LAMPIRAN 1
Surat Keterangan Uji SEM & EDX di Lab. FMIPA UM

LABORATORIUM SENTRAL
FMIPA UNIVERSITAS NEGERI MALANG (UM)
Jl. Semarang 5 Malang, Telp. (0341) 9001088 / 551312 (psw 200) / (0341) 574895
Email: laboratoriumsentralum@yahoo.co.id ; Website : central-laboratory.um.ac.id

SURAT KETERANGAN
Nomor: LSUM.00674.2014

Bersama ini kami menerangkan bahwa mahasiswa berikut :

No	Nama	Judul Skripsi
1	Ahmad Aminnudin S NIM 115060201111017	Pengaruh Feed Rate dan Dept of Cuts terhadap Surface Roughness di Side Surface pada Proses Milling dengan Bantuan 4 Axiz CNC Mesin
2	Sulthan Adib NIM 125060200111080	Pengaruh Feed Rate dan Dept of Cuts terhadap Surface Roughness di Bottom Surface pada Proses Milling dengan Bantuan 4 Axiz CNC Mesin
3	Vidi Ilham Patria NIM 125060200111110	Pengaruh Cuting Speed dan Dept of Cuts terhadap Surface Roughness di Bottom Surface pada Proses Milling dengan Bantuan 4 Axiz CNC Mesin
4	Moch. Latif Prasetya NIM 0810620077	Pengaruh Variasi Feed Rate, Geometri Pahat dan Cutting Fluid terhadap Kekasaran Aluminium 6061 Pada Proses Turning
5	Satrio Muktiwibowo NIM 0810623072	Pengaruh Jenis Cutting Fluid dan Variasi Depth of Cut terhadap Surface Roughness Aluminium 6061 Hasil Proses Turning

telah melakukan kegiatan pengujian 1 (satu) sampel Aluminium 6061 dengan rincian sbb.

Pengujian : Analisis Unsur

Alat : SEM (*Scanning Electron Microscopy*) FEI Inspect S-50 / EDX AMETEK

Tempat : Laboratorium Sentral, Gd. O4 FMIPA UM

Waktu : Hari Jumat, Tanggal 10 Oktober 2014

Teknisi : Nur Zulaicha, S. Si

Demikian surat keterangan ini kami buat untuk digunakan sebagaimana mestinya.

Malang, 18 Desember 2014
a.n Dekan,
Wakil Dekan I
u.b Ketua Pengelola Laboratorium Sentral

Drs. Abdulloh Fuad, M.Si
NIP. 196302221988121002

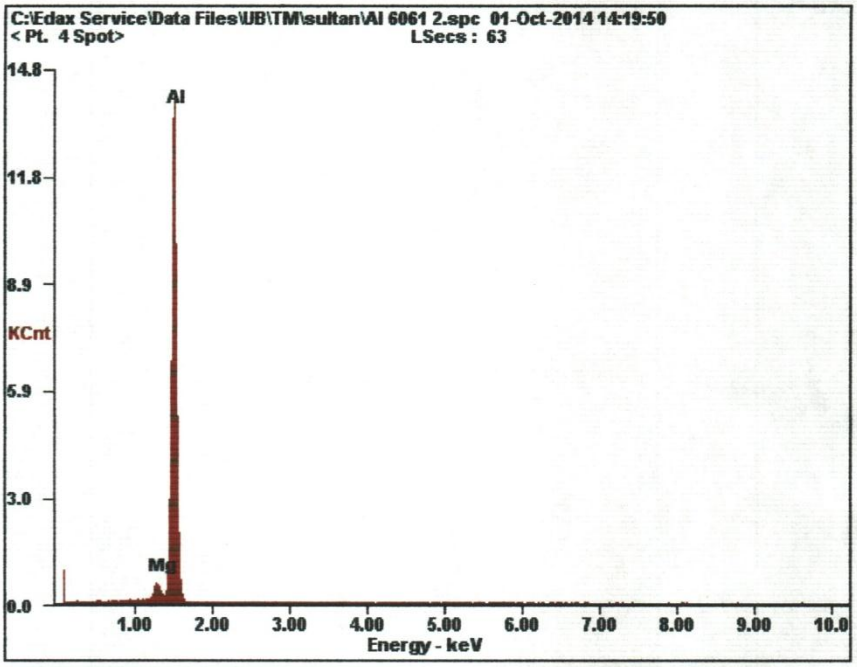
LAMPIRAN 2
Hasil Pengujian SEM & EDX (komposisi aluminium)

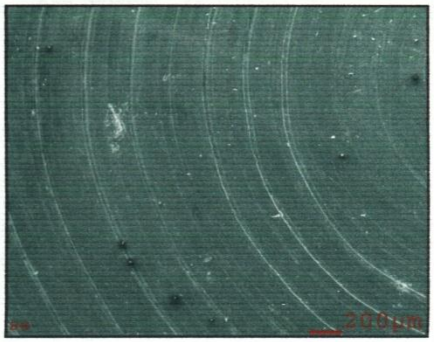
Microanalysis Report

Prepared for: *Sulthan Adib*

Prepared by: *Laboratorium Sentral FMIPA UM*

10/1/2014





Element	Wt%	At%
MgK	02.85	03.15
AlK	97.15	96.85
Matrix	Correction	ZAF

LAMPIRAN 3
Material Notes Aluminiun 6061-T6

Glemco Inc.

PO Box 217
Leander, TX 78646-0217
USA
800-621-9598
www.glemco.com
sales@glemco.com

6061-T6 Aluminum

Material Notes

Component	Wt. %
Al	95.8 - 98.6
Cr	0.04 - 0.35
Cu	0.15 - 0.4
Fe	Max 0.7

Component	Wt. %
Mg	0.8 - 1.2
Mn	Max 0.15
Other, each	Max 0.05
Other, total	Max 0.15

Component	Wt. %
Si	0.4 - 0.8
Ti	Max 0.15
Zn	Max 0.25

Physical Properties	Metric	English	Comments
Density	2.7 g/cc	0.0975 lb/in³	AA; Typical
Mechanical Properties			
Hardness, Rockwell B	60	60	Converted from Brinell Hardness Value
Hardness, Vickers	107	107	Converted from Brinell Hardness Value
Ultimate Tensile Strength	310 MPa	45000 psi	AA; Typical
Tensile Yield Strength	276 MPa	40000 psi	AA; Typical
Elongation at Break	12 %	12 %	AA; Typical; 1/16 in. (1.6 mm) Thickness
Modulus of Elasticity	68.9 GPa	10000 ksi	AA; Typical; Average of tension and compression. Compression modulus is about 2% greater than tensile modulus.
Poisson's Ratio	0.33	0.33	Estimated from trends in similar Al alloys.
Fatigue Strength	96.5 MPa	14000 psi	AA; 500,000,000 cycles completely reversed stress; RR Moore machine/specimen
Fracture Toughness	29 MPa-m½	26.4 ksi-in½	KIC; TL orientation.
Shear Strength	207 MPa	30000 psi	AA; Typical
Electrical Properties			
Electrical Resistivity	3.99e-006 ohm-cm	3.99e-006 ohm-cm	AA; Typical at 68°F
Thermal Properties			
CTE, linear 68°F	23.6 µm/m-°C	13.1 µin/in-°F	AA; Typical; Average over 68-212°F range.
CTE, linear 250°C	25.2 µm/m-°C	14 µin/in-°F	Estimated from trends in similar Al alloys. 20-300°C.
Thermal Conductivity	167 W/m-K	1160 BTU-in/hr-ft²-°F	AA; Typical at 77°F
Melting Point	582 - 652 °C	1080 - 1205 °F	AA; Typical range based on typical composition for wrought products 1/4 inch thickness or greater; Eutectic melting can be completely eliminated by homogenization.
Solidus	582 °C	1080 °F	AA; Typical
Liquidus	652 °C	1205 °F	AA; Typical

LAMPIRAN 4
Sertifikat Material dari PT.Global Contromation Indonesia

Rev. 00

MILL CERTIFICATE

01/AI X-MC/QA/03/2012

CUSTOMER REFERENCE

CUSTOMER NAME	GLOBAL CONTROMATION INDONESIA, PT TANJUNG SARI No. 44 RT.001 RW. 016 SIMOKERTO SUKOMANUNGGAL SURABAYA
INVOICE NO./PACKING LIST	-
S.O. NO.	000889/II/12
P/L NO.	-
ISSUING BANK	-
PROJECT NAME	-
DIE NO. / SECTION NO.	60, 56, 44, 51, 49, 142, 140, 133, 134
FINISH PRODUCT	Aluminium Extrusion Mill Finish

CHEMICAL COMPOSITION

CHEMICAL %	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
STANDARD REQUIREMENT	0.40 - 0.80	0.70 max	0.15 - 0.40	0.15 max	0.80 - 1.20	0.04 - 0.35	0.25 max	0.15 max
RESULT TEST	0.530	0.250	0.160	0.110	0.810	0.085	0.021	0.014

MECHANICAL PROPERTIES

SPECIFICATION	U. Tensile Strength (Mpa)	Elongation (%)	Hardness (Webster)
STANDARD REQUIREMENT	260 Min	7 Min	14 Min
RESULT TEST	281	10	15 -16

We hereby certify that the section specified above has been produced by own manufacture and has been inspected / tested in accordance with SNI - 0803 - 1989 - A

LAMPIRAN 5
Surat Keterangan Penelitian di Lab. CNC Lanjut POLINEMA

KEMENTERIAN PENDIDIKAN NASIONAL
POLITEKNIK NEGERI MALANG
JURUSAN TEKNIK MESIN
Terakreditasi A, Sesuai Kpts BAN No.:014/BAN-PT/Ak-VI/Dpl-III/VI/2006
Jl. Veteran PO. Box 04 Malang 65145 Telp/Fax. (0341)550180
http://www.poltek-malang.ac.id

SURAT KETERANGAN
NOMOR : 413/PL2.TM/KM/2014

Yang bertanda tangan dibawah ini :

Nama	:	Agus Dani, ST.MT
N I P	:	197908152005011004
Jabatan	:	Kepala Laboratorium CNC Lanjut Jurusan Teknik Mesin - Politeknik Negeri Malang

Menerangkan dengan sesungguhnya bahwa mahasiswa :

Nama	:	Sulthan Adib
Nim	:	125060200111080
Jurusan	:	Teknik Mesin (S1)
Fakultas	:	Teknik Universitas Brawijaya Malang

Benar benar telah melaksanakan praktek CNC Milling 4-axis DAHLIH MCV 1020-BA di Jurusan Teknik Mesin Politeknik Negeri Malang pada tanggal 22 Nopember 2014 sampai dengan 11 Desember 2014, guna keperluan penyusunan skripsi.

Demikian surat keterangan ini dibuat untuk dipergunakan sebagaimana mestinya.

Malang, 15 Desember 2014
Kepala Laboratorium CNC Lanjut
Jurusan Teknik Mesin

Agus Dani, ST.MT
197908152005011004

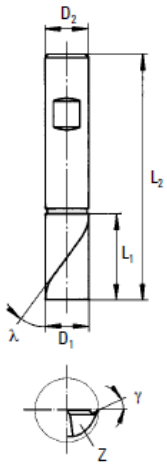
LAMPIRAN 6
Spesifikasi Mesin CNC Milling 4-axis DAHLIH MCV 1020-BA

SPECIFICATIONS

MODEL	Unit	MCV-1020BA	MCV-1020A
TABLE			
Working Surface	mm (inch)	1250 x 660 (49 x 25.98)	
T-Slots (Size x Number)	mm (inch)	18 x 5 (0.71 x 5)	
Max. Table Load	kg (lbs)	1000 (2200)	
TRAVEL			
Longitudinal Travel (X)	mm (inch)	1020 (40.16)	
Cross Travel (Y)	mm (inch)	550 (21.65)	
Headstock Travel (Z)	mm (inch)	560 (22.05)	
Distance Between Spindle End and Table Top	mm (inch)	150-710 (5.91-27.95)	
Distance Between Spindle Center and Column Surface	mm (inch)	600 (23.62)	
SPINDLE			
Spindle Nose		NT40	
Spindle Speeds	rpm	8000	6000
Spindle Speed Range		Infinitly variable	Two Gears Variable
FEED			
Cutting Feed	mm/min (inch/min)	10000 (393.7)	
Rapid Traverse	m/min (inch/min)	30 / 30 / 20 (1181 / 1181 / 787)	
Minimum Input Increment	mm (inch)	0.001 (0.0001)	
ATC (Automatic Tool Changer)			
Tool Holder		BT40	
Tool Storage Capacity	Tools	24 CAM	25 Arm Type
Max. Tool Dia. x Length	ø x mm (inch)	77 x 300 (3.03 x 11.81)	
Max. Tool Weight	kg (lbs)	7 (15)	
Max. Tool Dia. (adjacent pots are empty)	ø x mm (inches)	127 (5)	
Tool Selection		Bi-Directional	Random
MOTORS			
Spindle Drive	Continuous Rating kW (HP)	7.5 (10)	
Motor	Rated Output for 30 Min kW (HP)	11 (14.7)	
Drive Motors	X, Y, Z Axis kW (HP)	3.0 (4), 3.0 (4), 4.2 (5.5)	
MACHINE WEIGHT SPACE AND PACKING			
Floor Space	mm (inch)	3260 x 3060 (128.35 x 120.47)	
Net Weight	Kg (lbs)	6000 (13200)	8000 (17600)

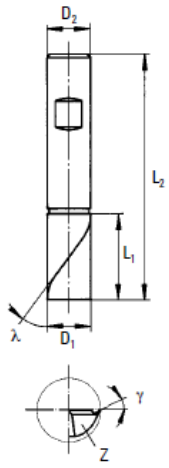
Specifications may change according to optional accessories. The manufacturers represented reserve the right to modify the design, specifications and mechanisms of the machine without notice.

LAMPIRAN 7
Catalog Cutter Milling 1026 KESTAG



Typ / Norm	*Type / Norme*	HSS-Co8	TiAlN
		N	N
		DIN 327 D	DIN 327 D
γ	γ	~14°	~14°
λ	λ	~30°	~30°

Katalog-Nr.	*N° de catalogue*					1026 ...	1027 ...
D_1 e8	D_2 h6	L_1	L_2	Z	Ident. N°	CHF/Stück *CHF/pièce*	CHF/Stück *CHF/pièce*
2	6	4	48	2	 020	10.55	19.20
2,5	6	5	49	2	 025	11.10	19.20
3	6	5	49	2	 030	10.55	17.15
3,5	6	6	50	2	 035	11.10	19.70
4	6	7	51	2	 040	10.55	17.15
4,5	6	7	51	2	 045	11.10	19.70
5	6	8	52	2	 050	10.55	17.15
5,5	6	8	52	2	 055	11.10	19.70
6	6	8	52	2	 060	10.55	17.15
6,5	10	10	60	2	 065	12.60	22.40
7	10	10	60	2	 070	12.85	18.40
7,5	10	10	60	2	 075	14.05	25.10
8	10	11	61	2	 080	12.85	22.50
8,5	10	11	61	2	 085	15.60	27.80
9	10	11	61	2	 090	15.60	28.—
9,5	10	11	61	2	 095	17.25	29.80
10	10	13	63	2	 100	15.60	25.30
10,5	12	13	70	2	 105	19.45	–
11	12	13	70	2	 110	19.60	34.20
11,5	12	13	70	2	 115	21.30	–
12	12	16	73	2	 120	19.60	30.20
13	12	16	73	2	 130	25.30	41.80
14	12	16	73	2	 140	24.—	37.70
15	12	16	73	2	 150	29.10	–



Typ / Norm	*Type / Norme*	HSS-Co8	TiAlN
		N	N
		DIN 327 D • ≠ DIN	DIN 327 D
γ	γ	~14°	~14°
λ	λ	~30°	~30°

Katalog-Nr.	*N° de catalogue*					1026 ...	1027 ...
D_1 e8	D_2 h6	L_1	L_2	Z	Ident. N°	CHF/Stück *CHF/pièce*	CHF/Stück *CHF/pièce*
16	16	19	79	2	 160	29.10	46.—
17	16	19	79	2	 170	35.10	–
18	16	19	79	2	 180	35.10	55.80
19	16	19	79	2	 190	43.20	–
20	20	22	88	2	 200	41.—	65.60
21	20	22	88	2	 210	55.50	–
22	20	22	88	2	 220	55.50	84.20
23	20	22	88	2	 230	70.90	–
24	25	26	102	2	 240	70.90	–
25	25	26	102	2	 250	70.90	107.70
26	25	26	102	2	 260	89.70	–
28	25	26	102	2	 280	89.70	–
30	25	26	102	2	 300	102.50	–
32	32	32	112	2	 320	115.50	–
34	32	32	112	2	 340	149.70	–
35	32	32	112	2	 350	149.70	–
36	32	32	112	2	 360	149.70	–
38	•32	38	•118	2	 380	188.70	–
40	•32	38	•118	2	 400	188.70	–

Bestell-Nr.: Entsprechende Katalog-Nummer und Ident. N° in dieser Reihenfolge zusammenfügen, z.B.: 1026 020

Lieferung ab Lager ( ) ab Werkslager

N° de commande: *Joindre dans cet ordre au numéro de catalogue l'Ident. N°, par exemple: 1026 020*

Livraison du stock ( ) du stock d'usine

LAMPIRAN 8
Table Techanical Data Coblat HSS dan HSS End Mills

COBALT HSS AND HSS END MILLS

Speed and Feed Data - Applications in Various Materials

MATERIAL	HEAT-RESISTANT COBALT BASE ALLOYS, HIGH TENSILE STEELS (50-55 C)		HEAT-RESISTANT AUSTENITIC ALLOYS, HIGH TENSILE STEELS (46-50 C)		HEAT-RESISTANT NICKEL BASE ALLOYS, HIGH STRENGTH STAINLESS STEELS, HIGH STRENGTH TITANIUM ALLOYS		HIGH STRENGTH STAINLESS STEELS, HIGH TENSILE STEELS (40-60 C) MEDIUM STRENGTH TITANIUM ALLOYS		HEAT RESISTANT FERRITIC BASE ALLOYS MEDIUM STRENGTH STAINLESS STEELS UNALLOYED TITANIUM TOOL STEELS (30-40 C)		MACHINE STEEL, HARD BRASS AND BRONZE, ELECTROLYTIC COPPER MILD STEEL FORGINGS (20-30 C)		CAST IRON, MILD STEEL, HALF-HARD BRASS AND BRONZE		BRASS, BRONZE, ALLOYED ALUMINUM, ABRASIVE PLASTICS		ALUMINUM, PLASTICS, WOOD	
	SPEED 5-10 SFM	FEED	SPEED 10-15 SFM	FEED	SPEED 15-20 SFM	FEED	SPEED 20-40 SFM	FEED	SPEED 40-60 SFM	FEED	SPEED 60-80 SFM	FEED	SPEED 80-100 SFM	FEED	SPEED 100-200 SFM	FEED	SPEED 200-600 SFM	FEED
DIA. OF END MILLS	RPM	CHIP LOAD PER TOOTH	RPM	CHIP LEAD PER TOOTH	RPM	CHIP LEAD PER TOOTH	RPM	CHIP LEAD PER TOOTH	RPM	CHIP LEAD PER TOOTH	RPM	CHIP LEAD PER TOOTH	RPM	CHIP LEAD PER TOOTH	RPM	CHIP LEAD PER TOOTH	RPM	CHIP LEAD PER TOOTH
1/16	-	-	-	-	-	-	1222-2444	.0002-.0005	2444-3667	.0002 -.005	3667-4888	.0002 -.0005	4888-6111	.0002 -.0005	6111-12222	.0002 -.0005	12222 UP	.0002 -.0005
3/32	-	-	-	-	611-815	.0002 -.0005	815-1629	.0002-.0005	1629-2750	.0002 -.005	2750-3259	.0002 -.0005	3259-4073	.0002 -.0005	4073-8146	.0002 -.0005	8146 UP	.0002 -.0005
1/8	-	-	-	-	456-611	.0002 -.0005	611-1222	.0002-.0005	1222-1833	.0002 -.005	1833-2440	.0002 -.001	2440-3056	.0002 -.001	3056-6112	.0002 -.001	6112 UP	.0002 -.001
3/16	-	-	204-306	.0002 -.0005	306-407	.0002 -.0005	407-815	.0002-.0005	815-1222	.0002 -.005	1222-1625	.0002 -.001	1625-2037	.0002 -.001	2037-4074	.0002 -.001	4074-12222	.0002 -.001
1/4	76-153	.0002 -.001	153-230	.0002 -.001	229-306	.0002 -.001	306-611	.0002 -.001	611-917	.0002 -.001	917-1222	.0005 -.002	1222-1528	.0005 -.002	1528-3056	.0005 -.002	3056-9168	.0005 -.002
5/16	61-122	.0002 -.001	122-183	.0002 -.001	183-244	.0002 -.001	244-489	.0002 -.001	489-733	.0002 -.001	733-978	.0005 -.002	978-1222	.0005 -.002	1222-2444	.0005 -.002	2444-7332	.0005 -.002
3/8	51-102	.0002 -.001	102-153	.0002 -.001	153-203	.0002 -.001	203-407	.0005 -.002	406-611	.0005 -.002	611-815	.001 -.003	815-1019	.001 -.003	1019-2038	.0005 -.003	2038-6114	.0005 -.002
7/16	44-88	.0005 -.001	88-132	.0005 -.001	131-175	.0005 -.002	175-349	.0005 -.002	349-524	.0005 -.002	524-698	.001 -.003	698-873	.001 -.003	873-1746	.0005 -.003	1746-5238	.0005 -.002
1/2	38-76	.0005 -.001	76-115	.0005 -.001	115-153	.0005 -.002	153-306	.0005 -.003	306-458	.001 -.003	458-611	.001 -.003	611-764	.001 -.003	764-1528	.0005 -.003	1528-4584	.0005 -.002
9/16	34-68	.0005 -.002	68-104	.0005 -.002	104-136	.0005 -.002	136-272	.0005 -.003	272-412	.001 -.003	412-543	.001 -.004	543-678	.001 -.004	678-1356	.0005 -.004	1356-4071	.0005 -.003
5/8	31-61	.0005 -.002	61-92	.0005 -.002	92-122	.0005 -.002	122-244	.001 -.004	244-367	.001 -.004	367-489	.001 -.004	489-611	.001 -.004	611-1222	.0005 -.004	1222-3666	.0005 -.003
11/16	28-56	.0005 -.002	56-84	.0005 -.002	84-111	.0005 -.002	111-222	.001 -.004	222-337	.001 -.004	337-444	.001 -.004	444-555	.001 -.004	555-1110	.0005 -.004	1110-3330	.0005 -.003
3/4	26-51	.0005 -.002	51-76	.0005 -.002	76-102	.001 -.004	102-203	.001 -.004	203-306	.001 -.004	306-407	.001 -.004	407-509	.002 -.006	509-1018	.001 -.006	1018-3054	.001 -.004
13/16	24-47	.001 -.003	47-71	.001 -.003	71-94	.001 -.004	94-189	.001 -.004	189-284	.001 -.004	284-379	.002 -.006	379-469	.002 -.006	469-938	.001 -.006	938-2814	.001 -.004
7/8	22-44	.001 -.003	44-65	.001 -.003	65-87	.001 -.004	87-175	.001 -.004	175-262	.002 -.006	262-349	.002 -.006	349-436	.002 -.006	436-872	.001 -.006	872-2616	.001 -.004
15/16	20-40	.001 -.003	40-62	.001 -.003	62-81	.001 -.004	81-163	.001 -.004	163-246	.002 -.006	246-326	.002 -.006	326-407	.002 -.006	407-814	.001 -.006	514-2442	.001 -.004
1	19-38	.001 -.003	38-58	.001 -.003	58-76	.001 -.004	76-153	.002 -.006	153-229	.002 -.006	229-306	.002 -.006	306-382	.002 -.006	382-764	.002 UP	764-2292	.002 UP
1 1/8	34	.0015 -.004	34-51	.0015 -.004	51-68	.0015 -.005	68-136	.002 -.006	136-204	.002 -.006	204-272	.002 -.006	272-340	.003 UP	340-680	.002 UP	680-2040	.002 UP
1 1/4	31	.0015 -.004	31-46	.0015 -.004	46-61	.0015 -.005	61-122	.002 -.006	122-183	.002 -.006	183-244	.003 UP	244-306	.003 UP	306-612	.002 UP	612-1836	.002 UP
1 3/8	28	.0015 -.004	28-42	.0015 -.004	42-55	.0015 -.005	55-111	.002 -.006	111-167	.003 UP	167-222	.003 UP	222-278	.003 UP	278-556	.002 UP	556-1668	.002 UP
1 1/2	26	.0015 -.004	26-38	.0015 -.004	38-51	.002 UP	51-102	.003 UP	102-153	.003 UP	153-204	.003 UP	204-255	.003 UP	255-510	.003 UP	510-1530	.002 UP
1 5/8	24	.002 UP	35	.002 UP	35-47	.002 UP	47-94	.003 UP	94-141	.003 UP	141-188	.003 UP	188-235	.003 UP	235-470	.003 UP	470-1410	.002 UP
1 3/4	22	.002 UP	32	.002 UP	32-43	.002 UP	43-87	.003 UP	87-131	.003 UP	131-175	.003 UP	175-218	.003 UP	218-436	.003 UP	436-1308	.002 UP
1 7/8	20	.002 UP	30	.002 UP	30-40	.003 UP	40-81	.003 UP	81-122	.003 UP	122-163	.003 UP	163-204	.003 UP	204-408	.003 UP	408-1224	.003 UP
2	19	.002 UP	29	.003 UP	29-38	.003 UP	38-76	.003 UP	76-115	.003 UP	115-153	.003 UP	153-191	.003 UP	191-382	.003 UP	382-1146	.003 UP
2 1/8	18	.003 UP	28	.003 UP	36	.003 UP	36-72	.003 UP	72-108	.003 UP	108-144	.003 UP	144-179	.003 UP	179-358	.003 UP	358-1074	.003 UP
2 1/4	17	.003 UP	26	.003 UP	34	.003 UP	34-68	.003 UP	68-102	.003 UP	103-136	.003 UP	136-170	.003 UP	170-340	.003 UP	340-1020	.003 UP
2 3/8	16	.003 UP	25	.003 UP	32	.003 UP	32-64	.003 UP	64-97	.003 UP	97-128	.003 UP	128-161	.003 UP	161-322	.003 UP	322-966	.003 UP
2 1/2	15	.003 UP	23	.003 UP	30	.003 UP	30-61	.003 UP	61-92	.003 UP	92-122	.003 UP	122-153	.003 UP	153-306	.003 UP	306-918	.003 UP
2 5/8	15	.003 UP	22	.003 UP	29	.003 UP	29-58	.003 UP	58-88	.003 UP	88-116	.003 UP	116-145	.003 UP	145-290	.003 UP	290-870	.003 UP
2 3/4	14	.003 UP	21	.003 UP	28	.003 UP	28-56	.003 UP	56-83	.003 UP	83-111	.003 UP	111-139	.003 UP	139-278	.003 UP	278-834	.003 UP
2 7/8	14	.003 UP	20	.003 UP	27	.003 UP	27-53	.003 UP	53-80	.003 UP	80-106	.003 UP	106-132	.003 UP	132-264	.003 UP	264-792	.003 UP
3	13	.003 UP	19	.003 UP	26	.003 UP	26-51	.003 UP	51-76	.003 UP	76-102	.003 UP	102-127	.003 UP	127-154	.003 UP	254-762	.003 UP

Note: All speed and feed data are suggested starting points. They may be increased or decreased depending on machine condition, depth of cut, finish required, coolant, etc.

LAMPIRAN 9
Kode Program 4-axis CNC Milling DAHLIH MCV 1020-BA

```
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LAMPIRAN 10
Surat Keterangan Pengukuran di Lab. Metrologi Industri UB

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
FAKULTAS TEKNIK JURUSAN MESIN UNIVERSITAS BRAWIJAYA
LABORATORIUM METROLOGI INDUSTRI
Jl. Mayjen Haryono 167 Telp. 553286 Pes. 216 Malang 65145

Lampiran : 1 lembar

SURAT KETERANGAN

Nomer. 001/UN10.6/LK/MI/2015

Yang bertanda tangan dibawah ini adalah kepala laboratorium Metrologi Industri Jurusan Teknik Mesin Fakultas Teknik Universitas Brawijaya, menerangkan bahwa mahasiswa :

Nama : SULTHAN ADIB
NIM : 125060200111080
Jurusan : Teknik Mesin, Fakultas Teknik - Universitas Brawijaya

Telah melaksanakan penelitian pengukuran kekasaran permukaan hasil proses bubut pada *Surface Roughness Tester SJ-301* dan pengolahan data dengan judul skripsi :
"PENGARUH *SPINDLE SPEED* DAN *FEED RATE* TERHADAP *BOTTOM SURFACE ROUGHNESS* PADA PROSES *MILLING* CNC 4 AXIS"
di Laboratorium Metrologi Industri Jurusan Teknik Mesin Fakultas Teknik Universitas Brawijaya.

Malang, 15 Januari 2015
Ka.Lab. Metrologi Industri

Asisten Pendamping :

Mochamat Kurniawan
Nim. 1110623034

Ir. Hastono Wijaya, MT.
NIP. 19601204 198601 1002

LAMPIRAN 11

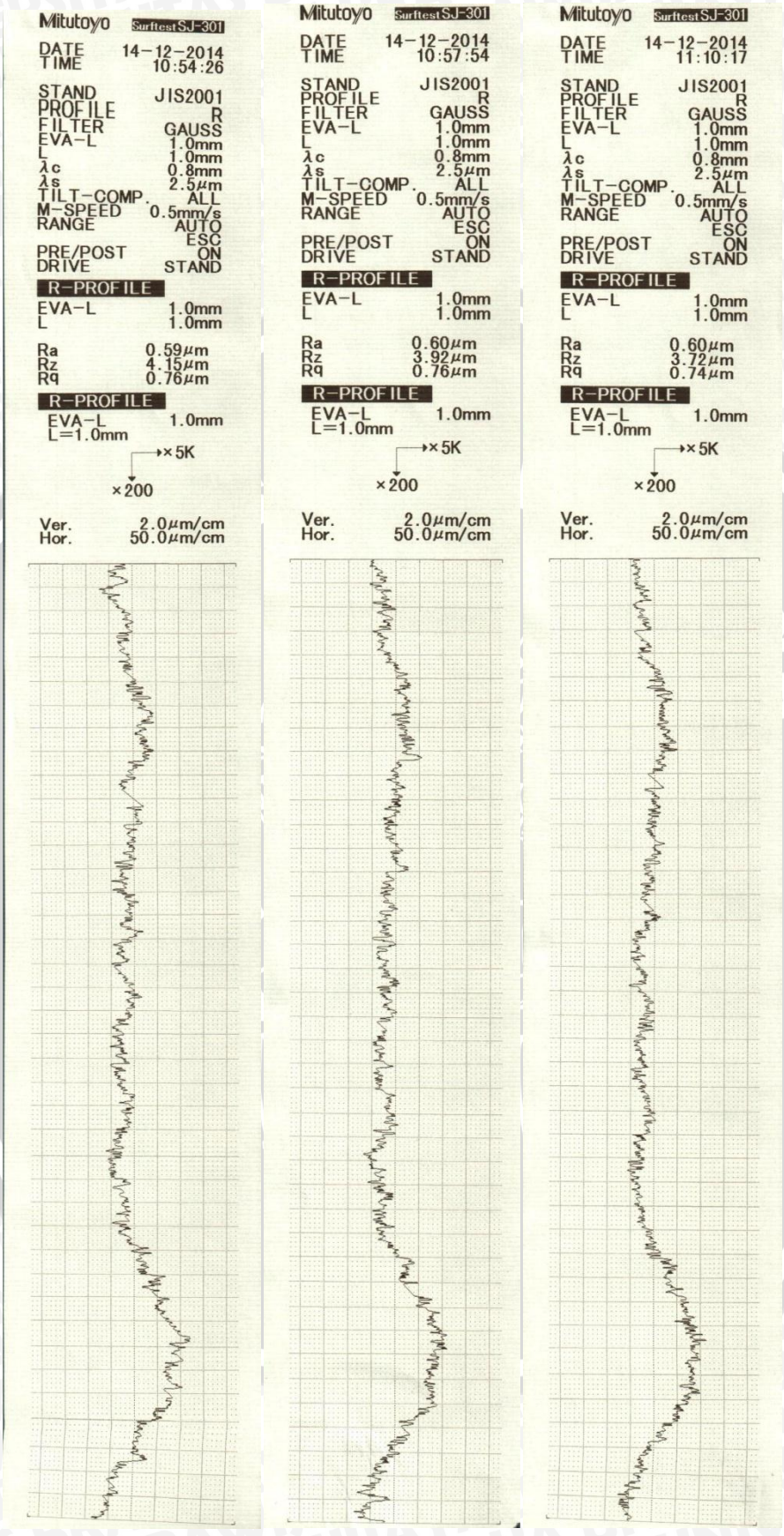
Hasil Pengukuran Kekasaran Permukaan

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
FAKULTAS TEKNIK JURUSAN MESIN UNIVERSITAS BRAWIJAYA
LABORATORIUM METROLOGI INDUSTRI
Jl. Mayjen Haryono 167 Telp. 553286 Pes. 216 Malang 65145

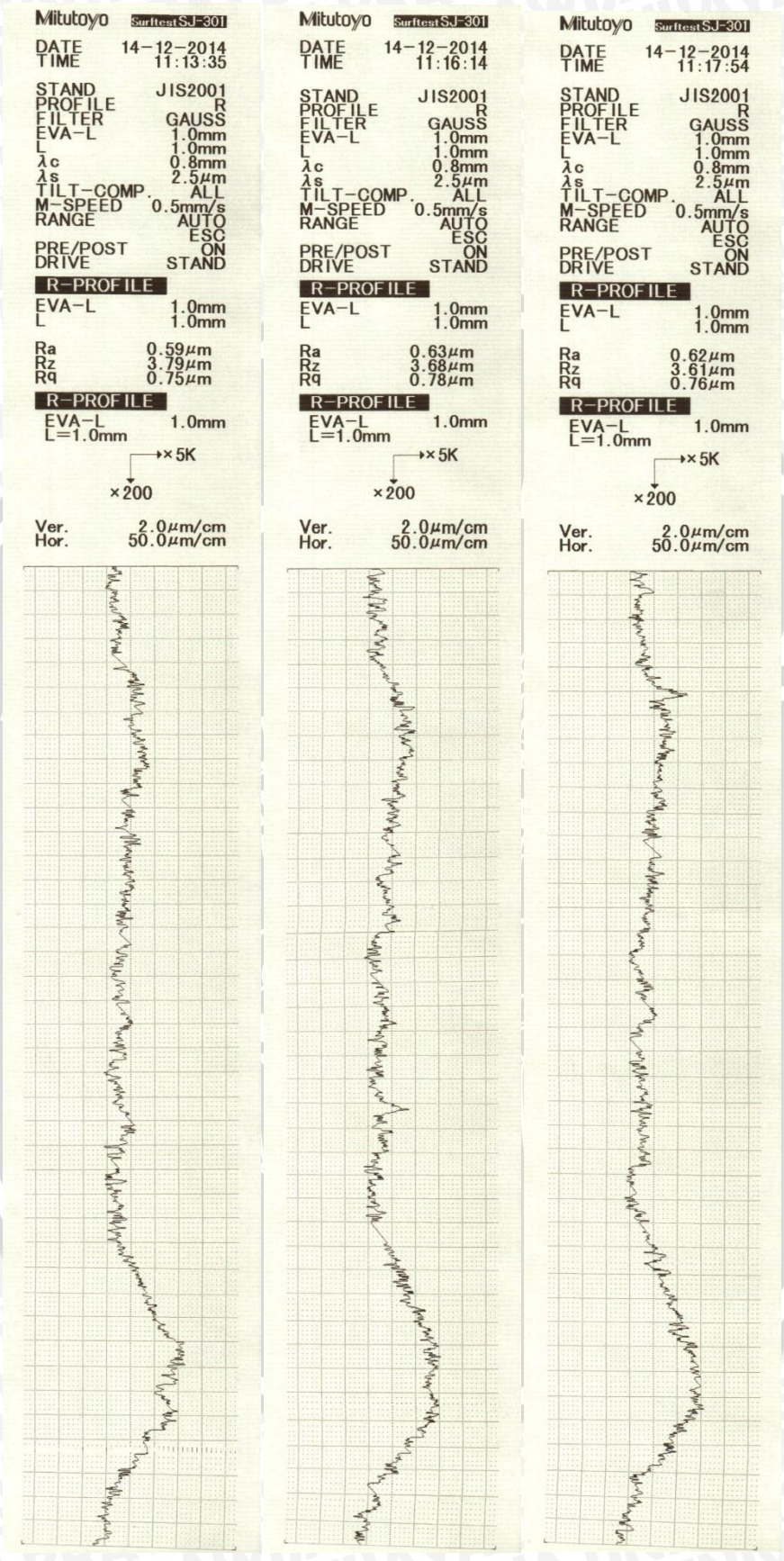
DATA HASIL PENGUKURAN

No.	*Spindel speed* (rpm)	*feed rate* (mm/min)	Pengulangan	*Surface Roughness* (µm)
1	6000	24	1	0,59
			2	0,60
			3	0,60
		48	1	0,59
			2	0,62
			3	0,63
		72	1	0,60
			2	0,61
			3	0,65
2	5000	24	1	0,62
			2	0,62
			3	0,63
		48	1	0,61
			2	0,62
			3	0,66
		72	1	0,63
			2	0,64
			3	0,64
3	4000	24	1	0,63
			2	0,65
			3	0,65
		48	1	0,64
			2	0,64
			3	0,66
		72	1	0,65
			2	0,65
			3	0,67

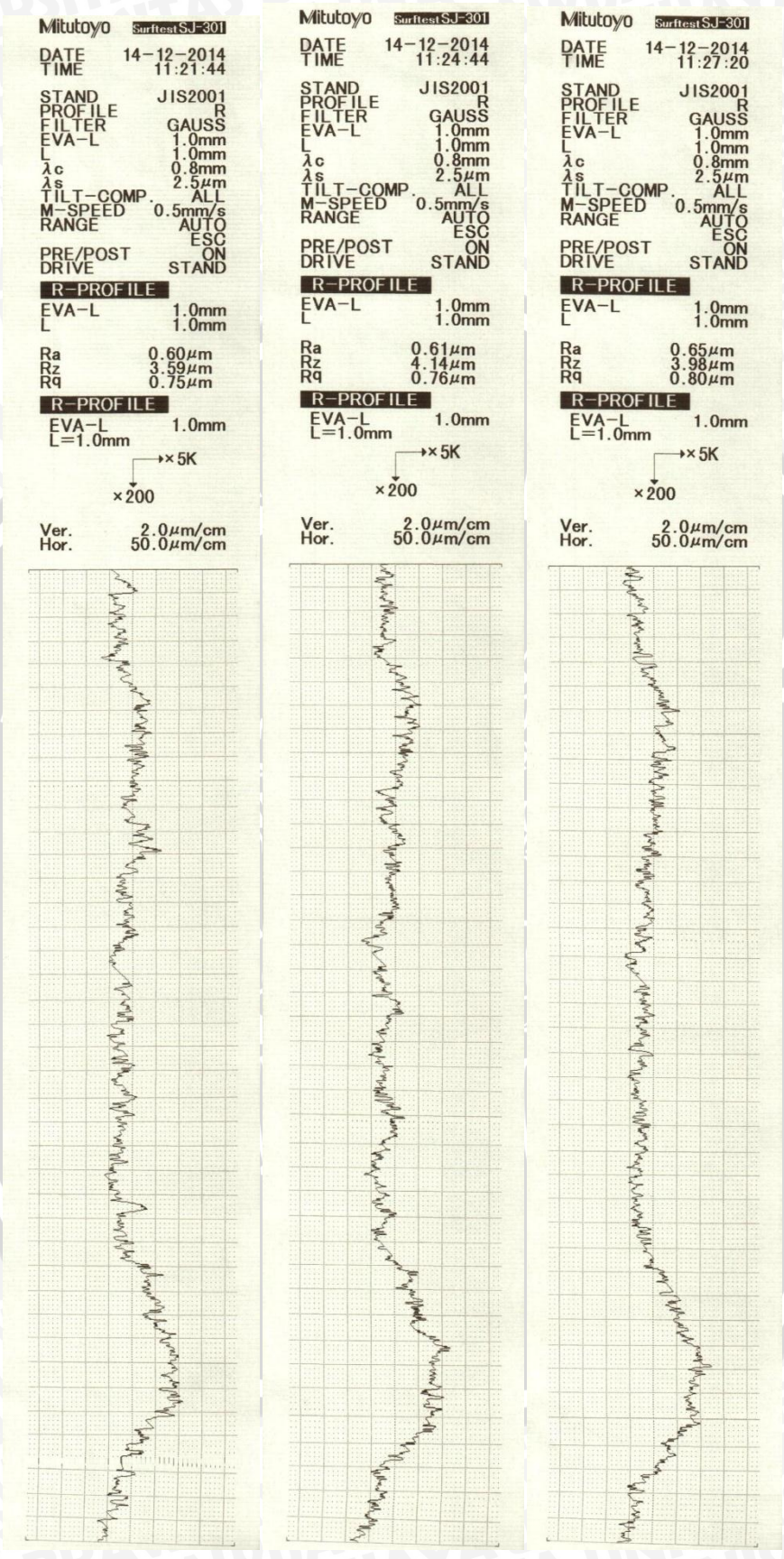
Spindle Speed 6000 rpm, feed rate 24 mm/menit



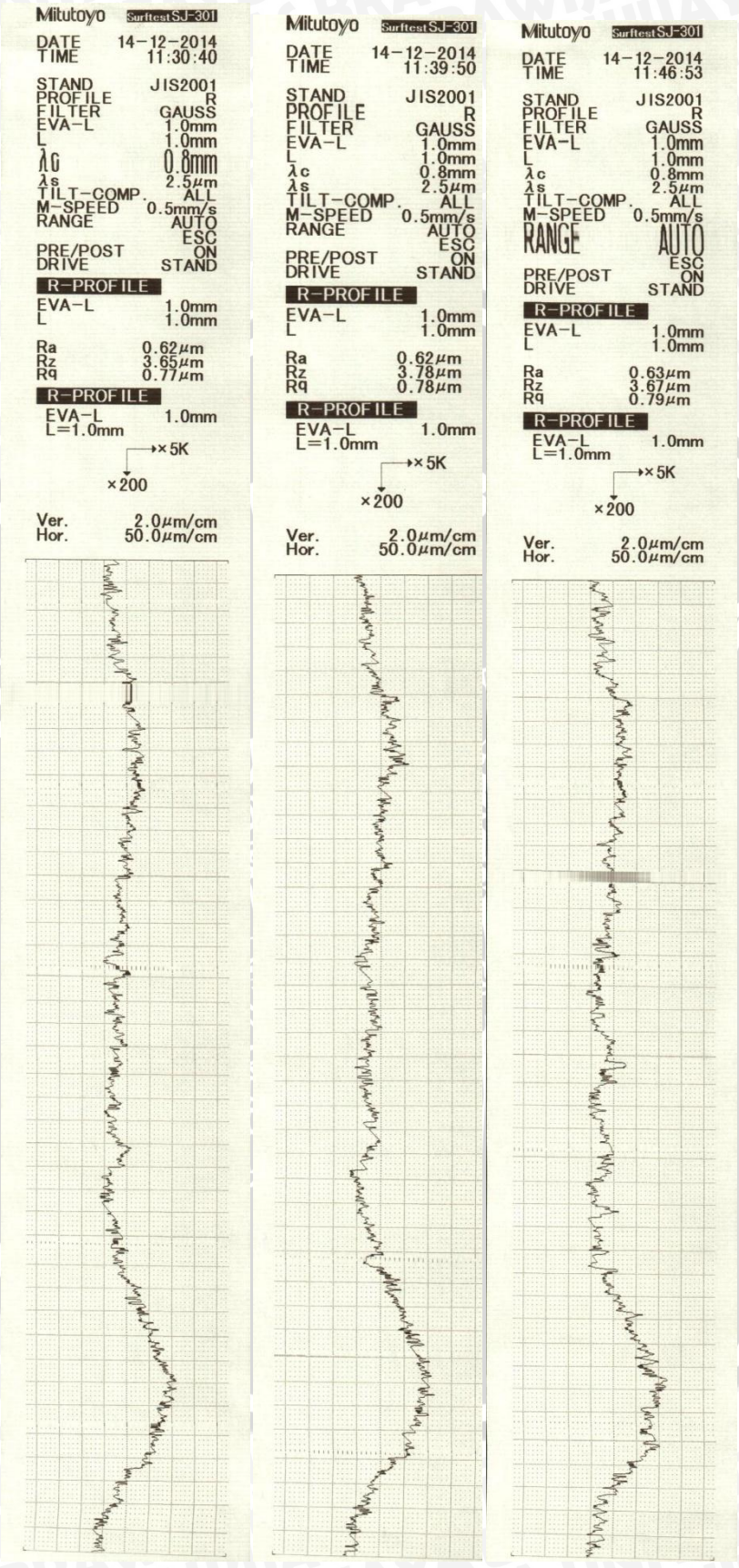
Spindle Speed 6000 rpm, feed rate 48 mm/menit



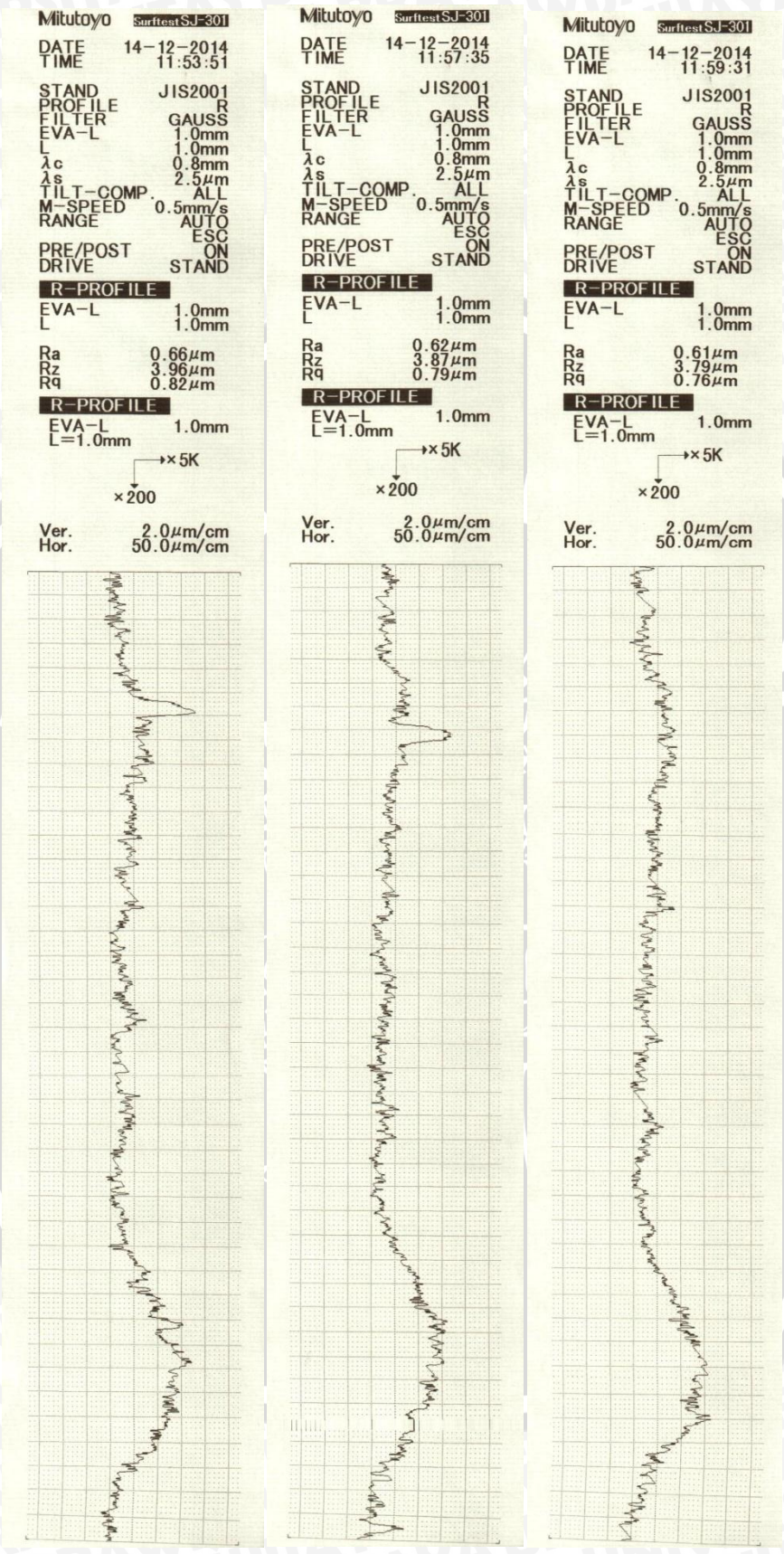
Spindle Speed 6000 rpm, feed rate 72 mm/menit



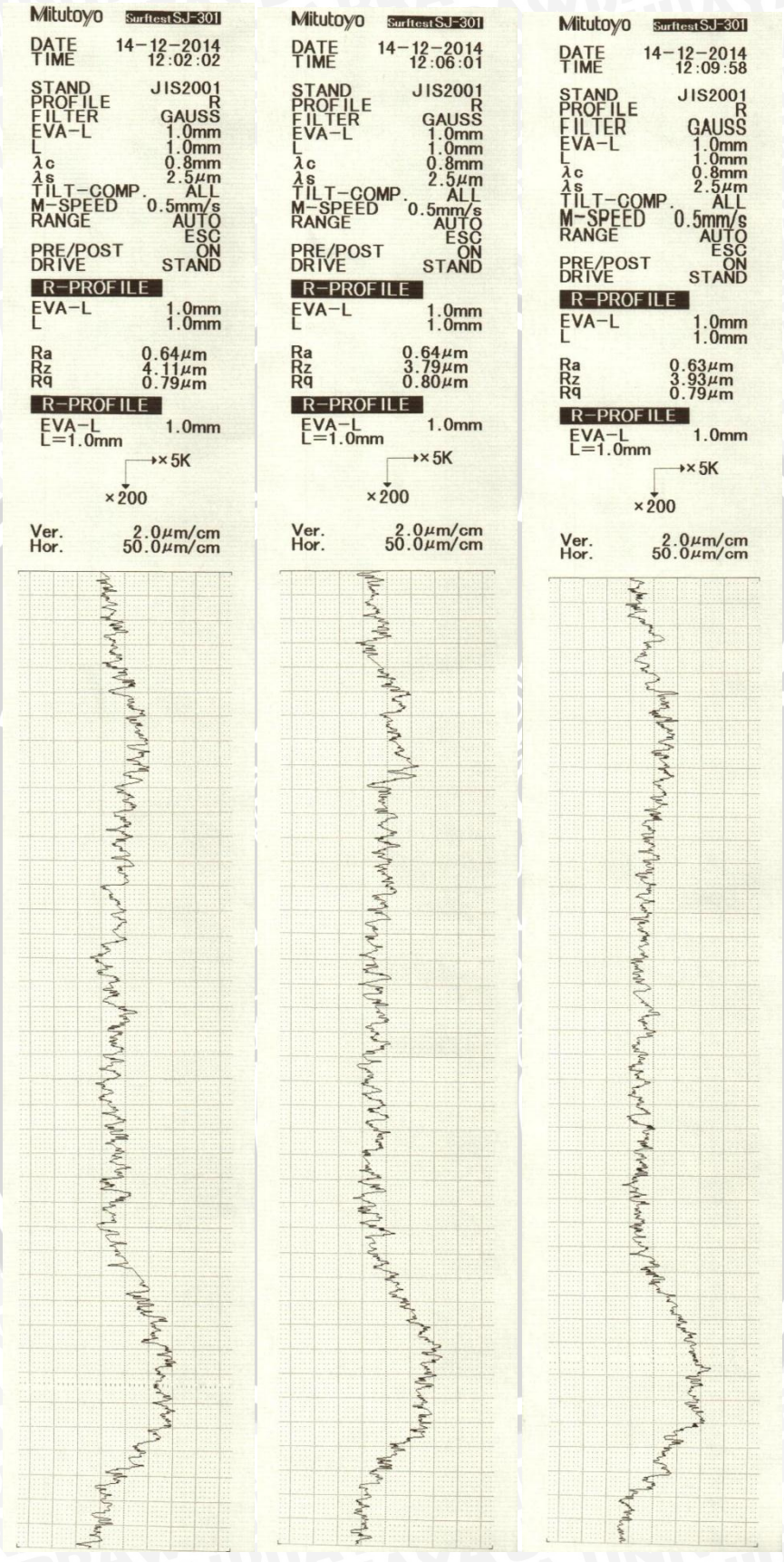
Spindle Speed 5000 rpm, feed rate 24 mm/menit



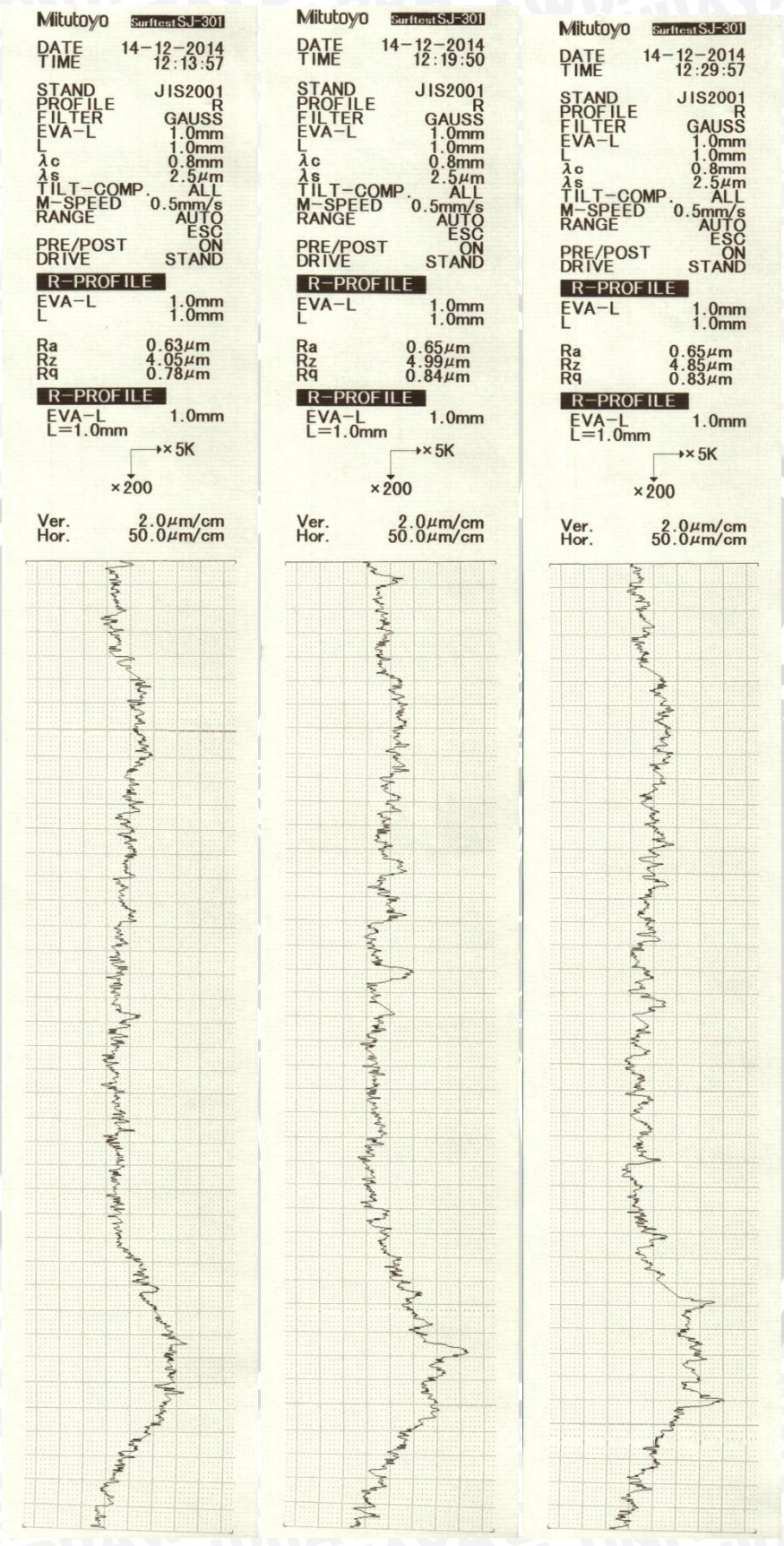
Spindle Speed 5000 rpm, feed rate 48 mm/menit



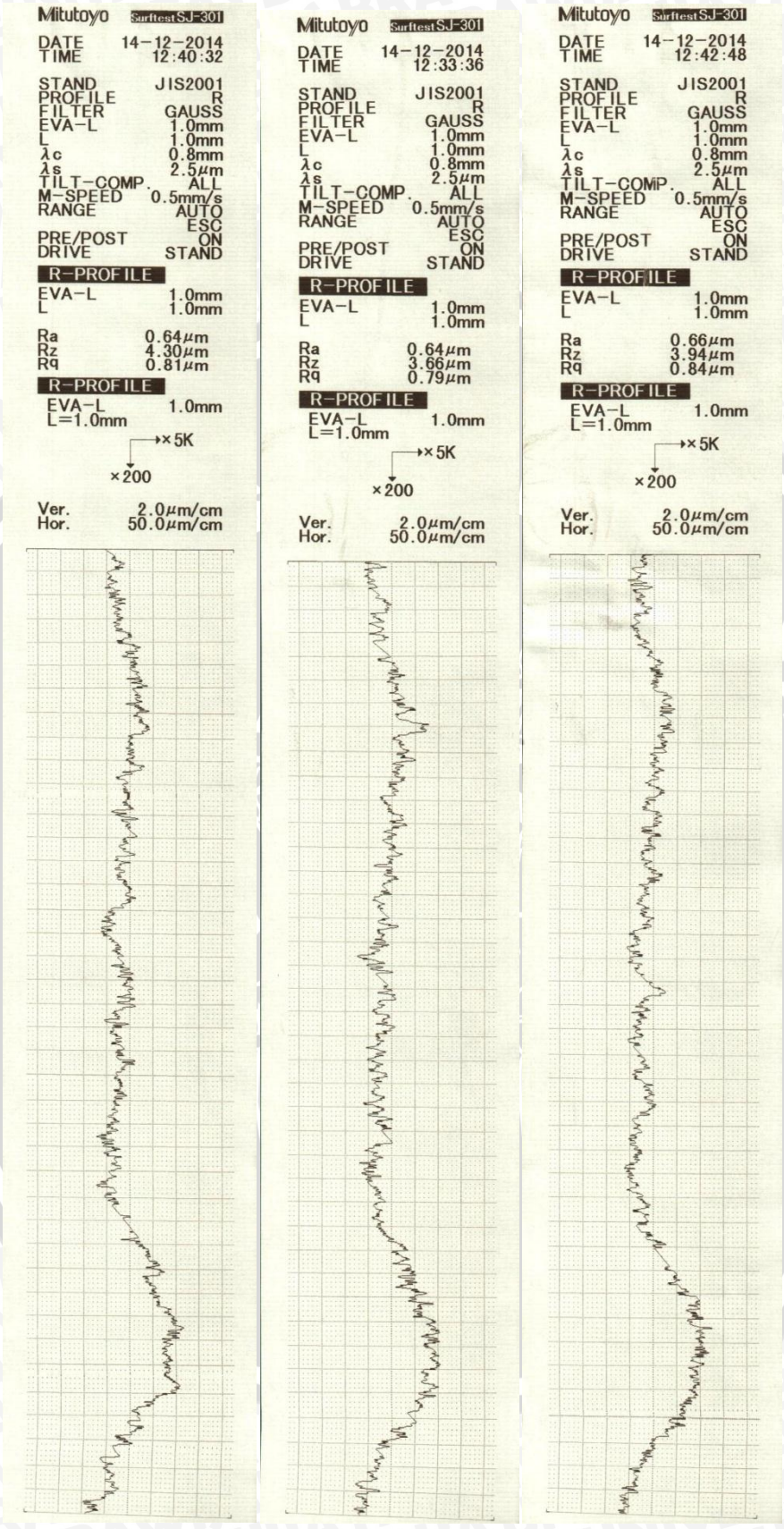
Spindle Speed 5000 rpm, feed rate 72 mm/menit



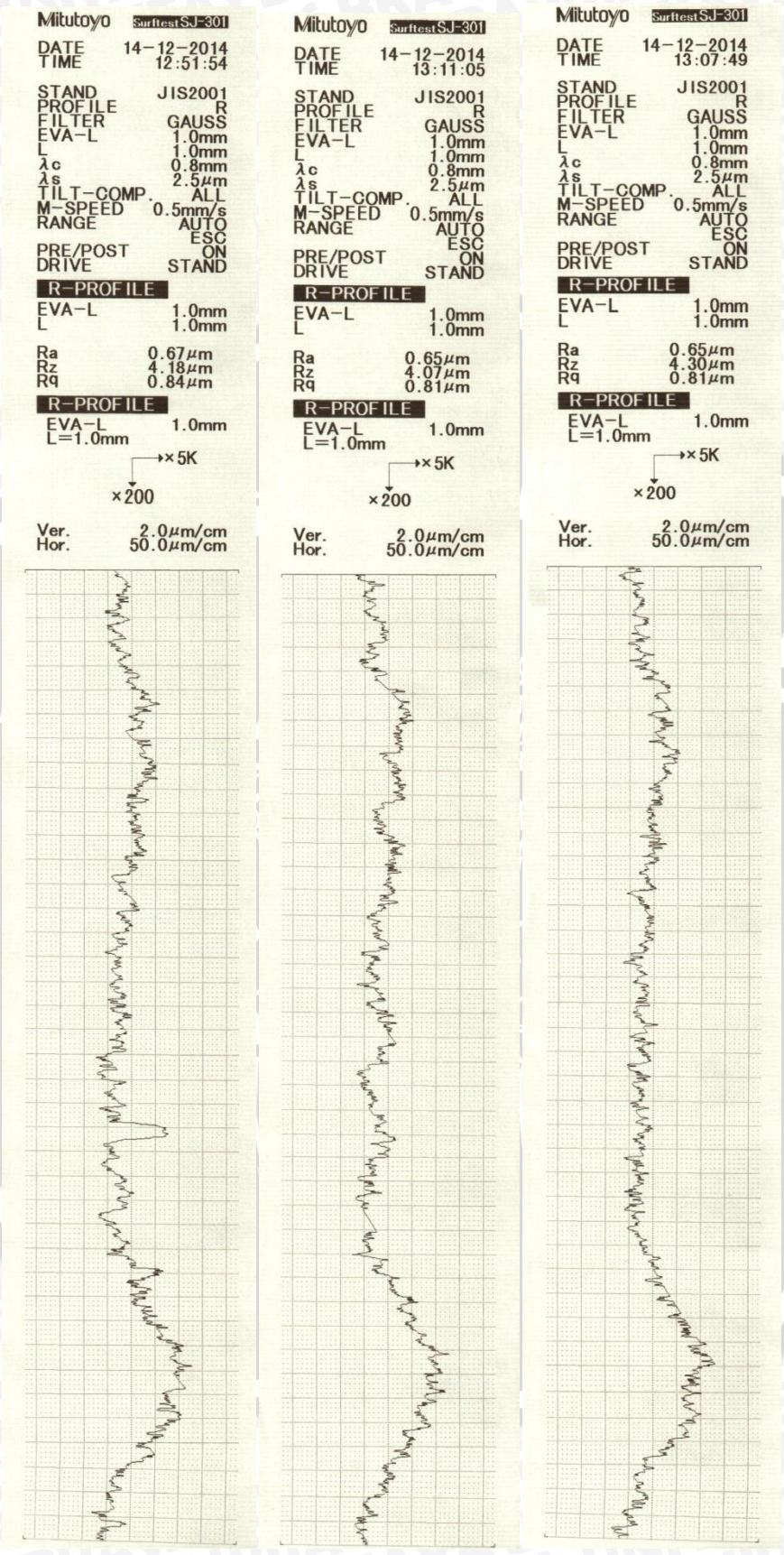
Spindle Speed 4000 rpm, feed rate 24 mm/menit



Spindle Speed 4000 rpm, feed rate 48 mm/menit



Spindle Speed 4000 rpm, feed rate 72 mm/menit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STAND JIS2001
PROFILE R
FILTER GAUSS
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L 1.0mm
λc 0.8mm
λs 2.5μm
TILT-COMP. ALL
M-SPEED 0.5mm/s
RANGE AUTO
ESC
PRE/POST ON
DRIVE STAND
R-PROFILE
EVA-L 1.0mm
L 1.0mm
Ra 0.67μm
Rz 4.18μm
Rq 0.84μm
R-PROFILE
EVA-L 1.0mm
L=1.0mm
×5K
×200
Ver. 2.0μm/cm
Hor. 50.0μm/cm
Mitutoyo Surftest SJ-301
DATE 14-12-2014
TIME 13:11:05
STAND JIS2001
PROFILE R
FILTER GAUSS
EVA-L 1.0mm
L 1.0mm
λc 0.8mm
λs 2.5μm
TILT-COMP. ALL
M-SPEED 0.5mm/s
RANGE AUTO
ESC
PRE/POST ON
DRIVE STAND
R-PROFILE
EVA-L 1.0mm
L 1.0mm
Ra 0.65μm
Rz 4.07μm
Rq 0.81μm
R-PROFILE
EVA-L 1.0mm
L=1.0mm
×5K
×200
Ver. 2.0μm/cm
Hor. 50.0μm/cm
Mitutoyo Surftest SJ-301
DATE 14-12-2014
TIME 13:07:49
STAND JIS2001
PROFILE R
FILTER GAUSS
EVA-L 1.0mm
L 1.0mm
λc 0.8mm
λs 2.5μm
TILT-COMP. ALL
M-SPEED 0.5mm/s
RANGE AUTO
ESC
PRE/POST ON
DRIVE STAND
R-PROFILE
EVA-L 1.0mm
L 1.0mm
Ra 0.65μm
Rz 4.30μm
Rq 0.81μm
R-PROFILE
EVA-L 1.0mm
L=1.0mm
×5K
×200
Ver. 2.0μm/cm
Hor. 50.0μm/cm

LAMPIRAN 12

Perhitungan Gaya Potong

1. Untuk Spindle Speed 6000 rpm.
   a. *Feed Rate 24* mm/min

$$f_z = \frac{24}{6000.2}$$
$$f_z = 0{,}002\ mm/min$$
$$\theta = arc\ tan \frac{0{,}002}{12{,}9 - 2}$$
$$\theta = 0{,}010°$$
$$h = tan.\ 0{,}010.2 + \frac{12{,}9 - 2}{\cos 0{,}010} - (12{,}9 - 2)$$
$$h = 1{,}103\ mm$$
$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$
$$\phi = arc\ tan \frac{cos\ 30}{1{,}103 - sin\ 30}$$
$$\phi = 55{,}132°$$
$$F_t = 207.2.1{,}103 \frac{\cos(25 - 30)}{\sin 55{,}132 \cos(\ 55{,}132 + \ 25 - \ 30)}$$
$$F_t = 9{,}268\ N$$

2. Untuk Spindle Speed 6000 rpm.
   b. *Feed Rate 48* mm/min

$$f_z = \frac{48}{6000.2}$$
$$f_z = 0{,}004\ mm/min$$
$$\theta = arc\ tan \frac{0{,}004}{12{,}9 - 2}$$
$$\theta = 0{,}019°$$
$$h = tan.\ 0{,}019.2 + \frac{12{,}9 - 2}{\cos 0{,}021} - (12{,}9 - 2)$$
$$h = 2{,}207\ mm$$
$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$
$$\phi = arc\ tan \frac{cos\ 30}{2{,}207 - sin\ 30}$$
$$\phi = 26{,}905°$$
$$F_t = 207.2.2{,}207 \frac{\cos(25 - 30)}{\sin 26{,}905 \cos(\ 26{,}905 + \ 25 - \ 30)}$$
$$F_t = 29{,}567\ N$$

3. Untuk Spindle Speed 6000 rpm.
   c. *Feed Rate 72* mm/min

$$f_z = \frac{72}{6000.2}$$
$$f_z = 0{,}006\ mm/min$$
$$\theta = arc\ tan \frac{0{,}002}{12{,}9 - 2}$$
$$\theta = 0{,}029°$$

$$h = tan.\,0{,}029.2 + \frac{12{,}9-2}{\cos 0{,}029} - (12{,}9-2)$$

$$h = 3{,}309\ mm$$

$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$

$$\phi = arc\ tan \frac{cos\ 30}{3{,}309 - sin\ 30}$$

$$\phi = 17{,}132°$$

$$F_t = 207.2.3{,}309 \frac{\cos(25-30)}{\sin 17{,}132 \cos(\ 17{,}132 + \ 25 - \ 30)}$$

$$F_t = 66{,}524N$$

4. Untuk Spindle Speed 5000 rpm.

d. Feed Rate 24 mm/min

$$f_z = \frac{24}{5000.2}$$

$$f_z = 0{,}002\ mm/min$$

$$\theta = arc\ tan \frac{0{,}002}{12{,}9-2}$$

$$\theta = 0{,}012°$$

$$h = tan.\,0{,}012.2 + \frac{12{,}9-2}{\cos 0{,}012} - (12{,}9-2)$$

$$h = 1{,}324\ mm$$

$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$

$$\phi = arc\ tan \frac{cos\ 30}{1{,}324 - sin\ 30}$$

$$\phi = 46{,}421°$$

$$F_t = 207.2.1{,}324 \frac{\cos(25-30)}{\sin 46{,}421 \cos(\ 46{,}421 + \ 25 - \ 30)}$$

$$F_t = 11{,}994N$$

5. Untuk Spindle Speed 5000 rpm.

e. Feed Rate 48 mm/min

$$f_z = \frac{48}{5000.2}$$

$$f_z = 0{,}005\ mm/min$$

$$\theta = arc\ tan \frac{0{,}005}{12{,}9-2}$$

$$\theta = 0{,}023°$$

$$h = tan.\,0{,}023.2 + \frac{12{,}9-2}{\cos 0{,}023} - (12{,}9-2)$$

$$h = 2{,}648\ mm$$

$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$

$$\phi = arc\ tan \frac{cos\ 30}{2{,}648 - sin\ 30}$$

$$\phi = 21{,}960°$$

$$F_t = 207.2.2{,}648 \frac{\cos(25-30)}{\sin 21{,}960 \cos(\ 21{,}960 + \ 25 - \ 30)}$$

$$F_t = 42{,}364N$$

6. Untuk Spindle Speed 5000 rpm.
   f. Feed Rate 72 mm/min

$$f_z = \frac{72}{5000.2}$$
$$f_z = 0{,}007\ mm/min$$
$$\theta = arc\ tan \frac{0{,}007}{12{,}9 - 2}$$
$$\theta = 0{,}035°$$
$$h = tan.\,0{,}035.2 + \frac{12{,}9 - 2}{\cos 0{,}035} - (12{,}9 - 2)$$
$$h = 3{,}971\ mm$$
$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$
$$\phi = arc\ tan \frac{cos\ 30}{3{,}971 - sin\ 30}$$
$$\phi = 14{,}010°$$
$$F_t = 207.2.3{,}971 \frac{\cos(25 - 30)}{\sin 14{,}010 \cos(\ 14{,}010 + \ 25 - \ 30)}$$
$$F_t = 96{,}605N$$

7. Untuk Spindle Speed 4000 rpm.
   g. Feed Rate 24 mm/min

$$f_z = \frac{24}{4000.2}$$
$$f_z = 0{,}003\ mm/min$$
$$\theta = arc\ tan \frac{0{,}003}{12{,}9 - 2}$$
$$\theta = 0{,}014°$$
$$h = tan.\,0{,}014.2 + \frac{12{,}9 - 2}{\cos 0{,}014} - (12{,}9 - 2)$$
$$h = 1{,}655\ mm$$
$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$
$$\phi = arc\ tan \frac{cos\ 30}{1{,}655 - sin\ 30}$$
$$\phi = 36{,}861°$$
$$F_t = 207.2.1{,}655 \frac{\cos(25 - 30)}{\sin 36{,}861 \cos(\ 36{,}861 + \ 25 - \ 30)}$$
$$F_t = 17{,}325N$$

8. Untuk Spindle Speed 4000 rpm.
   h. Feed Rate 48 mm/min

$$f_z = \frac{48}{4000.2}$$
$$f_z = 0{,}006\ mm/min$$

$$\theta = arc\ tan \frac{0{,}006}{12{,}9 - 2}$$
$$\theta = 0{,}029°$$
$$h = tan.\ 0{,}029.2 + \frac{12{,}9 - 2}{\cos 0{,}029} - (12{,}9 - 2)$$
$$h = 3{,}309\ mm$$
$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$
$$\phi = arc\ tan \frac{cos\ 30}{3{,}309 - sin\ 30}$$
$$\phi = 17{,}132°$$
$$F_t = 207.2.3{,}309 \frac{\cos(25 - 30)}{\sin 17{,}132 \cos(\ 17{,}132 + \ 25 - \ 30)}$$
$$F_t = 66{,}524N$$

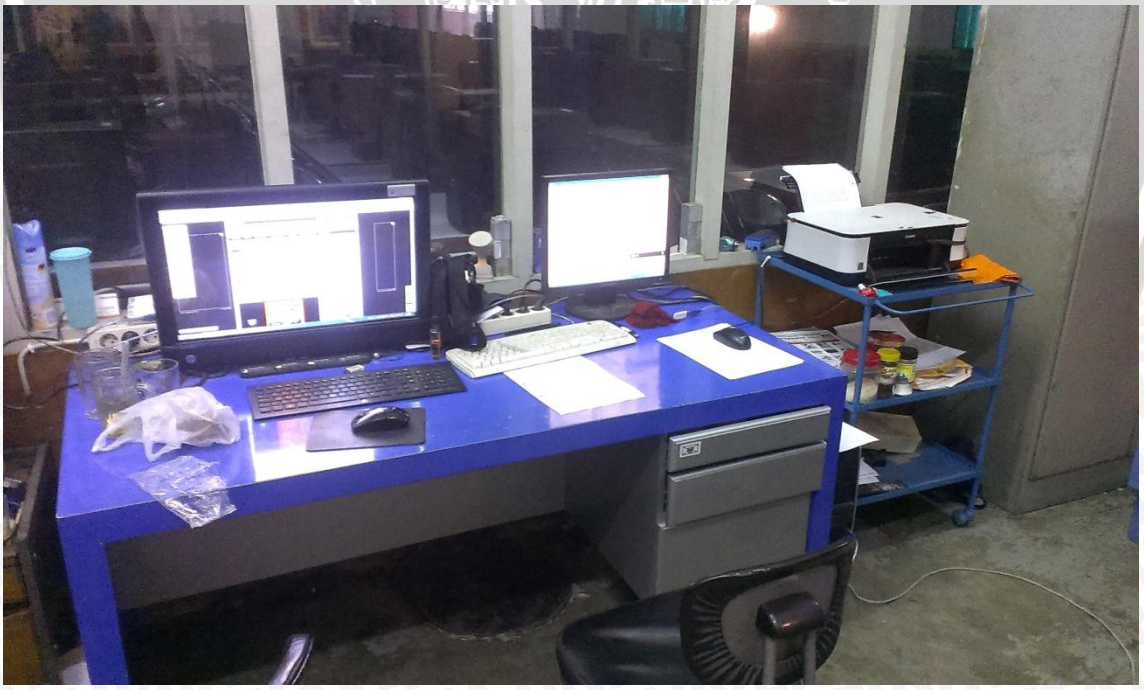
9. Untuk Spindle Speed 4000 rpm.
   i. Feed Rate 72 mm/min

$$f_z = \frac{72}{4000.2}$$
$$f_z = 0{,}009\ mm/min$$
$$\theta = arc\ tan \frac{0{,}009}{12{,}9 - 2}$$
$$\theta = 0{,}043°$$
$$h = tan.\ 0{,}043.2 + \frac{12{,}9 - 2}{\cos 0{,}043} - (12{,}9 - 2)$$
$$h = 4{,}962\ mm$$
$$\tan \phi = \frac{\cos 30}{h - \sin 30}$$
$$\phi = arc\ tan \frac{cos\ 30}{4{,}962 - sin\ 30}$$
$$\phi = 10{,}983°$$
$$F_t = 207.2.4{,}962 \frac{\cos(25 - 30)}{\sin 10{,}983 \cos(\ 10{,}983 + \ 25 - \ 30)}$$
$$F_t = 152{,}776N$$

LAMPIRAN 13

Dokumentasi Kegiatan Penelitian

Gambar foto: 4-axis CNC Milling Machine



Gambar foto: Personal Komputer

Gambar foto: Proses Milling

Gambar foto: Cutter Milling Flat End Mills KESTAG

Gambar foto: Spesimen Uji

Gambar foto: Pengukuran Kekasaran Permukaan