



# IÐNTÖLVUSTÝRING FYRIR GRÓÐURHÚS

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## Lokaverkefni í rafíðnfræði

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## Formáli

Með þessu verkefni er ætlunin að hanna PLC iðntölvustýringu fyrir gróðurhús. Vildi ég hanna stýringu sem myndi henta vel gróðurhúsum og þá miðað við aðstæður okkar hér á landi.

Stýringu sem myndi fylgjast með hinum helstu nauðsynjum sem plöntur þurfa á að halda, og búa til þannig kjöraðstæður fyrir ræktun á hinum ýmsu tegundum.

Það er margt sem getur farið úrskeiðis og margt sem þarf að fylgjast með, því er tilvalið að nota stýringu sem passar upp á heilsu plantnanna.

Vil ég þakka öllum þeim sem hjálpuðu mér við að vinna þetta verkefni. Allir sem ég leitaði til voru mjög hjálpfúsir.

## 1. Inngangur

Á Íslandi eru hörð skilyrði til ræktunar og því tilvalið að nota gróðurhús. Sólríkir dagar mættu vera fleiri og þegar það er sól þá getur hitinn inni orðið of mikill. Með því að hafa sjálfvirka gluggaopnara er hægt að koma í veg fyrir að plönturnar eyðileggist vegna of mikils hita. Eins þegar það er of mikill hiti, getur fylgt honum mikill raki og rakinn getur valdið því að plönturnar fái margskonar plágur.

Upphitun er líka góður kostur að hafa, því þá er hægt að nýta allt árið til ræktunar. Plöntur þola ekki miklar hitasveiflur, eins og með rakan þá getur það valdið þeim skaða. Því er tilvalið að nota stýringu sem stjórnar þessum þáttum sem eru svo nauðsynlegir til að halda plöntunum við bestu heilsu og að auki fá sem bestan ávöxt.

Í þessari skyrslu verður fjallað um hönnun á PLC stýringu fyrir gróðurhús. Fyrst í 2.kafla verður talað um hvað sé fólgioð í gróðurhúsastýringu og af hverju hún sé svo nauðsynleg, síðan verður farið yfir virkni stýringarinnar og hverju hún á að stjórna. Í 3.kafla verður síðan farið ýtarlega í lausn verkefnisins.

## 2. Verkefnislýsing

### 2.1. Verkefnið

Verkefnið snýst um það að hanna stýringu sem getur fylgst með og stjórnað hinum ýmsu þáttum sem eru mikilvægir í gróðurhúsaræktun.

Til að allt virki sem skildi þarf að fylgjast með hita, raka, sólmagni og CO<sub>2</sub> magninu inni í gróðurhúsinu svo það mikilvægasta sé nefnt.

Gróðurhúsið á að vera 53m<sup>2</sup>, skiptir miklu máli að velja nógu öfluga ljósgjafa svo að vöxtur verði sem bestur, verður farið í það í 3.kafla.

### 2.2. Virknilýsing

Virkni gróðurhúsastýringarinnar á að vera eftirfarandi:

Það eiga að vera fjórar mismunandi stillingar eftir því hvað á að rækta. Í skjámynd eiga að vera fjórir takkar með þessum fjórum valmöguleikum, S1, S2,S3 og S4. Undir þessum valmöguleikum eiga að vera sér stillingar fyrir hitastigið inni í gróðurhúsinu, rakastig moldar, rakastig andrúmslofts, gildi CO<sup>2</sup> (koldíoxíð) og lámarks ljósmagn. Þau gildi sem eiga að vera í hverri stillingu fyrir sig koma fram í töflunni hér fyrir neðan.

Stillingar	Hitastig í °C	Raki í mold í %	Loftraki í %	CO <sup>2</sup> í ppm	Sólarljós Min í PAR-W
Stillung 1	17	45	30	700	85
Stillung 2	20	40	35	1000	90
Stillung 3	25	35	40	1500	100
Stillung 4	30	30	50	2000	115

Mynd 2.1 Tafla yfir gildi stillinga

Stilling 1 hentar fyrir harðgerðustu plönturnar, ræktun á t.d. gulrótum, káli, jarðaberjum, spergilkáli og þessháttar. Fara stillingarnar eins og sést í töflunni á blaðsíðunni hér á undan eftir hækjun á hitastigi, kröfum fyrir meira CO<sup>2</sup> magni og sólarljósi. Með því að hafa þessa valmöguleika er hægt að spara orkukostnað. Fer það þá allt eftir því hvernig gróður er verið að rækta.

Skynjarar eiga að vera inni í gróðurhúsinu og eiga að fylgjast með hinum ýmsu atriðum.

Það á að vera hitaskynjari sem fylgist með hitastiginu inni í gróðurhúsinu, á hitastigið að haldast á kjörhita.

Það eiga að vera rakaskynjarar í mold sem fylgjast með vökvun moldar. Þeir eiga að halda rakastigi moldar í kjörgildi.

Það á að vera rakaskynjari sem fylgist með raka loftsins inni í gróðurhúsinu og sér um að opna og loka gluggum eftir þörf. Möguleiki skal vera að hægt sé að slökkva á gluggastýringunni og opna og loka gluggum handvirkta.

Það á að vera skynjari sem fylgist með CO<sub>2</sub> magninu inni í gróðurhúsinu, skal halda því í kjörgildi. Skal vera tankur með CO<sub>2</sub> inni í gróðurhúsinu og því losað inn eftir þörfum.

Þegar koldíoxíð magn tanksins fer undir 1kg á viðvörun að koma á skjámynd.

Það á að vera birtuskynjari sem fylgist með því sólmagni sem kemur inn í gróðurhúsið. Ef það fer undir lámarksgildi skal kerfið kveikja á lömpum.

Ef hitastig fer yfir hámarksgildi eiga viftur að fara í gang. Eiga þær að vera í gangi þangað til hitastig fer undir hættumörk.

### 3. Lausn verkefnisins

#### 3.1. Upphitun

Góð upphitun er nauðsynleg í gróðurhúsum. Til að geta valið réttan hitara þá er nauðsynlegt að finna út hver hitaþörfin er. Með nákvæmum útreikningum er hægt að finna hvert hitatapið frá gróðurhúsinu er.

$$Q = \left[ \frac{A1}{R1} + \frac{A2}{R2} \right] * (ti - t0) * (fc)$$

Til þess notum við formúlu:

$Q$  stendur fyrir heildar hitatapið í wöttum.

$A1$ ,  $A2$  eru flatarmál ytri veggja gróðurhússins.

$R1$ ,  $R2$  eru hitaviðnám þess efnis sem er notað í gróðurhúsinu, t.d. gler, plast eða trefjagler. Það er mælt í  $M^2 \text{C/W}$ .

$ti$  er lægsta gildi hitastigs inni í gróðurhúsinu.

$t0$  er lægsta gildi hitastigs úti sem búist er við.

$fc$  er sá stuðull sem settur er á gæði gróðurhússins.

Gróðurhúsið á að vera  $53m^2$ .

$A1$ : Lögð voru saman öll flatarmál allra hliða gróðurhússins. Fjórar hliðar, tvær hliðar þaksins og tveir gaflar. Alls gerði þetta  $119,61m^2$ . (**Ýtarlegri lýsing á útreikningum er hægt að finna í viðauka**).

$A2$ : Þetta er flatarmál grunnsins, hann samanstendur af 33,3% hluta undir yfirborði og 66,7% hluta yfir yfirborði jarðar. Reiknað flatarmál grunnsins er  $26,46m^2$ .

$R1$ : Undir Töflu 1 í *Greenhouse heating requirements* í viðauka, eru talin upp þau RSI gildi fyrir ýmis byggingarefni. Fyrir þetta tiltekna gróðurhús á að nota tvöfalt gler með 6mm loftrými á milli, sem gerir RSI upp á 0,27.

$R2$ : Fyrir grunninn verður notað sement sem gerir  $RSI=0,16$  og 50mm þykkt frauðplast sem er  $RSI=1,76$ . Samtals gerir það 1,92.

$ti$ : Til ræktunar er kjörhiti í um  $27^\circ\text{C}$ . Til að halda kröfuhörðustu plöntunum ánægðum er best að fara ekki undir  $20^\circ\text{C}$ . Við höfum því hér  $ti=20^\circ\text{C}$ .

$t0$ : Til viðmiðunar setjum við hér sem kaldast  $-10^\circ\text{C}$ .

fc: Undir Töflu 3 eru taldir upp nokkrir möguleikar af gróðurhúsagerðum og stuðlar.  
 Þetta gróðurhús verður úr málmi og með gler, sem hefur stuðulinn 1,08.

Þegar allar þessar upplýsingar eru settar inn í formúluna lítur þetta svona út:

$$Q = \left[ \frac{119,61}{0,27} + \frac{26,46}{1,92} \right] * (20 - (-10)) * (1,08)$$

Og gerir þetta  $Q = 14,8\text{kW}$ .

Ráðlöggð stærð á hitara er 10% meiri en áætlað hitatap er. Sem gerir  $16,28\text{kW}$

$1\text{kW}$  eru  $3414 \text{ Btu/h}$  sem gerir  $16,28\text{kW} = \underline{\underline{55.580 \text{ Btu/h}}}$

### 3.2. Lýsing

Að hafa góða lýsingu er jafn mikilvægt og að hafa góða hitun. Það litróf sem gróðurvöxtur vinnur á er á milli 400-700nm, þetta er innan sjónsviðsins. Aðallega vaxa plöntur við rauð og blátt ljós.

Hægt er að velja margar tegundir af perum sem geta unnið þetta verk vel. Algengt er að nota peru sem kallast HPS (High pressure sodium lamps). Þessir lampar eru valdir af mörgum gróðurhúsa ræktendum vegna breiðs litrófssviðs og ágætis nýtni.

Sú orka sem plönturnar þurfa er mæld í PAR wöttum, (photo synthetically active radiation). Þetta er það svið sem þær geta notað.

HPS perur gefa um 40% af því afli sem þær gefa frá sér í PAR wöttum. Það þarf um 115 PAR wött á hvern fermeter til að fá góðan árangur.

Ég valdi að nota 600W HPS ljósgjafa frá Philips: Horticulture MASTER GreenPower CGT 600W Mogul I SL.



Mynd 3.1 HPS pera sem notuð verður

600W pera er að gefa frá sér 40% PAR Wött sem eru 240W.

Eins og kom fram áðan þarf 115W á fermeter sem þýðir að ein 600W pera dugar fyrir  
 $\frac{240}{115} = 2,08m^2$  Fyrir 50m<sup>2</sup> gróðurhús þarf:  $\frac{50}{2,08} = 24 \text{ lampa}$

Það þarf tuttugu og fjóra 600W HPS lampa til að gefa nægilegt magn af PAR wöttum.  
 Það gerir 14,4kW

Sá möguleiki er líka til staðar að nota LED gróðurhúsalampa,( **light-emitting diode**), í þessum lömpum eru settar sama bláar og rauðar díóður sem gefa frá sér aðeins það ljós sem plönturnar þurfa.

Sá munur er á LED díóðum og HPS lömpum að HPS lamparnir hitna mikið og stór hluti af aflinu fer í hitatap. LED ljósin verða ekki heitari en það að hægt sé að snerta þau, nýtnin hjá LED ljósunum er í kringum 75%.



Mynd 3.2 LED Lampi 300W

300W LED lampi er því að gefa 225W.

225W eru að duga fyrir 1,95m<sup>2</sup> sem þýðir að fyrir 50m<sup>2</sup> gróðurhús þarf 26 lampa.

26 300W lampar gerir 7,8kW. Við sjáum á þessu að kostirnir við að nota LED ljósin eru að þau nota aðeins um 54% af þeirri orku sem HPS lamparnir eru að taka. En þessir lampar eru dýrir og gera byrjunarkostnaðinn mikið hærri.

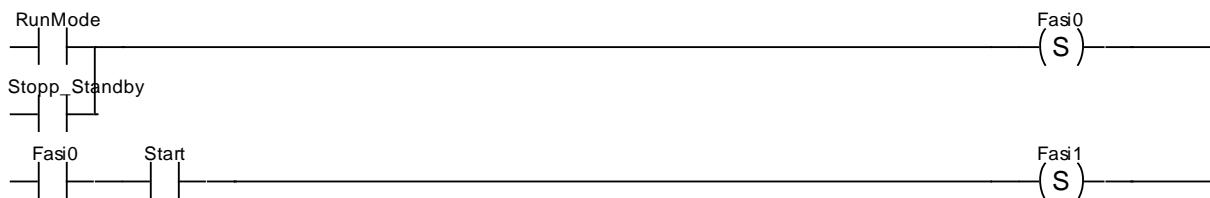
Eitt stykki af 300W LED Lampa eins og sést á myndinni fyrir ofan er að kosta rétt yfir 100.000kr en 600W HPS Lampi er í kringum 40.000kr. 26 LED lampar gera 2,6m.kr. en 24 HPS 960þ.kr.

Fyrir stórræktendur gæti LED leiðin hentað betur upp á langtíma sparnað, en fyrir þessa stærð á gróðurhúsi verða HPS lampar fyrir valinu.

### 3.3. Stýringin

Hér verður farið ýtarlega í virkni stýringarinnar.

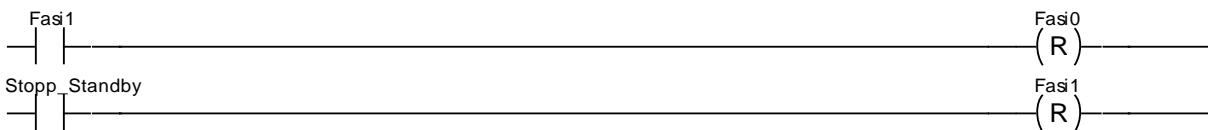
Það eru tveir fasar í þessari stýringu,



Mynd 3.3 Fasar stýringarinnar

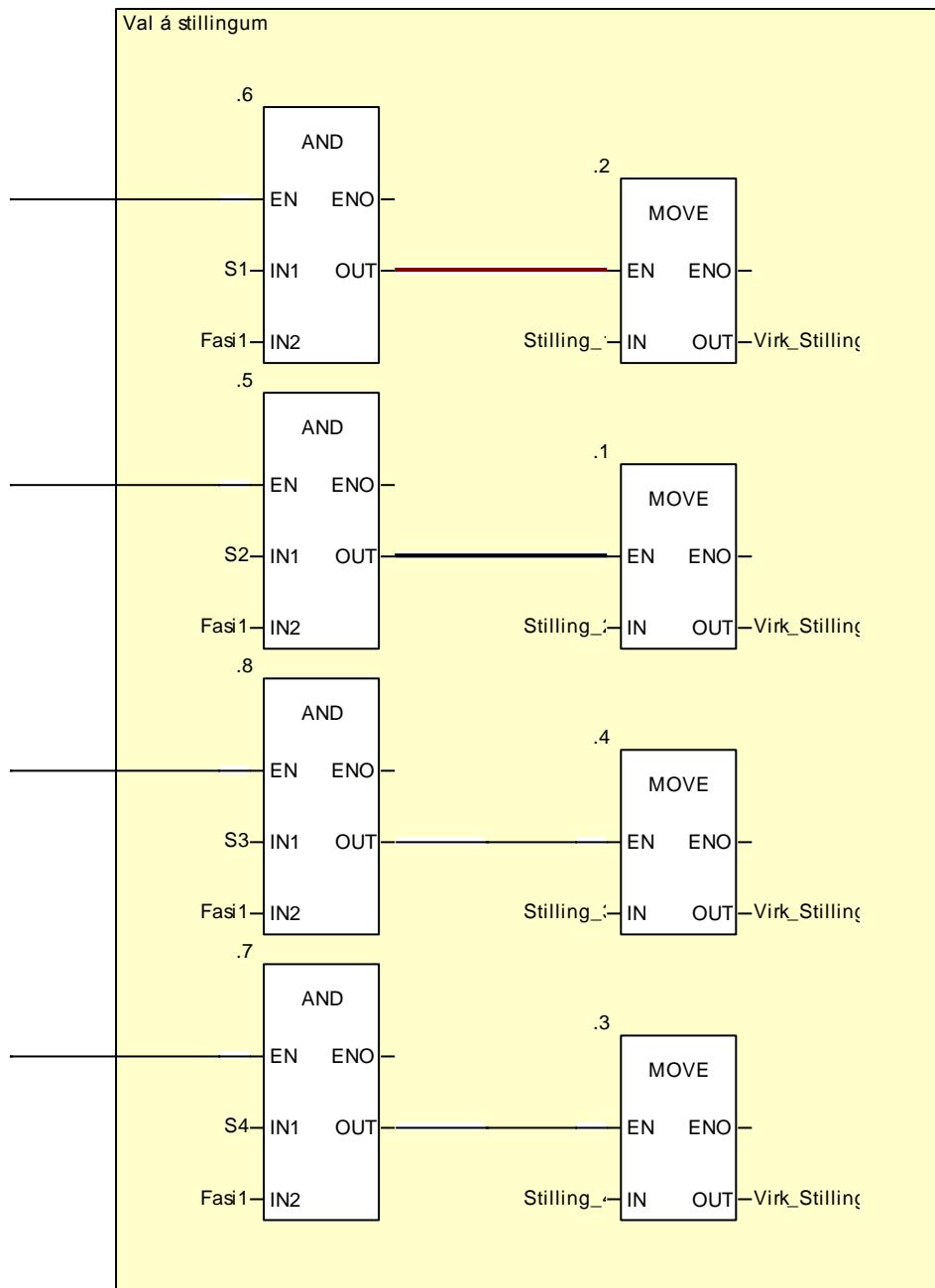
**Fasi0** er biðfasi sem kerfið bíður á þegar það er sett í gang með **RunMode** (innri breytu). Það þarf að vera búið að setja hann í gang til að geta sett kerfið af stað. Kerfið er sett í gang með Ebool breytunni **Start**, sem er rofi, staðsettur í rofaboxi inni í gróðurhúsini. Til að stöðva kerfið er notaður rofinn **Stopp\_Standby** sem sendir kerfið aftur í biðstöðu með því að ræsa **Fasa0**.

Þegar kerfið er sett af stað endurstillir **Fasi1 Fasa0** því hann er óþarfur nema sem biðfasi.



Mynd 3.4 Fasar endurstilling

Í stýringunni höfum við valmöguleikana **S1, S2, S3 og S4**. Þetta eru þrýstirofar staðsettir bæði í skjámynd og í rofaboxi. Þessir valmöguleikar gefa kost á að breyta gildum hita,raka í mold og andrúmslofti, koldíoxíð magni og lámarks sólarmagni.



Mynd 3.5 Val á stillingum

Notuð eru AND og MOVE blokkir. Svo hægt sé að velja stillingu þarf **Fasi1** að vera virkur. Það eru fjórar stillingar, ein stilling fyrir hvern valmöguleika. Þegar ein af þessum fjórum stillingum er valin færist sú stilling með MOVE blokk yfir á breytuna **Virk\_Stilling** (REAL). Hér fyrir neðan sést dæmi um stillingu, undir hverri stillingu eru 5 stillingar. Sést líka breytan **Virk\_Stilling**.

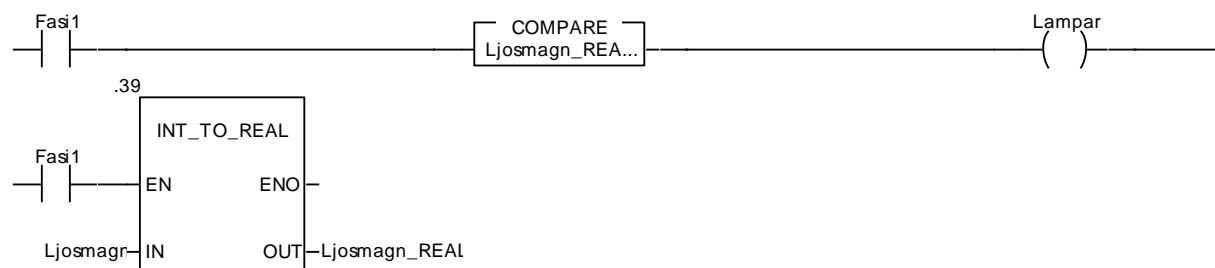
Stilling_1	ARRAY[0....]		Kjörgildi fyrir stillingu1.
• Stilling_1[0]	REAL	170.0	Kjörhitastig.
• Stilling_1[1]	REAL	700.0	CO2 óskgildi.
• Stilling_1[2]	REAL	45.0	Raki í mold óskgildi.
• Stilling_1[3]	REAL	30.0	Raki í andrúmslofti óskgildi.
• Stilling_1[4]	REAL	85.0	Sólarljós Min.

Mynd 3.6 Stilling 1

Virk_Stilling	ARRAY[0....]		Sú stilling sem er virk hverju sinni.
• Virk_Stilling[0]	REAL		Kjörhitastig.
• Virk_Stilling[1]	REAL		CO2 óskgildi.
• Virk_Stilling[2]	REAL		Raki í mold óskgildi.
• Virk_Stilling[3]	REAL		Raki í andrúmslofti óskgildi.
• Virk_Stilling[4]	REAL		Sólarljós Min.

Mynd 3.7 Virk Stilling

Gróðurhúsalömpunum er stjórnað af breytunni **Ljosmagn** (sem er birtuskynjari staðsettur á þaki gróðurhúss) og breytunni **Virk\_Stilling[4]** (sem er fyrir Ljósmagn Min). Vegna þess að **Virk\_Stilling** er týpan REAL og **Ljosmagn** er týpan INT þarf að nota INT\_TO\_REAL blokk til að breyta breytunni **Ljosmagn** yfir í REAL. Notuð er síðan COMPARE blokk til að bera saman raungildið við lámarksgildið. (**Ljosmagn\_REAL < Virk\_Stilling[4]**). Ef raungildið er minna þá eru lampar settir í gang.

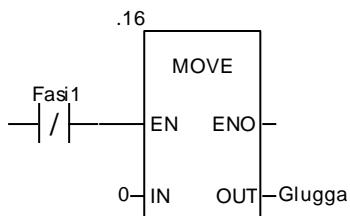


Mynd 3.8 Stýring lampana

Gluggunum er stjórnað stiglaust frá 0-100% opnum. Við sjálfvirku stýringuna er notuð breytan **deltaRA** sem er mismunurinn á Lofraki(Raungildi) og Loftraka\_oskgildi.

**OPERATE** deltaRA:=Lofraki-Loftraki\_oskgildi; – Óskgildið er fengið frá **Virk\_Stilling[3]** (REAL), henni er breytt yfir í INT breytuna Loftraki\_oskgildi. Gluggunum er síðan stjórnað með **OPERATE** blokk, – **OPERATE** Gluggar:=deltaRA\*10; – Er þeim stjórnað útfrá 0-10% rakastigi yfir óskgildi, t.d. 2% munur gerir 20% opnum og 6% munur gerir 60% opnum.

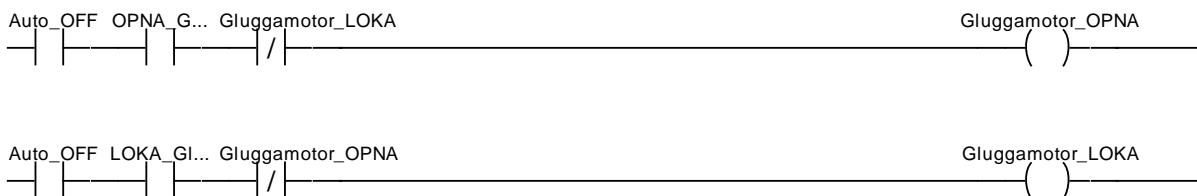
Þegar kerfið er stöðvað sér kerfið um að náll stilla **Gluggar**, og lokar því gluggum sjálfkrafa.



Mynd 3.9 Gluggastýring núllstiltt

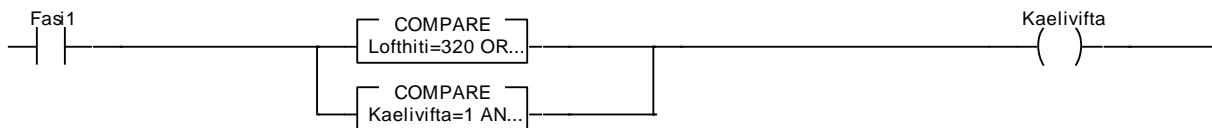
Möguleiki er líka á því að stjórna gluggunum handvirkt. Með breytunni **Auto\_OFF** er hægt að taka stýringuna úr sjálfstýringu. Síðan eru tveir rofar **OPNA\_Glugga** og **LOKA\_Gluggum**. Eru þeir notaðir til að opna og loka gluggum handvirkta.

Hvort sem það er verið að opna eða loka gluggum kemur sú stjórnun sem er í notkun í veg fyrir að hin sé sett í gang.



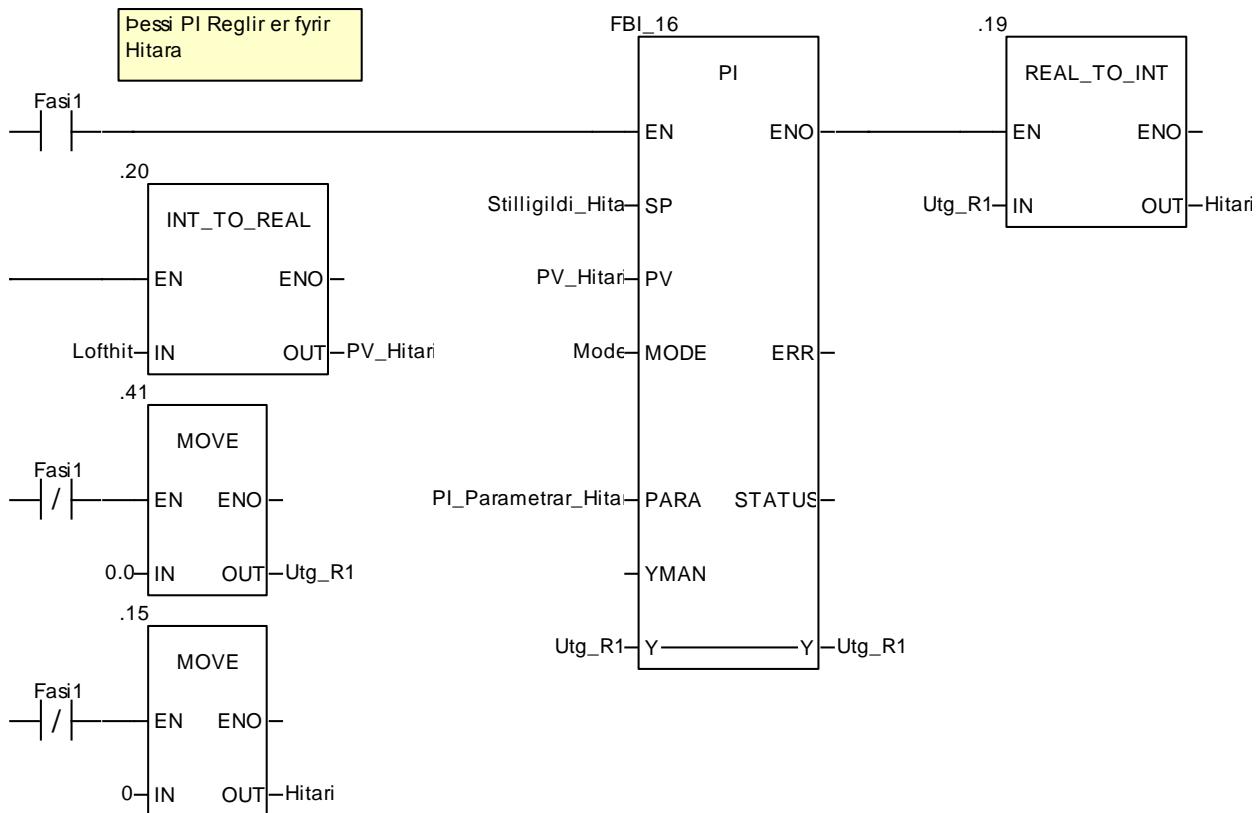
Mynd 3.10 Gluggar, sjálfvirk stýring

Kælivifta er notuð þegar hiti fer yfir hámarkið. Notaðar eru **COMPARE** blokkir til að stjórna því. Viftan fer í gang ef hitinn er  $32^{\circ}\text{C}$  eða ef hann er yfir  $32^{\circ}\text{C}$ . Helst kæliviftan í gangi þangað til að hitastigið fer undir  $25^{\circ}\text{C}$ , ( $\text{Kaelivifta}=1 \text{ AND } \text{Lofthiti}>250$ ).



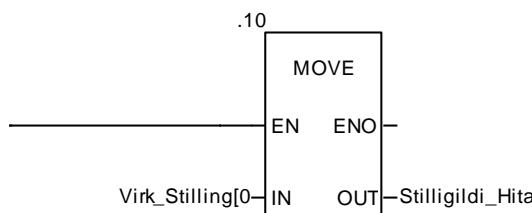
Mynd 3.11 Stýring kæliviftu

Til stýringar á hita, vökvun og  $\text{CO}^2$ , eru notaðir PI reglar eins og sá sem er á myndinni hér fyrir neðan. Til útskýringar notast ég við mynd af PI regli hitarans.



Mynd 3.12 PI reglir hitara

Breytan sem er tengd við SP **Stilligildi\_Hitari** er fengin frá **Virk\_Stilling[0]** sem er breytan fyrir kjörhitastig. Þegar valin er stilling, (S1,S2,S3 eða S4) verður það gildi að virkri stillingu. Er það gildi síðan flutt með MOVE blokk sem **Stilligildi\_Hitari** fyrir SP inngang reglisins.



Mynd 3.13 Kjörgildi hita flutt yfir á stilligildi

Er þetta gert eins með SP gildi Vökvunar og CO<sup>2</sup>.

PV-Inngangurinn sem er inngangur fyrir raungildi er notaður fyrir breytuna **Lofthiti** sem er hitaskynjari inni í gróðurhúsi. Vegna þess að PV-Inngangurinn er REAL breyta og **Lofthiti** er INT, þarf að nota INT\_TO\_REAL blokk til að breyta **Lofthita** yfir í REAL, verður þannig til nýja breytan **PV\_Hitari**.

Tengd við PARA innganginn er breytan PI\_Parametrar\_Hitari, hún hefur að geyma breyturnar gain, ti,ymax og ymin. Gain er sú mögnun sem sett er fyrir reglinn. Ti er sá tími sem reglirinn notar til að reikna út útgangsmerkið.

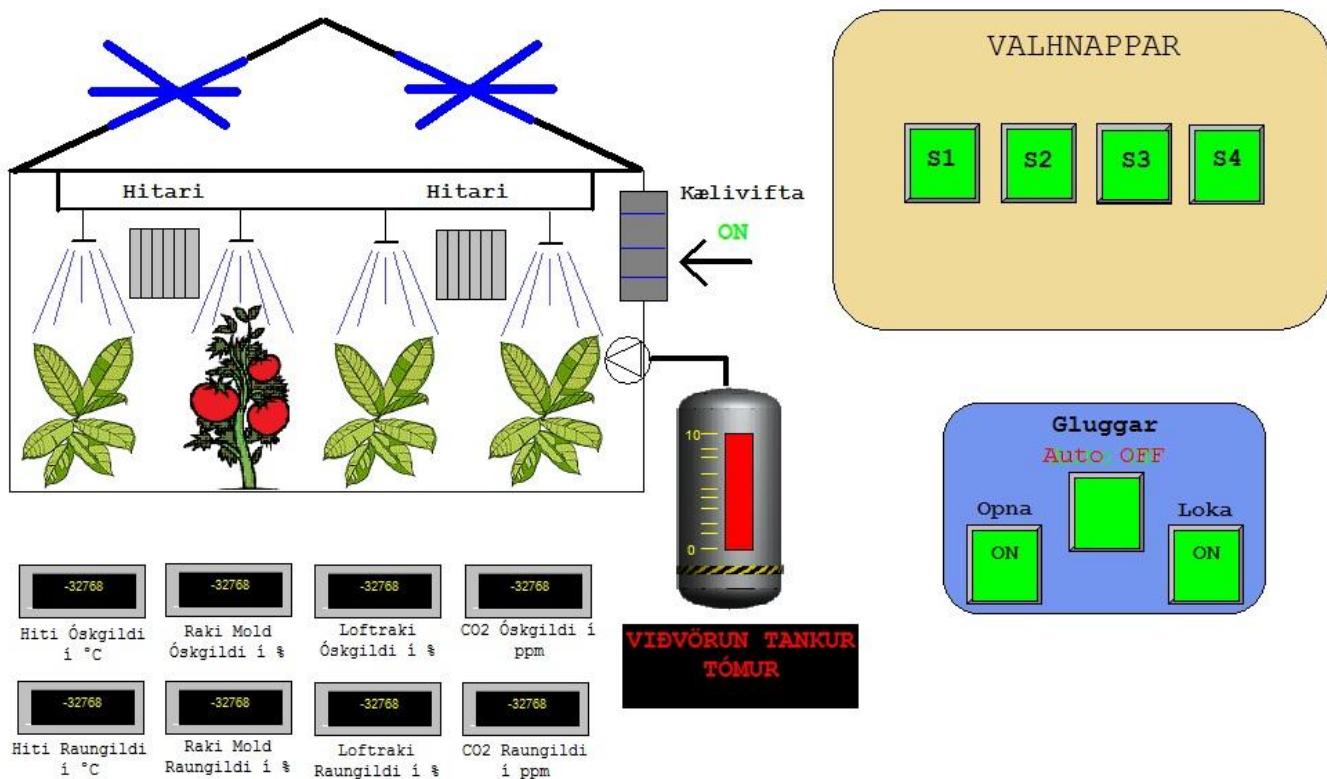
PI_Parametrar_Hitari	Para_PI		PI Parametrar fyrir Hitara Regli.
gain	REAL	2.0	Mögnun reglisins.
ti	TIME	t#120s	Integral tíminn sem hann tekur á milli þess sem hann athugar gildin.
ymax	REAL	100.0	Hámarksgildi Útgangsins.
ymin	REAL	0.0	Lámarksgildi Útgangsins.

Mynd 3.14 Dæmi um PI Parametra

Þegar slökkt er á kerfinu stendur reglirinn fastur á þeim stað þar sem hann var að vinna þegar kerfið var stöðvað, því þarf að nota Move blokk til að núllstilla reglinn. Eins með breytuna **Hitari**, hún er sett af **Utg\_R1** með REAL TO INT blokk og helst þar þegar kerfið er stöðvað, því er farið sömu leið til að núllstilla breytuna **Hitari**.

Allir reglarnir eru með eins virkni.

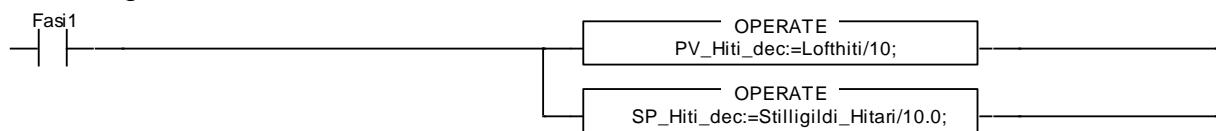
### 3.4. Skjámyndakerfi



Mynd 3.15 Skjámynd

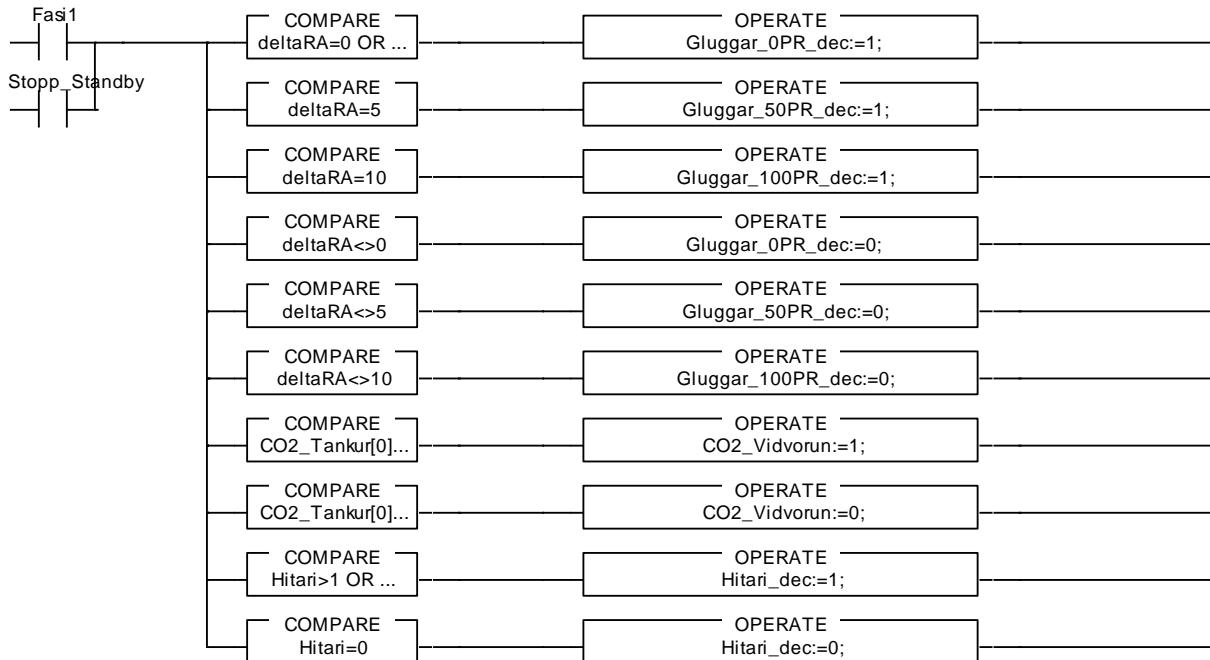
Inni í gróðurhúsinu á að vera HMI snertiskjár sem sýna á skjámyndina. Hægt verður þar að velja á milli stillinganna fjögurra, taka gluggastýringuna úr sjálfvirku og yfir í handvirk, opna og loka gluggum, sjá það magn sem eftir er af koldíoxíð í tanknum og fá viðvörun ef magnið fer undir 1kg. Mælar sýna raungildi og óskgildi á þeim gildum sem þarf að stjórna. Mynd af gróðurhúsinu sýnir þegar gluggar eru lokaðir, 50% opnir eða 100% opnir. Sést líka á skjámynd hvort vökvun sé í gangi, hvort hitari sé virkur og hvort kælivifta sé í gangi. Hér fyrir neðan er ladder stýring skjámyndarinnar.

Til að fá rétt gildi fyrir hita á skjámynd þarf að deila með 10 í Lofthita. Eins er það með óskgildið.



Mynd 3.16 Hitagildi flutt yfir í skjámynd

Skjámyndastýringin er virk þótt það sé búið að stöðva stýringuna og hún komin í biðstöðu. Skjámyndin sýnir glugga lokaða ef deltaRA=0 eða Endastoppsrofi=1. Við deltaRA=5 fara gluggar í 50% opnum og við 10% verða þeir 100% opnir.



Mynd 3.17 Stýring skjámyndar

Í skjámynd kemur einnig fram viðvörun ef magnmælir (breytan CO2\_Tankur[0]) fer undir lámarksgildi.

CO2_Tankur	ARRAY[0....]			CO2 tankur magnmæling.
CO2_Tankur[0]	INT			Magnmælir 10kg kútur
CO2_Tankur[1]	INT	1		Magn Min 1kg.
CO2_Vidvorun	EBOOL			Viðvörun í skjámynd ef magn í tank fer undir 10kg.

Mynd 3.18 CO<sup>2</sup> Viðvörunarkerfi

### 3.5. Val á búnaði

Í þessum hluta verður farið yfir þann búnað sem valinn var fyrir þetta verkefni.

**(Hægt er að nálgast tæknilegar upplýsingar um búnað í viðhengi).**



Modicon BMX CPS 2000 Aflgjafi. Ég valdi þennan aflgjafa því hann hentar vel þessari stýringu, hefur hann einnig nóg afl til að fæða örgjörvann og einingarnar.



Modicon P34 2030 CPU. Þessi PLC tölva er með ethernet. Með því að tengja við hana net einingu væri möguleiki á að tengjast stýringunni í gegnum netið.



Modicon BMX DDM 3202K. Það eru aðeins stafrænir (digital) inngangar og útgangar í þessari einingu. 16 Inngangar og 16 útgangar.



Modicon BMX AMM 0600, þessi eining er hliðræn (analog), hún hefur aðeins 4 hliðræna innganga og 2 hliðræna útganga. Hentar hún vel fyrir þau tæki sem þarf að stjórna hliðrænt, t.d hitarann.



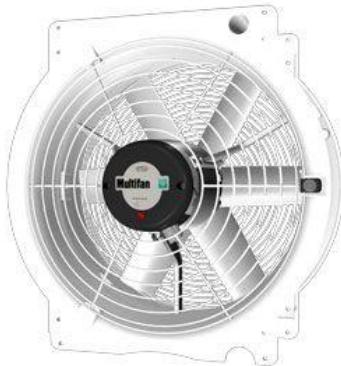
Modicon BMX ART 0414, þessi eining hefur 4 innganga. Eru þeir sér gerðir fyrir hitaskynjara eins og RTD PT100.



TTC25X Triac (Thyristor) 3fasa 400V 25A

Max:17kW framleiddur af Regin. Þessi thyristor er ætlaður fyrir hitastýringu, sérstaklega rafmagnsofna. Hann gefur on/off púlsa á útganginn og nær þannig að halda réttu hitastigi. TTC25X útgáfan notast við boð frá utanaðkomandi stýringu (0-10V), svo sem analog merki frá PLC stöð.

Fyrir þetta gróðurhús er best að vera með þrjá 3f 400V 5,5kW rafmagnsofna (fyrir bestu hitadreifingu), tengda í stjörnu við triac eininguna.



Kælivifta framleidd af Multifan. 370W, 230V 1,6A. Hún er 50,8cm í þvermál. Hún er hönnuð einmitt fyrir aðstæður eins og eru í gróðurhúsum þolir vel rakan og útinotkun. Hún hefur hraðastilli sem hentar vel því plöntur þola ekki hröð hitaskipti.



TEFC mótor,(Catalog:113908) sem hentar vel fyrir gróðurhúsa aðstæður og er góður fyrir gluggastýringuna. Hann er með IP54 staðal. 1f, 704W, 220V 50Hz 3,2A. Hver mótor fyrir sig tekur mest 11,8kg í álag.



Echo EA-10 rakaskynjari sem er ætlaður fyrir iðnaðarumhverfi og sjálfvirk kerfi. Hann hefur two víra, hann vinnur á 4-20mA hliðrænu merki. Til að fá sem bestu gildi þarf að stilla mælin eftir því í hvernig mold hann er. Hann tekur litla orku og búast má við löngum líftíma.



QSO-S PAR Photon Flux mælir. Þetta er ljósmælir sem hentar mjög vel fyrir gróðurhús því hann mælir aðeins ljóstillífandi geislun sólarinnar, sú geislun sem plönturnar þurfa. ( Talað var betur um PAR-W í kafla 3.2.Lýsing). Skynjarinn gefur á útgangi 0,2mV fyrir hvert micro-mol. Skal hann vera tengdur samkvæmt leiðbeiningum um mælinn sem eru í viðauka.



EE16 Hita og rakaskynjari frá framleiðandanum

E+E Elektronik. Þessir skynjarar gefa nákvæma mælingu, og eiga þeir að virka vel við flestar aðstæður. Rakaskynjarinn heitir HC101, hann á að halda upprunalegri nákvæmni í langan tíma. Við 20°C er frávikið um  $\pm 3\%$ RH.

Hitaskynjarinn er Pt1000, hann vinnur á 0-10V og er frávikið við 20°C  $\pm 0.3^\circ\text{C}$ .

CO<sub>2</sub> mælir. Týpa EE82-2C2 frá E+E Elektronik.

Hann er sérstaklega gerður fyrir erfiðar aðstæður, sem dæmi mikinn raka og ryk sem gæti komið frá áburði. Þetta tæki notar innrauða tækni kölluð NDIR, það er með sjálfvirka stillingu sem sér um að halda innrauðum geismanum á réttum styrkleika, sem tryggir góða nákvæmni. Mælir hann á bilinu 0-2000ppm (parts per million) sem sendir á útganginn frá 0-5V.

### 3.6. Rafmagnstafla og heildarorkunotkun

#### Rafmagnstaflan:

Rafmagnstaflan fyrir gróðurhúsið verður fengin frá aðaltöflu. Þrír 16q fasar eru tengdir beint við 63A aðalvarrofa. Hægt er að sjá töfluteikninguna í viðauka.

Jörð er fengin frá sökkulskauti gróðurhússins. Það er einn lekastraumsrofi í þessari töflu, hann er 3fasa 63A/30mA. Út frá honum eru tengd átta sjálfvör.

Það eru fjögur C25A sjálfvör, þrjú fyrir lýsinguna og eitt fyrir thyristorinn sem stjórnar rafmagnsofnunum.

Það er eitt C20A sjálfvör fyrir gluggamótora.

Svo eru tvö B10A sjálfvör, eitt fyrir PLC smáspennutöfluna og annað sem auka.

#### Orkunotkun:

Samkvæmt útreikningum í kafla 3.2. Lýsing þarf 24 lampa til að útvega næga lýsingu. Gerði það 14,4 kW.

Ef við gerum ráð fyrir að lamparnir séu notaðir 8 klst. á dag yfir árið gerir það 42MWh.

Samkvæmt útreikningum í kafla 3.1.Upphitun er hitatap frá gróðurhúsinu 14,8kW, það er sú orka sem þarf í upphitun til að halda hitanum stöðugum. Til að vera örugg með nógu öflugan hitara er ráðlagt að velja hitara sem er 10% öflugri, sem gerir 16,28kW.

Segjum að upphitun sé í 100% yfir mánuðina janúar til febrúar. Það eru 2880klst, sem gerir 46,8MWh í orkunotkun yfir þessa mánuði. Gefum okkur síðan að upphitun sé 40% yfir mánuðina maí til ágúst, það gerir 19,2MWh. Svo yfir mánuðina september til desember með 70% orkunotkun, það gerir 33,4MWh.

Heildar orkunotkun sem sett er í upphitun yfir árið er því 99,4MWh.

Gluggamótorarnir eru sex taldir, allir eru þeir 704W sem gerir þá samtals 4,2kW. Ef við gefum okkur að samanlagður vinnutími gluggamótoranna sé 5klst, gerir það 21kWh yfir árið.

Það eru tvær kæliviftur í þessu gróðurhúsi. Samtals eru þær 704W. Ef hitinn inni í gróðurhúsini fer yfir 32°C þá fara kælivifturnar í gang. Ef við gefum okkur að það séu yfir hásumarið 21 dagar sem hitinn sé það mikill og í um 9 tíma hvern dag. Það gerir 139,8kWh yfir árið.

Alls er orkunotkun gróðurhússins um 141,56MWh yfir árið.

Samkvæmt verðskrá Orkuveitu Reykjavíkur yfir heimili er fast verð á dag 34,4kr. Síðan er álag lagt á eftir því hversu margar kWh eru notaðar. Verð á hverja kWh er 11,96kr.

Samkvæmt þessum upplýsingum er heildarkostnaður yfir árið á 50m<sup>2</sup> gróðurhúsi: 1.705.614kr.

(Nánari upplýsingar um útreikninga er hægt að nálgast í viðauka).

#### 4. Niðurstaða

Þegar ég byrjaði á þessu verkefni hugsaði ég með mér hvað það væri hagstætt fyrir gróður að hafa stöðugt allar þær bestu aðstæður sem völ væru á, og hver er betri leið en að hafa þetta allt stýrt af tölvu sem sér um að halda hita, raka og fleiru í hárréttum hlutföllum.

En það er ekki það eina sem er hagstætt við það að hafa gróðurhúsastýringu. Með henni er hægt að spara kostnað.

Þegar öllu er stjórnað af tölvu, er öll orka sem þarf að nota notuð í lámarki, t.d með vökvun, þá er ekki verið að vökva umfram það sem þarf, eins með upphitun, það er ekki að vera hita meira en þarf hvert skipti.

Með því að fylgjast með CO<sup>2</sup> magninu er hægt að minnka þörfina á sólarljósi. Þannig er hægt að spara raforkukostnað en fyrir sama ávöxt.

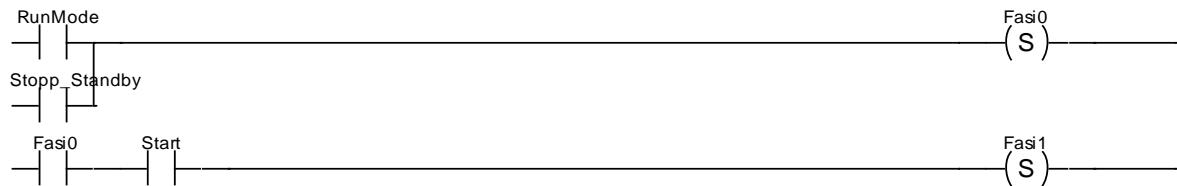
Sparnaður er líka í vinnuaflí. Þegar vöktun er stjórnað af tölvustýringu veldur það því að það þarf færra vinnuaflí.

Án vöktunar á hita, raka, vökvun, sólmagni og CO<sup>2</sup> er ekki hægt að búast við löngum líftíma hjá plöntum.

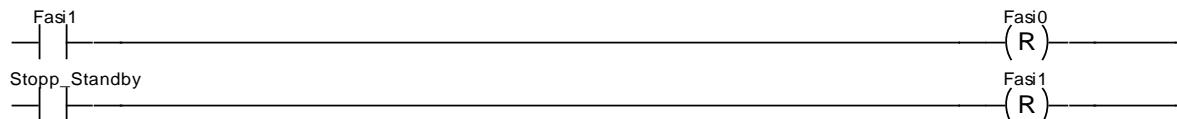
Því er tilvalið þegar litið er til allra þessa þátta að nota gróðurhúsastýringu.

## 5. Viðauki

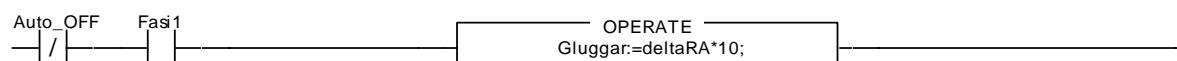
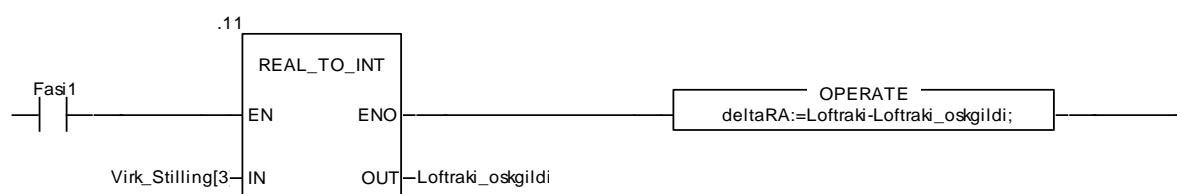
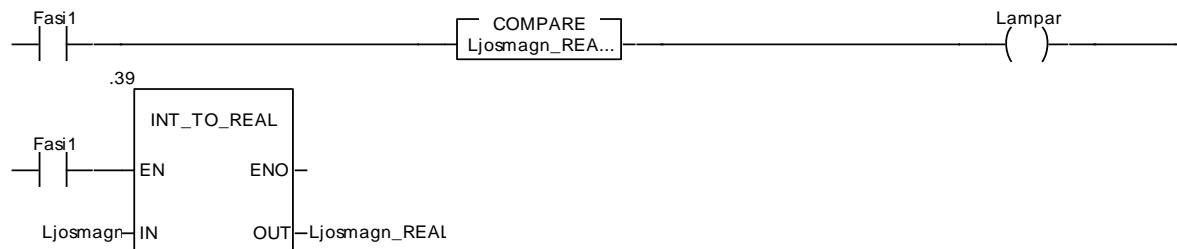
Fasastýring (Fasar settir)

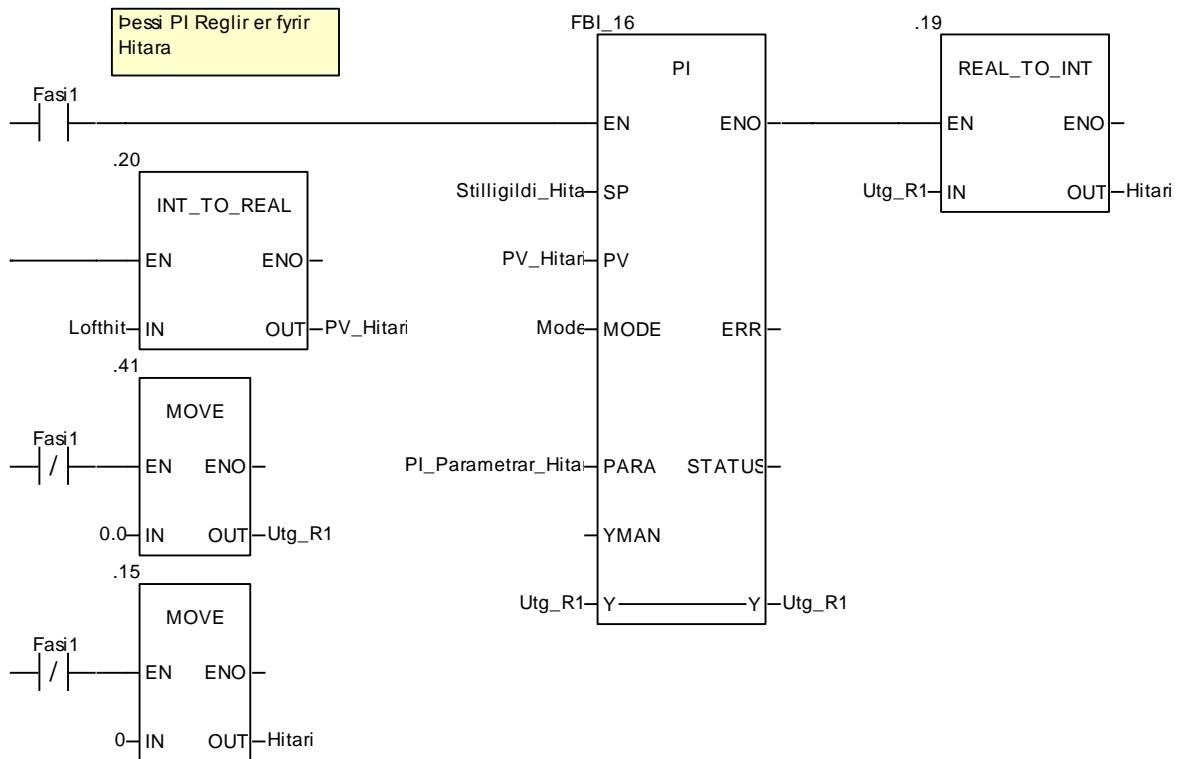
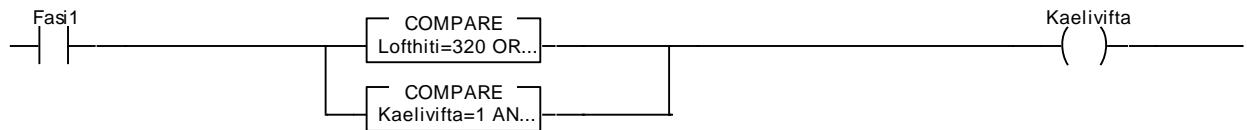
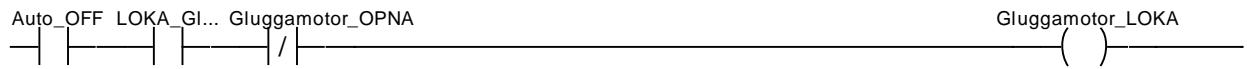
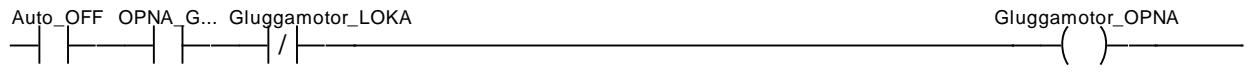
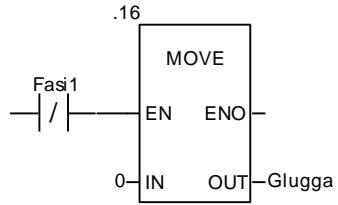


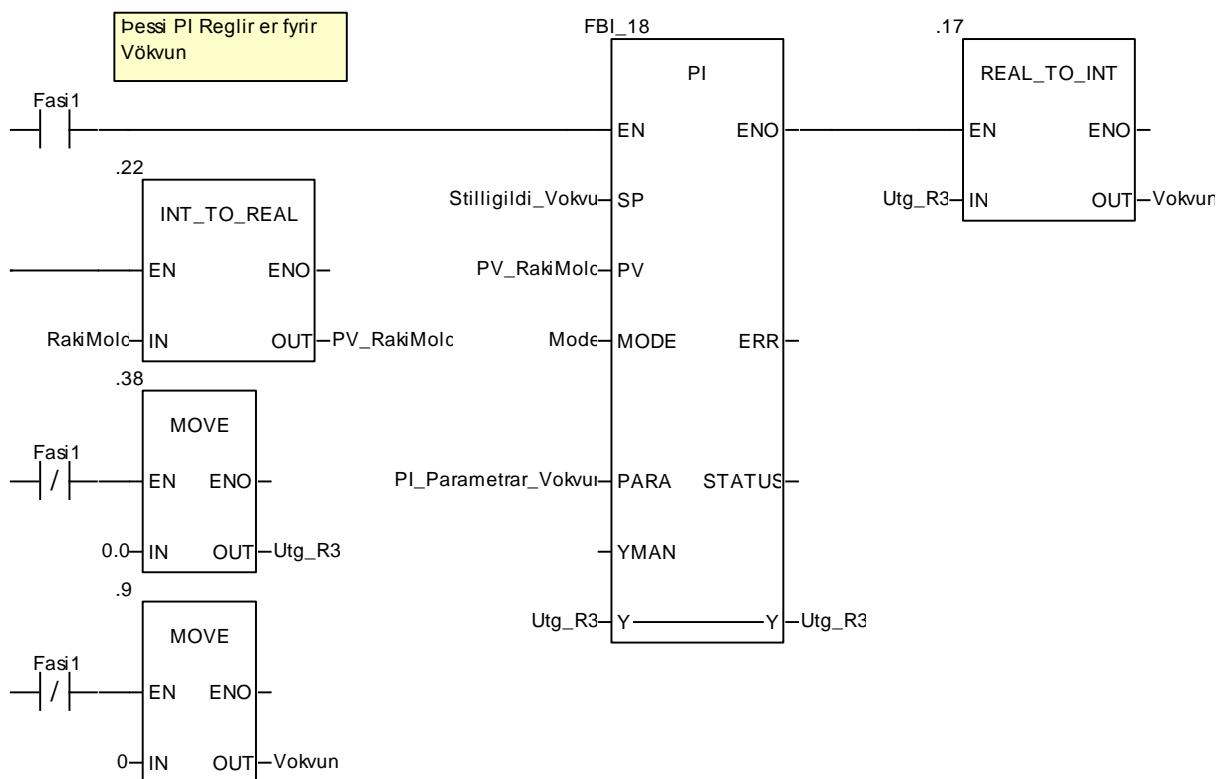
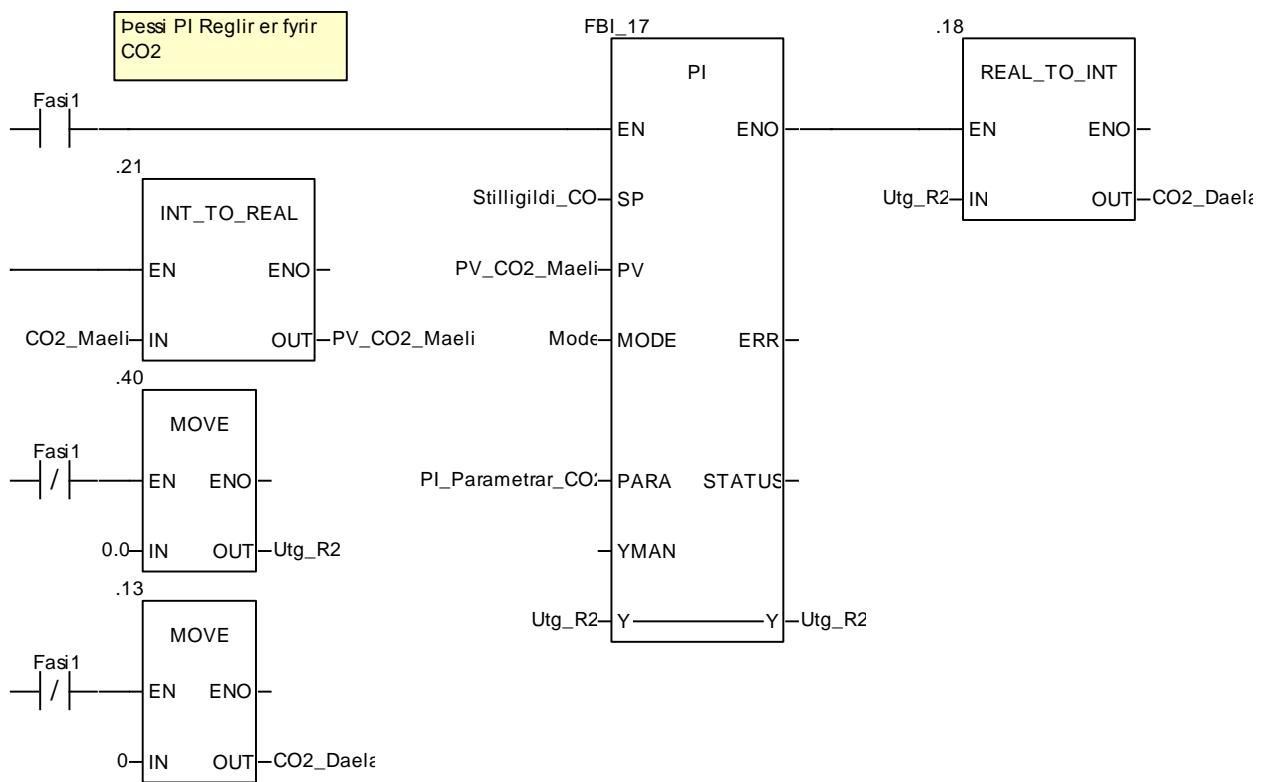
Fasar endursettir

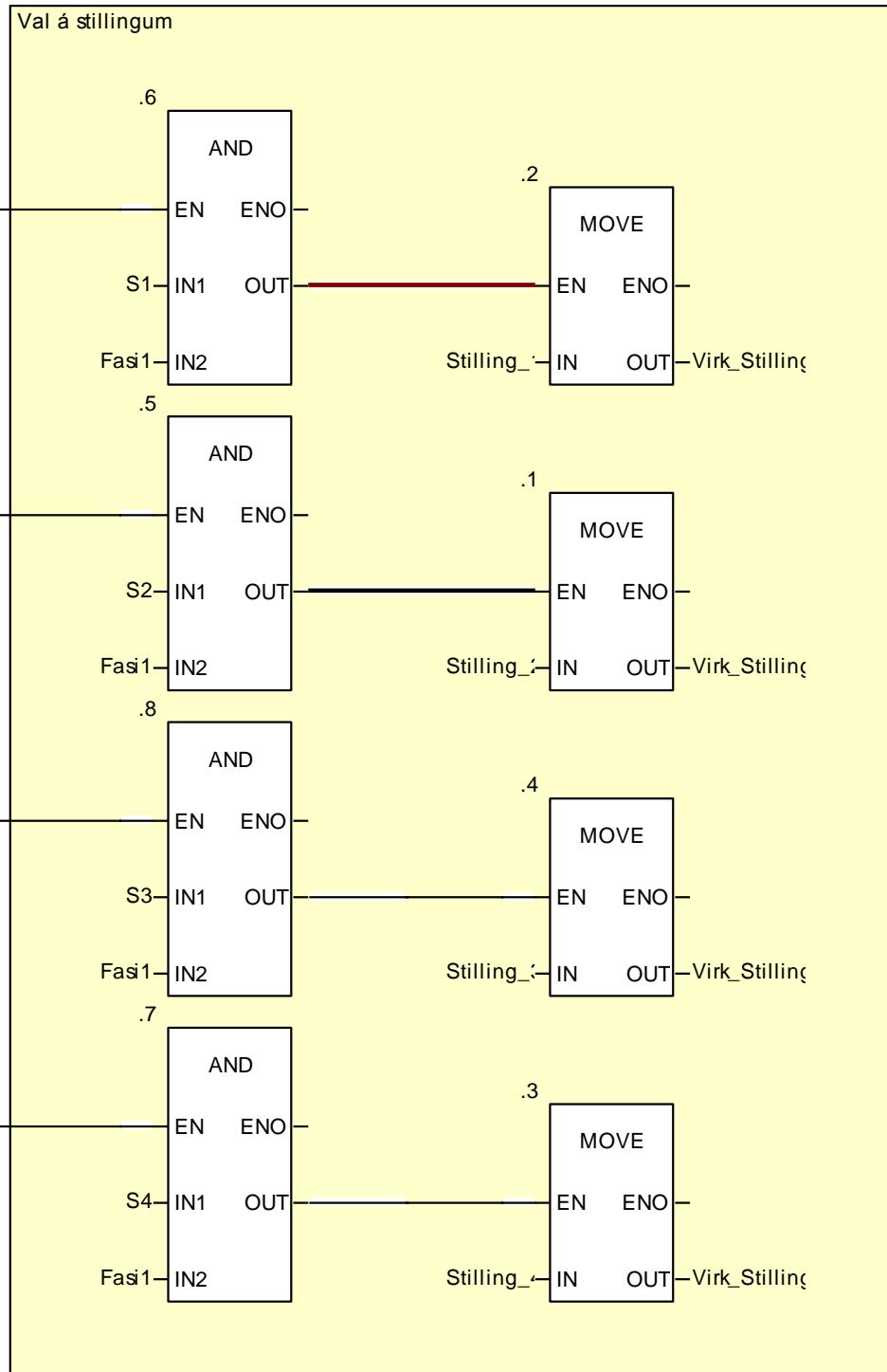


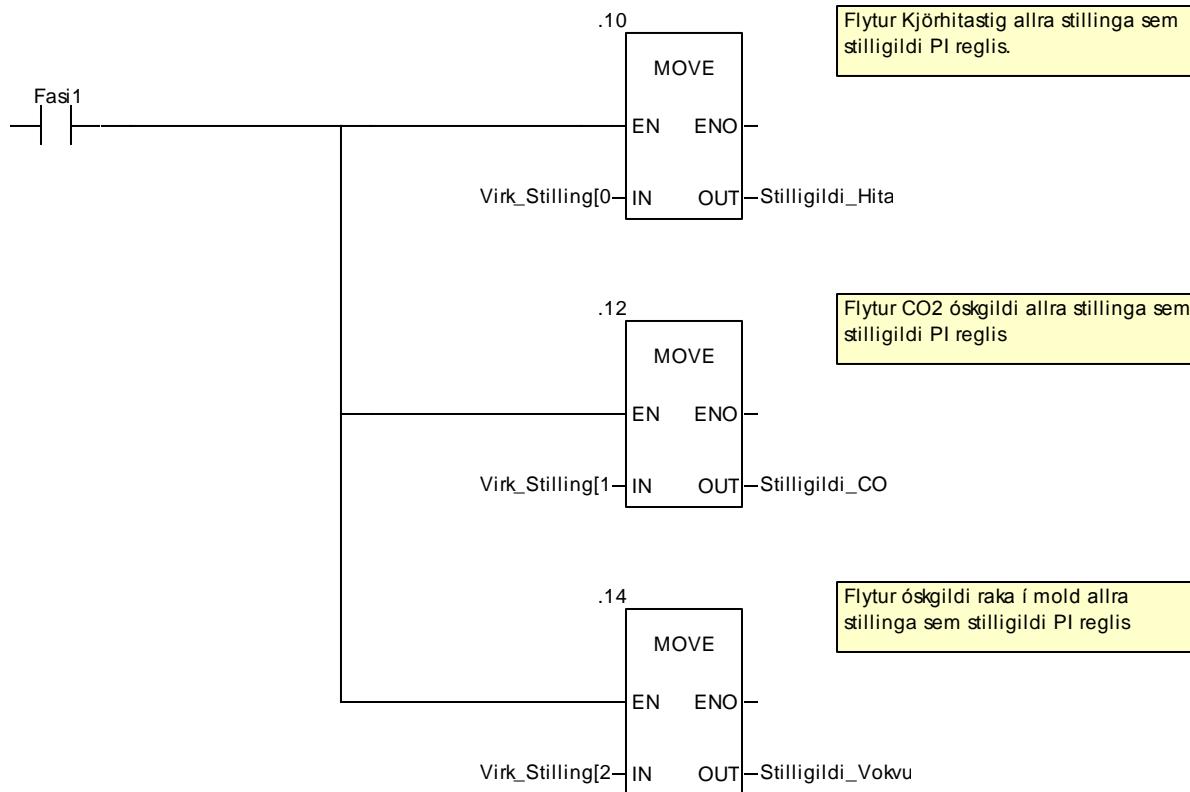
Stýringin



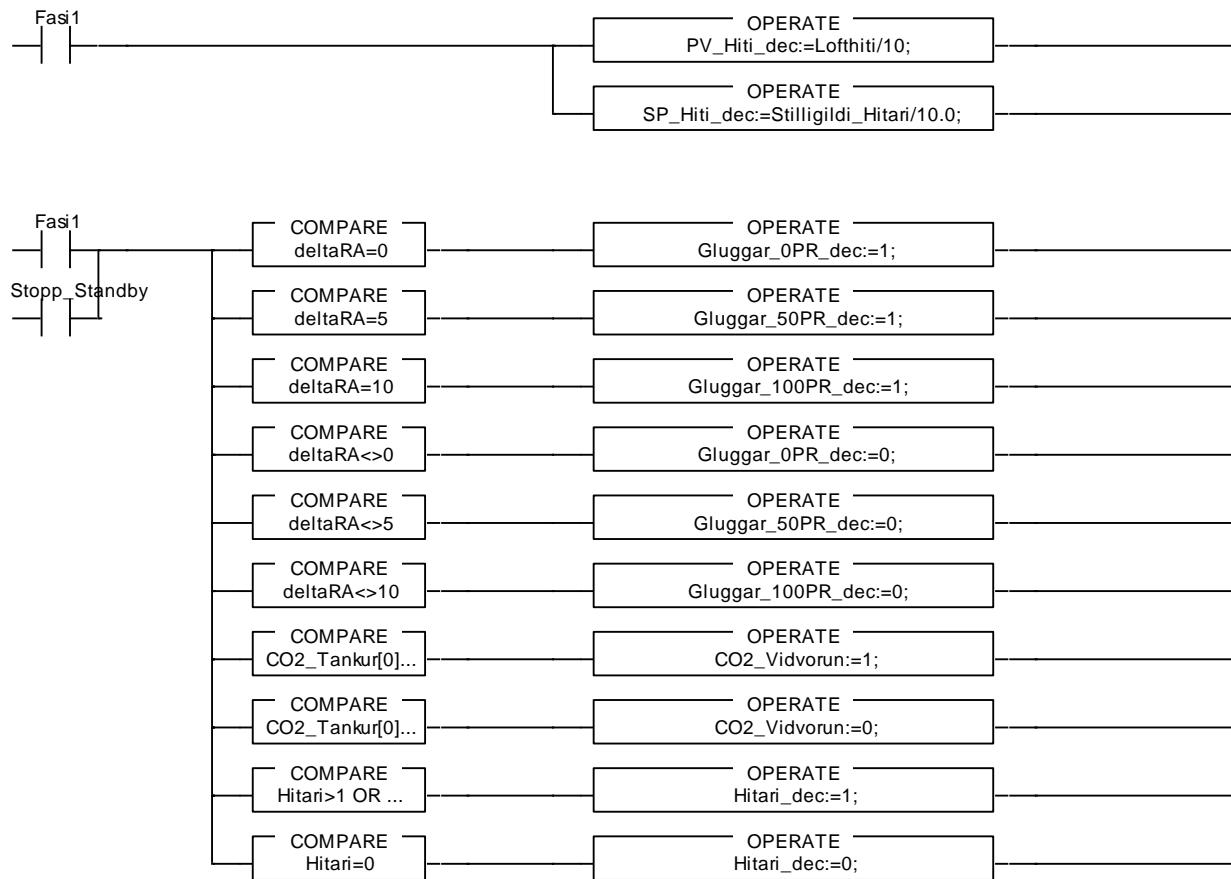








Stýring fyrir skjámynd



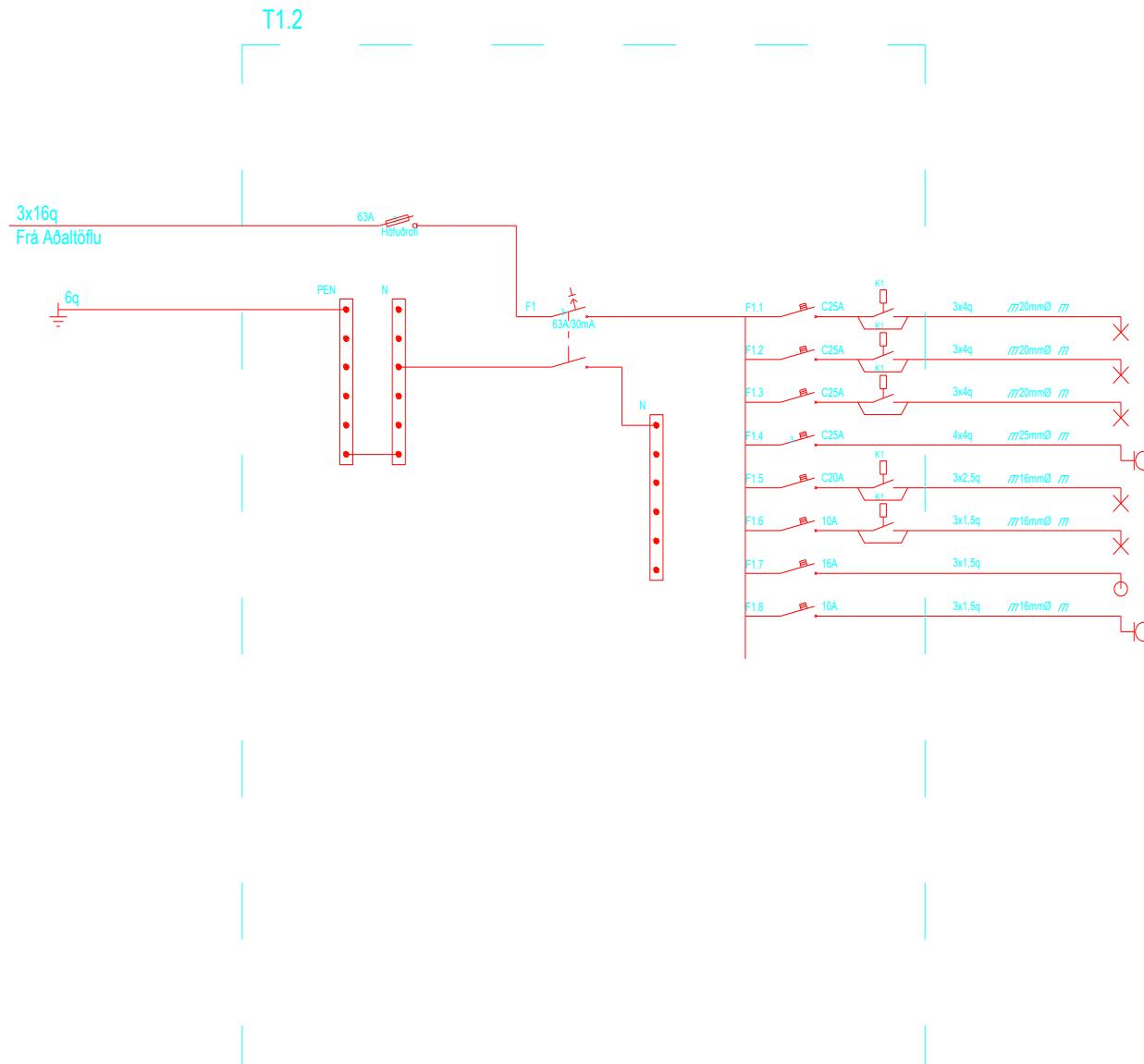
## Breytur stýringarinnar

Hér fyrir neðan er listi yfir allar þær breytur sem notaðar eru í stýringunni. Þeim er raðað upp eftir stafrófsröð. Hægt er að sjá típu, það gildi sem sett er á þær og lýsingu á því hvað þær gera.

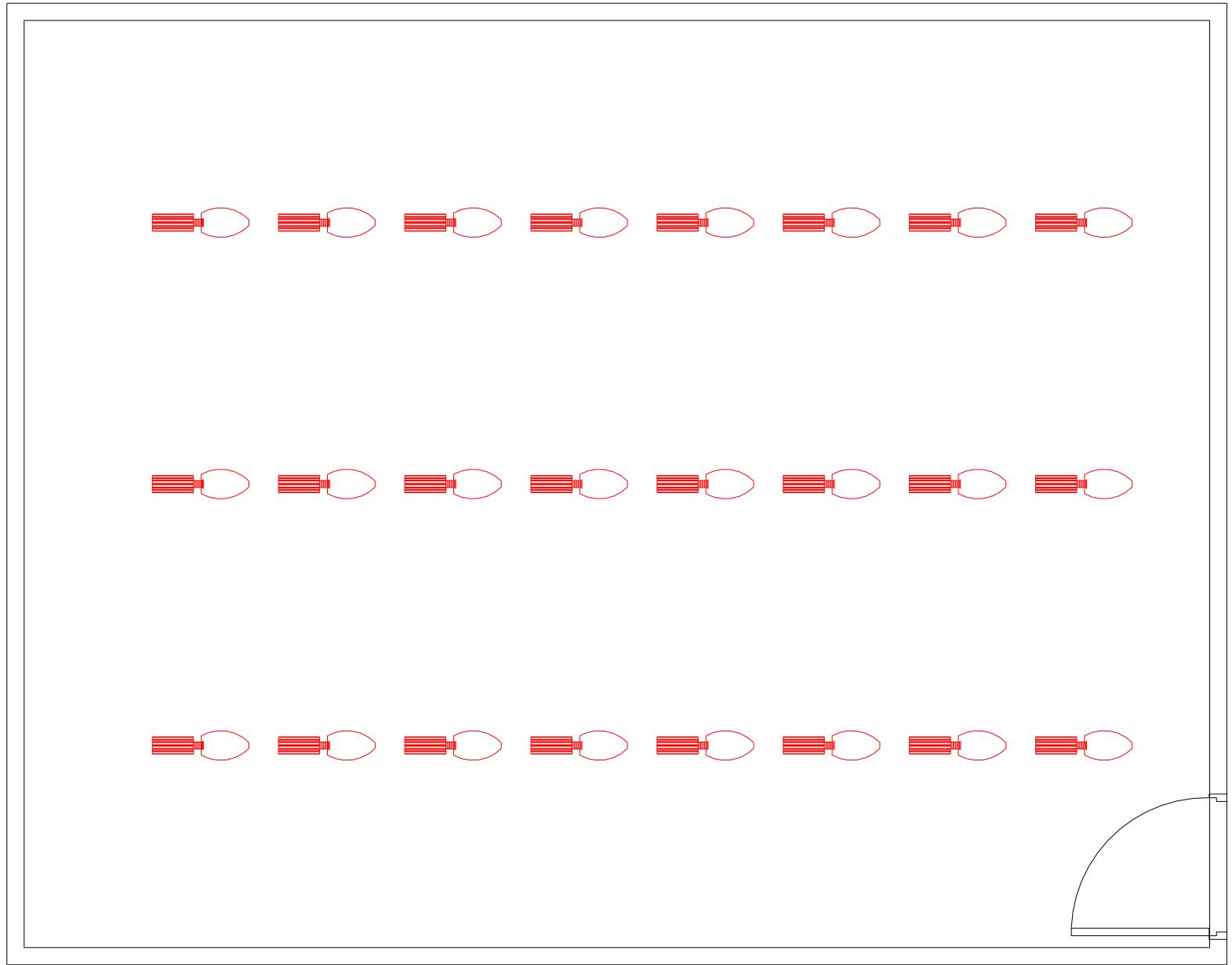
Name	Type	Address	Value	Comment
Auto_OFF	EBOOL			Rofi í skjámynd sem gerir gluggastýringuna óvirkra svo hægt sé að opna og loka handvirk.
CO2_Dæla	INT			Dæla sem heldur CO2 (koldíoxíð) í réttum hlutföllum.
CO2_Maelir	INT			Skynjan inni í gróðurhúsi sem skynjar CO2 magnið
CO2_Tankur	ARRAY[0....]			CO2 tankur magnmæling.
CO2_Tankur[0]	INT			Magnmælir 10kg kútur
CO2_Tankur[1]	INT	1		Magn Min 1kg.
CO2_Vidvorun	EBOOL			Viðvörðun í skjámynd ef magn í tank fer undir 10kg.
deltaRA	INT			Raki Raungildi - Raki Óskgildi ( Notað fyrir gluggastýringuna ).
Fasi0	BOOL			Biðfasi ( Standby ) fasi kerfissins.
Fasi1	BOOL			Keyrslu fasi kerfissins
Gluggamotor_LOKA	EBOOL			Fyrir handvirkja lokun.
Gluggamotor_OPNA	EBOOL			Fyrir handvirkja opnun.
Gluggar	INT			Mótör sem opnar glugga frá 0-100% opnum.
Gluggar_0PR_dec	EBOOL			Ef gluggar eru 0% opnir sést það á skjámynd.
Gluggar_50PR_dec	EBOOL			Ef gluggar eru 50% opnir sést það á skjámynd.
Gluggar_100PR_dec	EBOOL			Ef gluggar eru 100% opnir sést það á skjámynd.
Hitari	INT			Hitaelement fyrir upphitun á gróðurhúsi.
Hitari_dec	EBOOL			Tengdur við skjámynd, sýnir ef hitari er í gangi.
Kaelivifta	EBOOL			Vifta sem keilir gróðurhúsið ef hiti fer yfir Max gildi.
Lampar	EBOOL			Kveikir á gróðurhúsalompum.
Ljosmagn	INT			Birtuskynjan sem skynjar það ljósagn sem kemur inn í gróðurhúsið.
Ljosmagn_REAL	REAL			Breyta notuð til að bera saman raungildi birtu og óskgildi.
Lofthiti	INT			Hitaskynjan inni í gróðurhúsi.
Loftraki	INT			Rakaskynjarar fyrir lofraka.
Loftraki_óskgildi	INT			Breyta sem sýnir óskgildi frá virkri stillingu til samanburðar við raungildi.
LOKA_Gluggum	EBOOL			Rofi í skjámynd og í rofaboxi fyrir handvirkja lokun á gluggum.
Mode	Mode_MH			
OPNA_Glugga	EBOOL			Rofi í skjámynd og í rofaboxi fyrir handvirkja opnun á gluggum.
PI_Parametrar_CO2	Para_PI			PI Parametrar fyrir CO2 Regli.
gain	REAL	2.0		Mögnun reglisins.
ti	TIME	t#10s		Integral tíminn sem hann tekur á milli þess sem hann athugar gildin.
ymax	REAL	100.0		Hámarksgildi útgangsins.
ymin	REAL	0.0		Lámarksgildi útgangsins.
PI_Parametrar_Hitari	Para_PI			PI Parametrar fyrir Hitara Regli.
gain	REAL	2.0		Mögnun reglisins.
ti	TIME	t#120s		Integral tíminn sem hann tekur á milli þess sem hann athugar gildin.
ymax	REAL	100.0		Hámarksgildi útgangsins.
ymin	REAL	0.0		Lámarksgildi útgangsins.
PI_Parametrar_Vokvun	Para_PI			PI Parametrar fyrir Vökvnar Regli.
gain	REAL	2.0		Mögnun reglisins.
ti	TIME	t#5s		Integral tíminn sem hann tekur á milli þess sem hann athugar gildin.
ymax	REAL	100.0		Hámarksgildi útgangsins.
ymin	REAL	0.0		Lámarksgildi útgangsins.

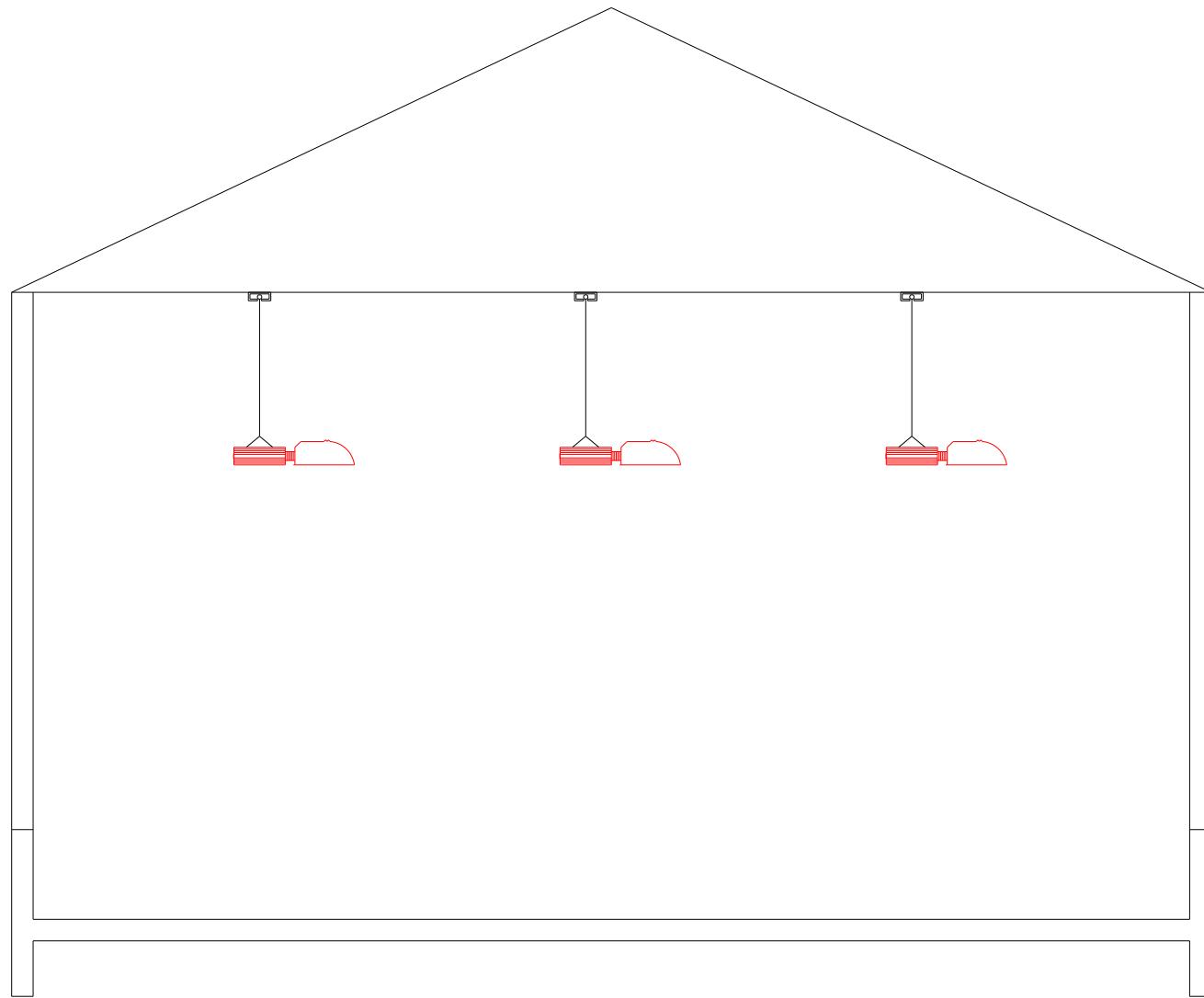
● PV_CO2_Mælir	REAL		Raungildi CO2 breytt yfir í REAL fyrir PI Regli.
● PV_Hitan	REAL		Raungildi Hita breytt yfir í REAL fyrir PI Regli.
● PV_Hiti_dec	INT		Tengdur við skjámynd.
● PV_RakiMold	REAL		Raungildi Raka í Mold breytt yfir í REAL fyrir PI Regli.
● RakiMold	INT		Rakaskynjarar í mold.
● RunMode	BOOL	%S13	Ræsir kerfið.
● S1	EBOOL		Hnappur til að velja stillingu1.
● S2	EBOOL		Hnappur til að velja stillingu2.
● S3	EBOOL		Hnappur til að velja stillingu3.
● S4	EBOOL		Hnappur til að velja stillingu4.
● SP_Hiti_dec	REAL		Tengdur við skjámynd.
● Start	EBOOL		Start hnappur til að ræsa kerfið.
● Stillingi_CO2	REAL		Kjörgildi fyrir CO2 Regli.
● Stillingi_Hitari	REAL		Kjörgildi fyrir Hitara Regli.
● Stillingi_Vokvun	REAL		Kjörgildi fyrir Vökvnar Regli, Raka í Mold.
● Stilling_1	ARRAY[0....]		Kjörgildi fyrir stillingu1.
● Stilling_1[0]	REAL	170.0	Kjörhitastig.
● Stilling_1[1]	REAL	700.0	CO2 óskgildi.
● Stilling_1[2]	REAL	45.0	Raki í mold óskgildi.
● Stilling_1[3]	REAL	30.0	Raki í andrúmslofti óskgildi.
● Stilling_1[4]	REAL	85.0	Sólarljós Min.
● Stilling_2	ARRAY[0....]		Kjörgildi fyrir stillingu2.
● Stilling_2[0]	REAL	200.0	Kjörhitastig.
● Stilling_2[1]	REAL	600.0	CO2 óskgildi.
● Stilling_2[2]	REAL	40.0	Raki í mold óskgildi.
● Stilling_2[3]	REAL	35.0	Raki í andrúmslofti óskgildi.
● Stilling_2[4]	REAL	90.0	Sólarljós Min.
● Stilling_3	ARRAY[0....]		Kjörgildi fyrir stillingu3.
● Stilling_3[0]	REAL	250.0	Kjörhitastig.
● Stilling_3[1]	REAL	800.0	CO2 óskgildi.
● Stilling_3[2]	REAL	35.0	Raki í mold óskgildi.
● Stilling_3[3]	REAL	40.0	Raki í andrúmslofti óskgildi.
● Stilling_3[4]	REAL		Sólarljós Min.
● Stilling_4	ARRAY[0....]		Kjörgildi fyrir stillingu4.
● Stilling_4[0]	REAL	300.0	Kjörhitastig.
● Stilling_4[1]	REAL	1000.0	CO2 óskgildi.
● Stilling_4[2]	REAL	30.0	Raki í mold óskgildi.
● Stilling_4[3]	REAL	50.0	Raki í andrúmslofti óskgildi.
● Stilling_4[4]	REAL	5000.0	Sólarljós Min.
● Stopp_Standby	EBOOL		Stopp hnappur til að stóðva kerfið.

● Utg_R1	REAL		Útgangur reglis 1.
● Utg_R2	REAL		Útgangur reglis 2.
● Utg_R3	REAL		Útgangur reglis 3.
● Virk_Stilling	ARRAY[0....]		Sú stilling sem er virk hverju sinni.
● Virk_Stilling[0]	REAL		Kjörhitastig.
● Virk_Stilling[1]	REAL		CO2 óskgildi.
● Virk_Stilling[2]	REAL		Raki í mold óskgildi.
● Virk_Stilling[3]	REAL		Raki í andrúmslofti óskgildi.
● Virk_Stilling[4]	REAL		Sólarljós Min.
● Vokvun	INT		Vökvnardæla.



- T1.1-F1.1 Tenglar fyrir HPS ljóslampa
- T1.1-F1.2 Tenglar fyrir HPS ljóslampa
- T1.1-F1.3 Tenglar fyrir HPS ljóslampa
- T1.1-F1.4 Þriggja fasa grein fyrir Triac sem stjórnar hiturum.
- T1.1-F1.5 Gluggamótorar
- T1.1-F1.6 Tenglar fyrir kæliviftur
- T1.1-F1.7 16A grein fyrir PLC Smáspennutöflu
- T1.1-F1.8 Auka grein til vara





## Útreikningar á hitatapi og orkubörf til upphitunar á 50m<sup>2</sup> gróðurhúsi.

L=8,2m

B=6,5m

H=3,5m (2,9+600) 600mm er grunnurinn, hann er 300mm undir jörð og nær 600mm yfir  
Grunnur=(600+300)=900mm eða 0,9m

### Útreikningar á flatarmáli

	í m <sup>2</sup>
Allar hliðar:	(8,2+8,2+6,5+6,5)*(2,9)
Gabblar:	1,5*6,5*0,5*2
Þak:	1,5*8,2*2
Grunnur:	(8,2+8,2+6,5+6,5)*(0,9)

Notuð verður formúlan: 
$$Q = \left[ \frac{A_1}{R_1} + \frac{A_2}{R_2} \right] * (t_i - t_0) * (f_c)$$

A1= 85,26+9,75+24,6 119,61

A2=Grunnur 26,46

R1= 0,27 -> Tvöfallt gler með 6mm loft á milli

(Upplýsingar um RSI einangrunarstaðla efnis er hægt að finna í viðauka)

R2= 1,92 -> Cement og 50mm frauðplast

ti-t0= ti = 20°C t0 = -10°C => ti-t0 = 30°C

fc= 1,08 -> Vel byggt hús

$$Q = \left[ \frac{119,61}{0,27} + \frac{26,46}{1,92} \right] * (20 - (-10)) * (1,08) \quad Q = 14.799,7 \text{ W eða } 14,8 \text{ kW}$$

Ráðlöggð stærð á hitara er 10% meiri en hitatapið er.  $14,8 \text{ kW} + 1,48 \text{ kW} = 16,28 \text{ kW}$

## Útreikningar á heildar orkunotkun 50m<sup>2</sup> gróðurhúss.

Samkvæmt útreikningum var heildar orka lampana 14,4kW

Með því að gefa okkur að lamparnir séu í gangi í 8 tíma á dag reiknum við:

$$8*365=2.920 \text{ klst} \Rightarrow 2.920*14,4 = \underline{\underline{42MWh}} \text{ yfir árið}$$

Fyrir upphitun þurfti 16,28kW hitara.

Til að hafa þetta nákvæmara skulum við gefa okkur að yfir tímabilið janúar til apríl sé 100% notkun á hiturum.

Yfir mánuðina maí til ágúst sé 40% notkun og september til desember sé 70% notkun.

jan-apr

Það eru 120 dagar samtals.  $120*24 = 2.880\text{klst} \Rightarrow 16.280*2.880 = \underline{\underline{46,8MWh}}$

maí-ágú

Það eru 123 dagar.  $123*24 = 2.950\text{klst} \quad 40\% \text{ notkun gerir} = 0,4*16.280 = 6.512\text{W}$

Samtals orkan yfir þessa mánuði er þá  $2.950*6.512 = \underline{\underline{19,2MWh}}$

sept-des

Það eru 122 dagar.  $122*24 = 2.928\text{klst} \quad 70\% \text{ notkun gerir} = 0,7*16.280 = 11.396\text{W}$

Samtals orkan yfir þessa mánuði er þá  $2.928*11.396 = \underline{\underline{33,4MWh}}$

Samtals orkuþörf til upphitunar yfir árið er því:

jan-apr	46,8MWh
maí-ágú	19,2MWh
sept-des	33,4MWh
Alls:	99,4MWh

Það er erfitt að segja hvað gluggamótornir vinna mikið yfir árið en ef við gefum okkur að þeir séu í gangi í 5 klst yfir árið þá er heildar orkuþörf þeirra:

Hver mótor er 704W, það eru 6 mótorar sem gerir  $6*704 = 4224\text{W}$

$5*4224 = \underline{\underline{21kWh}}$  sem er þá heildar orkuþörf þeirra yfir árið.

Það eru tvær kæliviftur í þessu gróðurhúsi. Þær eru báðar 370W sem gerir þær samtals:

$2*370 = 740\text{W} \quad \text{Gefum okkur að það séu 21 dagur með 9 heitum klst. } 9*21 = 189\text{klst}$

$189*740 = \underline{\underline{139,8kWh}}$  yfir árið.

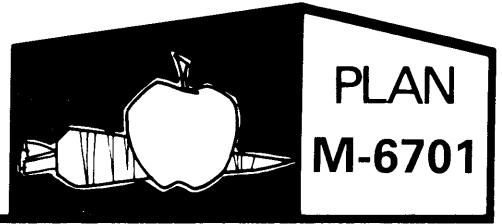
Hér er talin upp heildar orkuþörf gróðurhússins.

Lampar	42MWh
Hitarar	99,4MWh
Gluggamótorar	21kWh
Kæliviftur	139,8kWh
Alls:	<b>141,56MWh</b>

Samkvæmt taxta A1 fyrir heimili er verð á raforku, fast gjald = 34,40kr á dag.  
Síðan 11,96kr fyrir hverja kílowatt orku sem keypt er.

Fyrir eitt ár þarf því að borga  $365 \times 34,40 = 12.556$ kr í fast gjald  
141,56MWh notkun gerir:  $141.560 \times 11,96 = 1.693.058$ kr

Samtals:  $12.556 + 1.693.058 = \underline{\underline{1.705.614}}\text{kr}$  yfir árið



## GREENHOUSE HEATING REQUIREMENTS

**CALCULATING HEAT LOSS** A good heating system is essential to greenhouse operation. The system should be properly sized to the needs of the greenhouse under extreme weather conditions. A heat loss calculation is the first step in determining heating system capacity before selecting the system and its various components.

Greenhouse heat loss is determined by the following equation:

$$Q = \frac{A_1 + A_2 + \dots}{R_1 R_2} (t_i - t_o) (f_w) (f_c) (f_s)$$

Where:

$Q$  = overall heat loss, Watts

$A_1, A_2$  = surface area of various components, m<sup>2</sup>

$R_1, R_2$  = thermal resistance of each component,

M<sup>2</sup>°C/W

$t_i$  = inside design temperature, °C

$t_o$  = outside design temperature, °C

$f_w$  = wind or exposure factor, (Table 2)

$f_c$  = construction type or quality factor (Table 3)

$f_s$  = system factor (Table 4)

**EXPLANATION OF FACTORS** This equation is a standard building heat loss formula, modified to account for the particular requirements of a glass building. Heat loss for any greenhouse can be readily determined by plugging the appropriate values into this equation. Following is an explanation of all items, and tables of the various factors. Design examples illustrate the use of this equation.

$Q$  - is the overall heat loss used to determine the minimum size of heater or boiler required to maintain the inside design temperature.

$A_1, A_2$  - are the surface areas of the various building components such as glazing, walls and foundations (m<sup>2</sup>).

$R_1, R_2$  -

are the thermal resistances (often called "RSI" in metric) of each construction material. Table 1 lists the RSI values for common greenhouse materials and building components. In making heat loss calculations, be sure to use the metric RSI value to match the metric units of this equation.

$t_i$  - is the lowest inside air temperature consistent with good management or growing practice.

$t_o$  - is the design outdoor air temperature; either the coldest expected, or the "winter design temperature" stated in the building codes for the locality.

$f_w$  - is the wind or exposure factor. The heat loss equation is based on a 25 km/h wind speed;  $f_w$  increases 5% for every 10 km/h that the hourly wind speed is expected to exceed 25 km/h during the coldest weather, as shown in Table 2. Whether you select a sheltered or exposed location to determine  $f_w$ , is very much a matter of judgement.

$f_c$  - is the construction factor (Table 3). This factor adjusts heat loss for the type, tightness and quality of construction. It accounts for the effect of both framing and air leakage. Note that tightness and state of repair are important to heating requirements. For a 'very loose' house, this factor is relatively high and is a rough estimate at best.

$f_s$  - is a system factor (Table 4) that relates to the type of heating system and management practices. Indoor temperature always above 20°C, heat delivered through convection tubes near the roof, or radiant heating pipes mostly overhead - these are all systems that create higher surface temperatures and/or greater turbulence, increasing heat loss. The values in Table 4 reflect this.



The Canada Plan Service prepares detailed plans showing how to construct modern farm buildings, livestock housing systems, storages and equipment for Canadian Agriculture.

This leaflet gives the details for a farm building component or piece of farmstead equipment. To obtain another copy of this leaflet, contact your local provincial agricultural engineer or extension advisor.

## GREENHOUSE HEATING REQUIREMENTS

PLAN M-6701 REVISED 83:09

**OTHER CONSIDERATIONS** This heat loss formula does not allow for solar heat gain, since it computes heat loss at night when maximum heating is required. Various methods are available to help reduce heat loss:

- double polyethylene covering
- double-wall polycarbonate or acrylic glazing materials
- night time insulating shades
- insulation of some surfaces, such as north walls
- polyethylene beads in double coverings
- improved system efficiencies and maintenance
- heat exchangers
- perimeter foundation insulation

When considering insulating some areas, such as the north wall, pay particular attention to the possible reduction of available light, as this may cause a loss in yield or quality. Some crops and management systems are more sensitive than others to light levels. For this reason, it is generally not recommended to place a double polyethylene system over existing glass houses, or to insulate north roof slopes. Insulating north walls is usually cost effective in Canada.

There are several types of heating systems that are commonly used for greenhouses. The capacity of the system selected should normally be 10 to 20% greater than that calculated by this formula, to allow a safety factor. Also, consider a larger system if expansion is contemplated, using a central heating system.

**TABLE 1. THERMAL RESISTANCE OF BUILDING SYSTEMS**

Material	Thickness mm	RSI value m <sup>2</sup> C°/W
<b>Glazing materials</b>		
Single glass <sup>1</sup>	3	0.15
Double glass (6 mm air space)	-	0.27
Fiberglass	-	0.16
Polyethylene	0.15	0.14
Double acrylic or polycarbonate	6 - 12	0.30 - 0.35
Air inflated, double polyethylene	-	0.25 - 0.28
<b>Construction materials</b>		
Asbestos cement	6	0.16
Wood (typical softwood)	25	0.30
Concrete	100	0.20
	150	0.23
Concrete block	200	0.35
Insulation <sup>2</sup>		
Rigid polystyrene	25	0.88
Polyurethane foam	25	1.10

<sup>1</sup> RSI value for glass is for a temperature difference of 50°C; value decreases by 0.005 for each 10°C greater than 50°C, and increases when the temperature difference is less than 50°C. RSI value is for sloping roofs and increases by 10% for walls, though this difference is generally ignored.

<sup>2</sup> RSI value for insulations is proportional to thickness and can be added to the RSI for construction materials.

**TABLE 2. WIND OR EXPOSURE--FACTOR (fw)**

Wind velocity (km/h)	fw
less than 25	1.00
30	1.03
40	1.08
50	1.13
60	1.18
70	1.22

**TABLE 3. CONSTRUCTION FACTORS (fc)**

House description	fc
All metal, tight glass, lapped somewhat loose glass	1.08 1.15 - 1.20
Wood frame, steel gutters, tight construction	1.05
All wood bars, vents, etc. good, tight sealed	1.00
moderately good	1.10
loose fitting	1.20 - 1.30
Fiberglass, caulked ribs unsealed joints	0.95 1.05 - 1.10
Polyethylene film double or single layer	0.90 - 0.95
Double acrylic or polycarbonate	0.90

**TABLE 4. SYSTEM DESCRIPTION (fs)**

fs
1. Heat supplied by unit heaters via polytubes near roof
2. Radiation or convection pipe system, over 50% overhead
3. System 2, with polytube circulation
4. Radiation or convection heat near ground or below benches
* 5. Greenhouse always below 20°C for cold operation of a glass house

\* At moderately low temperatures, during cold outdoor conditions lapped joints of glass houses freeze, thus sealing the house and reducing heat loss.

### EXAMPLE 1

Rectangular greenhouse, as illustrated (Fig. 1). 12 x 30 m with 2.6 m high sidewall height. Foundation 300 mm below grade and 600 mm above, insulated with 50 mm styrene foam. Lapped glass on metal frame. Outside temperature -35°C and inside temperature 15°C, exposed location with 50 km/h wind. Heating by overhead unit heater connected to a polytube. Basic formula is:

$$Q_2 = \frac{[A_1 + A_2]}{[R_1 \quad R_2]} (t_i - t_o) (f_w) (f_c) (f_s)$$

$$t_i - t_o = 50^\circ\text{C}$$

$f_w = 1.13$  for 50 km/h wind speed (Table 2)

$f_c = 1.08$  for a good lapped glass house (Table 3)

$f_s = 1.15 \times 0.95$  overhead heat unit, but temperature kept moderately low for coldest weather (Table 4)

$R_1 = 0.15$  for single glass (Table 1)

$R_2 = (0.16 + 1.76) = 1.92$  (asbestos cement plus 50 mm foam of RSI 0.88 per 25 mm)

Area calculation:

$$\begin{aligned} \text{Walls} &= \text{perimeter} \times \text{height} \\ &= (30 + 30 + 12 + 12) \times 2.0 \\ &= 168 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Gable ends} &= \text{width} \times \text{height} \times 0.5 \text{ for} \\ &\quad \text{triangular areas} \\ &= 12.0 \times 3.0 \times 0.5 \times 2 \text{ ends} \\ &= 36 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Roof area} &= \text{slope distance} \times \text{building} \\ &\quad \text{length} \\ &= 6.70 \times 30.0 \times 2 = 402 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Foundation} &= \text{perimeter} \times \text{height} (\text{height} = \\ &\quad 0.9 \text{ m above and below grade}) \\ &= (30 + 30 + 12 + 12) \times 0.9 \\ &= 75.6 \text{ m}^2 \end{aligned}$$

$$A_1 = 168 + 36 + 402 = 606 \text{ m}^2$$

$$A_2 = 75.6 \text{ m}^2$$

$$Q = \frac{[606 + 75.6]}{[0.15 \quad 1.92]} (50)(1.13)(1.08)(1.15)(0.95) \\ = 272\,000 \text{ W or } 272 \text{ kW}$$

Suggested unit size is  $272 + 10\% = 300 \text{ kW}$

(NOTE: 1 kW = 3414 Btu/h)

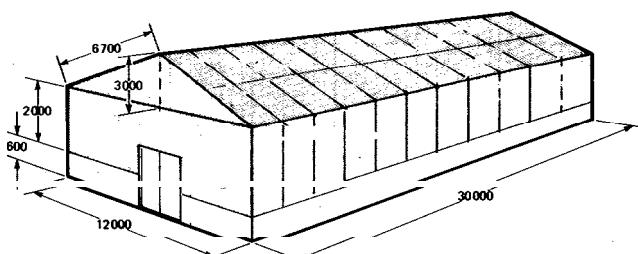


Figure 1

### EXAMPLE 2

Same house with double-poly roof, fiberglass walls

Now

$A_1 = \text{wall areas at } R_1 = 0.16$  for fiberglass

$A_2 = \text{foundation area at } R_2 = 1.92$

$A_3 = \text{roof area at } R_3 = 0.25$  for double-poly fc is reduced to 1.00 (combining 0.95 for roof with 1.08 for walls)

From previous example,

$$A_1 = 168 + 36 = 204 \text{ m}^2$$

$$A_2 = 75.6 \text{ m}^2$$

$$A_3 = 402 \text{ m}^2$$

Now:

$$Q = \frac{[204 + 75.6 + 402]}{[0.16 \quad 1.92 \quad 0.25]} (50)(1.13)(1.0)(1.15)(0.95)$$

= 180,000 W or 180 kW; use about a 200kW heater

Changing to the double-poly roof has reduced heater size by 100 kW or about 35%. Note that the values in brackets below  $A_1$ ,  $A_2$ , etc. represent the relative heat loss for each area; in fact, heat loss for each area could be calculated separately.

### EXAMPLE 3

Small greenhouse (Fig. 2), 3.6 m x 4.8 m x 2.0 m sidewall freight. Insulated foundation 300 mm below grade and 600 mm above on walls. Glass structure on metal frame. Same exposure factors as EXAMPLE 1.

$$\text{Wall area: } (3.6 + 3.6 + 4.8 + 4.8)(1.4) = 23.52 \text{ m}^2$$

$$\text{Gable ends: } 1.0 \times 3.6 \times 0.5 \times 2 = 3.6 \text{ m}^2$$

$$\text{Roof area: } 2.06 \times 4.80 \times 2 = 19.78 \text{ m}^2$$

$$\text{Foundation: } (3.6 + 3.6 + 4.8 + 4.8)(0.9) = 15.12 \text{ m}^2$$

$$A_1 = 23.52 + 3.60 + 19.78 = 46.9 \text{ m}^2$$

$$A_2 = 15.12 \text{ m}^2$$

$$R_1 = 0.15$$

$$R_2 = 1.88$$

$$t_i - t_o = 50^\circ\text{C}$$

$$f_w = 1.13$$

$$f_c = 1.08$$

$$f_s = 1.15 \times 0.95$$

Heat loss,

$$Q = \frac{[46.9 + 15.12]}{[0.15 \quad 1.88]} (50)(1.13)(1.108)(1.15)(0.95)$$

= 21 380 W or 21.4 kW

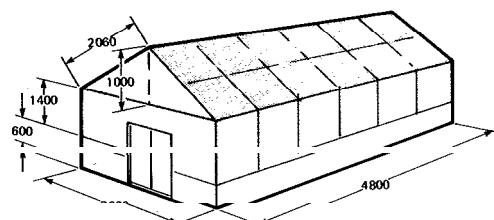


Figure 2

## COMMENTS ON EXAMPLES

The following summarizes the heat loss calculations for the three examples:

Example	Greenhouse Floor area m <sup>2</sup>	Heat loss	
		Total kW	Per unit area W/m <sup>2</sup>
1	360	272	755
2	360	180	500
3	17.3	21.4	1240

Comparing Examples 1 and 3 of houses of similar construction, note that the heat loss per unit area is much higher for the small backyard size greenhouse than for the large commercial house. This is due to the higher ratio of surface to floor area. Small houses are less economical to heat and respond more rapidly to weather variations. Heater sizing is more critical and a greater safety factor is recommended.

The effect of a more energy efficient double-poly covering in reducing peak heat loss is evidence when comparing Examples 1 and 2.



## Comparison of Energy Needed to Heat Greenhouses and Insulated Frame Buildings Used in Aquaculture<sup>1</sup>

P.A. Fowler, R.A. Bucklin, C.D. Baird, F.A. Chapman, C.A. Watson<sup>2</sup>

### Introduction

A water recycling aquacultural production system must be housed in a building to be effective. A typical water recycling aquacultural production system consists of production tanks, a pump, a filtering system, a temperature control system, a heating system and/or cooling system, the plumbing and valves necessary to control the flow of the water, a source of water and housing for the system. Locating production inside a building offers several advantages such as stable water conditions, protection from predators, the ability to control photoperiod, security from vandalism, and better overall management. Because of the high stocking densities in closed systems, it is necessary to maintain close control of several water quality factors. The system's temperature is an important parameter which must be maintained at a stable value. Fish grow fastest when maintained within a narrow temperature zone. Also, heating energy is saved by maintaining stable temperatures. A wide variety of types of structures can be used for ornamental fish production. These structures range from pond covers and plastic covered greenhouse structures to insulated frame buildings.

### Greenhouse Structures

Inexpensive plastic covered greenhouse structures of the type used by the horticulture industry for plant production are frequently used to house closed recycling aquaculture systems. Aquacultural producers do not commonly use the more expensive glass greenhouses used by some of the plant production industry. A plastic covered greenhouse structure is easy to construct on almost any site and has a low initial cost. Building material costs for the structure can be as low as \$1 per square foot, but plastic covered greenhouse structures have the disadvantages of a short lifetime, of requiring regular maintenance and of requiring a cooling system during the summer. In addition, greenhouse structures are difficult and expensive to heat during cold weather.

### Frame Structures

Low-cost wood or metal frame structures covered with siding material offer an alternative to plastic covered greenhouse structures. Building costs for this type of structure can be as low as \$4 to \$6 per square foot. Construction costs for wood or metal frame

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1. This document is CIR 1198, one of a series of the Energy Extension Service, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. First printed June 1997. Please visit the FAIRS Website at <http://hammock.ifas.ufl.edu>
  2. P.A. Fowler, R.A. Bucklin, & C.D. Baird are Graduate Assistant, Professor, and Assistant Professor, Dept. of Agricultural and Biological Engineering. F.A. Chapman is Assistant Professor, Department of Fisheries and Aquatic Sciences. C.A. Watson is Aquaculture Extension Agent II, Multi-county, Seffner. Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

buildings are greater than for greenhouse type structures, making the initial cost higher, but this type of structure also has a much longer expected lifetime than a greenhouse structure. The best grades of greenhouse plastic films will last for only three years in Florida unless they are covered with paint or shadecloth. The plastic films are broken down by the high ultraviolet levels in Florida summer sunlight. Even when painted or covered with shade cloth, the plastic film will seldom last over five years. A well-constructed wood or metal frame building has an expected lifetime of over twenty years. The frames of these buildings can be covered with a variety of siding materials including metal and wood. Plastic sheet material can be used to cover frame buildings if it has been treated to resist ultraviolet degradation. Wood or metal frame buildings also are better suited to withstand the high wind loads that can be expected periodically in Florida. In addition, insulation is easy to install in frame structures. Insulated structures cost less to heat and are easier to keep at stable temperatures.

### **Comparison of Structures**

A greenhouse does offer more control over the environment than an open pond, but it offers less control than a frame building. Greenhouse structures are designed for plant production and compromise between providing an enclosure for the plants and letting in the maximum amount of light for plant production. The high light levels needed for plant production are not needed for ornamental fish production and may promote algae growth or cause overheating of the structure during the summer. An unventilated greenhouse in Florida will frequently reach temperatures well over 100 °F during the summer, and in some cases temperatures rise as high as 130 to 140 °F. Ventilation and cooling systems must be installed to keep water temperatures low and for workers to be able to function in this type of building during the summer. During winter conditions, a greenhouse structure does offer some protection from cold temperatures, but greenhouses are expensive to heat because of the low insulation value of their plastic walls.

A wood frame or metal building can be designed specifically to house an aquacultural facility and make managing the system easier. The floorplans of frame

buildings offer more flexibility in the arrangement of tanks and plumbing than those of greenhouses. The higher strength of the frame makes it easier to support suspended plumbing and electrical work for better routing and safer installation. It is easier to construct separate rooms to house filters, feed storage, and sensitive equipment. The higher initial costs of a frame building are offset by the longer building life, reduction in energy costs, and improved working conditions. Insulation is easily installed in the walls of frame buildings to reduce the amount of energy needed to heat the building during cold weather.

### **Energy Needed for Heating**

Either type of building can be successfully used in aquaculture. Each type of construction has its advantages. A greenhouse structure is advantageous when low initial cost is required or when it is planned for a building to be in use for only a year or two. A wood or metal frame building has advantages when a permanent building is planned and operating costs are most important. The main difference in operating costs is caused by the energy used to heat the structure and water during cold weather. The energy lost through the walls of a structure during cold weather must be replaced by the heating system in order to maintain a stable temperature inside a structure. The amount of energy that must be supplied is related to the difference between inside and outside temperatures and the thermal resistance or "R" value of the building's roof and walls. The amount of energy required to heat a building is calculated from the equation in Figure 1.

Plastic greenhouses can be covered with either polyethylene film or fiberglass sheet, or any combination of film and sheet. A sheet of fiberglass or a single layer of polyethylene film has an R value of 0.85. Most plastic greenhouses are constructed using a type of construction called double poly consisting of two layers of polyethylene. By inflating the space between the two layers of film, the R value is increased about 50% to 1.25.

Table 1. Annual Energy Use

Building Type	Thermal Resistance, R (ft <sup>2</sup> ·°F·h/BTU)	Annual Energy Use for Heating for 75°F Inside Temperature	Annual Energy Use for Heating for 80°F Inside Temperature
Greenhouse Covered with One Layer of Plastic Film	0.85	388,000,000	560,000,000
Greenhouse Covered with Two Inflated Layers of Plastic Film	1.25	251,000,000	380,000,000
Insulated Frame Building	11.00	28,000,000	43,000,000

Frame buildings can be covered with a wide variety of coverings ranging from plastic sheets to wooden and metal siding. The coverings seldom add significantly to the thermal resistance of a building. The R value of a sheet of metal is the same as that for a sheet of plastic. However, insulating materials are easily installed in the walls of frame buildings, and the thermal resistance of the building can be increased to very high values. However, extremely high levels of insulation are usually not economical and R-11 will normally be adequate. The recommended R value used for frame buildings used for aquacultural production is R-11.

## Cost Comparison

To illustrate the difference in costs for a typical greenhouse structure and the same size frame building used for aquacultural production, consider a structure 30 feet wide and 100 feet long with an eave height of 10 feet. Assuming that the same number of tanks and the same operating equipment are located in both structures, the differences in costs will be in the initial costs, maintenance costs, depreciation, and energy costs.

Table 2. Energy Contents of Electricity and Common Fossil Fuels

Fuel	Energy Content
Propane	85,000 BTU/gal
#2 Fuel Oil	141,000 BTU/gal
Electricity	3,413 BTU/kwh
Natural Gas	100,000 BTU/therm

The estimated initial cost of the 3,000 square foot greenhouse structure at \$1 a square foot is \$3000. The estimated initial cost of an uninsulated frame building

insulated with R-11 insulation at \$5 per square foot is \$15,000. About \$2,500 of the cost of the frame building is spent on purchase and installation of the R-11 insulation. Note that both these estimates are for the building only and do not include foundation and flooring or any of the production equipment. Both buildings have the same total surface area of about 5,800 square feet and are assumed to be located with the same orientation to the sun and in the same general area away from any nearby buildings.

The amount of energy used to heat a building depends on the desired inside temperature, the surface area of the building, the thermal resistance of the material covering the building and the outside weather conditions. Typical aquacultural systems operate at temperatures in the range of 75°F to 80°F. The following comparisons are between a plastic greenhouse structure covered with a single layer of polyethylene film (R = 0.85), a plastic greenhouse structure covered with two inflated layers of polyethylene film (R = 1.25) and a frame building covered with metal siding and metal roofing material with the walls and ceiling insulated with R-11 insulation (R = 11). The weather conditions assumed are for central and south Florida. Hourly average temperatures were extracted from 11 years of records for 1980 to 1990 from this area of Florida. The total number of degree-hours below 75°F and 80°F was calculated from the set of hourly average temperatures and, for an average one year period, was 54,000 and 82,000, respectively. The energy use for a building during a year is calculated using the estimate of the total degree-hours for one year with Equation 1, the building surface area and the R value for the building material. The results of this calculation for the three building types and inside temperatures of 75°F and 80°F are shown in Table 1.

Table 3. Fuel and Electricity Energy Costs

Electricity	Propane	#2 Fuel Oil	Natural Gas
34,100 BTU/\$	47,600 BTU/\$	98,700 BTU/\$	133,300 BTU/\$
\$0.10/kwh	\$1.25/gal	\$1.00/gal	\$0.75/therm

Energy used to heat a structure is usually provided by the combustion of some fuel on site, but energy can be provided by electricity or in some cases alternative energy sources such as solar or geothermal can be used. The main factor used to compare different types of fuel is usually the cost of the fuel per unit of energy delivered. Table 2 shows the energy content of several common fuels. The cost of heating a structure depends on the fuel's energy content and on the cost of the fuel. Table 3 compares the number of BTUs that a dollar will buy for electricity, propane and #2 fuel oil. The values for propane and #2 fuel oil account for a 70% combustion efficiency when used for heating.

Annual costs for heating each of the three building types are shown in Table 4, based on the energy cost of \$1.25 per gallon for propane. The cost of fuel varies with fuel type and with time. Fossil fuels typically range in cost from less than \$1 per gallon for fuel oils to greater than \$1 per gallon for propane and gasoline. The most expensive source of energy for heating is electricity.

The results shown in Table 4 depend on the values assumed in all the previous calculations and on weather conditions in future years. However, if the higher initial cost of a frame building can be afforded, the savings in energy consumption can result in significant savings over the lifetime of a structure housing a closed recycling aquaculture system.

Table 4. Annual Energy Costs

Building Type	Annual Cost for Heating for 75°F Inside Temperature	Annual Cost for Heating for 80°F Inside Temperature
Greenhouse Covered with One Layer of Plastic Film	\$8,100	\$11,700
Greenhouse Covered with Two Inflated Layers of Plastic Film	\$5,200	\$7,900
Insulated Frame Building	\$540	\$900

# Rafmagn

Verðskrá gildir frá 01.11.2010

## Heimili

Með tilkomu raforkulaga þann 1. janúar 2005 var orkufyrirtækjum gert skylt að skilja að dreifingu og orkusölu. Orkureikningar eru því sundurliðaðir í flutning, dreifingu og sölu. Dreifing og flutningur er háð einkaleyfi en sala á raforku er frjáls.

### Sala (án dreifingar og flutnings)

Taxti	Almenn notkun	Sala	Orku	skattur	Samtals	Samtals m. 25,5%	vsk	Grunnur
A1	Orkuverð	4,61	0,12	4,73	5,94			kr/kWh

### Dreifing og flutningur (án sölu)

Taxti	Almenn notkun	Dreifing	Flutningur	Samtals	Samtals m. 25,5%	vsk	Grunnur
A1	Fast gjald	27,41		27,41	34,40		kr/dag
	Orkuverð	3,53	1,27	4,80	6,02		kr/kWh

### Sala (án dreifingar og flutnings)

Taxti	Blönduð notkun	Sala	Orku	skattur	Samtals	Samtals m. 7%	vsk	Grunnur
A4	Orkuverð	4,61	0,12	4,73	5,06			kr/kWh

### Dreifing og flutningur (án sölu)

Taxti	Blönduð notkun	Dreifing	Flutningur	Samtals	Samtals m. 7%	vsk	Grunnur
A4	Orkuverð	3,53	1,27	4,80	5,14		kr/kWh

### Samtals

Taxti	Almenn notkun	Dreifing	Flutningur	Sala	Orku	skattur	Samtals	Samtals m. 25,5%	Grunnur
A1	Fast gjald	27,41			27,41	34,40			kr/dag
	Orkuverð	3,53	1,27	4,61	0,12	9,53	11,96		kr/kWh
Taxti	Blönduð notkun	Dreifing	Flutningur	Sala	Orku	skattur	Samtals	Samtals m. 25,5% vsk	Grunnur
A4	Fast gjald	27,41			27,41	34,40			kr/dag
	Orkuverð	3,53	1,27	4,61	0,12	9,53		10,20	kr/kWh

**Skýringar:**

Fast verð er fyrir föstum kostnaði, óháðum orkunotkun.

Orkuverð er fyrir hverja notaða kWh.

Verðið miðast við orkuverð OR og dreifingarverð af veitusvæði OR.

Taxti A.1 gildir fyrir alla almenna raforkunotkun.

Taxti A.4 gildir fyrir sumarhús og hesthús sem hituð eru upp með rafmagni.

Sjá nánari skilgreiningu í [sölkilmálum](#).

Greiða skal í ríkissjóð sérstakan skatt af seldri raforku.

Fjárhæð orkuskatts af raforku skal vera 0,12 kr. á hverja kílowattstund af seldri orku.

Heimilt er að miða innheimtu skatts af raforku við áetlaða sölu.

# Product data sheet

## Characteristics

# BMXCPS2000

## power supply module M340 - 100..240 V AC - 20 W



### Main

Range of product	Modicon M340 automation platform
Product or component type	Power supply module
Primary voltage	100...240 V
Supply circuit type	AC
Total useful secondary power	<= 20 W
Secondary power	8.3 W 3.3 V DC I/O module logic power supply 10.8 W 24 V DC sensor power supply 16.8 W 24 V DC I/O module power supply and processor

### Complementary

Primary voltage limit	85...264 V
Network frequency	50/60 Hz
Network frequency limits	47...63 Hz
Apparent power	0.07 kVA
Power supply input current	0.61 A 115 V 0.31 A 240 V
Inrush current	<= 60 A 240 V <= 30 A 120 V
I <sup>2</sup> t on activation	2...3 A <sup>2</sup> s 240 V
It on activation	<= 0.06 A s 240 V <= 0.03 A s 120 V
Protection type	Overvoltage protection secondary circuit Short-circuit protection secondary circuit Internal fuse not accessible primary circuit Overload protection secondary circuit
Current at secondary voltage	2.5 A 3.3 V DC I/O module logic power supply 0.7 A 24 V DC I/O module power supply and processor 0.45 A 24 V DC sensor power supply
Power dissipation in W	<= 8.5 W
Status LED	1 LED green rack voltage OK 1 LED green sensor voltage
Control type	RESET pushbutton cold restart
Electrical connection	1 connector 5 pin(s)line supply, protective earth, 24 V DC input sensor 1 connector 2 pin(s)alarm relay
Insulation resistance	>= 100 MOhm primary/ground >= 100 MOhm primary/secondary
Product weight	0.3 kg

### Environment

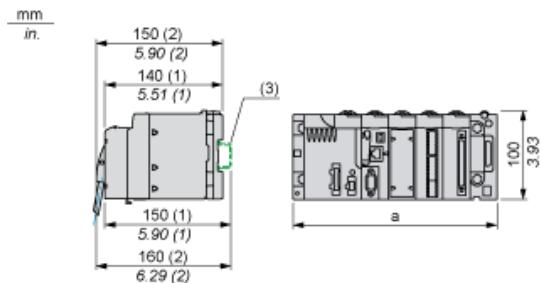
Immunity to microbreaks	<= 1 ms
Dielectric strength	1500 V primary/secondary I/O module power supply and processor 500 V 24 V sensor output/ground 1500 V primary/ground 2300 V primary/secondary sensor power supply 1500 V primary/secondary I/O module logic power supply
IP degree of protection	IP20
Standards	EN 61131-2 IEC 61131-2
Ambient air temperature for storage	-40...85 °C

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric Industries SAS nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein.

Ambient air temperature for operation	0...60 °C
Relative humidity	10...95 % without condensation
Protective treatment	TC

## Modules Mounted on Racks

### Dimensions



- (1) With removable terminal block (cage, screw or spring).
- (2) With FCN connector.
- (3) On AM1 ED rail: 35 mm wide, 15 mm deep. Only possible with BMXXBP0400/0400H/0600/0600H/0800/0800H rack.

	a in mm	a in in.
BMXXBP0400 and BMXXBP0400H	242.4	9.54
BMXXBP0600 and BMXXBP0600H	307.6	12.11
BMXXBP0800 and BMXXBP0800H	372.8	14.68
BMXXBP1200	503.2	19.81

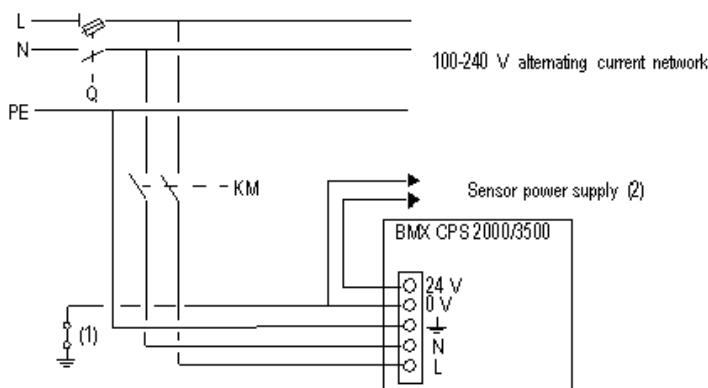
## installing power supplies Connection of Alternating Current Power Supply Modules

### Introduction

This section presents the connection of BMXCP2000/3500 alternating current power supply modules.

### Connection of a PLC Station Constituted of a Single Rack

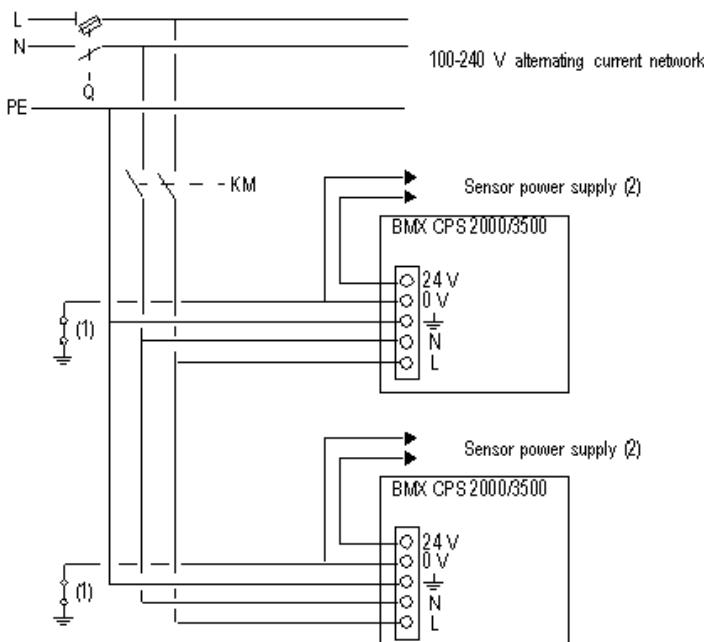
The following diagram shows the connection of a BMXCP2000/3500 module to an alternating current network:



BMXCP2000/3500 alternating current power supply modules are already equipped with a protective fuse. This fuse, connected at the input phase of the alternating current network, is inside the module and is not accessible.

### Connection of a PLC Station Constituted of Several Racks

The following diagram shows the connection of several BMXCP2000/3500 modules to an alternating current network:



Where there are several PLC stations supplied by the same network, the connection principle is the same.

# Product data sheet

## Characteristics

# BMXDDM3202K

discrete I/O module M340 - 16 inputs - 24 V DC  
- 16 outputs - solid state



### Main

Range of product	Modicon M340 automation platform
Product or component type	Discrete I/O module
Electrical connection	20-way connector
Discrete input number	16
Input type	Current sink (logic positive)
Discrete input voltage	24 V DC positive
Discrete input current	2.5 mA
Input compatibility	With 2-wire/3-wire proximity sensors conforming to IEC 60947-5-2
Discrete output number	16
Discrete output type	Solid state
Discrete output voltage	24 V 19...30 V DC
Discrete output current	0.1 A

### Complementary

Sensor power supply	19...30 V
Voltage state 1 guaranteed	$\geq 11$ V
Current state 1 guaranteed	$\geq 2$ mA
Voltage state 0 guaranteed	$\leq 5$ V
Current state 0 guaranteed	$\leq 1.5$ mA
Current per channel	$\leq 0.125$ A
Current per module	$\leq 3.2$ A
Leakage current	$\leq 0.1$ mA at state 0
[Ures] residual voltage	$\leq 1.5$ V at state 1
Input impedance	9600 Ohm
Insulation resistance	> 10 MOhm 500 V DC
Power dissipation in W	$\leq 4$ W
DC typical filtering time	4 ms
DC maximum filtering time	7 ms
Response time on output	1.2 ms
Paralleling of outputs	Yes : 3 maximum
Typical current consumption	125 mA 3.3 V DC 69 mA 24 V DC
Current consumption	$\leq 104$ mA 24 V DC $\leq 166$ mA 3.3 V DC
MTBF reliability	432904 h
Protection type	Overvoltage protection on output 1 external fuse per group of input channel 0.5 A fast blow Reverse polarity protection on input Reverse polarity protection on output
Output overload protection	With electronic circuit breaker $0.125 \text{ A} < Id < 0.185 \text{ A}$ With current limiter
Output overvoltage protection	With transil diode
Output short-circuit protection	With 2 A external fuse
Reverse polarity protection	Reverse mounted diode
Voltage detection threshold	< 14 V DC preactuator fault > 18 V DC preactuator OK < 14 V DC sensor fault > 18 V DC sensor OK

Tungsten load	<= 1.2 W
Switching frequency	0.5/LI <sup>2</sup> Hz
Overload time	<= 15 ms
Load impedance ohmic	<= 220 Ohm
Status LED	1 LED per channel green channel diagnostic 1 LED green module operating (RUN) 1 LED red module I/O 1 LED red module error (ERR)
Product weight	0.11 kg

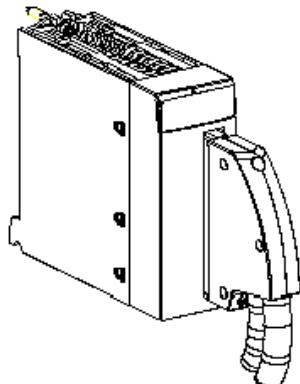
## Environment

IP degree of protection	IP20
Standards	IEC 664 IEC 1131-2 NF C 63-850 UL 508 CSA 22-2 No 142 UL 746C
Dielectric strength	1500 V AC at 50/60 Hz 1 minute, output/internal logic 1500 V AC at 50/60 Hz 1 minute, primary/secondary 1500 V AC at 50/60 Hz 1 minute, output/ground 500 V DC 1 minute, between group of inputs and outputs
Ambient air temperature for operation	0...60 °C
Relative humidity	10...95 % without condensation
Protective treatment	TC

## Connecting the Module

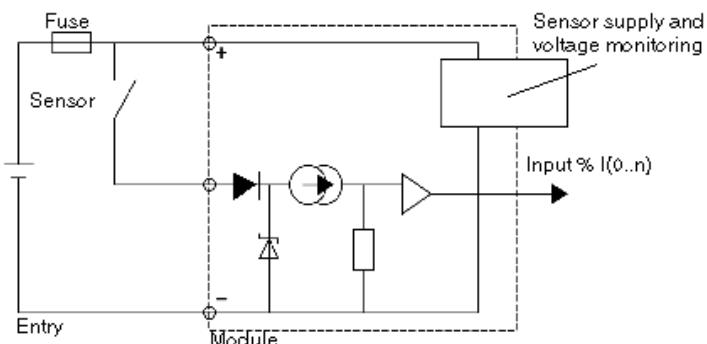
### At a Glance

The module is fitted with a 40-pin connector for the connection of sixteen input channels and sixteen output channels.



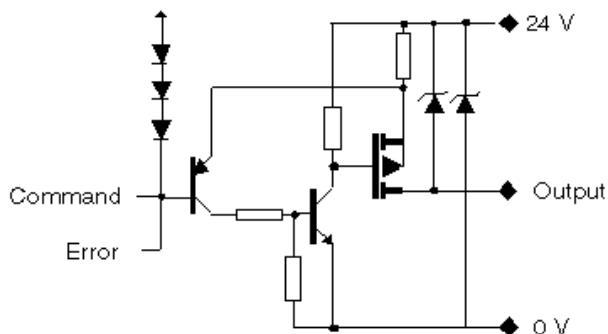
### Input Circuit Diagram

The following diagram shows the circuit of a direct current input (positive logic).



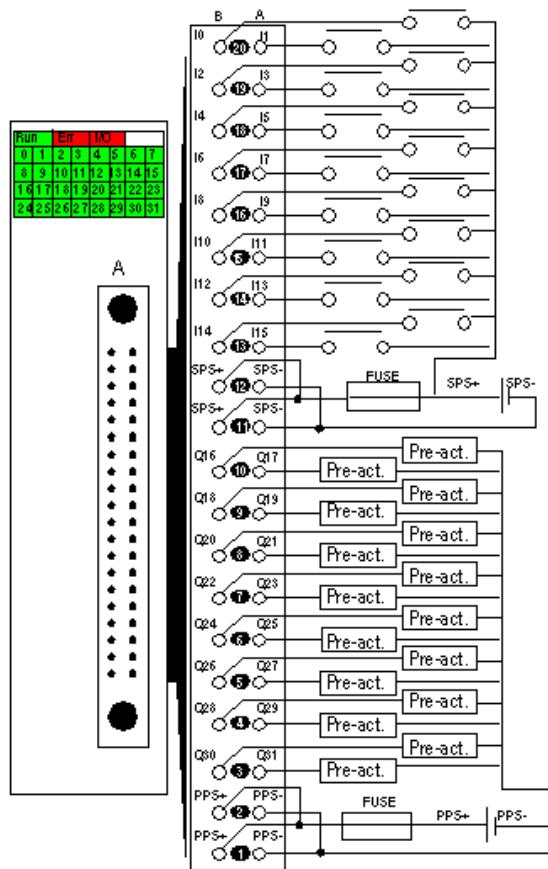
### Output Circuit Diagram

The following diagram shows the circuit of a direct current output (positive logic).



## Module Connection

The following diagram shows the connection of the module to the sensors and pre-actuators.



power 24 VDC

supply:

input fast blow fuse of 0.5 A

fuse:

output fast blow fuse of 2 A

fuse:

pre- pre-actuator

act:

SPS: sensor power supply

PPS: pre-actuator power supply

# Product data sheet

## Characteristics

# BMXART0414

## analog input module M340 - 4 inputs - temperature



### Main

Range of product	Modicon M340 automation platform
Product or component type	Analog input module
Electrical connection	1 connector 40 ways
Input output isolation	Isolated
Input level	Low level
Analogue input number	4
Analogue input type	Voltage +/- 320 mV Voltage +/- 80 mV Resistor 4000 Ohm 2 wires Temperature probe -60...+180 °C Ni 100 Thermocouple -270...+1370 °C thermocouple K Thermocouple -50...+1769 °C thermocouple R Voltage +/- 160 mV Temperature probe -100...+450 °C Pt 100 UL/JIS Thermocouple -200...+600 °C thermocouple U Thermocouple -200...+900 °C thermocouple L Resistor 400 Ohm 3 wires Resistor 4000 Ohm 4 wires Temperature probe -60...+180 °C Ni 1000 Thermocouple +130...+1820 °C thermocouple B Thermocouple +270...+1300 °C thermocouple N Voltage +/- 1.28 V Thermocouple -50...+1769 °C thermocouple S Voltage +/- 640 mV Temperature probe -100...+450 °C Pt 1000 UL/JIS Thermocouple -200...+760 °C thermocouple J Thermocouple -270...+1000 °C thermocouple E Thermocouple -270...+400 °C thermocouple T Voltage +/- 40 mV Resistor 400 Ohm 2 wires Temperature probe -100...+260 °C Cu 10 Resistor 400 Ohm 4 wires Resistor 4000 Ohm 3 wires Temperature probe -200...+850 °C Pt 100 IEC Temperature probe -200...+850 °C Pt 1000 IEC

### Complementary

Analog/Digital conversion	Sigma delta 16 bits
Analogue input resolution	15 bits + sign
Input impedance	10 MOhm
Permitted overload on inputs	+/- 7.5 V +/- 1.28 V +/- 7.5 V +/- 40 mV +/- 7.5 V +/- 80 mV +/- 7.5 V +/- 160 mV +/- 7.5 V +/- 320 mV +/- 7.5 V +/- 640 mV
Common mode rejection	120 dB 50/60 Hz
Differential mode rejection	60 dB 50/60 Hz
Cold junction compensation	External by Pt100 probe
Type of filter	First order digital filtering
Nominal read cycle time	200 ms with thermocouple 400 ms with temperature probe

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric Industries SAS nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein.

Measurement error	+/- 4.5 °C thermocouple J 0...60 °C +/- 4.5 °C thermocouple U 0...60 °C <= 0.15 % of full scale +/- 80 mV 0...60 °C +/- 2.1 °C Pt 100 25 °C +/- 4.5 °C thermocouple R 0...60 °C +/- 5 °C thermocouple B 0...60 °C <= 0.15 % of full scale +/- 40 mV 0...60 °C +/- 4 °C Cu 10 25 °C <= 0.15 % of full scale +/- 320 mV 0...60 °C 0.05 % of full scale +/- 320 mV 25 °C +/- 1.3 °C Ni 1000 0...60 °C +/- 3.7 °C thermocouple N 25 °C +/- 4 °C Cu 10 0...60 °C +/- 5 °C thermocoupleE 0...60 °C +/- 0.7 °C Ni 1000 25 °C +/- 5 °C thermocouple N 0...60 °C +/- 2.8 °C thermocouple J 25 °C +/- 3.7 °C thermocouple T 25 °C <= 0.15 % of full scale +/- 160 mV 0...60 °C +/- 2.1 °C Ni 100 25 °C +/- 2 °C Pt 100 0...60 °C +/- 3.2 °C thermocouple R 25 °C +/- 3.7 °C thermocouple K 25 °C <= 0.15 % of full scale +/- 640 mV 0...60 °C 0.05 % of full scale +/- 1.28 V 25 °C +/- 3.2 °C thermocouple S 25 °C <= 0.2 % of full scale 4000 Ohm 0...60 °C 0.05 % of full scale +/- 640 mV 25 °C 0.12 % of full scale 400 Ohm 25 °C 0.12 % of full scale 4000 Ohm 25 °C +/- 2 °C Pt 1000 0...60 °C +/- 2.1 °C Pt 1000 25 °C +/- 4.5 °C thermocouple S 0...60 °C +/- 5 °C thermocouple K 0...60 °C 0.05 % of full scale +/- 40 mV 25 °C <= 0.2 % of full scale 400 Ohm 0...60 °C 0.05 % of full scale +/- 160 mV 25 °C 0.05 % of full scale +/- 80 mV 25 °C +/- 3 °C Ni 100 0...60 °C +/- 4.5 °C thermocouple L 0...60 °C +/- 2.7 °C thermocouple U 25 °C +/- 3.5 °C thermocouple B 25 °C <= 0.15 % of full scale +/- 1.28 V 0...60 °C +/- 3 °C thermocouple L 25 °C +/- 3.7 °C thermocoupleE 25 °C +/- 5 °C thermocouple T 0...60 °C
Temperature drift	30 ppm/°C +/- 40 mV 30 ppm/°C +/- 640 mV 25 ppm/°C thermocouple J 25 ppm/°C thermocouple R 30 ppm/°C +/- 1.28 V 30 ppm/°C +/- 80 mV 25 ppm/°C Ni 1000 25 ppm/°C thermocouple B 25 ppm/°C thermocouple T 25 ppm/°C thermocouple U 30 ppm/°C Cu 10 25 ppm/°C thermocouple K 25 ppm/°C thermocouple L 30 ppm/°C Pt 100 30 ppm/°C +/- 160 mV 25 ppm/°C thermocouple N 25 ppm/°C thermocouple S 30 ppm/°C Pt 1000 25 ppm/°C 400 Ohm 25 ppm/°C 4000 Ohm 30 ppm/°C +/- 320 mV 30 ppm/°C Ni 100 25 ppm/°C thermocoupleE
Recalibration	Internal
Isolation between channels	750 V DC
Isolation between channels and ground	750 V DC
Isolation between channels and bus	1400 V DC

Detection type	Open circuit Cu 10 Open circuit Ni 1000 Open circuit thermocouple T Open circuit Pt 1000 Open circuit thermocouple U Open circuit thermocouple S Open circuit thermocouple J Open circuit thermocouple K Open circuit thermocouple E Open circuit Ni 100 Open circuit Pt 100 Open circuit thermocouple L Open circuit thermocouple R Open circuit thermocouple N Open circuit thermocouple B
Maximum wiring resistance	20 Ohm 3 wires Ni 100 20 Ohm 3 wires Pt 100 200 Ohm 3 wires Pt 1000 20 Ohm 2 wires Pt 100 50 Ohm 4 wires Cu 10 50 Ohm 4 wires Pt 100 200 Ohm 2 wires Ni 1000 20 Ohm 2 wires Cu 10 20 Ohm 2 wires Ni 100 500 Ohm 4 wires Ni 1000 20 Ohm 3 wires Cu 10 200 Ohm 2 wires Pt 1000 500 Ohm 4 wires Pt 1000 200 Ohm 3 wires Ni 1000 50 Ohm 4 wires Ni 100
Measurement resolution	320/2exp14 mV +/- 320 mV 0.1 °C Ni 1000 160/2exp14 mV +/- 160 mV 0.1 °C thermocouple R 0.1 °C thermocouple T 0.1 °C Pt 100 0.1 °C Ni 100 0.1 °C thermocouple S 40/2exp14 mV +/- 40 mV 40/2exp14 mV 400 Ohm 0.1 °C thermocouple N 0.1 °C thermocouple U 0.1 °C thermocouple L 640/2exp14 mV +/- 640 mV 0.1 °C thermocouple B 1280/2exp14 mV +/- 1.28 V 80/2exp14 mV +/- 80 mV 0.1 °C Cu 10 0.1 °C Pt 1000 0.1 °C thermocouple J 0.1 °C thermocouple E 0.1 °C thermocouple K 4000/2exp14 mV 4000 Ohm
Maximum conversion value	+/- 100 % 400 Ohm +/- 102.5 % +/- 640 mV +/- 102.5 % +/- 320 mV +/- 102.5 % +/- 40 mV +/- 102.5 % +/- 160 mV +/- 100 % 4000 Ohm +/- 102.5 % +/- 1.28 V +/- 102.5 % +/- 80 mV
Status LED	1 LED green RUN 1 LED red I/O 1 LED per channel green channel diagnostic 1 LED red ERR
Product weight	0.135 kg

## Environment

Ambient air temperature for operation	0...60 °C
Relative humidity	10...95 % without condensation
IP degree of protection	IP20
Protective treatment	TC

## Wiring Diagram

### Introduction

The BMXART0414/BMXART0414H input module consists of a 40-pin FCN connector.

The BMXART0814/BMXART0814H input module consists of two 40-pin FCN connectors.

### WARNING

#### UNEXPECTED EQUIPMENT OPERATION

Take every precaution at the installation to prevent any subsequent mistake in the connectors. Plugging the wrong connector would cause an unexpected behavior of the application.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

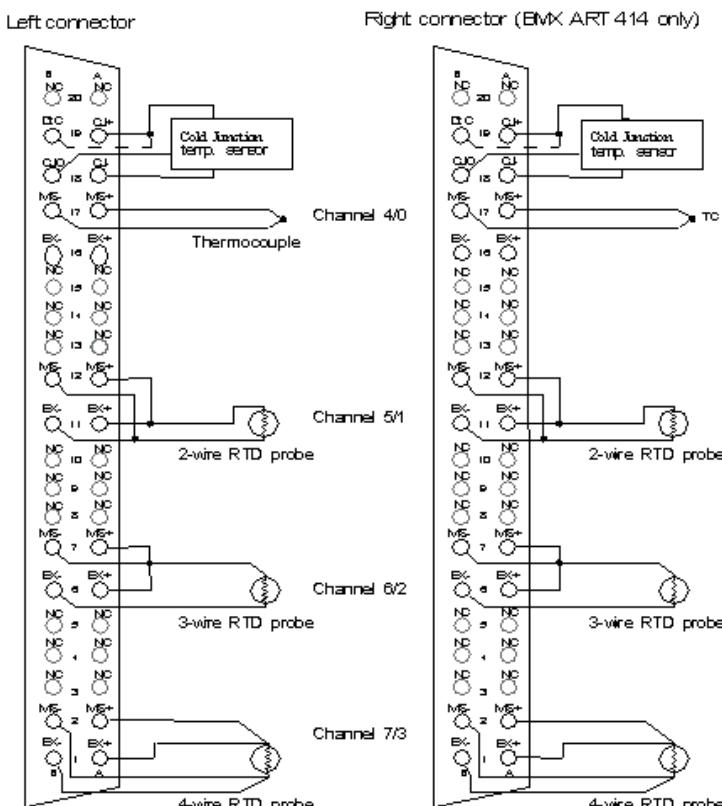
### Connector Pin Assignment and Sensors Wiring

This example uses a probe configuration with:

- Channel 0/4: Thermocouple
- Channel 1/5: 2-wires RTD
- Channel 2/6: 3-wires RTD
- Channel 3/7: 4-wires RTD

The pin assignment for the 40-pin FCN connector and the sensors wiring is shown below:

Module Front view - cabling view



MS+: Thermocouple + input

MS-: Thermocouple - input

EX+: RTD probe current generator + output

EX-: RTD probe current generator - output

NC: Not connected

DtC: The CJC sensor detection input is connected to CJ+ if the sensor type is DS600. It is not connected (NC) if the sensor type is LM31.

The CJC sensor is needed for TC only.

## cold junction compensation BMXART0814 Cold Junction Compensation

For each block of 4 channels (channels 0 to 3 and channels 4 to 7), the external compensation of the module is performed in the TELEFAST ABE7CPA412 accessory. This device provides a voltage in mV corresponding to:

$$\text{Voltage} = (6.45 \text{ mV} * T) + 509 \text{ mV} \text{ (where } T = \text{temperature in } ^\circ\text{C).}$$

The overall margin of error when using this device is reduced to 1.2°C in the -5°C to +60°C temperature range.

It is possible to increase the precision of the compensation by using a 2/3-wires Pt100 probe directly connected to channels 0 and 4 (only for the BMXART0814 and the BMXART0814H) on the module or connected to the TELEFAST terminal blocks. Channel 0 is thus dedicated to the cold junction compensation of channels 1, 2 and 3. channel 4 is thus dedicated to channels 4 to 7.

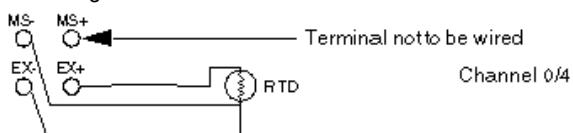
It is also possible, by using a 2-wire Pt100 probe, provided the initial length of the probe is limited, to maintain channel 0 as a thermocouple input.

The wiring would then look like this:



The wiring is only valid if the channel 0 is used. If the channel 0 is not used, select a cold junction with external Pt100. The range of the channel 0 is changed to a 3-wires Pt100 probe.

The wiring would then look like this:



For BMXART0814 and BMXART0814H modules, the CJC values of channels 4 to 7 can also be used for channels 0 to 3. Therefore, only one external CJC sensor is wired on channel 4.

# Product data sheet

## Characteristics

# BMXAMM0600

analog I/O module M340 - 4 inputs - 2 outputs - high level



### Main

Range of product	Modicon M340 automation platform
Product or component type	Mixed analog I/O module
Electrical connection	1 connector 20 ways
Input output isolation	Non isolated
Input level	High level
Analogue input number	4
Analogue input type	Voltage +/- 10 V Voltage 0...10 V Voltage 1...5 V Current 0...20 mA Voltage 0...5 V Current 4...20 mA

### Complementary

Analogue input resolution	12 bits 4...20 mA 12 bits 0...5 V 13 bits 0...10 V 12 bits 0...20 mA 14 bits +/- 10 V 12 bits 1...5 V
Permitted overload on inputs	+/- 30 V 0...5 V +/- 30 mA 0...20 mA +/- 30 mA 4...20 mA +/- 30 V 0...10 V +/- 30 V +/- 10 V +/- 30 V 1...5 V
Internal conversion resistor	250 Ohm
Precision of internal conversion resistor	0.1 % - 15 ppm/°C
Type of filter	First order digital filtering by firmware
Fast read cycle time	1 ms + 1 ms x number of channels used
Nominal read cycle time	5 ms for 4 channels
Measurement error	<= 0.5 % of full scale 0...20 mA 0...60 °C <= 0.6 % of full scale 0...20 mA 0...60 °C 0.25 % of full scale 4...20 mA 25 °C <= 0.35 % of full scale +/- 10 V 0...60 °C 0.25 % of full scale +/- 10 V +/- 10 V 25 °C 0.25 % of full scale 0...5 V 25 °C 0.25 % of full scale 1...5 V 25 °C 0.25 % of full scale 0...20 mA 25 °C <= 0.35 % of full scale 0...5 V 0...60 °C <= 0.35 % of full scale 1...5 V 0...60 °C <= 0.5 % of full scale 4...20 mA 0...60 °C <= 0.6 % of full scale 4...20 mA 0...60 °C 0.25 % of full scale 0...10 V 25 °C 0.35 % of full scale 4...20 mA 25 °C <= 0.6 % of full scale +/- 10 V 0...60 °C 0.35 % of full scale 0...20 mA 25 °C <= 0.35 % of full scale 0...10 V 0...60 °C
Temperature drift	100 ppm/°C +/- 10 V 100 ppm/°C 0...20 mA 30 ppm/°C 0...10 V 30 ppm/°C +/- 10 V 100 ppm/°C 4...20 mA 50 ppm/°C 4...20 mA 30 ppm/°C 0...5 V 50 ppm/°C 0...20 mA 30 ppm/°C 1...5 V
Recalibration	Factory calibrated on outputs Internal on inputs

Isolation between channels and ground	1400 V DC
Isolation between channels and bus	1400 V DC
Isolation between group of I/O channels	750 V DC
Output level	High level
Analogue output number	2
Analogue output type	Current 4...20 mA Voltage +/- 10 V Current 0...20 mA
Analogue output resolution	11 bits 0...20 mA 11 bits 4...20 mA 12 bits +/- 10 V
Conversion time	<= 2 ms
Maximum conversion value	+/- 11.25 V 0...10 V 0...24 mA 0...20 mA +/- 11.25 V 0...5 V 0...30 mA 4...20 mA +/- 11.25 V 1...5 V 0...24 mA 4...20 mA +/- 11.25 V +/- 10 V +/- 10 V 0...30 mA 0...20 mA
Fallback mode	Predefined Configurable
Status LED	1 LED per channel green channel diagnostic 1 LED red ERR 1 LED red I/O 1 LED green RUN
Product weight	0.155 kg

## Environment

Ambient air temperature for operation	0...60 °C
Relative humidity	10...95 % without condensation
IP degree of protection	IP20
Protective treatment	TC

## Wiring Diagram

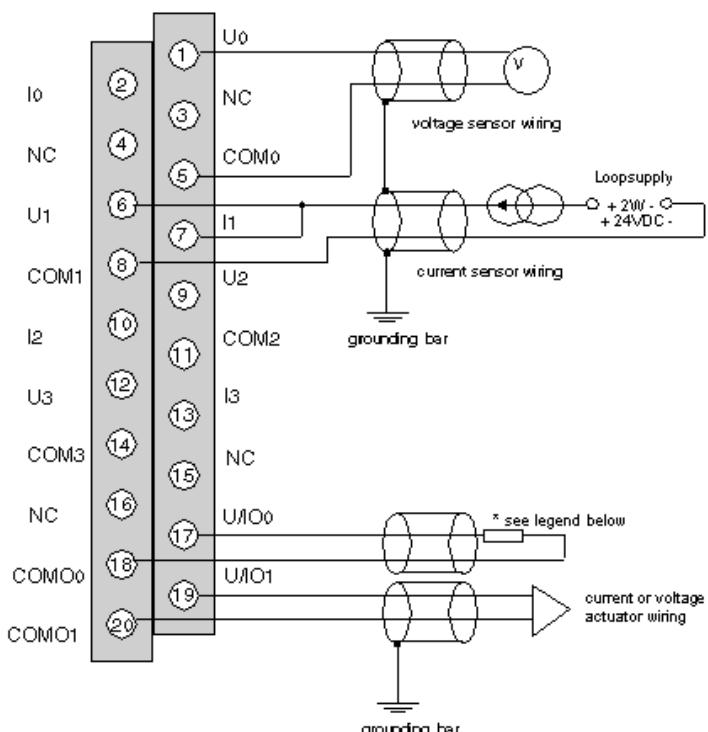
### Introduction

The actuators are connected using the 20-point terminal block.

### Illustration

The terminal block connection, the sensors, and the actuators wiring are as follows.

Cabling view



U<sub>x</sub> + pole input for channel x

COM<sub>x</sub> pole input for channel x

U/ - pole output for channel x

I<sub>Ox</sub>:

COM<sub>Ox</sub> pole output for channel x

\* The current loop is self-powered by the output and does not request any external supply.

# EE82 Series

## CO<sub>2</sub> Transmitters and Switches for Agriculture Applications

Measuring instruments in green houses or life stock barns are exposed to a very demanding environment: high humidity levels, pollutants like fertilizers, herbicides and high ammonia concentrations are just a few of the many hazards.

The robust, functional housing of the EE82 with integrated special filter has been designed for such applications.

The air diffuses through the filter into the instrument enclosure. Then the air diffuses further through a second membrane filter integrated in the CO<sub>2</sub> measuring cell.

The CO<sub>2</sub> measurement is based on the non-dispersive infrared (NDIR) technology. The patented auto-calibration procedure compensates for aging of the infrared source and guarantees high reliability, long term stability and eliminates the need of periodical recalibration in the field.

Measuring ranges of 0...2000/5000/10000ppm correspond to an analogue interface of 0 - 5/10V or 4 - 20mA. Selectively a switching output with adjustable switching point and hysteresis is available.

The very practical snap-in mounting flange and connector for the supply voltage and outputs allow quick and easy installation of the EE82 without ever opening the housing.



### Typical Applications

green houses  
fruit and vegetable storage  
life stock barns

**Features**  
easy installation  
compact housing  
auto-calibration  
measuring range 0...10000ppm  
analogue or switching output

### Technical Data

#### Measuring Values

Measuring principle	Non-Dispersive Infrared Technology (NDIR)	
Sensing element	E+E Dual Source Infrared System	
Measuring range	0...2000 / 5000 / 10000ppm	
Accuracy at 25°C (77°F) and 1013mbar	0...2000ppm:	< ± (50ppm +2% of measuring value)
	0...5000ppm:	< ± (50ppm +3% of measuring value)
	0...10000ppm:	< ± (100ppm +5% of measuring value)
Response time $T_{63}$	< 195s	
Temperature dependence	typ. 2ppm CO <sub>2</sub> /°C	
Long term stability	typ. 20ppm / year	
Sample rate	approx. 15s	

#### Output

<b>Analogue Output</b>		
0...2000 / 5000 / 10000ppm	0 - 5 / 0 - 10V 4 - 20mA	-1mA < I <sub>L</sub> < 1mA R <sub>L</sub> < 500 Ohm

<b>Switching Output</b>		
Max. switching voltage	50V AC / 60V DC	
Max. switching load	1A at 50V AC	1A at 30V DC
Min. switching load	1mA at 5V DC	
Contact material	Ag+Au clad	

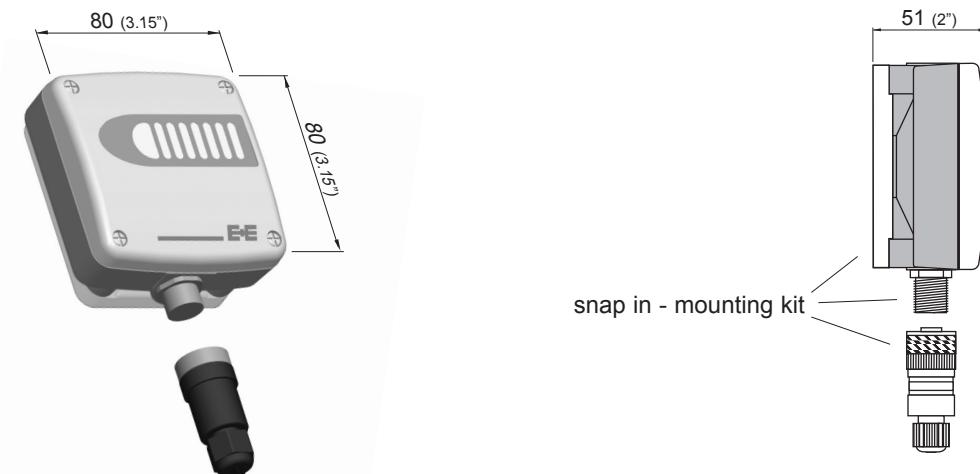
#### General

Supply voltage	24V AC ±20%	15 - 35V DC
Current consumption	typ. 10mA + output current	
	max. 0.5A for 0.3s	
Warm up time <sup>1)</sup>	< 5 min	
Housing / protection class	PC / IP54	
Electrical connection	M12 plug	
Electromagnetic compatibility	EN61326-1 EN61326-2-3	FCC Part 15 ICES-003 ClassB
Working temperature and conditions	-20...60°C (-4...140°F)	0...100% RH
Storage temperature and conditions	-20...60°C (-4...140°F)	0...95% RH (not condensating)



1) warm up time for performance according specification

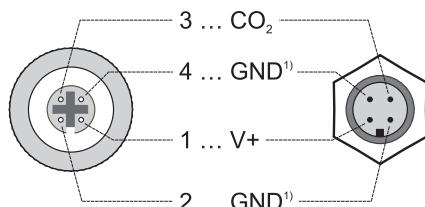
## Dimensions (mm)



## Connection Diagram

### Analogue Output

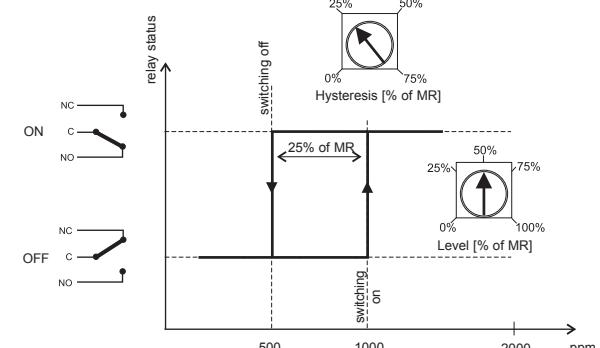
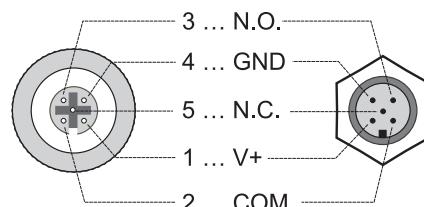
EE82-xC2/3/6



1) GND internally connected

### Switching Output

EE82-xCS



## Ordering Guide

MEASURING RANGE	MODEL	OUTPUT
0...2000ppm (2)	CO <sub>2</sub>	0 - 5V (2)
0...5000ppm (5)		0 - 10V (3)
0...10000ppm (10)		4 - 20mA (6) switching output (S)
<b>EE82-</b>		

## Order Example

**EE82-5C3**

Measuring range: 0...5000ppm  
Model: CO<sub>2</sub>  
Output: 0 - 10V

## SPECIFICATIONS

**Length:**

10 cm

**Measurement:**

Volumetric Water Content

**Range:**

0-40% VWC

**Power:**

line powered 7-32 V; DC

**Output:**

Current, correlated linearly with VDC

**Resolution:**

0.1% VWC

**Measurement Time:**

10 ms

**Cable Length:**

5 m

**Temperature:**

-40°C to +50°C

**Electrical Interface:**

2-wire analog, 4-20mA)

**Accuracy:**

±4 % VWC, medium textured mineral soils up to 1 ds/m

# Echo EA-10 Sensor

The EA-10 is a standard ECH2O sensor similar in size and specification to the EC-10. The EA-10 is designed for use with industrial data acquisition and control systems. It has a standard 2-wire, 4-20 mA analog interface.

Like the classic EC-10 and EC-20 sensors, the EA-10 sensors are only for use in medium-textured soil types with low EC conditions. Their typical accuracy in these soil types is ±4% without calibration and 1-2% with soil-specific calibration.

### Applications:

- Irrigation control of turf and home landscapes
- 2-wire moisture monitoring

### Benefits:

- Very low power requirement
- High resolution
- Many measurements over a long period, with minimal battery usage

### How It Works:

In essence, the EA-10 monitors the water budget of the soil in which it is placed. It senses water addition and water loss. If the soil is too wet, irrigation can be stopped. If the soil becomes too dry, additional irrigation time can be programmed



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# EE16 Series

## Humidity / Temperature Transmitter for HVAC Applications

EE16 transmitters are the ideal solution for accurate measurement of relative humidity and temperature at a reasonable price in HVAC applications. The appropriate filter cap enables employment in heavily polluted environment.

The new developed E+E humidity sensors HC101 guarantee excellent long term stability and resistance against chemical pollutants. Their excellent reproducibility allows a simple low-cost-one-point calibration for very good accuracy over the entire working range.

EE16 transmitters are available as wall or duct mounted, with current or voltage output signals.



### Typical Applications

**building-automation**  
**storage rooms**  
**climate and ventilation control**

### Features

**excellent price/performance ratio**  
**wettable**  
**long term stable**  
**traceable calibration**

### Technical Data

#### Measuring values

##### Relative Humidity

Sensor	HC101	
Output appropriate 0...100% RH	0-10 V 4-20 mA (two wire)	-1 mA < I <sub>L</sub> < 1 mA R <sub>L</sub> < 500 Ohm
Working range <sup>1)</sup>	10...95% RH	
Accuracy at 20°C (68°F)	±3% RH	Traceable to intern. standards, administrated by NIST, PTB, BEV...
Temperature dependence at 45% RH	typ. -0.05% RH / °C (-0.03% RH / °F)	

##### Temperature

Sensor	Pt1000 (class A, DIN EN 60751)	
Output appropriate 0...50°C (32...122°F)	0-10 V 4-20 mA (two wire)	-1 mA < I <sub>L</sub> < 1 mA R <sub>L</sub> < 500 Ohm
Accuracy at 20°C (68°F) <sup>2)</sup>	±0.3°C (±0.5°F)	

#### General

Supply voltage		
for 0 - 10 V	15 - 35V DC or 24V AC ±20%	
for 4 - 20 mA	10V + R <sub>L</sub> × 20 mA < U <sub>V</sub> < 35V DC	
Current consumption	for DC supply for AC supply	typ. 8 mA typ. 20 mA <sub>eff</sub>
Electrical connection		screw terminals max. 1.5 mm <sup>2</sup> (AWG 16)
Housing / protection class		Polycarbonat / IP65; Nema 4
Cable gland	M16 x 1.5	cable Ø 4.5 - 10 mm (0.18 - 0.39")
Sensor protection		membrane filter, metal grid filter, stainless steel sintered filter
Electromagnetic compatibility	EN 61000-6-1 EN 61000-6-3	EN 61326-1+A1+A2
Temperature range	working temperature: storage temperature:	-5...50°C (23...122°F) -25...60°C (-13...140°F)

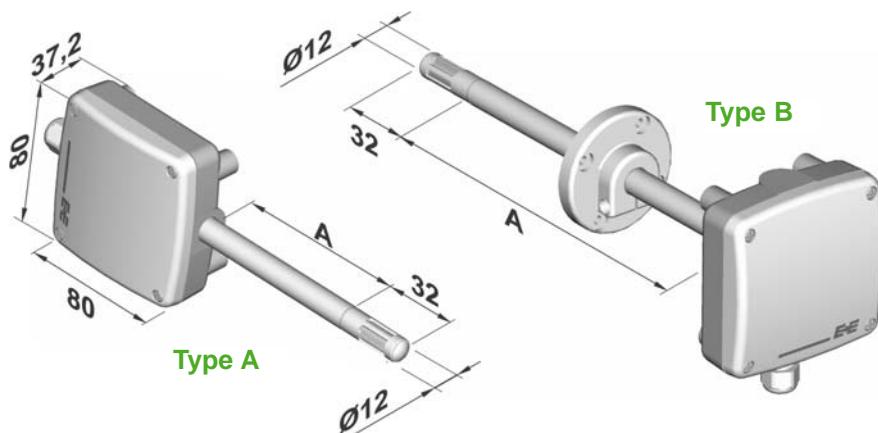


1) Please refer to working range of HC101

2) Please note: temperature accuracy EE16-x6xx2x: ±0.5°C (±0.9°F)

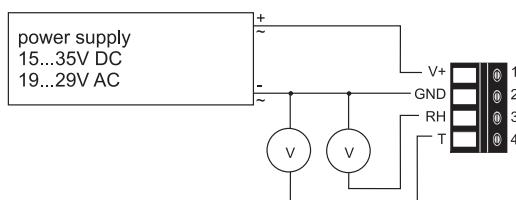
## Housing Dimensions (mm)

1 mm = 0.03937" / 1" = 25.4 mm

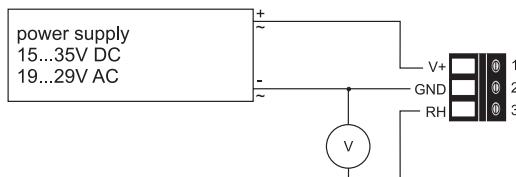


## Connection Diagram

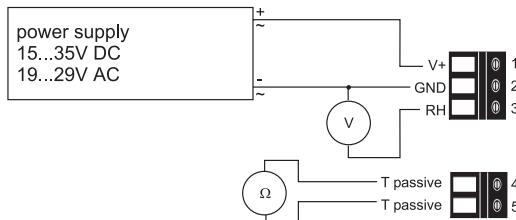
**EE16-FT3xxx**



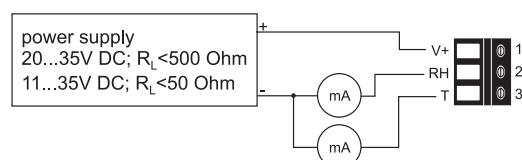
**EE16-F3xxx**



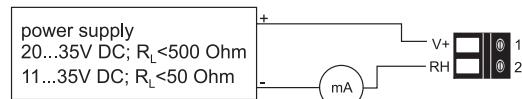
**EE16-FP3xxx**



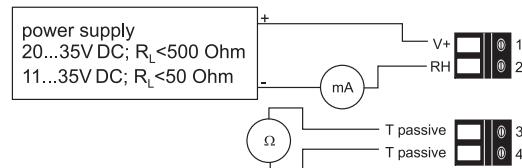
**EE16-FT6xxx**



**EE16-F6xxx**



**EE16-FP6XXX**



## Ordering Guide

MODEL	OUTPUT	T-Sensor (only model FP)	HOUSING	PROBE LENGTH (according to "A")	FILTER
humidity + temperature <b>(FT)</b>	0-10V (3) 4-20 mA (6)	Pt 100 DIN A (A) Pt 100 DIN B (B) Pt 1000 DIN A (C) Pt 1000 DIN B (D) others on request	wall mounting (A) duct mounting (B)	50 mm (1.9") (2) 200 mm (7.9") (5)	membrane filter (1) sintered stainless steel filter (3) metal grid (6)
humidity <b>(F)</b>					
humidity + temperature passive <b>(FP)</b>					
<b>EE16-</b>					

## Order Example

**EE16-F3A21**

model: humidity transmitter  
output: 0-10V  
housing: wall mounting  
probe length: 50 mm (1.9")  
filter: membrane filter



## Greenhouse Fans

### Application:

Designed for heavy duty, high moisture laden ventilation and circulation in a greenhouse.

16" & 20"

### Component Specifications:

- Fan housing, impellers, and motor all white.
- Vostermans limited 3-year warranty on motor.
- TEAO, severe duty motor.
- Class F insulation for temperatures to 155 degrees F.
- Permanently lubricated, sealed ball bearings,
- The motor is C-UL recognized.
- Wash down ready for wet applications or outdoor use.
- Impact resistant, polypropylene housing and blades.
- Corrosion resistant hardware.
- Fan housings are stackable.
- Variable speed, with optional speed control.
- Also available in 3 phase by request.



### Performance Specifications:

Part #	Impeller Dia.	HP	Volts	Amps	Watts	RPM	CFM	Sound @23' dB(A)	Throw *	Weight	Height	Width	Depth
T4E4005M81100	16"	1/4	120	2.6	290	1,600	3,294	50	171'	27lbs.	20.25"	20.25"	12.25"
T4E4001M81100	16"	1/4	240	1.2	280	1,600	3,310	50	171'	27lbs.	20.25"	20.25"	12.25"
T4E5003M81100	20"	1/3	120	3.6	410	1,600	4,765	55	197'	38lbs	24.50"	24.50"	13.00"
T4E5002M81100	20"	1/3	240	1.6	370	1,600	4,850	55	197'	38lbs	24.50"	24.50"	13.00"

\*Throw is the distance in which the air velocity is still 1.6 ft/sec.



# 50 HERTZ MOTORS

## SINGLE PHASE

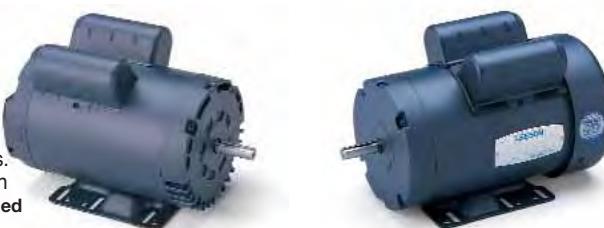
### 50 HZ • SINGLE PHASE

#### General Specifications:

50 Hz single phase designs produce full rated HP on 50 Hz power supply. Designed for general purpose application.

#### Electrical Features:

High efficiency energy saving designs. Centrifugal switch specifically designed for 50 Hz service. Conduit box with leads. Torque at rated HP on 50 Hz power supply is 20% greater than the running torque of a 60 Hz motor. All 180 and 210 frame Rolled Steel motors have Class F Insulation.



### SINGLE PHASE • DRIP-PROOF • RIGID BASE • IP22

RPM HP	NEMA Frame	Catalog Number	List Price	Disc. Sym.	App. Wgt. (lbs.)	Voltage	Over- load Prot.	F.L. Amps 220V	"C" Dim. (Inches)	
<b>1/3</b>	2850	...	...	...	...	...	...	...	...	
1425	56	110394	\$368	A	22	110/220	None	3.2	9.88	
1425	...	...	...	...	...	...	...	...	...	
<b>1/2</b>	2850	56	113901	329	A	25	110/220	None	3.8	10.34
1425	56	110395	466	A	25	110/220	None	4.1	10.38	
1425	...	...	...	...	...	...	...	...	...	
<b>3/4</b>	2850	56	113902	412	A	27	110/220	None	5.6	10.34
1425	56	110396	559	A	30	110/220	None	5.9	10.88	
1425	...	...	...	...	...	...	...	...	...	
<b>1</b>	2850	56	113903	457	A	31	110/220	None	6.6	10.84
1425	56H	110397□	616	A	35	110/220	None	6.4	11.88	
1425	...	...	...	...	...	...	...	...	...	
<b>1½</b>	2850	56H	113904	587	A	37	110/220	None	8.6	11.84
1425	56H	110398☆□	694	A	43	110/220	None	8.4	12.35	
1425	...	...	...	...	...	...	...	...	...	
<b>2</b>	2850	56H	113905	719	A	42	110/220	None	10.7	12.34
1440	182T	131553	835	B	70	220	None	11.8	13.69	
1440	...	...	...	...	...	...	...	...	...	
<b>3</b>	2850	56H	113937†	852	A	47	220	None	12.4	12.84
2850	...	...	...	...	...	...	...	...	...	
1440	184T	131554	954	B	80	220	None	16.8	14.69	
1440	...	...	...	...	...	...	...	...	...	
<b>5</b>	2850	...	...	...	...	...	...	...	...	
1440	184T	131555☆	1952	B	95	220	None	23.2	15.69	
1440	...	...	...	...	...	...	...	...	...	

### SINGLE PHASE • TEFC • RIGID BASE • IP54

NEMA Frame	Catalog Number	List Price	Disc. Sym.	App. Wgt. (lbs.)	Voltage	Over- load Prot.	F.L. Amps 220V	"C" Dim. (Inches)
56	113916	\$339	A	25	110/220	None	3.2	10.81
56	110423	429	A	24	110/220	None	3.2	10.81
56	113908	433	A	26	110/220	Man.	3.2	10.81
56	113917	362	A	27	110/220	None	3.8	11.31
56	110064	492	A	25	110/220	None	4.1	11.31
56	113909	492	A	29	110/220	Man.	4.1	11.31
56	113918	412	A	29	110/220	None	5.6	11.31
56	110065†	563	A	32	110/220	None	5.9	11.81
56	113910	584	A	32	110/220	Man.	5.9	11.81
56	113919	478	A	32	110/220	None	6.6	11.81
56H	110066□	677	A	38	110/220	None	6.4	12.81
56	113911†	677	A	34	110/220	Man.	6.4	12.31
56H	113920	629	A	44	110/220	None	8.0	13.31
56H	110424†☆□	767	A	47	110/220	None	8.6	13.31
56H	113929†☆	700	A	49	110/220	Man.	8.6	13.31
56HZ	113928†■	761	A	44	110/220	None	10.7	13.76
182T	131556	1151	B	95	220	None	11.2	15.96
182T	131600	1136	B	71	220	Man.	12.0	14.96
145T	121070†☆	936	B	50	220	None	12.4	12.84
56H	113936†☆	936	A	48	220	None	12.4	13.81
184T	131557	1644	B	98	220	None	15.9	16.96
184T	131601	1618	B	98	220	Man.	15.9	16.96
184T	131638☆	1083	B	98	220	None	20.5	17.46
184T	131578☆	2085	B	103	220	None	21.0	17.46
213TZ	140475☆	2095	B	163	220	Man.	24.5	18.71

### SINGLE PHASE • DRIP-PROOF • RESILIENT BASE • IP22

RPM HP	NEMA Frame	Catalog Number	List Price	Disc. Sym.	App. Wgt. (lbs.)	Voltage	Over- load Prot.	F.L. Amps 220V	"C" Dim. (Inches)	
<b>1/3</b>	2850	56	114222	\$287	A	24	110/220	None	3.2	10.82
1425	56	114223	376	A	24	110/220	None	3.2	10.81	
1425	...	...	...	...	...	...	...	...	...	
<b>1/2</b>	2850	56	114224	335	A	26	110/220	None	3.8	11.32
1425	56	114225	469	A	27	110/220	None	4.1	11.31	
1425	...	...	...	...	...	...	...	...	...	
<b>3/4</b>	2850	56	114226	408	A	28	110/220	None	5.6	11.32
1425	56	114227	560	A	31	110/220	None	5.9	11.81	
1425	...	...	...	...	...	...	...	...	...	
<b>1</b>	2850	56	114228	464	A	31	110/220	None	6.6	11.82
1425	56	114229	617	A	35	110/220	None	6.4	12.31	
1425	...	...	...	...	...	...	...	...	...	
<b>1½</b>	2850	...	...	...	...	...	...	...	...	
1425	56H	114231☆	693	A	42	110/220	None	8.4	13.32	
1425	...	...	...	...	...	...	...	...	...	
<b>2</b>	2850	...	...	...	...	...	...	...	...	
1440	56H	114233†	845	A	49	220	None	9.6	13.82	
1440	...	...	...	...	...	...	...	...	...	

### SINGLE PHASE • TEFC • C FACE LESS BASE • IP54

NEMA Frame	Catalog Number	List Price	Disc. Sym.	App. Wgt. (lbs.)	Voltage	Over- load Prot.	F.L. Amps 220V	"C" Dim. (Inches)
...	...	...	...	...	...	...	...	...
56C	113921	\$442	A	22	110/220	Man.	3.2	10.81
56C	113912	380	A	25	110/220	None	3.8	11.31
...	...	...	...	...	...	...	...	...
56C	113922	505	A	29	110/220	Man.	4.1	11.31
56C	113913	422	A	28	110/220	None	5.6	11.31
...	...	...	...	...	...	...	...	...
56C	113923	578	A	31	110/220	Man.	5.9	11.81
56C	113914	520	A	32	110/220	None	6.6	11.81
...	...	...	...	...	...	...	...	...
56C	113924†	609	A	34	110/220	Man.	6.4	12.31
56C	113915	676	A	43	110/220	None	8.0	13.31
...	...	...	...	...	...	...	...	...
56C	113925†☆	738	A	42	110/220	Man.	8.6	13.31
145TC	120990†☆	780	B	47	110/220	None	8.6	13.75
...	...	...	...	...	...	...	...	...
182TC	131599	1164	B	70	220	Man.	12.0	14.97

■ Combination 56HZ base has mounting holes for NEMA 56 and 143-5T and a standard NEMA 145T frame shaft of 7/8" diameter.

□ Combination 56H base motors have mounting holes for NEMA 56 and NEMA 143-5T and a standard NEMA 56 shaft.

☆ Capacitor start/capacitor run design for reduced amperage, others are capacitor start/induction run.

† Class F insulated.

## 50 HZ • THREE PHASE

### General Specifications:

Totally enclosed fan cooled, 12-lead motors designed specifically for 50 Hz service. These motors are intended for equipment built in North America and destined for use in 50 Hz service areas of the world.



### Features:

These NEMA frame motors are designed to North American performance standards, but for 50 Hz service. Suitable for 220/380 volt, 50 Hz, or 440 volt, 50 Hz, three phase power. Torques exceed NEMA performance standards for Design B motors and produce the full rated horsepower at 50 Hz speeds.

Construction meets IEC, IP54 degree of protection standards and utilizes external fan cooling (IEC cooling method IC41). Gasketed conduit box is in the North American standardized F1 location, with leads.

All 180 and 210 frame Rolled Steel motors have Class F Insulation.



CONFORMITE  
EUROPEENNE

## THREE PHASE • TEFC • RIGID BASE • IP54

KW/HP	RPM 50 Hz	NEMA Frame	Catalog Number	List Price	App. Wgt. (lbs.)	Voltage	F.L. Amps 380 V.	% F.L. Eff.	"C" Dim. (Inches)
<b>0.18/1/4</b>	1425	48	<b>102685</b>	\$357	A 19	220/380/440	1.00	56.0	9.06
<b>0.25/1/3</b>	2850	48	<b>102686</b>	356	A 19	220/380/440	0.80	60.0	9.93
	1425	48	<b>102688</b>	429	A 19	220/380/440	1.10	65.0	9.31
	1425	S56	<b>102183</b>	401	A 19	220/380/440	1.10	65.0	9.69
<b>0.37/1/2</b>	2850	48	<b>102690</b>	412	A 20	220/380/440	1.00	69.0	10.43
	1425	48	<b>102692</b>	485	A 20	220/380/440	1.40	72.0	9.81
	1425	S56	<b>102693</b>	448	A 20	220/380/440	1.40	72.0	10.19
	1425	56	<b>114304●</b>	482	A 25	220/380/440	1.02	78.0	10.38
<b>0.55/3/4</b>	2850	56	<b>114306</b>	436	A 24	220/380/440	1.75	72.0	10.81
	1425	56	<b>114307</b>	514	A 27	220/380/440	1.85	74.0	11.31
<b>0.75/1</b>	2850	56	<b>114308</b>	523	A 26	220/380/440	2.40	71.0	11.31
	1425	56	<b>114888</b>	519	A 28	220/380/440	2.00	77.0	11.31
	1425	143T	<b>121096</b>	519	B 35	220/380/440	2.00	77.0	12.75
<b>1.1/1½</b>	2850	145T	<b>121097</b>	538	B 34	220/380/440	2.90	80.0	12.76
	1425	145T	<b>121093</b>	538	B 40	220/380/440	3.30	75.5	12.75
<b>1.5/2</b>	2850	145T	<b>121094</b>	582	B 42	220/380/440	3.60	80.0	12.76
	1425	145T	<b>121095</b>	609	B 40	220/380/440	3.65	81.5	13.25
<b>2.2/3</b>	2850	182T	<b>131480</b>	751	B 58	220/380/440	4.80	82.5	13.46
	1425	182T	<b>131459</b>	718	B 64	220/380/440	4.70	84.0	13.46
<b>3.7/5</b>	2850	184T	<b>131481</b>	886	B 76	220/380/440	7.40	84.0	14.46
	1425	184T	<b>131454</b>	819	B 82	220/380/440	8.10	85.0	15.46

● These motors are totally enclosed, non-ventilated, IEC cooling method IC40.



## THREE PHASE • TEFC • C FACE LESS BASE • IP54

KW/HP	RPM 50 Hz	NEMA Frame	Catalog Number	List Price	App. Wgt. (lbs.)	Voltage	F.L. Amps 380 V.	% F.L. Eff.	"C" Dim. (Inches)
<b>0.18/1/4</b>	1425	S56C	<b>102184</b>	\$380	A 18	220/380/440	1.00	56.0	9.44
<b>0.25/1/3</b>	2850	S56C	<b>102687</b>	374	A 19	220/380/440	0.80	60.0	10.31
	1425	S56C	<b>102689</b>	410	A 19	220/380/440	1.10	65.0	9.69
	1425	56C	<b>114889</b>	439	A 18	220/380/440	1.10	68.0	10.31
<b>0.37/1/2</b>	2850	S56C	<b>102691</b>	434	A 20	220/380/440	1.00	69.0	10.81
	1425	S56C	<b>102694</b>	482	A 20	220/380/440	1.40	72.0	10.19
	1425	56C	<b>114891</b>	486	A 20	220/380/440	1.15	73.0	10.81
	950	56C	<b>114892</b>	538	A 28	220/380/440	1.50	68.0	11.31
<b>0.55/3/4</b>	2850	56C	<b>114893</b>	436	A 24	220/380/440	1.75	72.0	10.81
	1425	56C	<b>114894</b>	520	A 27	220/380/440	1.85	74.0	11.31
<b>0.75/1</b>	2850	56C	<b>114895</b>	526	A 26	220/380/440	2.40	71.0	11.31
	1425	56C	<b>114896</b>	542	A 28	220/380/440	2.00	77.0	11.31
	1425	143TC	<b>121272</b>	542	B 31	220/380/440	2.00	77.0	11.75
	950	145TC	<b>121273</b>	623	B 39	220/380/440	2.65	73.0	13.25
<b>1.1/1½</b>	2850	143TC	<b>121274</b>	559	B 33	220/380/440	2.90	80.0	12.25
	1440	145TC	<b>121275</b>	567	B 37	220/380/440	3.30	75.5	12.75
<b>1.5/2</b>	2850	145TC	<b>121276</b>	560	B 41	220/380/440	3.60	80.0	12.75
	1440	145TC	<b>121277</b>	610	B 40	220/380/440	3.65	81.5	13.75
<b>2.2/3</b>	2850	182TC	<b>131505</b>	765	B 59	220/380/440	4.80	82.5	13.97
	1440	182TC	<b>131506</b>	710	B 63	220/380/440	4.70	84.0	13.97
<b>3.7/5</b>	2850	184TC	<b>131507</b>	905	B 75	220/380/440	7.40	84.0	14.47
	1440	184TC	<b>131508</b>	810	B 82	220/380/440	8.10	85.0	15.47

## SPECIFICATIONS

### Output:

*Output Responsivity*

**0.200 mV per  $\mu\text{mol m}^{-2} \text{s}^{-1}$**

*In full sunlight*

**400 mV (2000  $\mu\text{mol m}^{-2} \text{s}^{-1}$ )**

*Linear range*

**1000 mV (5000  $\mu\text{mol m}^{-2} \text{s}^{-1}$ )**

### Sensitivity Calibrated:

**5.00  $\mu\text{mol m}^{-2} \text{s}^{-1}$  per mV**

### Input power:

**None, self-powered**

### Operating environment:

**-40 to 55 °C**

**0 to 100% relative humidity**

### Sensor Dimensions:

**2.4 x 2.75 cm**

### Sensor Weight:

**170 g**

### Shipping Weight:

**300 g**

### Cable Length:

**3 m**



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# QSO-S Par Photon Flux Sensor

The QSO-S PAR Photon Flux sensor measures the Photosynthetic Photon Flux (PPF) in  $\mu\text{mol m}^{-2} \text{s}^{-1}$ . from a field of view of 180 degrees. It is completely water proof, submersible, and designed for continuous outdoor use.

The cosine-corrected head has a domed diffusion disk for improved self-cleaning. The diffusion disk is composed of characterized pigments for improved spectral response. Accurate measurement depends on cleanliness of the lens, and installation at horizontal (180°). A leveling plate is included for accurate installation.

For use with the Em50 Data logger.

### Conversion:

Sensors are calibrated for outside use.



### Materials

Anodized aluminum with acrylic lens.

### Wiring Instructions

Attach the sensor to a meter or datalogger that can display or record a mV output.

The sensor is self-powered.

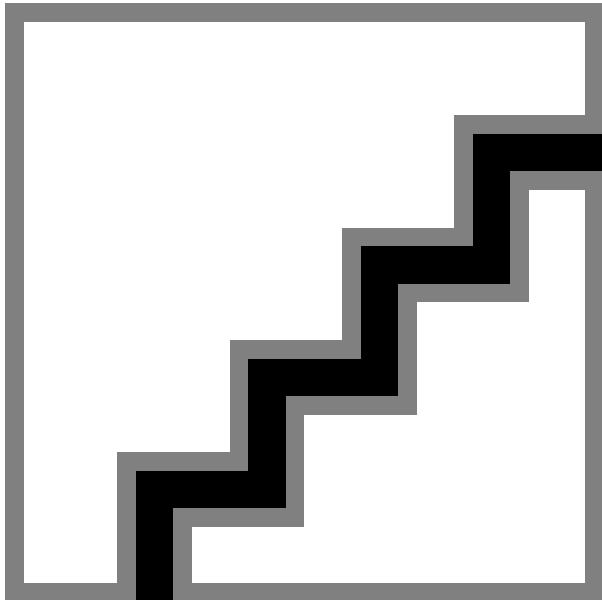
DO NOT attach the sensor to any power source

**Red:** positive (signal from sensor)

**Black:** negative (signal from sensor)

**Clear:** shield/ground





# The role of light in the growth and development of plants

## Horticulture

Plant growth (photosynthesis) is not then determined by lux or energy, but by the photons from the blue to red (400–700 nm) part of the spectrum. This is called growth light! For horticulture, natural daylight (global radiation) is in most cases measured in terms of energy (J or W) with a solar meter. This meter is generally positioned on top of the greenhouse. The value of global radiation is important for climate and humidity control in the greenhouse.

Agrolite XT lamps are specially developed for maximum growth light and are among the most efficient light sources available for horticulture.

### Benefits

- Control the light period by extending the natural day length with artificial light.
- Supplements daylight in greenhouses with "growth-light".
- Replaced daylight with artificial light for ultimate climate control (cultivation without daylight).

### Features

- High lumen and growth light maintenance safeguards a constant crop quality and quantity over life.
- Ceramic discharge tube with PIA technology for long and reliable lifetime.
- Simple and robust construction for enhanced reliability and longer life.
- Available in 400 and 600 watt(230V,347V,480V) versions.

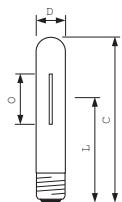
### Application

- Ideal for growing vegetables and flowers.

## Related products

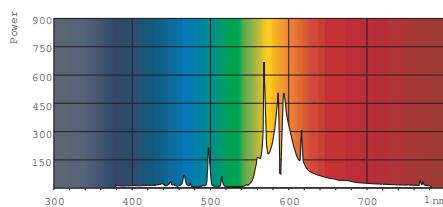


## Dimensional drawing



Product	A (Min)	A (Norm)	A (Max)	C (Max)	D (Max)	L (Norm)	O (Norm)
SON GreenPower CG T 600W E39	-	-	-	-	-	-	102
SON GreenPower CG T 400W E39	-	-	-	-	-	-	83
SON GreenPower 600W 480V Mogul	-	-	-	-	-	-	120
SON GreenPower 600W 347V Mogul	-	-	-	-	-	-	102

## Photometric data



## Compare table

Product number	Full product name	Bulb	Bulb Finish	Base	Operating Position	System Description	Color Code	Voltage	Watts	Lamp Voltage	Lamp Current EM
404889	MASTER GreenPower CG T 600W Mogul 1SL	T14 1/2	Clear	Mogul	Universal	External Ignitor	220	230	600	115	6.3
404871	MASTER GreenPower CG T 400W Mogul 1SL	T14 1/2	Clear	Mogul	Universal	External Ignitor	220	230	400	113	4.230
404905	MASTER GreenPower 600W 480V Mogul 1SL	T14 1/2	Clear	Mogul	Universal	System 480V	220	480	600	208	3.620
404897	MASTER GreenPower 600W 347V Mogul 1SL	T14 1/2	Clear	Mogul	Universal	System 400V	220	347	600	191	3.620

## Compare table

Product number	Full product name	Lamp Current EL	Dimmable	Chroma-ticity Coordinate X	Chroma-ticity Coordinate Y	Color Rendering Index	Life to 10% failures	Life to 20% failures	Life to 5% failures	RatedAvgLife(See Family Notes)	Cap-Base Temperature
404889	MASTER GreenPower CG T 600W Mogul 1SL	-	Yes	533	432	26	-	24000	16000	-	250
404871	MASTER GreenPower CG T 400W Mogul 1SL	-	Yes	-	-	20 (nom), 25 (max)	-	16000	12500	-	250
404905	MASTER GreenPower 600W 480V Mogul 1SL	-	Yes	526	420	33	-	16000	12000	-	250
404897	MASTER GreenPower 600W 347V Mogul 1SL	-	Yes	526	420	33	-	16000	12000	-	250

## Compare table

Product number	Full product name	Bulb Temperature	Color Temperature	Design Mean Lumens	Mercury (Hg) Content	Lum Efficacy Rated EM 25°C	Lamp Wattage EM 25°C, Rated	Lamp Wattage EL 25°C, Rated	Lumi-nous Flux EM 25°C, Rated	Lumi-nous Flux EL 25°C, Nominal	Lamp Wattage EL 25°C, Nominal	Lamp Wattage EM 25°C, Nominal	Lum Efficacy Rated EL 25°C
404889	MASTER GreenPower CG T 600W Mogul 1SL	450	-	80960	30	147	605	-	88000	-	-	-	-
404871	MASTER GreenPower CG T 400W Mogul 1SL	450	-	53820	20	140	420	-	58500	-	-	-	-
404905	MASTER GreenPower	450	2040	80500	42	142	595	-	84500	-	-	-	-

Product number	Full product name	Bulb Temperature	Color Temperature	Design Mean Lumens	Mercury (Hg) Content	Lum Efficacy Rated EM 25°C	Lamp Wattage EM 25°C, Rated	Lamp Wattage EL 25°C, Rated	Luminous Flux EM 25°C, Rated	Luminous Flux EL 25°C, Rated	Lamp Wattage EL 25°C, Nominal	Lamp Wattage EM 25°C, Nominal	Lamp Wattage EL 25°C
600W 480V Mogul 1SL													
404897	MASTER GreenPower 600W 347V Mogul 1SL	450	2040	80500	42	144	608	-	87500	-	-	-	-



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2011, February 24  
data subject to change



**TTC25 is a controller for controlling 3-phase electric heating batteries. TTC25 is a controller which provides a high degree of versatility at a reasonable price.**

- \* The same unit for 3-phase 230V and 3-phase 400V.  
Automatic voltage adaption.
- \* Can control both star-connected and delta-connected loads.
- \* PI-control for constant supply air temperature control and P-control for room temperature control with automatic function adaption.
- \* Minimum and maximum limits adjustable.
- \* TTC25 is a complete controller for use with Regin temperature sensors.
- \* TTC25X is controlled by a 0 - 10V signal from another controller.

## Function

TTC25 is a 3-phase triac controller for controlling electric heating up to 25 A. It is made for DIN-rail mounting in an electric cabinet or other enclosure. TTC25 is to be connected in series between power-supply and an electric heater and can control both Y- and Delta- connected loads. TTC25 can also control assymetrical Delta-loads.

### Function

The controller pulses the entire power output ON/OFF. The controller utilises time-proportional control, the ratio between On-time and Off-time is varied to fit the prevailing heating requirement. E.g. ON = 30 sec. and OFF= 30 sec. gives 50% output power. The cycle-time (the sum of on-time and off-time) is adjustable 6-60 sec.

This control accuracy contributes to reduced energy costs and to the increased comfort of an even temp-erature. Since the current is switched by semiconductors (triacs) there are no moving parts that can wear out. As the current is switched at zero phase angle, network disturbance is eliminated.

TTC25 automatically adapt control mode to suit the dynamics of the controlled object.

### Supply air temperature control

For rapid temperature changes, TTC25 will work as a PI-controller with a fixed proportional band of 20K and a fixed reset time of 6 minutes.

### Room temperature control

For slow temperature changes, TTC25 will work as a P-controller with a fixed proportional band of 2K. When running room temperature control the supply air temperature can be maximum and/or minimum limited.

### Controlling larger electric heaters

At larger loads TTC25 can be combined with step controller TT-S4/D or TT-S6/D. See under section 2.

### TTC25X

This controller has to be controlled by a 0 - 10V signal from another controller.

## Models

TTC25	Triac controller for Regin NTC sensors.
TTC25X	Triac controller for external signal 0-10 V DC only .

## Technical data

### General

Supply voltage	3-phase 210-255/380-415 V AC 50-60 Hz. Automatic adaption.
Power output	Maximum 25A/phase. Minimum 3A/phase. Both Y- and Delta- connected loads.
Ambient, running	0...40°C with no condensation. N.B. TTC25 generates 50W
Ambient, storage	-40 - +50°C.
Humidity	90% RH maximum.
Dimensions (w x h x d)	192 x 198 x 95 mm.
Form of protection	IP20
CE	This product conforms with the requirements of European EMC standards CENELEC EN 50081-1 and EN 50082-1, European LVD standards IEC 669-1 and IEC 669-2-1 and carries the CE mark.

### Control unit parameters TTC25

Proportional band	(Supply air temperature control) 20K, fixed.
Reset time	(Supply air temperature control) 6 minutes, fixed.
Proportional band	(Room temperature control) 1,5 K, fixed.
Indicator	LED that is lit when power is pulsed to the heater.
Sensor inputs	Two (2) inputs for main sensor and maximum/minimum sensor. See Section 6-100 for choice of sensor. N.B. Max/min sensor must be 0...60°C.
Setpoint	Selectable, either internal setpoint potentiometer or external setting device.
Signal input	0 - 10V DC when running against other controllers.
Signal output	0-10 V connected to the output unit by wire strap (terminals 7-9).
<b>Setting options</b>	
Setpoint	0 - 30°C, adjustable. The choice of sensor determines the controller setpoint range.
Minimum limits	0 - 30°C, adjustable.
Maximum limits	20 - 60°C, adjustable.
Cycle time	6 - 60 seconds, adjustable.
Night set-back	Possible by using Night Set-back unit NS/D , see datasheet section 1 position 325.

### TTC25X

Input	Only for external input signal 0-10 V DC with adjustable cycling time. No internal control unit. No min- or maximum limiting, all other technical data as above.
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## Dimensions and wiring

