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Fabrication of Dual-Axis Solar Tracking Controller Project

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ABSTRACT

The recentdecadeshave seentheincreaseindemandforreliable andcleanformofelectricityderivedfrom renewableenergysources.One suchexampleissolarpower.The challenge remainstomaximizethe capture oftheraysfrom thesunforconversionintoelectricity.Thispaperpresentsfabricationandinstallationofa solarpanelmountwithadual-axissolartrackingcontroller.Thisisdonesothatraysfrom thesunfallper-pendicularlyuntothesolarpanelstomaximizethecaptureoftheraysbypointingthesolarpanelstowards thesunand followingitspathacrossthesky.Thuselectricityandefficiencyincreased.

Keywords: Controller,Tracker, Sensor,Battery,Inverter,Timer,Switches,Program,Installation

I. INTRODUCTION

Electricalenergyfromsolarpanelsisderivedby con- vertingenergyfromthe raysofthesunintoelectrical currentinthesolarcells.Themainchallengeisto maxi- mizethecaptureofthe raysofthesunuponthesolar panels,whichinturn maximizestheoutputof electricity. Apracticalwayofachievingthisisby positioningthe panelssuchthattheraysofthesunfallperpendicularly onthesolarpanelsby trackingthemovementofthesun [1].Thiscanbe achievedbymeansofusingasolarpanel mountwhichtracksthe movementofthesunthroughout theday.Energyconversionismostefficientwhenthe raysfallperpendicularly ontothesolarpanels.Thus,the workisdividedintothreemainpartsnamelythe mount- ingsystem,thetrackingcontrollersystemand theelec- tricalpowersystem.

Insolartrackingsystems,solarpanelsaremountedon astructurewhichmovestotrackthemovementofthe sunthroughoutthe day.There are three methodsof tracking: active, passive and chronological tracking. Thesemethodscanthenbeconfiguredeitherassin- gle- axis ordual-axissolartrackers.Inactivetracking,the positionofthesuninthesky duringtheday iscontinu- ouslydeterminedbysensors.Thesensorswilltriggerthe motororactuatortomovethemountingsystemsothat thesolarpanelswillalwaysfacethesunthroughout the day.This methodofsun-trackingis reasonably accurate exceptonverycloudydayswhenitishardforthesensor todeterminethepositionofthesunintheskythusmak-

ingithardtoreorientthestructure[2].

PassiveTrackingunlike activetrackingwhichdeter- mines thepositionofthesuninthesky,apassivetracker movesin responseto animbalanceinpressurebetween twopoints atbothendsofthetracker.The imbalanceis causedby solarheatcreatinggaspressureona“lowboil- ingpointcompressedgasfluidthatisdriventooneside orthe other”[2]whichthenmovesthe structure.How- ever,this methodof sun-trackingis notaccurate.A chronological tracker isatimer-based trackingsystem whereby thestructureismovedatafixedratethroughout theday.Thetheory behindthisisthatthesunmoves acrosstheskyatafixedrate.Thusthemotororactuator isprogrammedtocontinuously rotateata“slowaverage rateofone revolutionperday(15degreesperhour)”[2]. This methodofsun-trackingisveryaccurate.However, thecontinuousrotationofthe motororactuatormeans morepowerconsumptionand trackingthesunonavery cloudydayisunnecessary.

Asingle-axissolartrackerfollowsthemovementof thesunfromeasttowestby rotatingthestructurealong theverticalaxis.Thesolarpanelsareusually tiltedata fixedanglecorrespondingtothelatitudeof thelocation. Accordingto[3],the useofsingle-axistrackingcanin- creasetheelectricityyieldby asmuchas27to32per- cent.Onthe otherhand,adual-axissolartrackerfollows theangularheightpositionofthesuninthesky inaddi-tiontofollowingthesun’seast-westmovement[3] re- ports that dual-axis tracking increases the electricity outputasmuchas35to40percent.

II. DESCRIPTION

Theprimarytaskofthispilotprojectistobuildanactual solarpanelmountwithasun-trackingsystemto bein-stalledoutdoorsin Miri(location:4°23′ 35″ N113°58′ 49″ E) inSarawak,Malaysia.Basedonthebackground infor- mationofthevarioustypesofsolartrackers,it hasbeen decidedthatactivetrackingwithadual-axisset-upwill beused.The reasonforthischoiceisactivetrackingisa fairly effectivemethodtotrackthesunandadual-axis trackingsystem hasthe capabilityofincreasingthe yield ofelectricalenergy outputfromthesolarpanels.

Forthe purposeofclarity,theeast-westofthetracker willbe calledthe“horizontaltracking”whiletheangular height trackerwillbereferred toas“verticaltracking”.

Anactive,dual-axistrackingsystemprototype has al- readybeendesignedandbuiltby[4],whichconsistsof thesensorsystemtodeterminethepositionofthesun andacontrolsystemwhichreadsdatafromthesensors tocommand themovementofthetracker.A programto controlthetrackingsystemhasbeenalsodeveloped[4]. Thesensorsystemconsistsoftwosensors:onetodeter- minethepositionofthesunintheskyandanotherto determinethepositionofthesun’smovementfromeast towest.EachsensorconsistsoftwoCadmiumSulphate (CdS)lightdependantresistors(LDRs).

The LDRs were placed as shown in Figure 1, a shadowwillfallononeoftheLDRswhenthesensoris notpointingdirectly towardthesunresultingindiffer- enceofthelevelofresistancebetweenthetwoLDRs. Thisdifferencewillbedetectedby themicrochipinthe controlsystemandwillmovethetrackeraccordingly so thatbothLDRs arepointingtowardsthesun.

Todecidehow thetrackerwouldmove,itisimportant toconsiderthemovementofthesuninthesky through-outtheyear.ThesunpathdiagramofFigure2shows theannualvariationofthepathofthesuninMiri.

Fromthesunpathdiagram,themovement ofthesun

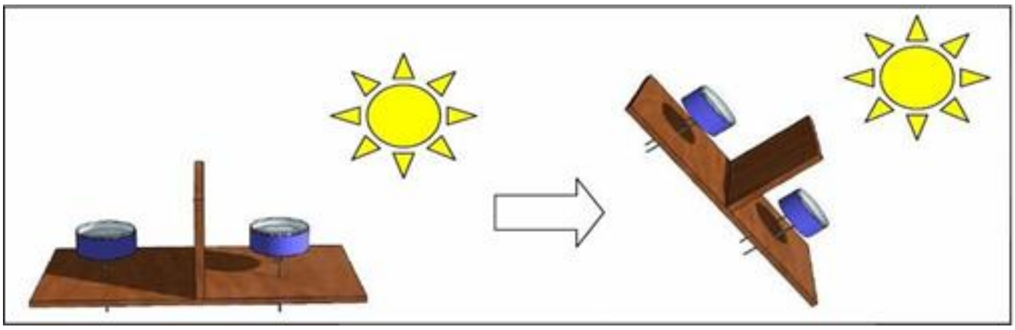


Figure1.Sensorresponseonceashadowis castononeLDR.

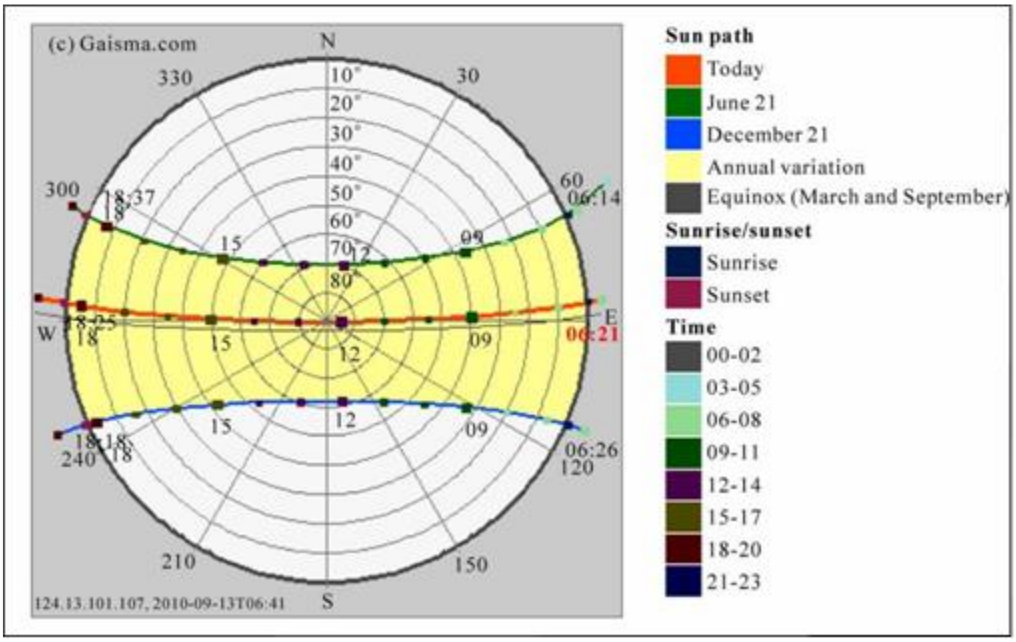


Figure2.Sun pathdiagramforMiri,Sarawak,Malaysia.

intheskythroughout theyearinMiricanbedividedinto threedifferentscenarios.AsthesunrisesfromtheEast tosetstotheWest,thesunpathmay moveintheSouth- ernorNorthern region,oritmay movealmostdirectly overhead. If thepathof thesunisintheNorthern region,the structuremustbe ableto trackthesunfromEastto West inanti-clockwisedirection.Ifthe pathofthesunis inthe Southernregion,thestructuremustbeabletotrackthe sunfromEasttoWestinclockwisedirection.Ifthesun ismovingoverhead,only theaxiswhichtracksthean-gularheightofthe sunwillmove.Inallthreesituations, theremustbeaway toturnbackthetrackertoitsorigi-nalpositionafterithasfollowedthemovementofthe sun from morning to dusk. To achieve this, limit switchesareaddedtothesystem.Whenthelimitswitch istriggered attheendof theday,thetrackerwillmove backtoitsoriginalposition.

Whiletheprototypehasbeendoneandtestedinthe lab,thispaperfocusesonthedesign,fabricationand in-stallationofasolarpanelmountingsystemwithdual- axissolartrackingcontrollerto betestedand in- stalled outdoors.Thesystemisthen connected toabat-tery bankviaachargecontrollerandDCvoltagefromthe solarpanelsis convertedtoACvoltagethroughan inverter.Improvementsweremade tothedesignofthe sensor,the controllerprogramandlimitswitcheswere addedtothesystem.

III. MOUNTINGSYSTEM

Themountingsystemrefersto thestructurewhichholds thesolarpanels;thestructure consistsofmovableand fixedpartsbasedonaset ofcriteria.

Firstly, the structure must be able to support the weightofthesolarpanelswhicharemountedonit.In thiswork,twosolarpanelsareused.Thetotalweightis 31kg,15.5kgeach.Besidesthat,thecolumnandthe baseofthestructureshould alsobeabletosupportthe weightoftheframe,whichisestimatedtobe about70kg [5].Thatgivesatotalweightofslightlymorethan100 kg.

Secondly,sincethe structurewillbeerectedoutdoors, thestructuremustbeabletowithstand theelementsof nature,mostnotably theeffectsfromthesun(heat),rain (water)andthewind(air).Ofutmostconcernwillbe effectofwindloadonthestructure whenwindloadis actinguponthesolarpanels.Basedonthe recorded maximumwindspeeddataofMiriwhichis 78 km/h[6], andassumingthewindflowisacting perpendicularly uponthemaximumareaofthesolarpanels,thewind loadiscalculatedusingthe genericformula[7]asfol- lows:

Windload:Force,F =A ×P× Cd

A =projectedareaofthe item=(1.58m×0.808m×2)

=2.553m2

P =Windpressure(Psf), =0.00256×V2(V=windspeed

74.5652Mph)=0.00256×74.5652=14.233 Psf=

0.0988 Psi =69.492 Kg/m2

Cd=Dragcoefficient,=2.0forflatplates.

Windloadforce=A ×P×Cd=2.553m2×69.492 kg/m2×2.0=354.826kg≈3548.26N

The calculation shows that the material chosen to make thestructurewouldneedtobeabletowithstanda perpendicularactingforceof3548.26N.

Thirdly,themovablepartsofthestructuremustbe abletorotatetofollowthemovementofthesun throughouttheday.Adouble-axissolartrackermeans thetrackermustbeabletorotatealongtheverticalaxis tofollowthemovementofthesunfromEasttoWest, andalso rotatealongthehorizontalaxistofollowthe positionofthesun’s angularheightinthesky.Inthat manner,thestructurewouldbeableto pointthesolar panelstowardsthepositionofthesuninthesky.

Themotorusedforthispilotprojectisa12VDC motorwhichhasatorqueofabout13.5pound-feet(18.3 Nm)to17.5pound-feet(23.73Nm)[8].Tojustifythe useofthis motor,thefollowingcalculationwasdone to ensurethatithasenoughpowertorotatethemassof100 kg;the radiusofthesprocketr=0.1m,andtakingval- uesofcoefficientoffrictionofthebearing=0.001[9] and thecoefficientoffrictionbetweenthechainand the sprocket(steelandsteel)=0.42[9],the torque neededis calculatedas:

Torque=F×r, whereF=mgcf(Serway2000, 132)

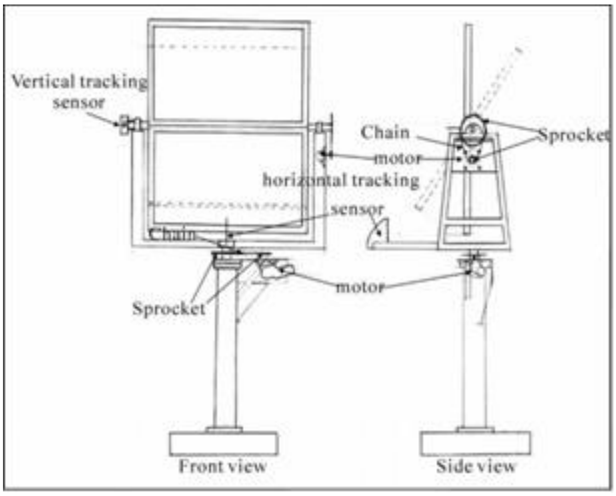
=(mgcf)× r=(100kg×10m•s–2×0.001

×0.42)×0.1m=0.042 Nm

Theultimatetensilestrengthis about50,000psiwhile theyieldstrengthis about30,000psi.[10].Basedonthe strengthof steel,thestructurewouldbeabletowithstand theeffectofwindloadas wellas the otherweightloads placedonit.Thus,theoptimum designisasshownin Figure3.Itisimportantthatthereare noshadowscast uponthesolarpanel.Any shadowscangreatlyaffectthe outputofelectriccurrent[11].Itis thereforeimportantto ensure thatduringday-time at thesiteforthe installation ofthesystem, noshadowsfromtrees,buildings orother tallobjectssuchaspolesarecastonto thesolarpanels. Thus,thesiteselection for thispilotprojecttookinto considerationthisparticularissue.

IV. FABRICATION AND INSTALLATION

Thefirstpart tobefabricatedwastheframe ofthestruc- ture.Ateachendoftheframe,apillowblockbearing is usedtoenabletheframetorotatealongthehorizontal



Pillow block bearing

Steel frame

DC motorplacedatthe sideoftheframe

Figure3.Finaliseddesignof thestructure.

Flangebearing

axis.A metalshaftwhichgoesthroughthecentreofthe frameconnectsthetwobearings.Also,theDC motor controllingtheverticalmovementisplacedononeside oftheframe.Figure4illustratethefabricationparts.

Oncetheframewascompleted,thecolumnof the structurewasmade.The upperpartofthecolumnisde- signedto holdtheotherDCmotorwhichcontrolsthe horizontalmovementthelower partoftheframewas thenattachedtothe upperpartofthecolumnusingtwo flangebearingswhichareconnectedby ashaft.The bearingsare usedtoenablethe structure toturnaboutthe verticalaxis.

Asprocketis affixeduntotheshaftofthe motor,unto oneendoftheshaft,besidesthe pillowblockbearingand attheendoftheshaftontoptheflangebearing.Achain isthenput inplacesothatwhenthe motorsarepowered, thestructurecan rotate.Thegearratiousedis10:40(1:4),

10onthe motorand40onthe shaft.Afterinstallingthe solarpanelsuntotheframe,itwasfoundthat therotation

ThecolumnDCmotoraffixedatthetop

Frameandcolumn attached

wasnotstabledue to imbalanceinweight.Therefore,a counter-weightwasaddedtothebackof theframeto balancethe torque actionontheshaft,asgiveninFigure 5.

Fromleft to right:Sprocketattachedto motor,sprocketattachedto frame,chainconnectingthetwosprockets

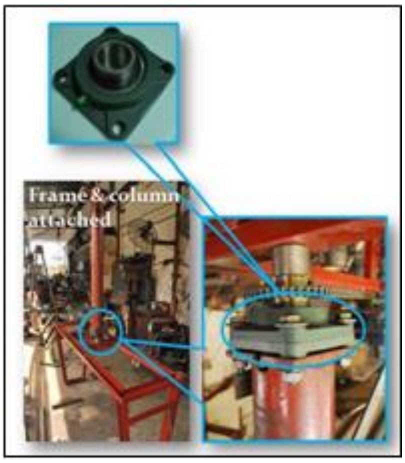
Figure4.Fabricationparts.

Thebaseofthecolumnwasconcretedwitha tubepipe andweldedunto thegalvanisedpipebeforeboltingthe columnuntothebase.Then,theframe wassecuredunto thecolumnalsousing nutsandbolts.Anextralayerof concretewasthenaddedtocoverthelowerpartofthe baseofthecolumn.Figures6illustratethe installation process.

V. TRACKING CONTROLLER SYSTEM

Theprogramforthe trackingcontrollerwaswrittenby PICBasicwhichisthenconvertedtobinary ormachine languagebeforebeingloadedintothemicrocontroller.

Figure5.Thesolarpanelaffixedtotheframe(left).The counter-weight(circled,right).



Baseofthecolumnisweldedandthecolumnbeingsetup

Theframebeingattachedtothecolumn

Applyinganextralayer of concreteto thebase

Figure6. Installationprocess.

Themicrocontrollertogetherwiththecontrollercircuit andthesensorwillcontrolthe movementofthestructure to trackthesun.[4]Haschosento useMicrochip's PIC16F84Amicrocontroller,giveninFigures7and8.

Theprogramandcircuithasbeendevelopedby[4]. Eachtrackingaxishasitsowncontrolcircuit.Tocontrol the rotational direction of the motor, [4] used an H- Bridge. The works and writings of [2,12] have been referredtowhenmakingthefollowing modificationsto [4]program:

Renamingsymbols

Reassigningports

Including limitswitches

Changingvaluesof scalesandtime

Thealgorithmisbasedontheclassicalbasic language todetectthevoltagesignalfromthelightsensors and comparebetween2 signals andcalculatethedifferent.

Thisdifferentisconvertedto setacertainpositionangle andsendthesignaltothemotortorotateprecisely toan accuratepositionsothat facing thesun.

Theprogramistoolongandisnottypedinthispaper,

butsmallpartoftheprogram isgivenbelow:

```
Include "bs1defs.bas" Start:
Symbol CDS1 = B0
Symbol CDS2 = B1
Symbol Diff = B6
```

TRISB.0=1'setpinRB0asinput(sensor1)
TRISB.1=1'setpinRB1asinput(sensor2) TRISB.2 = 0 'set pin RB2 as output TRISB.3 = 0 'set pin RB3 as output
Low PORTB.2 'pin RB2 set to low
Low PORTB.3 'pin RB3 set to low
Low PORTB.4 'pin RB4 set to low
(limit-switch1)
Low PORTB.5 'pin RB5 set to low
(limit-switch2)

Theabovedescriptionis:Symbolsaredeclaredand theinput/outputandvariablesareinitialised.Thecode waswritteninPICBasic (savedas a.bas file)usingMi- croCodeStudio.Withinthissoftware,theprogramcode isthencompiledandthe .hexfileisobtained.Figure9 shows theMicroCode Studio.

Toloadtheprogramintothe microcontroller,Micro- chip'sMPLAB IDEwasusedtogetherwithPICSTART Plus. Followingthestepstaken toset-upthePICSTART Plusprogrammer,Figures10and11:

•Ensurethat PICSTARTPlusispoweredandcon- nectedtotheRS232portofthecomputer.
•OpenMPLABIDE.
•Go to "configure >select device" and the corre- sponding microcontroller model was chosen. Click "ok".
•Goto"programmer>selectprogrammer"and"PIC- STARTPlus"waschosen.

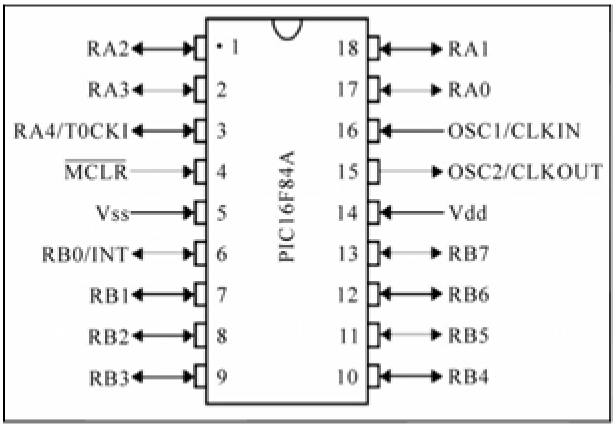


Figure7.Pin setup for thePIC16F84Amicrocontroller.

PinNo.	Name	Function
1	RA2–PORTAbit2	Secondpinon portA.Hasnoadditionalfunction.
2	RA3–PORTAbit3	Thirdpinon portA.Hasnoadditionalfunction.
3	RA4/T0CK1	FourthpinonportA.T0CK1whichfunctionsasatimesisalsofoundonthispin.
4	MCLR–masterclear	Resetinputand VssprogrammingvoltageofPIC.
5	Vss–Gnd	Groundofpowersupply.
6	RB0/INT–PORTBbit 0	ZeropinonportB.Interruptinputisanextrafunction.
7	RB1–PORTBbit 1	Firstpinon portB.Noadditionalfunction.
8	RB2–PORTBbit 2	Secondpinon portB.Noadditionalfunction.
9	RB3–PORTBbit 3	Thirdpinon portB.Noadditionalfunction.
10	RB4–PORTBbit 4	FourthpinonportB. Noadditionalfunction.
11	RB5–PORTBbit 5	FifthpinonportB. Noadditionalfunction.
12	RB6–PORTBbit 6	SixthpinonportB.'Clock'lineinprogrammode.
13	RB7– PORTB bit 7	SeventhpinonportB.'Data' linein programmode.
14	Vdd+Vsupply	Positivepowersupplyof+2.0Vto+5.5V
15	OSC2	Pinassignedforconnectingwithanoscillator.
16	OSC1	Pinassignedforconnectingwithanoscillator.
17	RA0–PORTAbit0	SecondpinonportA. Noadditionalfunction.
18	RA1–PORTAbit1	FirstpinonportA. Noadditionalfunction.

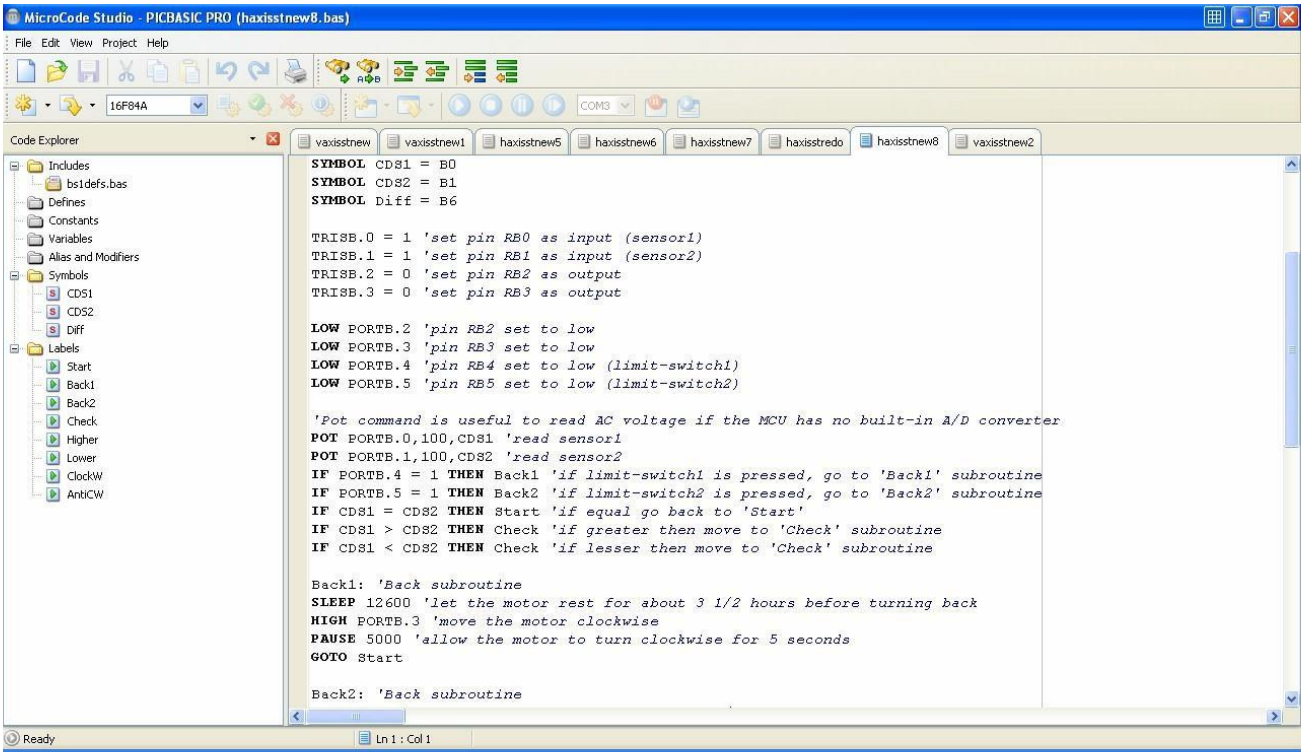


Figure8.Pinfunctionfor thePIC16F84Amicrocontroller.

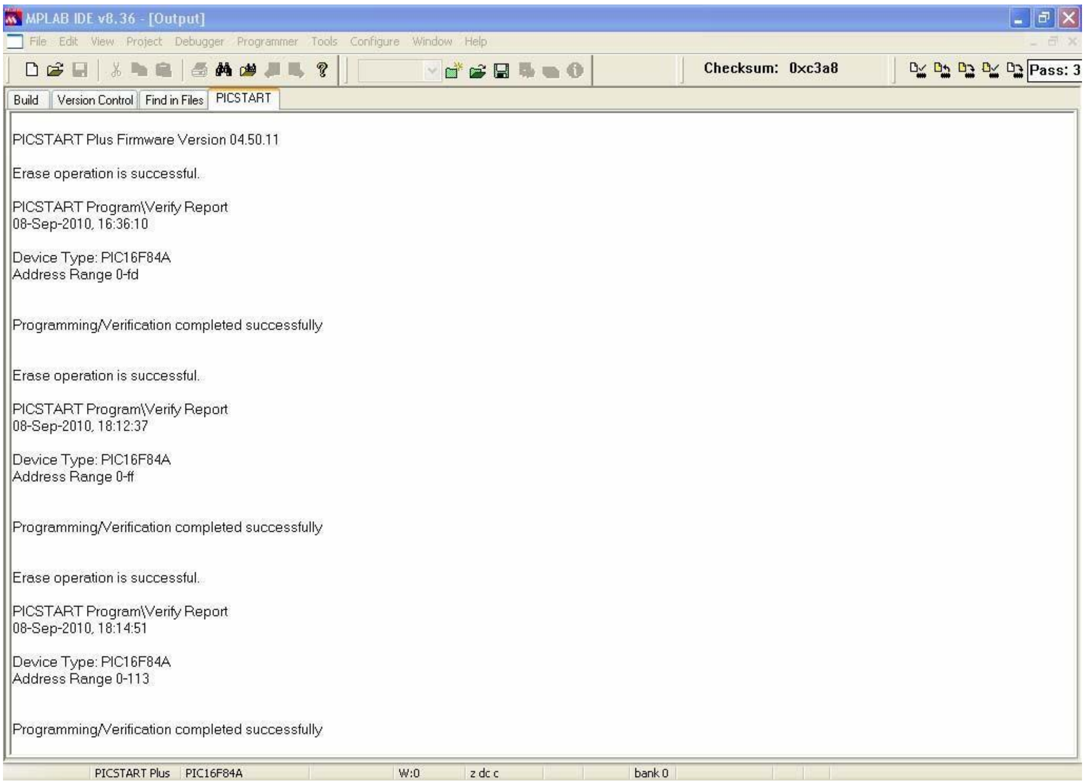


Figure9.ScreenshotofMicrocodestudio.

Figure10.ScreenshotofMPLABIDE.

Figure11.PICSTARTPlusprogrammer.

•Goto“programmer >enableprogrammer”.
• Goto“programmer >settings”andchoosethe“communications” tab. The port which the PICSTART Plusprogrammerisconnectedto was selected.Click “ok”.
Oncetheprogrammerhasbeenproperlyset-up,fol- lowingwerethestepstakentoprogramthemicrocon- trollerusingPICSTARTPlus:
•The microcontroller was inserted into the corre- spondingpinholesoftheprogrammer.
•Goto“file>import”andfromthetargeteddirectory, the“.hex”filewhichistobeprogrammedintothe microcontrollerwasselected.
•Goto“programmer >eraseflashdevice”toeraseany datastoredinthemicrocontroller.
•Goto“programmer>program”toprogramthemi- crocontroller.
•Iftheprogrammingwasunsuccessful,thesettingsof theprogrammerwerere-checked.Ifthesettingsare correct,the microcontrollermightbespoilt.Another waytocheck ifthemicrocontroller isspoiltisby verifyingthe microcontroller.Goto“programmer>verify”andiftheverification isunsuccessful,itis possiblethatthemicrocontrollerisfaulty.

Printed Circuit Board (PCB)

ThePCBsinthispilotprojectweremadeby meansof chemicaletching,itwasnotedthatthePCB makingpro- cedurecanbedividedintosixmainprocesses.Theseare:
• DesignthePCBby EAGLEsoftware,theschematic circuitwasdrawnintheprogram,by wiringup the correspondingelectroniccomponents
•Developtheimageoftheboardbyplacingthetrans- parencyfacedown untotheUVexposureunit,and thenplacetheboardintothesolution
• Etching by250gof FerricChlorideHexahydrate granuleswasmixedwith500mlboilingwaterandin anotherplasticcontainer
•Spraytheboardwitha photoresiststripsolution
•Fortin-plating,Fourteaspoonsoftincrystalswere dissolvedin300mlboilingwaterandtheboardwas immersedinto thesolutionto coatthecopperpartof thecircuitwiththinlayerof tintopreventoxidation andactsassolder flux.Oncecoated, theboardis givenarinse
•Drillingholes and soldering theelectronic compo- nents andtestingthecircuit board
Figure12showsthecompletedPCB.

Sensor

Thesensorswilltriggerthemotorto movethemounting systemso thatthesolarpanelswillalwaysfacethesun. Some Improvements were made to the design of the sensorholdertomakethesensormoresensitive.This wasdonebyincreasingthelengthofthesensorholder. Forthefrontsensor,thesensorholderwas redesignedto suit theangularmovementofthesunsothatshadowcan

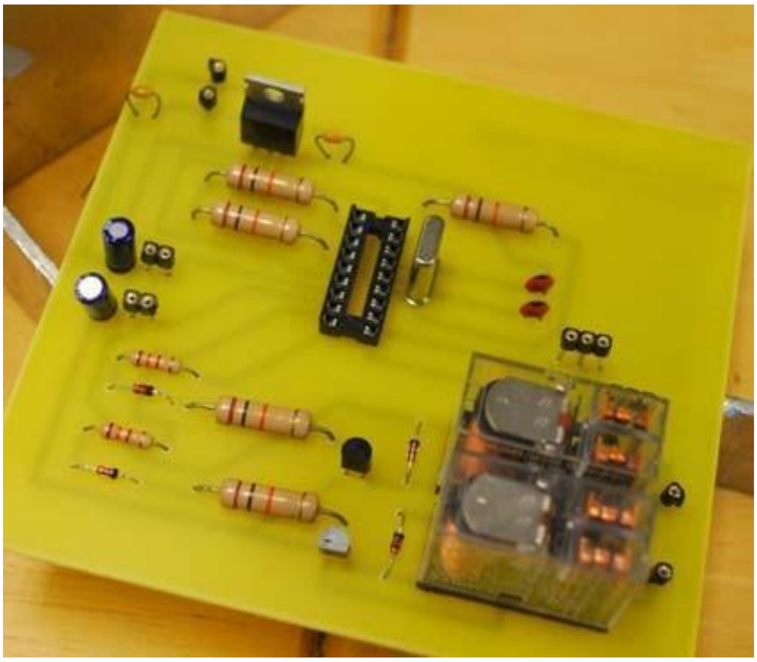


Figure12.AcompletedPCB withelectroniccomponents solderedon.

becastontotheLDRfromanyangular heightofthesun inthesky.Figure13shows thenewdesignofthehold- ers Thesensorholderwasthenpainted.Afterthepaint wasdry,theLDRswereinsertedintothe holderanda plasticcoverwasplacedontopof thesensorandsilicone appliedaroundthecoverof thesensorholdertoprevent wateringressintotheLDRs.ThisisshowninFigure14.

VI. SYSTEM CONNECTION

The overallelectricalconnectionforthesystemisgiven byFigure15. Asseen,thesolarpanelsare connectedto

Verticaltracking Horizontaltracking

Figure13.Sensorholders.

Figure14.Placementof the sensorson thestructure.

fromthesolarpanelsis higherthanthevoltageofthe batterybank,whichis48Vto enablechargingthebat- teries.

ChargeController

Thewirefromthesolarpanelisconnectedto thecharge controller.Thechargecontroller,Figure20,is usedto maintainpropercharging voltageonthebatteries.Itpre- ventsoverchargingofthebatteriesshouldthe input voltagefromthesolarpanelsrises.

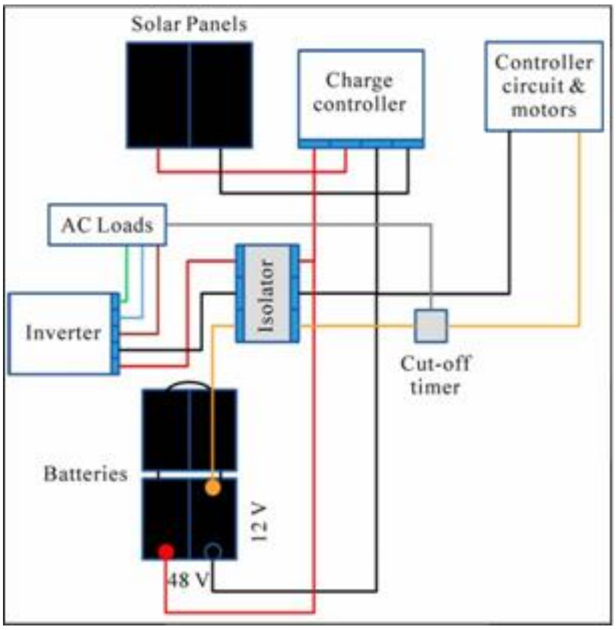


Figure15.System connection.

thechargecontroller,whichisthenconnectedtothe bat- tery bank.Thebatterybankisthenconnectedtothein- verterandalsoanotherwireisconnectedfromthebat- tery topowerthecontrollercircuitandthemotors(rep- resentedby theorangecolouredwireintheFigure15). The controller box houses the controller circuits and servesasa junctionboxforthevariouselectricalcon- nectionsisasshowninFigure16.

Figure17explains thevariouswireconnectionsin the junctionbox.Forthe wiringofthesensor, thewiring configurationof Figure18wasused:

Twosolarpanels,Figure19, areconnectedinseriesto giveatotaloutputvoltageof72V.Thereasontheyare connectedinseriesistoensure that theoutputvoltage

Figure16.Insidethecontrollerbox.

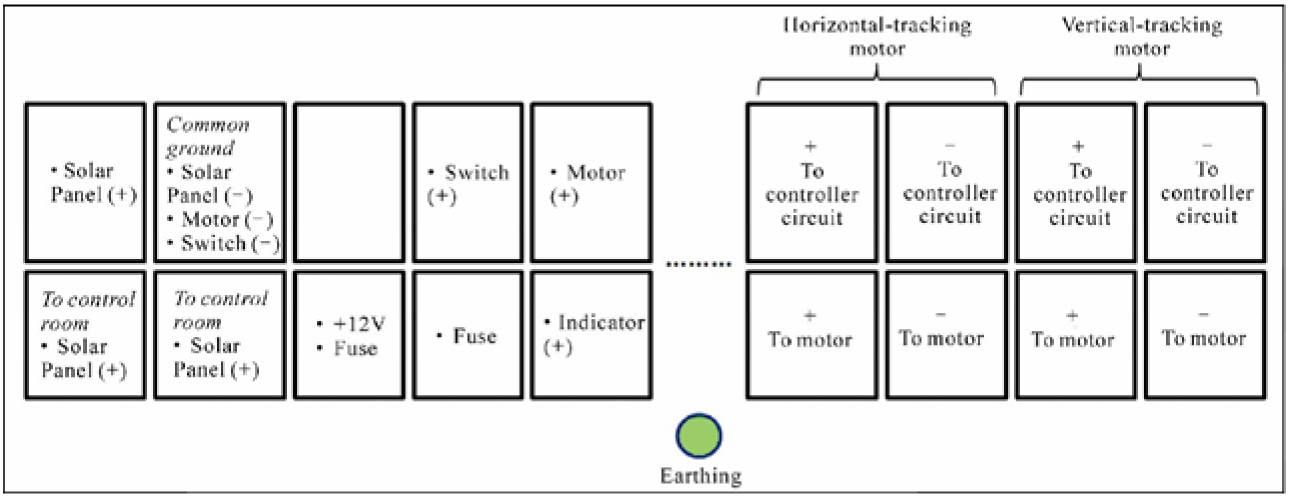


Figure17.Explanationof thewiringconnectioninsidethe junctionbox.

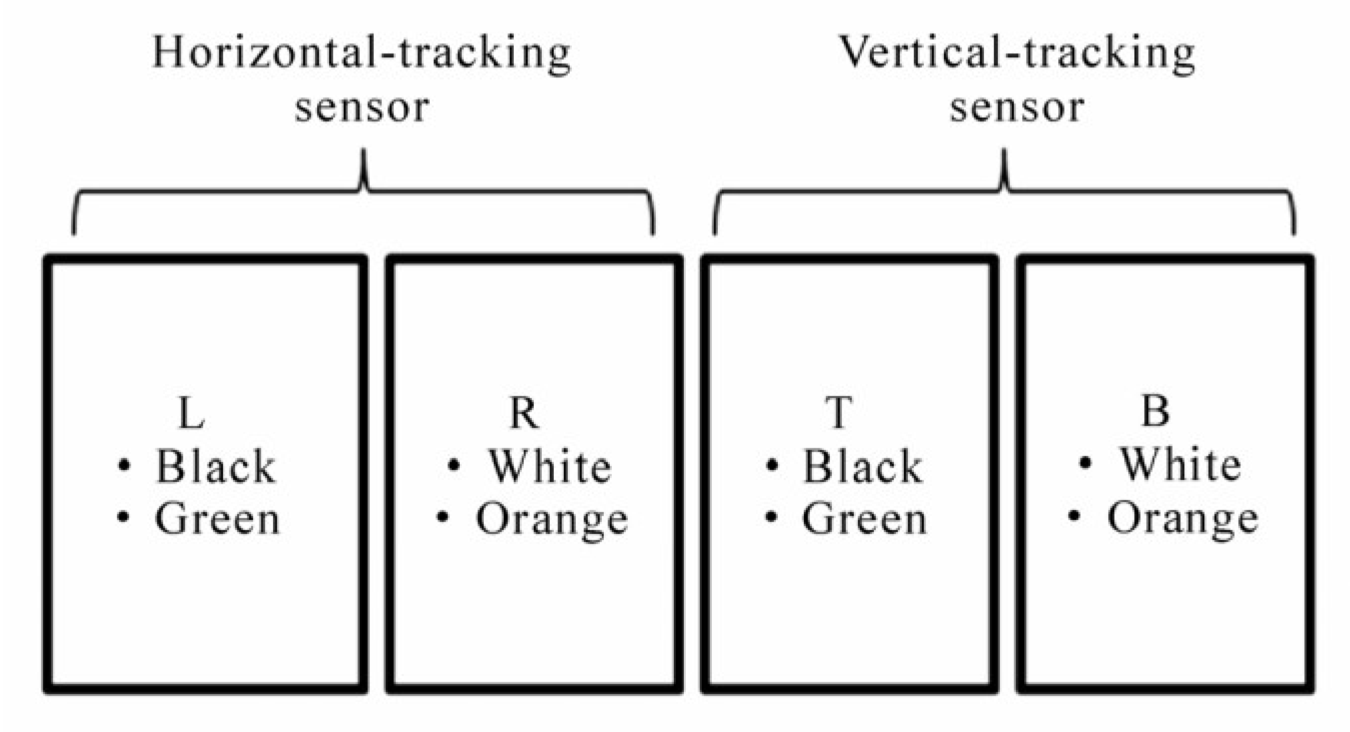


Figure18.Connectionofthecolouredwiresfor the sensor.

Figure19.Thesolarpanels.

Figure20.Thechargecontroller.

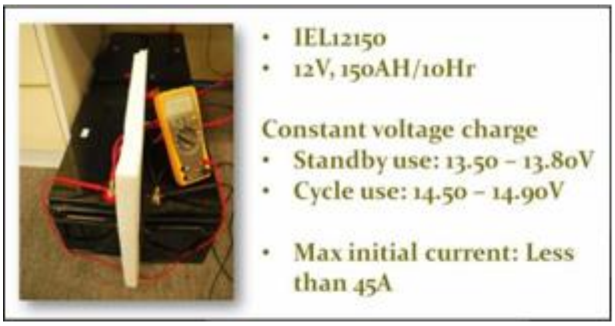


Figure21.Thebatterybank.

Figure22.Theinverter.

BatteryBank

Four12Vbatteriesareconnectedinseriestocreatea totaloutputvoltageof48V,showninFigure21.The wirefromthechargecontrolleristhenconnectedto the battery bankwhichenablesthebatteriestobecharged. Fromthebatterybank,awire isconnectedtotheinverter. Thenanotherwireis placeononeof the12Vbatteriesto powerthe12VDCloadssuchasthemotorsaswellas thecontrollercircuit.

Inverter,Isolator and Cut-offTimer

Theinverter,Figure22,convertsthe48DCvoltageof thebattery to230ACsinglephasevoltage topowerAC loads.Anisolatorisput inplaceto makemaintenance workonthesystemeasier.

Thecut-offtimer,Figure23,isa24-hourbasedtimer whichallowselectriccurrenttopassthroughatpre-set times.ThetimerispoweredusingACvoltagefromthe inverter.Thepurposeofthetimerisbecausetheframe holdingthesolarpanel has made morethanonefull rota- tiontothepointthatthecableswerealltwisted.Upon inspection,itwasdiscoveredthatthesensorrespondedto thestreetlightingsalonglakesidewhichwerelitafter sunset.Toovercometheproblem,acut-offtimerwas placedtocut-offtheelectricitysupplytothecontroller circuitbetweenjustbeforesunset(around6p.m.)until8 a.m.thenext morning. Thistimerisadjustable.
Itwasdiscoveredthatthestructuredid notrotateback to itsoriginalpositionjustbeforesunsetbecausethe magnet never triggered the limit switch because they nevercameincontact.Thepositionofthelimitswitch andthemagnetwasdeterminedby notingthetimeand position when thehorizontal tracking has reached its maximumfortheday.However,due to thevaryingde- greeofmovementofthesuninthesky throughoutthe

year,thepositionofthelimitswitchand magnetforto- dayisnotthesameasthepositioninthreeweekstime. To deal with this problem, the position of the limit switch was manuallyadjusted to correspond with the pathofthesetting sun.

Another problem which occurred was rain water startedtosipintotheLDRsalthoughthesensorholder has beencoveredwithsilicone.This was mostprobably due toinadequatesiliconeapplication.Hence,thesensor

Figure23.24-hourbasedtimerswitch.

wastakenapartandthe LDRs replaced.This time,sili- conewasagainappliedto thesensor holderand anextra plasticsheetwasputoverthesensor.

Outputand Loads

Theelectricityoutputfromthe inverterisasingle-phase sinusoidal230 VAC voltageat50 Hz.This wascon- firmedandverifiedby connectingtheoutputofthein- verterto anoscilloscope.Figure24showstheACvolt- agewaveform.

Whilethe aimofthisworkwastocreateadual-axis solar-trackingsolarpanelmount, neverthelesstheelec- tricityoutputderivedwastestedonafewACloadssuch aslightbulbs,computer monitorand CPU,and aspot- light.Meanwhile,theACvoltageisalsousedtopower thecut-offtimer.TheDCvoltagederivedfromoneof the12Vbatteriesisusedtopowerthecontrollercircuit aswellas themotors.

VII. SUGGESTIONS

Itissuggestedto:

•Applygreasetothegears andchains.

•Paintstructure.

•Inspectforwateringressintocontrollerboxandsen- sor.

•Change plasticsheetoverthesensorfromtimeto time.

•Positionoflimitswitchesandmagnetneedstobe adjustedfromtimetotime

Itisrecommendedtomakethismaintenanceevery2 monthsoraftereverysession ofheavyrain,tocheck lightsensors,timersensors,alljunctions,ironandcable

connections 2009/06/solar-trackers-facing-the-sun

VIII. CONCLUSIONS

Theobjectiveofthispilotprojecttodesign,fabricate and

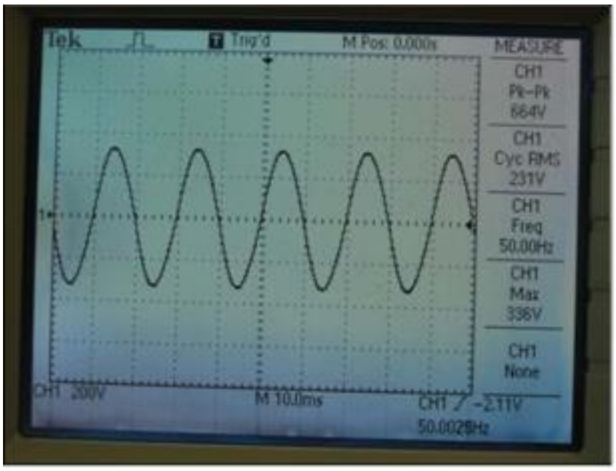


Figure24.Thevoltagewaveformof theoutputACvoltage formtheinverter.

installasolarpanel mount withdual-axissuntracking capabilityhasbeenachieved.Theworkwasmadepossi- ble throughthecooperationandinvolvementofmany differentparties.Planningandcommunicationskills wereessentialtoensurethat theprojectwentsmoothly.
Thereisstillroomforimprovementforthissystemandit ishopedthat furtherstudycanbecarriedouttofurther developthesystem.Improvementscanbedone tothe designofthestructure,forexamplebyaddingcoversfor the motors andalsoimprovingthedesignofthesensor holderbymakingitwaterproof.Besidesthat,improve- mentscanbe madetothecurrentmethodofturningback theframetoitsoriginalposition,removingtheneedto manuallyadjustthelimitswitches.Also,a detailedstudy shouldbecarriedouttoascertainthepercentageincrease ofelectricityyieldbyusingthissystemtoestablish whetherornot thesystemisviable.

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