

**STUDI EKSPERIMENTAL PENGARUH PERUBAHAN
DIMENSI DAN MATERIAL BEARING
TERHADAP PERFORMANCE TURBINE ANGIN
SUMBU VERTIKAL**

TUGAS AKHIR



Oleh :

YACOBUS FERDINAND
NIT: 30418047

**PROGRAM STUDI DIPLOMA 3 TEKNIK PESAWAT UDARA
POLITEKNIK PENERBANGAN SURABAYA**

2021
**STUDI EKSPERIMENTAL PENGARUH PERUBAHAN
DIMENSI DAN MATERIAL BEARING
TERHADAP PERFORATION ICE TURBINE ANGIN
SUMBU VERTIKAL**

TUGAS AKHIR

Diajukan sebagai Salah Satu Syarat Memperoleh Gelar Ahli Madya (A.Md.)
pada Program Studi Diploma 3 Teknik Pesawat Udara



Oleh:
YACOBUS FERDINAND
NIT: 30418047

**PROGRAM STUDI DIPLOMA 3 TEKNIK PESAWAT UDARA
POLITEKNIK PENERBANGAN SURABAYA**

2021

HALAMAN PERSETUJUAN

**“STUDI EKSPERIMENTAL PENGARUH PERUBAHAN DIMENSI DAN
MATERIAL BEARING TERHADAP *PERFORMANCE TURBINE ANGIN*
SUMBU VERTIKAL”**

Oleh:

YACOBUS FERDINAND
NIT: 30418047

Disetujui untuk diujikan pada:
Surabaya, 19 Agustus 2021

Pembimbing I : GUNAWAN SAKTI, S.T., M.T.
NIP. 19881001 200912 1 003



Pembimbing II : SUKAHIR, S.Si.T., M.T.
NIP. 19740714 199803 1 001

HALAMAN PENGESAHAN

**“STUDI EKSPERIMENTAL PENGARUH PERUBAHAN DIMENSI DAN
MATERIAL BEARING TERHADAP PERFORMANCE TURBINE ANGIN
SUMBU VERTIKAL”**

Oleh:

YACOBUS FERDINAND
NIT: 30418047

Telah dipertahankan dan dinyatakan lulus pada Sidang Tugas Akhir Program
Pendidikan Diploma III Teknik Pesawat Udara
Politeknik Penerbangan Surabaya
Pada tanggal: 19 Agustus 2021

Panitia Pengaji:

1. Ketua : Dr. SETYO HARIYADI, S.P., S.T., M.T.
NIP. 19790824 200912 1 001

2. Sekretaris : Ir. AULIA REGIA, S.P., M.M.
NIP. 19780626 200912 1 001

3. Anggota : GUNAWAN SAKTI, S.T., M.T.
NIP. 19881001 200912 1 003

Ketua Program Studi
D.III TEKNIK PESAWAT UDARA

Ir. BAMBANG JUNIPITOYO, S.T., M.T.
NIP. 19780626 200912 1 001

ABSTRAK

STUDI EKSPERIMENTAL PENGARUH PERUBAHAN DIMENSI DAN MATERIAL BEARING TERHADAP PERFORMANCE TURBINE ANGIN SUMBU VERTIKAL

Oleh:
YACOBUS FERDINAND
NIT: 30418047

Bearing merupakan element mesin yang sering digunakan, tidak hanya pada bidang *automotive*, namun juga dimanfaatkan di bidang rumah tangga dan industri. Fungsi dari *bearing* yaitu untuk menumpu sebuah poros agar poros dapat berputar tanpa mengalami gesekan yang berlebihan.

Dalam penelitian kali ini, akan dilaksanakan penelitian terkait pengaruh ketebalan *bearing* terhadap putaran poros turbin angin yang dilaksanakan dengan menempatkan *bearing* pada sebuah turbin angin sumbu vertikal tipe *Savonius* kemudian diputar menggunakan aliran *linear eksternal* yang berasal dari *exhaust wind tunnel* dengan kecepatan aliran udara 5 m/s. Untuk pengukuran dengan menggunakan *Torque Transducer* tipe M425 yang memiliki *torque tolerance* 0-10Nm dan *sample rate* dari 1 sps hingga 4.000 sps. *M425 torque transducer* memiliki 14 rentang torsi standar, serta dapat mengatasi perpindahan parallel 0.18 mm dan deviasi sudut 0,06°.

Dalam penelitian kali ini, dilihat bagaimana pengaruh ketebalan sebuah bearing terhadap performa putaran poros sebuah turbin angin tipe sumbu vertikal yaitu berupa daya, torsi, dan RPM. Hasil dalam penelitian ini didapat RPM tertinggi yaitu 383 RPM, torsi tertinggi yaitu 0,0550 Nm, daya tertinggi yaitu 1,050 Watt, juga Cp dan Cm yaitu 0,143 dan 0,235.

Kata kunci : *Bearing, Savonius, Wind Tunnel, Turbine, Torque Transducer*

ABSTRACT

EXPERIMENTAL STUDY OF THE EFFECT OF CHANGES IN DIMENSION AND MATERIAL BEARING ON THE PERFORMANCE OF VERTICAL AXIS WIND TURBINE

By:
YACOBUS FERDINAND
NIT: 30418047

Bearings are machine elements that are often used, not only in the automotive field, but also in the household and industrial fields. The function of the bearing is to support a shaft so that the shaft can rotate without experiencing excessive friction.

In this research, research will be carried out related to the effect of bearing thickness on wind turbine shaft rotation which is carried out by placing the bearing on a Savonius type vertical axis wind turbine then rotated using an external linear flow originating from the exhaust wind tunnel with air flow velocity of 5 m/s. For measurements using the M425 type Torque Transducer which has a torque tolerance of 0-10Nm and a sample rate from 1 sps to 4,000 sps. M425 torque transducer has 14 standard torque ranges, and can handle 0.18mm parallel displacement and 0.06° angle deviation.

In this research, it is seen how the thickness of a bearing affects the rotational performance of a vertical axis wind turbine in the form of power, torque, and RPM. The results in this study obtained that the highest RPM is 383 RPM, the highest torque is 0.0550 Nm, the highest power is 1.050 Watt, also Cp and Cm are 0.143 and 0.235.

Key words : Bearing, Savonius, Wind Tunnel, Turbine, Torque Transducer

PERNYATAAN KEASLIAN DAN HAK CIPTA

Saya yang bertanda tangan di bawah ini :

Nama : Yacobus Ferdinand
NIT : 30418047
Program Studi : D3 Teknik Pesawat Udara
Judul Tugas Akhir : STUDI EKSPERIMENTAL PENGARUH PERUBAHAN DIMENSI DAN MATERIAL BEARING TERHADAP PERFORMANCE TURBINE ANGIN SUMBU VERTIKAL

Dengan ini menyatakan bahwa :

1. Tugas Akhir ini merupakan karya asli dan belum pernah diajukan untuk mendapatkan gelar akademik, baik di Politeknik Penerbangan Surabaya maupun di Perguruan Tinggi lain, serta dipublikasikan, kecuali secara tertulis dengan jelas dicantumkan sebagai acuan dalam naskah dengan disebutkan nama pengarang dan dicantumkan dalam daftar pustaka.
2. Demi pengembangan ilmu pengetahuan, menyetujui untuk memberikan Hak Bebas Royalti Non Eksklusif (*Non-Exclusive Royalty-Free Right*) kepada Politeknik Penerbangan Surabaya beserta perangkat yang ada (jika diperlukan). Dengan hak ini, Politeknik Penerbangan Surabaya berhak menyimpan, mengubah instalasi, mengelola, merawat, dan mempublikasikan Tugas Akhir saya dengan tetap mencantumkan nama saya sebagai penulis / pencipta dan sebagai pemilik Hak Cipta.

Demikian pernyataan ini saya buat dengan sebenarnya. Apabila di kemudian hari terdapat penyimpangan dan ketidakbenaran, maka saya bersedia menerima sanksi akademik berupa pencabutan gelar yang telah diperoleh, serta sanksi lainnya sesuai dengan norma yang berlaku di Politeknik Penerbangan Surabaya.

Surabaya, 19 Agustus 2021

Yang membuat pernyataan



Yacobus Ferdinand
NIT.30418047

KATA PENGANTAR

Segala puji dan syukur penulis panjatkan kepada Tuhan Yang Maha Esa atas segala Rahmat dan Karunia-Nya yang telah memberikan kesehatan, pengetahuan, keterampilan, dan pengalaman dengan baik, sehingga Tugas Akhir yang berjudul “STUDI EKSPERIMENTAL PENGARUH PERUBAHAN DIMENSI DAN MATERIAL BEARING TERHADAP PERFORMANCE TURBINE ANGIN SUMBU VERTIKAL” ini dapat diselesaikan dengan baik.

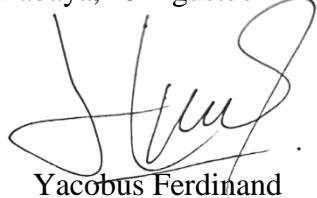
Proses penyusunan Tugas Akhir ini dimaksudkan sebagai salah satu syarat menyelesaikan pendidikan di Politeknik Penerbangan Surabaya dan memperoleh gelar Ahli Madya (A.Md).

Maka pada kesempatan ini, ucapan terima kasih tak henti-hentinya disampaikan kepada segenap pihak yang telah membantu selama proses penyusunan Tugas Akhir ini, terutama kepada:

1. Bapak M. Andra Adityawarman, S.T., M.T., selaku Direktur Politeknik Penerbangan Surabaya
2. Bapak Ir. Bambang Junipitoyo, S.T., M.T., selaku Ketua Program Studi Teknik Pesawat Udara di Politeknik Penerbangan Surabaya.
3. Bapak Gunawan Sakti, S.T., M.T., selaku Dosen Pembimbing materi yang senantiasa membimbing dan membantu dalam penyusunan Tugas Akhir.
4. Bapak Sukahir, S.Si.T., M.T., selaku Dosen Pembimbing penulisan yang senantiasa membimbing dan membantu dalam penyusunan Tugas Akhir.
5. Seluruh Dosen dan *civitas akademika* Program Studi Teknik Pesawat Udara Politeknik Penerbangan Surabaya yang telah memberikan ilmu yang bermanfaat khususnya tentang perawatan pada pesawat udara.
6. Kepada orang tua, serta saudara yang telah memberikan doa, kasih sayang, dukungan moril dan materiil, serta bantuan dan dorongan sampai terselesaikannya penulisan Tugas Akhir ini.
7. Rekan – rekan Diploma III Teknik Pesawat Udara angkatan IV yang selalu memberikan motivasi.

Tentunya karya tulis ini masih jauh dari sempurna. Semoga Tugas Akhir ini dapat memberikan manfaat khususnya bagi taruna Politeknik Penerbangan Surabaya. Semoga penulisan ini dapat dikembangkan dan dapat bermanfaat bagi semua pihak.

Surabaya, 15 Agustus 2021



Jacobus Ferdinand

DAFTAR ISI

	Halaman
HALAMAN JUDUL	ii
HALAMAN PERSETUJUAN	iii
HALAMAN PENGESAHAN	iv
ABSTRAK	v
<i>ABSTRACT</i>	vi
PERNYATAAN KEASLIAN DAN HAK CIPTA	vii
KATA PENGANTAR	viii
DAFTAR ISI	ix
DAFTAR GAMBAR	xii
DAFTAR TABEL	xiii
DAFTAR LAMPIRAN	xiv

BAB I PENDAHULUAN

1.1. Latar Belakang Masalah	1
1.2. Rumusan Masalah	2
1.3. Batasan Masalah	2
1.4. Tujuan Penelitian	4
1.4.1. Tujuan Umum	4
1.4.2. Tujuan Khusus	4
1.5. Hipotesis	4
1.6. Manfaat Penelitian	5
1.7. Sistematika Penulisan	5

BAB II LANDASAN TEORI

2.1. Teori Penunjang	7
2.1.1. <i>Bearing</i>	7
2.1.1.1. <i>Plain Bearing</i>	7
2.1.1.2. <i>Roller Bearing</i>	8
2.1.1.3. <i>Ball Bearing</i>	10
2.1.2. Parameter Performa Putaran <i>Bearing</i>	11
2.1.2.1. Daya	11
2.1.2.2. Torsi	12
2.1.2.3. RPM	12
2.1.2.4. <i>Power Coefficient</i>	13
2.1.2.5. <i>Moment Coefficient</i>	14
2.1.2.6. <i>Uncertainty</i>	14
2.1.2.7. <i>Reynolds Number</i>	15
2.1.3. Instrumen Pengujian	16
2.1.3.1. <i>Wind Tunnel</i>	16
2.1.3.1.1. Klasifikasi <i>Wind Tunnel</i>	16
2.1.3.1.2. Prinsip Kerja <i>Wind Tunnel</i>	17
2.1.3.2. <i>Torque Transducer</i>	19

2.1.3.3. <i>Anemometer</i>	22
2.1.3.3.1. Klasifikasi <i>Wind Anemometer</i>	22
2.1.3.3.2. Prinsip Kerja <i>Wind Anemometer</i>	24
2.2. Kajian Penelitian Terdahulu yang Relevan	25
2.2.1. Aryanto, Firman, I Made Mara dan Made Nuarsa (2013) .	25
2.2.2. Eka Sari Wijianti, Saparin (2018).....	26
2.2.3. P.C. Santhos Kumar, R. Naveen Kumar (2020).....	28
2.2.4. Adesh Kumar T., Satish C. Sharma (2020)	30
2.2.5. Yeong-Jar Lee, Kwang-Heng Lee, Chul-Hee Lee (2018)...	31
BAB III METODE PENELITIAN	
3.1. Desain Penelitian	32
3.1.1. Alur Penelitian	32
3.1.2. Desain Rancangan Alat	34
3.1.3. Teknik Pengujian	34
3.2. Variabel Penelitian.....	35
3.2.1. Variabel Bebas	35
3.2.2. Variabel Terikat	36
3.2.3. Variabel Kontrol	36
3.3. Populasi, Sampel, dan Objek Penelitian	37
3.3.1. Sampel	37
3.3.2. Objek Penelitian	37
3.4. Teknik Pengumpulan Data dan Instrumen Penelitian	37
3.4.1. Teknik Pengumpulan Data	37
3.4.2. Instrumen Penelitian	38
3.5. Teknik Analisis Data	42
3.6. Tempat dan Waktu Penelitian	43
BAB IV HASIL DAN PEMBAHASAN	
4.1. Contoh Perhitungan, Ketelitian, dan Hasil Pengujian	45
4.1.1. Contoh Perhitungan	45
4.1.1.1. Perhitungan <i>Reynolds Number</i>	45
4.1.1.2. Perhitungan <i>TSR</i> (λ).....	46
4.1.1.3. Perhitungan <i>Cp</i>	47
4.1.1.4. Perhitungan <i>Cm</i>	47
4.1.2. Ketelitian Perhitungan	48
4.1.2.1. <i>Reynolds Number</i>	48
4.1.2.2. <i>Uncertainty</i>	49
4.1.3. Hasil Pengujian	52
4.1.3.1. RPM	52
4.1.3.2. Torsi	52
4.1.3.3. Daya	54
4.1.3.4. <i>Cp</i> dan <i>Cm</i>	56
4.2. Perbandingan dengan Penelitian Serupa	58

BAB V PENUTUP

5.1. Kesimpulan	63
5.2. Saran	64

DAFTAR PUSTAKA	65
LAMPIRAN.....	66

DAFTAR GAMBAR

	Halaman
Gambar 1.1 Dimensi Bearing	2
Gambar 2.1 <i>Plain Bearing</i>	8
Gambar 2.2 <i>Roller Bearing</i>	9
Gambar 2.3 <i>Straight Roller Bearing</i>	9
Gambar 2.4 <i>Tapered Roller Bearing</i>	9
Gambar 2.5 <i>Ball Bearing Assembly</i>	10
Gambar 2.6 3d View <i>Standing Turbine</i>	15
Gambar 2.7 <i>Wind Tunnel</i>	16
Gambar 2.8 <i>Wind Tunnel Rangkaian Terbuka</i>	17
Gambar 2.9 <i>Wind Tunnel Rangkaian Tertutup</i>	18
Gambar 2.10 <i>Torque Transducer</i>	19
Gambar 2.11 <i>Metal Foil Strain Gage</i>	20
Gambar 2.12 <i>Strain Gage</i> pada <i>Rotating Shaft</i>	21
Gambar 2.13 <i>Rotary Torque Transducer</i>	21
Gambar 2.14 Grafik Konsumsi <i>Fuel</i> oleh Eka Sri Wijanti dan Sapirin	27
Gambar 2.15 Total <i>Heat Flux</i> dari <i>High Carbon Chromium Steel</i>	28
Gambar 2.16 Total <i>Heat Flux</i> dari <i>Metal Matrix</i>	29
Gambar 2.17 Total <i>Heat Flux</i> dari <i>Stainless Steel</i>	29
Gambar 3.1 Diagram Alur Penelitian.....	33
Gambar 3.2 <i>Setting Penempatan Turbin Angin</i>	34
Gambar 3.3 Ilustrasi <i>Setting Standing Turbine</i> terhadap Laptop	35
Gambar 3.4 <i>Dimension Ball Bearing</i>	35
Gambar 3.5 Komponen <i>Torque Transducer</i>	38
Gambar 3.6 Dimensi Datum M425 <i>Torque Transducer</i>	40
Gambar 3.7 Wind Tunnel pada <i>Aerodynamic Shop</i>	41
Gambar 4.1 Grafik Perbandingan Torsi	53
Gambar 4.2 Grafik Perbandingan Daya	55
Gambar 4.3 Grafik Pemetaan <i>Cp</i>	56
Gambar 4.4 Grafik Pemetaan <i>Cm</i>	58
Gambar 4.5 Grafik Perbandingan <i>Cp</i> Maksimum dengan Penelitian lain	60
Gambar 4.6 Grafik Perbandingan <i>Cm</i> Maksimum dengan Penelitian lain	61

DAFTAR TABEL

	Halaman	
Tabel 1.1	Spesifikasi <i>Bearing</i> yang Diujikan	3
Tabel 3.1	Detail Spesifikasi <i>Bearing</i>	36
Tabel 3.2	Spesifikasi <i>Torque Transducer</i>	39
Tabel 3.3	Kualifikasi Lingkungan <i>Torque Transducer</i>	39
Tabel 3.4	Spesifikasi Datum M425 <i>Torque Transducer Size 1-A</i>	40
Tabel 3.5	Pemetaan Variabel Penelitian	42
Tabel 3.6	Waktu Perencanaan Penelitian	44
Tabel 4.1	Data Pengujian <i>Reynolds Number</i>	48
Tabel 4.2	Data <i>Uncertainty Cp</i>	49
Tabel 4.3	Data <i>Uncertainty Cm</i>	50
Tabel 4.4	Data <i>Uncertainty Reynolds Number</i>	51
Tabel 4.5	Hasil Data RPM	52
Tabel 4.6	Hasil Data Torsi	52
Tabel 4.7	Hasil Data Daya	54
Tabel 4.8	Pemetaan Hasil <i>Cp</i>	56
Tabel 4.9	Pemetaan Hasil <i>Cm</i>	57
Tabel 4.10	Perbandingan <i>Cp</i> Maksimum dengan Penelitian Lain	59
Tabel 4.11	Perbandingan <i>Cm</i> Maksimum dengan Penelitian Lain	61

DAFTAR LAMPIRAN

- Lampiran A Alat dan Bahan Penelitian
- A1 *Deep Groove Ball Bearing 17×40×12*
 - A2 *Deep Groove Ball Bearing 17×47×14*
 - A3 *Self Aligning Ball Bearing 17×47×14*
 - A4 *Wind Anemometer*
 - A5 *Standing Turbine*
 - A6 *Wind Tunnel and Turbine setup*
 - A7 *Datum Torque Transducer*
 - A8 *Datum Universal Interface*
 - A9 *DUI desktop layout*
- Lampiran B Prosedur Pengoperasian Instrumen Penelitian
- B1 *Wind Tunnel*
 - B2 *Torque Transducer*
- Lampiran C DUI *Configuration*
- Lampiran D Perhitungan *Density* dan *Dynanic Viscosity*
- D1 Perhitungan pada Suhu 26,1°C
 - D2 Perhitungan pada Suhu 26,2°C
 - D3 Perhitungan pada Suhu 26,3°C
 - D4 Perhitungan pada Suhu 26,4°C
 - D5 Perhitungan pada Suhu 26,5°C

DAFTAR PUSTAKA

- Bent, Ralph D. dan McKinley, James L. 1996. *Aircraft Powerplant*.
- Crane, Dale. 1996. *Aviation Maintenance Technician Series: Powerplant*. Washington: Aviation Supplies & Academics, Inc.
- FAA. 2012. *Aircraft Maintenance Technician Handbook Series Powerplant Vol 1*. United States: Department of Transportation.
- Sumadi, Budi Karya. 2017. *Transportasi Sudah Menjadi Kebutuhan Dasar Masyarakat*. Semarang: Departemen Perhubungan.
- Arikunto, Suharsimi. 2002. *Prosedur Penelitian Suatu Pendekatan Praktek*. Edisi revisi iv. Jakarta: PT Rineka Cipta.
- Jar Lee Yeong, Heng Lee Kwang, Hee Lee Chul. 2018. Friction performance of 3D printed ball bearing: Feasibility study. Incheon: Sciencedirect
- Tomar Adesh Kumar, Satish C. Sharma. 2020. An Investigation into Surface Texture Effect on Hole-Entry Hybrid Spherical Journal Bearing Performance. Uttarakhand: Sciencedirect
- Santhos Kumar P.C, Naveen Kumar R, Lakshmana Moorthy S.K, Meighnanamoorthy M. 2020. Heat transfer analysis for different materials of ball bearing using ANSYS. Tamilnadu: Sciencedirect
- Wijianti, Eka S., Saparin. 2018. "Pengaruh Material Bearing Terhadap Konsumsi Bahan Bakar Mobil Hemat Energi" dalam Jurnal Teknik Mesin Vol 4. Bangka Belitung: Universitas Bangka Belitung.
- Aryanto, Firman., I Made Mara, dan Made Nuarsa. 2013. "Pengaruh Kecepatan Angin dan Variasi Jumlah Sudu Terhadap Unjuk Kerja Turbin Angin Poros Horizontal" dalam *Jurnal Dinamika Teknik Mesin, Volume 3 No. 1*. Mataram: Universitas Mataram.
- Liu, Jing et. all. 2019. "An Analytical Method for Dynamic Analysis of a Ball Bearing with Offset and Bias Local Defects in the Outer Race" dalam *Journal of Sound and Vibration*. China: Science Direct.
- Wasilczuk, Michal., Filip Wasilczuk. 2020. "Combined Thrust Radial Bearing of a Submarine Main Shaft – Design and Analysis of Failure" dalam *Jurnal Engineering Failure Analysis*. Poland: Science Direct.

LAMPIRAN

Lampiran A. Alat dan Bahan Penelitian



A1. Deep Groove Ball Bearing Material Steel Berdimensi 17×26×5mm



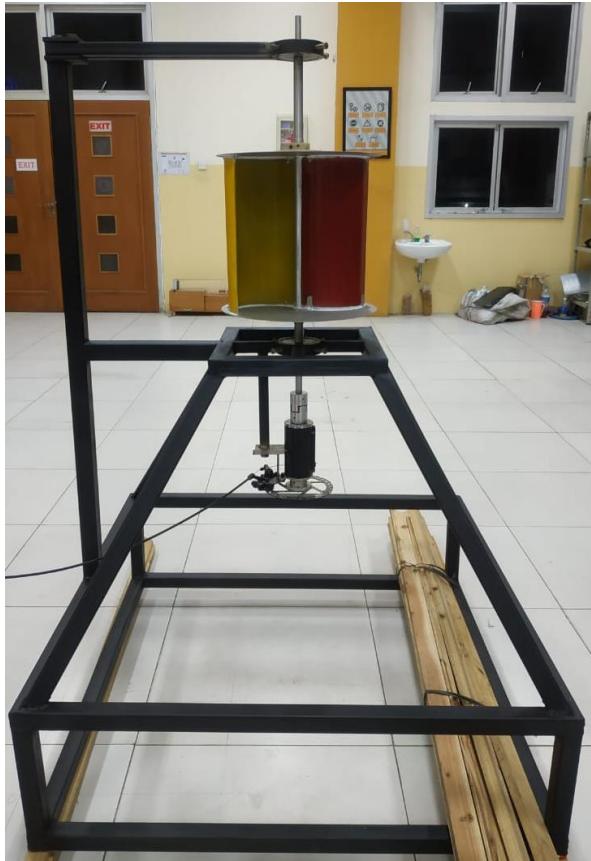
A2. Deep Groove Ball Bearing Material Steel Berdimensi 17×30×7mm



A3. Deep Groove Ball Bearing Material Ceramic Berdimensi 17×30×7mm



A4. Wind Anemometer



A5. Standing Turbine



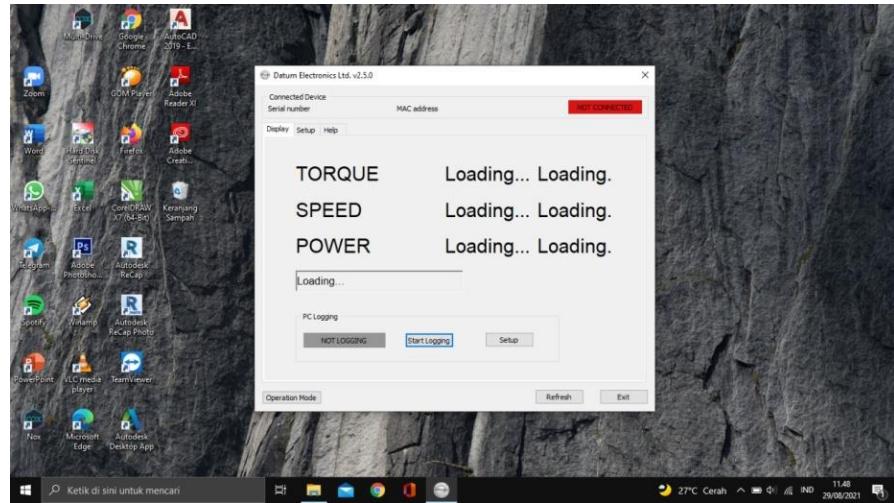
A6. Wind Tunnel and Turbine Setup



A7. Datum M425 Torque Transducer



A8. Datum Universal Interface



A9. *Datum Universal Interface Desktop Layout*

Lampiran B. Prosedur Pengoperasian Instrument Penelitian

B1. Wind Tunnel

1. Menyambungkan *wind tunnel* dengan aliran listrik.
2. Menjalankan *wind tunnel* dengan menekan tombol START berwarna hijau.
3. Melakukan *setting wind tunnel* hingga diperoleh nilai kecepatan angin sebesar 5 m/s pada *anemometer*. Setting dilakukan dengan menari atau mendorong *throttle* pada *wind tunnel*.
4. Setelah diperoleh kecepatan angin yang diinginkan, kunci *throttle* agar tidak bergeser sehingga kecepatan menjadi konstan.
5. Setelah menggunakan *wind tunnel*, dapat dimatikan dengan menekan tombol STOP berwarna merah di sebelah kanan tombol START. Memastikan aliran listrik diputus kembali.

B2. Torque Transducer

1. Melakukan *setting torque transducer* dengan turbin.
2. Menyambungkan *torque transducer* dengan DUI.
3. Menyambungkan DUI dengan aliran listrik. Jika semua telah terhubung, maka DUI akan menyala dan lampu hijau pada *torque transducer* akan menyala.
4. Setelah DUI berada pada posisi ON, menghubungkan DUI dengan *desktop* (PC atau Laptop).

Melakukan Instalasi aplikasi DUI pada *desktop* agar desktop dapat digunakan untuk pengukuran (panduan penginstalan aplikasi dapat dilihat pada *manual installation*).

Lampiran C. DUI Configuration

Installation

Transfer the application onto the PC desktop and then double click to launch the Datum Configuration Utility.

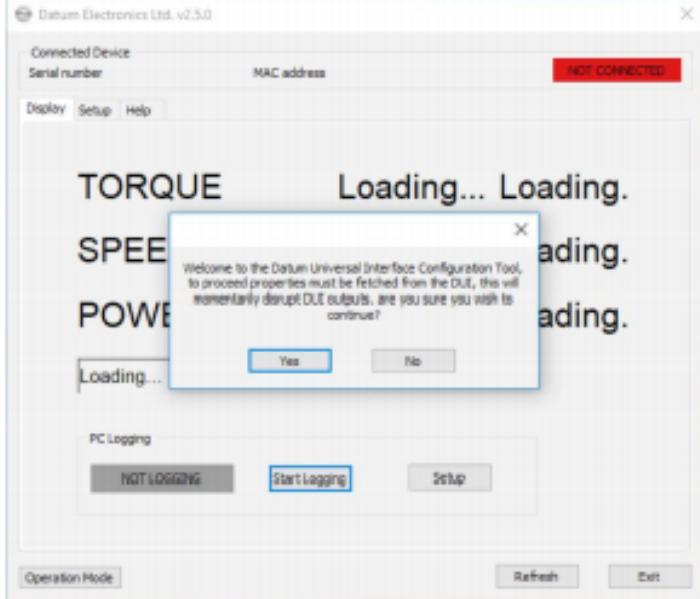


The V2.5.0 release will launch direct without having to install onto your machine.

Initial Screen

Before opening the utility, a Datum Universal Interface (DUI) should be connected to the PC via the USB Mini B port and powered on.

When the utility is first opened the screen will show that there is "no connection" by displaying **NOT CONNECTED** in the status bar, located in the top right corner of the screen. Shortly after launch a box will appear in the centre of the screen [see below].

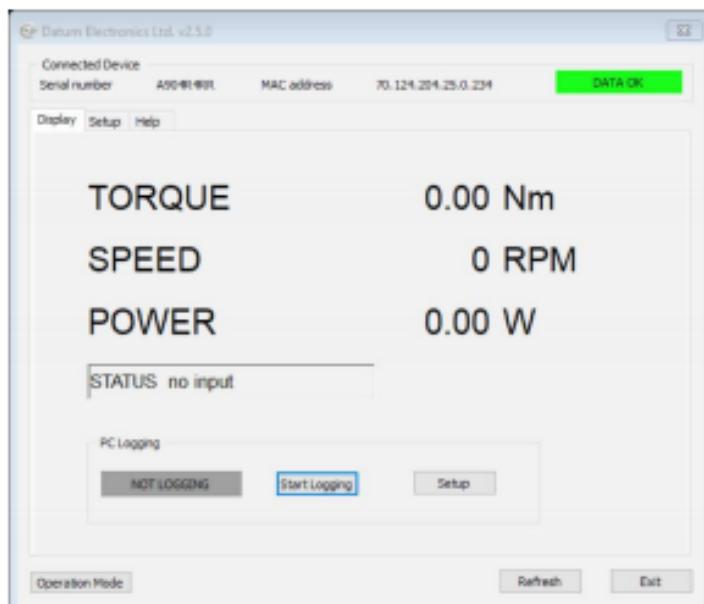


A screenshot of the DUI Configuration Tool window. The title bar says "Datum Electronics Ltd. v2.5.0". The status bar shows "NOT CONNECTED". The main interface has sections for "TORQUE", "SPEED", and "POWER", each with a "Loading..." message. A central dialog box is open, asking "Welcome to the Datum Universal Interface Configuration Tool, to proceed properties must be fetched from the DUT, this will momentarily disrupt DUT outputs, are you sure you wish to continue?". It has "Yes" and "No" buttons. At the bottom, there's a "PC Logging" section with "NOT LOGGING", "Start Logging" (which is highlighted), and "Setup" buttons, along with "Operation Mode", "Refresh", and "Exit" buttons.

2

Selecting 'No' will abort the connection. Select 'Exit' to close the utility.
To modify any system settings or log data via the utility to the PC select 'Yes'. The utility will then connect with the DUI.
Initially the display may read very high, these figures will settle to the input from the transducer or display 0 with no transducer connected. The status bar will now display **DATA OK**. The DUI is in RUN mode.

Display Tab



This Tab will mimic the display on the DUI screen showing the calibrated values of torque, speed, and power, as well as the samples per second from the transducer. In the example above no transducer is connected to the DUI.

Units and Number of decimal point displayed can be changed, with the DUI in CONFIG mode in the 'Setup' - 'Units' tab. For selecting CONFIG mode see page 6, for more details about the 'Setup' - 'Units' tab see page 9.

The PC logging default file path is C:\Users\<username>\Documents\Datum\DUI_LOG . Selecting 'Setup' will redirect to the 'Setup'-'PC Log' tab. For more details about this tab see page 5.

3

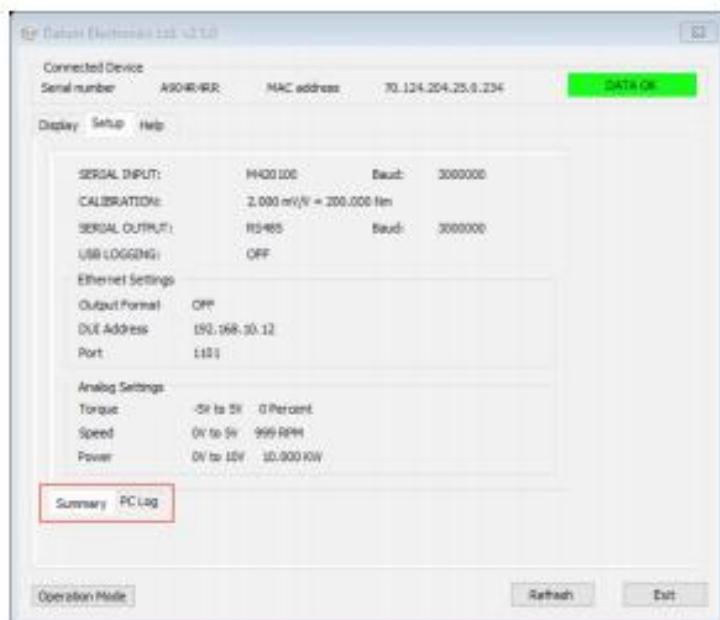
C2

When logging the PC Logging status will show as green below.



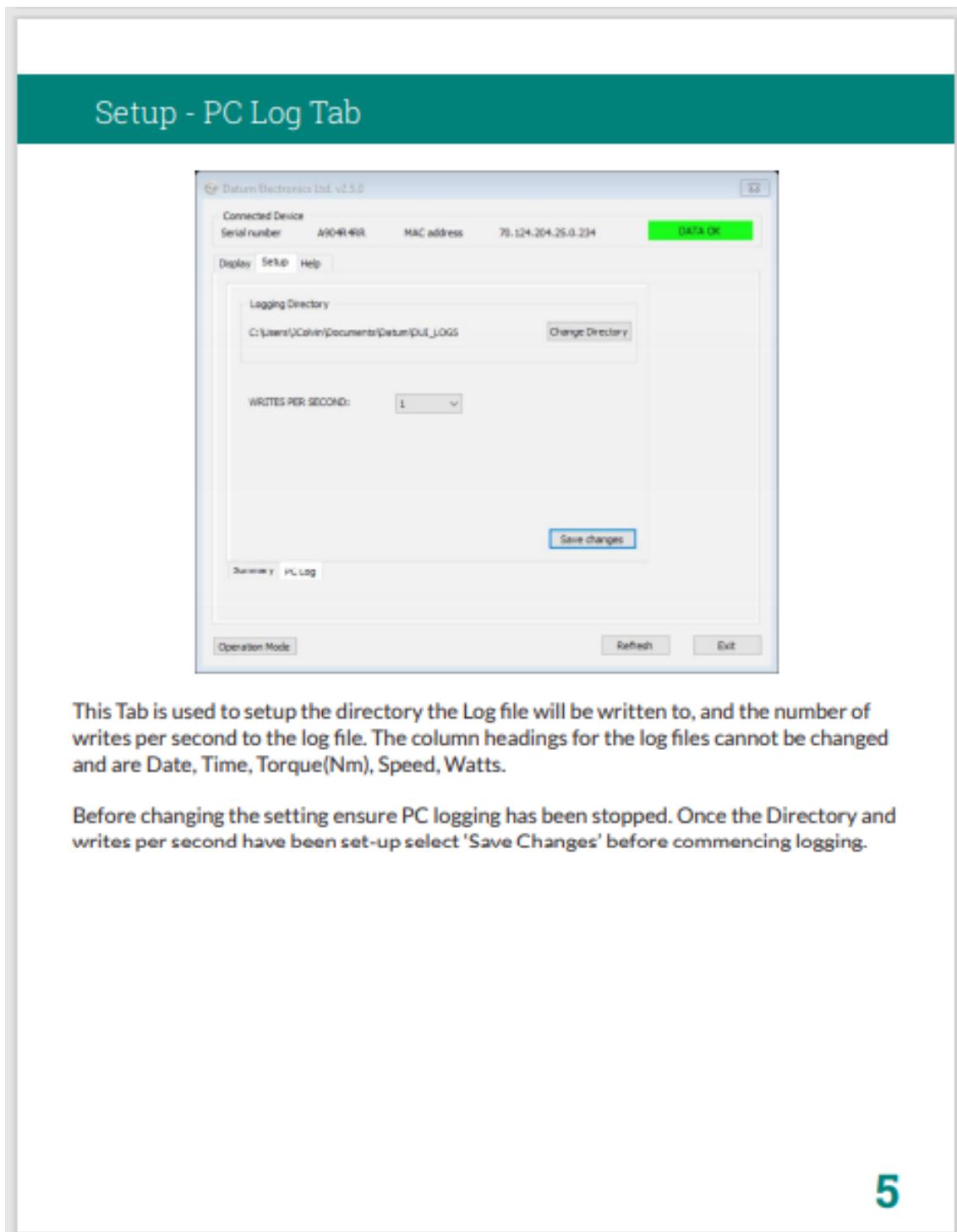
Setup Tabs

The Setup tab in RUN mode has an additional two tabs at the bottom of the screen.



Setup - Summary Tab

Shows all the current configuration settings for the DUI, any changes made to the DUI for calibration, digital outputs, analogue outputs and USB logging can be viewed here.



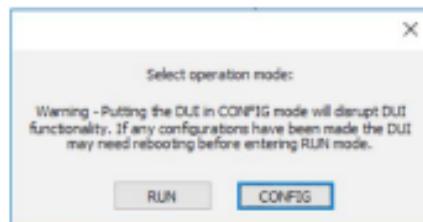
5

C4

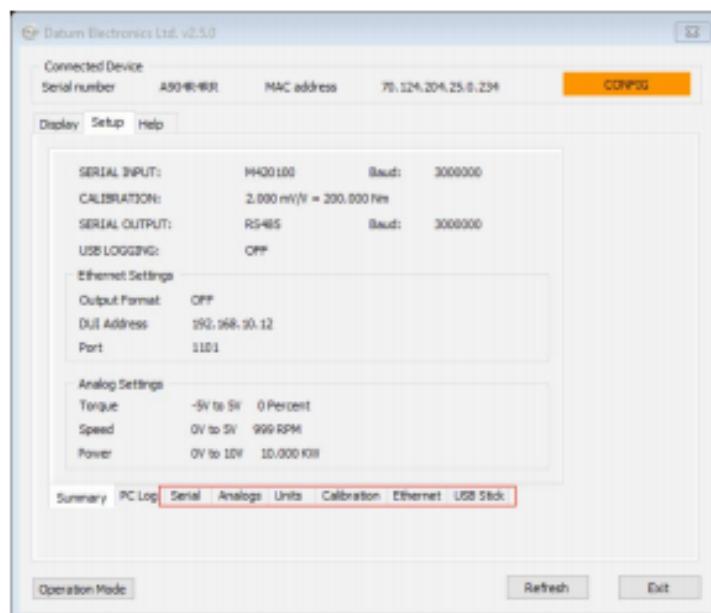
Modifying Settings

To modify any DUI settings the DUI must be set to CONFIG mode.

Select 'Operation Mode' then 'CONFIG' in the pop-up box.

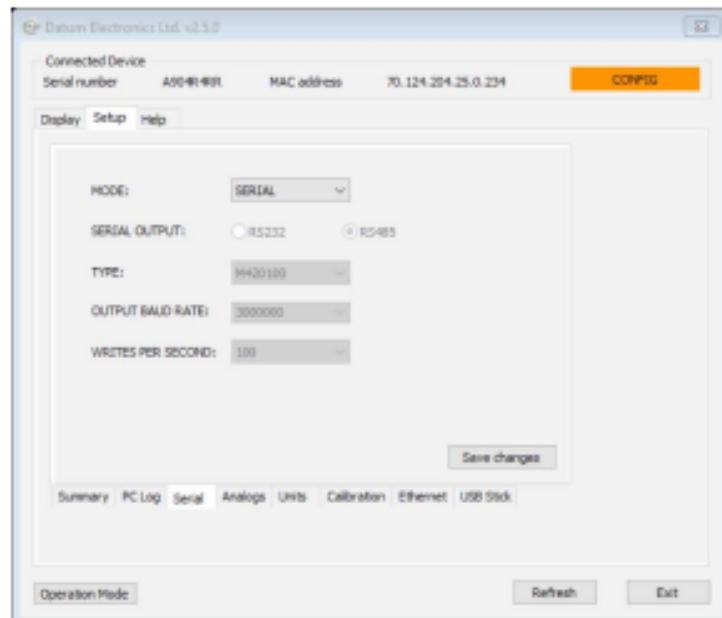


The status bar will now display **CONFIG** and [additional tabs](#) at the bottom of the screen are now available.



Note: After changing any settings please select 'Save Changes' before moving on to another tab; This will cause the DUI to re-start. Please keep the DUI connected to the PC and allow the DUI to re-connect to the software.

Setup - Serial Tab



MODE: Via a drop-down menu can be set to "OFF" "MODBUS" or "SERIAL". For MODBUS output protocols see page 19

SERIAL OUTPUT: Select between RS232 or RS485

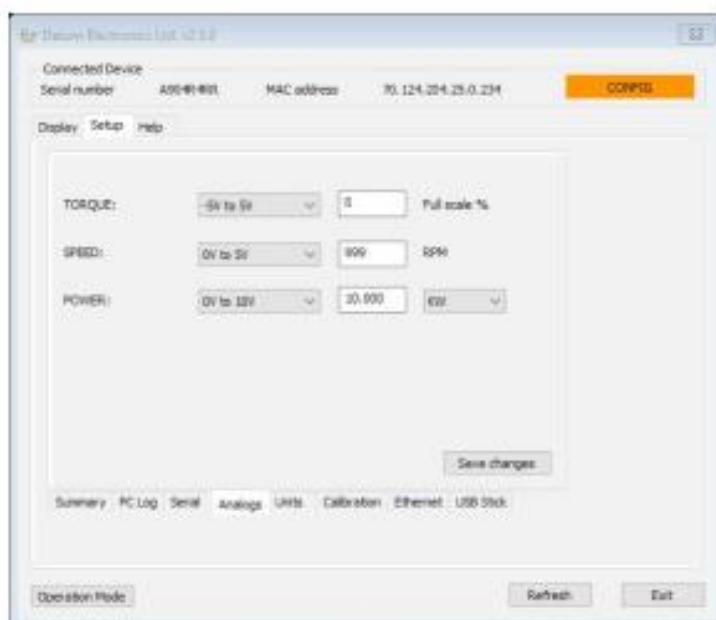
TYPE: Only available when Serial mode has been selected. A range of options are available. See page 16 for the protocols for three recommended output types.

OUTPUT BAUD RATES: Options available from 2400 to 3000000 Baud. Contact support@datum-electronics.co.uk for additional advice on baud rates and serial outputs.

WRITES PER SECOND: Options available from 1 to 4000 Writes Per Second (WPS). The Max number of WPS is dictated by the transducer configuration and cannot exceed the transducer Samples Per Second. E.g. A transducer with a sample rate of 100 SPS can be set to 100 WPS maximum. Choosing a slower WPS will not average the results but will only write at the selected rate.

Once all settings are as required select 'Save Changes'. The DUI will re-start in RUN mode.

Setup - Analogs Tab



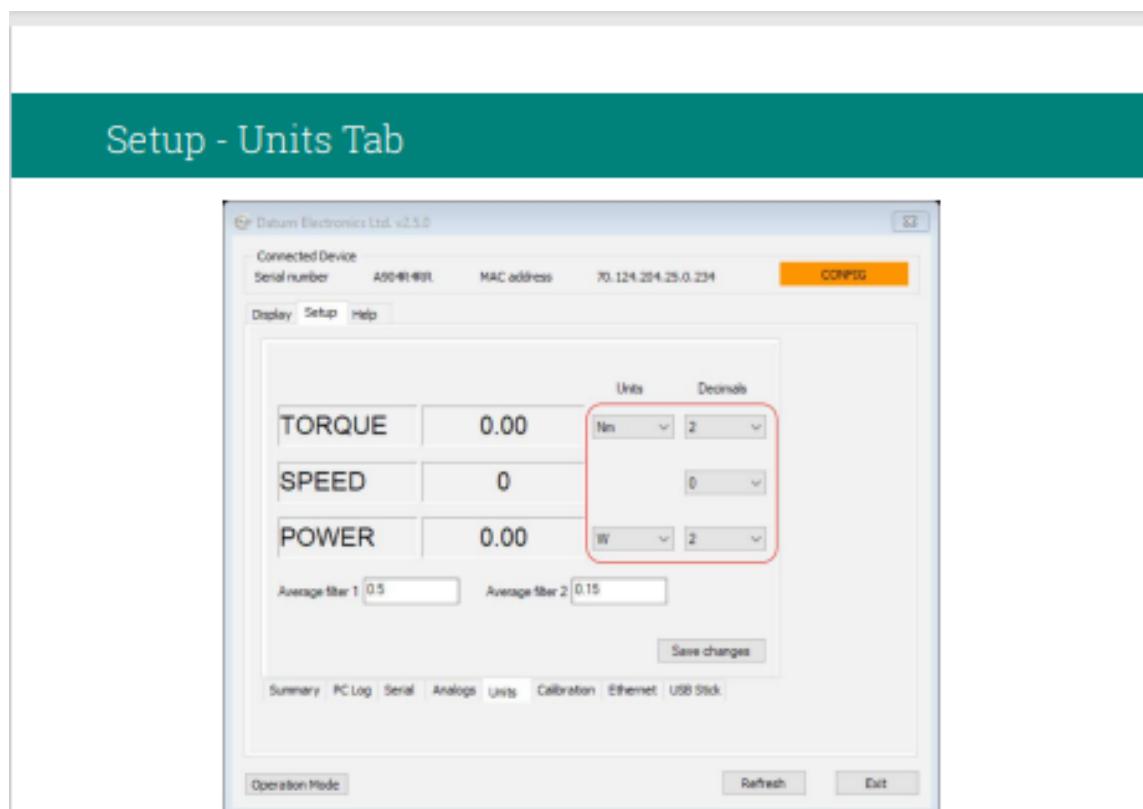
The analogue output ranges are set from the corresponding drop-down menu. Options available are: 0-5V, 0-10V, +/-5V, +/-10V, 4-20mA, or 12+/-8mA and, OFF.

TORQUE: The output is calibrated at a percentage of the full-scale value of the transducer e.g. for a 200Nm transducer to reach 10V at 180 Nm select 0-10V and enter 90 percent in the text box.

SPEED: The output is calibrated at an absolute RPM value at which the output reaches the maximum of the selected range. The speed output is a Uni-polar output as the direction of RPM is not measured.

POWER: The output is calibrated as a value of power at which the output reaches the maximum of the selected range. The power units can be selected from the drop-down box, options are W, KW, MW.

Once all settings are as required select 'Save Changes'. The DUI will re-start in RUN mode.



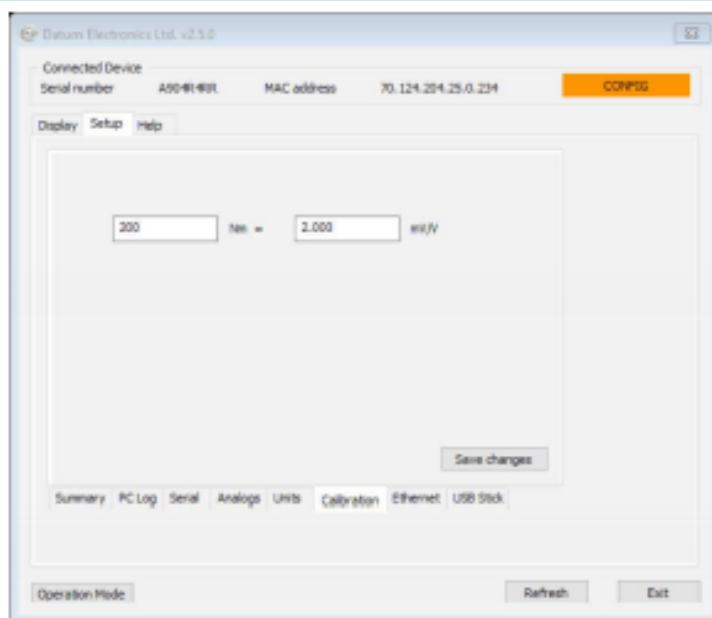
This tab will change the Units and number of decimal places shown on the DUI screen and on the 'Display Tab'. The settings are changed using the **drop-down menus** as seen above.

The Average filters can be used to even out fluctuations in the readings. The values for these filters vary depending on the dynamics of the system so will need adjusting depending on the performance desired. The value can be set anywhere between 1 and 0, at 1 there is no averaging and at 0 maximum averaging is applied. Greater averaging will decrease fluctuation but slow response time.

For more advice about averaging contact support@datum-electronics.co.uk

Once all settings are as required select 'Save Changes'. The DUI will re-start in RUN mode.

Setup - Calibration Tab



This tab contains the clockwise calibration information from the most recent calibration of the transducer. The values here should match the torque calibration certificate supplied by Datum Electronics.

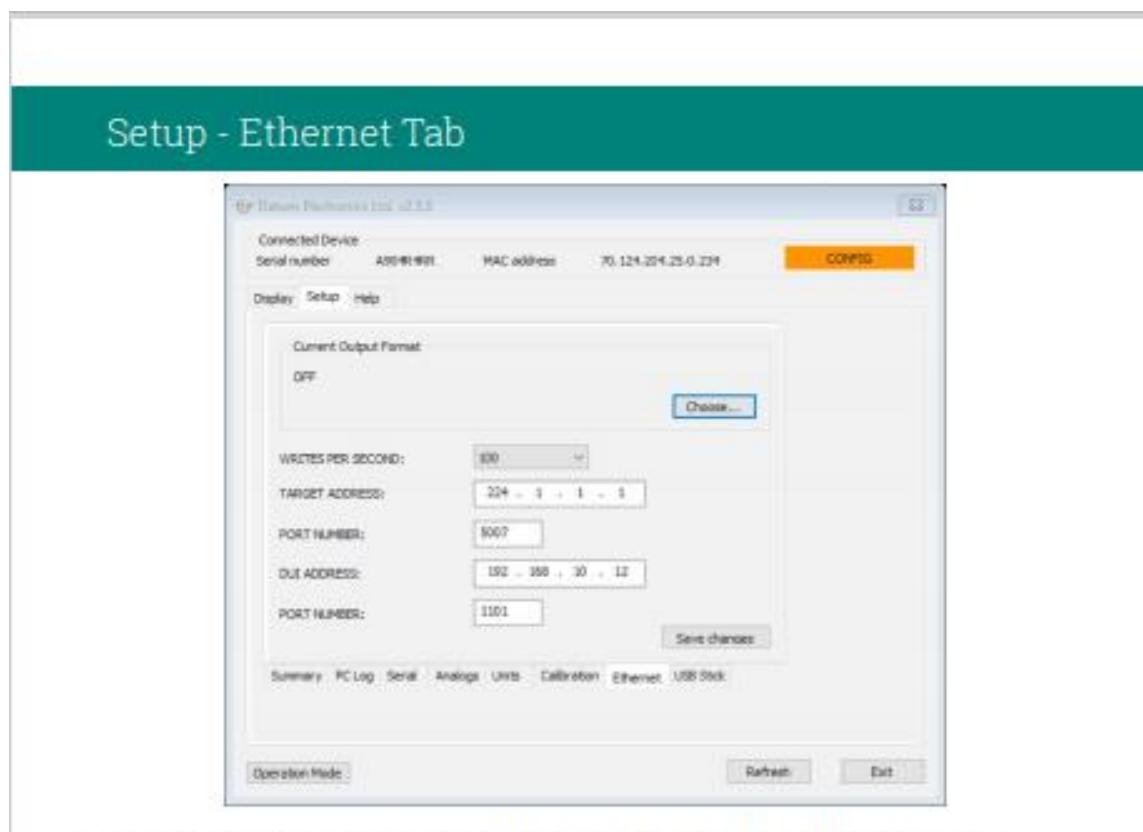
When used with a system where no calibration certificate is provided (e.g. SPMK) this can be calculated using the Torque, Power and Thrust Calculator spreadsheet provided.

Note: If using one DUI with multiple transducers ensure that the correct calibration values have been entered for the transducer in use.

Once the calibration values are as required select 'Save Changes'. The DUI will re-start in RUN mode.

10

C9



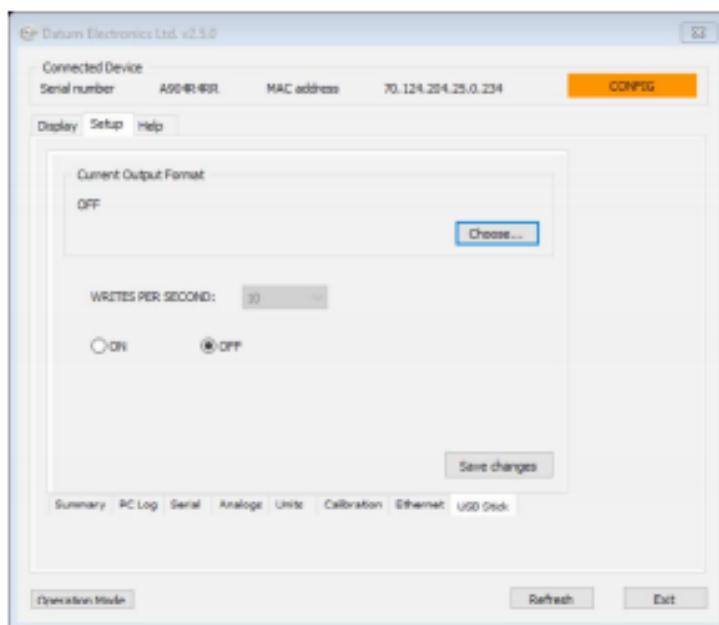
The Ethernet output string can be output in a number of different formats. Select 'Choose' to select the preferred format from a list. See page 18 for a description of recommended options.

The number of writes per second is selectable from a drop-down. The maximum number of writes per second cannot exceed the sample per second rate of the transducer.

The Target IP Address, Target Port number, DUT IP address, and DUT Port Number can also be amended in this Tab.

After making any changes select 'Save Changes'. The DUT will re-start in RUN mode.

Setup - USB Stick Tab



The USB logging will write to a .csv file with a filename format of Sxxxxyyy where xxx= day of the year, yyyy = Time log commenced. For example, S1690846, June 18 is 169th day of the year & the log started at 08:46.

The column headings can be selected from a list of options by selecting 'Choose'. Each column is separated by a coma.

The number of writes per second is selectable from a drop-down. The maximum number of writes per second cannot exceed the sample per second rate of the transducer. Once setup select 'Save changes' and the DUI will re-start in RUN mode.

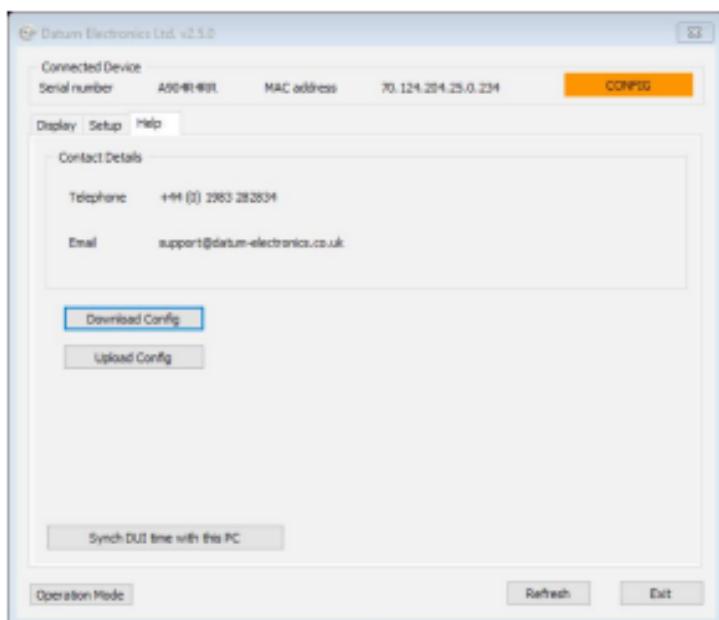
Note:

It is recommended that the DUI is powered down when inserting or removing the USB stick. Once set up, logging will automatically commence when the DUI is powered up with a USB stick Inserted.

While USB logging a new file will be started every 2000 writes, and depending on the formatting of the USB stick, it may be limited to 512 files even if more memory is available.

USB logging will pause at 100 writes of 0 RPM and will automatically resume when the RPM increases.

Help Tab



The Download Config and Upload config buttons are for diagnostic purposes.

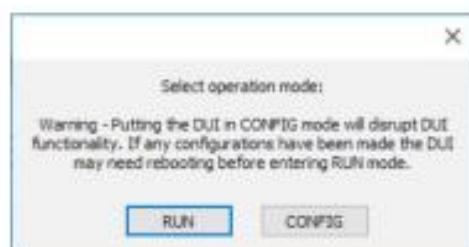
DO NOT USE these functions unless directed by Datum Electronics.

The DUI time should automatically synchronise with the PC. If this does not occur, while in run mode, the status in the display tab will show config mode, rather than Status OK. In addition, PC logging will not work correctly. To rectify this problem, select config mode (see page 6) then select 'Sync DUI time with this PC'. The DUI will then require powering off for 3 seconds and then powering on again.

Returning To RUN Mode

If no settings were changed the software will need to manually be returned to RUN mode.

Select 'Operation Mode' then 'RUN' in the pop-up box.



The DUI will return to RUN mode, as when first opening the DuiCfg software the display may read very high, these figures will settle to the input from the transducer or display 0 with no transducer connected.

The status bar will now display **DATA OK**. The DUI is in RUN mode.

FAQ

DUI is not connecting with the DuiCfg software.

Ensure the DUI is connected via the USB mini-B port to the PC, other ports will not connect to the DuiCfg software, and powered on.

Ensure there are no outstanding updates for the PC.

Ensure the device drivers are up to date. Drivers, or a driver setup executable, are available to download from <http://www.ftdichip.com/Drivers/D2XX.htm>.

Please restart the PC after any updates or installing drivers.

Software starts in config mode / PC logging is not working.

Please see page 13 Help tab for instructions to Synch DUI time with PC.

Lampiran D. Perhitungan *Density* dan *Dynamic Viscosity*

Fluid Properties Calculator

Instructions

1. Select fluid from options box
2. Enter temperature value and choose units
3. Enter number of significant digits for output
4. Browser will re-calculate when a change is made and the mouse is clicked in another box, the Tab key is pushed (Enter key for UNIX), or the Calculate button is clicked.
5. To convert units for all properties, change the units selected for temperature. To convert units for single properties only, use pulldown menus in results area.

Input Values			Results		
Fluid:	<input type="text" value="Air"/>	<input type="button" value="▼"/>	Density:	<input type="text" value="1.1797"/>	<input type="button" value="kg/m^3"/>
Temperature:	<input type="text" value="26.2"/>	<input type="button" value="degrees C"/>	Dynamic Viscosity:	<input type="text" value="1.8501E-5"/>	<input type="button" value="kg/m.s"/>
Digits:	<input type="text" value="5"/>	<input type="button" value="▼"/>	Kinematic Viscosity:	<input type="text" value="1.5682E-5"/>	<input type="button" value="m^2/s"/>
<input type="button" value="Calculate"/>			Specific Heat: c_p	<input type="text" value="1.0063E+3"/>	<input type="button" value="J/kg.K"/>
			Conductivity: k	<input type="text" value="0.026059"/>	<input type="button" value="W/m.K"/>
			Prandtl number:	<input type="text" value="0.71443"/>	
			Thermal Diffusivity:	<input type="text" value="2.1951E-5"/>	<input type="button" value="m^2/s"/>
			Thermal Expansion Coefficient:	<input type="text" value="3.3406E-3"/>	<input type="button" value="1/K"/>

Copyright 1997, Microelectronics Heat Transfer Laboratory

D1. Perhitungan pada suhu 26,2°C

Fluid Properties Calculator

Instructions

1. Select fluid from options box
2. Enter temperature value and choose units
3. Enter number of significant digits for output
4. Browser will re-calculate when a change is made and the mouse is clicked in another box, the Tab key is pushed (Enter key for UNIX), or the Calculate button is clicked.
5. To convert units for all properties, change the units selected for temperature. To convert units for single properties only, use pulldown menus in results area.

Input Values			Results		
Fluid:	<input type="text" value="Air"/>	<input type="button" value="▼"/>	Density:	<input type="text" value="1.1793"/>	<input type="button" value="kg/m^3"/>
Temperature:	<input type="text" value="26.3"/>	<input type="button" value="degrees C"/>	Dynamic Viscosity:	<input type="text" value="1.8505E-5"/>	<input type="button" value="kg/m.s"/>
Digits:	<input type="text" value="5"/>	<input type="button" value="▼"/>	Kinematic Viscosity:	<input type="text" value="1.5692E-5"/>	<input type="button" value="m^2/s"/>
<input type="button" value="Calculate"/>			Specific Heat: c_p	<input type="text" value="1.0063E+3"/>	<input type="button" value="J/kg.K"/>
			Conductivity: k	<input type="text" value="0.026066"/>	<input type="button" value="W/m.K"/>
			Prandtl number:	<input type="text" value="0.71442"/>	
			Thermal Diffusivity:	<input type="text" value="2.1964E-5"/>	<input type="button" value="m^2/s"/>
			Thermal Expansion Coefficient:	<input type="text" value="3.3395E-3"/>	<input type="button" value="1/K"/>

Copyright 1997, Microelectronics Heat Transfer Laboratory

D2. Perhitungan pada suhu 26,3°C

Fluid Properties Calculator

Instructions

1. Select fluid from options box
2. Enter temperature value and choose units
3. Enter number of significant digits for output
4. Browser will re-calculate when a change is made and the mouse is clicked in another box, the Tab key is pushed (Enter key for UNIX), or the Calculate button is clicked.
5. To convert units for all properties, change the units selected for temperature. To convert units for single properties only, use pulldown menus in results area.

Input Values		
Fluid:	Air	(kg/m ³)
Temperature:	26.4	(degrees C)
Digits:	5	

Results		
Density:	1.1789	(kg/m ³)
Dynamic Viscosity:	1.8510E-5	(kg/m.s)
Kinematic Viscosity:	1.5710E-5	(m ² /s)
Specific Heat: c_p	1.0063E+3	(J/kg.K)
Conductivity: k	0.026074	(W/m.K)
Prandtl number:	0.71440	
Thermal Diffusivity:	2.1978E-5	(m ² /s)
Thermal Expansion Coefficient:	3.3383E-3	(1/K)

Copyright 1997, Microelectronics Heat Transfer Laboratory

D3. Perhitungan pada suhu 26,4°C

Fluid Properties Calculator

Instructions

1. Select fluid from options box
2. Enter temperature value and choose units
3. Enter number of significant digits for output
4. Browser will re-calculate when a change is made and the mouse is clicked in another box, the Tab key is pushed (Enter key for UNIX), or the Calculate button is clicked.
5. To convert units for all properties, change the units selected for temperature. To convert units for single properties only, use pulldown menus in results area.

Input Values		
Fluid:	Air	(kg/m ³)
Temperature:	26.5	(degrees C)
Digits:	5	

Results		
Density:	1.1785	(kg/m ³)
Dynamic Viscosity:	1.8515E-5	(kg/m.s)
Kinematic Viscosity:	1.5710E-5	(m ² /s)
Specific Heat: c_p	1.0063E+3	(J/kg.K)
Conductivity: k	0.026081	(W/m.K)
Prandtl number:	0.71438	
Thermal Diffusivity:	2.1992E-5	(m ² /s)
Thermal Expansion Coefficient:	3.3372E-3	(1/K)

Copyright 1997, Microelectronics Heat Transfer Laboratory

D4. Perhitungan pada suhu 26,5°C

Fluid Properties Calculator

Instructions

1. Select fluid from options box
2. Enter temperature value and choose units
3. Enter number of significant digits for output
4. Browser will re-calculate when a change is made and the mouse is clicked in another box, the Tab key is pushed (Enter key for UNIX), or the Calculate button is clicked.
5. To convert units for all properties, change the units selected for temperature. To convert units for single properties only, use pulldown menus in results area.

Input Values		
Fluid:	Air	(kg/m ³)
Temperature:	26.6	(degrees C)
Digits:	5	▼

Results		
Density:	1.1781	(kg/m ³)
Dynamic Viscosity:	1.8520E-5	(kg/m.s)
Kinematic Viscosity:	1.5720E-5	(m ² /s)
Specific Heat: c _p	1.0063E+3	(J/kg.K)
Conductivity: k	0.026089	(W/m.K)
Prandtl number:	0.71436	
Thermal Diffusivity:	2.2005E-5	(m ² /s)
Thermal Expansion Coefficient:	3.3361E-3	(1/K)

Copyright 1997, Microelectronics Heat Transfer Laboratory

D5. Perhitungan pada suhu 26,6°C

DAFTAR RIWAYAT HIDUP



YACOBUS FERDINAND, lahir di Surabaya pada tanggal 21 Januari 2000, anak ke empat dari empat bersaudara, dilahirkan dari pasangan Toha dan Liliek Agustina. Bertempat tinggal di Desa Bedali Kecamatan Lawang Kabupaten Malang. Pada tahun 2006 Memulai pendidikan sekolah dasar di SDK St. Fransiskus Lawang sampai lulus pada tahun 2012.

Melanjutkan pendidikan di SMPN 1 Singosari pada tahun 2012 dan lulus pada tahun 2015. Setelah itu masuk ke SMK Penerbangan Angkasa Abd. Saleh pada tahun 2015 dan lulus pada tahun 2018.

Kemudian pada tahun 2018 diterima sebagai taruna di Politeknik Penerbangan Surabaya pada Program Studi Diploma III Teknik Pesawat Udara Angkatan IV Bravo sampai dengan saat ini. Selama mengikuti pendidikan di Politeknik Penerbangan Surabaya, telah mengikuti *On the Job Training* (OJT) di AKADEMI PENERBANG INDONESIA BANYUWANGI pada bulan April sampai dengan Juni 2021.

Harapan saya setelah menyelesaikan pendidikan di Politeknik Penerbangan Surabaya, bisa menjadi seorang insan perhubungan yang bertanggung jawab, disiplin dan bisa berguna bagi Bangsa dan Negara. Rasa syukur kepada Tuhan Yang Maha Esa yang selalu memberikan Kasih dan Anugerah-Nya serta tidak lupa kepada orang tua yang selalu mendukung di setiap kegiatan. Allah tidak semata-mata mendatangkan cobaan dan musibah tanpa ada suatu pembelajaran dan sesuai dengan kemampuan hamba-Nya. Berkaitan dengan segala keinginan, harapan, ketakutan atau apapun kepada Allah pemilik segala-galanya, penentu segalanya, niscaya kita akan tenang dan akan ditolong.