

SKRIPSI

PERENCANAAN DAN PEMBUATAN PROTOTYPE BALANCE LOAD CONTROLLER UNTUK PLTMH DENGAN KAPASITAS 1,1 KW MENGGUNAKAN PID CONTROLLER OMEGA TIPE ISERIES



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**JURUSAN TEKNIK ELEKTRO S1
KONSENTRASI TEKNIK ENERGI LISTRIK
FAKULTAS TEKNOLOGI INDUSTRI
INSTITUT TEKNOLOGI NASIONAL MALANG**

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LEMBAR PERSETUJUAN

PERENCANAAN DAN PEMBUATAN PROTOTYPE BALANCE LOAD CONTROLLER UNTUK PLTMH DENGAN KAPASITAS 1,1 KW MENGGUNAKAN PID CONTROLLER OMEGA TIPE iSERIES

SKRIPSI

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Sarjana Teknik Elektro Strata Satu (S-1)*

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ABSTRAK

Perencanaan Dan Pembuatan Prototype Balance Load Controller Untuk PLTMh Dengan Kapasitas 1.1 KW Menggunakan PID Controller OMEGA Tipe iSeries. Fadli Shalad 0212040, Fakultas Teknik Industri, Jurusan Teknik Energi Listrik S1, Institut Teknologi Nasional Malang, Dosen Pembimbing I : Ir. Widodo Pujdi M.,MT, Dosen Pembimbing II : Irrine Budi S., ST.MT

Kata Kunci :*PID controller, Power Controller, Dummy Load, Microhydro.*

Pada Pembangkit Listrik Tenaga Mikrohidro (PLTMh) aspek kualitas penyaluran tenaga listrik ke konsumen harus terpenuhi dengan tetap menjaga frekuensi agar selalu konstan. Namun terdapat beberapa kendala dalam pengoperasian PLTMh diantaranya: Daya beban yang bervariasi menyebabkan perubahan frekwensi. Pengaturan putaran turbin menggunakan Governor, pada pembangkit energi listrik konvensional tidak digunakan pada PLTMh karena alasan ekonomis. Salah satu alternatif pengganti governor untuk mengendalikan frekwensi yaitu pengaturan secara elektronis untuk mengatur beban (output) generator dengan mekanisme balance load controller menggunakan PID controller. Perencanaan dan pembuatan balance load controller dilakukan dilaboratorium Teknik Ektro S1 ITN Malang.

Dari studi literatur diketahui bahwa frekuensi sebanding dengan putaran generator. Penambahan beban akan berakibat turunnya frekuensi dan juga sebaliknya. Untuk menjaga agar beban konstan maka digunakan *dummy load*. Pada tahap perancangan alat, sensor frekuensi menggunakan tranduser putaran menghasilkan tegangan sebagai input PID Controller dan output PID Controller sebagai inputan Power Controller, kemudian outputan Power Controller menentukan besarnya daya yang masuk ke *dummy load*. Pada tahap pembuatan sensor putaran menggunakan generotor DC 6 Volt sedangkan Proses Controller menggunakan PID Omega tipe iSeries dan Power Controller menggunakan Autonics SPC1-50.

Dari data pengujian dengan Variasi beban R=165 W, S=165 W, T=165 W maka *Output Proses Controller* = 3,8 Volt dan *Input Power Controller* = 1,73 Volt, R=60 W, S=5 W, T=100 W maka *Output Proses Controller* = 8 Volt dan *Input Power Controller* = 4,6 Volt. Tegangan output Generator DC (Yang digunakan sebagai Sensor) pada 2000 Rpm 0,264 Volt Dan pada 3000 Rpm 0,4 Volt.

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Skripsi ini untuk memenuhi kurikulum akademik yang harus ditempuh oleh setiap mahasiswa ITN Malang sekaligus mengakhiri pendidikan pada jenjang S-1 pada Jurusan Teknik Elektro Konsentrasi Energi Listrik.

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BAB I

PENDAHULUAN

1.1. Latar Belakang

Kebutuhan akan energi di Indonesia yang sangat tinggi menyebabkan PT. PLN (Persero) sebagai penyedia energi listrik dituntut untuk bisa memenuhi seluruh kebutuhan daya listrik. Faktor utama yang menjadi kendala antara lain semakin menipisnya sumber daya energi (batubara, gas dan minyak bumi) dunia sehingga menyebabkan naiknya harga bahan bakar minyak, batubara dan gas yang merupakan bahan dasar pembangkitan sehingga mengakibatkan penyediaan energi listrik menjadi mahal.

Indonesia memiliki sumber energi terbarukan yang cukup bervariasi termasuk sumber daya air. Sumber daya air yang dapat dibangkitkan menjadi listrik terdiri atas skala besar (PLTA) dan skala kecil (PLTM/PLTMh). Total potensi tenaga air diperkirakan mencapai 75 GW sedangkan tenaga mini/mikrohidro mencapai sekitar 500 MW namun yang telah dimanfaatkan saat ini baru sekitar 54 MW.

Pada Pembangkit Listrik Tenaga Mikrohidro (PLTMh) aspek kualitas penyaluran tenaga listrik ke konsumen harus terpenuhi dengan tetap menjaga frekuensi agar selalu konstan. Namun terdapat beberapa kendala dalam pengoperasian PLTMh diantaranya: Daya beban yang bervariasi menyebabkan perubahan frekuensi selanjutnya debit air yang ada selalu bervariasi sehingga daya turbin dan putarannya tidak konstan menyebabkan frekuensi yang fluktuatif (tidak

stabil). Pengaturan putaran turbin menggunakan Governor, pada pembangkit energi listrik konvensional tidak digunakan pada PLTMh karena alasan ekonomis. Salah satu alternatif pengganti governor untuk mengendalikan frekuensi yaitu dengan mengatur beban (*output*) generator.

1.2. Rumusan Masalah

1. Berapa nilai tegangan generator terhadap putaran,
2. Bagaimana hubungan antara input dan output pada rangkaian pengkondisi sinyal dari generator ke PID,
3. Bagaimana hubungan antara input dan output pada rangkaian pengkondisi sinyal dari PID ke Power Controller,
4. Menurut metode kurva reaksi berapa nilai settingan dari PID.

1.3. Tujuan Pembahasan

Adapun tujuan skripsi ini adalah perancangan dan pembuatan Prototype Balance Load Controller PLTMh dengan kapasitas 1.1 KW, untuk mengendalikan frekwensi dengan mengatur beban (*output*) generator.

1.4. Batasan Masalah

Untuk menyederhanakan masalah yang akan dibahas, maka diberikan batasan-batasan sebagai berikut :

1. Tidak membahas masalah kontruksi sipil PLTMh, hidrologi, topografi dan peralatan mekanikal.
2. Prime mover tidak menggunakan turbin.
3. Tidak membahas secara detail rangkaian elektroniknya.
4. Tidak membahas sistem proteksinya.
5. PID Controller yang digunakan merk Omega type iSeries.
6. Peralatan pengatur arus menggunakan sistem phasa controlled menggunakan TRIAC dan pengatur sudut menggunakan PWM controlled.

1.5. Metode Pembahasan

Metode yang digunakan dalam pembahasan skripsi adalah :

1. Studi literatur, yaitu kajian pustaka untuk mempelajari teori-teori yang terkait melalui literatur yang berhubungan dengan permasalahan.
2. Tahap perancangan.

Menyusun dan merancang perangkat keras dari sistem.

3. Tahap pembuatan.

Membuat perangkat keras sesuai perencanaan dan menggabungkan fungsi-fungsi rangkaian sehingga menjadi satu kesatuan yang utuh.

4. Tahap pengujian

Melakukan pengujian kerja sistem membandingkan terhadap rancangan bila perlu melakukan perbaikan.

5. Tahap pengambilan data dan analisa

Melakukan pengambilan data dilaboratorium sistem kendali industri untuk dianalisa sebagai dasar pengambilan kesimpulan.

1.6 . Sistematika Penulisan

Pembahasan dalam Skripsi ini akan diuraikan dalam lima bab, yang penjabarannya adalah sebagai berikut :

Bab I : PENDAHULUAN

Membahas tentang latar belakang, rumusan masalah, tujuan, metodologi dan sistematika pembahasan yang akan dipaparkan dalam laporan Skripsi ini.

Bab II : LANDASAN TEORI

Membahas tentang berbagai macam teori yang mendukung pengontrolan beban dummy load, komponen-komponen elektronika yang digunakan, konsep kontroler PID

Bab III : PERANCANGAN PERANGKAT KERAS

Pada bab ini berisi tentang uraian dan penjelasan tentang bagaimana tahap-tahap perencanaan dan proses pembuatan perangkat keras dan cara kerja sistem.

BAB II

LANDASAN TEORI

2.1. Prinsip Kerja Generator DC

Prinsip kerja generator arus searah berdasarkan hukum Faraday :

$$E = - N \frac{d\phi}{dt} \quad (1)$$

Dimana, N : jumlah lilitan

ϕ : fluksi magnet

e : Tegangan imbas, ggl (gaya gerak listrik)

Apabila suatu konduktor memotong garis-garis fluksi magnetik yang berubah-ubah, maka ggl akan dibangkitkan dalam konduktor itu. Jadi syarat untuk membangkitkan ggl adalah

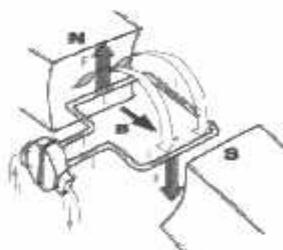
- harus ada konduktor (hantaran kawat)
- harus ada medan magnetik
- harus ada gerak atau perputaran dari konduktor dalam medan, atau ada fluksi yang berubah yang memotong konduktor itu.

Untuk menentukan arah arus pada setiap saat, berlaku pada kaidah tangan kanan :

- ibu jari : gerak perputaran
- jari telunjuk : medan magnetik kutub u dan s
- jari tengah : besaran galvanis tegangan U dan arus I

Untuk perolehan arus searah dari tegangan bolak-balik, meskipun tujuan utamanya adalah pembangkitan tegangan searah, tampak bahwa tegangan

kecepatan yang dibangkitkan pada kumparan jangkar merupakan tegangan bolak-balik. Bentuk gelombang yg berubah-ubah tersebut karenanya harus disearahkan. Δ/Y .



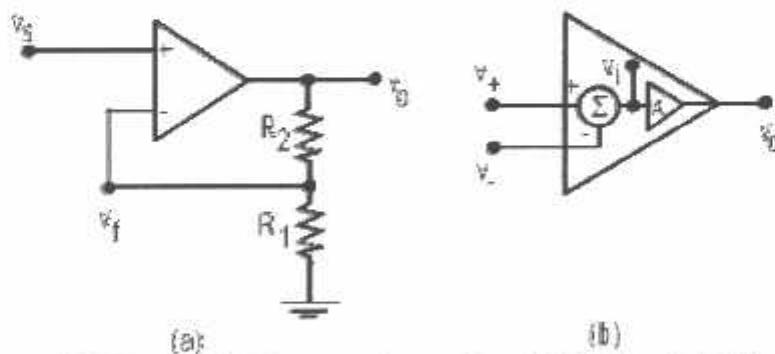
Gambar 2.1. Interaksi Antara Medan Magnet Dan Pengantar

Yang Dialiri Arus⁵

2.2. PENGUAT OPERASIONAL

2.2.1. Penguatan Tak-Membalik (*Non-Inverting Amplification*)

Op Amp dapat dipasang sebagai penguat tak membalik seperti gambar 2.2. Terlihat bahwa masukan diberikan pada v_+ .



Gambar 2.2. Rangkaian Penguat Operasional Tak Membalik³

Op amp tersebut berfungsi sebagai :

$$v_o = A(v_- - v_+) \quad (2)$$

dan selanjutnya dapat dituliskan untuk penjumlahan (Σ) dan penguat ujung tunggal (A) seperti pada gambar 2.2.a.

$$\begin{aligned} v_i &= v_- + v_+ \\ v_o &= A v_i \end{aligned} \quad (3)$$

Dari pembagi tegangan didapatkan :

$$\begin{aligned} v_f &= v_o \times \frac{R_1}{R_1 + R_2} \\ v_f &= \beta v_o \end{aligned} \quad (4)$$

Jadi terlihat bahwa gambar 2.2.b adalah salah satu contoh dari penguat balikan

$$\beta = R_f / (R_f + R_i) \quad (5)$$

Dengan demikian dapat dituliskan penguat lingkar tertutup sebagai :

$$A_f = A / (1 + A\beta) \quad (6)$$

Karena A sangat besar maka :

$$\begin{aligned} A_f &\approx 1/\beta \\ &= (R_i + R_f) / R_i \\ &= 1 + (R_f/R_i) \end{aligned} \quad (7)$$

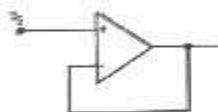
Didapat persamaan terakhir dengan cepat dengan menggunakan metode hubung singkat :

$$\begin{aligned} v_o &= v_f \text{ (karena } A \text{ sangat besar)} \\ &= v_s \times \frac{R_1}{R_1 + R_2} \end{aligned} \quad (8)$$

Jadi :

$$v_o / v_s = 1 + (R_1 / R_2) \quad (9)$$

Maka didapatkan bentuk khusus penguat tak membalik secara sederhana seperti pada gambar 2.3.



Gambar 2.3. Rangkaian Khusus Penguat Operasional Tak Membalik³

Dengan metode Hubung Singkat diperoleh :

$$\begin{aligned} v_o &\approx v_s \\ v_o / v_s &= 1 \end{aligned} \quad (10)$$

Jadi penguat seperti terlihat pada gambar 2.3 menghasilkan penguatan + 1. Rangkaian ini sangat menguntungkan karena kita dapat memperoleh suatu penguat dengan hambatan masukan yang sangat tinggi ($10-1012\Omega$), dengan hambatan keluaran sangat rendah ($10-3-10-1\Omega$), yaitu mendekati kondisi ideal.

Rangkaian ini disebut rangkaian pengikut (*follower*), suatu bentuk peningkatan dari penguat pengikut emitor. Jadi penguat ini berfungsi sebagai penyanga (*buffer*) dengan penguatan = 1. Sebagai gambaran pada tabel 2.1 diperlihatkan kinerja rangkaian pengikut dan rangkaian pengikut emitor.

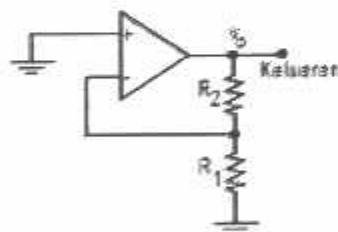
Tabel 2.1. Kinerja Rangkaian Pengikut Dan Rangkaian Pengikut Emitor

	Rangkaian pengikut (<i>Follower</i>)	Rangkaian pengikut emitor (<i>Emitter follower</i>)
Penguatan	0,99999	0,995
Hambatan masukan	$\sim 10^7$	10^5
Hambatan keluaran	10^{-2}	5
Pergesekan DC	2	650
Frekuensi 3 dB	1	50

Dalam praktik untuk penguat operasional tak-membalik, besarnya frekuensi 3 dB BW penguatan lingkar tertutup G diberikan oleh :

$$G \times \text{BW} = \text{frekuensi penguatan} - \text{tunggal}$$

Jadi jika menggunakan penguat dengan frekuensi penguatan tunggal 1 MHz, maka dapat diperoleh lebar tanggapan frekuensi sebesar 1 MHz..



Gambar 2.4. Penguat Tak-Membalik Dengan Masukan Nol³

Efek dari V_{io} (tegangan offset masukan) pada kondisi panjar penguat, tidak terlalu sulit untuk diperkirakan. Perhatikan penguat tak-membalik dengan masukan nol seperti diperlihatkan pada gambar 2.4 agar diperoleh keluaran sebesar kira-kira 0 volt, kedua masukan harus berbeda sebesar V_{io} , yaitu :

$$v_+ = V_{io} \quad (11)$$

Dari pembagi potensial dapat diperoleh :

$$V_{io} = v_o \times \frac{R_1}{R_1 + R_2} \quad (12)$$

dan juga :

$$v_o = V_{io} \times \text{Penguatan} \quad (13)$$

Biasanya untuk amplifier dengan penguatan $100\times$ mungkin akan memiliki keluaran sebesar 200 mV untuk masukan 0 volt. Jika arus masukan tidak dapat diabaikan (seperti diasumsikan di atas), analisis di atas harus dimodifikasi sebagai pembagi tegangan yang terbebani arus masukan I_B , dimana :

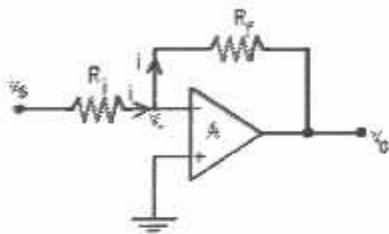
$$V_{io} = v_o \frac{R_1}{R_1 + R_2} - I_B \times \frac{R_1 R_2}{R_1 + R_2} \quad (14)$$

Perlu juga dicoba untuk menghubungkan v_+ ke tanah tidak dengan hubung singkat melainkan dengan hambatan R_1 paralel dengan R_2 . Arus sebesar I_B juga mengalir lewat hambatan tersebut, efek dari suku kedua pada persamaan dapat dihilangkan. Dengan demikian akan diperoleh :

$$V_{os} = v_o \frac{R_1}{R_1 + R_2} - I_{os} \times \frac{R_1 R_2}{R_1 + R_2}, \quad (15)$$

2.2.2 Penguat Membalik (*Inverting Amplifier*)

Pada penguat membalik sumber isyarat dihubungkan dengan masukan membalik sedangkan masukan positif ditanahkan seperti terlihat pada gambar 2.5.



Gambar 2. 5. Penguat Operasional Membalik ³

Pada gambar 2.5 terlihat bahwa sebagian dari keluaran diumpulkan kembali ke masukan melalui R_f . Penguat ini termasuk penguat pembalik negatif. Penguatan dari rangkaian ini dapat ditentukan sebagai berikut. Dengan berasumsi bahwa arus i tidak melalui masukan, jadi arus i yang lewat R_i dan R_f .

Dengan mempunyai :

$$v_1 - v_- = i R_i$$

$$v_1 - v_o = i R_f$$

$$v_o = -A v_-$$

(16)

dari ketiga persamaan dapat diperoleh :

$$\begin{aligned} v_s + \frac{v_o}{A} &= i R_i \\ -\frac{v_o}{A} - v_o &= i R_f \end{aligned} \tag{17}$$

selanjutnya diprololoh :

$$\frac{v_s + (v_o / A)}{v_s + (v_o / A)} = -\frac{R_f}{R_i} \tag{18}$$

Nilai A sangat besar (sekitar 10^5) sehingga v_o/A berharga sangat kecil dibandingkan dengan v_s dan v_o , maka didapatkan penguatan lingkar tertutup

$$v_o/v_s \approx -R_f/R_i \tag{19}$$

ternyata secara sederhana hanya merupakan perbandingan kedua hambatan yang dipasang. Karena masukan positif ditanahkan, maka terminal masukan negatif juga ditanahkan maya (walaupun tidak terdapat penghubung langsung ke tanah).

Dengan mempunyai :

$$i \approx v_s / R_i \approx -v_o / R_f$$

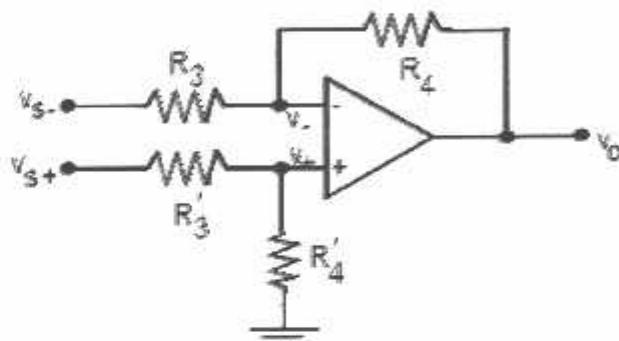
dan juga :

$$v_o / v_s \approx -R_f / R_i \tag{20}$$

2.2.3. Rangkaian Pengurang

Operasi pengurangan dapat dilakukan dengan hanya memakai sebuah opamp seperti pada gambar 2.6 Terlihat bahwa V_{S+} dan V_+ membentuk pembagi tegangan.

$$V_+ = V_{S+} \times \frac{R_4}{(R_3 + R_4)} \quad (21)$$

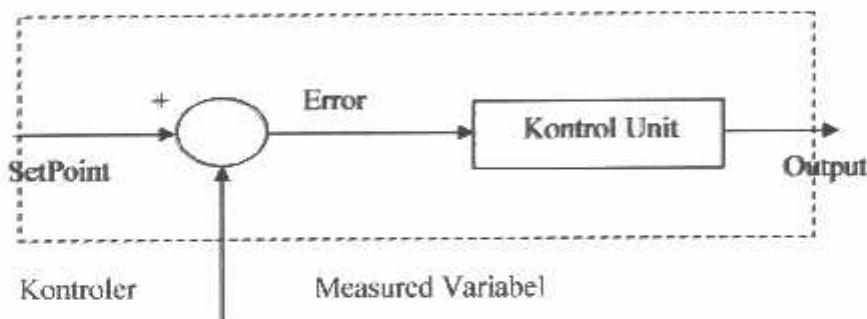


Gambar 2.6. Penguat Operasional Sebagai Rangkaian Pengurang³

2.3. Prinsip Kerja Pengendali

Ada tiga jenis pengendali kontinyu, yaitu pengendali proposisional di singkat P, pengendali integral di singkat I, dan pengendali diferensial di singkat D. Karena kelebihan dan kekurangan ketiga pengendali itu, mereka seringkali dipakai dalam bentuk kombinasi, yaitu P+I disingkat PI, P+D disingkat PD, dan P+I+D disingkat PID. Ketiga jenis pengendali ini memberikan respon yang berbeda-beda. Pada dasarnya, tugas sebuah kontinyu terbagi dalam dua tahap, yaitu membandingkan dan menghitung.

Pembandingan itu sendiri dilakukan dengan mengurangi besarnya *set point* dengan besaran *measurement variable*, yang hasilnya adalah besaran yang disebut *error*. Karena set point bisa lebih besar atau lebih kecil dari *measurement variable*, nilai *error* bisa positif dan bisa juga negatif. Jadi *error* adalah input unit kontrol dan *manipulated variable* adalah output unit kontrol. Besarnya *manipulated variable* dihitung berdasarkan *error* dan *transfer function* unit kontrol. Bentuk *transfer function* dari unit kontrol terhitung pada “mode” yang ada dikontroler.



Gambar 2.7. Kontroler Dan Diagram Kotaknya⁵

Dari gambar 2.7 diatas, jelas bahwa *set point* diproduksi oleh kontroler itu sendiri, yang besarnya dapat diatur dengan memutar knop *set point* yang ada pada kontroler. Kontrol menerima sinyal *measurement variable* di bagian yang lazim ditulis “*input*”, dan menghasilkan sinyal *manipulated variable* dibagian yang lazim disebut “*output*”.

Kita tidak akan dapat membedakan kontrol mode unit kontrol dengan melihat kontroler dari luar. Untuk mengetahui mode dari satu unit kontroler, kita

harus membuka bagian dalam kontroler tersebut dan melihat apa saja yang ada pada unit tersebut. Bentuk luar semua unit kontrol sama. Karena tidak semua dari ketiga mode tersebut cocok dengan aplikasi kita, maka hanya mode yang dibutuhkan yang akan difungsikan di unit ini. Konsekuensinya, orang tidak dapat melihat mode suatu kontroler hanya dengan melihat bentuk fisik luarnya saja.

Selanjutnya untuk memudahkan pembahasan, maka akan dijabarkan bahwa kontroler adalah seluruh bagian dari diagram kotak yang ada pada gambar 2.7 Sedangkan unit kontrol hanyalah bagian dari kontroler yang secara langsung menghitung besarnya koreksi atau besarnya *manipulated variable*.

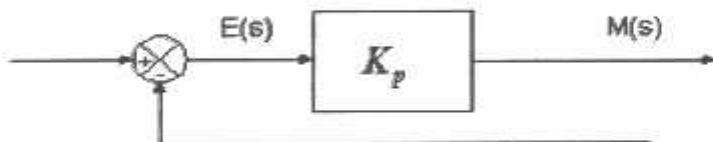
Seperi yang telah dikatakan diatas, ada tiga unsur unit kontroler, yaitu proporsional, integral dan diferensial, yang akan dijelaskan secara bertahap.

2.3.1. Pengendali Proporsional (*Proporsional Controller*)

Salah satu dari ketiga unit kontrol yang paling popular dan paling banyak dipakai adalah unit kontrol P, seperti tercermin dari namanya, besar *output* unit kontrol P selalu sebanding dengan besarnya *input*. Bentuk *transfer function* unit kontrol *proporsional* oleh karenanya akan sederhana sekali, sehingga bentuk *transfer function*-nya juga sederhana. Unit kontrol P adalah unit kontrol yang paling banyak dipakai, baik tersendiri dalam bentuk pengendali *P-only* maupun dalam kombinasi dengan mode integral (I) dan diferensial (D).

Kontroler proporsional memiliki keluaran yang sebanding / proporsional dengan besarnya sinyal kesalahan (selisih antara besaran yang diinginkan dengan harga aktualnya). Secara lebih sederhana dapat dikatakan bahwa keluaran

kontroler proporsional merupakan perkalian antara konstanta proporsional dengan masukan. Perubahan pada sinyal masukan akan segera menyebabkan sistem secara langsung mengubah keluarannya sebesar konstanta pengalinya. *Gambar 2.8* menunjukkan blok diagram yang menggambarkan hubungan antara besaran *setting*, besaran *actual* dengan besaran keluaran kontroler proporsional. Sinyal kesalahan (*error*) merupakan selisih antara besaran *setting* dengan besaran aktualnya. Selisih ini akan mempengaruhi kontroler, untuk mengeluarkan sinyal positif (mempercepat pencapaian harga *setting*) atau negative (memperlambat tercapainya harga yang diinginkan).



Gambar 2.8. Diagram Blok Kontroler Proporsional⁵

Kontroler proporsional memiliki 2 parameter, yaitu pita proporsional (*proporsional band*) dan konstanta proporsional.

Hubungan antara pita proporsional (*PB*) dengan konstanta proporsional (K_p) ditunjukkan secara prosentase oleh persamaan berikut ini :

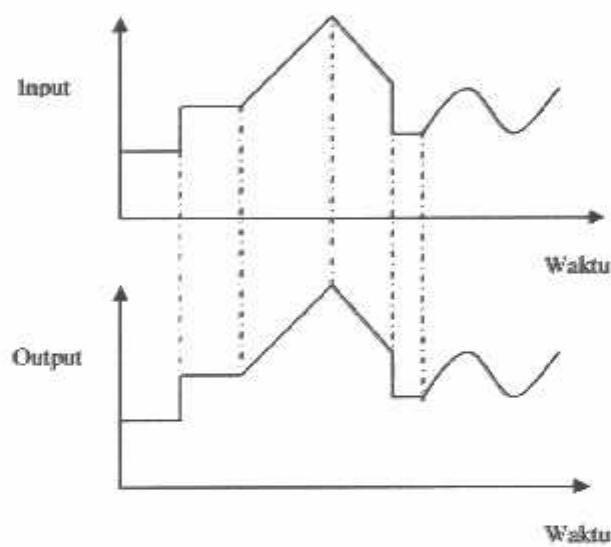
$$PB = \frac{1}{K_p} \times 100\% \quad (22)$$

Dimana :

PB = Proporsional Band

K_p = Konstanta Proporsional

Walaupun hubungan input-output unit kontrol proporsional bukan merupakan fungsi waktu, untuk bahan perbandingan dengan unit kontrol lain, ada baiknya kalau hubungan itu dinyatakan dalam bentuk kurva fungsi waktu. Dari gambar 2.9 jelas terlihat bahwa output selalu mengikuti input secara proporsional. Naik turunnya input diikuti secara langsung oleh output, dan besarnya selalu sama dengan input kali gain. Karena unit kontrol proporsional ini bukan fungsi waktu, dinamik gain pengendali ini sama dengan *steady state* gainnya. Dengan kata lain, besarnya gain tidak tergantung pada besarnya frekuensi loop.



Gambar 2.9. Response Sebuah Pengendali Proporsional¹

Contoh pengendali integral proporsional yang mudah ditemui dalam kehidupan sehari-hari adalah pengisian tangki penampung air di kloset. Hal yang perlu diperhatikan pada contoh ini adalah bahwa kontrol unit di contoh bekerja secara proporsional. Artinya, koreksi dalam hal ini buka tutupnya *control valve*

akan selalu sebanding dengan ketinggian level. *Set point* dalam hal ini adalah sama dengan ketinggian level maksimum.

2.3.2. Pengendali Integral (*Integrator Controller*)

Setelah pengendali proporsional diketahui "gagal" mengendalikan sistem secara sempurna dalam arti masih adanya *offset*. Dikarenakan sifat dasar pengendali proporsional yang masih memerlukan *error* untuk menghasilkan *output*. Oleh karena itu, untuk menghilangkan *offset*, diperlukan pengendali lain yang dapat menghasilkan *output* walaupun sudah tidak ada *input* lagi. Sifat unit inilah yang dimiliki oleh pengendali integral. Sayangnya, kemampuan pengendali integral menghilangkan *offset* tidak disertai kemampuan bercaksi secara cepat. Karena lambatnya reaksi tersebut maka pengendali integral biasanya dipakai dalam kombinasi dengan pengendali proporsional. Kedua pengendali tersebut dipasang secara paralel sehingga kelebihan kedua pengendali dapat dimanfaatkan secara serempak.

Kalau diteliti dengan seksama, *offset* dapat terjadi di sistem pengendali proporsional, karena pengendali proporsional selalu membutuhkan *error* (dalam hal ini *input* ke *unit control*) untuk menghasilkan suatu *output*. Kalau tidak ada *error*, *output* yang keluar dari pengendali proporsional hanyalah bias yang biasanya disetel 50 %.

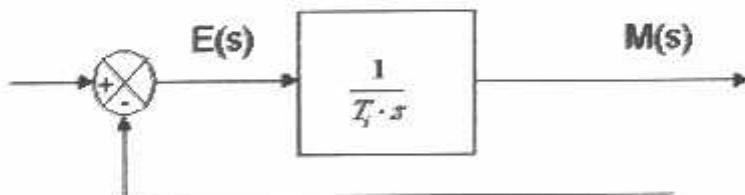
Jadi untuk menghasilkan *offset* dibutuhkan sebuah pengendali lain, yang dapat menghasilkan *output* walaupun padanya tidak diberikan *input*. Dengan kata lain, diperlukan pengendali yang dapat menghasilkan *output* lebih besar atau lebih

kecil dari bias pada saat *input (error)* sama dengan nol. Pengendali yang memenuhi kriteria ini adalah pengendali integral, disingkat I.

Kontroler integral berfungsi menghasilkan respon sistem yang memiliki kesalahan keadaan mantap nol. Kalau sebuah plant tidak memiliki unsur *integrator* ($1/s$), kontroler proporsional tidak akan mampu menjamin keluaran sistem dengan kesalahan keadaan mantapnya nol. Dengan kontroler integral, respon sistem dapat diperbaiki, yaitu mempunyai kesalahan keadaan mantapnya nol.

Kontroler integral memiliki karakteristik seperti halnya sebuah integral. Keluaran kontroler sangat dipengaruhi oleh perubahan yang sebanding dengan nilai sinyal kesalahan. Keluaran kontroler ini merupakan jumlahan yang terus menerus dari perubahan masukannya. Kalau sinyal kesalahan tidak mengalami perubahan, keluaran akan menjaga keadaan seperti sebelum terjadinya perubahan masukan.

Gambar 2.10 menunjukkan blok diagram antara kesalahan dengan keluaran suatu kontroler integral.



Gambar 2.10. Blok Diagram Kontroler Integral⁵

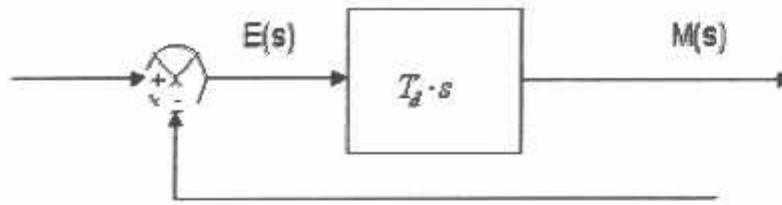
2.3.3. Pengendali Differensial (*Derivative Controller*)

Setelah kekurangan pengendali P yang meninggalkan *offset* diperbaiki oleh pengendali PI, namun masih saja ada ketidakpuasan karena masih lambatnya respon pengendali PI maka digunakanlah pengendali D untuk mengatasi kelambatan respon pengendali PI ini.

Pengendali jenis ini mengandung unsur *derivative* pada *transfer function*-nya, itulah sebabnya pengendali differensial juga disebut pengendali derivative (*derivative controller*), disingkat pengendali D. Kemudian karena sifatnya yang mampu mengeluarkan output ekstra disaat-saat awal, pengendali differensial juga sering disebut *pre-act controller*.

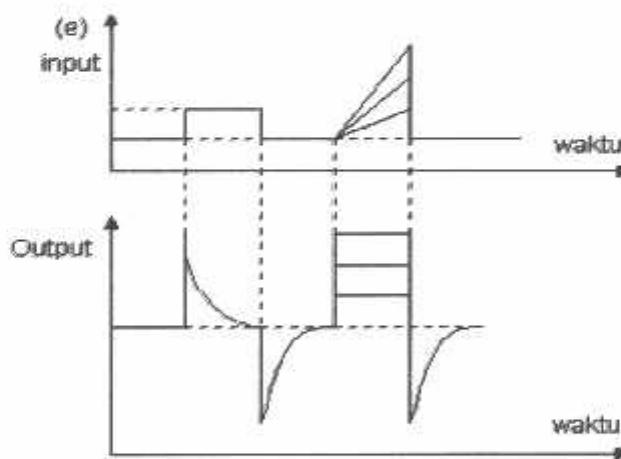
Namun dari segi lain sifat reaktif ini justru membatasi pemakaian pengendali differensial. Pengendali differensial tidak akan pernah dapat dipakai pada proses *variable* yang bergelombang atau mengandung *noise*, misalnya pengendali level atau *flow*. Sinyal yang keluar dari kedua proses *variable* tersebut, biasanya mengandung riak dan gelombang yang oleh pengendali D akan dideferensialkan menjadi pulsa-pulsa yang tidak beraturan dan sistem menjadi kacau. Keadaan kacau itu akan diikuti kerusakan peralatan mekanik yang ada pada loop dan berakibat fatal.

Keluaran kontroler differensial memiliki sifat seperti halnya suatu operasi *derivative*. Perubahan yang mendadak pada masukan kontroler, akan mengakibatkan perubahan yang sangat besar dan cepat. *Gambar 2.11* menunjukkan blok diagram yang menggambarkan hubungan antara sinyal kesalahan dengan keluaran kontroler.



Gambar 2.11. Blok Diagram Kontroler Differensial⁵

Gambar 2.12 menyatakan hubungan antara sinyal masukan dengan sinyal keluaran kontroler differensial. Ketika masukannya tidak mengalami perubahan, keluaran kontroler juga tidak mengalami perubahan, sedangkan apabila sinyal masukan berubah mendadak naik (berbentuk fungsi *step*), keluaran menghasilkan sinyal berbentuk *impuls*. Jika sinyal masukan berubah naik secara perlahan (fungsi *ramp*), keluarannya justru merupakan fungsi *step* yang besar *magnitude*-nya sangat dipengaruhi oleh kecepatan naik dari fungsi *ramp* dan faktor konstanta differensialnya T_d .



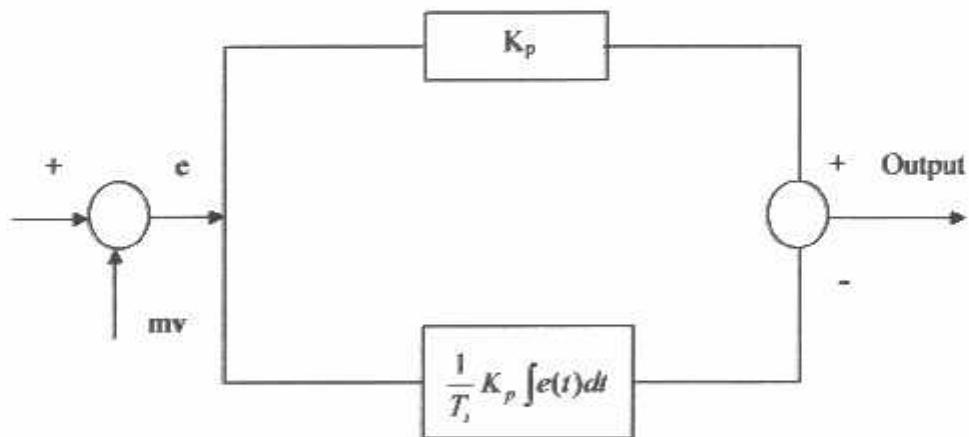
Gambar 2.12. Kurva Waktu Hubungan Input-Output

KontrolerDifferensial¹

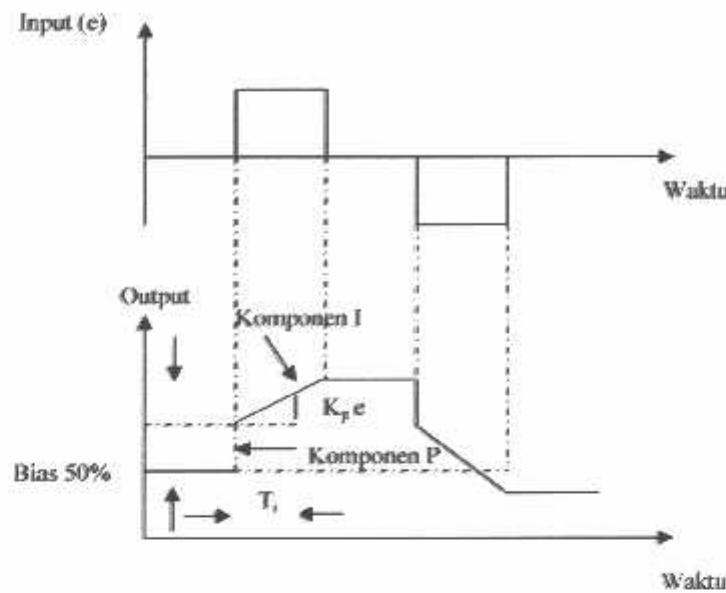
Berdasarkan karakteristik kontroler tersebut, kontroler differensial umumnya dipakai untuk mempercepat respon awal suatu sistem, tetapi tidak memperkecil kesalahan pada keadaan tunaknya. Kerja kontroler differensial hanyalah efektif pada lingkup yang sempit, yaitu pada periode peralihan. Oleh sebab itu kontroler differensial tidak pernah digunakan tanpa ada kontroler lain di dalam sistem tersebut.

2.3.4. Pengendali Proporsional Plus Integral (*PI Controller*)

Karena sifatnya yang tidak mengeluarkan *output* sebelum selang waktu tertentu, pengendali integral jadi memperlambat respon, walaupun *offset* hilang oleh karenanya. Untuk memperbaiki lambatnya respon, umumnya pengendali integral dipasang paralel dengan pengendali proporsional seperti *gambar 2.13*. Gabungan kedua pengendali tersebut lazim disebut dengan pengendali PI atau PI kontroler, dan pengendali dikatakan punya dua mode, yaitu P dan I.



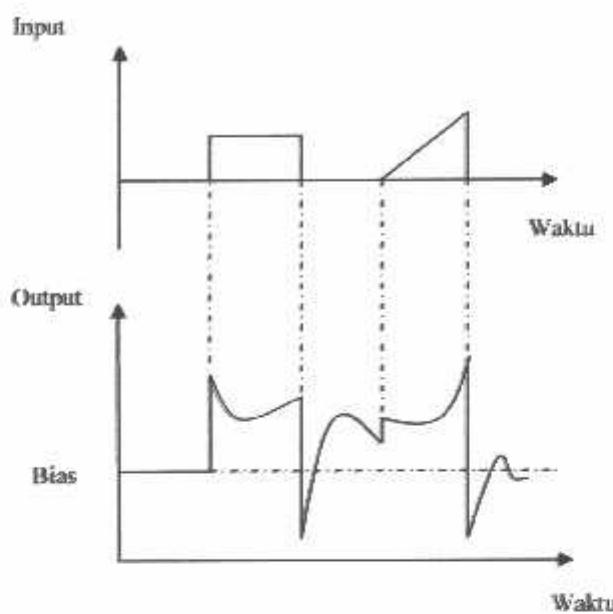
Gambar 2.13. Diagram Kotak Pengendali Proporsional Plus Integral¹



Gambar 2.14. Hubungan Input-Output Pengendali PI dalam Fungsi Waktu¹

2.3. 5. Pengendali Proporsional Plus Differensial (*PD Controller*)

Karena sifatnya yang hanya menghasilkan *output* bila ada perubahan input, pengendali differensial tidak pernah dipakai sendirian. Desain, pengendali differensial dipasang paralel dengan pengendali proporsional, kemudian disebut pengendali PD. Karena pengendali PD adalah gabungan proporsional dan pengendali differensial, ia memiliki sifat yang ada pada pengendali P dan pengendali D.



Gambar 2.15. Output Pengendali Proporsional Plus Differensial Terhadap Input Fungsi Step¹

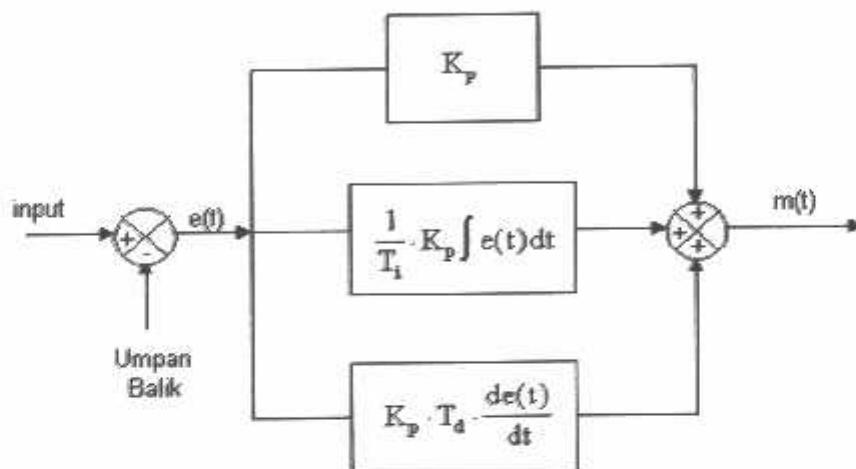
Transfer function pengendali PD adalah *transfer function* pengendali P ditambah *transfer function* pengendali D, sehingga dinamik gain pengendali D.

Selain itu, unit kontrol D dirangkaikan secara unik didalam sebuah pengendali, baik pengendali dengan mode PID. Unit D dibuat hanya bekerja untuk perubahan load, namun tidak untuk perubahan *set point*.

2.3.6. Proporsional Plus Integral Plus Differensial (*PID Controller*)

Setiap kekurangan dan kelebihan dari masing-masing kontroler P, I dan D dapat saling menutupi dengan menggabungkan ketiganya secara paralel menjadi kontroler proporsional plus integral plus differensial (kontroler PID). Elemen-

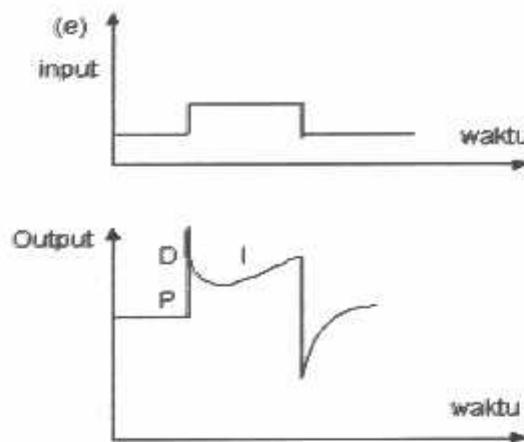
elemen kontroler P, I dan D masing-masing secara keseluruhan bertujuan untuk mempercepat reaksi sebuah sistem, menghilangkan *offset* dan menghasilkan perubahan awal yang besar. Gambar 2.16 menunjukkan blok diagram kontroler PID.



Gambar 2.16. Blok Diagram Kontroler PID⁵

Keluaran kontroler PID merupakan jumlahan dari keluaran kontroler proporsional, keluaran kontroler integral. Gambar 2.17 menunjukkan hubungan tersebut. Seperti pengendali PI dan PD, diagram kotak pengendali PID akan merupakan bentuk paralel dari ketiga unit kontrol seperti gambar 2.16. Transfer function pengendali ini adalah sebagai berikut :

$$\begin{aligned} O &= \frac{100\%}{PB} \left(1 + \frac{1}{T_i} \int e(t) dt + T_d \frac{de(t)}{dt} \right) \\ &= K_p \left(1 + \frac{1}{T_i} \int e(t) dt + T_d \frac{de(t)}{dt} \right) \end{aligned}$$



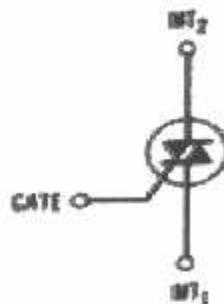
Gambar 2.17. Hubungan Dalam Fungsi Waktu Antara Sinyal Keluaran Dengan Masukan Untuk Kontroler PID⁵

Karakteristik kontroler PID sangat dipengaruhi oleh kontribusi besar dari ketiga parameter P , I dan D . Penyetelan konstanta K_p , T_i dan T_d akan mengakibatkan penonjolan sifat dari masing-masing elemen. Satu atau dua dari ketiga konstanta tersebut dapat disetel lebih menonjol dibandingkan dengan yang lain. Konstanta yang menonjol itulah akan memberikan kontribusi pengaruh pada respon sistem secara keseluruhan.

2.4. TRIAC

Triac dapat bersifat konduktif dalam dua arah dan biasa digunakan untuk pengendali fasa ac. Hal ini dapat dianggap sebagai dua buah SCR yang dihubungkan secara paralel berkebalikan dengan terminal gate bersama. Triac dapat dipicu dengan tegangan polaritas positif dan negatif, serta dapat dihidupkan

dengan menggunakan tegangan bolak-balik pada gate. Triac banyak digunakan pada rangkaian pengendali dan pensaklaran.



Gambar 2.18. Lambang TRIAC⁶

karena Triac merupakan komponen bidirectional, terminalnya tidak dapat ditentukan sebagai anoda/katoda. Jika terminal MT2 positif terhadap MT1, Triac dapat dimatikan dengan memberikan sinyal gerbang positif antara gerbang G dan terminal MT1. jika terminal MT2 negatif terhadap MT1, maka Triac dapat dihidupkan dengan memberikan sinyal pulsa negatif antara gerbang G dan terminal MT1. Tidak perlu untuk memiliki kedua sinyal gerbang positif maupun negatif dan Triac dapat dihidupkan oleh sinyal gerbang positif maupun negatif.

BAB III

PERANCANGAN SISTEM

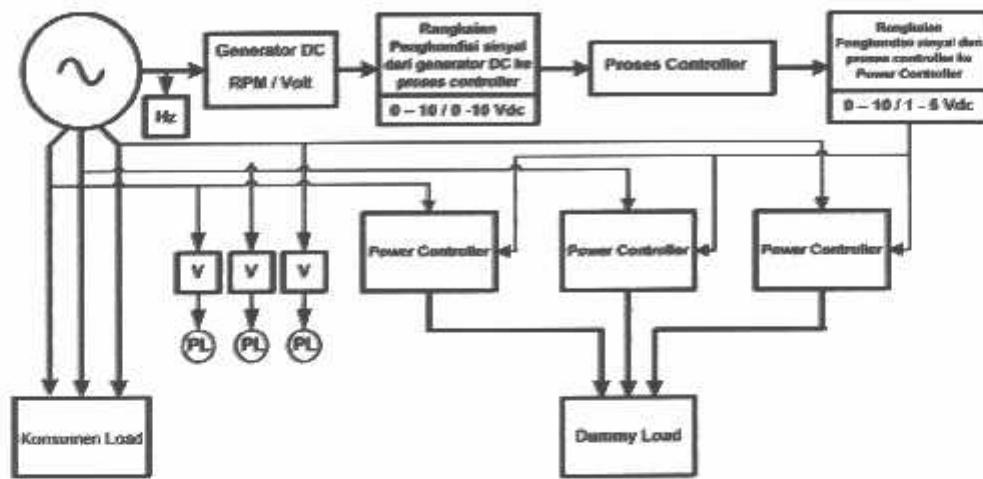
3.1. Perancangan Perangkat Keras.

Secara umum rancangan perangkat keras dari alat terdiri dari 8 bagian utama, yaitu :

- 1) Generator utama
- 2) RPM ke Volt
- 3) Rangkaian pengkondisi sinyal dari generator DC ke Proses Controller
- 4) Proses Controller
- 5) Rangkaian pengkondisi sinyal dari Proses Controller ke Power controller
- 6) Power controller
- 7) Dummy Load
- 8) Beban Konsumen

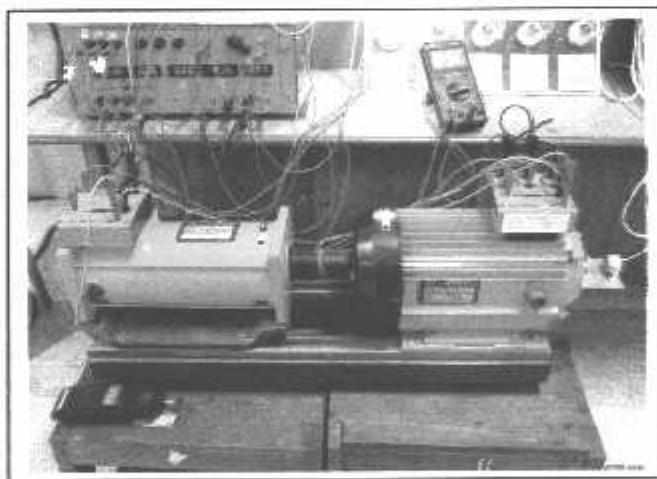
3.2. Diagram Blok

Secara garis besar, rancangan keseluruhan dari sistem ini dapat digambarkan seperti gambar 3.1. berikut ini.



Gambar 3.1. Diagram blok keseluruhan sistem

3.2.1. Generator Utama



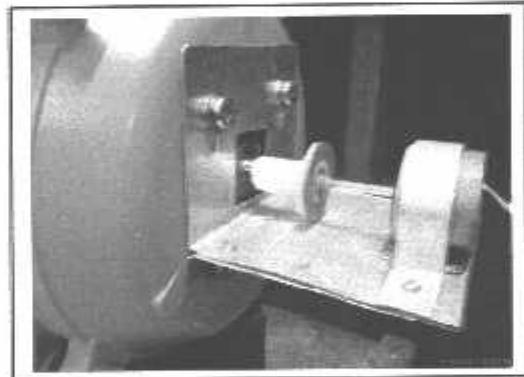
Gambar 3.2. Generator Utama

Menggunakan generator sinkron dengan spesifikasi sebagai berikut :

Model	DL1026A
Daya	1,1KVA
Cosφ	0,85
frekuensi	50HZ
Tegangan Penguatan	175 Volt
Putaran	3000 RPM
Tegangan keluaran	220/380 V Δ/Y
Arus keluaran	2,9/1,7 Amp Δ/Y

3.2.2. Transducer Putaran

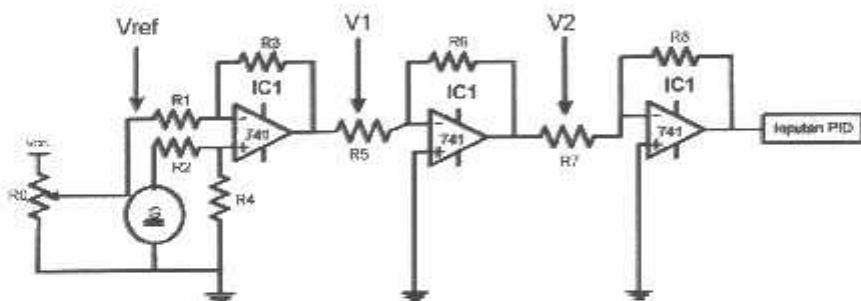
Untuk merubah frekuensi ke tegangan menggunakan generator DC yang dikopel langsung dengan rotor generator utama.



Gambar 3.3. Generator DC 6 Volt

3.2.3. Rangkaian Pengkondisi Sinyal dari generator ke PID

Rangkaian ini berfungsi untuk menseting agar pada saat putaran generator 2000 rpm PID mendapat inputan 0 Volt dan ketika mencapai 3000 rpm PID mendapat inputan 10 Volt. Settingan ini didasarkan pada inputan PID yang membutuhkan tegangan 0-10 Volt. Perubahan output proporsional dengan perubahan input. Pertama-tama Vref dibuat sama dengan tegangan generator pada saat 2000 RPM dengan jalan memutar potensiometer ini dimaksudkan agar pada saat 2000 RPM V_1 sama dengan nol maka V_2 juga nol dan inputan PID juga nol (mengsetting agar pada saat 2000 RPM dan inputan PID juga nol). Untuk lebih jelasnya perhatikan gambar rangkaian dibawah ini:



Gambar 3.4. Rangkaian antar muka dari generator ke PID

Daftar Komponen :

- ◆ Resistor $R_1, R_2, R_3, R_4, R_5, R_6$: $10\text{ K}\Omega$.
- ◆ Resistor R_7 : $1\text{ K}\Omega$
- ◆ Resistor R_9 : $10\text{ K}\Omega$
- ◆ Potensiometer (R_8) : $10\text{ K}\Omega$ (Disetting $73529,411\text{ }\Omega$)

↳ Op Amp (IC1) : UA 741

↳ V_{ref} : 0,264 Volt

↳ V_{gen} : 0,4 Volt

Analisa perhitungan dari gambar diatas didasarkan pada putaran generatator 3000 rpm dengan frekuensi 50Hz.

$$V_1 = (\text{Gen- } V_{\text{ref}}) \frac{R_3}{R_1}$$

$$= (0,4 - 0,264) \frac{10}{10}$$

$$= 0,136 \text{ Volt}$$

$$V_2 = V_1 \frac{R_2}{R_4}$$

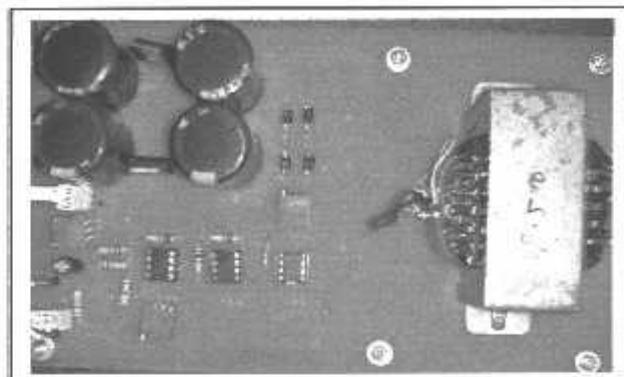
$$= 0,136 \frac{10}{10}$$

$$= 0,136 \text{ Volt}$$

$$\text{Inputan Proses Controller} = V_2 \frac{R_8}{R_7}$$

$$= 0,136 \frac{73529,411}{1000}$$

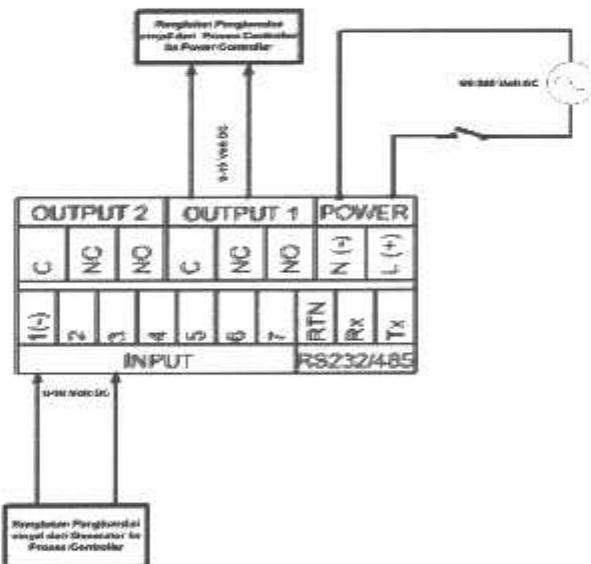
$$= 10 \text{ Volt}$$



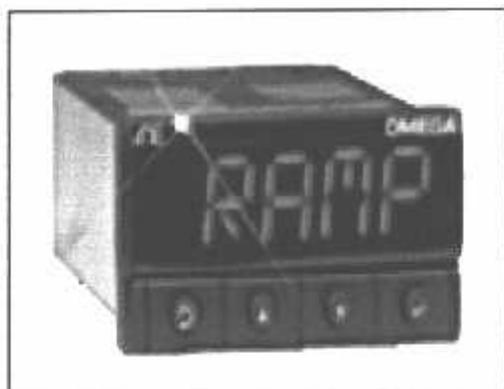
Gambar 3.5. Foto rangkaian Pengkondisi Sinyal dari generator ke PID

3.2.4. Proses Controller

Catu daya yang dibutuhkan oleh proses controller 90-240 Vac. Memilih inputan tegangan analog 0-10 Vdc dan outputan tegangan analog 0-10 Vdc. Untuk detail pengawatannya dapat dilihat pada gambar dibawah:



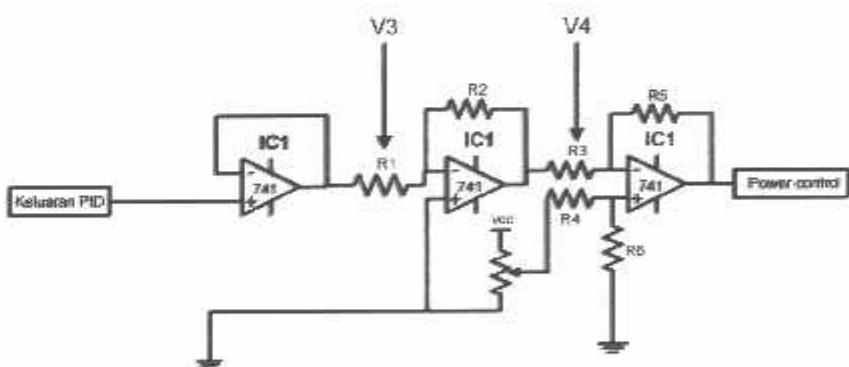
Gambar 3.6.Pengawatan Proses Controller⁸



Gambar 3.7. Bentuk fisik dari Proses Control merk Omega tipe iSeries⁸

3.2.5. Rangkaian Pengkondisi Sinyal dari PID ke Power Control

Rangkaian ini bersfungsi untuk menseting agar pada saat outputan PID 0 Volt power control mendapat inputan 1 Volt dan ketika outputan PID 10 volt power control mendapat inputan 5 Volt. Setingan ini didasarkan pada inputan power control yang membutuhkan tegangan 1-5 Volt. Perubahan output proporsional dengan perubahan input. Pertama-tama Vref dibuat sama dengan tegangan V_1 pada saat 2000 RPM dengan jalan memutar potensiometer ini dimaksudkan agar pada saat 2000 RPM power control mengeluarkan tegangan 1 Volt. Untuk lebih jelasnya perhatikan gambar rangkaian dibawah ini:



Gambar 3.8. Rangkaian Pengkondisi Sinyal dari PID ke Power Controller

Daftar Komponen :

↳ Resistor $R_1, R_3, R_4, R_5 = 10 \text{ k}\Omega$.

↳ Potentiometer (R_2) : $10 \text{ k}\Omega$.

↳ Op Amp (IC1) : UA 741

Analisa perhitungan dari gambar diatas didasarkan pada putaran generotor 2000 rpm dengan frekuensi 33,333 Hz.

V_3 – Keluaran PID

$$= 10 \text{ Volt}$$

$$V_4 = V_3 \left(-\frac{R_2}{R_1} \right)$$

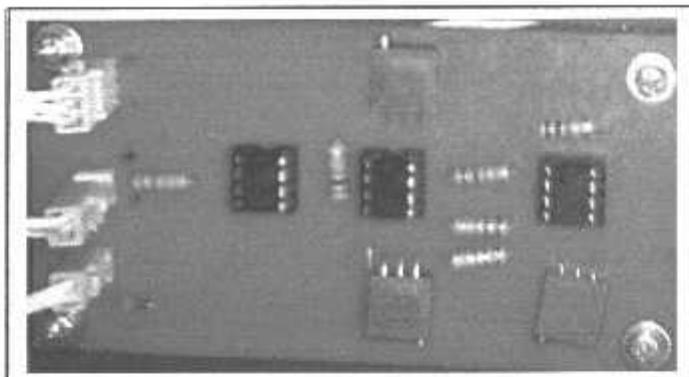
$$= 10 \left(-\frac{4}{10} \right)$$

$$= 4 \text{ Volt}$$

$$\text{Input Power control} = -(V_{ref} + V_4) \frac{R_5}{R_6}$$

$$= -(1+4) \frac{10}{10} \text{ Volt}$$

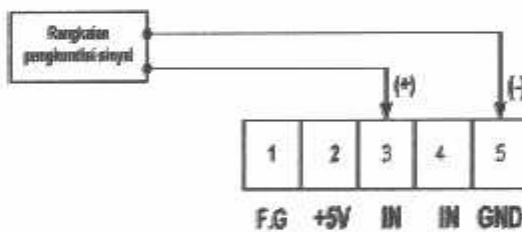
$$= 5 \text{ Volt}$$



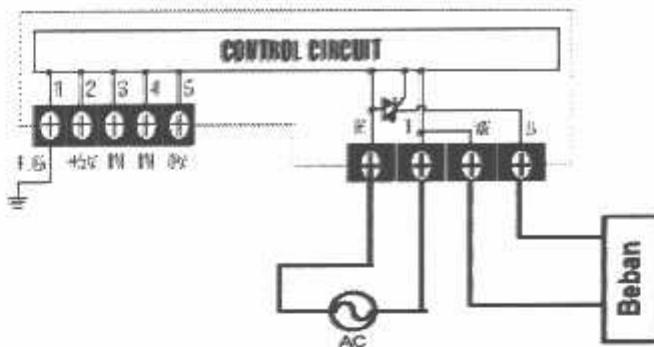
Gambar 3.9. Bentuk fisik Rangkaian Pengkondisi Sinyal dari generator ke PID Controller

3.2.6. Power Controller

Sambungan terminal input dan output pada power controller (autonics), tegangan input control 1-5 Vdc. Pemkontrolan dapat diterapkan mulai dari 0-100% pada terminal 3 dan 5, perhatikan gambar dibawah :



Gambar 3.10. Pengawatan Sinyal Inputan Power Controller⁹



Gambar 3.11. Pengawatan output dan input Power Controller⁹

Power controller mempunyai 3 mode yaitu :

1. Fasa control

Fasa control dapat mengontrol power dari 0 % ke 100%, hal ini dapat dilakukan dengan sinyal masukan 1-5 Volt.

2. Cycle control

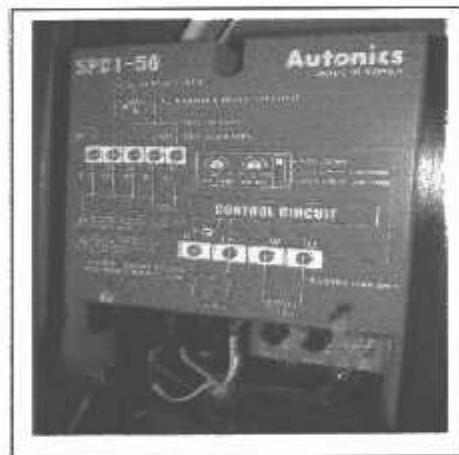
Control tegangan yang diberikan kebeban merupakan siklus on/off berkesinambungan yang mana bersesuaian dengan sinyal masukan. Pengontrolan ini tidak menimbulkan noise karena perpindahan on dan off berada pada titik zero tetapi hanya mempunyai empat variasi :

- Dengan inputan 1 VoltDC / 4 mADC menyalurkan daya 0 %.
- Dengan inputan 2 VoltDC / 8 mADC menyalurkan daya 25 %.
- Dengan inputan 3 VoltDC / 12 mADC menyalurkan daya 50 %.
- Dengan inputan 5 VoltDC / 20 mADC menyalurkan daya 100 %.

3. On/Off control

Ketika inputan ON maka output 100 % dan ketika Off output 0 %, fungsi ini sama dengan relay.

Dari ketiga jenis mode control diatas, cycle control hanya mempunyai 4 variasi control, hal ini tidak dimungkinkan untuk mengontrol dummy load karena dummy load harus variasi control dari 0 – 100 %. Sedangkan ON/Off control hanya mempunyai 2 variasi outputan 0 % atau 100 %, hal ini juga tidak memenuhi syarat untuk mengontrol dummy load. Selanjutnya fasa control mempunyai variasi output 0 – 100 %, jadi fasa control dipilih sebagai mode control yang tepat untuk mengontrol dummy load. Bentuk fisik Power Controller seperti dibawah ini:



Gambar 3.12. Foto dari Power Control

3.2.7. Dummy Load

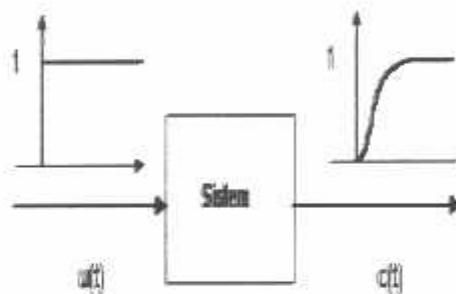
Untuk beban dummy load menggunakan lampu pijar 6x 100 Watt dengan beban masing-masing fasa R = 200 Watt, S = 200 Watt, T = 200 Watt.

3.2.8. Beban Konsumen

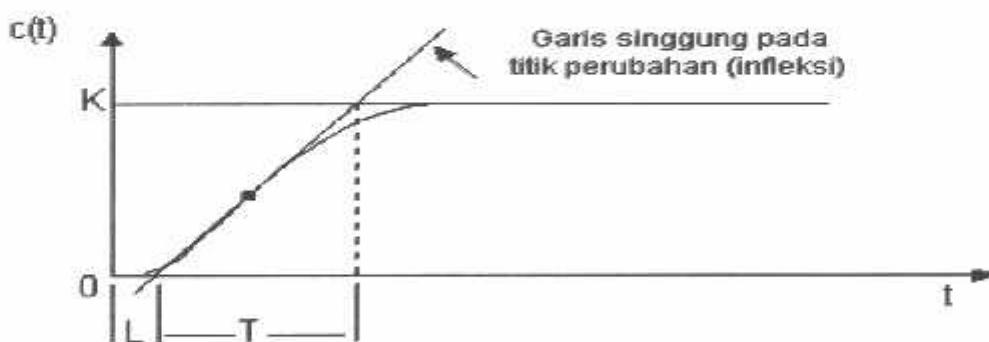
Untuk beban dummy load menggunakan lampu pijar 3x 100 Watt, 3x 60 Watt, 3x 100 Watt dengan beban masing-masing fasa $R = 165$ Watt, $S = 165$ Watt, $T = 165$ Watt.

3.3. Menggunakan Metode Kurva Reaksi

Untuk mencari parameter dari PID perhitungan didasarkan pada Metode Kurva Reaksi karena metode ini sangat memungkinkan untuk digunakan mengingat keterbatasan alat di laboratorium.



Gambar 3.13. Respon Tangga Satuan Sistem¹



Gambar 3.14. Kurva Respons Berbentuk S¹

Dari data didapatkan: L = 0,8 detik

$$T = 0,2 \text{ detik}$$

$$K_p = \frac{T}{L}$$

$$= \frac{0,8}{0,2}$$

$$= 4$$

$$T_i = 0$$

$$T_d = 0$$

$$K_d = K_p \times T_d$$

$$= 4 \times 0$$

$$= 0$$

$$K_i = \frac{K_p}{T_i}$$

$$K_i = \frac{4}{0}$$

$$= 0 \text{ mS}$$

Maka untuk PI

$$K_p = 0,9 \frac{T}{L}$$

$$= 0,9 \frac{0,8}{0,2}$$

$$= 3,6$$

$$T_i = \frac{L}{0,3}$$

$$= \frac{0,2}{0,3}$$

$$= 0,666 \text{ mS}$$

$$T_d = 0$$

$$K_d = K_p \times T_d$$

$$= 3,6 \times 0$$

$$= 0 \text{ mS}$$

$$K_i = \frac{K_p}{T_i}$$

$$K_i = \frac{3,6}{0,666}$$

$$= 5,4 \text{ mS}$$

Maka untuk PID

$$K_p = 1,2 \frac{T}{L}$$

$$= 1,2 \frac{0,8}{0,2}$$

$$= 4,8$$

$$T_i = 2L$$

$$T_i = 2 \times 0,2$$

$$= 0,4 \text{ mS}$$

$$K_d = K_p \times T_d$$

$$= 4,8 \times 0,1$$

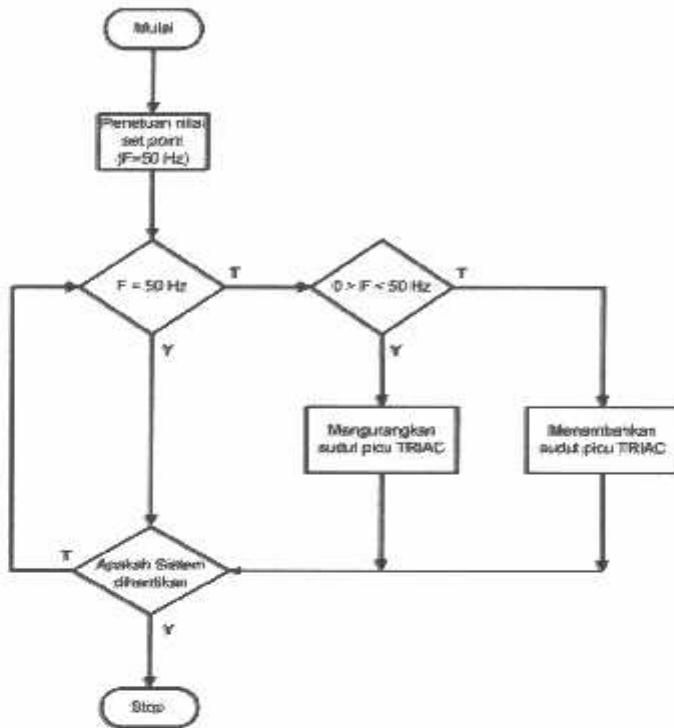
$$= 0,48 \text{ mS}$$

$$K_i = \frac{K_p}{T_i}$$

$$K_i = \frac{4,8}{0,4}$$

$$= 5,4 \text{ mS}$$

3.4. Flowchart



BAB IV

PENGUJIAN ALAT

4.1. Prosedur Pengujian Alat

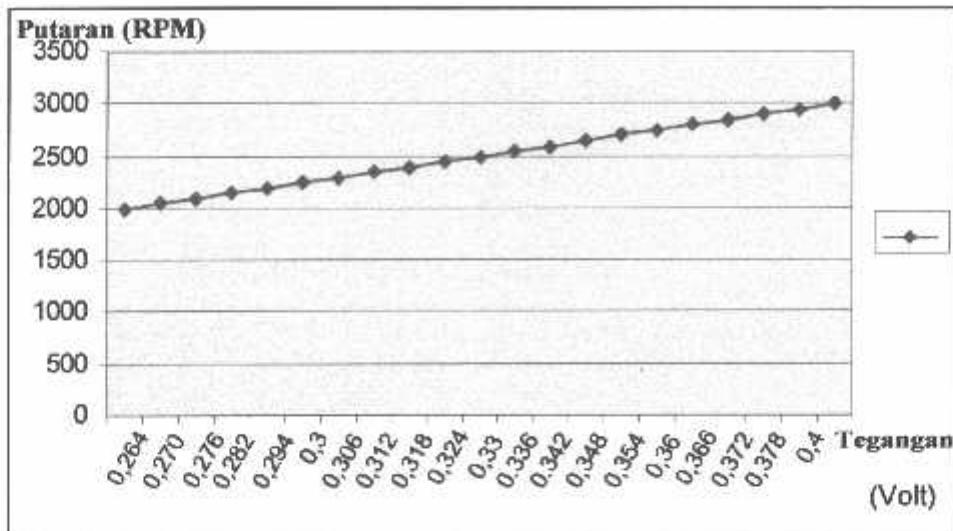
1. Aktifkan MCB utama 3 fasa
2. Setting Voltage Regulator sampai motor mulai berputar pelan.
3. Posisikan starting Rheostart ke posisi 0Ω .
4. Posisikan Rheifield Rheostart pada Posisi Maksimum
5. Setting kembali Voltage Regulator sampai putaran motor yang diinginkan mencapai 3000 rpm.
6. Masukkan penguatan generator sampai tegangan output generator mencapai 220 Volt.
7. Pastikan tegangan generator 220 Volt dan putaran 3000 rpm.
8. Masukkan beban ke Dummy Load.
9. Atur variasi beban pada beban konsumen sesuai dengan yang diinginkan.

4.2. Pengujian Tranduser Putaran

Sebelum menentukan $V_{refcrensi}$ dari rangkaian pengkondisi sinyal diperlukan data dari tranduser putaran hubungan antara putaran dan tegangan.

Tabel 4.1. Data Pengujian IIhubungan antara Putaran dan Tegangan

No	Putaran (RPM)	Frekuensi (Hz)	Tegangan (Volt)
1	2000	33,33	0,264
2	2050	34,16	0,27
3	2100	35	0,276
4	2150	35,83	0,282
5	2200	36,66	0,288
6	2250	37,5	0,294
7	2300	38,33	0,3
8	2350	39,16	0,306
9	2400	40	0,312
10	2450	40,83	0,318
11	2500	41,66	0,324
12	2550	42,5	0,33
13	2600	43,33	0,336
14	2650	44,16	0,342
15	2700	45	0,348
16	2750	45,83	0,354
17	2800	46,667	0,36
18	2850	47,5	0,366
19	2900	48,33	0,372
20	2950	49,16	0,378
21	3000	50	0,4

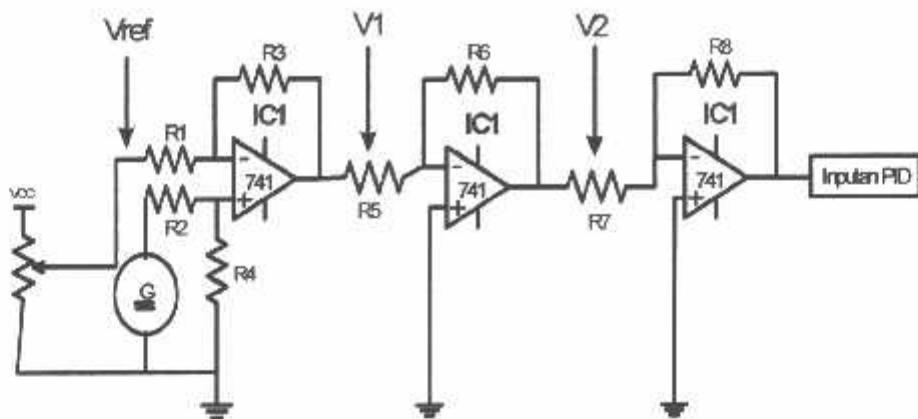


Gambar 4.1. Grafik Putaran dan Tegangan

4.3. Pengujian Rangkaian Pengkondisi Sinyal dari generator ke Proses

controller

Untuk membuktikan bahwa rangkaian pengkondisi sinyal dari generator ke Proses Controller dapat bekerja sesuai dengan yang direncanakan maka dilakukan pengujian dengan menggunakan osilloscope dan hasilnya dibandingkan dengan perencanaan dan bila perlu dilakukan perbaikan. Gambar 4.2. menjelaskan dititik mana saja yang diamati. Untuk lebih jelasnya perhatikan gambar rangkaian dibawah ini:



Gambar 4.2. Rangkaian pengkondisi sinyal dari generator ke PID

Tabel 4.2. Data Perancangan dan Pengujian VI Rangkaian Pengkondisi Sinyal dari Generator ke Proses Controller

No	Putaran (rpm)	Perancangan V1 (Volt)	Pengujian V1 (Volt)	Error
1	2000	0	0	0
2	2050	0,006	0,005	0,0006
3	2100	0,012	0,014	0,002
4	2150	0,018	0,02	0,002
5	2200	0,024	0,027	0,003
6	2250	0,03	0,039	0,009
7	2300	0,036	0,044	0,008
8	2350	0,042	0,052	0,01
9	2400	0,048	0,06	0,012
10	2450	0,054	0,068	0,014
11	2500	0,06	0,074	0,014
12	2550	0,066	0,08	0,014
13	2600	0,072	0,092	0,02
14	2650	0,078	0,092	0,014
15	2700	0,084	0,098	0,014
16	2750	0,09	0,106	0,016
17	2800	0,096	0,112	0,016
18	2850	0,102	0,12	0,018
19	2900	0,108	0,126	0,018
20	2950	0,114	0,134	0,02
21	3000	0,136	0,142	0,0062

Dari tabel diatas, Error terendah terjadi pada 2000 rpm dengan error 0 dan error tertinggi terjadi pada 2950 rpm dan 2600 rpm dengan error 0,02.

Tabel 4.3. Data Perancangan dan Pengujian V2 Rangkaian Pengkondisi Sinyal dari Generator ke Proses Controller

No.	Putaran (rpm)	Perancangan V2 (Volt)	Pengujian V2 (Volt)	Error
1	2000	0	0	0
2	2050	-0,006	-0,0068	0,0008
3	2100	-0,012	-0,014	0,002
4	2150	-0,018	-0,019	0,001
5	2200	-0,024	-0,026	0,002
6	2250	-0,03	-0,033	0,003
7	2300	-0,036	-0,034	0,002
8	2350	-0,042	-0,048	0,006
9	2400	-0,048	-0,044	0,004
10	2450	-0,054	-0,052	0,002
11	2500	-0,06	-0,062	0,002
12	2550	-0,066	-0,068	0,002
13	2600	-0,072	-0,074	0,002
14	2650	-0,078	-0,079	0,001
15	2700	-0,084	-0,081	0,003
16	2750	-0,09	-0,094	0,004
17	2800	-0,096	-0,098	0,002
18	2850	-0,102	-0,101	0,001
19	2900	-0,108	-0,108	0
20	2950	-0,114	-0,144	0,03
21	3000	-0,136	-0,1263	0,009

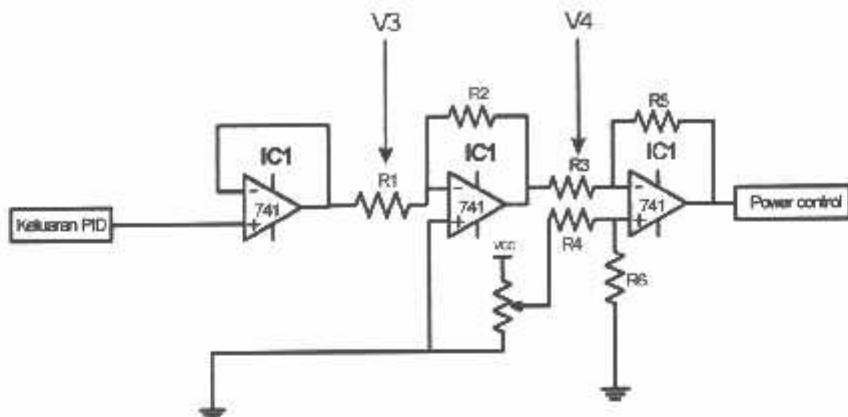
Dari tabel diatas, Error terendah terjadi pada 2000 rpm dan 2900 rpm dengan error 0 dan error tertinggi terjadi pada 2950 rpm dengan error 0,03.

Tabel 4.4. Data Perancangan dan Pengujian *Input Proses Controller* Rangkaian Pengkondisi Sinyal dari Generator ke *Proses Controller*

No	Putaran (rpm)	Perancangan <i>Input Proses Controller</i> (Volt)	Pengujian <i>Input Proses Controller</i> (Volt)	Error
1	2000	0	0,02	0,02
2	2050	0,441	0,46	0,018
3	2100	0,882	0,92	0,037
4	2150	1,323	1,28	0,043
5	2200	1,764	1,72	0,044
6	2250	2,205	2,34	0,134
7	2300	2,647	2,72	0,072
8	2350	3,088	3,02	0,068
9	2400	3,529	3,49	0,039
10	2450	3,970	3,94	0,030
11	2500	4,411	4,88	0,468
12	2550	4,852	5	0,147
13	2600	5,294	5,25	0,044
14	2650	5,7358	5,7	0,035
15	2700	6,176	6,12	0,056
16	2750	6,617	6,65	0,0321
17	2800	7,058	7,09	0,031
18	2850	7,5	8	0,5
19	2900	7,941	8,5	0,558
21	2950	8,382	9,44	1,057
21	3000	10	9,88	0,12

4.4. Pengujian Rangkaian Pengkondisi Sinyal dari PID ke Power Controller

Untuk membuktikan bahwa rangkaian pengkondisi sinyal dari PID ke power controller dapat bekerja sesuai dengan yang direncanakan maka dilakukan pengujian dengan menggunakan osiloscope dan hasilnya dibandingkan dengan perencanaan dan bila perlu dilakukan perbaikan. Gambar 4.3. menjabarkan titik mana saja yang diamati. Untuk lebih jelasnya perhatikan gambar rangkaian dibawah ini:



Gambar 4.3. Rangkaian pengkondisi sinyal dari PID ke Power Controller

Tabel 4.5. Data Perancangan dan Pengujian V3 Rangkaian Pengkondisi Sinyal dari Proses Controller ke Power Controller

No	Keluaran Proses Controller (Volt)	Perancangan V3 (Volt)	Pengujian V3 (Volt)	Error
1	0	0	0,001	0,001
2	1	1	1,02	0,02
3	2	2	2,02	0,02
4	3	3	3,04	0,04
5	4	4	4,02	0,02
6	5	5	5,08	0,08
7	6	6	5,5	0,5
8	7	7	6,9	0,1
9	8	8	7,98	0,02
10	9	9	8,99	0,01

Dari tabel diatas, Error terendah terjadi pada 0 Volt dengan error 0,001 dan error tertinggi terjadi pada 6 Volt dengan error 0,5.

Tabel 4.6. Data Perancangan dan Pengujian V4 Rangkaian Pengkondisi Sinyal dari Proses Controller ke Power Controller

No	Perancangan V4 (Volt)	Pengujian V4 (Volt)	Error
1	0	0	0
2	0,4	0,38	0,02
3	0,8	0,82	0,02
4	1,2	1,19	0,01
5	1,6	1,64	0,04
6	2	1,98	0,02
7	2,4	2,38	0,02
8	2,8	2,79	0,01
9	3,2	3,22	0,02
10	3,6	3,62	0,02
11	4	3,89	0,11

Tabel 4.7. Data Perancangan dan Pengujian Power Control Rangkaian Pengkondisi Sinyal dari Proses Controller ke Power Controller

No	Perancangan power control (Volt)	Pengujian power control (Volt)	Error
1	1	0,88	0,12
2	1,4	1,39	0,01
3	1,8	1,78	0,02
4	2,2	2,23	0,03
5	2,6	2,59	0,01
6	3	3,05	0,05
7	3,4	3,46	0,06
8	3,8	3,74	0,06
9	4,2	4,18	0,02
10	4,6	4,53	0,07
11	5	4,97	0,03

4.5. Tabel perhitungan parameter PID dengan menggunakan metode kurva reaksi

Tabel 4.8. Hasil Perhitungan Parameter kontroler K_p, T_i dan T_d

Sistem loop tertutup Ziegler –Nicolt	K _p	T _i	T _d
Kontrol P	4	0	0
Kontrol P+I	3,6	0,666 mS	0
Kontrol P+I+D	4,8	0,4 mS	0,1 mS

Tabel 4.9. Hasil Perhitungan Parameter kontroler K_p, K_i dan K_d

Sistem loop tertutup Ziegler –Nicolt	K _p	K _i	K _d
Kontrol P	4	0	0
Kontrol P+I	3,6	5,4 mS	0
Kontrol P+I+D	4,8	5,4 mS	0,48 mS

4.6. Pengujian Rangkaian keseluruhan dari sistem

Pengujian Rangkaian keseluruhan dari sistem dengan parameter dari PID dengan nilai

$$P = 4,8$$

$$I = 5,4 \text{ mS}$$

$$D = 0,48 \text{ mS}$$

Tabel 4.10. Data pengujian berbeban

Beban	Fasa	Beban (Watt)	Output Proses Controller	Input Power Controller
1	R	165	3,8	2,52
	S	165		
	T	165		
2	R	60	8	4,2
	S	5		
	T	100		
3	R	100	7,0	3,8
	S	60		
	T	100		
4	R	5	5,7	3,28
	S	100		
	T	100		
5	R	100	6,8	3,72
	S	100		
	T	100		

Analisa data dari tabel diatas:

❖ Pada beban 1:

$$V_3 = \text{Keluaran Proses Controller}$$

$$= 3,8 \text{ Volt}$$

$$V_4 = V_3 \left(-\frac{R_2}{R_1} \right)$$

$$= 3,8 \left(-\frac{4}{10} \right)$$

$$= 1,52 \text{ Volt}$$

$$\text{Input Power control} = -(V_{ref} + V_4) \frac{R_t}{R_o}$$

$$= -(1+1,52) \frac{10}{10} \text{ Volt}$$

$$= -2,52 \text{ Volt}$$

❖ Pada beban 2:

$$V_3 = \text{Keluaran Proses Controller}$$

$$= 8 \text{ Volt}$$

$$V_4 = V_3 \left(-\frac{R_2}{R_1} \right)$$

$$= 8 \left(-\frac{4}{10} \right)$$

$$= 3,2 \text{ Volt}$$

$$\begin{aligned}\text{Input Power control} &= -(V_{ref} + V_4) \frac{R_3}{R_6} \\ &= -(1+3,2) \frac{10}{10} \text{ Volt} \\ &= 4,2 \text{ Volt}\end{aligned}$$

❖ Pada beban 3:

V_3 = Keluaran Proses Controller

= 7 Volt

$$\begin{aligned}V_4 &= V_3 \left(-\frac{R_2}{R_1} \right) \\ &= 7 \left(-\frac{4}{10} \right)\end{aligned}$$

= 2,8 Volt

$$\begin{aligned}\text{Input Power control} &= -(V_{ref} + V_4) \frac{R_3}{R_6} \\ &= -(1+2,8) \frac{10}{10} \text{ Volt} \\ &= 3,8 \text{ Volt}\end{aligned}$$

❖ Pada beban 4:

V_3 = Keluaran Proses Controller

= 5,7 Volt

$$V_4 = V_3 \left(-\frac{R_2}{R_1} \right)$$

$$= 5,7 \left(-\frac{4}{10} \right)$$

$$= 2,28 \text{ Volt}$$

$$\text{Input Power control} = -(V_{ref} + V_4) \frac{R_5}{R_6}$$

$$= -(1+2,28) \frac{10}{10} \text{ Volt}$$

$$= 3,28 \text{ Volt}$$

❖ Pada beban 5;

$$V_3 = \text{Keluaran Proses Controller}$$

$$= 6,8 \text{ Volt}$$

$$V_4 = V_3 \left(-\frac{R_2}{R_1} \right)$$

$$= 6,8 \left(-\frac{4}{10} \right)$$

$$= 2,72 \text{ Volt}$$

$$\text{Input Power control} = -(V_{ref} + V_4) \frac{R_5}{R_6}$$

$$= -(1+2,72) \frac{10}{10} \text{ Volt}$$

$$= 3,72 \text{ Volt.}$$

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- [8] Manual Book Omega Tipe iSeries
- [9] Manual Book Autonics SPC1-50



PERSETUJUAN PERBAIKAN SKRIPSI

Dari hasil ujian skripsi Jurusan Teknik Elektro jenjang strata satu (S-1) yang diselenggarakan pada :

Hari : Senin
Tanggal : 03 September 2007
Telah dilakukan perbaikan skripsi oleh :

1. Nama : Fadli Shalad
2. NIM : 02.12.040
3. Jurusan : Teknik Elektro
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5. Judul Skripsi : PERENCANAAN DAN PEMBUATAN PROTOTYPE BALANCE LOAD CONTROLLER UNTUK PLTMH DENGAN KAPASITAS 1,1 KW MENGGUNAKAN PID CONTROLLER OMEGA TIPE iSERIES.

Perbaikan meliputi :

No	Materi Perbaikan	Ket
1.	Abstrak dibetulkan	✓
2.	Latar belakang, harapan dan kenyataan bagaimana	✓
3.	Nomor halaman diperhatikan	✓
4.	Data pengujian dilengkapi	✓

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Dosen Pembimbing II

Irrine Budi S., ST. MT



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Hari : Senin
Tanggal : 03 September 2007
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2.	Data perancangan tabel V1,V2,V3 diberi penjelasan	
3.	Kesimpulan 1-6 darimana,tambahkan dianalisa	
4.	Tuliskan semua hasil pengujian alat	

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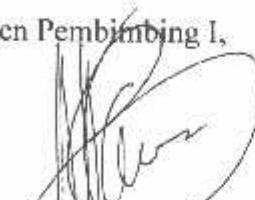
FORMULIR BIMBINGAN SKRIPSI

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Nim : 02.12.040
Masa Bimbingan : 23 Juni 2007 s/d 23 Desember 2007
Judul Skripsi : **Perencanaan Dan Pembuatan Prototype Balance Load Controller Untuk PLTMh Dengan Kapasitas 1.1 KW Menggunakan PID Controller OMEGA Tipe iSeries.**

NO	Tanggal	Uraian	Paraf Pembimbing
1.	28/6 2007	konsultasi BAB I dan II	
2.	3/7 2007	ACC Bab I dan II	
3.	16/7 2007	konsultasi BAB III	
4.	20/7 2007	revisi Bab III	
5.	27/7 2007	ACC Bab III	
6.	1/8 2007	konsultasi BAB IV dan V	
7.	4/8 2007	Revisi BAB IV	
8.	6/8 2007	konsultasi hasil revisi	
9.	10/8 2007	konsultasi hasil revisi bab IV dan V	
10.	16/8 2007	ACC Bab IV dan V.	

Malang,

Dosen Pembimbing I,


(Ir. Widodo Pudji M., MT.)
NIP. P. 102 870 0171

Form S-4b

MANUAL BOOK

OMEGA TIPE iSERIES

(Proses Controller)

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--	-----------------------------------

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It is the policy of OMEGA to comply with all worldwide safety and EMC/EMI regulations that apply.
CE mark to every appropriate device upon certification.
The information contained in this document is believed to be correct, but DIMEGA Engineering, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.
WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.
This device is marked with the international caution symbol. It is important to read the *Sanus Guide* before installing or commissioning this device as the guide contains important information relating to safety and EMC.



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NOTES, WARNINGS and CAUTIONS

Information that is especially important to note is identified by following labels:

- * NOTE
- * WARNING or CAUTION
- * IMPORTANT
- * TIP



NOTE: Provides you with information that is important to successfully setup and use the Programmable Digital Meter.



WARNING or CAUTION: Tells you about the risk of electrical shock.



IMPORTANT: Tells you of circumstances or practices that can effect the instrument's functionality and must refer to accompanying documents.



TIP: Provides you helpful hints.

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PART 1 INTRODUCTION

1.1 Description

 This device can be purchased as monitor (read process value only) or as a controller.

- The iSeries controller offers unparalleled flexibility in process measurement. Each unit allows the user to select the input type, from 10 thermocouple types (J, K, T, E, R, S, B, C, N and J DIN), Pt RTDs (100, 500 or 1000 Ω, with either 385 or 392 curve), DC voltage or DC current. The voltage/current inputs are fully scalable to virtually all engineering units, with selectable decimal point, perfect for use with pressure, flow or other process input.
- The temperature control can be achieved by using on/off or PID heat/cool control strategy. Control can be optimized with an auto tune feature. The instrument offers a ramp to setpoint with timed soak period before switching off the output.
- The iSeries device features a large, three color programmable display with capability to change a color every time the Alarm is triggered. The standard features include dual outputs with relay, SSR, dc pulse, analog voltage or current. Options include programmable RS-232 or RS-485 serial communication and excitation. Analog Output is fully scalable and may be configured as a proportional controller or retransmission to follow your display. Universal power supply accepts 90 to 240 Vac. Low voltage power option accepts 24 Vac or 12 to 36 Vdc.

1.2 Safety Considerations

 This device is marked with the international caution symbol. It is important to read this manual before installing or commissioning this device as it contains important information relating to Safety and EMC (Electromagnetic Compatibility).

This instrument is a panel mount device protected in accordance with Class II of EN 61010 (115/230 AC power connections), and Class III for the low voltage power option (12-36 Vdc or 24 Vac). Installation of this instrument should be done by qualified personnel. In order to ensure safe operation, the following instructions should be followed.

This instrument has no power-on switch. An external switch or circuit-breaker shall be included in the building installation as a disconnecting device. It shall be marked to indicate this function, and it shall be in close proximity to the equipment within easy reach of the operator. The switch or circuit-breaker shall meet the relevant requirements of IEC 947-1 and IEC 947-3 (International Electrotechnical Commission). The switch shall not be incorporated in the main supply cord.

This instrument has no power-on switch. An external switch or circuit-breaker shall be included in the building installation as a disconnecting device. It shall be marked to indicate this function, and it shall be in close proximity to the equipment within easy reach of the operator. The switch or circuit-breaker shall meet the relevant requirements of IEC 947-1 and IEC 947-3 (International Electrotechnical Commission). The switch shall not be incorporated in the main supply cord.

 Furthermore, to provide protection against excessive energy being drawn from the main supply in case of a fault in the equipment, an overcurrent protection device shall be installed.

- Do not exceed voltage rating on the label located on the top of the instrument housing.
- Always disconnect power before changing signal and power connections.
- Do not use this instrument on a work bench without its case for safety reasons.
- Do not operate this instrument in flammable or explosive atmospheres.
- Do not expose this instrument to rain or moisture.
- Unit mounting should allow for adequate ventilation to ensure instrument does not exceed operating temperature rating.
- Use electrical wires with adequate size to handle mechanical strain and power requirements. Install without exposing bare wire outside the connector to minimize electrical shock hazards.

EMC Considerations

- Whenever EMC is an issue, always use shielded cables.
- Never run signal and power wires in the same conduit.
- Use signal wire connections with twisted-pair cables.
- Install Ferrite Bead(s) on signal wires close to the instrument if EMC problems persist.

Failure to follow all instructions and warnings may result in injury!

1.3 Before You Begin

Inspecting Your Shipment:

Remove the packing slip and verify that you have received everything listed. Inspect the container and equipment for signs of damage as soon as you receive the shipment. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent. The carrier will not honor damage claims unless all shipping material is saved for inspection. After examining and removing the contents, save the packing material and carton in the event reshipment is necessary.

Customer Service:

If you need assistance, please call the nearest Customer Service Department, listed in this manual.

Manuals, Software:

The latest Operation and Communication Manual as well as free configuration software and ActiveX controls are available from the website listed in this manual or on the CD-ROM enclosed with your shipment.

To Disable Outputs:

Standby Mode is useful during setup of the instrument or when maintenance of the system is necessary. When the instrument is in standby, it remains in the ready condition but all outputs are disabled. This allows the system to remain powered and ready to go.

When the instrument is in "RUN" Mode, push **①** twice to disable all outputs and alarms. It is now in "STANDBY" Mode. Push **①** once more to resume "RUN" Mode.

PUSH ① TWICE to disable the system during an **EMERGENCY**.

To Reset the Meter:

When the controller is in the "MENU" Mode, push **①** once to direct controller one step backward of the top menu item.

Push ① twice to reset controller, prior to resuming "Run" Mode except after "Alarms", that will go to the "Run" Mode without resetting the controller.

4

PART 2 SETUP

2.1 Front Panel

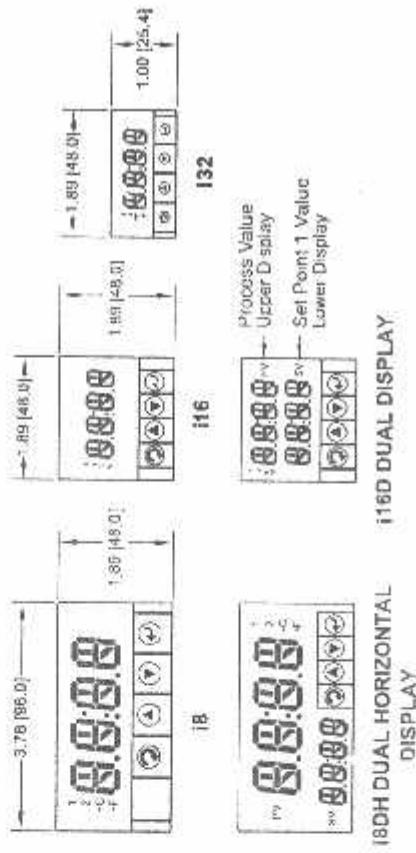


Figure 2.1 Front Panel Display



18DV DUAL VERTICAL DISPLAY

Table 2.1 Front Panel Annunciators

1	Output 1/Setpoint 1/ Alarm 1 indicator
2	Output 2/Setpoint 2/ Alarm 2 indicator
°C	°C unit indicator
°F	°F unit indicator
PV	Upper Display shows the Process Value
SV	Lower Display shows the Setpoint 1 Value
②	Changes display to Configuration Mode and advances through menu items*
③	Used in Program Mode and Peak Recall*
④	Used in Program Mode and Valley Recall*
⑤	Accesses submenus in Configuration Mode and stores selected values*

- * See Part 3 Operation: Configuration Mode

The Dual Display model allows the user to observe the Process Value (upper display) and Setpoint 1 Value (lower display) at the same time.

5

2.2 Rear Panel Connections

The rear panel connections are shown in Figures 2.2 and 2.3.



Figure 2.2 Rear Panel Power and Output Connections

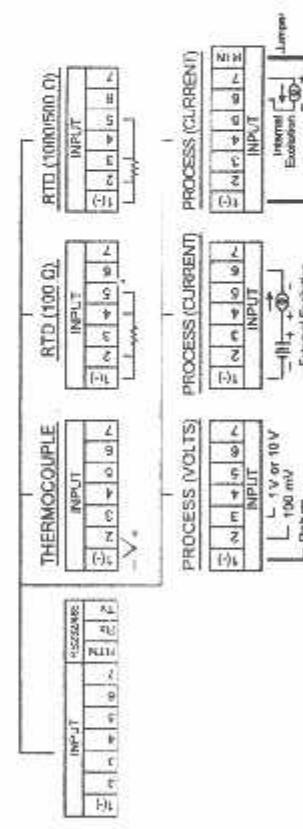


Figure 2.3 Rear Panel Input Connections

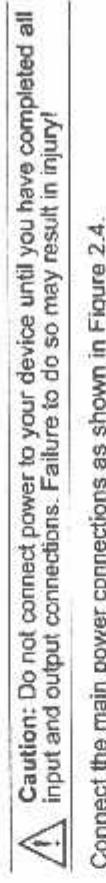
Table 2.2 Rear Panel Connector

POWER	AC/DC Power Connector: All models
INPUT	All models TC, PR (Process), RTD Input Connector:
OUTPUT 1	Based on one of the following models: Relay SPDT Solid State Relay Pulse
	Analog Output (Voltage and Current) Based on one of the following models: Relay SPDT Solid State Relay Pulse
OPTION	Based on one of the following models: RS-232C or RS-485 programmable Excitation

6

2.3 Electrical Installation

2.3.1 Power Connections



Connect the main power connections as shown in Figure 2.4.

Figure 2.4 Main Power Connections

Table 2.3 Fuse Requirement (see specifications)	
FUSE	Connector
FUSE 1	Power
FUSE 2	Power

For the low voltage power option, in order to maintain the same degree of protection as the standard high voltage input power units (90 - 240 Vac), always use a Safety Agency Approved DC or AC source with the same Overvoltage Category and pollution degree as the standard AC unit (90 - 240 Vac).



The Safety European Standard EN61010-1 for measurement, control, and laboratory equipment requires that fuses must be specified based on IEC127. This standard specifies for a Time-lag fuse, the letter code "T". The above recommended fuses are of the type IEC127-2-sheet III. Be aware that there are significant differences between the requirements listed in the UL 248-14/CSA 248-14 and the IEC 127 fuse standards. As a result, no single fuse can carry all approval listings. A 1.0 Amp IEC fuse is approximately equivalent to a 1.4 Amp UL/CSA fuse. It is advised to consult the manufacturer's data sheets for a cross-reference.

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2.3.2 Thermocouple

The figure below shows the wiring hookup for any thermocouple type. For example, for Type K hookup, connect the yellow wire to the "2+" terminal and the red wire to the "1(-)" terminal.

When configuring your controller, select Thermocouple and Thermocouple Type in the Input Type menu (see Part 3).

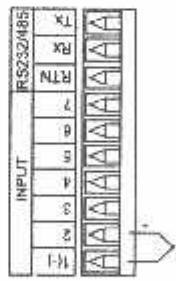


Figure 2.5 Thermocouple Wiring Hookup

Table 2.4 TC Wire Color Chart

TYPE	Input Connector	Jacket (external insulation)	Grade
J	Terminal 1 (-)	Terminal 2 (+)	Extension
K	Red	White	Black
T	Red	Yellow	Yellow
E	Red	Blue	Blue
N	Red	Purple	Purple
R	Red	Brown	dark-Brown
S	Red	Black	dark-Brown
B	Red	Black	-

Figure 2.6 a) RTD-1000 ohm and
500 ohm Wiring Hookup

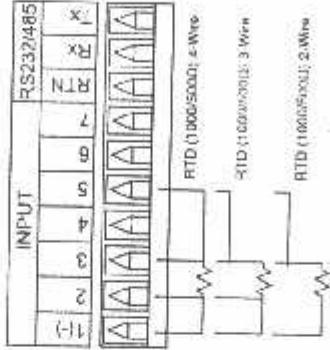
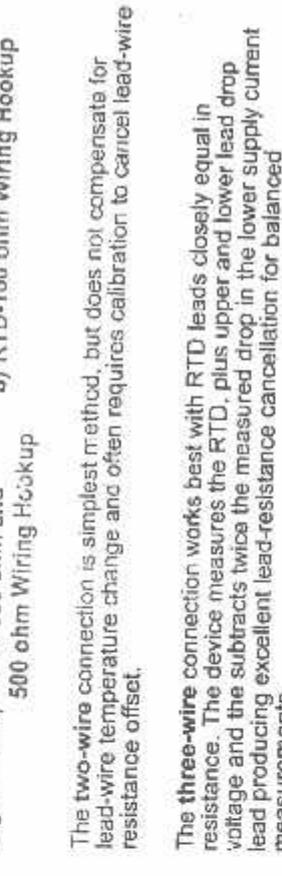
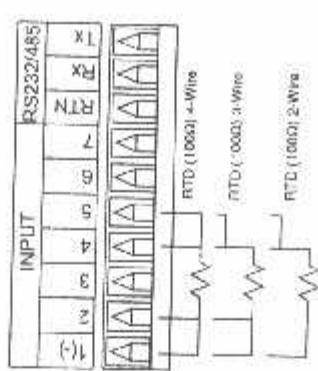


Figure 2.6 b) RTD-100 ohm Wiring Hookup



2.3.3 Two/Three/Four-Wire RTD

The figures below show the input connections and input connector jumpers (shown in bold lines) required to hookup a 2-, 3- or 4-wire RTD.

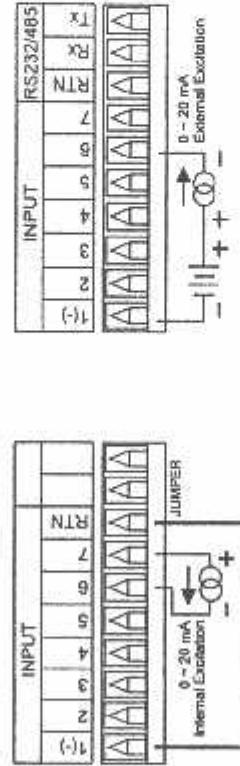


- a) RTD-1000 ohm and 500 ohm Wiring Hookup**
- The two-wire connection is simplest method, but does not compensate for lead-wire temperature change and often requires calibration to cancel lead-wire resistance offset.
- The three-wire connection works best with RTD leads closely equal in length. The device measures the RTD, plus upper and lower lead drop voltage and the subtracts twice the measured drop in the lower supply current lead producing excellent lead-resistance cancellation for balanced measurements.
- The four-wire RTD hookup is applicable to unbalanced lead resistance and enables the device to measure and subtract the lead voltage, which produces the best lead-resistance cancellation.
- When configuring your controller, select RTD type and RTD value in the Input Type menu (see Part 3).**

If the input wires of the meter get disconnected or broken, it will display **3822** "Input (-) Open" message except in case of 500' 100Ω 2-wire RTD. In this case the display shows **3822** "Input (-) Open" message. For safety purpose you may want to set up your alarm to be triggered when input is open. See Alarm 1 & 2 chapters for details

2.3.4 Process Current

The figure below shows the wiring hookup for Process Current 0 – 20 mA.

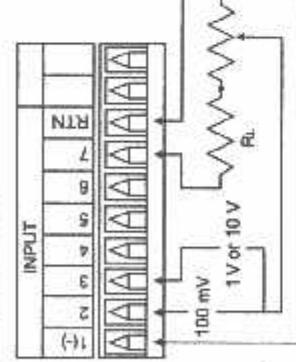


**Figure 2.7 Process Current Wiring Hookup
(Internal and External Excitation)**

When configuring your instrument, select Process Type in the Input Type Menu (see Part 3).

2.3.5 Process Voltage

The figure below shows the wiring hookup for Process Voltage 0 – 100 mV, 0 – 1 V, 0 – 10 V.



**Figure 2.8 a) Process Voltage Wiring Hookup
with Sensor Excitation**

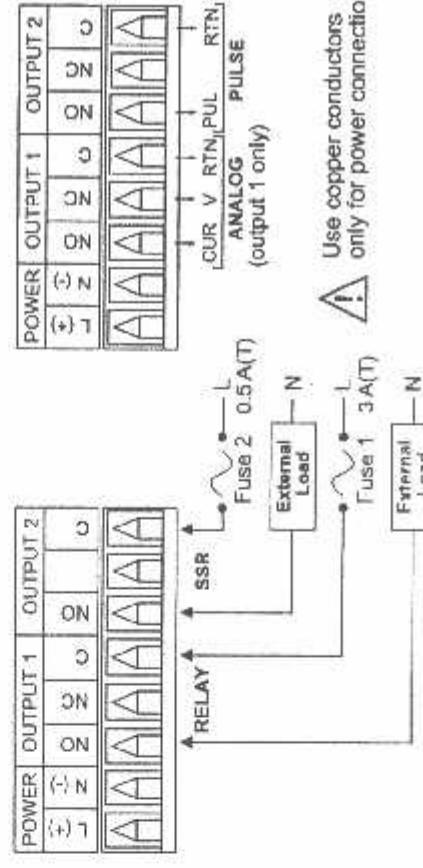
R_L - Voltage limited resistor, which allows to convert 24 Vdc internal excitation voltage to the appropriate process input value. For instance: if the potentiometer value is equal to 10 k Ω , the minimum R_L is 14 k Ω for 10 V process input.

When configuring your instrument, select Process Type in the Input Type Menu (see Part 3).

10

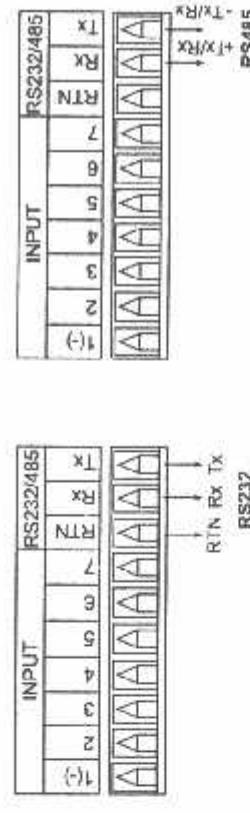
2.3.6 Wiring Outputs

This meter has two, factory installed, outputs. The SPDT Mechanical Relay, SPST Solid State Relay, Pulse and Analog Output Connection are shown below.



**Figure 2.9
a) Mechanical Relay and SSR
Outputs Wiring Hookup**

This device may have a programmable communication output. The RS-232 and RS-485 Output Connection are shown below.



**Figure 2.10
a) RS-232 Output Wiring Hookup**

b) RS-485 Output Wiring Hookup

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This device may also have an excitation output.

2.3.7 Dual Display Color Setup

The dual display option allows the user to change the color of the upper and lower displays.

To change the color of the upper display, see section 3.2.15 (Display Color section).

To change the color of the lower display follow the instructions below:
The unit should be removed from the panel and opened.

Figure 2.11 Excitation Output

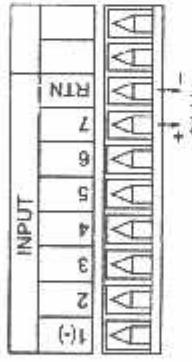


Figure 2.11 Excitation Output

Excitation is not available if communication option is installed.

If the Dual Display model has a Low Voltage power supply option, then excitation is not available.

This device has snubber circuits designed to protect the contacts of the mechanical relays when it switches to inductive loads (i.e. solenoids, relays). These snubbers are internally connected between the Common (C) and Normally Open (NO) relay contacts of Output 1 and Output 2.

If you have an inductive load connected between Common (C) and Normally Closed (NC) contacts of the mechanical relays and you want to protect them from the rush current during the switching period, you have to connect an external snubber circuit between Common (C) and Normally Closed (NC) contacts as indicated in the figure below.

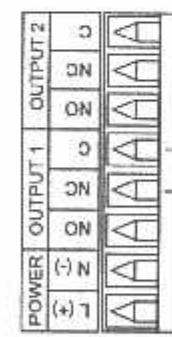


Figure 2.12 Snubber Circuits Wiring Hookup

Refer to the Quick Start Guide for assembly and disassembly instructions.

The S1 Jumper is located on the back side of the display board. The location of S1 and p1r selection jumpers are shown below.



Use a Jumper for GREEN or RED, never leave S1 open.

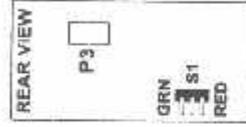


Figure 2.13 i/8 D Location of S1 and Selectable Jumper Positions



Figure 2.14 i/16D Location of S1 and Selectable Jumper Positions

PART 3 OPERATION: Configuration Mode

3.1 Introduction

The instrument has two different modes of operation. The first, Run Mode, is used to display values for the Process Variable, and to display or clear Peak and Valley values. The other mode, Menu Configuration Mode, is used to navigate through the menu options and configure the controller. Part 3 of this manual will explain the Menu Configuration Mode. For your instrument to operate properly, the user must first "program" or configure the menu options.

Turning your Controller On for the First Time

The device becomes active as soon as it is connected to a power source. It has no On or Off switch. The device at first momentarily shows the software version number, followed by reset **RESET**, and then proceeds to the Run Mode.

Table 3.1 Button Function in Configuration Mode

② MENU	<ul style="list-style-type: none"> To enter the Menu, the user must first press ② button. Use this button to advance/navigate to the next menu item. The user can navigate through all the top level menus by pressing ②. While a parameter is being modified, press ② to escape without saving the parameter.
③ UP	<ul style="list-style-type: none"> Press the up ③ button to scroll through "flashing" selections. When a numerical value is displayed press this key to increase a value of a parameter that is currently being modified. Holding the ③ button down for approximately 3 seconds will speed up the rate at which the set point value increments. In the Run Mode press ③ causes the display to flash the PEAK value – Press again to return to the Run Mode. Press the down ④ button to go back to a previous Top Level Menu item. Press this button twice to reset the controller to the Run Mode. When a numerical value is flashing (except set point value) press ③ to scroll digits from left to right allowing the user to select the desired digit to modify. When a setpoint value is displayed press ③ to decrease value of a setpoint that is currently being modified. Holding the ③ button down for approximately 3 seconds will speed up the rate at which the setpoint value is decremented. In the Run Mode press ③ causes the display to flash the VALLEY value – Press again to return to the Run Mode. Press the enter ⑤ button to access the submenus from a Top Level Menu item. Press ③ to store a submenu selection or after entering a value — the display will flash a SET message to confirm your selection. To reset flashing Peak or Valley press ③. In the Run Mode, press ③ twice to enable Standby Mode with flashing STBY.
④ DOWN	<ul style="list-style-type: none"> Press the enter ⑤ button to access the submenus from a Top Level Menu item. Press ④ to store a submenu selection or after entering a value — the display will flash a SET message to confirm your selection. To reset flashing Peak or Valley press ④. In the Run Mode, press ④ twice to enable Standby Mode with flashing STBY.
⑤ ENTER	<ul style="list-style-type: none"> Reset: Except for Alarms, modifying any settings of the menu configuration will reset the instrument prior to resuming Run Mode.

3.2 Menu Configuration

Note: It is recommended that you put the controller in the Standby Mode for any configuration change other than Setpoints & Alarms.

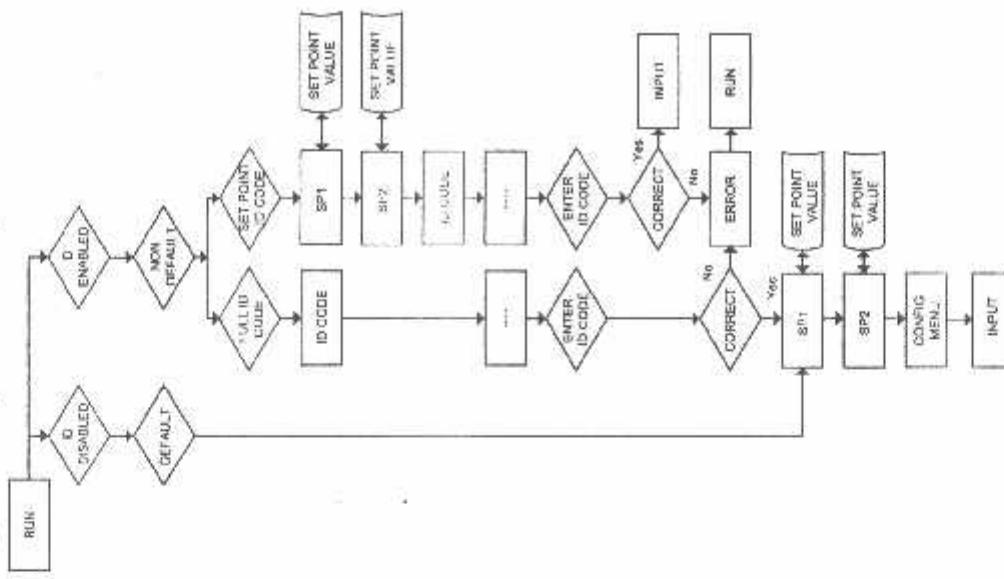


Figure 3.1 Flow Chart for ID and Setpoints

3.2.1 ID Number

SEE ID MENU SELECTION IN CONFIGURATION SECTION FOR ENABLE/DISABLE OR CHANGE ID CODE.

If ID Code is Disabled or set as Default (0000) the menu will skip ID step to Setpoint Menu.
 If ID Code is set to Full Security Level and user attempts to enter the Main Menu, they will be prompted for an ID Code.

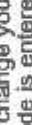
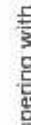
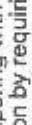
If ID Code is set to Setpoint/ID Security Level and user attempts to enter the Configuration Menu, they will be prompted for an ID Code.

ENTERING YOUR NON-DEFAULT FULL SECURITY ID NUMBER.

- Press  1) Display shows .
- 2) Display advances to .
- 3) Press  to increase digit 0-9. Press  to activate next digit (flashing). Continue to use  and  to enter your 4-digit ID code.
- 4) If the correct ID code is entered, the menu will advance to the Setpoint 1 Menu, otherwise an error message  will be displayed and the instrument will return to the Run Mode.

 To change ID Code, see ID Menu in the Configuration section.

ENTERING YOUR NON-DEFAULT SETPOINT/ID SECURITY ID NUMBER.

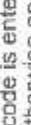
- Press  5) Display shows  Setpoint 1 Menu.
- 6) Display shows  Setpoint 2 Menu.
- 7) Display shows  ID Code Menu.
- 8) Display advances to .
- 9) Use  and  to change your ID Code.
- 10) If correct ID Code is entered, the display will advance to the  Input Menu, otherwise the error message  will be displayed and the controller will return to the Run Mode.

To prevent unauthorized tampering with the setup parameters, the instrument provides protection by requiring the user to enter the ID Code before allowing access to subsequent menus. If the ID Code entered does not match the ID Code stored, the controller responds with an error message and access to subsequent menus will be denied.

 Use numbers that are easy for you to remember. If the ID Code is forgotten or lost, call customer service with your serial number to access and reset the default to .

3.2.2 Set Points

SETPOINT 1:

- Press  1) Press , if necessary until  prompt appears.
Press  2) Display shows previous value of "Setpoint 1".
Press  &  3) Press  and  to increase or decrease Setpoint 1 respectively.
-  Holding  &  buttons down for approximately 3 seconds will speed up the rate at which the Setpoint value increments or decrements.
- Press  &  4) Continue to use  and  to enter your 4-digit Setpoint 1 value.
Press  5) Display shows  stored message momentarily and then advances to  only, if a change was made, otherwise press  to advance to  Setpoint 2 Menu.

SETPOINT 2:

- Press  6) Display shows previous value of "Setpoint 2".
Press &  7) Press  and  to increase or decrease Setpoint 2 respectively.
-  Holding  &  buttons down for approximately 3 seconds will speed up the rate at which the setpoint value increments or decrements.
- Press  8) Display shows  stored message momentarily and then advances to  only, if a change was made, otherwise press  to advance to  Configuration Menu.

3.2.3 Configuration Menu

Input Type (Thermocouple)

ENTER INPUT TYPE MENU:

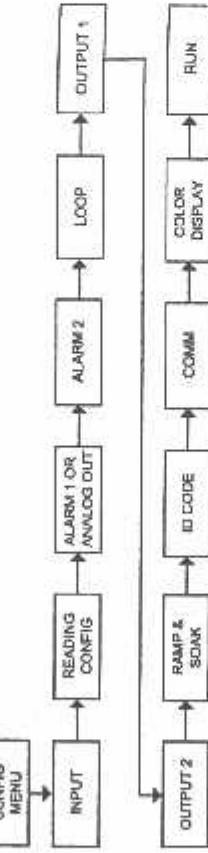


Figure 3.2 Flow Chart for Configuration Menu

Enter Configuration Menu:

- Press **②**
 Press **③**
 Press **④**
 1) Press **②**, if necessary, until **INPUT** prompt appears.
 2) Display advances to **INPUT** Menu.
 3) Pressing and releasing **②** to scroll through all available menus of Configuration section.

3.2.4 Input Type Menu

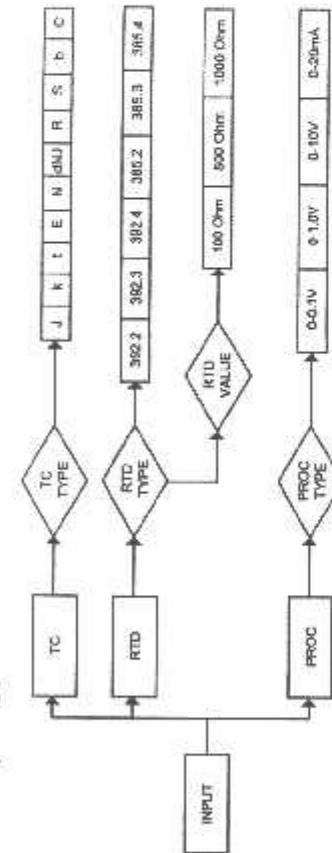


Figure 3.3 Flow Chart for Input Type Menu



Input Type (RTD)

ENTER INPUT TYPE MENU:

- Press **②**
1) Press **②**, if necessary, until **INPUT** prompt appears.
2) Display advances to **INPUT** Input Menu.
3) Display flashes **RTD**, **RTD** or **RTD** (Thermocouple, RTD or Process). If the displayed input type is **RTD**, press **②** to skip to step 6 (**RTD** stops flashing).

RTD SUBMENU:

- Press **②**
4) Scroll through the available selection to **RTD** (flashing).
5) Display shows **RTD** stored message momentarily and then **RTD** (not flashing).
6) Display flashes previous RTD type selection i.e. **385**.
(see below for RTD types selection).
7) Scroll through the available RTD types to the selection of your choice.
8) Display shows **RTD** stored message momentarily and then advances to **RTD** RTD value.

RTD Types: **385**
Display: **392.2**, **392.3**, **392.4**, **385.2**, **385.3**, **385.4**

NOTE: Last digit indicates: 2-, 3- or 4-wire input.

RTD VALUE SUBMENU:

- Press **②**
9) Display flashes previous RTD value selection i.e. **1000**.
(see below for RTD value selection).
10) Scroll through the available RTD values to the selection of your choice.
11) Display shows **RTD** stored message momentarily and then advances to **RTD** Reading Configuration Menu.

RTD Values: **100 ohm** **500 ohm** **1000 ohm**
Display: **100** **500** **1000**

Input Type (Process)

ENTER INPUT TYPE MENU:

- Press **②**
1) Press **②**, if necessary, until **INPUT** prompt appears.
2) Display advances to **INPUT** Input Menu.
3) Display flashes **TC**, **TC** or **TC** (Thermocouple, RTD or Process). If the displayed input type is **TC**, press **②** to skip to step 6 (**TC** stops flashing).

PROCESS SUBMENU:

- Press **②**
4) Scroll through the available selection to **POPC** (flashing).
5) Display shows **POPC** stored message momentarily and then **POPC** (not flashing).
6) Display flashes previous Process type selection, i.e. **0-10** (see below for Process types selection).
7) Scroll through the available Process types to the selection of your choice.
8) Display shows **POPC** stored message and then advances to **POPC** Reading Configuration Menu.

Process Types: **100 mV** **1 V** **10 V** **0 - 20 mA**
Display: **0-10** **0-10** **0-10** **0-20**

For 4-20 mA Input select 0-20 mA then adjust the Input/Reading accordingly. To adjust 4-20 mA input, see example under INPUT/READING submenu. The factory preset value is 4-20 mA.

3.2.5 Reading Configuration

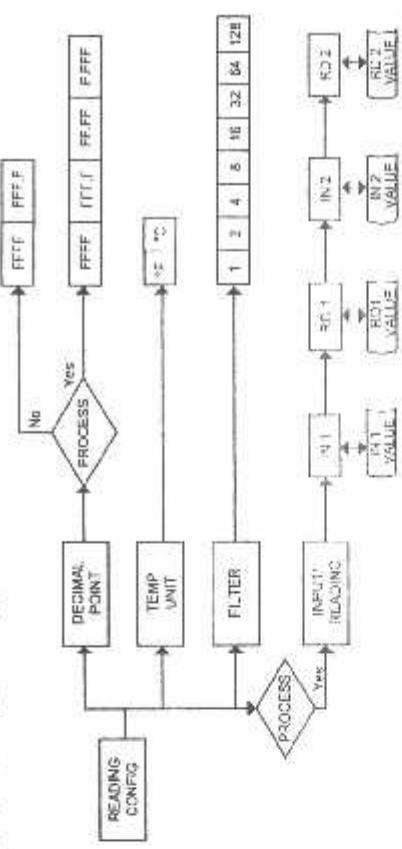


Figure 3.4 Flow Chart for Reading Configuration Menu

ENTER READING CONFIGURATION MENU:

- DECIMAL POINT SUBMENU:**

 - 1) Press **(2)**, if necessary, until **[SET]** prompt appears.
 - 2) Display advances to **[1.123]** Input Menu.
 - 3) Display advances to **[RD]** Reading Configuration Menu.
 - 4) Display advances to **[DE]** Decimal Point.

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- DECIMAL POINT SUBMENU:**

 - Press Press
 - Press Press
 - Press Press
 - Press Press

5) Display flashes previous selection for Decimal location.
 6) Scroll through the available selections and choose Decimal location: or (also and – if Process type was selected in the Input Type Menu).
 7) Display shows stored message momentarily and then advances to Temperature Unit.

Note: Decimal Point for Process Input Type is passive.

TEMPERATURE UNIT \$SUBMENU:

 - Press Press
 - Press Press
 - Press Press

8) Display flashes previous Temperature Unit selection.
 9) Scroll through the available Selections to the Temperature of your choice: or
 10) Display shows stored message momentarily and then advances to Filter Constant.

TEMPERATURE UNIT SUBMENU:

- Press 8) Display flashes previous Temperature Unit selection.
 Press 9) Scroll through the available selections to the Temperature Unit of your choice: or
 Press 10) Display shows and stored message momentarily and then advances to Filter Constant.

FILTER CONSTANT SUBMENU:

If Process was selected in the Input Type Menu the display will advance to **14.5 Input/Reading Submenu**, otherwise the display advances to the **15.2 Alarm 1 Menu**.

The Filter Constant Submenu allows the user to specify the

For PID control select filter value 0001-0004. A filter value of 2 is approximately equal to 1 second RC low pass time constant.

Boarding Configuration (If Process was selected)

INFLUENCE OF COAL AND OCEAN CURRENTS

Input Voltage or Current can be converted or scaled into values appropriate for the process or signal being measured. So, a reading may be displayed, for example, in units of weight or velocity instead of in amperes or volts.

The instrument determines Scale and Offset values based on two user-provided input values entered with the corresponding readings. Note that "In1" Input 1 and "In2" Input 2 are represented and entered as a product of the input voltage/current and the conversion number from the Table 3-1.

Note The following instructions include details for a specific scenario in which a 4-20 mA input (in the 20 mA Process Mode) is to be represented as a measurement of 0-100 percent.

Press ② at the [14.8d] prompt. Display shows [14.8] Input 1

Press **15** Display shows input 1 value with 1st digit flashing.
Press **16** Use and buttons to enter value.

Note: Disregard the position of the decimal point, such that 2000 counts may actually appear as "200.0", "20.00", or "2.000".

Press **②** & **③**
Example: 4 mA as $4(\text{mA}) \times 500 = 2000$.
17) Display advances to **R** & **J** Reading 1 Submenu.
18) Use **①** and **②** buttons to enter **R** & **J** value.
This value represents **100** in terms of some meaningful

engineering units. To show the 4 mA as zero percent enter **[d]**.
value = 0000
Example: **[d]** value = 0000.
19 Display **[d]** Input 2 Submenu.
Press **[d]**

The **Max** button = max input value conversion number.
 Example: $20(\text{mA}) \times 500 = 10000$ (9999).

Press & 23) Use and buttons to enter & value.
Example: value = 0100.

Press 24) Display flashes & stored message momentarily and then advances to only if change was made, otherwise press to advance to Alarm 1 Menu.

Notes:
Conversion number is a coefficient of conversion between input values and real full display range (100000 counts). See Table 3.1 below for proper conversion number.

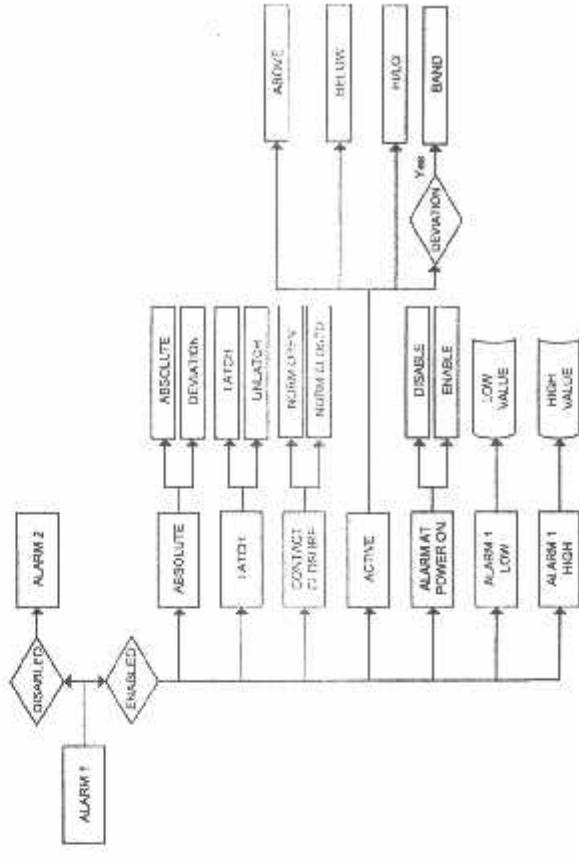
Table 3.2 Conversion Table

RANGE	CONVERSION NUMBER
100 mV	$100000 / (100 \times 1) = 100$
1 V	$100000 / (1000 \times 1) = 10$
10 V	$100000 / (10000 \times 1) = 1$
0 -20 mA	$100000 / (20 \times 1) = 5000$

3.2.6 Alarm 1

This unit is equipped with two physical outputs that can only be configured as follows: **Alarm 1 & Alarm 2, Alarm 1 & Output 2, Output 1 & Alarm 2, Output 1 & Output 2, Analog Out 1 & Alarm 2, Analog Out 1 & Output 2, Analog Out available only if Analog Output Option board is factory installed.**

If Analog Output Option is installed, the controller will skip Alarm 1 Menu item to Analog Output.



ALARM 1 ENABLE/DISABLE SUBMENU:

- Press **①**
5) Scroll through the available selection until **[Energ]** displays to use Alarm 1.
Press **②**
6) Display shows **Set 2** stored message momentarily and then advances to **Set 3**, only if it was changed, otherwise press **③** to advance to **Set 5**. Alarm 1 Absolute/Deviation Submenu.

Note:
If **[Energ]** Alarm 1 Disabled was selected, all submenus of Alarm 1 Menu will be skipped and meter advances to **Set 2** Alarm 2 Menu. If **[Energ]** Alarm 1 Enabled was selected, Output 1 would be automatically Disabled, and reassigned as Alarm 1.

ALARM 1 ABSOLUTE/DEVIATION SUBMENU:

- Press **④**
7) Display flashes previous selection. Press **⑤** to **Set 5**.
Press **⑥** Absolute or **Set 5** Deviation.
Press **⑦** Display shows **Set 3** stored message momentarily and then advances to **Set 4**, only if it was changed, otherwise press **⑧** to advance to **Set 6**. Alarm 1 Latch/Unlatch Submenu.

Absolute Mode allows Alarm 1 to function independently from Setpoint 1. If the process being monitored does not change often, then "Absolute" Mode is recommended.

Deviation Mode allows changes to Setpoint 1 to be made automatically to Alarm 1. Deviation mode is typically the ideal mode if the process temperature changes often. In Deviation Mode, set Alarm 1 a certain number of degrees or counts away from Setpoint 1 — this relation remains fixed even if Setpoint 1 is changed.

ALARM 1 LATCH/UNLATCH SUBMENU:

- Press **⑨**
9) Display flashes previous selection. Press **⑩** to **Set 4**.
Press **⑪**
10) Display shows **Set 3** stored message momentarily and then advances to **Set 4**, only if it was changed, otherwise press **⑫** to advance to **Set 6**. Contact Closure Submenu.

Latched Mode: Relay remains "latched" until reset. To reset already latched alarm, select Alarm Latch and press Max twice (i.e. Unlatch and then back to Latch) or from a Run Mode, push **③** twice to put the controller in Standby Mode and then push **③** one more time to return to the Run Mode.

Unlatched Mode: Relay remains latched only as long as the alarm condition is true.

CONTACT CLOSURE SUBMENU:

- Press **⑬**
11) Display flashes previous selection. Press **⑭** to **Set 6**. Normally Closed or **Set 7** Normally Open.
Press **⑮**
12) Display shows **Set 5** stored message momentarily and then advances to **Set 6**, only if it was changed, otherwise press **⑯** to advance to **Set 7**. Active Submenu.
- Normally Open:** If this feature is selected, then the relay is "energized" only when an alarm condition occurs.
- Normally Closed:** "Fail Safe" Mode. Relay is energized under "normal" conditions and becomes de-energized during alarm or power failure.

ACTIVE SUBMENU:

- Press **⑰**
13) Display flashes previous selection. Press **⑱** to scroll through the available selections: **Set 4** Above, **Set 5** Below, **Set 6** Hi/Low and **Set 7** Band. (Band is active if **Set 7** Deviation was selected)
- Press **⑲**
14) Display shows **Set 6** stored message momentarily and then advances to **Set 7**, only if it was changed, otherwise press **⑳** to advance to **Set 8**. Alarm Enable/Disable at Power On Submenu.

Above: Alarm 1 condition triggered when the process variable is greater than the Alarm Hi Value (Low value ignored).

Below: Alarm 1 condition triggered when the process variable is less than the Alarm Low Value (Hi value ignored).

Hi/Low: Alarm 1 condition triggered when the process variable is less than the Alarm Low Value or above the Hi Value.
Band: Alarm 1 condition triggered when the process variable is above or below the "band" set around Setpoint 1. Band equals Hi Value (Low Value ignored). A "band" is set around the Setpoint by the instrument only in the "Deviation" Mode.

ALARM ENABLE/DISABLE AT POWER ON:

- Press $\textcircled{2}$ 15) Display flashes previous selection. Press $\textcircled{4}$ to \textcircled{ENT} enable or \textcircled{DIS} disable.
Press $\textcircled{2}$ 16) Display shows $\textcircled{ST}\textcircled{RD}$ stored message, momentarily and then advances to \textcircled{AL} only if it was changed, otherwise press $\textcircled{2}$ to advance to the \textcircled{BL} Alarm 1 Low Value Submenu.
- Note:* If the alarm is enabled at Power On, the alarm will be active right after reset. If the alarm is disabled at Power On, the alarm will become enabled when the process value enters the non alarm area. The alarm is not active while the process value is approaching Setpoint 1.

ALARM 1 LOW VALUE SUBMENU:

- Press $\textcircled{2}$ 17) Display flashes 1st digit of previous value. Use $\textcircled{4}$ and $\textcircled{5}$ to enter new value.
Press $\textcircled{2}$ & $\textcircled{4}$ 18) Use $\textcircled{4}$ and $\textcircled{5}$ to enter Alarm 1 Low Value.
Press $\textcircled{2}$ 19) Display shows $\textcircled{ST}\textcircled{RD}$ storage message momentarily and then advances to \textcircled{BL} only, if it was changed, otherwise press $\textcircled{2}$ to advance to \textcircled{BL} Alarm 1 Hi Value Submenu.

ALARM 1 HI VALUE SUBMENU:

- Press $\textcircled{2}$ 20) Display flashes 1st digit of previous value. Use $\textcircled{4}$ and $\textcircled{5}$ to enter new value.
Press $\textcircled{2}$ & $\textcircled{4}$ 21) Use $\textcircled{4}$ and $\textcircled{5}$ to enter Alarm 1 Hi Value.
Press $\textcircled{2}$ 22) Display shows $\textcircled{ST}\textcircled{RD}$ stored message momentarily and then advances to the next menu only, if it was changed, otherwise press $\textcircled{2}$ to advance to the next menu.

3.2.7 Analog Output (Retransmission)

- NOTE:** Analog Output can be configured as Retransmission or Control outputs.
- NOTE:** In this section we will discuss Retransmission Output.

This unit is equipped with two physical outputs that can only be configured as follows: Alarm 1 & Alarm 2, Output 1 & Alarm 2, Output 1 & Output 2, Analog 1 & Output 2, Analog Out 1 & Alarm 2, Analog Out 1 & Output 2. Analog Output is available only, if Analog Output Option board is factory installed.

- NOTE:** If Analog Output Option is not installed, the instrument will skip to Alarm 2 Menu.

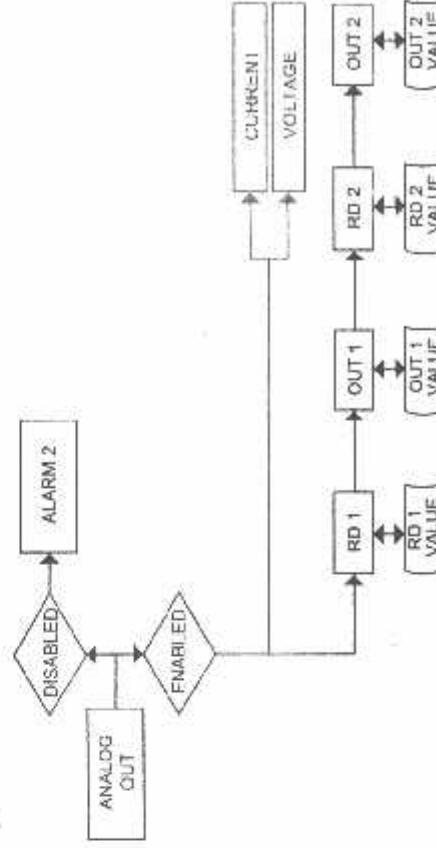


Figure 3.6 Flow Chart for Analog Output (Retransmission)

ENTER ANALOG OUTPUT MENU:

- Press $\textcircled{2}$ 1) Press $\textcircled{2}$, if necessary, until \textcircled{ENT} prompt appears.
Press $\textcircled{2}$ 2) Display advances to \textcircled{BL} Input Menu.
Press $\textcircled{2}$ 3) Press $\textcircled{2}$, if necessary, until Display advances to \textcircled{BL} Analog Output Menu.
Press $\textcircled{2}$ 4) Display advances to Analog Output \textcircled{BL} Enable or \textcircled{BL} Disable Submenu and flashes the previous selection.

ANALOG OUTPUT ENABLE/DISABLE SUBMENU:

- Press 5) Scroll through the available selection until displays to use Analog Output Retransmission (output proportional to the input signal).
 Press 6) Display shows stored message momentarily and then advances to or Submenu only if it was changed. Otherwise press to advance to or Current/Voltage Submenu.

If Analog Output Disabled was selected, all submenus of Analog Output Menu will be skipped and the meter will advance to Alarm 2 Menu. If Analog Output Enabled was selected, Output 1 would be automatically **Disabled**, and reassigned as Analog Output.

CURRENT/VOLTAGE SUBMENU:

- Press 7) Display flashes Current or Voltage.
 Press 8) Scroll through the available selection: Current or Voltage (Example).
 Press 9) Display shows stored message momentarily and then advances to Submenu only if it was changed, otherwise press to advance to Reading 1 Submenu.

READING 1:

- Press 10) Display flashes 1st digit of previous "Reading 1" value.
 Press & 11) Enter "Reading 1" value. (Example 0000)
 Press 12) Display advances to Out 1 Submenu.

OUT 1:

- Press 13) Display flashes 1st digit of previous "Out 1" value.
 Press & 14) Enter "Out 1" value. (Example 00)
 Press 15) Display advances to Reading 2 Submenu.

READING 2:

- Press 16) Display flashes 1st digit of previous "Reading 2" value.
 Press & 17) Enter "Reading 2" value. (Example 10.00)
 Press 18) Display advances to Out 2 Submenu.

OUT 2:

- Press 19) Display flashes 1st digit of previous "Out 2" value.
 Press & 20) Enter "Out 2" value. (Example 10.00)
 Press 21) Display advances to the Alarm 2 Menu.

The above example is for 0-10 V of the entire range of the Process Input and Analog Output. For 0-20 mA output you need to set "Analog Type" to Current and OUT 2 to 20.00.

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Accuracy of Analog Output board is +/- 1% of FS (Full Scale) when following conditions are satisfied:

1. The input is not scaled below 1% of Input FS (10 mV @ 1 V or 0.2 mA @ 20 mA input ranges).
2. Analog Output is not scaled below 3% of Output FS (300 mV @ 10 V or 0.6 mA @ 20 mA output ranges).

Otherwise certain corrections need to be applied.

For example:
 For entire range of process input, the Analog Output on 10 V FS scaled for 300 mV output range:

$$\begin{aligned} Rd1 &= 0000, \quad Out1 = 00.00 \\ Rd2 &= 9999, \quad Out2 = 00.30 \end{aligned}$$

The measured output will be as follows:

$$\begin{aligned} Rd1 &= 0000, \quad Out1 = -0.07 V \\ Rd2 &= 9999, \quad Out2 = 0.23 V \end{aligned}$$

This means that for 300 mV output range we have -70 mV offset at zero and at full scale. In order to compensate this 70 mV offset the correct scaling will be as follows:

$$\begin{aligned} Rd1 &= 0000, \quad Out1 = 00.07 \\ Rd2 &= 9999, \quad Out2 = 00.37 \end{aligned}$$

The above corrections need to be applied only for Input scaled below 1% of FS and Output scaled below 3% of FS or if you need the Analog Output accuracy to be better than 1% of FS.

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3.2.8 Alarm 2

This unit is equipped with two physical outputs that can only be configured as follows: **Alarm 1 & Alarm 2, Alarm 1 & Output 2, Output 1 & Alarm 2, Output 1 & Output 2, Analog Out 1 & Alarm 2, Analog Out 1 & Output 2, Analog Out 2, Analog Out 1 & Output 2**. Analog Output Option board is factory installed.

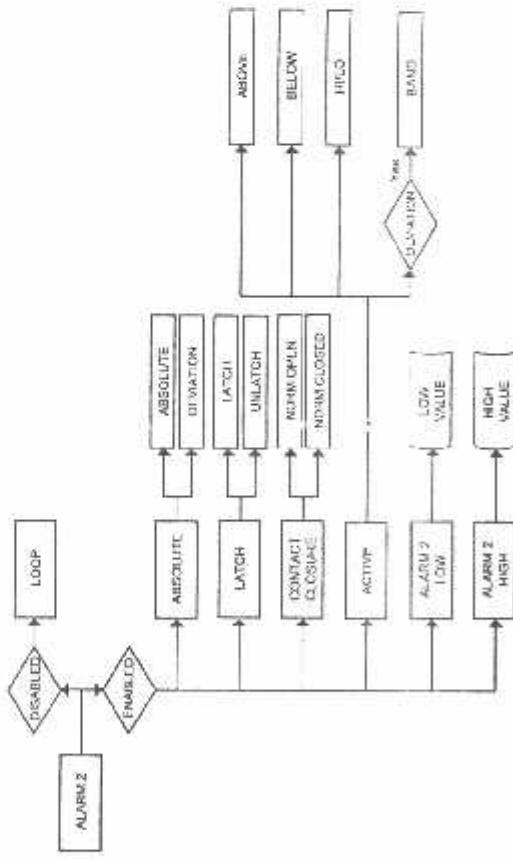


Figure 3.7 Flow Chart for Alarm 2

CENTRAL ASIAN STUDIES

- Press **①** 1) Press **②**, if necessary, until **Cuff** prompt appears.
 Press **②** 2) Display advances to **Input Menu**.
 Press **③** 3) Press **②**, if necessary, until Display advances to **Alarm 2** menu.
 Press **④** 4) Display advances to **Alarm 2 Setup**: Enable or **Disable Submenu**.

ALABM 2 ENABLING DISABILITY SILENCE:

Press ②

5) Display flashes previous selection. Press ④ until 2:45:1 displays to use Alarm 2.

Press ①

6) Display shows 51 P stored message momentarily and then advances to 51 P only if it was changed; otherwise press ④ to advance to 9630 Absolute/Deviation Submenu

- Press ②**

⑤ Display flashes previous selection. Press ④ until 8451 displays to use Alarm 2.

Press ④

⑥ Display shows 850 stored message momentarily and then advances to 8650 only if it was changed, otherwise press ④ to advance to 8650 Absolute/Deviation Submenu.

If 850? Alarm 2 Disabled was selected, all submenus of Alarm 2 will be skipped and meter advances to 8650 Loop Break Time Menu. If 8481 Alarm 2 Enabled was selected, Output 2 will automatically Disabled, and reassigned as Alarm 2.

The remaining Alarm 2 menu items are identical to Alarm 1 Menu. Modifying Alarm Settings will not connect the two instances.

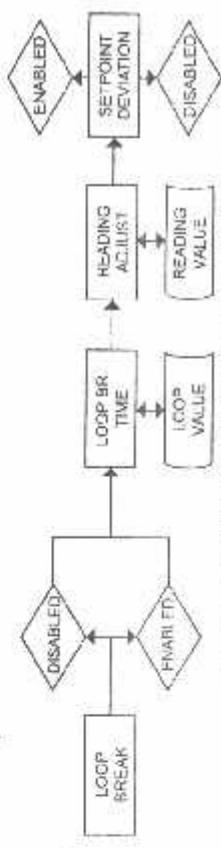


Figure 3.8 Flow Chart for Loop Break Time

ENTER | LOOP BREAK TIME MENU

- Press **©**

 - 1) Press **©**, if necessary, until **CONF** prompt appears.
 - 2) Display advances to **Input Menu**.
 - 3) Press **©**, if necessary, until Display advances to **CONF Loop Break Time Menu**.
 - 4) Display advances to **Loop Break Time Edit**. Enable or Disable Submenu and flashes the previous selection.

Press **©**

1000 DEEPEAK ENABLER EDISABLE EQUIPMENT

- Press Press 5) Scroll through the available selections: **E**ast or **W**est
6) Display shows **S**t & **d** stored message momentarily and then advances to **L**oop **B**reak **T**ime **V**alue **S**ubmenu

Loop Break is an additional safety feature intended to monitor the rate of change of the process value, while approaching the SP1. It is strictly intended as an additional warning system, therefore its use is entirely optional. An active Loop Break will cause the Setpoint digits to blink in a rotating pattern. If the process value reaches the set point the blinking will stop and **SP1** is completed successfully, otherwise **SP1** Break Alarm warning will flash, and Output 1 will be turned off.

LOOP BREAK TIME VALUE SUBMENU:

- 7) Display flashes 1st digit of previous Loop Value.
- 8) Press **• & •** buttons to enter a new Loop Value (0 to 99.59)
- 9) Display shows **SP2** stored message momentarily and then advances to **P-8:d** Reading Adjust Submenu.

C.J. READING ADJUST SUBMENU:

- 10) Display flashes 1st digit of previous reading adjust value.
- 11) Press **• & •** buttons to enter a new Reading Adjust value (-1999 to 9999).
- 12) Display shows **SP2** stored message momentarily and then advances to **P-8:d** Setpoint Deviation Menu.

SETPOINT DEVIATION ENABLE/DISABLE SUBMENU:

- 13) Display advances to Setpoint Deviation **E/D**. Enable or **D/S** Disable Submenu and flashes the previous selection.
- 14) Scroll through the available selections: **E/D** or **D/S**.
- 15) Display shows **SP2** stored message momentarily and then advances to **P-8:d** Output 1 Menu.

Loop Break Time Value allows the user to determine the time interval in M/M:S (from zero to 99 minutes and 59 seconds) that the Process Value changes at least 10 counts or if the Input Type is either RTD or Thermocouple, the value changes 4° Fahrenheit or 2° Celsius. At the specified time interval, if the process value change is less than the stated rate, flashing **SP2** will be displayed, the output 1 will be de-energized, and Alarm 1 energized. Loop break time will be disabled when the Process Value (PV) enters the control band.

Reading Offset Adjust (**C.J.**) allow the user to fine tune a minor error of the transducer, however some applications may require a large offset adjust. (Displayed Process Value = Measured Process Value \pm R.ADJ). R.ADJ is adjustable between -1999 to 9999.

Setpoint Deviation Submenu, if "enabled", allows changes to Setpoint 1 to be made automatically to Setpoint 2. This mode is very helpful if the Process Value changes often. In Setpoint Deviation Mode, set SP2 a certain number of degrees or counts away from SP1 - this relation remains fixed when SP1 is changed. For instance: Setting SP1=200 and SP2=20 and enabling **S2>1** means that the absolute value of SP2 becomes 320. Moving SP1 to 300, the absolute value of SP2 becomes 320.

3.2.10 Output 1

Alarm 1 and Output 1 or Analog Output (Retransmission) share the same contacts on the rear panel connector. If Alarm 1 or Analog Output (Retransmission) is Enabled, Output 1 is automatically Disabled.

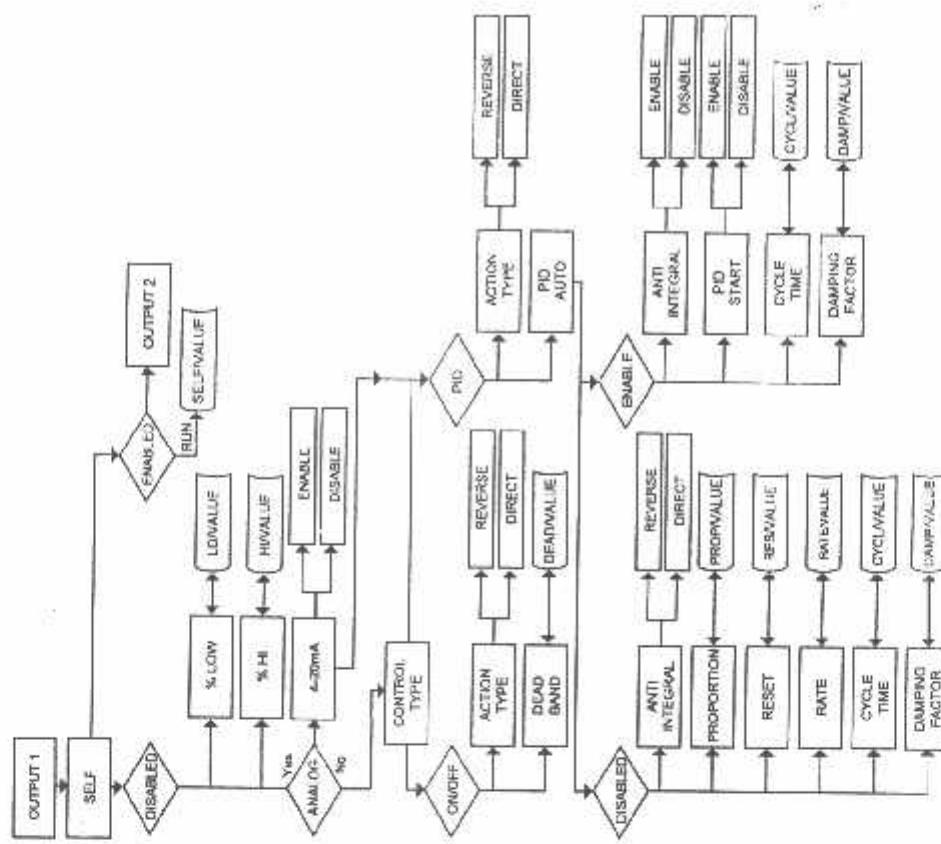


Figure 3.9 Flow Chart for Output 1

ENTER OUTPUT 1 MENU:

- Press **④** 1) Press **②**, if necessary, until **OUT** prompt appears.
 - 2) Display advances to **OUT** Input Menu.
 - 3) Press **②**, if necessary, until Display advances to **OUT 1** Output 1 Menu.
 - 4) Display advances to **SELF** Self Submenu.
- SELF SUBMENU:**
- The Self Option allows the output of the instrument to be controlled manually from the front panel.
- 5) Display flashes the current setting of Self, **SELF Enabled** or **SELF Disabled**.
 - 6) Press the **①** button to select between Enable and Disable.
 - 7) If Self **SELF Enabled** was selected, display shows **SEL 2d** stored message momentarily and then advances to the next menu (Output 1 setting is completed).

The output is now under the direct control of the operator and can be adjusted in the Run Mode (**RUN**) to **SEL 2d**, by pressing the **①** and **②** buttons, where M calls for the Manual (Self) Control. For example, setting of **SEL 0** an Analog Output of 0 in 10 Vdc would produce roughly 5 Vdc at the output.

8) If Self **SELF Disabled** was selected, display shows **SEL 0** stored message momentarily and then advances to **OUT 1** Menu.

Note: There is a shorter way to Enable or Disable Self Mode. From a Run Mode, press **②** and then press **②**. Self Mode is Enabled now. Press **②** or **③** to display **MXX.X**. To disable Self, press **②** and then press **②**. Display goes to the Run Mode. Self Mode is Disabled now.

MINIMUM/PERCENT LOW SUBMENU:

Specify in percent, the minimum value (0000) for control output. If the output is analog proportional (Current or Voltage), then the minimum voltage or current, in percent, is specified. If the output is time proportional (Relay, SSR or Pulse), then the minimum duty-cycle, in percent, is specified.

- 9) Display flashes 1st digit of previous "Percent Low" setting.
- 10) Use **①** and **②** buttons to enter a new value for "Percent Low".
- 11) Display shows **SEL 2d** stored message momentarily and then advances to **SEL 2d** Maximum/Percent High Submenu.

MAXIMUM/PERCENT HIGH SUBMENU:

Specify in percent, the maximum value (99) for control output. If the output is analog proportional (Current or Voltage), then the maximum voltage or current, in percent, is specified. If the output is time proportional (Relay, SSR, or Pulse), then the maximum duty-cycle, in percent, is specified.

Press **④** 12) Display flashes 1st digit of previous "Percent High" setting.

Press **①** & **②** 13) Use **①** and **②** buttons to enter a new value for "Percent High".

Press **④** 14) Display shows **SEL 2d** stored message momentarily and then advances to **SEL 2d** Control Type Submenu.

Example: On an Analog Output of 0~10 Vdc, a setting of %LO = 10 and %HI = 90, causes the minimum on the control output to be 1 V and the maximum on the control output to be 9 V. The same setting on a time proportional output, will cause 10% duty cycle for the minimum control output and 90% duty cycle for maximum control output. To disable %LO/HI, set LO to 00 and HI to 99. If %LO/HI is at other values than the default (%LO = 00, %HI = 99), **SEL 2d** is disabled.

CONTROL TYPE OUTPUT:

(Relay, SSR, Pulse, or Analog)

- Press **④** 15) Display flashes **SEL 2d** On/Off or **SEL 2d** Proportional, Integral, Derivative.
- 16) Scroll through the available selections: "On/Off" or "PID".
- 17) Display flashes **SEL 2d** stored message momentarily and then advances to **SEL 2d** only, if it was changed, otherwise press **②** to advance to **SEL 2d** Action Type Submenu.

The **ON/OFF** control is a coarse way of controlling the process. The "Dead Band" improves the cycling associated with the On/Off control. The **PID** control is best for processes where the Setpoint is continuously changing and/or a tight control of the process variable is required. **PID** control requires tuning and adjustment of the "Proportional", "Integral or Reset" and "Derivative or Rate" terms by a trial-and-error method. The instrument provides an "Auto Tuning" feature making the tuning process automatic, possibly optimum.

* If Analog Output (Current/Voltage) is your control Output 1, this menu i.e. **SEL 2d** type will not appear, instead **SEL 2d** Current will be displayed. Select **SEL 2d** for a 4-20 mA current (2-10 V Voltage) outputs or **SEL 2d** for a 0-10 V (Voltage) outputs. If 4-20 mA is enabled, %HI/LO setting will have no effect.

Note: Both Current and Voltage control outputs are active simultaneously.

ACTION TYPE SUBMENU:

The error that results from the measurement of the Process Variable may be positive or negative since it may be greater or smaller than the Setpoint. If a positive error should cause the instrument output to increase (i.e. cooling), it would be called **Direct Acting**. If a negative error should cause the output to increase (i.e. heating), it would be called **Reverse Acting**.

- Press **2**
Press **3**
Press **3**
Press **3**
- 18) Display flashes **E₅₅₅** Direct or **P₁₁₁** Reverse.
19) Scroll through the available selections: "Direct" or "Reverse".
20) Display shows **E₅₅₅** stored message momentarily and then advances to **P₁₁₁** only, if it was changed, otherwise press **3** to advance to **P₁₁₁** Auto PID Submenu (if PID Control Type was selected).

Note: If "ON/OFF" was selected in the Control Type, the display skips to the Dead Band Submenu.

AUTO PID SUBMENU:

- Press **3**
Press **3**
Press **3**
- 21) Display flashes **E₅₅₅** or **E₅₅₅**.
22) Scroll through the available selections: "Enable" or "Disable".
23) Display shows **E₅₅₅** stored message momentarily and then advances to **E₅₅₅** only, if it was changed, otherwise press **3** to advance to **E₅₅₅** Anti Integral Submenu.

Note: If "Enabled", the controller can determine, by enabling Start PID, the optimum values for the three adjustments — Proportional, Reset and Rate corresponding to P, I, and D. These values may be changed once the auto tuning is complete.

If "Disabled" is selected, the user will manually enter these three adjustment values. If you want the instrument to do the auto PID and the P, PI or PID, first select auto disable and enter 0000 for unwanted parameter i.e. for PI enter 0000 for the rate.

ANTI INTEGRAL SUBMENU:

- Press **3**
Press **3**
Press **3**
- 24) Display flashes **E₅₅₅** or **E₅₅₅**.
25) Scroll through the available selections: "Enable" or "Disable".
26) Display shows **E₅₅₅** stored message momentarily and then advances to **E₅₅₅** only, if it was changed, otherwise press **3** to advance to **E₅₅₅** to Start Auto Tune PID Submenu (if auto PID was Enabled).

Note: If Auto PID was disabled display advances to **E₅₅₅** Proportional Band Submenu.

Note: If Anti Integral (Anti Windup) Submenu "Enabled", this feature allows the error term outside the proportional band to be calculated and accumulated for integration. This may be an important feature in applications where fast response time is desirable.

START AUTO TUNE PID:

- Press **2**
Press **2**
Press **2**
Press **2**
- 27) Display flashes **E₅₅₅** or **E₅₅₅**.
28) Scroll through the available selections: "Enable" or "Disable".
29) Display shows **E₅₅₅** stored message momentarily and then advances to **E₅₅₅** only, if it was changed, otherwise press **3** to advance to **E₅₅₅** Cycle Time Submenu.

Note: If "Enabled", the controller is ready to calculate P, PI or PID parameters. The instrument performs this by activating the output and observing the delay and rate at which the Process Value changes. The setpoints must be at least 18°F or 10°C above the (PV) Process Value in order to perform Auto Tune, otherwise an error message will be displayed.

To start Auto Tune PID select PID, enable Auto PID and enable Start PID. Sometimes Auto PID parameter needs fine tuning i.e. for each 5°F overshoot increase the Proportional Band (PB) by 15% and for each $\pm 1^{\circ}\text{F}$ fluctuation at the Setpoint (SP) increase reset by 20%.

Once started, display shows **E₅₅₅** with letters blinking in the rotating pattern. When auto tune stops, display will show process value. Do not perform any operations or settings before first stopping Auto Tune. Any alarms or other output is disabled during Auto Tune.

Note: If "AUTO PID" was "DISABLED", the display will show the following three submenus. This allows the user to manually enter values for Proportional, Reset and Rate terms corresponding to P, I, and D. It also can be used for auto PID for disabling unwanted parameter i.e. PI enter 0000 for rate.

PROPORTIONAL BAND SUBMENU:

- Press **2**
Press **2**
Press **2**
- 30) Display flashes 1st digit of the previous P **E₅₅₅** Proportional band value.
31) Press **3** and **3** buttons to enter a new "Proportional Band" value.
32) Display shows **E₅₅₅** stored message momentarily and then advances to **E₅₅₅** only, if it was changed, otherwise press **3** to advance to **E₅₅₅** Reset Setup Submenu.

Proportional band is in degrees of temperature or counts of process. Proportional band is defined, as the change in the instrument input to cause a 100% change in the controller output.

RESET SETUP SUBMENU:

- Press **②** & **③** 33) Display flashes 1st digit of the previous **PAGE** Reset value.
Press **②** & **④** 34) Press **①** and **②** buttons to enter a new "Reset" value.
Press **②** & **⑤** 35) Display shows **Set** stored message momentarily and then advances to **PAGE** only, if it was changed, otherwise press **②** to advance to **PAGE** Rate Setup Submenu.

Reset unit is in seconds 0-3999.

RATE SETUP SUBMENU:

- Press **②** & **⑥** 36) Display flashes 1st digit of previous **D** Rate value.
Press **②** & **⑦** 37) Press **①** and **②** buttons to enter a new **Rate** value.
Press **②** & **⑧** 38) Display shows **Set** stored message momentarily and then advances to the **RTD** only, if it was changed, otherwise press **②** to advance to **RTD** Cycle Time submenu for RTD and Thermocouple types.

Rate unit is in seconds 000.0-399.9.

- If the Output 1 is Analog Option the display skips to Damping Factor.

CYCLE TIME SUBMENU:

- Press **②** 39) Display flashes 1st digit of the previous **CYC** Cycle Time value.
Press **②** & **⑨** 40) Press **①** and **②** buttons to enter a new "Cycle Time" value.
(1 to 199 seconds)
Press **②** & **⑩** 41) Display shows **Set** stored message momentarily and then advances to **SSR** only, if it was changed, otherwise press **②** to advance to **SSR** Damping Factor Submenu.

A Cycle Time selected between 1 and 199 seconds determines the total On/Off time of each proportional cycle. For example, a 15 second cycle time means that every 15 seconds the output will turn on for part or all of the cycle. For Relay control outputs, do not select a cycle time of less than 7 seconds or the relays' lifetime will be shortened. For a cycle time of less than 7 seconds select SSR or DC pulse. Use an external SSR with the DC pulse option for higher currents (higher than 1 Amp).

DAMPING FACTOR SUBMENU:

- Press **②** 42) Display flashes the previous "Damping Factor" selection.
Press **②** & **⑪** 43) Scroll through the available selections: **0.000**, **0.001**, **0.002**,
0.003, **0.004**, **0.005**, **0.006**, **0.007**.
Press **②** & **⑫** 44) Display flashes **Set** stored message and then advances to **DUE** only, if it was changed, otherwise press **②** to advance to **DUE** Output 2 Menu.

Damping Factor is a measure of speed, overshoot, and undershoot in which the process variable responds to the output changes of the instrument, which were used during the Auto Tune. This value is typically set to the ratio of Rate to Reset. This Default value is (0003). For fast response time, this value should be decreased while for slow response time it should be increased.

Note:
The "DEADBAND" Submenu will only appear if "ON/OFF" was selected from the "Control Type" Menu.

DEADBAND SUBMENU:

- Press **②** 45) Display flashes 1st digit of the previous **D&E** Deadband value.
Press **②** & **⑬** 46) Press **①** and **②** buttons to enter a new "Deadband" value.
Press **②** & **⑭** 47) Display shows **Set** stored message and then advances to **DUE** only, if it was changed, otherwise press **②** to advance to **DUE** Output 2 Menu.
- Dead Band units are the same as Proportional Band units.
- Note:**
The Dead Band or neutral zone is the number of degrees or counts (if Input Type is Process) around the Setpoint which the Process Variable must pass above or below the Setpoint, before the output changes state.

3.2.11 Output 2

Output 2 and Alarm 2 share the same contacts on the rear panel connector. If Alarm 2 is Enabled, Output 2 is automatically Disabled.

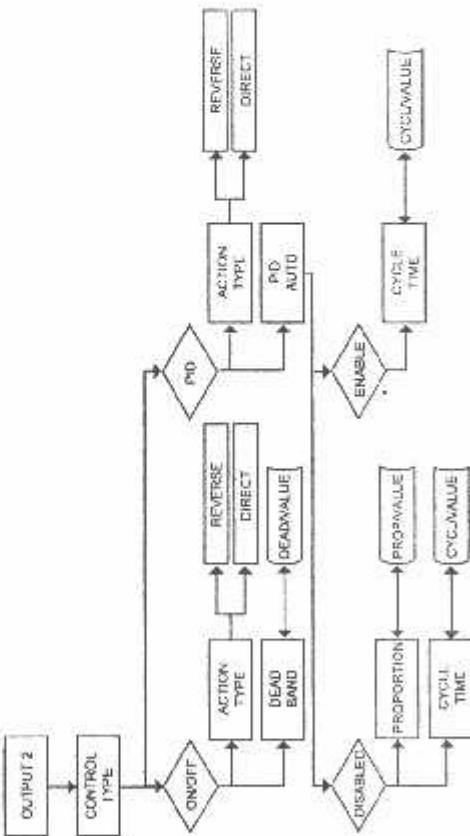


Figure 3.10 Flow Chart for Output 2

ENTER OUTPUT 2 MENU:

- Press **①** Press **②** if necessary, until **INPUT** prompt appears.
 Press **③** Display advances to **INPUT**. Input Menu.
 Press **④**, if necessary, until Display advances to **OUT 2**
 Output 2 Menu.
 Press **⑤** Display advances to **OUT 2**. Control Type Submenu.

CONTINUOUS ELEMENTS

- Press 3) Display flashes ON/OFF, or PID.
 Press 4) Scroll through the available selections: "ON/OFF" or "PID".
 Press 5) Display shows stored message momentarily and then advances to only, if it was changed, otherwise press advance to Action Type Submenu.

The ON/OFF control is a coarse way of controlling the Process. The "Dead Band" improves the cycling associated with the ON/OFF control. The PID control is best for processes where the Setpoint is continuously changing and/or tight control of the Process Variable is required.

ACTION TYPE SUMMARY

The error that results from the measurement of the Process Variable may be positive or negative since it may be greater or smaller than the Setpoint. If a positive error should cause the instrument output to increase (i.e. cooling), it would be called **Direct Acting**. If a negative error should cause the output to decrease (i.e. heating), it would be called **Reverse Acting**.



If AUTO PID was "ENABLED", the display skips to the CYCLE TIME submenu. If "AUTOPID" was "DISABLED", the display will show PROPORTIONAL BAND Submenu allowing the user to manually enter the Proportional Band value.

PROPOSITIONAL RAND SIGNIFICANCE

- Press **①** 12) Display flashes 1st digit of the previous Proportional Band value.
 Press **② & ③** 13) Press **④** and **⑤** buttons to enter a new Proportional Band value.
 Press **⑥** 14) Display shows **Set** stored message momentarily and then advances to **Set** only, if it was changed, otherwise press **⑦** to advance to the **Set** Cycle Time Submenu.

Note: Refer to "Proportional Band" Submenu of "Output 1" Menu.

CYCLE TIME SUBMENU:

- Press **⑤**
⑥ & **⑦** 15) Display flashes 1st digit of the previous "Cycle Time" value.
 Press **⑧** & **⑨** 16) Press **⑩** and **⑪** buttons to enter a new "Cycle Time" value
 (1 to 199 seconds).

- Press **⑫** 17) Display shows **Set&S** stored message momentarily and then advances to **RAMP** only, if it was changed, otherwise press **⑬** to advance to **RAMP Ramp Value Submenu**.

A cycle time selected between 1 to 199 seconds indicates the total On/Off time of each proportional cycle. For example, a 15 second cycle time means that every 15 seconds the output will turn on for part or all of the cycle. For Relays' Control Outputs, do not select a cycle time of less than 7 seconds or the relays' lifetime will be shortened. For a cycle time of less than 7 seconds select SSR or DC pulse. Use an external SSR with the DC pulse option for higher current (higher than 1 Amp).

The **DEADBAND** Submenu will only appear if the ON/OFF was selected from the "Control Type" Submenu.

DEADBAND SUBMENU:

- Press **⑤** & **⑥** 18) Display flashes 1st digit of the previous "Dead Band" value.
 Press **⑦** & **⑧** 19) Press **⑩** and **⑪** buttons to enter a new "Dead Band" value.
 Press **⑫** 20) Display shows **Set&P** stored message momentarily and then advances to **RAMP** only, if it was changed, otherwise press **⑬** to advance to **RAMP Ramp Value Menu**.

Dead Band units are the same as Proportional Band units.

The Dead Band is the number of degrees or counts around the Setpoint state, which the Process Variable must pass through before the output changes state.

Note:

3.2.12 Ramp & Soak

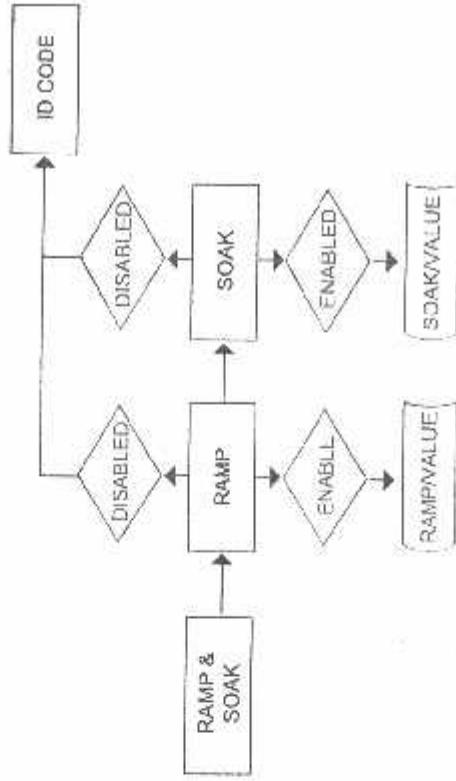


Figure 3.11 Flow Chart for Ramp and Soak

ENTER RAMP AND SOAK MENU:

- Press **④**
 Press **⑤**
 Press **⑥**
 Press **⑦**
 1) Press **⑩**, if necessary until **RAMP** prompt appears.
 2) Display advances to **RAMP** Input Menu.
 3) Press **⑩** if necessary, until Display advances to **RAMP** and **SOAK** Soak Menu.

RAMP ENABLE/DISABLE SUBMENU:

- Press **④**
 Press **⑤**
 Press **⑥**
 Press **⑦**
 4) Display advances to "Ramp Enable/Disable" Submenu and flashes **Set&P** or **Set&L**.
 5) Scroll through the available selections: "Enable" or "Disable".
 6) Display shows **Set&P** stored message momentarily and then advances to **SOAK** Soak Enable/Disable Menu.

- If **RAMP** Disable was selected, display skips to the next menu item (**ID Code**).

SOAK ENABLE/DISABLE SUBMENU:

- Press **④**
 Press **⑤**
 Press **⑥**
 Press **⑦**
 7) Display flashes **Set&L** or **Set&H**.
 8) Scroll through the available selections: "Enable" or "Disable".
 9) Display shows **Set&H** stored message momentarily and then advances to "Ramp Value" Submenu.

Ramp & Soak provides users with the flexibility to slowly bring the Process Variable (PV) to the desired setpoint. Ramp & Soak values are specified in HH:MM format. The Ramp value indicates the time specified to bring the process variable to Setpoint 1 (SP1). Once the set point is reached, the PID takes over and the Process Variable will be controlled at the desired set point indefinitely. If Soak is enabled, PID will control the Process Variable at the specified Setpoint for the duration of Soak time and then will turn off Output 1. To start a new Ramp/Soak cycle, reset the instrument by pressing **②** and then **③** button.

An active Ramp/Soak will change SP1 one degree above the PV and will cause the most significant digit to blink. The SP1 will be incremented by one degree until it reaches the original SP1. The minimum Ramp time must be at least twice the time that it will take the PV to reach the Setpoint Value (SV) with OUT 1 fully ON.

RAMP VALUE SUBMENU:

- Press **②**
- ③** & **④** 10) Display flashes 1st digit of previous stored "Ramp Value".
- Press **②** & **⑤** 11) Press **⑥** and **⑦** buttons to enter a new "Ramp Value".
- Press **②** 12) Display shows **SET** stored message momentarily and then advances to "Soak Value" Submenu.

SOAK VALUE SUBMENU:

- Press **②**
- ③** & **④** 13) Display flashes 1st digit of previous stored "Soak Value".
- Press **②** & **⑤** 14) Press **⑥** and **⑦** buttons to enter a new "Soak Value".
- Press **②** 15) Display shows **SET** stored message and advances to the **⑩** ID Code Menu.

The Ramp and Soak time is 00:00 to 99:59 i.e. HH:MM. (from zero to 99 hours and 59 minutes) During Ramp & Soak do not perform any operations or settings before first stopping it. Any alarms or other output are disabled during this time. To stop Ramp & Soak first put instrument into Standby Mode, then go to Ramp & Soak Menu and disable it.

3.2.13 ID CODE

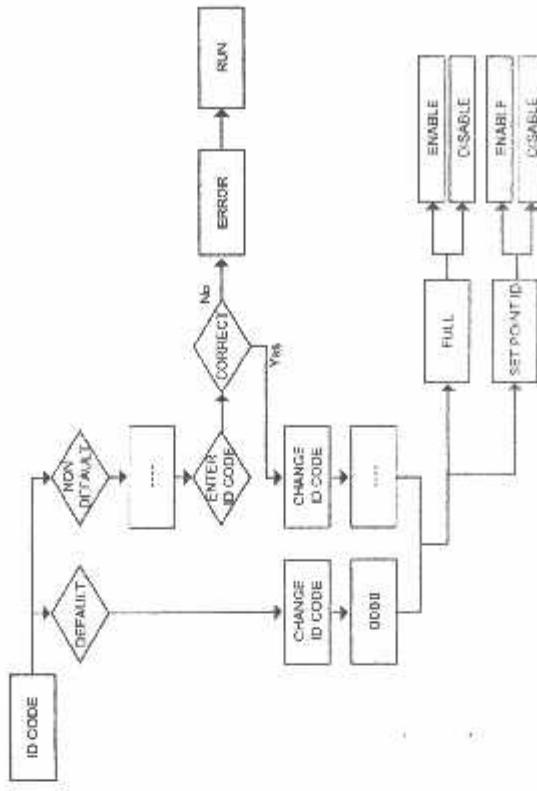


Figure 3.12 Flow Chart for ID Code

ENTER ID CODE MENU:

- Press **②**
- Press **③** & **④**
- Press **②**
- Press **②** & **⑤**
- Press **②**
- Press **②**
- Press **②**
- Press **②**

1) Press **②**, if necessary, until **E&S** prompt appears.

2) Display advances to **⑩** Input Menu.

3) Press **②**, if necessary, until Display advances to **⑪** ID Code Menu.

ENTERING OR CHANGING YOUR (NON-DEFAULT) ID CODE:

- Press **②**
- Press **③** & **④**
- Press **②**
- Press **②** & **⑤**
- Press **②**
- Press **②**
- Press **②**
- Press **②**

4) Display advances to **⑩** with 1st under score flashing
5) Press **⑥** and **⑦** to enter your 4-digit "ID Code" number.
6) Display advances to **⑪** Change ID Code Submenu.

If entered "ID Code" is incorrect display shows **E&S** Error message momentarily and then skips to the Run Mode.

- Press **②**
- 7) Display flashes the first digit of previous entered "ID Code" number.
- Press **③** & **④**
- 8) Press **⑥** and **⑦** buttons to enter your new "ID Code" number.
- 9) Display shows **SET** stored message momentarily and then advances to the **⑩** Full Security Submenu.

ENTERING OR CHANGING YOUR (DEFAULT) ID CODE:

Enter **10** menu (Repeat steps from 1 to 3).

- 10)** Display advances to **CH**. **11)** Display shows **0000** message with flashing 1st digit.

If you want to change your default "ID Code" you can do it now, otherwise press **2** and menu will skip to **Full Security** Submenu.

- Press **0** & **0** **12)** Press **0** and **0** buttons to enter your new "ID Code" number.
 Press **0** **13)** Display shows **5E82** stored message momentarily and then advances to the **FULL** Full Security Submenu.

FULL SECURITY LEVEL SUBMENU:

- Press **0**
 Press **0**
 Press **0** **14)** Display flashes **E451** Enable or **E550** Disable.
15) Scroll through the available selections: "Enable" or "Disable".
16) Display shows **5E82** stored message momentarily and then advances to **SP** **13** SetpointID Submenu.

If "Full" Security Level is "Enabled" and the user attempts to enter the Main Menu, they will be prompted for an ID Code. The ID Code should be correct to enter the instrument Menu item.

SETPOINT/ID SECURITY LEVEL SUBMENU:

This Security Level can be functional only if **E451** Security Level is Disabled.

- Note:** **17)** Display flashes **E451** Enable or **E550** Disable.
18) Scroll through the available selections: "Enable" or "Disable".
19) Display shows **5E82** stored message momentarily and then advances to **E451** Communication Submenu.

Note: If "Setpoint/ID" Security Level is "Enabled" and the user attempts to advance into the **E451** Configuration Menu, he will be prompted for ID Code number. The ID Code should be correct to proceed into the Configuration Menu, otherwise display will show an Error and skip to the Run Mode.

Note: If "Full" and "Setpoint/ID" Security Levels are "Disabled", the ID code will be "Disabled" and user will not be asked for ID Code to enter the Menu items ("ID" Submenu will not show up in "ID/Setpoint" Menu).

3.2.14 COMMUNICATION OPTION

Purchasing the controller with Serial Communications permits an instrument to be configured or monitored from an IBM PC compatible computer using software available from the website or on the CD-ROM enclosed with your shipment. For complete instructions on the use of the Communications Option, refer to the Serial Communications Reference Manual.

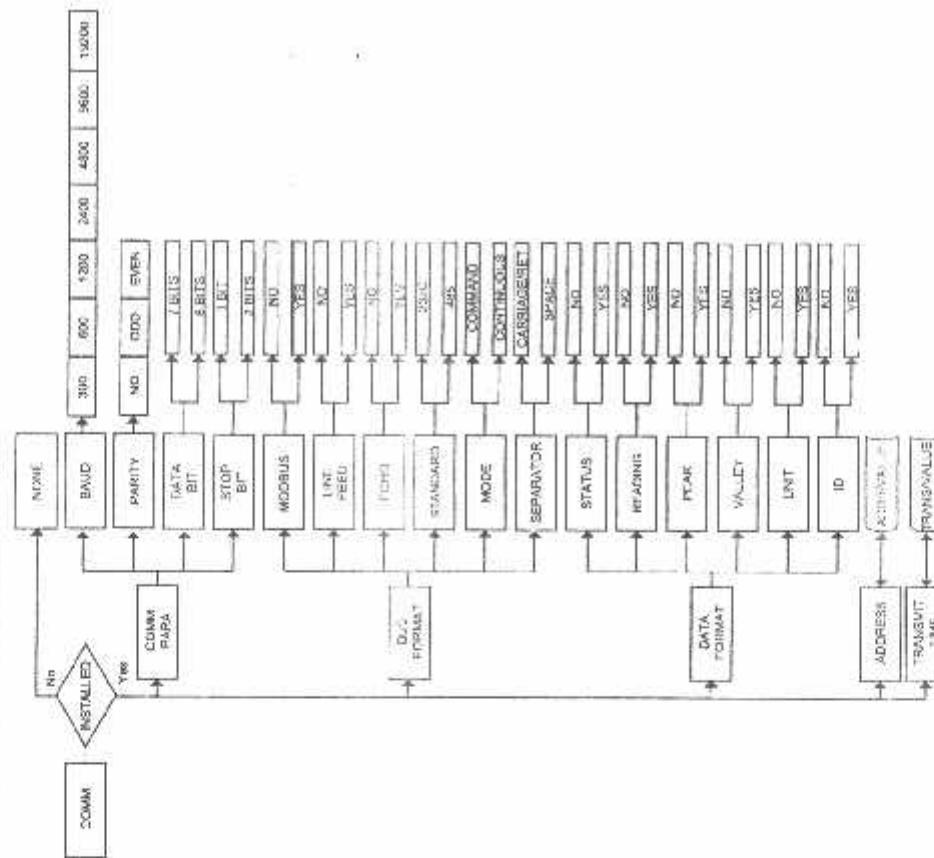


Figure 3.13 Flow Chart for Communication Option

ENTER COMMUNICATION OPTION MENU:

- Press **①** 1) Press **②**, if necessary, until **COMM** prompt appears.
Press **②** 2) Display advances to **LINE** Input Menu.
Press **③** 3) Press **②**, if necessary, until **COMM** advances to **COMM** Communication Options Menu.
Press **④** 4) Display advances to **FORMAT** Communication Parameters Submenu.



If Communication Option is not installed, the display shows **None** and skips to the Color Display Menu.

COMMUNICATION PARAMETERS SUBMENU:

Allows the user to adjust Serial Communications Settings of the Instrument. When connecting an instrument to a computer or other device, the Communications Parameters must match. Generally the default settings (as shown in Section 5) should be utilized.

- Press **⑤** 5) Display advances to **BAUD** Baud Submenu.

BAUD SUBMENU:

- Press **⑥** 6) Display flashes previous selection for **DATA** value.
Press **⑦** 7) Scroll through the available selections: **300**, **600**, **1200**, **2400**, **4800**, **9600**, **19200**.
Press **⑧** 8) Display shows **PAR** stored message momentarily and then advances to **PRES** only, if it was changed, otherwise press **⑩** to advance to **PRPS** Parity Submenu.

PARTY SUBMENU:

- Press **⑨** 9) Display flashes previous selection for "Parity".
Press **⑩** 10) Scroll through the available selections: NO, ODD, EVEN.
Press **⑪** 11) Display shows **DATA** stored message momentarily and then advances to **DATA** only, if it was changed, otherwise press **⑫** to advance to **DATA** Data Bit Submenu.

DATA BIT SUBMENU:

- Press **⑫** 12) Display flashes previous selection for "Data Bit".
Press **⑬** 13) Scroll through the available selections: 7-BIT, 8-BIT.
Press **⑭** 14) Display shows **STOP** stored message and then advances to **STOP** only, if it was changed, otherwise press **⑯** to advance to **STOP** Stop Bit Submenu.

STOP BIT SUBMENU:

- Press **⑮** 15) Display flashes previous selection for "Stop Bit".
Press **⑯** 16) Scroll through the available selections: 1-BIT, 2-BIT.
Press **⑰** 17) Display shows **SERIAL** stored message momentarily and then advances to **BUS** only, if it was changed, otherwise press **⑲** to advance to **SERIAL** Bus Format Submenu.

BUS FORMAT SUBMENU:

Determines Communications Standards and Command/Data Formats for transferring information into and out of the controller via the Serial Communications Bus. Bus Format submenu essentially determine how and when data can be accessed via the Serial Communications of the device.

- Press **⑳** 18) Display advances to **MODBUS** Modbus Submenu.

MODBUS PROTOCOL SUBMENU:

- Press **㉑** 19) Display flashes previous selection for **MODBUS**.
Press **㉒** 20) Scroll through the available selections: NO, YES.
Press **㉓** 21) Display shows **SLAVE** stored message momentarily and then advances to **MASTER** only, if it was changed, otherwise press **㉔** to advance to **SLAVE** Line Feed submenu.

Note:

To select I-Series Protocol, set Modbus submenu to "No".

To select Modbus Protocol, set Modbus submenu to "Yes".

Note:

If Modbus Protocol was selected, the following Communications Parameters must be set as: No Parity, 8-bit Data Bit, 1-Stop Bit. Do not attempt to change these parameters.

LINE FEED SUBMENU:

Determines if data sent from the instrument will have a Line Feed appended to the end - useful for viewing or logging results on separate lines when displayed on communications software at a computer.

- Press **㉕** 22) Display flashes previous selection for "Line Feed".
Press **㉖** 23) Scroll through the available selections: NO, YES.
Press **㉗** 24) Display shows **ECHO** stored message momentarily and then advances to **ECHO** only, if it was changed, otherwise press **㉘** to advance to **ECHO** Echo Submenu.

ECHO SUBMENU:

When valid commands are sent to the instrument, this determines whether the command will be echoed to the Serial Bus. Use of echo is recommended in most situations, especially to help verify that data was received and recognized by the controller.

Press **25**) Display flashes previous selection for "Echo".
Press **26**) Scroll through the available selections: NO, YES.
Press **27**) Display flashes **ECHO** stored message momentarily and then advances to **ECHO** only if it was changed, otherwise press **②** to advance to **Serial Communication Standard Submenu**.

COMMUNICATION INTERFACE STANDARD SUBMENU:

Note: This menu is applicable for Continuous Mode of RS-232 communication.

Press **28**) Display flashes previous selection for "Standard" -
Press **29**) Scroll through the available selections: 232C, 485.
Press **30**) Display shows **RS485** stored message momentarily and then advances to **RS485** only, if it was changed, otherwise press **②** to advance to **Data Flow Mode Submenu**.

DATA FLOW MODE SUBMENU:

Determines whether the instrument will wait for commands and data requests from the Serial Bus or whether the instrument will send data automatically and continuously to the Serial Bus. Devices configured for the RS-485 Communications Standard operate properly only under Command Mode.

Press **31**) Display flashes previous selection for "Mode".
Press **32**) Scroll through the available selections: **E&F**, "Command", **C&S**, "Continuous".
Press **33**) Display shows **E&F** stored message momentarily and then advances to **E&F** only, if it was changed, otherwise press **②** to advance to **Space Data Separation Submenu**.

DATA SEPARATION CHARACTER SUBMENU:

Determines whether data sent from the device in Continuous Data Flow Mode will be separated by spaces or by Carriage Returns.

Press **34**) Display flashes previous selection for "Separation" Submenu.
Press **35**) Scroll through the available selections: **E&P**, "Space" or **E&P**, "Carriage Return".
Press **36**) Display shows **E&P** stored message momentarily and then advances to **E&P** only, if it was changed, otherwise press **②** to advance to **Data Format Submenu**.

Press **25**) Display flashes previous selection for "Echo".
Press **26**) Scroll through the available selections: NO, YES.
Press **27**) Display flashes **ECHO** stored message momentarily and then advances to **ECHO** only if it was changed, otherwise press **②** to advance to **Serial Communication Standard Submenu**.

DATA FORMAT SUBMENU:

Preformatted data can be sent automatically or upon request from the controller. Use the Data Format Submenu to determine what data will be sent in this preformatted data string. Refer to the iSeries Communications Manual for more information about the data format. At least one of the following suboptions must be enabled and hence output data to the Serial Bus.

Note: This menu is applicable for Continuous Mode of RS-232 communication.

Press **37**) Display advances to **E&R** Alarm Status Submenu.

ALARM STATUS SUBMENU:

Includes Alarm Status bytes in the data string.
Press **38**) Display flashes previous selection for "Status" (alarm status).
Press **39**) Scroll through the available selections: NO, YES.
Press **40**) Display shows **E&R** stored message momentarily and then advances to **E&R** only, if it was changed, otherwise press **②** to advance to **E&R** Reading Submenu.

MAIN READING SUBMENU:

Includes Main Reading in the data string.

Press **41**) Display flashes previous selection for "Reading".
Press **42**) Scroll through the available selections: NO, YES.
Press **43**) Display shows **E&R** stored message momentarily and then advances to **E&R** only, if it was changed, otherwise press **②** to advance to **E&R** Peak Submenu.

PEAK VALUE SUBMENU:

Includes Peak Value in the data string.

Press **44**) Display flashes previous selection for **E&P** Submenu.
Press **45**) Scroll through the available selections: NO, YES.
Press **46**) Display shows **E&P** stored message momentarily and then advances to **E&P** only, if it was changed, otherwise press **②** to advance to **E&P** Valley Submenu.

VALLEY VALUE SUBMENU:

Includes Valley Value in the data string.

Press **47**) Display flashes previous selection for "Valley".
Press **48**) Scroll through the available selections: NO, YES.
Press **49**) Display shows **E&P** stored message momentarily and then advances to **E&P** only, if it was changed, otherwise press **②** to advance to **E&P** Temperature Unit Submenu.

TEMPERATURE UNIT SUBMENU:

Includes a byte in the data string to indicate whether reading is in Celsius or Fahrenheit.

- Press **②**
Press **③**
Press **④**
50) Display flashes previous selection for **DATA**.
51) Scroll through the available selections: NO, YES.
52) Display shows **DATA** stored message momentarily and then advances to **DATA** only, if it was changed, otherwise press **②** to advance to **DATA** Address Setup Submenu.

ADDRESS SETUP SUBMENU:

Note: This menu is applicable to the RS-485 Option only.

- Press **②**
53) Display advances to "Address Value" (00000 to 0199) Submenu.

ADDRESS VALUE SUBMENU:

- Press **②**
Press **③** & **④**
Press **⑤**
54) Display flashes 1st digit of previously stored Address Value.
55) Press **②** and **④** to enter new "Address Value".
56) Display shows **DATA** stored message momentarily and then advances to **DATA** only, if it was changed, otherwise press **②** to advance to **DATA** Transmit Time Interval Submenu.

TRANSMIT TIME INTERVAL SUBMENU:

- Note:** This menu is applicable if "Continuous" Mode was selected in the "Data Flow Mode" Submenu and the device is configured as an RS-232C Standard device. Also, one or more options under the Data Format Submenu must be enabled.
- Press **②**
57) Display advances to "Transmit Time Value" Submenu.

TRANSMIT TIME INTERVAL VALUE SUBMENU:

Determines the interval at which data will be emitted to the RS-232 Serial Bus when the instrument is in Continuous Data Flow Mode.

Press **②**
58) Display flashes 1st digit of previous "Transmit Time Value" in seconds.

- Press **③** & **④**
59) Press **②** and **④** to enter new "Transmit Time Value", e.g. 0030 will send the data every 30 seconds in Continuous Mode.
60) Display shows **DATA** stored message momentarily and then advances to **DATA** only, if it was changed, otherwise press **②** to advance to **DATA** Color Selection Menu.

Note: For more details, refer to the **Communication Manual** available at the website listed in the cover page of this manual.

3.2.15 DISPLAY COLOR SELECTION

This submenu allows the user to select the color of the display.

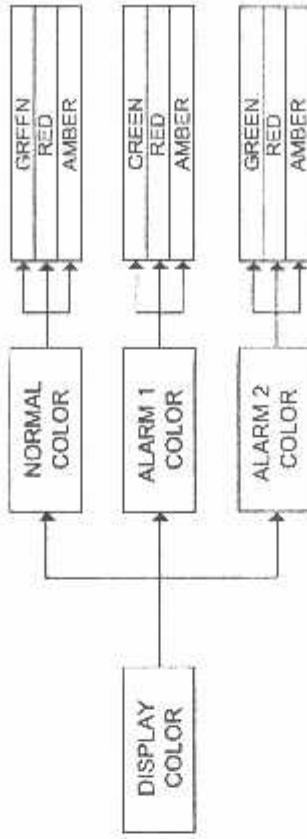


Figure 3.14 Flow Chart for Display Color Selection

ENTER DISPLAY COLOR SELECTION MENU:

- Press **②**
1) Press **②**, if necessary, until **DATA** prompt appears.
2) Display advances to **DATA** Input Menu.
Press **③**
3) Press **②**, if necessary, until Display advances to **EDITOR** Display Color Selection Menu.
Press **④**
4) Display advances to **EDITOR** Normal Color Submenu.
- Press **②**
5) Display flashes the previous selection for "Normal Color".
Press **③**
6) Scroll through the available selections: **GRF/N**, **RED** or **AMBER**.
Press **④**
7) Display shows **DATA** stored message momentarily and then advances to **DATA** only, if it was changed, otherwise press **②** to advance to **EDITOR** Alarm 1 Display Color Submenu.

The menu below allows the user to change the color of display when alarm is triggered.

ALARM 1 DISPLAY COLOR SUBMENU:

- Press **②**
8) Display flashes previous selection for "Alarm 1 Color Display".
Press **③**
9) Scroll through the available selections: **GRF/N**, **RED** or **AMBER**.
Press **④**
10) Display shows **DATA** stored message momentarily and then advances to **DATA** only, if it was changed, otherwise press **②** to advance to **EDITOR** Alarm 2 Display Color Submenu.

ALARM 2 DISPLAY COLOR SUBMENU:

- Press Press Press Press

 - 11) Display flashes previous selection for "Alarm 2 Color Display".
 - 12) Scroll through the available selections: or
 - 13) Display shows stored message momentarily and then momentarily shows the software version number, followed by Reset, and then proceeds to the Run Mode.

TIP IN ORDER TO DISPLAY ONE COLOR, SET THE SAME DISPLAY COLOR ON ALL THREE SUBMENUS ABOVE.

If user wants the Display to change color every time when both Alarm 1 and Alarm 2 are triggered, the Alarm values should be set in such a way that Alarm 1 value is always on the top of Alarm 2 value, otherwise value of Alarm 1 will overwrite value of Alarm 2 and Display Color would not change when Alarm 2 is triggered.

Example 1:

Output 1 & Output 2 = SSR
 Alarm Setup: Absolute, Above, Alarm 2 HI Value "A1.R.H" = 200, Alarm 1 HI Value "A1.R.H" = 400
 "Color Display" Setup: Normal Color "N CLR" = Green, Alarm 1 Color "1 CLR" = Amber, Alarm 2 Color "2 CLR" = Red

Display Colors change sometimes

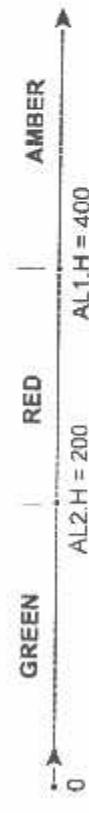
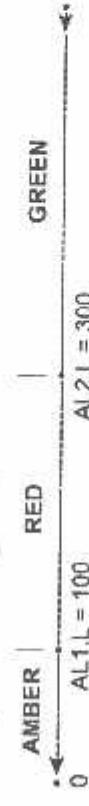


Exhibit 2.

Example 2:
Output 1 & Output 2 = Pulse
Alarm Setup: Absolute, Below, Alarm 2 Low Value "AL.R.L" = 300, Alarm 1
Low Value "AL.R.L" = 100
Color Display Setup: "NCLR" = Green, "1 CLR" = Amber, "2 CLR" = Red

Disney College Program



Example 3:

Example 5: Analog Output (Alarm 1 disabled), Setpoint 1 = 300, Output 1 = Relay, Setpoint 2 = 200
Output 2 = Relay, Setpoint 2 = 200
Alarm 1 & 2 Setup: Deviation, Band, "ALR.H" = 10
Color Display Setup: "N.CLR" = Green, "1.CLR" = Amber, "2.CLR" =

Display Colors change sequence



Alarm 1 is designed to monitor the Process Value around the Setpoint 1. Alarm 2 is designed to monitor the Process Value around the Setpoint 2. If Analog Output Option board is installed (Alarm 1 is disabled), only Alarm 2 is active and only two colors are available

Example 4: Output 1 = Relay, Setpoint 1 = 200
 Output 2 = Relay, Setpoint 2 = 200
 Alarm 1 Setup: Deviation, Band, "ALR.H" = 20
 Alarm 2 Setup: Deviation, H/Low, "ALR.L" = 10, "ALR.LT" = 5
 Color Display Setup "CLR" = Green, "CLR" = Amber, "CLR" = Red

Dienstverfahrensabschaffung



Reset: The instrument automatically resets after the last menu of the Configuration Mode has been entered. After the instrument resets, it advances to the Run Mode.

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PART 4 SPECIFICATIONS

Accuracy	±0.5°C temp; 0.03% reading process	Thermocouple Lead Resistance	100 ohm max
Resolution	1°/0.1%; 10 µV process	RTD Input	100/500/1000 Ω Pt sensor, 2-, 3- or 4-wire; 0.00385 or 0.00392 curve
Temperature Stability	1) RTD: 0.04°C/C 2) TC @ 25°C (77°F): 0.05°C/C - Cold Junction Compensation 3) Process: 50 ppm/°C	Voltage Input	0 to 100 mV, 0 to 1 V, 0 to 10 Vdc
		Input Impedance	10 MΩ for 100 mV 1 MΩ for 1 or 10 Vdc
NMRR	60 dB	Current Input	0 to 20 mA (5 ohm load)
CMRR	120 dB	Configuration	Single-ended
A/D Conversion	Dual slope	Polarity	Unipolar
Reading Rate	3 samples per second	Step Response	0.7 sec for 99.9%
Digital Filter	Programmable	Decimal Selection	None, 0.1 for temperature None, 0.1, 0.01 or 0.001 for process
Display	4-digit, 9-segment LED • 10.2 mm (0.40"); 132, 116, i16D (Dual Display), i8DV (Dual Vertical) • 21 mm (0.83"); i8 • 10.2 mm (0.40") and 21 mm (0.83"); i8PH (Dual Horizontal) red, green and amber programmable colors for process variable, set point and temperature units	Setpoint Adjustment	-1999 to 9999 counts
		Span Adjustment	0.001 to 9999 counts
		Offset Adjustment	-1999 to +9999
Warm up to Rated Accuracy	30 min.	CONTROL	Action Reverse (heat) or direct (cool)
INPUT		INPUT Types	Thermocouple, RTD, Analog Voltage, Analog Current
SSR			20-265 Vac @ 0.05-0.5 A (Resistive Load); continuous

Modes	DC Pulse Nor-isolated; 10 Vdc @ 20 mA	Analog Output (Output 1 only)	Non-isolated, Proportional 0 to 10 Vdc or 0 to 20 mA; 500 Ω max
COMMUNICATIONS (optional)	RS-232 or RS-485 programmable		
	300 to 19.2 K baud; complete programmable setup capability, program to transmit current display, alarm status, Peak and Valley value.		
RS-485			Addressable from 0 to 199
Connection	Screw terminals	ALARM 1 & 2 (programmable):	
		Type Same as Output 1 & 2	
Operation	High/low, above/below, band, latch/unlatch, normally open/normally closed and process/deviation; front panel configurations		
ANALOG OUTPUT (programmable)	Non-Isolated, Retransmission 0 to 10 Vdc or 0 to 20 mA, 500 Ω max (Output 1 only). Accuracy is ± 1% of FS when following conditions are satisfied		
	1) Input is not scaled below 1% of Input FS. 2) Analog Output is not scaled below 3% of Output FS.		
EXCITATION (optional In place of Communication)	24 Vdc @ 25 mA Not available for Low Power Option		

INSULATION**Power to Input/Output**

2500 Vac per 1 min. test

1500 Vac per 1 min. test

(Low Voltage/Power Option)

Power to Relays/SSR Outputs

2500 Vac per 1 min. test

Relays/SSR to Relay/SSR Outputs

2500 Vac per 1 min. test

RS-232/485 to Inputs/Outputs

500 Vac per 1 min. test

Environmental Conditions

• i8, i16, i32: 0 to 55°C (32 to 131°F), 90% RH non-condensing

• i8DV, i8DH, i16D: 0 to 50°C (32 to 122°F), 90% RH non-condensing

Protection

NEMA-4x (IP65) front bezel

Dimensions

i8 Series:

48 H x 96 W x 127 mm D

(1.89 x 3.78 x 5")

i16 Series:

48 H x 48 W x 127 mm D

(1.89 x 1.89 x 5")

i32 Series:

25.4 H x 48 W x 127 mm D

(1.0 x 1.89 x 5")

Panel Cutout

i8 Series:

45 H x 92 mm W (1.772" x 3.622").

1/8 DIN

i16 Series:

45 mm (1.772") square, 1/16 DIN

22.5 H x 45 mm W (0.886" x 1.772").

1/32 DIN

Low Voltage/Power Option

12-36 Vdc, 3 W, for i8, i16, i32 Models

20-36 Vdc, 4 W, for i8DV, i8DH, i16D Models

External power source must meet

Safety Agency Approvals for CAT II

Installation and double insulation

* Units can be powered safely with 24 Vac power but, no Certification for CE/UL are claimed.

Weight

i8 Series: 295 g (0.65 lb)

i16 Series: 159 g (0.35 lb)

i32 Series: 127 g (0.28 lb)

External Fuse Required

Time-Delay, UL 246-14 listed

100 mA/250 V

400 mA/250 V (Low Voltage/Power Option)

Time-Lag, IEC 127-3 recognized

100 mA/250 V

400 mA/250 V (Low Voltage/Power Option)

Table 4.1 Input Properties

TC	Input Type	Range	Accuracy
J	Iron-Constantan	-210 to 760°C -346 to 1400°F	0.4°C 0.7°F
K	CHROMEGA*- ALOMEGA*	-270 to -160°C -160 to 1372°C -454 to -256°F -256 to 2502°F	1.0°C 0.4°C 1.8°F 0.7°F
T	Copper-Constantan	-270 to -190°C -190 to 400°C -454 to -310°F -310 to 752°F	1.0°C 0.4°C 1.8°F 0.7°F
E	CHROMEGA- Constantan	-270 to -220°C -220 to 1000°C -454 to -364°F -364 to 1832°F	1.0°C 0.4°C 1.8°F 0.7°F
R	Pt/13%Rh-Pt	-50 to 40°C 40 to 1788°C -58 to 104°F 104 to 3250°F	1.0°C 0.5°C 1.8°F 0.9°F
S	Pt/10%Rh-Pt	-50 to 100°C 100 to 1768°C -58 to 212°F 212 to 3214°F	1.0°C 0.5°C 1.8°F 0.9°F
B	30%Rh-Pt/ 6%Rh-Pt	200 to 640°C 640 to 1820°C 212 to 1184°F 1184 to 3308°F	1.0°C 0.5°C 1.8°F 0.9°F
C	5%Re-W/ 26%Re-W	0 to 2354°C 32 to 4253°F	0.4°C 0.7°F
N	Nicrosil-Nisil	-250 to -100°C -100 to 1300°C -418 to -148°F -148 to -2372°F	1.0°C 0.4°C 1.8°F 0.7°F
L	DIN	-328 to 1652°F -328 to 900°C -200 to 900°C -328 to 1652°F	0.4°C 0.7°F 0.4°C 0.7°F
RTD	Pt, 0.00385, 100 Ω, 500 Ω, 1000 Ω	200 to 900°C -328 to 1652°F	0.4°C 0.7°F
RTD	Pt, 0.00392, 100 Ω, 500 Ω, 1000 Ω	-200 to 850°C -328 to 1652°F	0.4°C 0.7°F
PROCESS	Voltage	0 to 100 mV, 0 to 1 V, 0 to 10 Vdc	0.03% rdg 0.03% rdg
PROCESS	Current	0 to 20 mA, 4 to 20 mA	0.03% rdg

PART 5 FACTORY PRESET VALUES

Table 5.1 Factory preset value

MENU ITEMS	FACTORY PRESET VALUES	NOTES
Ramp & Soak (RAMP):		
Ramp (RAMP)	Disable (DSBL)	
Soak (SOAK)	Disable (DSBL)	
Ramp Value (RAMP)	00.00	
Soak Value (SOAK)	00.00	
ID:		
ID Value	0000	
Full ID (FULL)	Disable (DSBL)	
Set Point ID (ID.SP)	Disable (DSBL)	
Communication Parameters:		
Baud Rate (BAUD)	9600	
Parity (PRTY)	Odd	
Data bit (DATA)	7 bit	
Stop Bit	1 bit	
Modbus Protocol (MBUS)	No	
Line Feed (LF)	No	
Echo (ECHO)	Yes	
Standard Interface (STND)	RS-232 (732C)	
Command Mode (MOJE)	Command (CMD)	
Separation (SEPR)	Space (SPCE)	
Alarm Status (STAT)	No	
Reading (RUNG)	Yes	
Peak	No	
Valley (VALY)	No	
Units (UNIT)	No	
Multipoint Address (ADDR)	0001	
Transmit Time (TR.TM)	0016	
Display Color (COLR):		
Normal Color (N.CLR)	Green (GRN)	
Alarm 1 Color (1.CLR)	Red (RED)	
Alarm 2 Color (2.CLR)	Amber (AMBR)	
ANALOG OUTPUT (Retransmission):		
Analog Output (ANLG)	Enabled (ENBL)	
Current/Voltage (CURR/VOLT)	Voltage (VOLT)	
Scale and Offset	Reading: 0 - 999.9 cts, Output: 0 - 10 V	
OUTPUT 1 & 2:		
Self (SELF)	Disabled (DSBL)	Output 1 only
% Low Value (%LO)	0000	Output 1 only
% High Value (%HI)	0099	Output 1 only
Control Type (CTRL)	On/Off	
Action Type (ACTN)	Reverse (RVRS)	
Dead Band (DEAD)	020.0	
PID Auto (AUTO)	Disable (DSBL)	
Anti Integral (ANTI)	Disable (DSBL)	Output 1 only
Proportion Value (PROP)	020.0	
Reset Value (REST)	0180	Output 1 only
Rate Value (RATE)	0000	Output 1 only
Cycle Value (CYCL)	0007	
Damping Factor (DPNG)	0003	

MENU ITEMS	FACTORY PRESET VALUES	NOTES
Ramp & Soak (RAMP):		
Ramp (RAMP)	Disable (DSBL)	
Soak (SOAK)	Disable (DSBL)	
Ramp Value (RAMP)	00.00	
Soak Value (SOAK)	00.00	
ID:		
ID Value	0000	
Full ID (FULL)	Disable (DSBL)	
Set Point ID (ID.SP)	Disable (DSBL)	
Communication Parameters:		
Baud Rate (BAUD)	9600	
Parity (PRTY)	Odd	
Data bit (DATA)	7 bit	
Stop Bit	1 bit	
Modbus Protocol (MBUS)	No	
Line Feed (LF)	No	
Echo (ECHO)	Yes	
Standard Interface (STND)	RS-232 (732C)	
Command Mode (MOJE)	Command (CMD)	
Separation (SEPR)	Space (SPCE)	
Alarm Status (STAT)	No	
Reading (RUNG)	Yes	
Peak	No	
Valley (VALY)	No	
Units (UNIT)	No	
Multipoint Address (ADDR)	0001	
Transmit Time (TR.TM)	0016	
Display Color (COLR):		
Normal Color (N.CLR)	Green (GRN)	
Alarm 1 Color (1.CLR)	Red (RED)	
Alarm 2 Color (2.CLR)	Amber (AMBR)	
ANALOG OUTPUT (Retransmission):		
Analog Output (ANLG)	Enabled (ENBL)	
Current/Voltage (CURR/VOLT)	Voltage (VOLT)	
Scale and Offset	Reading: 0 - 999.9 cts, Output: 0 - 10 V	
OUTPUT 1 & 2:		
Self (SELF)	Disabled (DSBL)	Output 1 only
% Low Value (%LO)	0000	Output 1 only
% High Value (%HI)	0099	Output 1 only
Control Type (CTRL)	On/Off	
Action Type (ACTN)	Reverse (RVRS)	
Dead Band (DEAD)	020.0	
PID Auto (AUTO)	Disable (DSBL)	
Anti Integral (ANTI)	Disable (DSBL)	Output 1 only
Proportion Value (PROP)	020.0	
Reset Value (REST)	0180	Output 1 only
Rate Value (RATE)	0000	Output 1 only
Cycle Value (CYCL)	0007	
Damping Factor (DPNG)	0003	

CE APPROVAL INFORMATION

1. Electromagnetic Compatibility (EMC)

This device conforms with requirements of EMC Directive 89/336/EEC, amended by 93/68/EEC. This instrument complies with the following EMC Immunity Standards as tested per EN 50082-2, 1995 (Industrial environment)

Phenomena	Test Specification	Basic Standard
Electrostatic Discharge	+/- 4 kV contact discharge +/- 8 kV air discharge	IEC 1000-4-2 Performance Criteria B
Radio Frequency electromagnetic field.	27 - 1000 MHz 80% AM (1 kHz)	IEC 1000-4-3 Performance Criteria A
Radio Frequency electromagnetic field. Pulse modulated	800 MHz 10 V/m 50% Duty cycle @ 230 Hz	IEC 1000-4-3 Performance Criteria A
Fast Transients	+/- 2 kV [ac mains] +/- 1 kV [dc, signal, I/O] 5/50 ns Tr/Tth, \leq KHz top freq.	IEC 1000-4-4 Performance Criteria B
Radio Frequency conducted:	1.15 - 80 MHz 10 V/m 80% AM (1 kHz)	IEC 1000-4-6 Performance Criteria A

This Instrument complies with the following EMC Emission Standards as tested per EN 50081-1, 1992 (Residential, Commercial and Light Industrial)

Phenomena	Frequency Range	Limits	Basic Standard
Radiated Emission	30-230 MHz 230-1000 MHz	30 dB _V /m at 10 m 37 dB _V /m at 10 m quasi peak	CISPR 22 Class B
Conducted Emission	0.15-0.5 MHz 0.5-5 MHz 5-30 MHz	66-56 dB _V quasi peak 56 dB _V quasi peak 60 dB _V quasi peak	CISPR 22 Class B

2. Safety

This device conforms with Low Voltage Directive 73/23/EEC, amended by 93/68/EEC. The following LVD requirements have been met to comply with EN 61010-1, 1993 (Electrical equipment for measurement, control and laboratory use)

1. Pollution Degree 2
2. Installation Category II
3. Double Insulation
4. Class II Equipment (90-240 Vac Powered Units)
Class III Equipment (12-36 Vdc Low Power Option)

GENPOL NOTES

1	14
12,8	8,8
12,13	8,2
11,70	8,7
11,81	9,0
11,18	9,0
11,45	9,2
11,37	9,2
11,83	9,0
12,31	9,0
11,48	8,2

11,13 \rightarrow 82

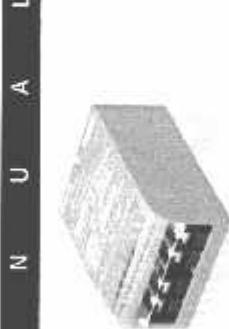
12.00 \rightarrow 90

MANUAL BOOK

AUTONICS SPC1-50

(Power Controller)

SFC SERIES



M A N U A L

	50 Rated current(A)
	1 Single phase
SPC	Series name (Solid state Power Control)

Specification

Model

SPC1-35 220VAC 50/60-Hz

SPC1-50 220VAC 50/60-Hz

SPC(Single phase)

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

35A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

SPC(Single phase)

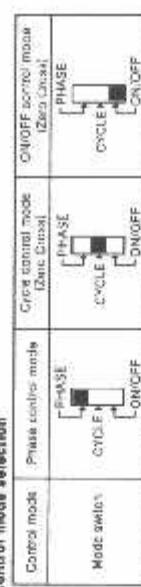
220VAC, 50/60-Hz

5A(Single phase)

220VAC, 50/60-Hz

90 ~ 110% of rated voltage

1. Control mode selection



When select Cycle control mode, the cycle has been set at 0.5sec. It can be variable 0.5sec.

and 1sec. By selecting function, the mode can be changed during it is running. Please be sure to set the proper mode after cut the power off then start the power again.

1) Phase control

It is output signal to control phase of power according as control input.

① Output wave form of power according as control input.

(Picture 1)

This is working type in output control single wave dividing equally according as control input signal.

② Output power characteristic by (Picture 1).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

③ Output wave form of power according as control input.

(Picture 2)

It is working type in output control single wave dividing equally according as control input signal.

④ Output power characteristic by (Picture 2).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑤ Output wave form of power according as control input.

(Picture 3)

It is working type in output control single wave dividing equally according as control input signal.

⑥ Output power characteristic by (Picture 3).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑦ Output wave form of power according as control input.

(Picture 4)

This is working type in output control single wave dividing equally according as control input signal.

⑧ Output power characteristic by (Picture 4).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑨ Output wave form of power according as control input.

(Picture 5)

This is working type in output control single wave dividing equally according as control input signal.

⑩ Output power characteristic by (Picture 5).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑪ Output wave form of power according as control input.

(Picture 6)

This is working type in output control single wave dividing equally according as control input signal.

⑫ Output power characteristic by (Picture 6).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑬ Output wave form of power according as control input.

(Picture 7)

This is working type in output control single wave dividing equally according as control input signal.

⑭ Output power characteristic by (Picture 7).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑮ Output wave form of power according as control input.

(Picture 8)

This is working type in output control single wave dividing equally according as control input signal.

⑯ Output power characteristic by (Picture 8).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑰ Output wave form of power according as control input.

(Picture 9)

This is working type in output control single wave dividing equally according as control input signal.

⑱ Output power characteristic by (Picture 9).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

⑲ Output wave form of power according as control input.

(Picture 10)

This is working type in output control single wave dividing equally according as control input signal.

⑳ Output power characteristic by (Picture 10).

When it is 0% ~ 20% occurs 1/2 load when 50% power at 50% makes all current increase.

For your safety, please read the following before using.

- ① Please read these instructions and review them before using this unit.
- ② Please observe the cautions that follow:

- ③ **Warning** Serious injury may result if instructions are not followed.
- ④ **Caution** Product may be damaged, or relay may result if instructions are not followed.

- ⑤ The following is an explanation of the symbols used in the operation manual:

- ⑥ **Caution** Injury or danger may occur under specific conditions.

△ Warning

- ① In case of using this unit with machinery(Nuclear power control, medical equipment, vehicle, train, airplane, combustion apparatus, entertainment or safety device etc), it requires installing fail-safe device, or contact us for information on type required.
- ② It may result in fatal damage, fire or human injury.

- ③ This unit must be installed on panel and F.G. terminal must be a good earth ground.
- ④ It may give an electric shock.
- ⑤ It may give an electric shock.
- ⑥ Do not connect terminals when it is power on.
- ⑦ If needs, please contact us.
- ⑧ It may give an electric shock and cause a fire.
- ⑨ Do not touch terminals after power off.
- ⑩ It may give an electric shock.

- ⑪ It may give an electric shock.
- ⑫ Please see the wire spec. chart for power and load connection by load current.
- ⑬ Please tighten bolt on terminal block to 43.5 ± 0.5 to $12N \cdot m(6 \pm 1.2kgf \cdot cm)$.
- ⑭ It may cause a fire due to contact error.

- ⑮ Please observe specifications rating.

- ⑯ In high humidity it will cycle of life product and cause a fire.
- ⑰ Do not use water or oil-based detergent.
- ⑱ Do not use 10% salt at place where there are flammable or explosive gas, humidity, direct ray of the sun, radiant heat, vibration, impact etc.
- ⑲ It may cause explosion.

- ⑳ Do not allow dust or wire dress into inside of this unit.

- ⑳ Do not touch the heating panel while it is running.

- ⑳ It may cause a fire or mechanical trouble.

- ⑳ The above specification are changeable without notice anytime.

△ Caution

- ① This unit shall not be used outdoors.
- ② Please see the wire spec. chart for power and load connection by load current.
- ③ It may give an electric shock.
- ④ Please tighten bolt on terminal block to 43.5 ± 0.5 to $12N \cdot m(6 \pm 1.2kgf \cdot cm)$.
- ⑤ It may cause a fire due to contact error.
- ⑥ Do not use 10% salt at place where there are flammable or explosive gas, humidity, direct ray of the sun, radiant heat, vibration, impact etc.
- ⑦ Do not allow dust or wire dress into inside of this unit.
- ⑧ It may cause a fire or mechanical trouble.

- ⑨ The above specification are changeable without notice anytime.

△ On/Off control-Zero Cross

- ⑩ This function is when control signal is 0% ~ 100%. When the On/Off signal is 0% ~ 10% (20~ADC, 3VDC)
- ⑪ When control signal is 90% ~ 100% (20~ADC, 3VDC) When control signal is 90% ~ 100% (20~ADC, 3VDC)

⑫ Control block

⑬ Terminal block

⑭ Terminal block for control power and load connection

⑮ SOFT START adjusting volume

⑯ OUT ACU volume

⑰ Selection SW of control mode

⑱ The LED display a³ output

⑲ The hole for fixing on panel

(Ball size M4 × 50)

⑳ Control input

⑳ Control output

⑳ Control wave form of On/Off control

1. Connection of control input terminals

When OUT ADJ = 0%
When OUT ADJ > 50%

This function must not be used in ON/OFF control mode.

2. Connection of control input terminals

1. 14-20mA DC control input
2. 5VDC control input

3. SOFT START function(0 to 50sec)

When the prove is actuated, the function is active in which the load when it becomes in 100%.
While prove, current limit, with increase current for width of rising temperature in the 5% to 10%.
Output:
100% → The output which is applied in the load is 100%
50% → The output which is applied in the load is 50%
0% → The output which is applied in the load is 0%
Time

4. OUT display function

This is LED name to identify the status of inputs and will be using brightness according to output.
10% (Minimum) ~ 100% (Maximum)
In this time, it makes the OUT ADJ before it becomes 10%, the time of the first output value reaches until 50% with the 1/2 times of the output as the value of making the value of moment of moment of OUT ADJ to 100%
When this function is not used, T/2 will be 0.

5. OUT OFF function

It controls 0.1 seconds with turning ON VR to connect 1 to 2, 3 to 4 terminals in case of the power supplied or after connecting 1P terminal to 2 terminals it is possible to control 3 to 4 terminals with turning OUT ADJ.
OUT ADJ will be satisfied in case above 1 to 2, 3, if it is not used, it is about the 100% output when it is OFF. Please keep below.

6. Control input specification and function for each mode

•Please see 'Connection of control input terminals' and 'Scaling function'

Input and function	Mode	Phase control (max)	Cycle control mode	OUT OFF control mode
Continuing specification		4~20mA DC 1~5VDC	External relay contact	
function		External volume OUT ADJ SOFT START OUT display	External volume OUT ADJ SOFT START OUT display	External volume OUT ADJ SOFT START OUT display

7. Factory specification and How to change additional function

1. Factory specification

When it goals to control cycle or che acoustic control type of three control mode, from factory specification, use JF1, JF2, JFB as below.

2. How to change additional function

When it goals to control cycle or che acoustic control type of three control mode, from factory specification, use JF1, JF2, JFB or JFB as below.

8. Dimension

9. Caution for using

1. Installation environment
This unit shall be used indoor
Operating Max. -10~0~40°C
Storage Degree: -20~40°C
Classification Category II.
2. Do not use this unit at severe places
① Places where there are severe vibration or impact.
② Places where there are direct ray of sun.
③ Places where strong magnetic field or electric noise are generated.
3. When this unit is used in the circuit of control panel,
① Please make all terminals of the circuit short-circuited.
② When you install on panel, it should be installed vertically at the place where is well ventilation.
③ Install a horizontal, under 70% of rated current around the terminal of R, T, Dose and the power.
4. The protective circuit must not be used because this is for resistive load only.
5. The cable cannot be charged during the operating. Please use care to the proper mode after turn off the power off then apply the power again.

10. Application

When it needs to control accurately with activating the power in phase control and cycle control mode. For example, it need to control 60% output when it is ON, 24% output when it is OFF. Please keep below.

•Control input terminal connection

Finally set OUT ADJ as 80% and control external volume at 30%.

•When the External contact signals ON / OFF
100% (External contact input) × 80% (OUT ADJ) = 80%
•When the External contact signal is OFF 30% (Volume result) × 80% (OUT ADJ) = 24%

EX22 This is how to control D to 100% without external volume in phase control mode and cycle control mode.

11. Autonics

http://www.autonics.net

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