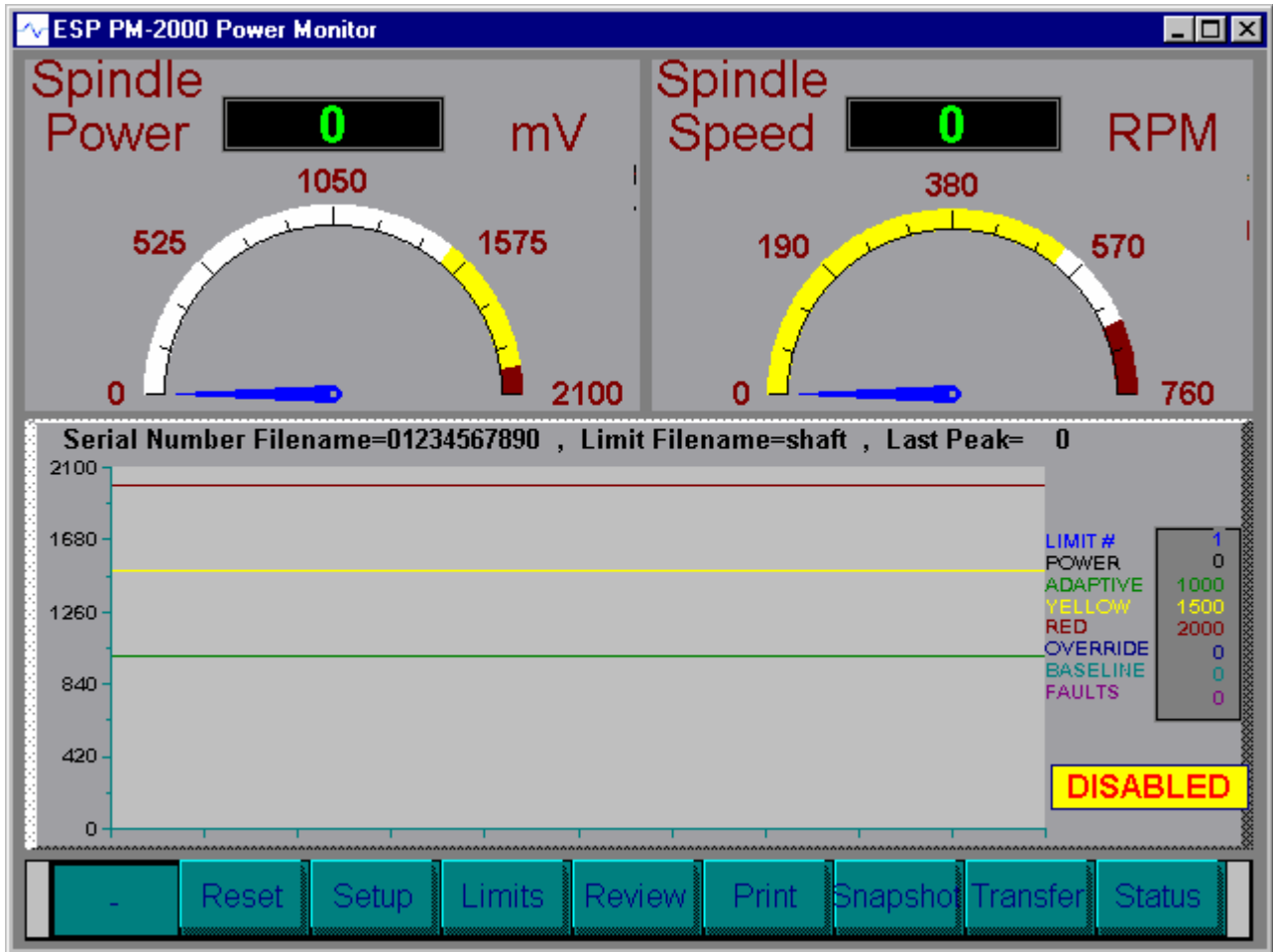
MAIN SCREEN CONTROLS



BUTTONS

- RESET** - USED TO CLEAR THE POWER MONITOR SYSTEM, IF NEEDED.
- SETUP** - SELECTS LIMIT SET & DATA FILE NAMES.
- LIMITS** - LIMIT SET PARAMETER ENTRY.
- REVIEW** - DISPLAYS DATA FILES.
- PRINT** - SENDS DATA FILES TO THE PRINTER.
- SNAPSHOT** - SENDS A PICTURE OF THE SCREEN TO THE PRINTER.
- TRANSFER** - MOVES DATA FILES TO AND FROM THE SYSTEM.
- STATUS** - DISPLAYS THE INTERNAL STATUS OF THE MONITOR.

ESP PM-2000 POWER MONITOR MAIN SCREEN DISPLAY



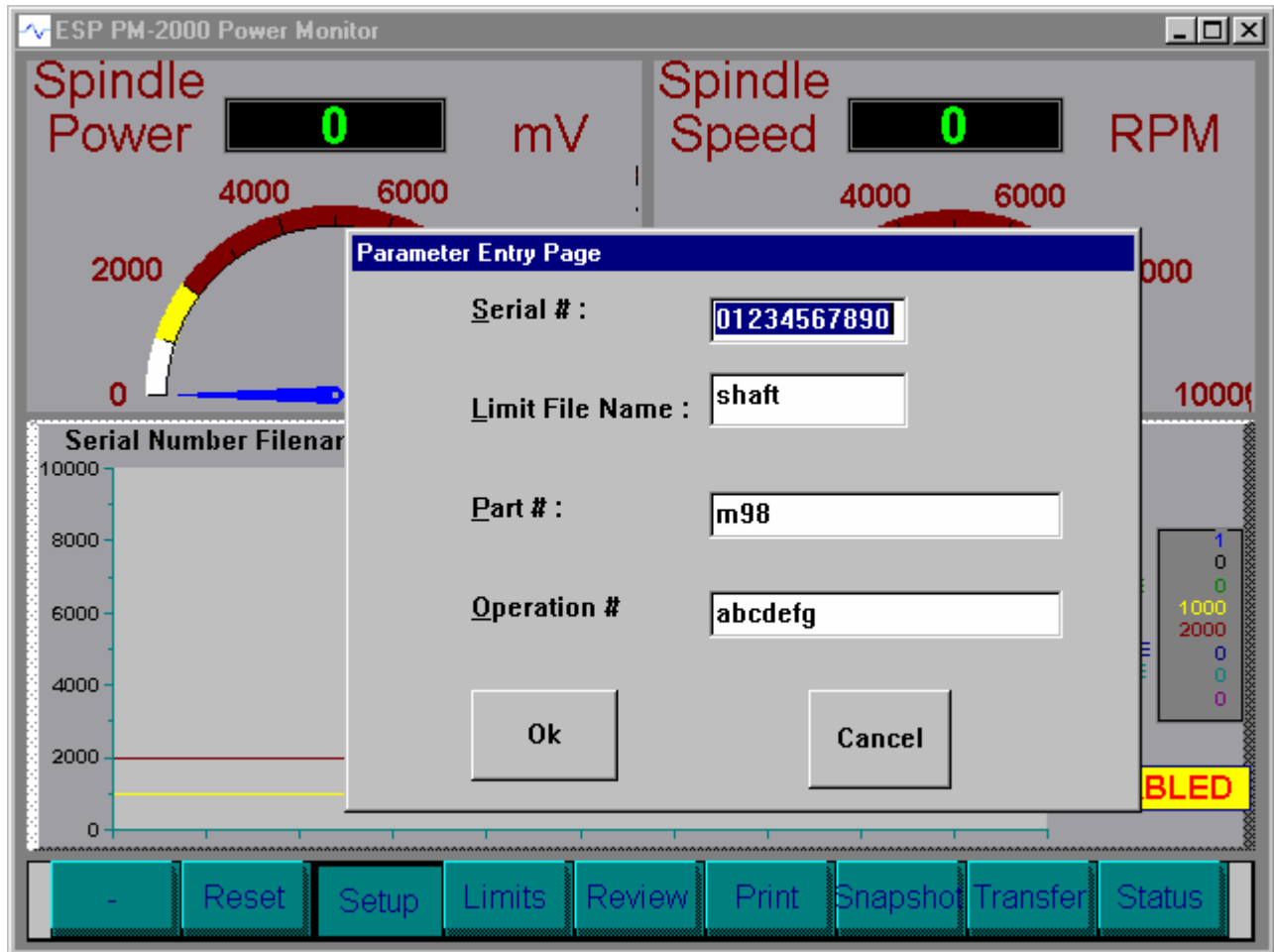
THE UPPER LEFT METER DISPLAYS THE SPINDLE POWER IN MILLIVOLTS, ALONG WITH THE YELLOW & RED LIMITS IN REAL TIME.

THE UPPER RIGHT METER DISPLAYS THE SPINDLE RPM, ALONG WITH YELLOW & RED LIMITS, IN REAL TIME.

THE SWEEP CHART AT THE MIDDLE OF THE SCREEN ACTS AS A CHART RECORDER.

THE LOWER RIGHT SIDE SHOWS CURRENT PARAMETERS AND STATUS.

ESP PM-2000 POWER MONITOR SETUP SCREEN



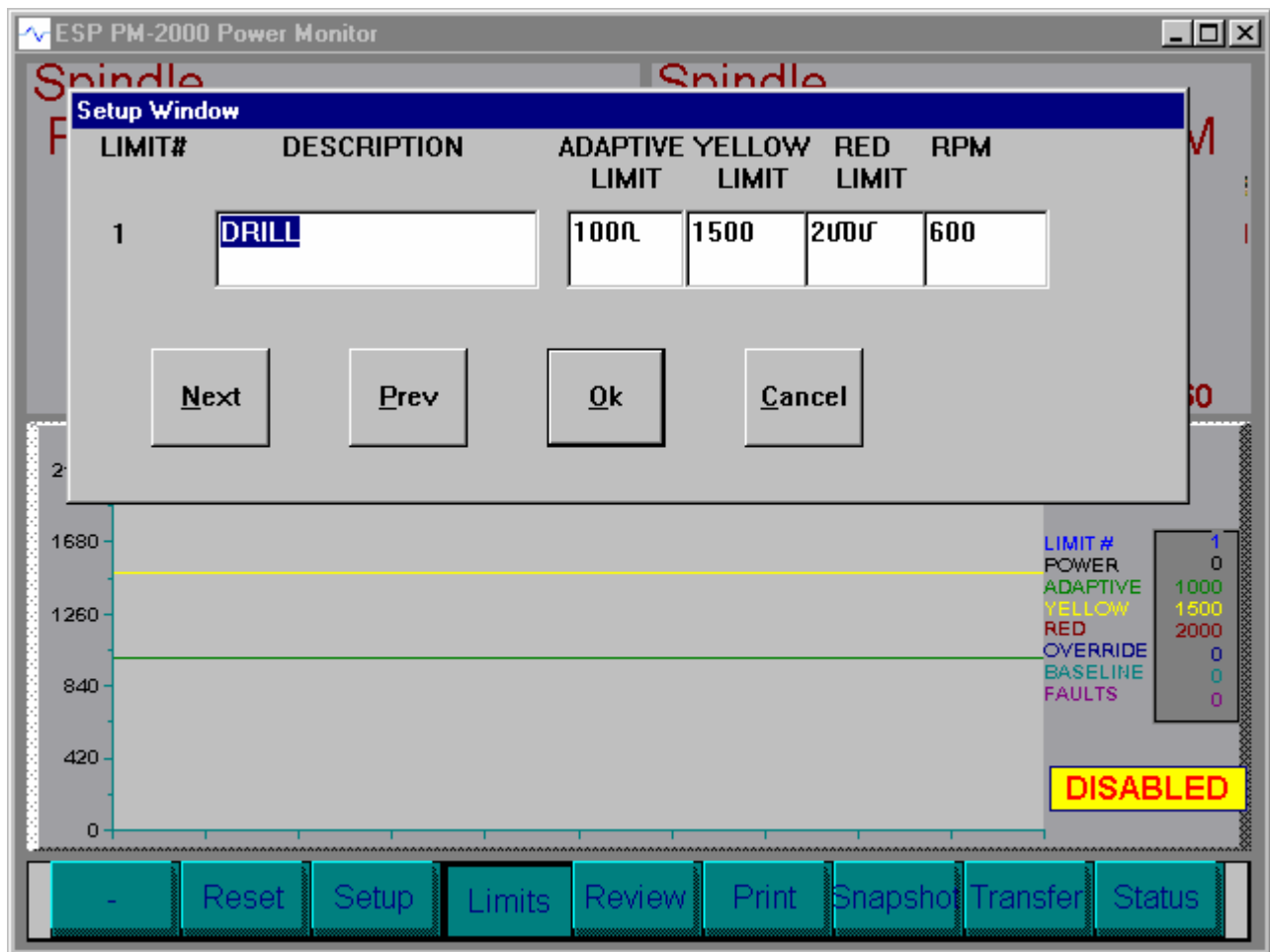
PURPOSE

TO ENTER THE DATA & LIMIT FILES TO BE USED IN THE CURRENT MONITORING PROCESS.

DIRECTIONS

- 1) TYPE IN THE SERIAL # DATA FILE NAME.
- 2) HIT TAB OR PRESS THE LIMIT FILE FIELD BOX.
- 3) TYPE IN THE LIMIT FILE NAME.
- 4) HIT TAB OR PRESS THE PART # FIELD BOX.
- 5) TYPE IN THE PART #.
- 6) HIT TAB OR PRESS THE OPERATION # FIELD BOX.
- 7) PRESS THE "OK" BUTTON.

POWER MONITOR LIMITS SCREEN



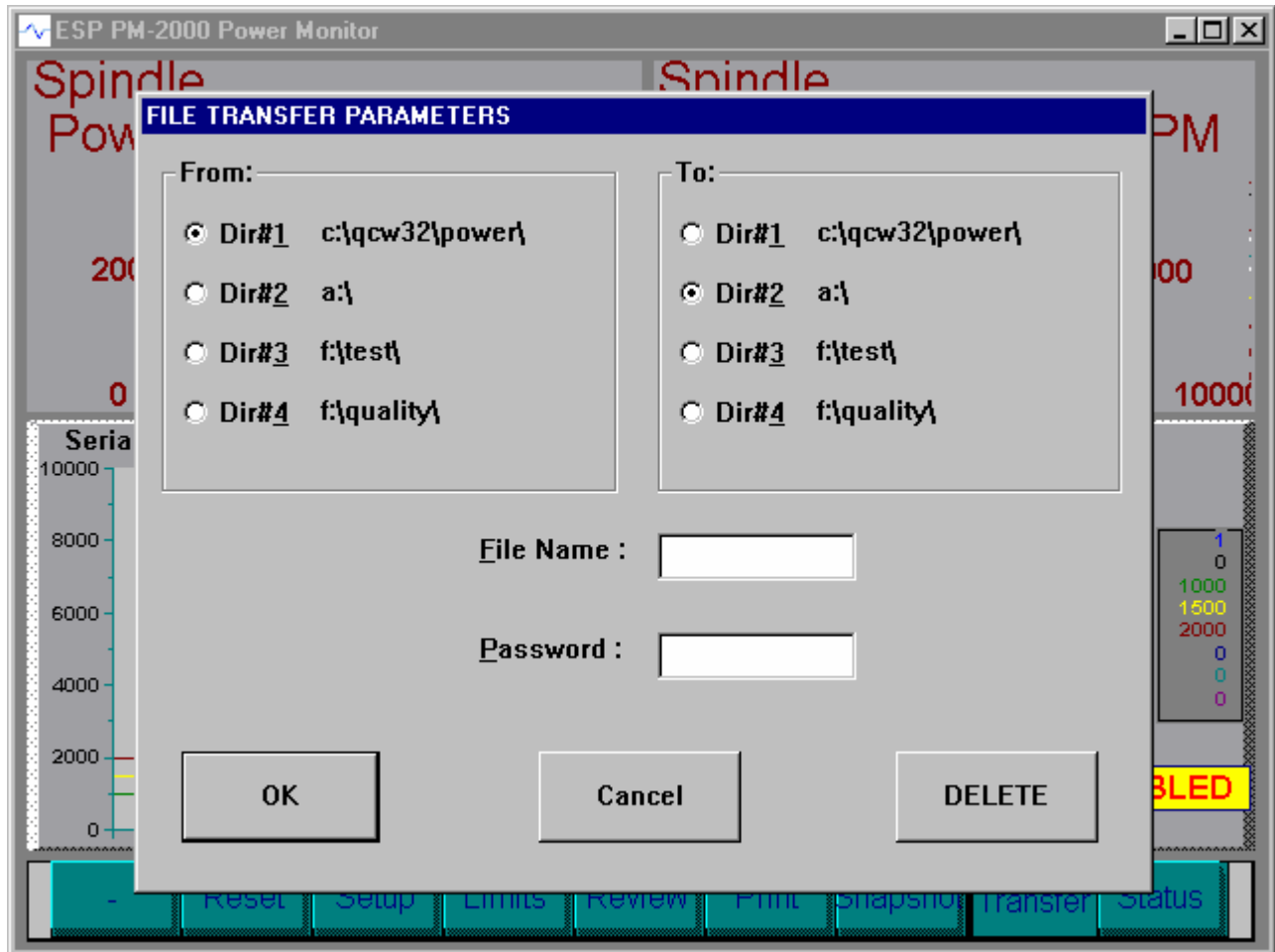
PURPOSE:

TO ENTER THE PARAMETERS INTO THE CURRENT LIMIT SET FILE.

DIRECTIONS:

- 1) TYPE IN A DESCRIPTION OF THE TOOL.
- 2) HIT TAB OR PRESS THE ADAPTIVE FIELD BOX.
- 3) TYPE IN THE ADAPTIVE LIMIT IF USED.
- 4) HIT TAB OR PRESS THE YELLOW LIMIT FIELD BOX.
- 5) TYPE IN THE YELLOW LIMIT.
- 6) HIT TAB OR PRESS THE RED LIMIT FIELD BOX.
- 7) TYPE IN THE RED LIMIT.
- 8) HIT TAB OR PRESS THE RPM LIMIT FIELD BOX.
- 9) TYPE IN THE NOMINAL RPM.
- 10) PRESS NEXT TO GO TO THE NEXT LIMIT SET.
- 11) PRESS THE "OK" BUTTON WHEN DONE.

POWER MONITOR FILE TRANSFER SCREEN



PURPOSE:

TO TRANSFER A PROGRAM TO OR FROM THE ESP PM-2000 USING A FLOPPY OR A NETWORK DRIVE.

PROCESS:

- 1) SELECT "FROM" DIRECTORY.
- 2) SELECT "TO" DIRECTORY.
- 3) ENTER FILE NAME.
- 4) PRESS THE "OK" BUTTON.

NOTE:

DIR#4 IS PASSWORD PROTECTED. IN ORDER TO COPY A FILE TO IT, YOU MUST ENTER THE CORRECT PASSWORD. TO DELETE A FILE, YOU MUST ALSO ENTER THE CORRECT PASSWORD.

SETUP NOTE:

THE DEFINITIONS OF DIR#1, DIR#2, DIR#3, AND DIR#4 CAN BE FOUND IN FILE CONFIG.DAT.



POWER MONITOR FILE DESCRIPTIONS

NOTE: ANYTHING AFTER “//” ARE DESCRIPTIONS ONLY AND ARE NOT TO BE CONTAINED IN THE FILE ITSELF.

CONFIG.DAT

```
SERIALNO 893op2n // LAST DATA ENTERED INTO THE SETUP SCREEN
LIMITFILE 893op2-2 // LAST DATA ENTERED INTO THE SETUP SCREEN
PARTNUMBER 893 // LAST DATA ENTERED INTO THE SETUP SCREEN
OPERATION 2 // LAST DATA ENTERED INTO THE SETUP SCREEN
LOOPTIME 100 // SPECIFIES THE A/D + I/O POLLING TIME IN MILLISECONDS
MISCLOOP 250 // SPECIFIES DISPLAY UPDATE TIME IN MILLISECONDS
RPMLOWCAL 0.090000 // LOW GEAR RPM MULTIPLIER
RPMLOWOFF 0.000000 // LOW GEAR RPM ZERO OFFSET
RPMHIGHCAL 0.360000 // HIGH GEAR RPM MULTIPLIER
RPMHIGHOFF 0.000000 // HIGH GEAR RPM ZERO OFFSET
RPMTIMEOUT 10 // # OF TIMES THRU LOOP BEFORE GENERATING A RPM FAULT
SPNPERCENT 10 // +/- % FROM NOMINAL FOR SPINDLE RPM FAULT CHECK
POWTIMEOUT 10 // # OF TIMES THRU LOOP BEFORE GENERATING A POWER FAULT
FLOTIMEOUT 30 // # OF TIMES THRU LOOP BEFORE GENERATING A COOLANT FAULT
AVGSAMPLE 100 // # OF TIMES TO SAMPLE THE A/D CARD FOR SPINDLE POWER + RPM
BASESAMPLE 400 // # OF TIMES TO SAMPLE THE A/D CARD FOR SPINDLE BASELINE
COOLCHECK 0 // ENABLES / DISABLES COOLANT FLOW-SWITCH CHECKING
STROBEHAND 1 // ENABLES / DISABLES M-FINISHED STROBE HANDSHAKING
STROBETIME 500 // SPECIFIES THE M-FINISHED STROBE TIME IN MILLISECONDS
DIRECTORY1 C:\QCW32\POWER\ // DIRECTORY DEFINITION FOR FILE TRANSFER SCREEN
DIRECTORY2 A:\ // DIRECTORY DEFINITION FOR FILE TRANSFER SCREEN
DIRECTORY3 F:\TEST\ // DIRECTORY DEFINITION FOR FILE TRANSFER SCREEN
DIRECTORY4 F:\PROD\ // DIRECTORY DEFINITION FOR FILE TRANSFER SCREEN
PASSWORD XXXX // PASSWORD DEFINITION TO DELETE FILES FOR FILE TRANSFER SCREEN
PRINTER 0 // 1= PRINTER AVAILABLE, 0= NO PRINTER
WORDLENGTH 8 // RS232 WORD LENGTH
PARITY N // RS232 PARITY
STOPBITS // RS232 STOP BITS
PROTOCOL 7 // RS232 HANDSHAKING - 7=SOFTWARE , 0=HARDWARE
RS232PARAM 1 // ENABLES LIMIT PARAMETER LOADING VIA SERIAL LINE
```

POWER MONITOR FILE DESCRIPTIONS

SAMPLE DATA FILE

Serial Number = 893op2n
 Limit File name = 893op2-2
 Part Number = 893
 Oper. Number = 2
 File Date = 11/20/96
 Start Time = 13:53:47
 Data Record Time (ms.) = 100

REC NUM	LIMIT NUM.	DESCRIPTION	PWR MV.	ADP	YEL	RED	RPM	BASE	FAULT	TIME	DATE	HOLE	REASON
							LIM	LIM		CODE			NUM
1	1	PLUNGE-T24	424	1000	1100	1500	459	1555	2	13:54:14	11/26/96	1	WRONG FEED RATE
2	1	PLUNGE-T24	395	1000	1100	1500	459	1552	0	13:54:14	11/26/96	****	*****
3	2	PLUNGE-T25	220	500	600	800	900	910	0	13:54:14	11/26/96	****	*****
4	2	PLUNGE-T25	275	500	600	800	900	915	0	13:54:14	11/26/96	****	*****
5	4	FINISH-T26	124	0	300	500	720	1813	0	13:54:14	11/26/96	****	*****
6	4	FINISH-T26	136	0	300	500	720	1810	0	13:54:14	11/26/96	****	*****
7	4	FINISH-T26	190	0	300	500	720	1811	0	13:54:14	11/26/96	****	*****
8	4	FINISH-T26	225	0	300	500	720	1812	0	13:54:14	11/26/96	****	*****
9	4	FINISH-T26	312	0	300	500	720	1812	1	13:54:14	11/26/96	5	DULL TOOL

FAULT CODES

CODE	DESCRIPTION
1	YELLOW LIMIT
2	RED LIMIT
4	RPM LOW LIMIT
8	RPM HIGH LIMIT
16	COOLANT FLOW FAULT
32	ABORTED BY OPERATOR RESET
64	LIMIT SET NUMBER TOO HIGH

THESE CODES ARE LOGICALLY "ANDED" TOGETHER TO PRODUCE THE FAULT NUMBER THAT IS RECORDED IN THE DATA FILE.

EXAMPLE: FAULT NUMBER = 3 - THIS IS YELLOW AND RED FAULTS TOGETHER
 FAULT NUMBER = 17 - THIS IS YELLOW AND COOLANT FAULTS TOGETHER
 FAULT NUMBER = 19 - THIS IS YELLOW + RED + COOLANT FAULTS TOGETHER

POWER MONITOR FILE DESCRIPTIONS

SAMPLE LIMIT SET FILE

1	PLUNGE-T24	1000	1100	1500	460
2	PLUNGE-T21	500	600	800	900
3	SEMI-FINISH-T25	350	420	500	300
4	FINISH-T26	0	300	500	720
5	SPRING-CUT-T26	0	600	700	300
6	*****	0	0	0	0
7	*****	0	0	0	0
8	*****	0	0	0	0
9	*****	0	0	0	0
10	*****	0	0	0	0
11	*****	0	0	0	0
12	*****	0	0	0	0
13	*****	0	0	0	0
14	*****	0	0	0	0
15	*****	0	0	0	0
16	*****	0	0	0	0
17	*****	0	0	0	0
18	*****	0	0	0	0
19	*****	0	0	0	0
20	*****	0	0	0	0
21	*****	0	0	0	0
22	*****	0	0	0	0
23	*****	0	0	0	0
24	*****	0	0	0	0
25	*****	0	0	0	0
26	*****	0	0	0	0
27	*****	0	0	0	0
28	*****	0	0	0	0
29	*****	0	0	0	0
30	*****	0	0	0	0
31	*****	0	0	0	0
32	*****	0	0	0	0

POWER MONITOR PROGRAMMING

THE FOLLOWING ARE SAMPLE PROGRAMS TO PROPERLY ENABLE THE POWER MONITOR SYSTEM ON A FANUC 15 MB CONTROL.

LIMIT SET #1 EXAMPLE RECORD PEAK POWER FOR COMPLETE PART

O0001
N10 T01M06 PUT TOOL 1 IN SPINDLE
N20 G90G00U3.75C0 ABSOLUTE MODE RAPID TO POSITION ABOVE HOLE
N30 Z5.0
N40 G01G94F0M01
N50 S800M03 TURN ON SPINDLE

N60 POPEN OPEN COMMUNICATION PORT
N70 BPRNT [LS_01_ADPT_0000_YL_3000_RL_4000_RPM_800"]

*** LOAD LIMIT SET 1 0000Mv ADAPTIVE, 3000Mv YELLOW, 4000Mv RED, 800 RPM SPINDLE SPEED

N80 G00Z2.0 MOVE CLEAR OF PART
N90 M08 TURN ON COOLANT
N100 M01
N110 Z.05 MOVE TO CLEARANCE PLANE

N120 G4 PREVENT CONTROL FROM READING BLOCK AHEAD
N130 [E_1] TURN ON MONITOR
N140 PCLOS CLOSE COMMUNICATION PORT

N150 G81U3.75Z-.065C0R.05F.8 AND DRILL FIRST HOLE
N160 G80
N170 G00U3.75Z.05
N180 C-345
N190 G81U3.75Z-.065C345.0R.05F.8 DRILL SECOND HOLE
N200 G80

N120 G4 PREVENT CONTROL FROM READING BLOCK AHEAD
N210 POPEN OPEN COMMUNICATION PORT
N220 [E_0] TURN OFF MONITOR
N230 PCLOS CLOSE COMMUNICATION PORT

N240 Z5.0 GO CLEAR OF PART
N250 M09 TURN OFF COOLANT
N260 M05 TURN OFF SPINDLE
N270 M00 PROGRAM STOP

**** G4 NEEDED TO PREVENT CONTROL FROM READING BLOCKS AHEAD, DO NOT PUT P NUMBER IN.
**** PRESSING RESET ON CONTROL WILL CLOSE COMMUNICATION PORT. PROGRAM RESTART WILL NEED TO START AT POPEN BLOCK OR BEFORE.

RECORD PEAK POWER FOR EACH HOLE

O0001
N10 T01M06 PUT TOOL 1 IN SPINDLE
N20 G90G00U3.75C0 ABSOLUTE MODE RAPID TO POSITION ABOVE HOLE
N30 Z5.0
N40 G01G94F0M01
N50 S800M03 TURN ON SPINDLE

N60 POPEN OPEN COMMUNICATION PORT
N70 BPRNT [LS_01_ADPT_0000_YL_3000_RL_4000_RPM_800"]

*** LOAD LIMIT SET 1 0000Mv ADAPTIVE, 3000Mv YELLOW, 4000Mv RED, 800 RPM SPINDLE SPEED

N80 G00Z2.0 MOVE CLEAR OF PART
N90 M08 TURN ON COOLANT
N100 M01
N110 Z.05 MOVE TO CLEARANCE PLANE

N120 G4 PREVENT CONTROL FROM READING BLOCK AHEAD
N130 [E_1] TURN ON MONITOR
N140 PCLOS CLOSE COMMUNICATION PORT

N150 G81U3.75Z-.065C0R.05F.8 DRILL FIRST HOLE
N160 G80
N170 G00U3.75Z.05
N180 C-345

N190 G4 PREVENT CONTROL FROM READING BLOCK AHEAD
N200 POPEN OPEN COMMUNICATION PORT
N210 [E_0] TURN OFF MONITOR
N220 PCLOS CLOSE COMMUNICATION PORT
N230 Z.05 MOVE TO CLEARANCE PLANE

N240 G4 PREVENT CONTROL FROM READING BLOCK AHEAD
N250 [E_1] TURN ON MONITOR
N260 PCLOS CLOSE COMMUNICATION PORT

N270 G81U3.75Z-.065C345.0R.05F.8 DRILL SECOND HOLE
N280 G80

N290 G4 PREVENT CONTROL FROM READING BLOCK AHEAD
N300 POPEN OPEN COMMUNICATION PORT
N310 [E_0] TURN OFF MONITOR
N320 PCLOS CLOSE COMMUNICATION PORT

N330 Z5.0 GO CLEAR OF PART
N340 M09 TURN OFF COOLANT
N350 M05 TURN OFF SPINDLE
N360 M00 PROGRAM STOP

**** **G4 NEEDED TO PREVENT CONTROL FROM READING BLOCKS AHEAD, DO NOT PUT P NUMBER IN.**
**** **PRESSING RESET ON CONTROL WILL CLOSE COMMUNICATION PORT. PROGRAM RESTART WILL NEED TO START AT POPEN BLOCK OR BEFORE.**

ESP PM-2000
POWER MONITOR
RELAY OUTPUTS

OUTPUT NUM	I/O TERM NUM	WIRE COLOR	WIRE NUM	DESCRIPTION
0	37			OUTPUT #1
	19			OUTPUT #1
1	36			OUTPUT # 2
	17			OUTPUT # 2
2	34			OUTPUT # 3
	16			OUTPUT # 3
3	33			OUTPUT # 4
	14			OUTPUT # 4
4	31			OUTPUT # 5
	13			OUTPUT # 5
5	30	Black		OUTPUT # 6 Feedhold
	11	Red		OUTPUT # 6
6	29	White		OUTPUT # 7 Spindle Stop
	10	Green		OUTPUT # 7
7	28			OUTPUT # 8
	9			OUTPUT # 8

ESP PM-2000

POWER MONITOR

INPUTS

IUTPUT NUM	I/O TERM NUM	WIRE COLOR	WIRE NUM	LOGIC	DESCRIPTION
0	8				INPUT #1
	27				24V COMMON
1	7				INPUT #2
	26				24V COMMON
2	6				INPUT #3
	25				24V COMMON
3	5				INPUT #4
	24				24V COMMON
4	4	Red	IO Cable		INPUT #5 Coolant Flow Switch
	23	Black	IO Cable		24V COMMON
5	3				INPUT #6
	22				24V COMMON
6	2				INPUT #7
	21				24V COMMON
7	1	White	KeyB Cable		INPUT #8 High Gear Selected
	20	Green	KeyB Cable		24V COMMON

ESP PM-2000
POWER MONITOR
ANALOG INPUTS

ANALOG INPUT NUM	TERM NUM	WIRE COLOR	WIRE NUM	DESCRIPTION
0	37	RED	CABLE A	SPINDLE POWER
	18	BLK		SPINDLE POWER COMMON
1	36	WHT	CABLE A	SPINDLE SPEED
	17	GRN		SPINDLE SPEED COMMON