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ΕΛΛΗΝΙΚΟ ΜΕΣΟΓΕΙΑΚΟ
ΠΑΝΕΠΙΣΤΗΜΙΟ

ΕΛ.ΜΕ.ΠΑ.

ΣΧΟΛΗ ΜΗΧΑΝΙΚΩΝ

ΤΜΗΜΑ ΗΛΕΚΤΡΟΝΙΚΩΝ
ΜΗΧΑΝΙΚΩΝ

ΗΛΕΚΤΡΟΝΙΚΑ ΣΥΣΤΗΜΑΤΑ
ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ &
ΑΥΤΟΜΑΤΙΣΜΟΥ (TeleAutoS)

ΔΙΠΛΩΜΑΤΙΚΗΕΡΓΑΣΙΑ
-------- THESIS -------

Απομακρυσμένος Έλεγχος & Διαχείρισης Αυτόνομων Ενεργειακά Καταναλώσεων

Ονοματεπώνυμο: **Εμμανουήλ Ι. Καπασάκης**

Εισηγητής: **Δρ. Αντώνιος Κωνσταντάρας**

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ΘΕΜΑ ΜΕΤΑΠΤΥΧΙΑΚΗΣ ΕΡΓΑΣΙΑΣ

(Ελληνικά):

Απομακρυσμένος έλεγχος & διαχείρισης αυτόνομων ενεργειακά εγκαταστάσεων

(Αγγλικά):

Remote control & management of autonomous energy systems

Η εργασία αυτή είναι πρωτότυπη και εκπονήθηκε αποκλειστικά και μόνο για την απόκτηση του συγκεκριμένου μεταπτυχιακού

ΠΕΡΙΛΗΨΗ ΘΕΜΑΤΟΣ ΕΡΓΑΣΙΑΣ:

Το internet στης μέρες μας έχει μπει για τα καλά στη ζωή μας. Σχεδόν όλοι έχουμε δυνατότητα πρόσβασης στο διαδίκτυο μέσο κινητών τηλεφώνων tablet κ.α. μέσα. Μια άλλη τεχνολογία που αυτήν τη στιγμή βρίσκει ευρύ πεδίο εφαρμογών είναιτο InternetOfThinks (IOT). Στην ουσία μπορούμε να ελέγχουμε και να χειριζόμαστεσυσκευές , μηχανές ,κατοικίες κ.α. από το internet μέσω εφαρμογών που επικοινωνούμε με hardware που έχουν εγκατασταθεί στο αντικείμενο που ελέγχουμε ή χειριζόμαστε.
Η συγκεκριμένη εργασία επικεντρώνεται στη αυτόνομα ενεργειακά εγκαταστάσεις με σκοπό να βελτιώσει την ενεργειακή απόδοση, τον απομακρυσμένο έλεγχο για την εξακρίβωση δυσλειτουργιών και βλαβών και την εύκολη και γρήγορη εκπαίδευση των χρηστών μιας τέτοιας εγκατάστασης απλά μαθαίνοντας ακόμα μια εφαρμογή.

Κίνητρο για τη Διεξαγωγής τις εργασίας:

Σαν Ηλεκτρολόγος Μηχανικός τα τελευταία 12 χρόνια μια από τις επαγγελματικές μου δραστηριότητες είναι να Μελετώ, Εγκαθιστώ και να Βελτιώνω αυτόνομες ενεργειακά κατοικίες.

Η εμπειρία μου έχει δήξει ότι η αυτόνομα ενεργειακά καταναλώσεις και κυρίως αυτές που χρησιμοποιούν Ανανεώσιμες πυγές ενέργειας χρήζουν την δυνατότητα απομακρυσμένου ελέγχους τόσο για την διακρίβωση τις εύρυθμης λειτουργίας και αντιμετώπιση τυχών δυσλειτουργιών χωρίς να είναι απαραίτητη η φυσική παρουσία στο χώρο όσο και για την γρήγορη και εύκολη εκπαίδευση των χρηστών (κάτοικων αυτόνομων κατοικιών, επιβλέπων αυτόνομων ενεργειακά αντλιοστασίων κ.α.).

Ένα άλλο πρόβλημα που αντιμετωπίζουν οι αυτόνομες ενεργειακά εγκαταστάσεις είναι συντονισμού και ενεργειακής διαχείρισης πολλές φορές έχουμε περίσσια ενέργεια που από τη στιγμή που δεν την καταναλώνουμε χάνετε και άλλες φορές η ενέργεια που έχουμε από ΑΠΕ δεν επαρκεί εξαντλώντας τα ενεργειακά αποθέματα που έχουμε στα συστήματα αποθήκευσης.

ΕΙΣΑΓΩΓΗ:

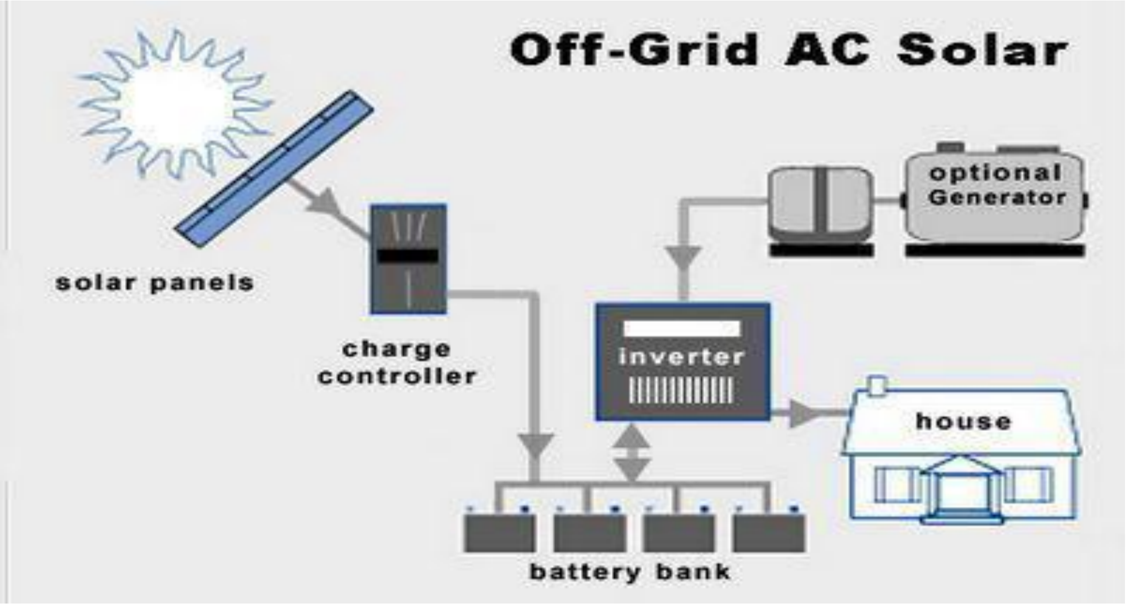
Σε μια αυτόνομη ενεργειακά κατανάλωση η παραγωγής ηλεκτρικής ενέργειας είναι απαλλαγμένη από τα αυξημένα κόστη των τιμολογίων της ΔΕΗ, μας εξασφαλίζει ενεργειακή αυτάρκεια και ανεξαρτησία ιδίως σε μέρη όπου δεν είναι επαρκής η σύνδεση με το υπάρχον δίκτυο της ΔΕΗ. Μπορούμε να τα κατηγοριοποιήσουμε σε δυο (2) κατηγορίες:

1. Για Αυτόνομη *παραγωγή ηλεκτρικής ενέργειας με φωτοβολταϊκά*
2. Για Αυτόνομη *παραγωγή ηλεκτρικής ενέργειας* με συνδυασμό *φωτοβολταϊκών* και μιας δεύτερης πηγής ρεύματος, τα λεγόμενα υβριδικά. Σε αυτή την περίπτωση μπορούμε να χρησιμοποιήσουμε σαν συμπληρωματική πηγή ενέργειας με ανεμογεννήτρια, υδρογεννήτρια, ηλεκτρογεννήτρια κ.α.

Μια φωτοβολταϊκή Διάταξη απαρτίζεται από τα εξής τμήματα:

1. Φωτοβολταϊκά πλαίσια
2. Ρυθμιστής φόρτισης μπαταριών
3. Μπαταρίες
4. Αντιστροφέας τάσης (*Inverter)*

Προαιρετικά ανεμογεννήτρια ή ηλεκτρογεννήτρια



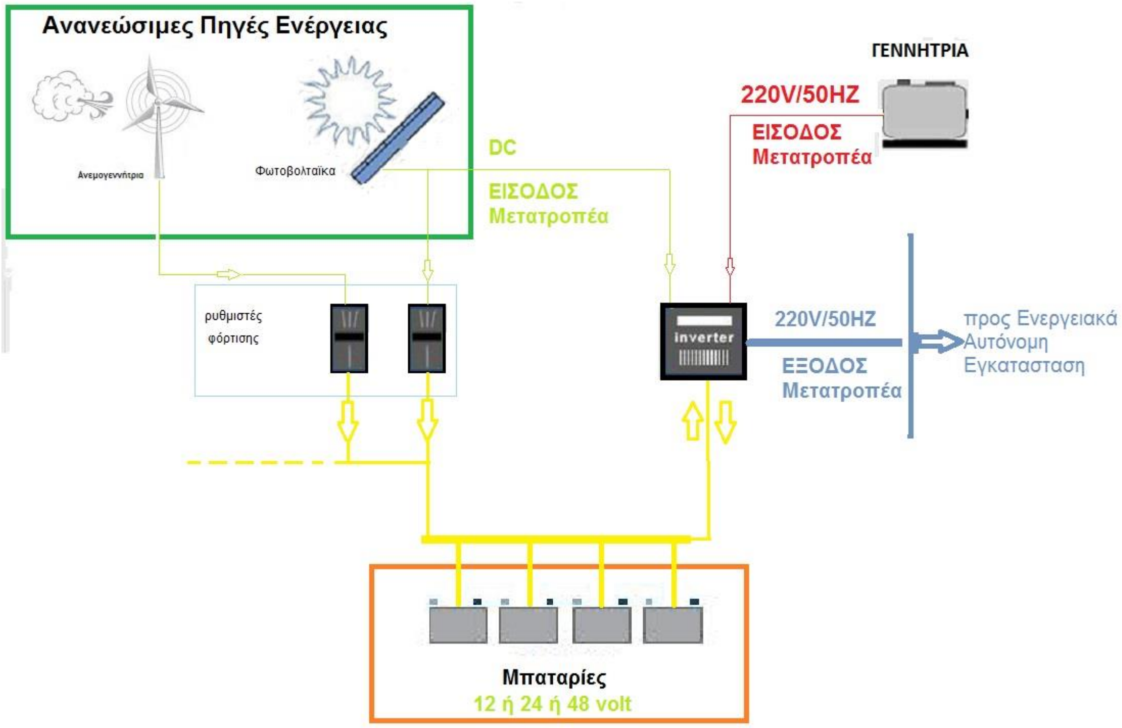
ΠΙΝΑΚΑΣ ΠΕΡΙΕΧΟΜΕΝΩΝ

ΚΕΦΑΛΑΙΟ 1 Αυτόνομη Ενεργειακά Κατανάλωση

Η αρχή λειτουργίας είναι η εξής όπως πέφτουν οι ακτίνες του ήλιου πάνω στο πλαίσιο των φωτοβολταϊκών επειδή τα φωτοβολταϊκά είναι ευαίσθητα (φωτοευαίσθητη επιφάνεια) στον ήλιο με την πτώση του φωτός γίνονται ομοιοπολικοί δεσμοί εσωτερικά και το αποτέλεσμα είναι να εμφανίζεται ρεύμα στα άκρα. Στην συνέχεια το ρεύμα αυτό θα πάει στον *ρυθμιστή φόρτισης* και από εκεί πάει θα στις *μπαταρίες*. Μέχρι και τις μπαταρίες το ρεύμα είναι *συνεχές* (*DC*). Επειδή όμως οι περισσότερες συσκευές λειτουργούν με *εναλλασσόμενο* ρεύμα *220 Volt*, χρησιμοποιούμε τους λεγόμενους αντιστροφής τάσης (*inverters*).

Σε μια ενεργειακή κατανάλωση ηλεκτρικού ρεύματος η εγκατάσταση περιορίζεται μόνο στο κομμάτι των καταναλώσεων ενώ σε μια αυτόνομαηλεκτρικήκατανάλωση η εγκατάστασηπεριλαμβάνει και το κομμάτιπαραγωγής, αποθηκεύεις και μετατροπής ηλεκτρικήςενέργειας.

Η παραγωγή συνήθως γίνεται με ανανεώσιμες πηγές ενέργειας για την αποθηκεύεις χρησιμοποιούμεσυστοιχίεςμπαταριών, ενώ για τη μετατροπή καθιστούνε ειδικοί μετατροπείς ενέργειας.



Εικόνα 1.Αυτόνομα Ενεργειακά Εγκατάσταση

1.1 Μέρη που Αποτελείται Μια Αυτόνομα Ενεργειακά Κατανάλωση.

1.1.1. Πηγές Ενέργειας

Πηγή:http://www.ypeka.gr

1.1.1 Ανανεώσιμες Πηγές Ενέργειας

Ανανεώσιμες Πηγές Ενέργειας (ΑΠΕ) είναι οι μη ορυκτές ανανεώσιμες πηγές ενέργειας, δηλαδή η αιολική, η ηλιακή και η γεωθερμική ενέργεια, η ενέργεια κυμάτων, η παλιρροϊκή ενέργεια, η υδραυλική ενέργεια, τα αέρια τα εκλυόμενα από χώρους υγειονομικής ταφής, από εγκαταστάσεις βιολογικού καθαρισμού και το βιοαέριο, όπως ορίζει η ΟΔΗΓΙΑ 2001/77/ΕΚ

α) Ηλιακή ενέργεια

Εικόνα 1.1.1 Φωτοβολταϊκά σε στέγη

Με τον όρο Ηλιακή Ενέργεια χαρακτηρίζουμε το σύνολο των διαφόρων μορφών ενέργειας που προέρχονται από τον Ήλιο. Το φως και η θερμότητα που ακτινοβολούνται, απορροφούνται από στοιχεία και ενώσεις στη Γη και μετατρέπονται σε άλλες μορφές ενέργειας. Η τεχνολογία σήμερα αξιοποιεί ένα μηδαμινό ποσοστό της προσπίπτουσας στην επιφάνεια του πλανήτη μας ηλιακής ενέργειας με τριών ειδών συστήματα: τα θερμικά ηλιακά, τα παθητικά ηλιακά και τα φωτοβολταϊκά συστήματα .

Οι φωτοβολταϊκες γεννήτριες (φωτοβολταϊκα)λόγο καλής απόδοσης παρέχουν την κύρια πυγή ενέργειας στα αυτόνομα ενεργειακά συστήματα.

Τα φωτοβολταϊκά στοιχεία χωρίζονται σε δυο βασικές κατηγορίες

1. Κρυσταλλικού Πυριτίου [1]

- Μονοκρυσταλλικού πυριτίου, με ονομαστικές αποδόσεις πλαισίων 14,5% έως 21%,
- Πολυκρυσταλλικού πυριτίου, με ονομαστικές αποδόσεις πλαισίων 13% έως 14,5%.

2. Λεπτών Μεμβρανών

- Άμορφου Πυριτίου, ονομαστικής απόδοσης ~7%.
- Χαλκοπυριτών CIS / CIGS, ονομαστικής απόδοσης από 7% έως 14%.

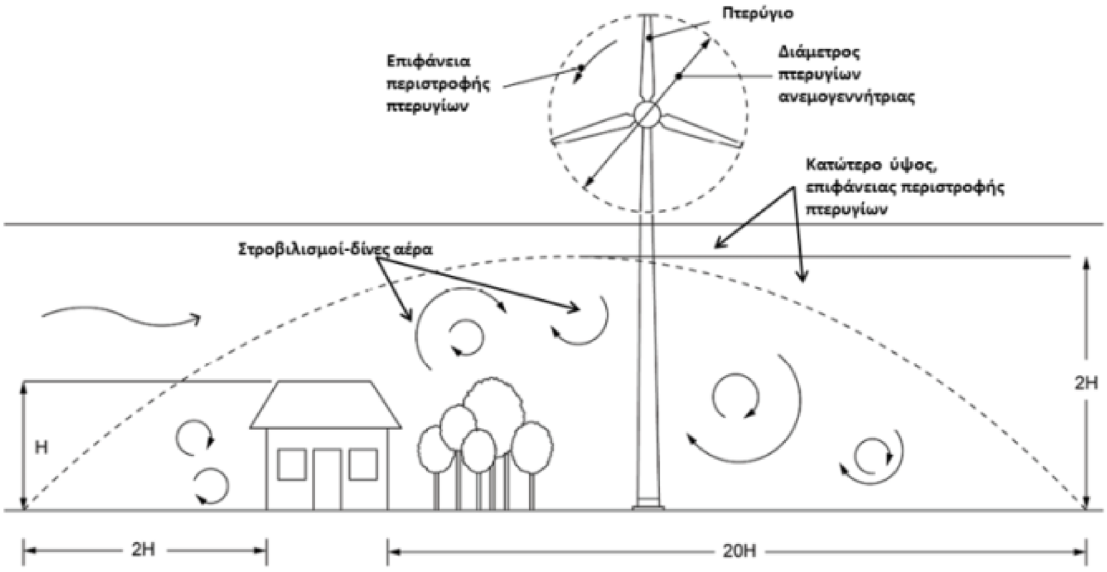
Η γνώση που προέκυψε έτσι για το πυρίτιο, τα χαρακτηριστικά του και η αφθονία του στη γη, το κατέστησαν ικανό και συμφέρον μέσο για την εκμετάλλευση της ηλιακής ενέργειας. [1] Εντούτοις, λόγω του ότι είναι εύθραυστο, το πυρίτιο απαιτεί τον σχηματισμό στοιχείων σχετικά μεγάλου πάχους.[1] Αυτό σημαίνει ότι μερικά από τα ηλεκτρόνια που απελευθερώνονται μετά την απορρόφηση της ηλιακής ενέργειας πρέπει να ταξιδέψουν μεγάλες αποστάσεις για να ενταχθούν στην ροή του ρεύματος και να συνεισφέρουν στο ηλεκτρικό κύκλωμα.[1] Συνεπώς, το υλικό θα πρέπει να έχει υψηλή καθαρότητα και δομική τελειότητα, ώστε να αποτρέψει την επιστροφή των ηλεκτρονίων στις φυσικές τους θέσεις. [1] Οι ατέλειες πρέπει να αποφευχθούν ώστε η ενέργεια του ηλεκτρονίου να μην μετατραπεί σε θερμότητα.[1] Η παραγωγή θερμότητας, η οποία είναι επιθυμητή στα ηλιακά θερμικά πλαίσια, όπου αυτή η θερμότητα μεταφέρεται σε ένα ρευστό, είναι ανεπιθύμητη στα Φ/Β πλαίσια, όπου η ηλιακή ενέργεια θα πρέπει να μετατραπεί σε ηλεκτρική.[1]

- Το πυρίτιο, ανάλογα με την επεξεργασία που έχει γίνει σε αυτό, δίνει μονοκρυσταλλικά, πολυκρυσταλλικά ή άμορφα υλικά, από τα οποία παράγονται τα Φ/Β στοιχεία. [1] Το αποτέλεσμα είναι αυτά τα λεπτά υλικά έτσι ώστε να μειωθεί το κόστος των Φ/Β πλαισίων και να αυξηθεί η απόδοσή τους.[1] Εκτός από τη χρήση μικρότερης ποσότητας υλικού, ένα άλλο πλεονέκτημα είναι ότι ολόκληρα πλαίσια μπορούν να κατασκευαστούν παράλληλα με τη διαδικασία απόθεσης. [1] Αυτό είναι συμφέρον οικονομικά, αλλά επίσης πολύ απαιτητικό τεχνικά, επειδή η επεξεργασία χωρίς ατέλειες αφορά μεγαλύτερη επιφάνεια.[1].

  Πηγή:wikipedia
  https://el.wikipedia.org/wiki/%CE%A6%CF%89%CF%84%CE%BF%CE%B2%CE%BF%CE%BB%CF%84%CE%B1%CF%8A%CE%BA%CE%AC [1]

β)Αιολική Ενέργεια

Μία καλή επιλογή για όσους θέλουν να ενισχύσουν τις Αυτόνομες Ενεργειακά Εγκαταστάσεις είναι να εγκαταλείψουμε την αιολική ενέργεια εγκαθιστώντας μία η περισσότερες μικρές ανεμογεννήτριες. Οι ανεμογεννήτριες είναι ηλεκτρικές γεννήτριες που χρησιμοποιούν την κινητική ενέργεια του ανέμου, για να παράξουν ρεύμα.



Εικόνα 1.2.2 ανεμογεννήτρια

γ)ΥδραυλικήΕνέργεια

Στις Αυτόνομες Ενεργειακά Εγκαταστάσεις είναι συνήθως μικρής ισχύος οπότε την υδραυλική ενέργεια μπορούν να τη εκμεταλλευτούν με μικρές υδρογεννήτριες. τύπου Pelton ή Turgo ή LH

1.1.1.2. Ηλεκτρογεννήτρια με Μηχανή Εσωτερικής Καύσης

Όταν η ενέργεια που μπορούμε να πάρουμε από τις Α.Π.Ε. δεν επαρκεί μπορούμε να ενεργοποιούμε μια γεννήτριαεσωτερικήςκαύσης (diesel,βενζίνη, υγραερίου) επικουρικά για να καλύψειενεργειακά τη εγκατάσταση.

1.1.2 Ρυθμιστής Φόρτισης

Οι ρυθμιστές φόρτισης αναλαμβάνουν τι να φορτίσουν σωστά τις μπαταριές από τις Α.Π.Ε. για να αποφύγουμε την ταχεία φόρτιση όπου γερνά τις μπαταρίες και την υπερφόρτιση που τις καταστρέφει.Οι πιο συνηθισμένοι ρυθμιστές είναι :

α) Ρυθμιστής φόρτισης τεχνολογίας PWM

β) Ρυθμιστής φόρτισης τεχνολογίας MPPT

1.1.3 DC/AC Μετατροπέας (Inverter)

Οι μετατροπείςDC/AC μετατρέπουν την συνεχές τάση από τις μπαταρίες σε εναλλασσόμενο για να είναι συμβατό με τις συμβατικές καταναλώσεις .

Τα κύρια χαρακτηριστικάενόςμετατροπέαείναι :

α) DC τάσηεισόδου= τάση της μπαταρίας

β) AC τάση εξόδου= τάση συμβατικών καταναλώσεων πχ 220 volt 50hz

γ) μέγιστη ισχύς εξόδου

Οι μετατροπείς μπορούν να κατηγοριοποιηθούν ε σε:

α)Μετατροπέαςτροποποιημένου ημίτονου

β)Μετατροπέας Καθαρού ημίτονου

γ)Μετατροπέας Καθαρού ημίτονου με φορτιστή από γεννήτρια

δ)Μετατροπέας Καθαρού ημίτονουμεφορτιστήαπό γεννήτρια και ρυθμιστή φόρτισης από φωτοβολταϊκά.

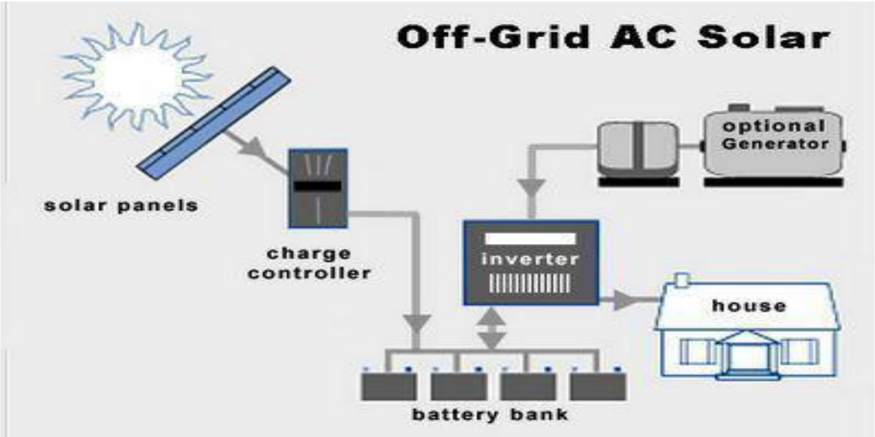
1.2Περιγραφήμιας Αυτόνομης Εγκατάστασης

Η λειτουργία μιας Αυτόνομης εγκατάστασης έχει ως εξής ,από τις **Α.Π.Ε.***(φωτοβολταϊκά, ανεμογεννήτριες, υδρογεννήτριες κ.α) παράγεται ενέργεια DC (συνεχές). Με την βοήθεια ενός η περισσότερων **ρυθμιστών φόρτισης**η ενέργεια που παράγεται από της **Α.Π.Ε** αποθηκεύεται με ασφάλεια** στις μπαταρίες. Οι μπαταρίες μπορεί να είναι 2 ή 4 ή 6 ή και 12 Voltκατάλληλα συνδεδεμένα μεταξύ τους ώστε να έχουμε συστοιχίες μπαταριών των 12 ή 24 ή και 48 Volt. Οι μπαταρίες μετά συνδέονται με τον inverterDC/AC που μετατρέπει το συνεχές σε εναλλασσόμενο. Όπου μετά από την έξοδο του inverterDC/AC πάει στις καταναλώσεις 220 V/ 50 Hz. O inverter επίσης μπορεί να συνδεθεί και με μια εξωτερική γεννήτρια Diesel ή Βενζίνης 220 V/50 Hz σε περίπτωση που δεν υπάρχειεπάρκεια ενεργείαςαπότις Α.Π.Ε. τότε μπορούμε να ενεργοποιήσουμε τη γεννήτρια. Όταν inverter δεχτεί στην είσοδο του 220 volt κάνει μεταγωγή σε γεννήτρια τις καταναλώσεις και ενεργοποιεί τον εσωτερικό φορτιστή για να φορτίσει τις μπαταριές από την ενέργεια που παράγει η γεννήτρια.

Το άλλο σενάριο είναι η έξοδος των φωτοβολταϊκών να οδηγηθεί κατευθείαν στον inverter με τον δικό του ρυθμιστή φόρτισης να φορτίσει τις μπαταριές εφόσον πρώτα καλύψει τις ενεργειακές ανάγκες των καταναλώσεων. Με αυτό τον τρόπο επειδή ένα μέρος τις ενεργείας που παράγεται καταναλώνεται αμέσως χωρίς να παρεμβάλλονται οι μπαταριές γλυτώνουμε κύκλους λειτουργιάς των μπαταριών και συνεπώς αυξάνεται το προσδόκιμο ζωής τους.

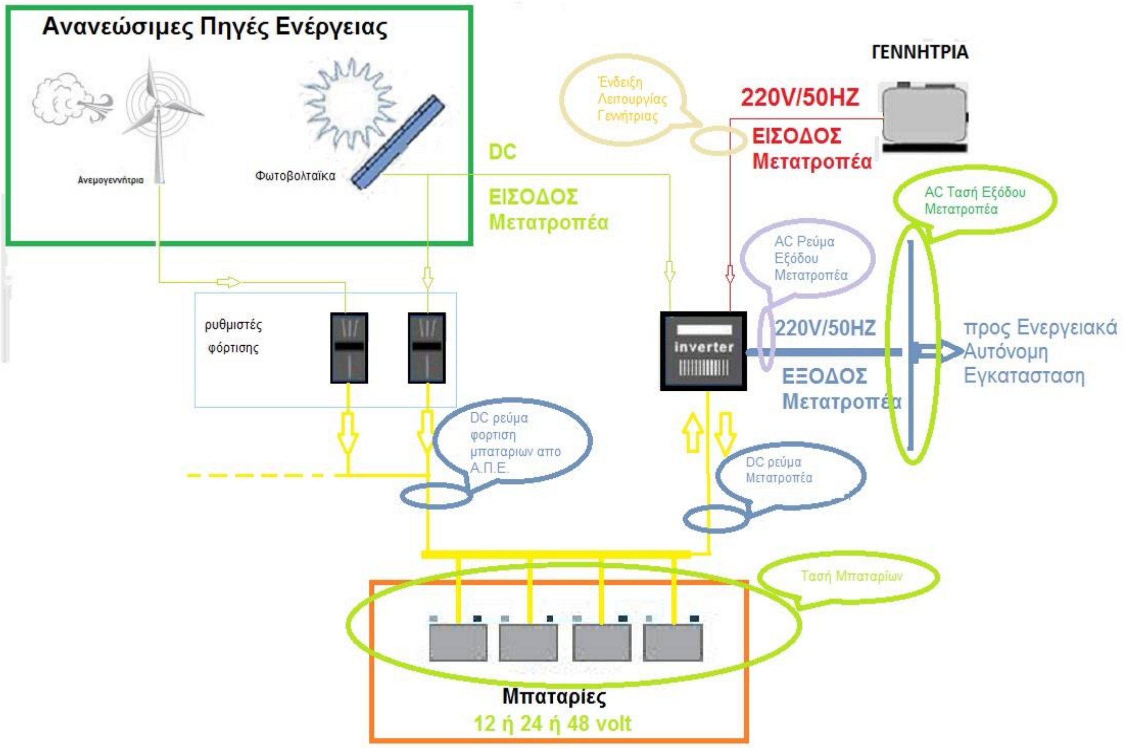
* Α.Π.Ε.==> Ανανεώσιμες Πηγές Ενέργειας

** ο ρυθμιστής φόρτισης προστατεύει την μπαταρία από ταχεία φόρτιση και υπερφόρτιση



Εικόνα 1.2.1 Αυτόνομο Φωτοβολταϊκά Σύστημα

1.3 ΣημείαΕλέγχουΜεγεθών (I,VAC/DC)



Εικόνα 1.3 Σημεία ελέγχουΑυτόνομωνΕνεργειακά Συστημάτων

1.3.1 **Σημείο ελέγχου 1** : Ρεύμαφόρτισηςμπαταριώναπό ΑΠΕ

Με την ένδειξη αυτή μπορούμε να διαπιστώσουμε αν οι Α.Π.Ε. παράγουν την αναμενόμενη ενέργεια για να καλύψει τις ενεργειακά τις καταναλώσεις καθώς και αν ο ρυθμιστής φόρτισης λειτουργεί κανονικά.

1.3.2 **Σημείο ελέγχου 2** : Τάση μπαταριών

Η τάση των μπαταριώνείναιενδεικτική τις απομένουσαςενέργειας που έχουμε στην διάθεση μας. Μπορούμε επίσης να δούμε αν οι φορτιστές υπερφορτίζουν τις μπαταρίες ανεβάζοντας την τάση τους πάνω από ένα επιτρεπτό όριο.

1.3.3 **Σημείο ελέγχου 3** : DC Ρεύμα Μετατροπέα inverter

Το ρεύμα του μετατροπέα μπορεί να είναι αμφίδρομο γιατί το inverterπαρά την αποφόρτιση των μπαταριών μπορεί και να τις φορτίσει από τον εσωτερικό φορτιστή μέσω γεννήτριας καθώς και με φωτοβολταϊκα μέσω του εσωτερικού ρυθμιστή φόρτισης. Η μέτρηση του DCρεύματος του inverterβλέπουμε αν είναιεπαρκή και σωστή η φόρτιση των μπαταριώναπόγεννήτρια και Α.Π.Ε. κατά την φόρτιση(αρνητικόπρόσημορεύματος) καθώς και την ισχύ τις κατανάλωσηςκατά τη αποφόρτιση των μπαταριών (θετικόπρόσημορεύματος).

1.3.4 **Σημείο ελέγχου 4**: Λειτουργία γεννήτριας

Η ένδειξη αυτή μας επιβεβαιώνει αν η γεννήτρια λειτουργεί κατά την απομακρυσμένη ενεργοποίηση η αν έχει σταματήσει κατά τη απομακρυσμένη απενεργοποίηση,είναι έναfeedbackδιακρίβωσης των χειρισμών του χρήστη.

1.3.5 **Σημείο ελέγχου 5**: ACΡεύμα Μετατροπέα inverter

Το ACΡεύμα του inverterείναι ενδεικτικό τις ισχύς καταναλώσεων βασική ένδειξη για σωστή ενεργειακή διαχείριση από τους χρήστες

1.3.6 **Σημείο ελέγχου 6**: Τάση εξόδου inverter

Ο απομακρυσμένος έλεγχος τις τάσης εξόδου του inverterείναι απαραίτητη για την προστασία των καταναλώσεων. Όταν το inverterκάνει μεταγωγή σε γεννήτρια μπορούμε να ελέγξουμε και την τάση τις γεννήτριας.

Κεφάλαιο 2 σχεδιασμός κατασκευής

2.1 Τεχνικά χαρακτηριστικά Μικρ/γκτής (PIC 18F4685) Συνοπτικά

2.1.1 Ενεργειακές απαιτήσεις του μικροεπεξεργαστή PIC 18F4685

RunMode: 7,2μA ενεργοποιημένα περιφερειακά και CPU

IdleMode: έως 5,8μA ενεργοποιημένα περιφερειακά και CPU απενεργοποιημένη

SleepMode: κάτω από 0,1μA απενεργοποιημένα περιφερειακά και CPU

Timer1 :1,1 μA

watchdog :2,1μA

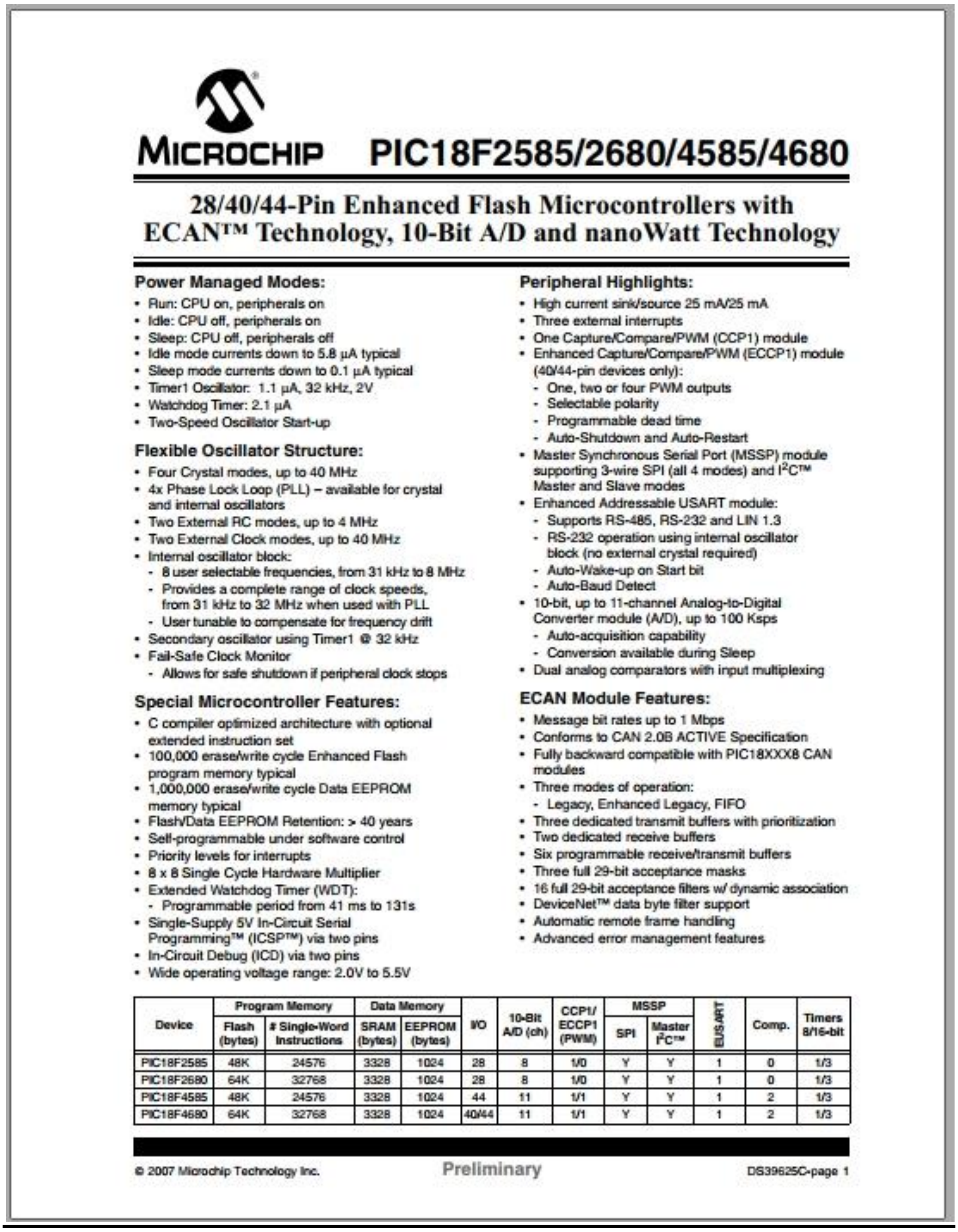
2.1.2 Εσωτερικός ταλαντωτής

χρησιμοποιώντας τον εσωτερικό κρύσταλλο για το χρονισμό έχουμε τη δυνατότητα να το ρυθμίσουμε από 31kHz έως 8MHz. Εάν εφαρμόσουμε τεχνική PLL η συχνότητα μπορεί να ρυθμιστεί από 31kHz έως 32MHz.

Ο Timer 1 έχει κρύσταλλο 32MHz.

2.1.3 ειδικά χαρακτηριστικά και Σημαντικά περιφερειακά του μικροεπεξεργαστή

- Ρεύμα ενεργοποίηση εισόδων και οδήγησης εξόδων 25μA
- Τρία εξωτερικά interrupt
- Μια είσοδος**CCP1** καταγραφής , συγκρίσεις ,PWM
- Μια είσοδος**ECCP1** καταγραφής , συγκρίσεως ,PWM
- **MSSP** (Master, Synchronous,Serial, Port) για**SPI** και **I^{2}P** επικοινωνίες
- **USART**για ασύγχρονες επικοινωνίες **RS232** και**RS485**



MICROCHIP

PIC18F2585/2680/4585/4680

28/40/44-Pin Enhanced Flash Microcontrollers with ECAN™ Technology, 10-Bit A/D and nanoWatt Technology

Power Managed Modes:

- Run: CPU on, peripherals on
- Idle: CPU off, peripherals on
- Sleep: CPU off, peripherals off
- Idle mode currents down to 5.8 µA typical
- Sleep mode currents down to 0.1 µA typical
- Timer1 Oscillator: 1.1 µA, 32 kHz, 2V
- Watchdog Timer: 2.1 µA
- Two-Speed Oscillator Start-up

Flexible Oscillator Structure:

- Four Crystal modes, up to 40 MHz
- 4x Phase Lock Loop (PLL) – available for crystal and internal oscillators
- Two External RC modes, up to 4 MHz
- Two External Clock modes, up to 40 MHz
- Internal oscillator block:
  - 8 user selectable frequencies, from 31 kHz to 8 MHz
  - Provides a complete range of clock speeds, from 31 kHz to 32 MHz when used with PLL
  - User tunable to compensate for frequency drift
- Secondary oscillator using Timer1 @ 32 kHz
- Fail-Safe Clock Monitor
  - Allows for safe shutdown if peripheral clock stops

Special Microcontroller Features:

- C compiler optimized architecture with optional extended instruction set
- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Flash/Data EEPROM Retention: > 40 years
- Self-programmable under software control
- Priority levels for interrupts
- 8 x 8 Single Cycle Hardware Multiplier
- Extended Watchdog Timer (WDT):
  - Programmable period from 41 ms to 131s
- Single-Supply 5V In-Circuit Serial Programming™ (ICSP™) via two pins
- In-Circuit Debug (ICD) via two pins
- Wide operating voltage range: 2.0V to 5.5V

Peripheral Highlights:

- High current sink/source 25 mA/25 mA
- Three external interrupts
- One Capture/Compare/PWM (CCP1) module
- Enhanced Capture/Compare/PWM (ECCP1) module (40/44-pin devices only):
  - One, two or four PWM outputs
  - Selectable polarity
  - Programmable dead time
  - Auto-Shutdown and Auto-Restart
- Master Synchronous Serial Port (MSSP) module supporting 3-wire SPI (all 4 modes) and I^2C™ Master and Slave modes
- Enhanced Addressable USART module:
  - Supports RS-485, RS-232 and LIN 1.3
  - RS-232 operation using internal oscillator block (no external crystal required)
  - Auto-Wake-up on Start bit
  - Auto-Baud Detect
- 10-bit, up to 11-channel Analog-to-Digital Converter module (A/D), up to 100 Ksps
  - Auto-acquisition capability
  - Conversion available during Sleep
- Dual analog comparators with input multiplexing

ECAN Module Features:

- Message bit rates up to 1 Mbps
- Conforms to CAN 2.0B ACTIVE Specification
- Fully backward compatible with PIC18XXX8 CAN modules
- Three modes of operation:
  - Legacy, Enhanced Legacy, FIFO
- Three dedicated transmit buffers with prioritization
- Two dedicated receive buffers
- Six programmable receive/transmit buffers
- Three full 29-bit acceptance masks
- 16 full 29-bit acceptance filters w/ dynamic association
- DeviceNet™ data byte filter support
- Automatic remote frame handling
- Advanced error management features

Device	Program Memory		Data Memory		I/O	10-Bit A/D (ch)	CCP1/ ECCP1 (PWM)	MSSP		EUSART	Comp.	Timers 8/16-bit
	Flash (bytes)	# Single-Word Instructions	SRAM (bytes)	EEPROM (bytes)				SPI	Master I^2C™			
PIC18F2585	48K	24576	3328	1024	28	8	1/0	Y	Y	1	0	1/3
PIC18F2680	64K	32768	3328	1024	28	8	1/0	Y	Y	1	0	1/3
PIC18F4585	48K	24576	3328	1024	44	11	1/1	Y	Y	1	2	1/3
PIC18F4680	64K	32768	3328	1024	40/44	11	1/1	Y	Y	1	2	1/3

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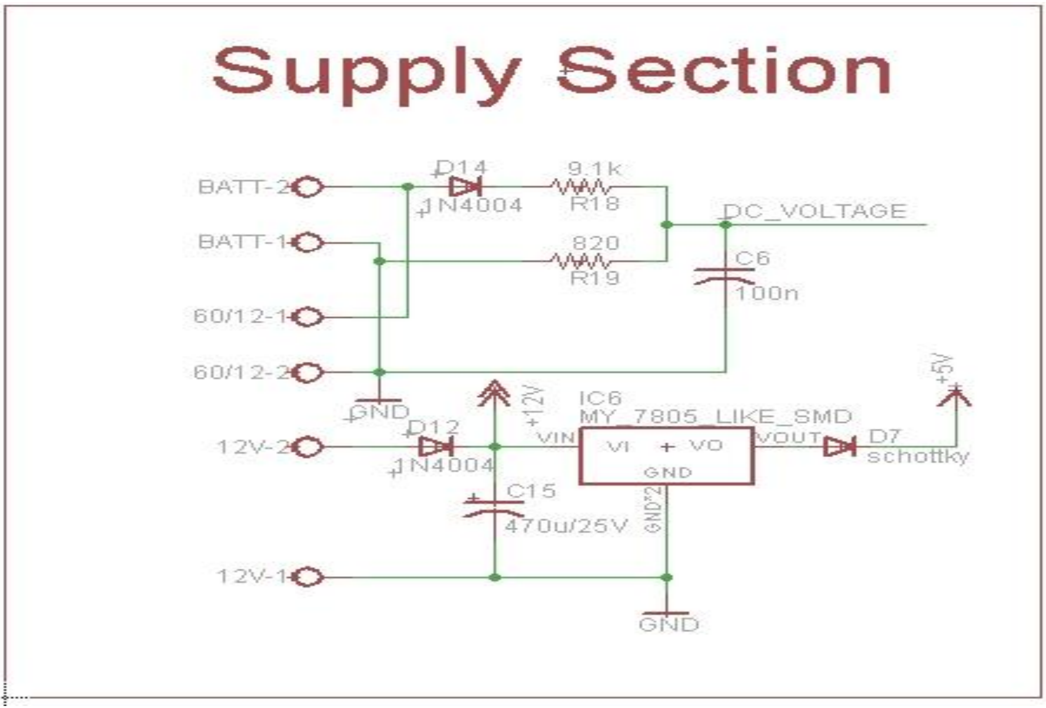
2.2 ΟρισμόςΕισόδων, Εξόδων(AI, DI, DO, MOSI, MISO , Rx, Tx, Int)

Στον παρακάτω πίνακα φαίνονται ο ορισμός του κάθε ποδιού του μικροεπεξεργαστή.

pin	NAME	MC	COMMENT	pin	NAME	MC	COMMENT
1		vpp	5 volt	21		RD2	DIGITAL INPUT
2	PV_CURRENT	AN0	ANALOG INPUT	22			
3	INV_CURRENT_1	AN1	ANALOG INPUT	23	MISO	MISO	SPI
4	INV_CURRENT_2	AN2	ANALOG INPUT	24	MOSI	MOSI	SPI
5	AC_CURRENT	AN3	ANALOG INPUT	25	TX	TX	INTRANET
6				26	RX	RX	INTRANET
7	AC_VOLTAGE	AN4	ANALOG INPUT	27	BUTTON_4	RD4	DIGITAL INPUT
8	DC_VOLTAGE	AN5	ANALOG INPUT	28	BUTTON_3	RD5	DIGITAL INPUT
9	RST	RE1	DIGITAL OUT FOR SPI	29	BUTTON_2	RD6	DIGITAL INPUT
10	CS	RE2	DIGITAL OUT FOR SPI	30	BUTTON_1	RD7	DIGITAL INPUT
11		VDD	5volt	31		VSS	GND
12		VSS	GND	32		VDD	5volt
13		CLKI	10MHG	33	INTERUP 0	INT0	DIGITAL INPUT from SPI
14		CLKO	10MHG	34	INTERUP 1	INT1	DIGITAL INPUT from BUTTONS
15	RL4	RC0	DIGITAL OUT	35			
16	RL3	RC1	DIGITAL OUT	36			
17	RL2	RC2	DIGITAL OUT	37			
18	SCK	SCK	CLOCK FOR SPI	38			
19	RL1	RD0	DIGITAL OUT	39		PGC	PROGRAMMING
20				40		PGD	PROGRAMMING

2.3 Εξασφάλιση Τροφοδοσίας 5 V(Μεθοδολογία)



Εικόνα 2.3 Εξασφάλιση Τροφοδοσίας 5 V

Ητροφοδοσίας τις κατασκευήςείναιαδιάλυτηαπό τις μπαταρίες τις αυτόνομηενεργειακάκατανάλωσης, η τάσητροφοδοσίαςείναι 12 voltμε κοινή κάθοδο έτσι όταν η μπαταρίαείναι 24 η 48 voltγια τροφοδοσία παίρνουμε μια μεσαία λήψη 12 volt.

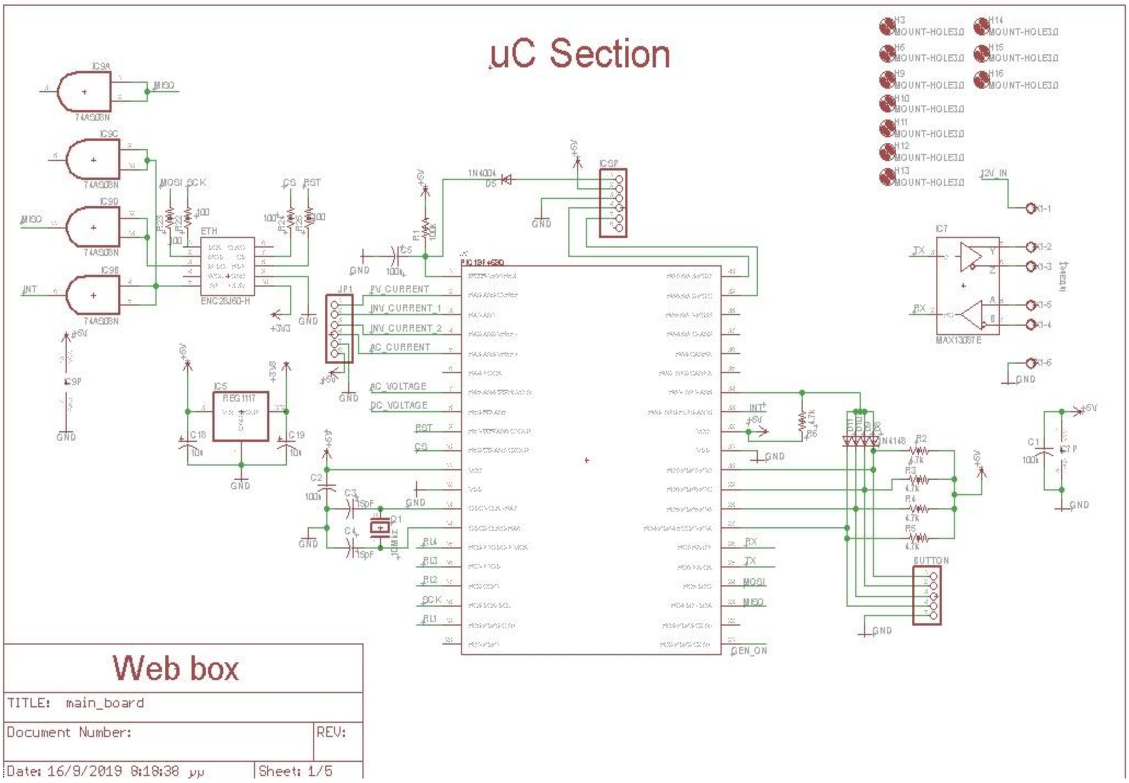
Η τάση λειτουργίας του μικροεπεξεργαστή είναι 5 voltπου τα παίρνουμε από την τάση τροφοδοσίας 12volt μέσο ενός regulatorlm7805.

2.4 Τρόπος Επικοινωνίας με το Internet

Την κατασκευή την έχουμεεξοπλίσει με το ENC28J60 Ethernetcontroller ο όποιοςπεριλαμβάνει και την SPIεπικοινωνία με τον μικροεπεξεργαστή.

Εικόνα 2.4 ENS28J60-H

2.5 Τρόπος Σύνδεσης Περιφερειακών (ENC28J60-H , MAX 13087E, ΚΡΥΣΤΑΛΛΟΣ 10 MHZ)



Εικόνα 2.5microcontroller section

2.5.1 Τρόπος Σύνδεσης Microcontrollerμε ENC28J60-H

Εισαγωγή στο SPI

Το SPI(SerialPeripheralInterface), όπως και το I2C αναπτύχθηκε με σκοπό την εύκολη επικοινωνία μεταξύ ολοκληρωμένων και τον καλύτερο τρόπο διασύνδεσης των περιφερειακών μονάδων και των μικροελεγκτών μεταξύ τους. Το Πρωτόκολλο **SPI**ή **SerialPeripheralInterfaceBus**επιτρέπει την σειριακή σύγχρονη επικοινωνία μεταξύ ολοκληρωμένων σε πλήρης αμφίδρομη επικοινωνία. Ο δίαυλος υλοποιήθηκε για πρώτη φορά από την εταιρία Motorola. Οι συσκευές επικοινωνούν μεταξύ τους σε modeMaster/Slave. OMaster του διαύλου είναι το ολοκληρωμένο που παράγει το frame των δεδομένων και το μεταδίδει προς τα ολοκληρωμένα slave. Μπορούν σε έναν SPI δίαυλο να διασυνδεθούν περισσότερες από μία συσκευές slave χρησιμοποιώντας

της γραμμές ChipSelect. Πολλές φορές το SPI το αποκαλούν "σειριακό δίαυλο 4 καλωδίων".
Το SPI επιτρέπει σε δεδομένα των 8-bits να αποστέλλονται σύγχρονα και ταυτόχρονα να λαμβάνονται σύγχρονα δεδομένα με ταχύτητα που φτάνει το 1Mbps.

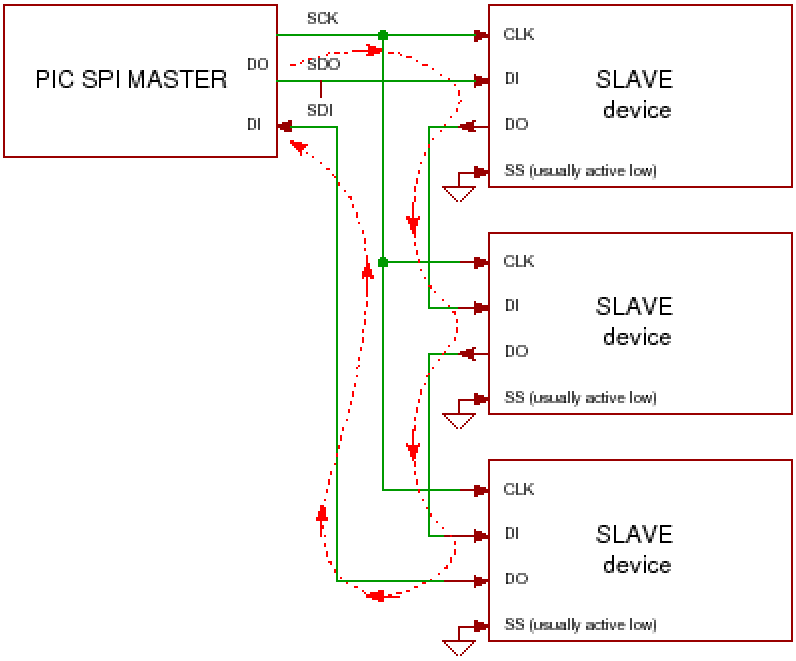
Για να επιτευχθεί επικοινωνία το SPI χρησιμοποιεί 4 ακροδέκτες:

1. Τον ακροδέκτη SDO(Σειριακά δεδομένα εξόδου)
2. Τον ακροδέκτη SDI(Σειριακά δεδομένα εισόδου)
3. Το σειριακό ρολόι (SCK)

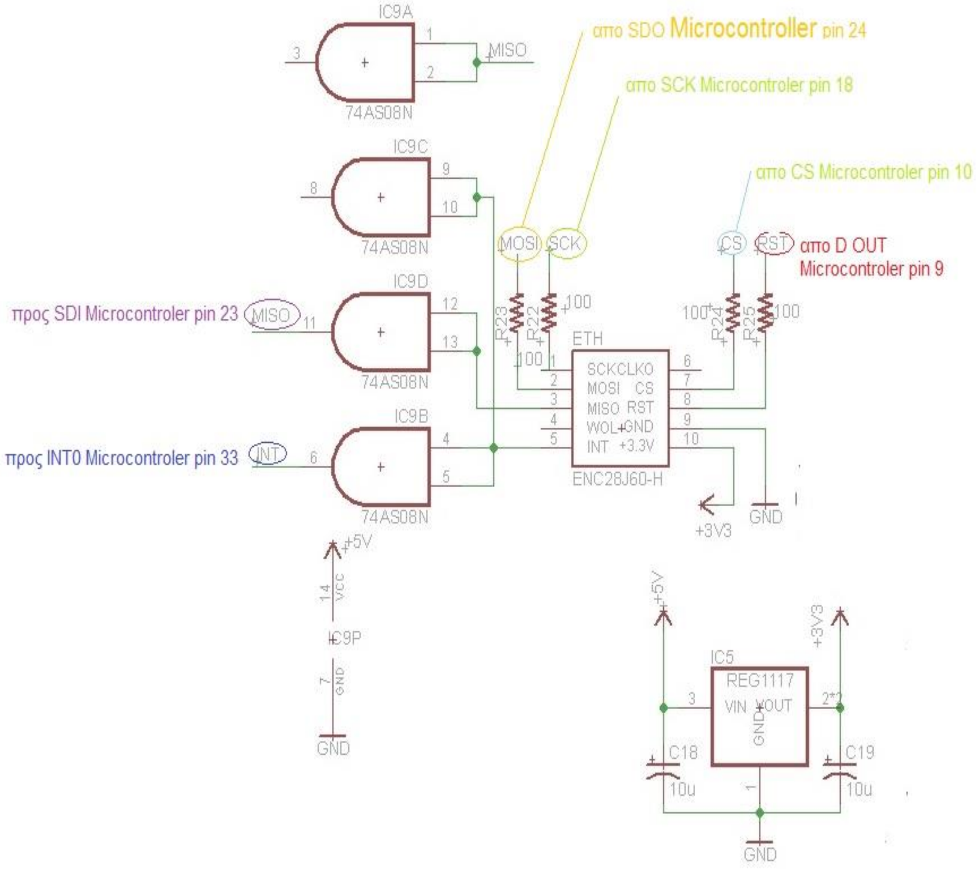
Επιπρόσθετα μπορεί να χρησιμοποιηθεί και ένας τέταρτος ακροδέκτης στην λειτουργία slave: Επιλογή slave (SS’). Σε όλες τις μεταφορές στο SPI το ψηφίο υψηλότερης αξίας στέλνεται πρώτο, όπως εξάλλου συμβαίνει και στο I2C. Όταν αρχικοποιείται το SPI, πρέπει να καθοριστούν ορισμένα χαρακτηριστικά.

Χαρακτηριστικά του SPI

1. Επιτρέπει την σύγχρονη επικοινωνία.
2. Είναι σειριακό.
3. Είναι πλήρως αμφίδρομο (full-duplex).
4. Δενείναι plug-and-play.
5. Υπάρχει ένας και μόνο ένας Master στον δίαυλο, ενώ μπορεί να υπάρξουν ένας ή περισσότεροι Slaves.



Εικόνα 2.5.1 SPI επικοινωνία

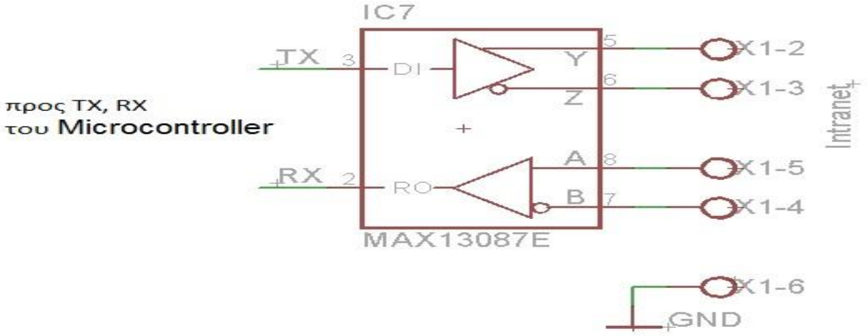


Εικόνα 2.5.1.1 Τρόπος Σύνδεσης Microcontrollerμε ENC28J60-H

Στα ποδαράκια του μικροεπεξεργαστή 24 MOSIκαι 23 MISO καθώς επίσης τα ποδαράκια 9 RST, 10 CS, 18 SCKκαι το ποδαράκι 33 INT(διακοπή) είναι για την επικοινωνία με το ολοκληρωμένο ENC28J60 – H που είναι υπεύθυνο για την επικοινωνία με τα router / webserver,επίσης αυτό το ολοκληρωμένο επικοινωνεί με τις πύλες AND που έχουν ως σκοπό την ψηφιακή ενίσχυση του σήματος διότι το ολοκληρωμένο ENC28J60 – Hλειτουργεί με 3,3 voltκαι εμείς θέλουμε 5 voltγια αυτό βάζουμε μετά τις πύλες και μετά οδηγούμαστε στον μικροεπεξεργαστή υC. Επίσης το ολοκληρωμένο ENC28J60 παίρνει τα 3,3 volt από τον regulatorREG 1117 που αυτό παίρνει 5 voltκαι τα κάνει 3,3 volt.

2.5.2 Τρόπος Σύνδεσης Microcontrollerμε το ολοκληρωμένο προστασίας πρωτόκολλου επικοινωνίας RS - 485MAX 13087E

Στο uCSection όπου βρίσκεται ο μικροεπεξεργαστής PIC18F4685 με τα 40 ποδαράκια (pin), στο ποδαράκι του μικροεπεξεργαστή 26 RXείναι λήψη σήματος που έρχεται από το ολοκληρωμένο MAX13087Eκαι στο ποδαράκι του μικροεπεξεργαστή είναι το 25 TXπου είναι η εκπομπή σήματος για το ολοκληρωμένο MAX13087E . Αυτό το ολοκληρωμένο εξασφαλίζει την ασφαλή επικοινωνία με τα άλλα τοπικά περιφερειακάμέσο intranet που θα γίνει με την βοήθεια καρτών επέκτασης.



Εικόνα 2.5.2 Τρόπος Σύνδεσης Microcontrollerμε MAX 13087E

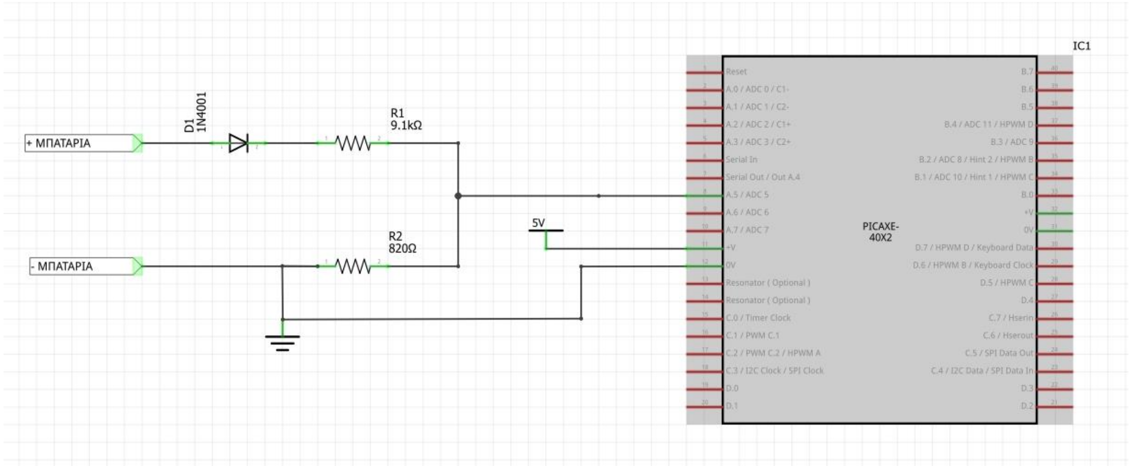
2.5.3 Τρόπος Σύνδεσης Microcontrollerμε Κρύσταλλο 10 MHZ

Ο χρονισμός του μικροεπεξεργαστή γίνεται με εξωτερικό κρύσταλλο 10Mhzο οποίος συνδέεται στο 13 pin (CLKI) και 14 pin (CLKO)

ΚΕΦΑΛΑΙΟ 3 Αισθητήρεςκαι Τεχνικές Μετρήσεων

Σε αυτό το κεφάλαιο θα αναλύσουμε τις τεχνικές δειγματοληψίας και μετρήσεις των μεγεθών από τα σημεία ελέγχους που έχουμε προαναφερθεί.

3.1 Μεθοδολογία Μέτρησης Τάσης Μπαταρίας (DC _VOLTAGEPIN 8)

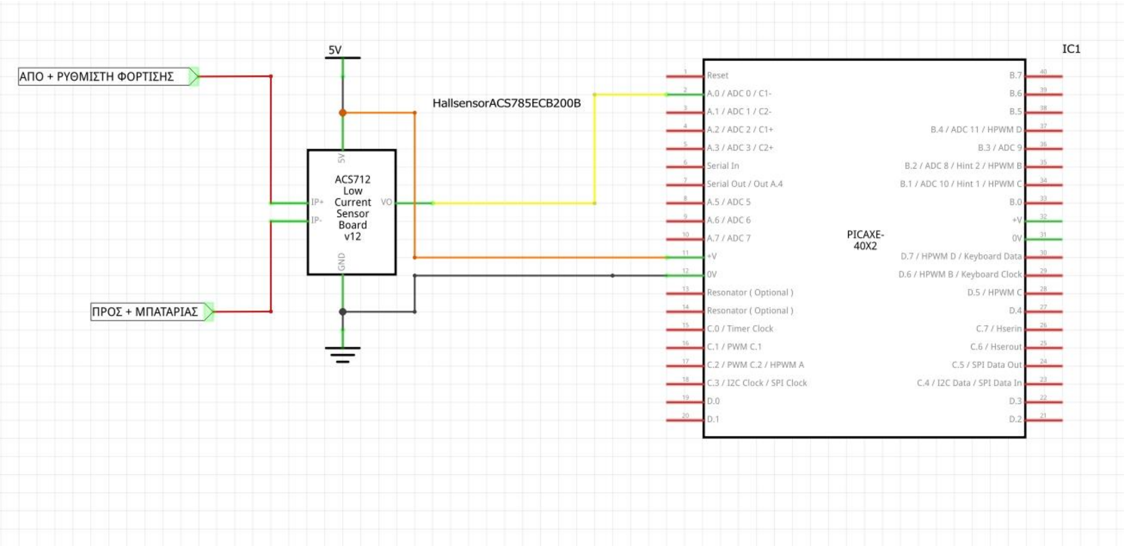


Εικόνα 3.1

Η τάση τις μπαταρίας ενός αυτονόμου ενεργειακά συστήματος μπορεί να είναι ή 12 ή 24 ή 48 volt. σε ένα σύστημα 48 volt η τάση μπορεί να φτάσει σε μια υποτιθέμενη υπερφόρτωση και τα 57 volt. Η αναλογική είσοδος του επεξεργαστή είναι 0-5 volt. φτιάχνοντας ένα διαιρετή τάσεις 9100/820 (R1/R2) 11,1 μπορούμε με κλιμακωτά να μετρήσουμε τη τάση τις μπαταρίας.

3.2 Μεθοδολογία Μέτρησης Έντασης Φόρτισης Μπαταρίας από Ανανεώσιμες Πηγές Ενέργειας(ΑΠΕ) (PV_CURRENTPIN 2)

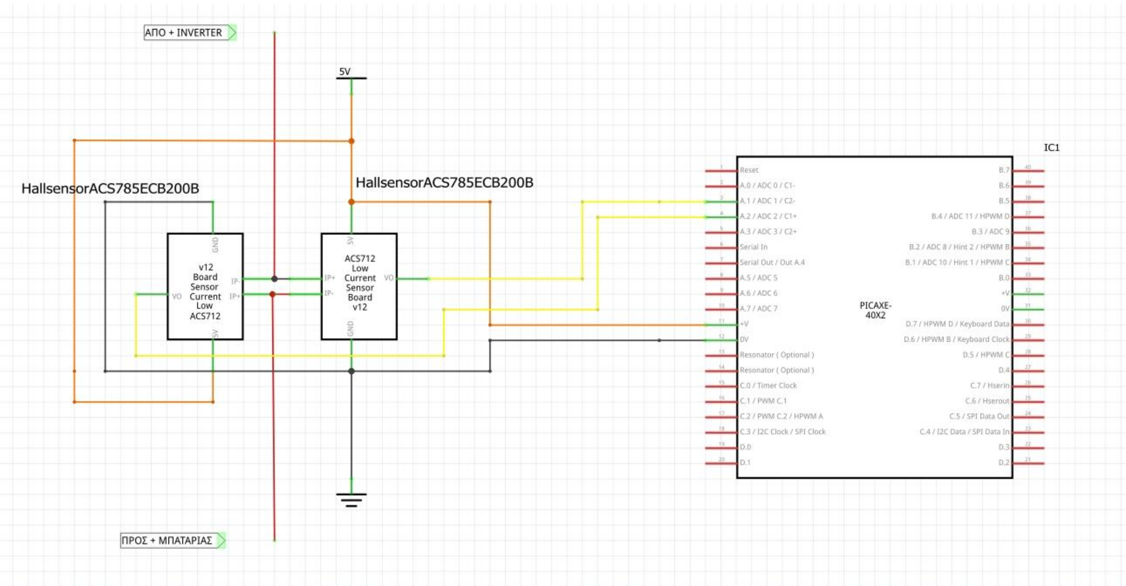
Για να μετρήσουμε το ρεύμαφόρτισης των μπαταριώναπό Α.Π.Ε. παρεμβάλουμεανάμεσαστουςρυθμιστέςφόρτισης και στις μπαταρίεςέναναισθητήραρεύματοςβασισμένο στο φαινόμενοHall. ο αισθητήραςείναι ο(HallsensorACS785ECB200B) ο οποίοςέχει την δυνατότηταανεξαρτήτωςτάσης να μετρήσειαπό -200 έως 200 Ampere



Εικόνα 3.2

3.3 Μεθοδολογία Μέτρησης DCΈντασηςINVERTER(INV_CURRENT1 PIN 3, INV_CURRENT2 PIN 4)

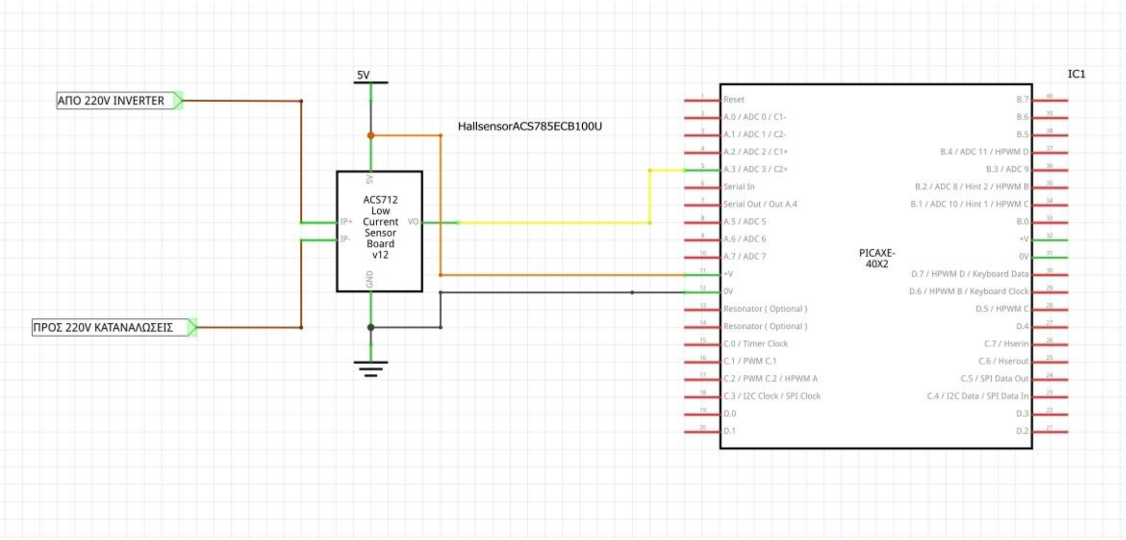
Για να μετρήσουμε τη DCρεύμα του inverterπαρεμβάλουμεανάμεσα στον inverter και στις μπαταρίες δυο αισθητήρεςρεύματοςHallACS785ECB200B που είναιικανοί να μετρήσουνρεύμαέως 400 Ampere και οι δυο μαζί



Εικόνα 3.3

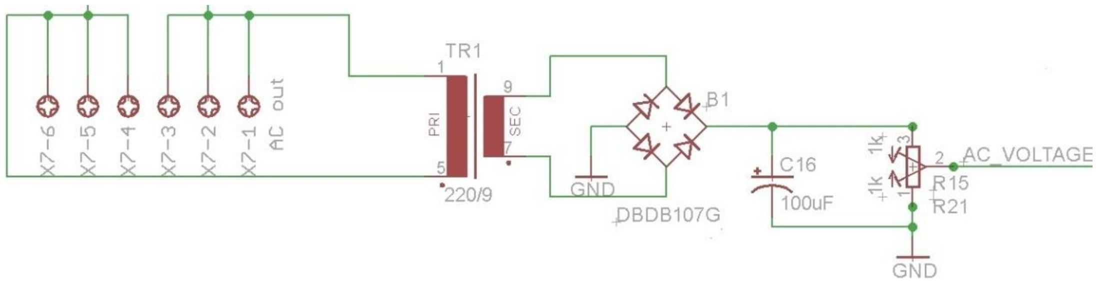
3.4 Μεθοδολογία Μέτρησης ACΈντασηςINVERTER(AC_CURRENTPIN 5)

Στην έξοδο του inverter σε έναΑπό τα δυο καλώδιαοποίοθέλουμεπαρεμβάλουμεέναΑισθητήρα (HallsensorACS758LB-100U) για να μετρήσουμε το ρεύμα που τραβά το φορτίο τη εγκατάστασης . ο αισθητήραςαυτόςέχει τη δυνατότητα να μετρήσειέως 100 Ampereεναλλασσόμενορεύμα η αντοχή του σε τάσηξεπερνάκατάπόλη τα 230 volt που έχουμε.



Εικόνα 3.4

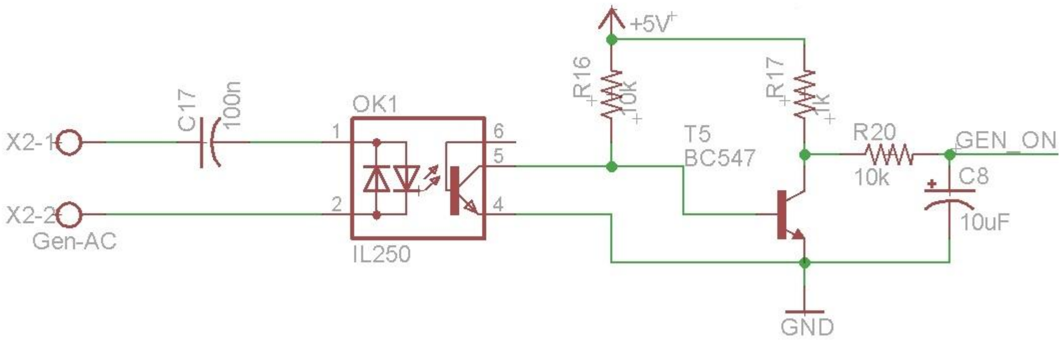
3.5 Μεθοδολογία Μέτρησης ACΤάσης INVERTER(AC_VOLTAGEPIN 7)



Εικόνα 3.5

Τα 220 voltαπό την έξοδο του inverter τα περνάμε από ένα μετασχηματιστή 220/9 στην συνάχια ανορθώνουμε την έξοδο του μετασχηματιστή και με το τριμερή 1ΚΩ ρυθμίζουμε την αναλογική είσοδο προς το μικροπωλητή συγκεκριμένηρύθμισηγίνεταιεμπειρικάτροφοδοτώντας με έναVariac το μετασχηματιστή και ελέγχουμε την τάση στο σημείοAC_VOLTAGE το Trimmer το ρυθμίζουμε μια φοράστα 2.5 v όταντροφοδοτούμε 220 volt το μετασχηματιστή οι υπόλοιπες ρυθμίσει γίνονται προγραμματιστικά.

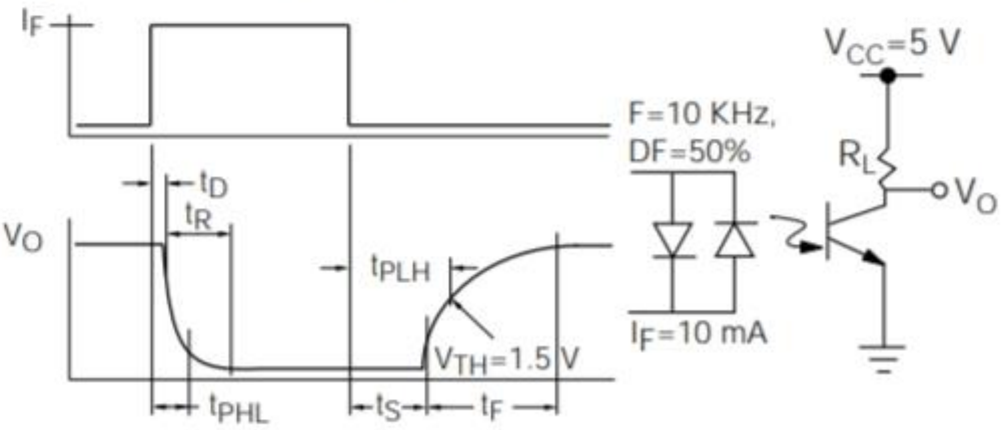
3.6 Μεθοδολογία Ελέγχου Λειτουργίας Γεννήτριας (GEN_ON)



Εικόνα 3.6

Στις κλέμμες x2-1 και x2-2 συνδέσουμε την έξοδο τις γεννήτριας 220 volt το ολοκληρωμένοIL250 είναιέναψηφιακόoptocoupler με φωτοδίοδο και φωτοτρανζίστορ. Όταν το φωτοτρανζίστορ έρθει στο κόροάρα οι φωτοδίοδοι διαρρέονται από ρεύμα I_Fτο τρανζίστορ T5 είναι σε κατάστασηαποκοπήςάρα η τάση στο σημείοGEN_ONείναι 5vόταν το I_Fείναι 0 το φωτοτρανζίστορείναι σε αποκοπή άρα το τρανζίστορ T5 άγει επομένως η τάση στο σημείο GEN_ON είναι 0v

Figure 14. Switching timing and schematic



Εικόνα 3.6.

ΚΕΦΑΛΑΙΟ 4 Έξοδοι Κατασκευής

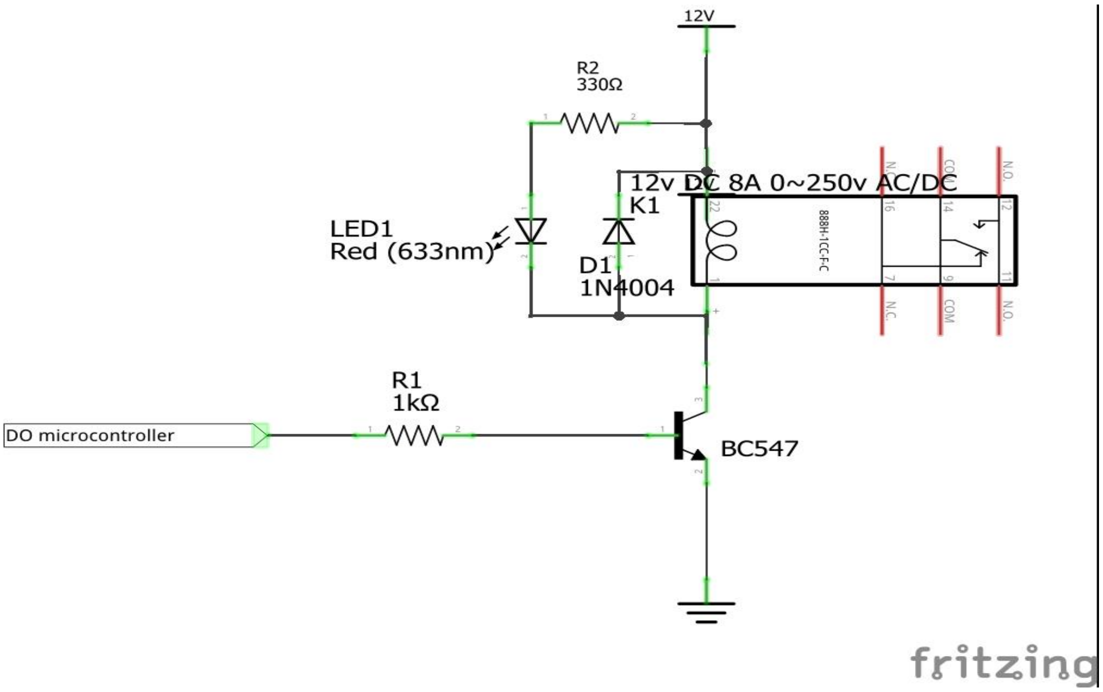
Στο κεφάλαιο αυτό έχουμε τις εξόδους της κατασκευής τις οποίες τις χρησιμοποιούμε για ενεργοποίηση – απενεργοποίηση καταναλώσεων καθώς και για την ενεργοποίηση της γεννήτριας. Οι έξοδοι είναι ψυχρές επαφές από ρελλέ.

4.1 Τεχνικάχαρακτηρίστηκα των ρελλέ

Τα ρελλέ που χρησιμοποιούμε είναι τύπουmini με πηνίο 12 voltdc και δυο επαφές NO 8A

4.2 Τεχνική Ενεργοποίησης των RELAY (Transistor) Από το MC

Για την ενεργοποίηση των Ρελλέ απαιτείται οδήγηση με transistorBC547 NPN από την έξοδο του μικροεπεξεργαστή PIC 18F4685. Όταν έρθει ένα σήμα +5v στη βάση του τρανζίστορ αυτό έρχεται σε κόρο με αποτέλεσμα να ενεργοποιεί το ρελλέ.



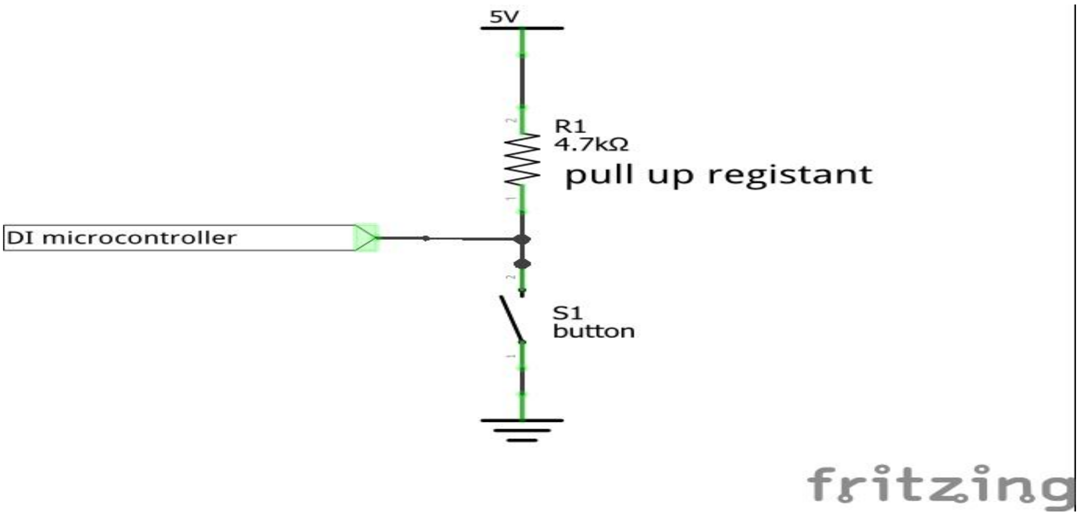
Εικόνα 4.2

Στην Βάση του τρανζίστορ παρεμβάλλεται μια αντίσταση 1 ΚΩ . Δέχεται 5 Vdcαπό το μCSectionόπου βρίσκεται ο μικροεπεξεργαστήςPIC 18F4685 και συγκεκριμένα το Ρελλέ 1 RL1 ενεργοποιείται από την έξοδο του μικροεπεξεργαστή στο ποδαράκι (pin 19) αντίστοιχα για το Ρελλέ 2 RL2 από την έξοδο του μικροεπεξεργαστή στο ποδαράκι (pin 17) ,αντίστοιχα για το Ρελλέ 3 RL3από την έξοδο του μικροεπεξεργαστή στο ποδαράκι (pin 16),αντίστοιχα για το Ρελλέ 4 RL4από την έξοδο του μικροεπεξεργαστή στο ποδαράκι (pin 15).

Χρησιμοποιούμε μια δίοδο IN4004 ανάστροφα πολωμένη μεταξύ των άκρων των πηνίων των Ρελλέ για προστασία των πηνίων των Ρελλέ από τα δινορεύματα. Για να οπλίσει το πηνίο του Ρελλέ πρέπει να πάρει 12 Vαπό την τάση τροφοδοσίας της πλακέτας,αλλά τελικά εφόσον το τρανζίστορ έρθει σε κόρο από τα 5Vdcπου θα πάρει από την έξοδο του μικροεπεξεργαστή.

4.3 Μπουτάν Τοπικού Χειρισμού ΕξόδωνRELAY

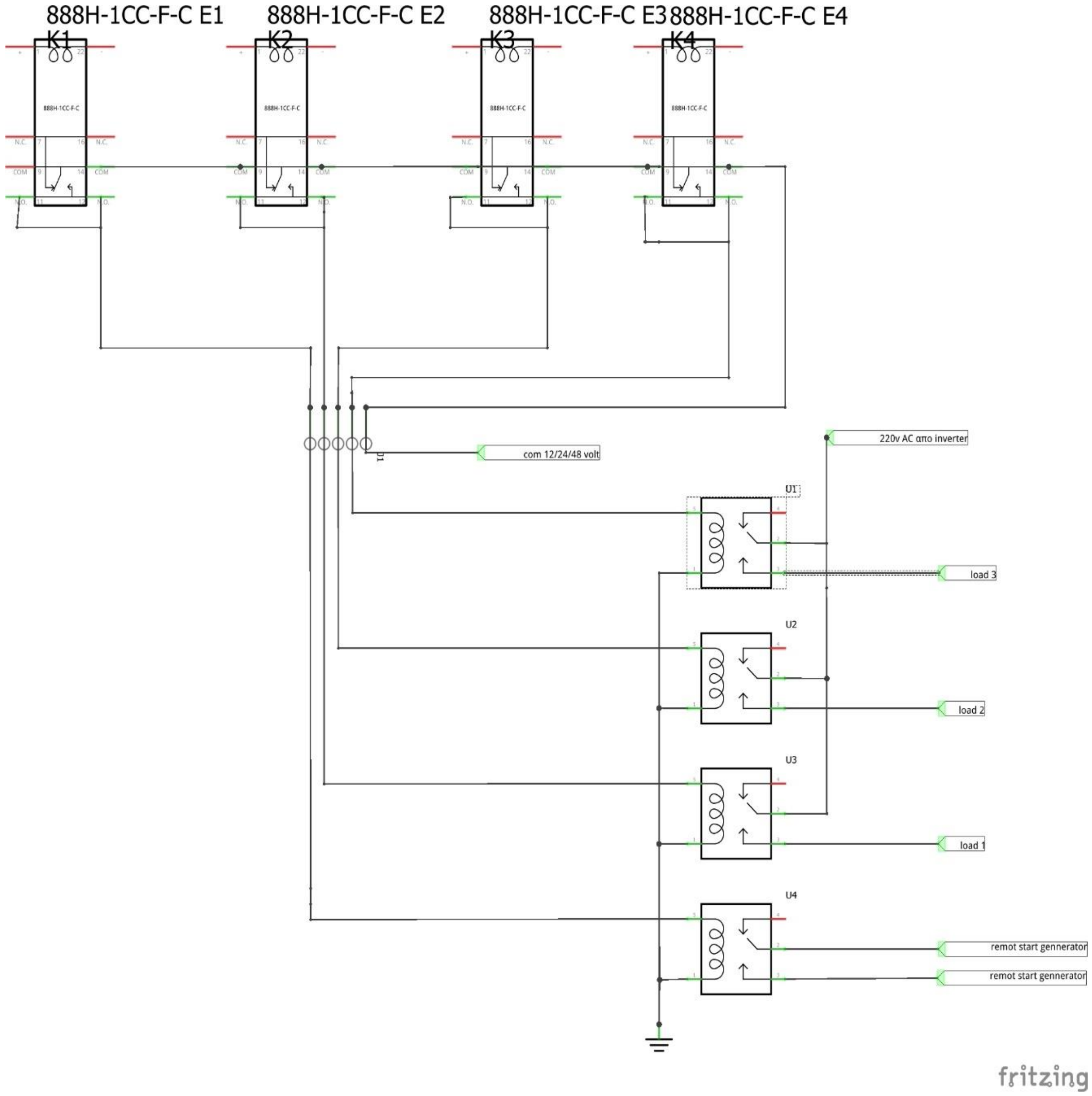
Τα μπουτόν του τοπικούχειρισμού είναι για την ενεργοποίηση και απενεργοποίηση των εξόδων. Όταν πατηθείκάποιο μπουτόν κάνειlow από hi την αντιστοιχείείσοδο του επεξεργαστεί. Κάθε φορά που πατιέταιεναλλάσσει την κατάσταση τις αντιστοιχείςεξόδου.



Εικόνα 4.3

Τα Ρελλέ μπορούν να παίρνουνε οποιαδήποτε τάση στην κοινή τους επαφή είτε 24 Vdc είτε 12 Vdcείτε 48 Vdcείτε εναλλασσόμενο 220 VACη οποία προέρχεται είτε από τις μπαταρίες άρα συνεχές είτε από την έξοδο του inverter 220 VAC(εναλλασσόμενο). Επίσης για την ενεργοποίηση των Ρελλέ απαιτείται οδήγηση με transistorBC547 NPN από την έξοδο του μικροεπεξεργαστή PIC 18F4685 .

Ενεργοποιώ το Ρελλέ ισχύος από το K1 (Ρελλέ Μίνι) αν βάλω 220 VAC (εναλλασσόμενο) στην άκρη του πηνίου του Ρελλέ ισχύος K2 στην άλλη άκρη έχω ουδέτερο (N) 0 VAC, εάν βάλω 12 ή 24 Vdcστο ένα άκρο στο άλλο άκρο βάζω (-) / -12 Vdcή -24 Vdcμε την προϋπόθεση ότι το πηνίο του Ρελλέ είναι αντίστοιχης τάσης.


888H-1CC-F-C E1
K1
888H-1CC-F-C E2
K2
888H-1CC-F-C E3
K3
888H-1CC-F-C E4
K4
888H-1CC-F-C
N.C.
COM
N.O.
J1
com 12/24/48 volt
220v AC απο inverter
U1
load 3
U2
load 2
U3
load 1
U4
remot start gennerator
remot start gennerator
fritzing

Εικόνα 4

ΚΕΦΑΛΑΙΟ 5Επικοινωνία συστήματος τηλεμετρίας μέσω internet με τη χρήσει webbrowser.

5.1 Τι είναιHTML

Η **HTML** είναι ένα **σύνολο κανόνων** για την διαμόρφωση της **εμφάνισης** και του **περιεχομένου** μιας ιστοσελίδας. Ουσιαστικά, δεν είναι γλώσσα προγραμματισμού, αλλά **γλώσσα περιγραφής ιδιοτήτων** των στοιχείων που αποτελούν μία ιστοσελίδα. Χρησιμοποιώντας ειδικές **ετικέτες** (**tags**) δίνονται εντολές, για το πως να διαχειριστεί ένα έγγραφο html το **περιεχόμενό** του και πως να το εμφανίσει στον χρήστη ένας **Web browser**, το πρόγραμμα δηλαδή που χρησιμοποιούμε για να προβάλουμε τις διάφορες σελίδες στο διαδίκτυο.

Ενδεικτικά, οι **εντολές** / **tags** της HTML, μπορούν:

- Να εισάγουν σε μία ιστοσελίδα **links** (συνδέσμους)
- Να εισάγουν σε μία ιστοσελίδα **εικόνες**
- Να διαμορφώσουν το κείμενο με **έντονα** ή **πλάγια** γράμματα κλπ.

Για να δημιουργηθεί ένα αρχείο html, αρκεί ένα **αρχείο απλού κειμένου**, το οποίο θα έχει κατάληξη **.html** ή **.htm** και το αρχείο αυτό να περιέχει τις επιθυμητές **εντολές** με τις ανάλογες **παραμέτρους** τους.Η **HTML** μπορεί να γραφτεί απευθείας ως **κώδικας** (**πηγαίος κώδικας**) ή μπορεί να παραχθεί αυτόματα από κάποιο **πρόγραμμα κατασκευής ιστοσελίδων** (υπάρχουν πολλά διαθέσιμα opensource προγράμματα που μπορεί να κατεβάσει κανείς και να εγκαταστήσει στο μηχάνημά του) την στιγμή που ο δημιουργός, σε **γραφικό περιβάλλον**, απλά χρησιμοποιεί τα διάφορα **εργαλεία** που του παρέχει το πρόγραμμα για να το **σχεδιασμό** της σελίδας του.

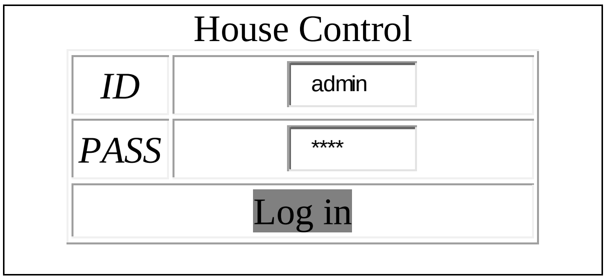
5.2 τρόπος επικοινωνίας πλακέτας μέσο Web browser

Στην μνήμη του επεξεργαστή είναι αποθηκευμένος ο κώδικας των html για την δυνατότητα ανταλλαγής πληροφοριών από το διαδίκτυο μέσω της Ethernet πόρτας κάνοντας portforward το donename που έχουμε ορίσει για την εποικημένοι.

Να σημειωθεί ότι η IP τις πλακέτας είναι στατική με δυνατότητα ορισμού της,δεν απαιτείτε server, μπορεί να επικοινωνήσει με οποιαδήποτε συσκευή που έχει εγκατασταθεί κάποιο πρόγραμμα browser.

5.3Διαδικασία επικοινωνίας με τη πλακέτα μέσο Web browser

Από οποιοδήποτε πρόγραμμα πλοήγησης στο internetγράφοντας την διεύθυνση επικοινωνίας(domainname) για internet ή (IP) για τοπικήσύνδεση στο αντίστοιχο πεδίο του browser εμφανίζεται η πρώτη σελίδα.



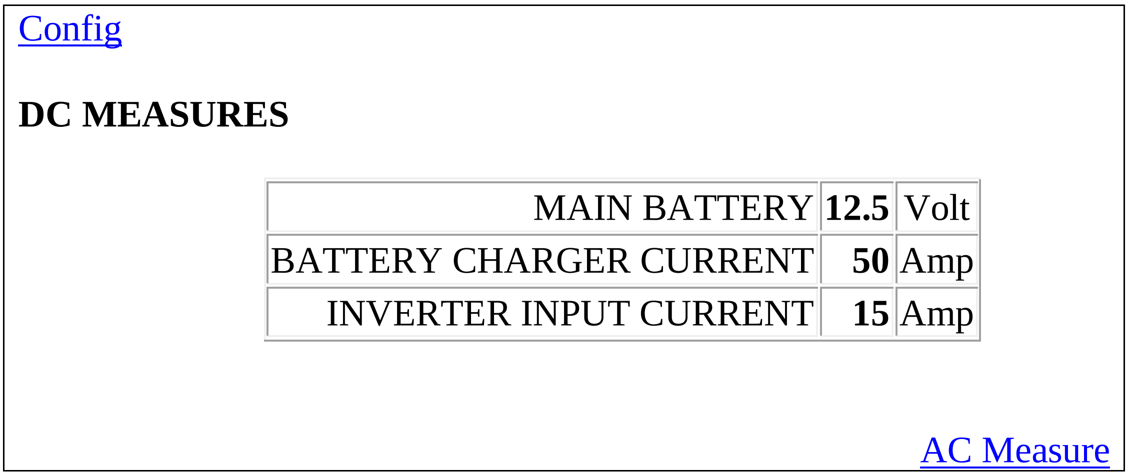
House Control

ID	admin
PASS	****
Log in	

Εικόνα 5.3.1

Με ID: admin καιpass: 1234

Πατώντας**Login** αν έχουμεπληκτρολογήσεισωστά το ID και το Κωδικό μπαίνουμε στην παρακάτω σελίδα.



Config

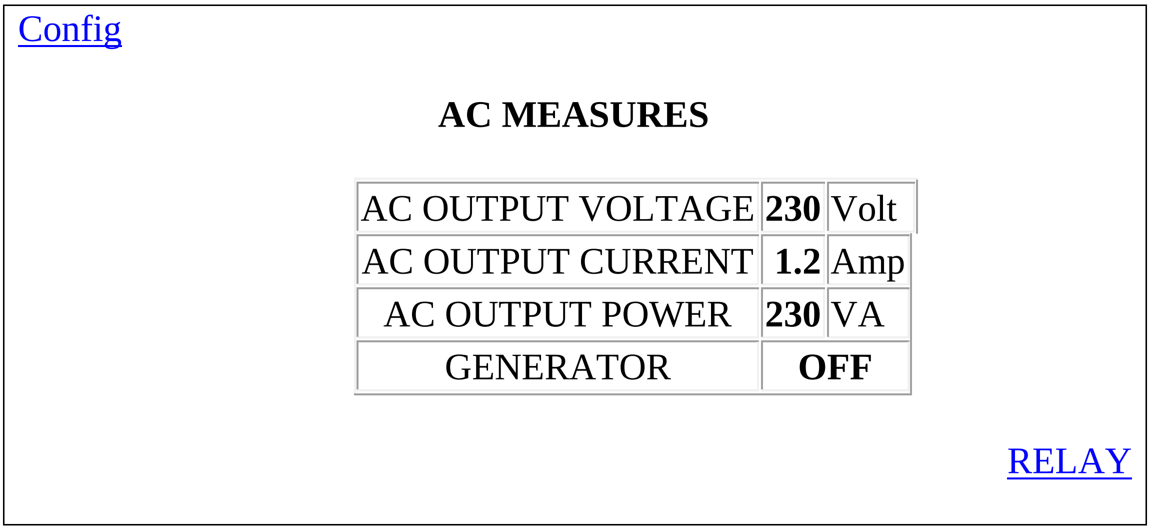
DC MEASURES

MAIN BATTERY	**12.5**	Volt
BATTERY CHARGER CURRENT	**50**	Amp
INVERTER INPUT CURRENT	**15**	Amp

AC Measure

Εικόνα 5.3.2

Σε αυτή σελίδα βλέπουμε την τάση των μπαταριών το ρεύμα φώτισης των μπαταριών από ΑΠΕ και το ρεύμα του inverter το οποίο αν είναι θετικό καταναλώνει από τι μπαταρίες ενώ αν είναι αρνητικό φορτίζει τις μπαταρίες. Πατώντας αριστερό κλικ AC Measureκάνουμε σύνδεση στην παρακάτω σελίδα.



Config

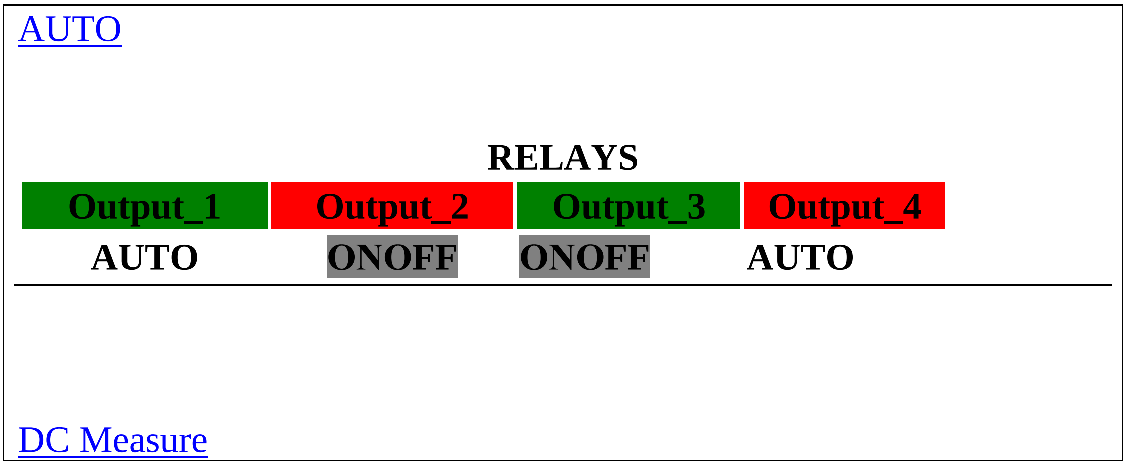
AC MEASURES

AC OUTPUT VOLTAGE	**230**	Volt
AC OUTPUT CURRENT	**1.2**	Amp
AC OUTPUT POWER	**230**	VA
GENERATOR	**OFF**	

RELAY

Εικόνα 5.3.3

Σε αυτή την σελίδα βλέπουμε την AC τάση , το AC ρεύμα τις εγκατάστασης ,την ισχύ που καταναλώνετε και εάν λειτουργεί η γεννήτρα. Πατώντας αριστερό κλικ RELAYκάνουμε σύνδεση στην παρακάτω σελίδα.



AUTO

RELAYS

Output_1	**Output_2**	**Output_3**	**Output_4**
AUTO	**ONOFF**	**ONOFF**	**AUTO**

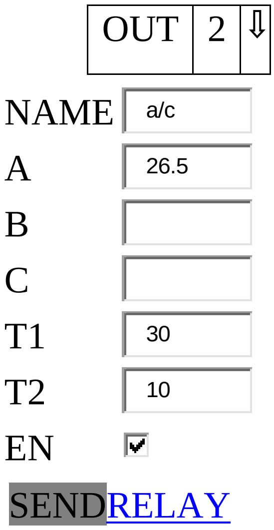
DC Measure

Εικόνα 5.3.4

Σε αυτή την σελίδα βλέπουμε την κατάσταση και την λειτουργιά των εξόδων όταν κάτω από κάθε έξοδο υπάρχουν τα μπουτόν **ONOFF**η έξοδος είναι σε χειροκίνητη λειτουργιά και πατώντας τα μπουτόν μπορούμε να ενεργοποιήσουμε η να απενεργοποιήσου με την έξοδο αν το φόντο της εξόδου είναι πράσινο η έξοδος είναι ενεργοποιημένη ενώ όταν είναι κόκκινη απενεργοποιημένη .

*Αν κάτω από τη έξοδο αντί για μπουτόν αναγράφετε **AUTO** η έξοδος είναι σε αυτόματη λειτουργία.

*Πατώντας αριστερό κλικ AUTOμπαίνουμε στην παρακάτω σελίδα



OUT 2 ⇩

NAME: a/c
A: 26.5
B:
C:
T1: 30
T2: 10
EN: ☑

SENDRELAY

Εικόνα 5.3.5

Σε αυτή την σελίδα ρυθμίζουμε την αυτόματη λειτουργιά των εξόδων.
Από το βελάκι επιλέγουμε μια από τις τέσσερεις εξόδους όταν το EN είναι στεκαρισμένο τότε η έξοδος είναι σε αυτόματη λειτουργιά για να μπει σε χειροκίνητη πρέπει να το ξετσεκάρουμε η να πατήσουμε το μπουτόν που χειρίζεται την έξοδο Τοπικά από την συσκευή για να επανέλθουμε στο αυτόματο πρέπει να στεκάρουμε το EN δικτυακά.
Στο πεδίο NAME γράφουμε το όνομα που θέλουμε να αφανίζετε η συγκεκριμένη έξοδος.
Με το μπουτόνSENDστέλνουμε της αλλαγές στην συσκευή

Αυτόματες λειτουργιές
Οι αυτόματες λειτουργίες που μπορούμε να επιλέξουμε για κάθε έξοδο είναι τρεις:

➔Πρώτη λειτουργία (εξασφάλιση αδιάλειπτης λειτουργίας με αυτόματη ενεργοποίηση γεννήτριας) για να επιλέξουμε αυτή την λειτουργιά πρέπει η παράμετρος A της συγκεκριμένης έξοδος να είναι μεγαλύτερη του μηδενός και η παράμετροι B και C να είναι μηδέν (A>0 ,B=0 και C=0). Το σενάριο που εκτελείτε σε αυτή τη λειτουργία είναι : εάν η τάση των μπαταριών είναι μικρότερη του A για χρόνο T1 (min) τότε θα ενεργοποιηθεί η έξοδος για χρόνο T2 (min).

➔Δεύτερη λειτουργία (ενεργειακή διαχείριση, ενεργοποίηση συσκευών π.χ κλιματίστηκα, αντλία κ.α. όταν οι μπαταρίες είναι φορτισμένες και υπάρχει ηλιοφάνεια) για να επιλέξουμε αυτή την λειτουργιά πρέπει η παράμετρος A της συγκεκριμένης έξοδος να είναι μηδέν και η παράμετροι B και C να είναι μεγαλύτερες μηδέν (A=0 ,B>0 και C>0). Το σενάριο που εκτελείτε σε αυτή τη λειτουργία είναι:

Εάν η τάση των μπαταριών είναι μεγαλύτερη του B για T1 (min) τότε θα ενεργοποιηθεί η έξοδος έως η τάση τον μπαταριών είναι μικρότερη του C για T2 (min) που θα απενεργοποιηθεί.
➔Τρίτη λειτουργία (αυτόματη εξωτερική ενεργοποίηση με μακροεντολές από ένα εικονικό, δικτυακό περιβάλλον που μπορούμε να κατασκευάσουμε για να

ικανοποιήσουμε οπουδήποτε σενάριο θέλετε) π.χ. αυτόματο εβδομαδιαίο πρόγραμμα ποτίσματος κήπου όπου ο χρήστης θα μπορεί να αλλάζει το πρόγραμμα ποτίσματος από το internet όποτε επιθέσιμη. Για ναεπιλέξουμε αυτή την λειτουργία πρέπει οι παράμετροι A,B,C να είναι μηδέν.

ΚΕΦΑΛΑΙΟ 6Επικοινωνία συστήματος τηλεμετρίας μέσω internet με τη χρήσηtelnet.

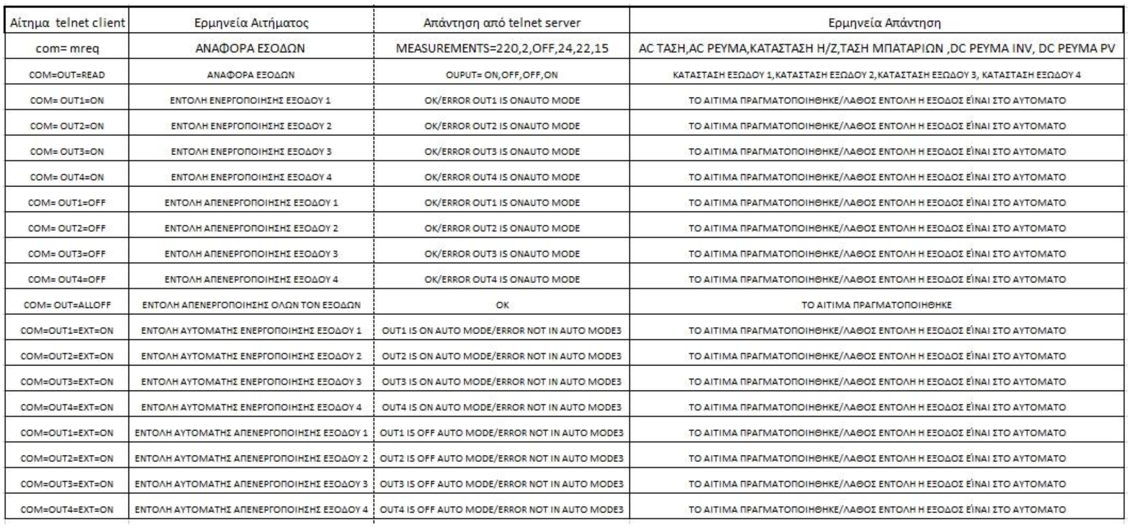
6.1 Τι είναι η telnet επικοινωνία

Το telnet βασίζεται στην Αρχιτεκτονική πελάτη - εξυπηρετητή, για να το χρησιμοποιήσουμε εκτελούμε ένα πρόγραμμα πελάτη (telnetclient). ενώ το απομακρυσμένο προς έλεγχο μηχάνημα εκτελεί το telnetserver.

Otelnet εξυπηρετητής μπορεί να ανταποκριθεί σε πολύ αιτήματα συγχρόνως δημιουργώντας μια νέα διεργασία για κάθε αίτημα.

6.2 Πως υλοποιούμε την telnetεπικοινωνία .

Στο παρακάτω πίνακα βλέπουμε τα αιτήματα (εντολές) προς το σύστημα τηλεμετρίας ,και τις αντίστοιχες απαντήσεις με τη ερμίνα τους



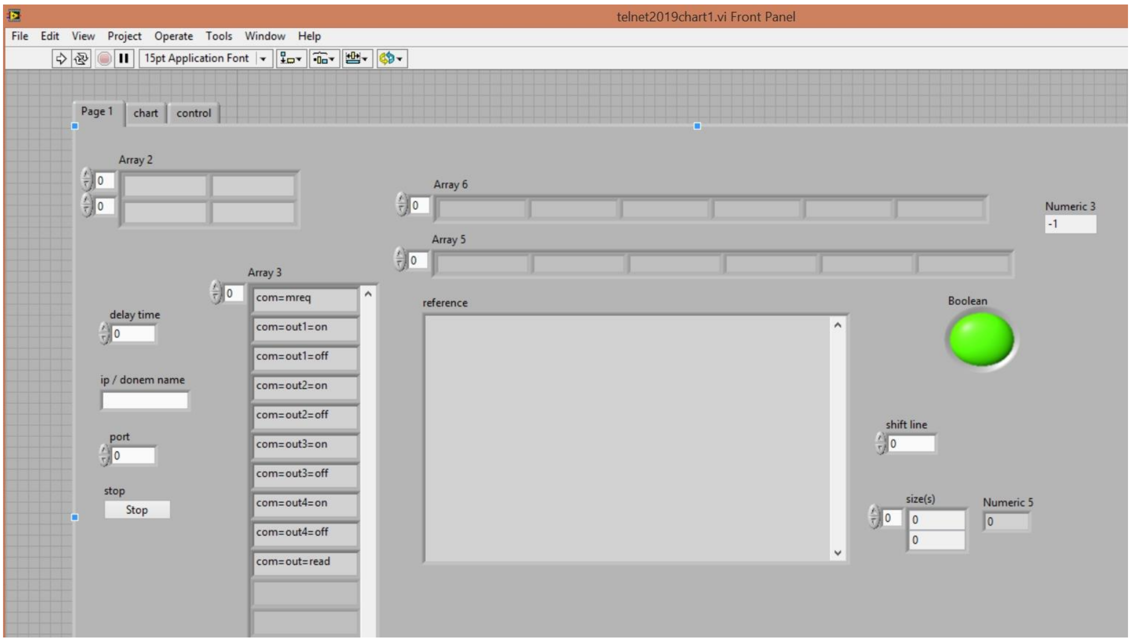
Αίτημα telnet client	Ερμηνεία Αιτήματος	Απάντηση από telnet server	Ερμηνεία Απάντηση
com= mreq	ΑΝΑΦΟΡΑ ΕΣΟΔΩΝ	MEASUREMENTS=220,2,OFF,24,22,15	AC ΤΑΣΗ,AC ΡΕΥΜΑ,ΚΑΤΑΣΤΑΣΗ Η/Ζ,ΤΑΣΗ ΜΠΑΤΑΡΙΩΝ ,DC ΡΕΥΜΑ INV, DC ΡΕΥΜΑ PV
COM=OUT=READ	ΑΝΑΦΟΡΑ ΕΞΟΔΩΝ	OUPUT= ON,OFF,OFF,ON	ΚΑΤΑΣΤΑΣΗ ΕΞΩΔΟΥ 1,ΚΑΤΑΣΤΑΣΗ ΕΞΩΔΟΥ 2,ΚΑΤΑΣΤΑΣΗ ΕΞΩΔΟΥ 3, ΚΑΤΑΣΤΑΣΗ ΕΞΩΔΟΥ 4
COM= OUT1=ON	ΕΝΤΟΛΗ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 1	OK/ERROR OUT1 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT2=ON	ΕΝΤΟΛΗ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 2	OK/ERROR OUT2 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT3=ON	ΕΝΤΟΛΗ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 3	OK/ERROR OUT3 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT4=ON	ΕΝΤΟΛΗ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 4	OK/ERROR OUT4 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT1=OFF	ΕΝΤΟΛΗ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 1	OK/ERROR OUT1 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT2=OFF	ΕΝΤΟΛΗ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 2	OK/ERROR OUT2 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT3=OFF	ΕΝΤΟΛΗ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 3	OK/ERROR OUT3 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT4=OFF	ΕΝΤΟΛΗ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 4	OK/ERROR OUT4 IS ONAUTO MODE	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM= OUT=ALLOFF	ΕΝΤΟΛΗ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΟΛΩΝ ΤΟΝ ΕΞΟΔΩΝ	OK	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ
COM=OUT1=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 1	OUT1 IS ON AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM=OUT2=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 2	OUT2 IS ON AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM=OUT3=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 3	OUT3 IS ON AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM=OUT4=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 4	OUT4 IS ON AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM=OUT1=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 1	OUT1 IS OFF AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM=OUT2=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 2	OUT2 IS OFF AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM=OUT3=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 3	OUT3 IS OFF AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ
COM=OUT4=EXT=ON	ΕΝΤΟΛΗ ΑΥΤΟΜΑΤΗΣ ΑΠΕΝΕΡΓΟΠΟΙΗΣΗΣ ΕΞΟΔΟΥ 4	OUT4 IS OFF AUTO MODE/ERROR NOT IN AUTO MODE3	ΤΟ ΑΙΤΙΜΑ ΠΡΑΓΜΑΤΟΠΟΙΗΘΗΚΕ/ΛΑΘΟΣ ΕΝΤΟΛΗ Η ΕΞΟΔΟΣ ΈΙΝΑΙ ΣΤΟ ΑΥΤΟΜΑΤΟ

6.3 Χρήσητου labview σαν telnet client.

Η γραφική φύση του labview το καθιστά ιδανικό για εφαρμογές μετρήσεων, αυτοματισμού, ελέγχου οργάνων και ανάλυσηδεδομένων. Έχοντας τη δυνατότητα επικοινωνίας μέσω telnet το καθιστά ιδανικό για την συγκεκριμένη εφαρμογή.

6.3.1 Επεξήγηση εφαρμογή labview

Στην σελίδαreference υπάρχουν οι παραμετροποιήσεις για τη επικοινωνία telnet και οι αναφορές από την κατασκευή. Στο πεδίο ip/domainname πληκτρολογούμε την ip για τοπική σύνδεση ή το domainname για απομακρυσμένη η προκαθορισμένη τιμή τις ip για την κατασκευή είναι 192.168.1.5. Στο πεδίο port βάζουμε την πόρτα 23 αφού πρόκριτε για telnet. στο πίνακαArray 3 τα αιτήματα που στέλνονται αυτόματα βάση του προγραμματισμού προς το telnetserver (κατασκευή). Στο πεδίοreference καταγράφονται όλες οι αναφορές που έρχονται από το server.

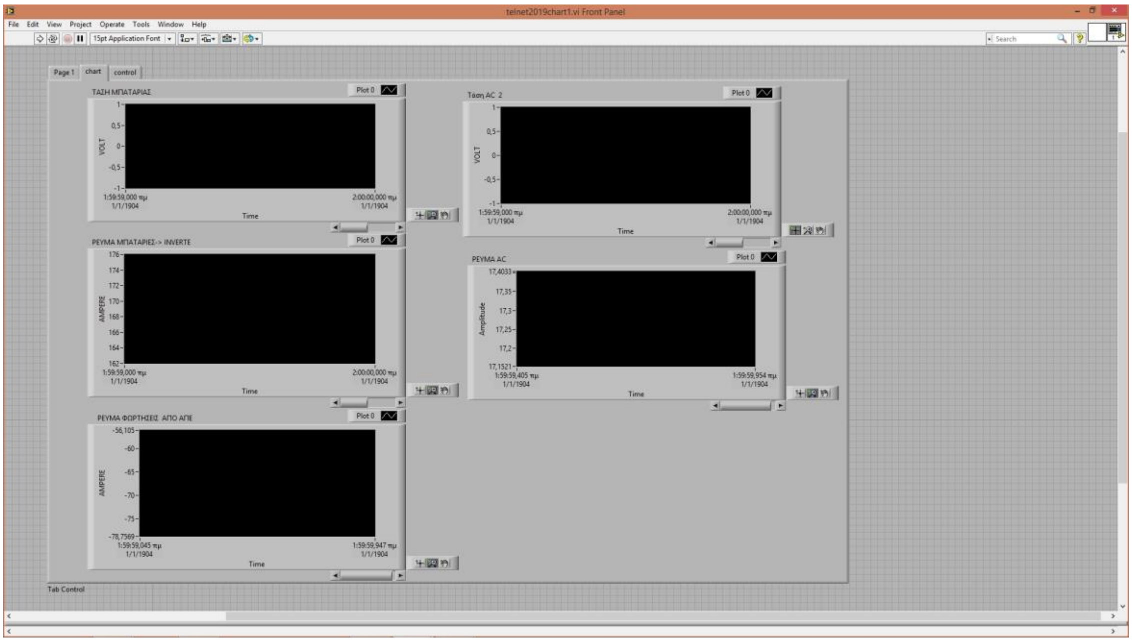


Array 3:
com=mreq
com=out1=on
com=out1=off
com=out2=on
com=out2=off
com=out3=on
com=out3=off
com=out4=on
com=out4=off
com=out=read

Numeric 3: -1

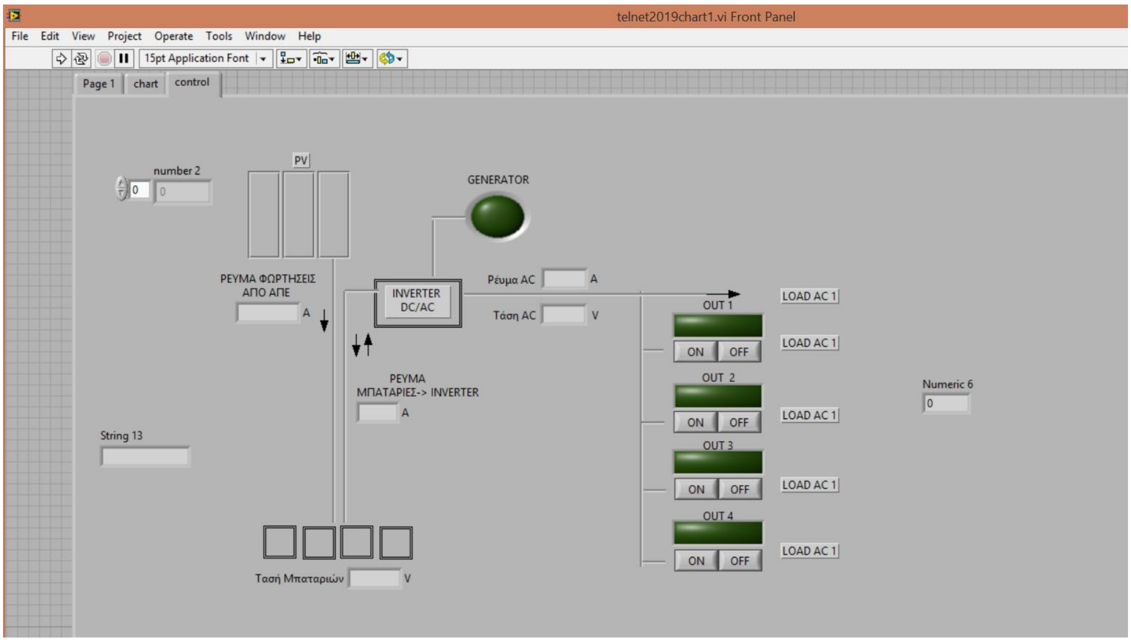
Εικόνα 6.3.1

Στην σελίδα chartυπάρχουν τα γραφήματα με βάση την ημερομηνία όλων των μετρουμένων μεγεθών έχοντας και την δυνατότητα να κάνουμε export σε φύλλο υπολογισμού exel για περεταίρω ανάλυση των δεδομένων.



Εικόνα 6.3.2

Στην σελίδα control εμφανίζονται οι τελευτές μετρήσεις που έχει στείλει ο telnetserver σε εικονικό περιβάλλον. Απεικονίζονται επίσης και η κατάσταση των εξόδων οπού έχουμε την δυνατότητα να στείλουμε αίτημα αλλαγής κατάστασης τους πατώντας το αντίστοιχο μπουτόνON ή OFF στην αντιστοιχεί έξοδο.

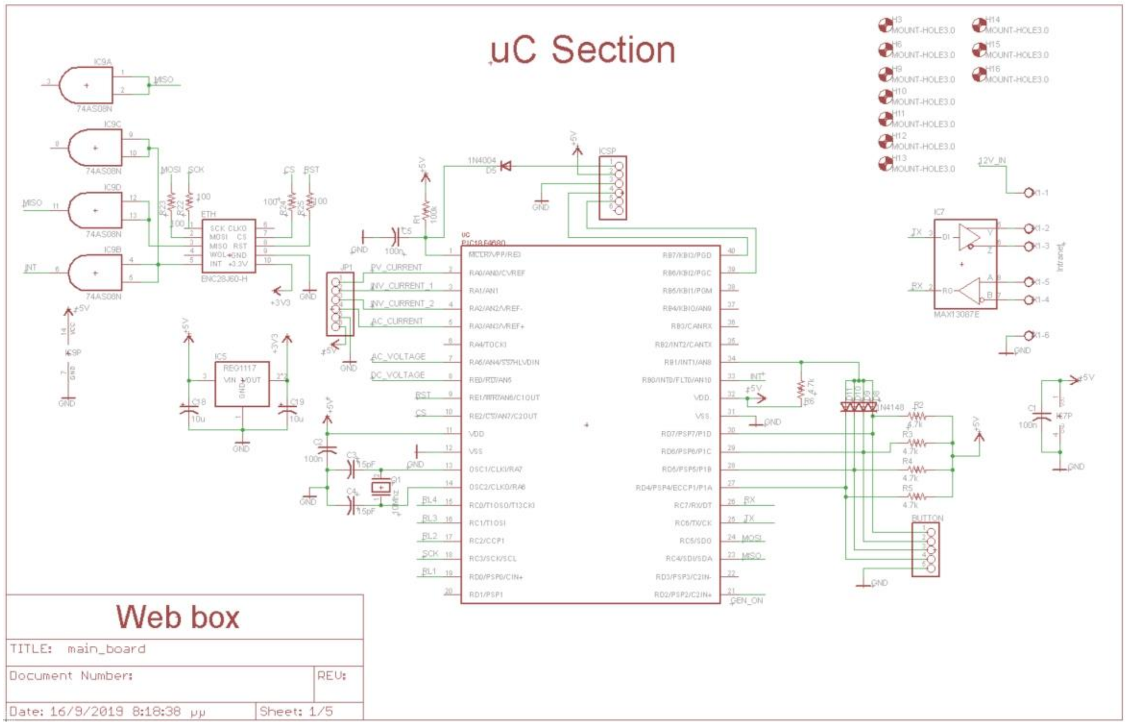


Εικόνα 6.3.3

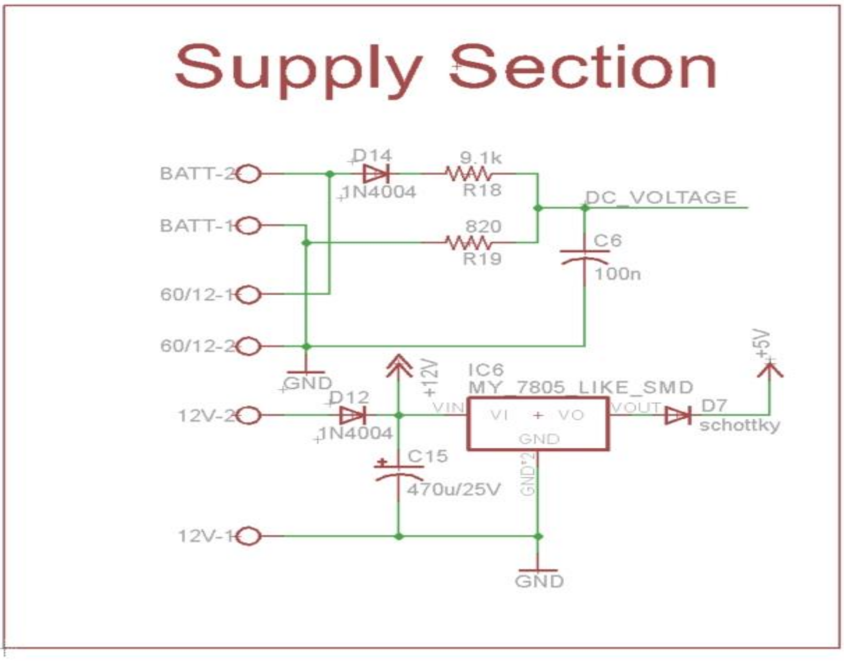
ΚΕΦΑΛΑΙΟ 7 Σχεδιασμός κατασκευής

7.1 Σχεδιασμούς πλακέτας σχηματικά διαγράμματα

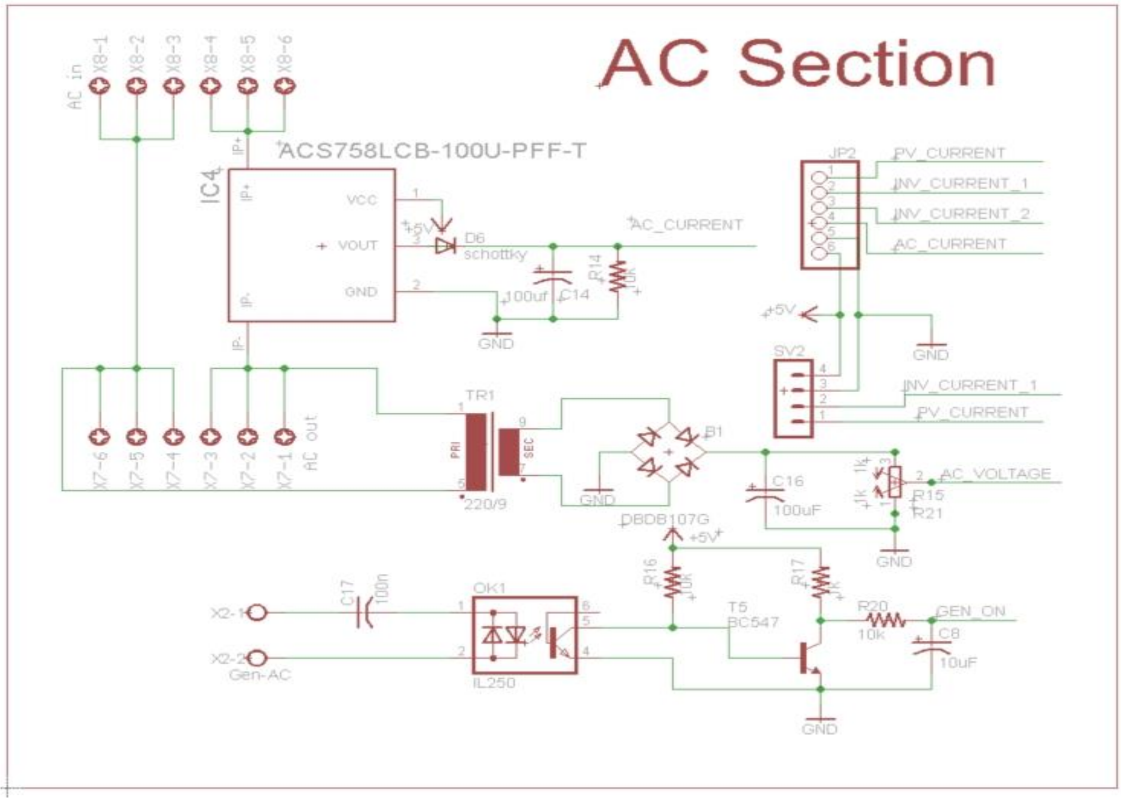
Το πρόγραμμα που χρησιμοποιήθηκε για το σχεδιασμό τις πλακέτας είναι το **EAGLE 6.4.0 Light**τα σχηματικά διαγράμματα ακολούθου στις παρακάτω εικόνες



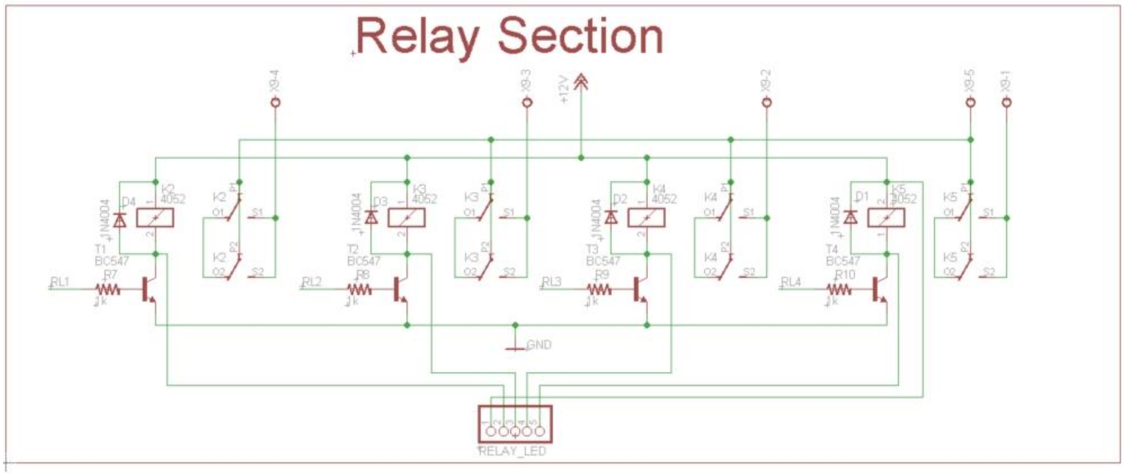
Εικόνα 7.1.1microcontroller section



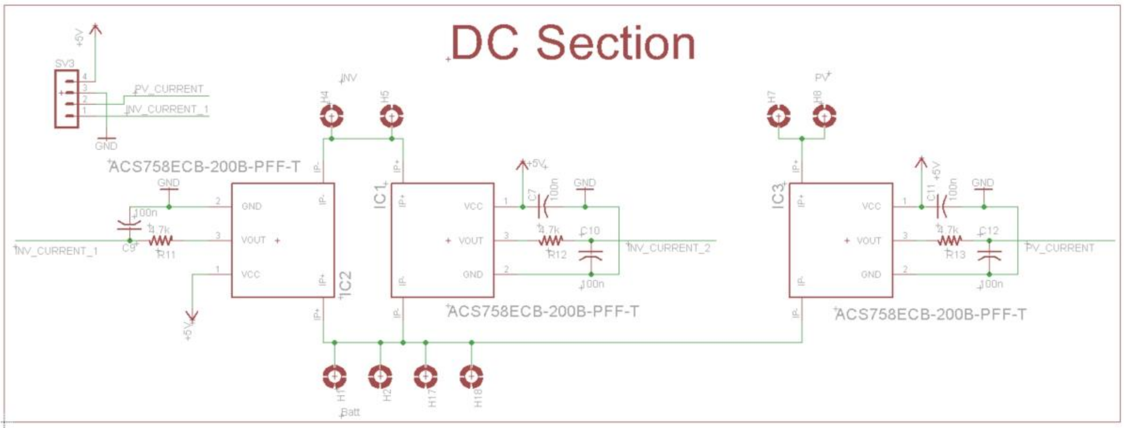
Εικόνα 7.1.2supply section



Εικόνα 7.1.3AC section



Εικόνα 7.1.4Relay section



Εικόνα 7.1.5 DCsection

7.2 Κατάλογος Εξαρτημάτων

DCSection

IC2 ACS758ECB-200B-PFF-T	Πιεζοηλεκτρικό
IC1 ACS758ECB-200B-PFF-T	Πιεζοηλεκτρικό
IC3 ACS758ECB-200B-PFF-T	Πιεζοηλεκτρικό
C9 100 nf	Πυκνωτής
R11 4.7 ΚΩ	Αντίσταση
C7 100 nf	Πυκνωτής
R12 4.7 ΚΩ	Αντίσταση
C10 100 nf	Πυκνωτής
C11 100 nf	Πυκνωτής
R13 4.7 ΚΩ	Αντίσταση
C12 100 nf	Πυκνωτής
SV3	Επαφή

SupplySection

IC6 MY_7805_LIKE_SMD

D14 1N4004 Diode

D12 1N4004Diode

C6 100 nf	Πυκνωτής
D7 Schottky Diode	
C15 470μf/25V	Πυκνωτής
R18 9.1KΩ	Αντίσταση
R19 820 Ω	Αντίσταση

ACSection

IC4 ACS758LCB-100U-PFF-T	Πιεζοηλεκτρικό
D6 Schottky	
R14 10KΩ	Αντίσταση
C14 100μf	Πυκνωτής
TR1 220/9	Μετασχηματιστής
B1 DBDB107G	Γέφυρα Πλήρης Ανόρθωσης
C16 100μf	Πυκνωτής
Trimmer 1 K	R21 – R15
OK1 IL250	Optocoupler
C17 100nf	Πυκνωτής
R16 10KΩ	Αντίσταση
R17 1KΩ	Αντίσταση
R20 10 KΩ	Αντίσταση
T5 BC547	Transistor
C8 10μf	Πυκνωτής
JP2 Jumper	Επαφή
SV2	Επαφή

RelaySection

RELAY_LED	
R7 1KΩ	Αντίσταση

RL1	
T1 BC547	Transistor
D4 1N4004	Diode
K2 4052	
K2	
K2	
RL2	
R8 1KΩ	Αντίσταση
T2 BC547	Transistor
D3 1N4004	Diode
K3 4052	
K3	
K3	
RL3	
T3 BC547	Transistor
R9 1KΩ	Αντίσταση
D2 1N4004	Diode
K4 4052	
K4	
K4	
RL4	
R10 1KΩΑντίσταση	
T4 BC547	Transistor
D1 1N4004	Diode
K5 4052	
K5	
K5	
S1	
S2	

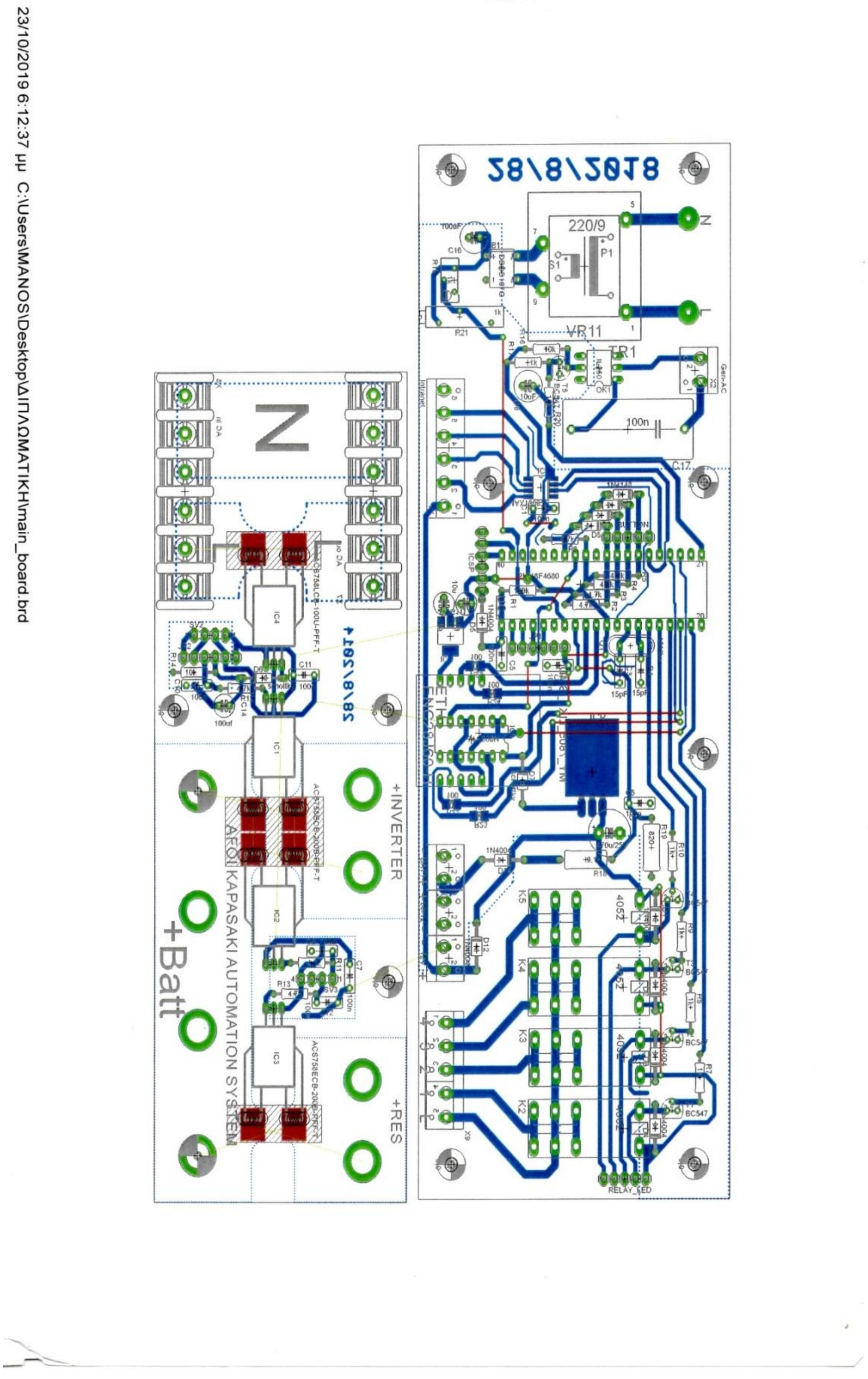
uCSection

IC9A 74AS08N	And Gate
IC9B 74AS08N	And Gate
IC9C 74AS08N	And Gate
IC9D 74AS08N	And Gate
R22 100	Αντίσταση
R23 100	Αντίσταση
R24 100	Αντίσταση
R25 100	Αντίσταση
ETHENC28J60-H	
IC9P	
IC5 REG1117	
C18 10μf	Πυκνωτής
C19 10μf	Πυκνωτής
C2 100nf	Πυκνωτής
C3 15pf	Πυκνωτής
C4 15pfΠυκνωτής	
Q1 1OMhz	Κρύσταλλος
JP1	
C5 100nf	Πυκνωτής
R1 100KΩ	Αντίσταση
D5 1N4004	Diode
ICSP	
UcPIC18F4680	Μικροεπεξεργαστής
R6 4.7 KΩ	Αντίσταση
D8 1N4148	Diode
D9 1N4148	Diode
D10 1N4148	Diode
D11 1N4148	Diode

R2 4.7 KΩ	Αντίσταση
R3 4.7 KΩ	Αντίσταση
R4 4.7 KΩ	Αντίσταση
R5 4.7 KΩ	Αντίσταση
BUTTON	
IC7 MAX13087E	Safety of INTRANET
C1 100nf	Πυκνωτής
IC	

7.3 Τυπωμένη πλακέτα κατασκευής (PCB)

Το τυπωμένο κύκλωμα αυτής τις κατασκευής αποτελείτε από δυο τμήματα το τμήμα των αισθητηρίων ρεύματος και το τμήμα τις κύριας κατασκευής.

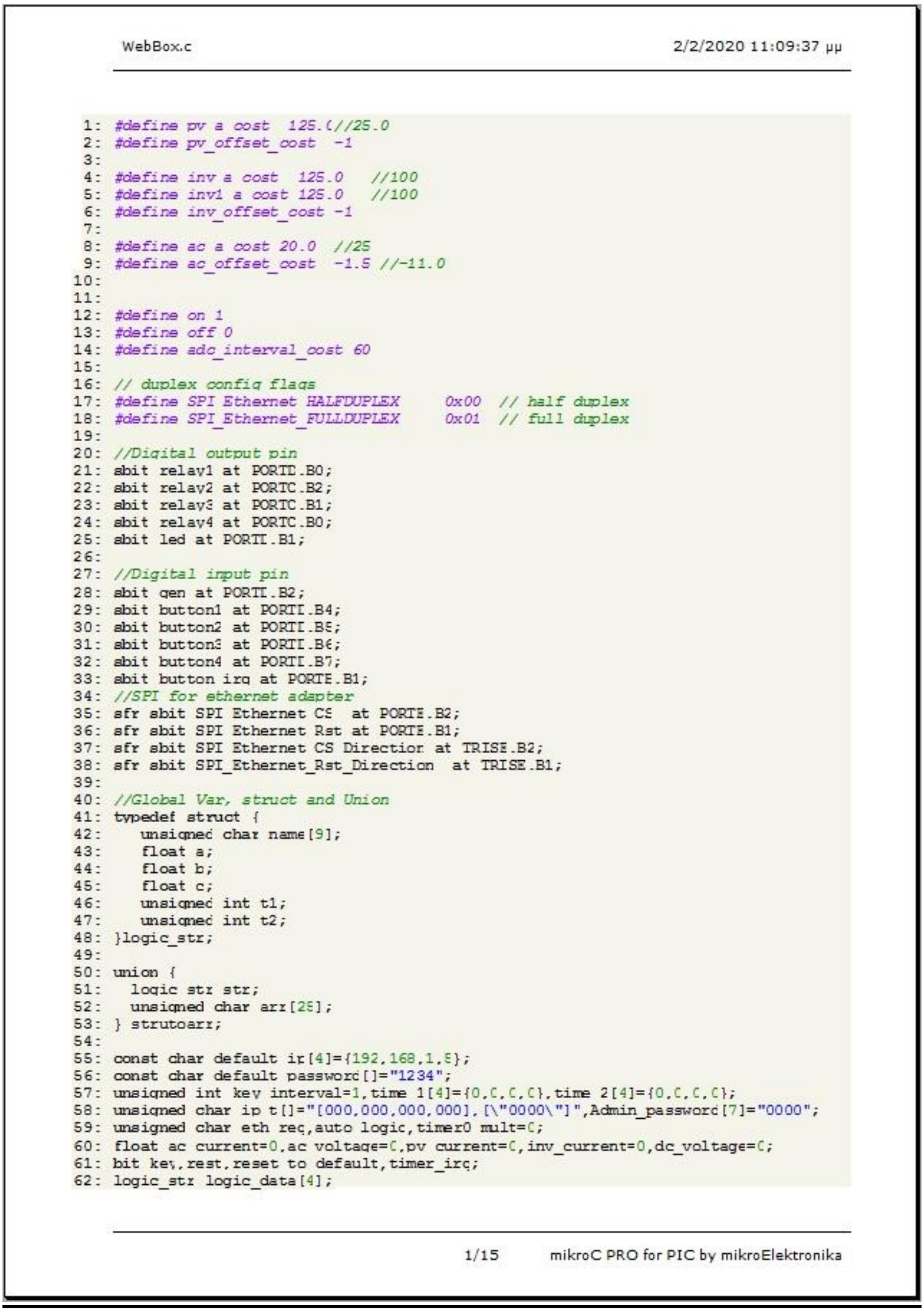


Εικόνα 7.3 PCB

ΚΕΦΑΛΑΙΟ 8 Προγραμματισμός Μικροεπεξεργαστή

Το πρόγραμμα που χρησιμοποιήθηκε για τον προγραμματισμό του μικροεπεξεργαστή είναι **mikroC PRO for PIC**

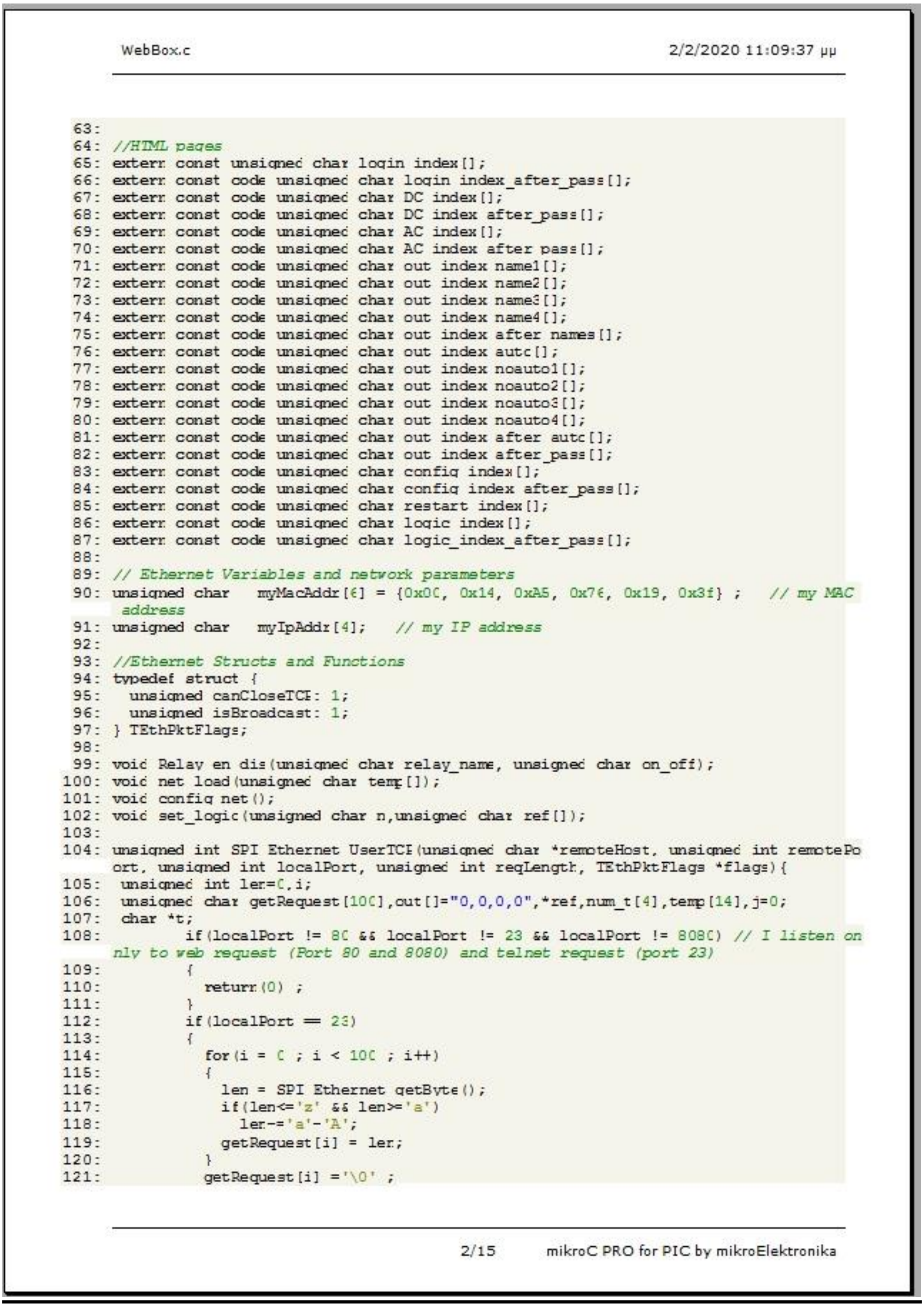
8.1 κώδικας c προγραμματισμού μικροεπεξεργαστή



WebBox.c 2/2/2020 11:09:37 μμ

```c
#define pv_a_cost  125.0//25.0
#define pv_offset_cost  -1

#define inv_a_cost  125.0   //100
#define inv1_a_cost 125.0   //100
#define inv_offset_cost -1

#define ac_a_cost 20.0  //25
#define ac_offset_cost  -1.5 //-11.0


#define on 1
#define off 0
#define adc_interval_cost 60

// duplex config flags
#define SPI_Ethernet_HALFDUPLEX     0x00  // half duplex
#define SPI_Ethernet_FULLDUPLEX     0x01  // full duplex

//Digital output pin
sbit relay1 at PORTD.B0;
sbit relay2 at PORTC.B2;
sbit relay3 at PORTC.B1;
sbit relay4 at PORTC.B0;
sbit led at PORTD.B1;

//Digital input pin
sbit gen at PORTD.B2;
sbit button1 at PORTD.B4;
sbit button2 at PORTD.B5;
sbit button3 at PORTD.B6;
sbit button4 at PORTD.B7;
sbit button_irq at PORTE.B1;
//SPI for ethernet adapter
sfr sbit SPI_Ethernet_CS  at PORTE.B2;
sfr sbit SPI_Ethernet_Rst at PORTE.B1;
sfr sbit SPI_Ethernet_CS_Direction at TRISE.B2;
sfr sbit SPI_Ethernet_Rst_Direction  at TRISE.B1;

//Global Var, struct and Union
typedef struct {
   unsigned char name[9];
   float a;
   float b;
   float c;
   unsigned int t1;
   unsigned int t2;
}logic_str;

union {
  logic_str str;
  unsigned char arr[25];
} strutoarr;

const char default_ip[4]={192,168,1,5};
const char default_password[]="1234";
unsigned int key_interval=1,time_1[4]={0,0,0,0},time_2[4]={0,0,0,0};
unsigned char ip_t[]="[000,000,000,000],[\"0000\"]",Admin_password[7]="0000";
unsigned char eth_req,auto_logic,timer0_mult=0;
float ac_current=0,ac_voltage=0,pv_current=0,inv_current=0,dc_voltage=0;
bit key,rest,reset_to_default,timer_irq;
logic_str logic_data[4];
```

1/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

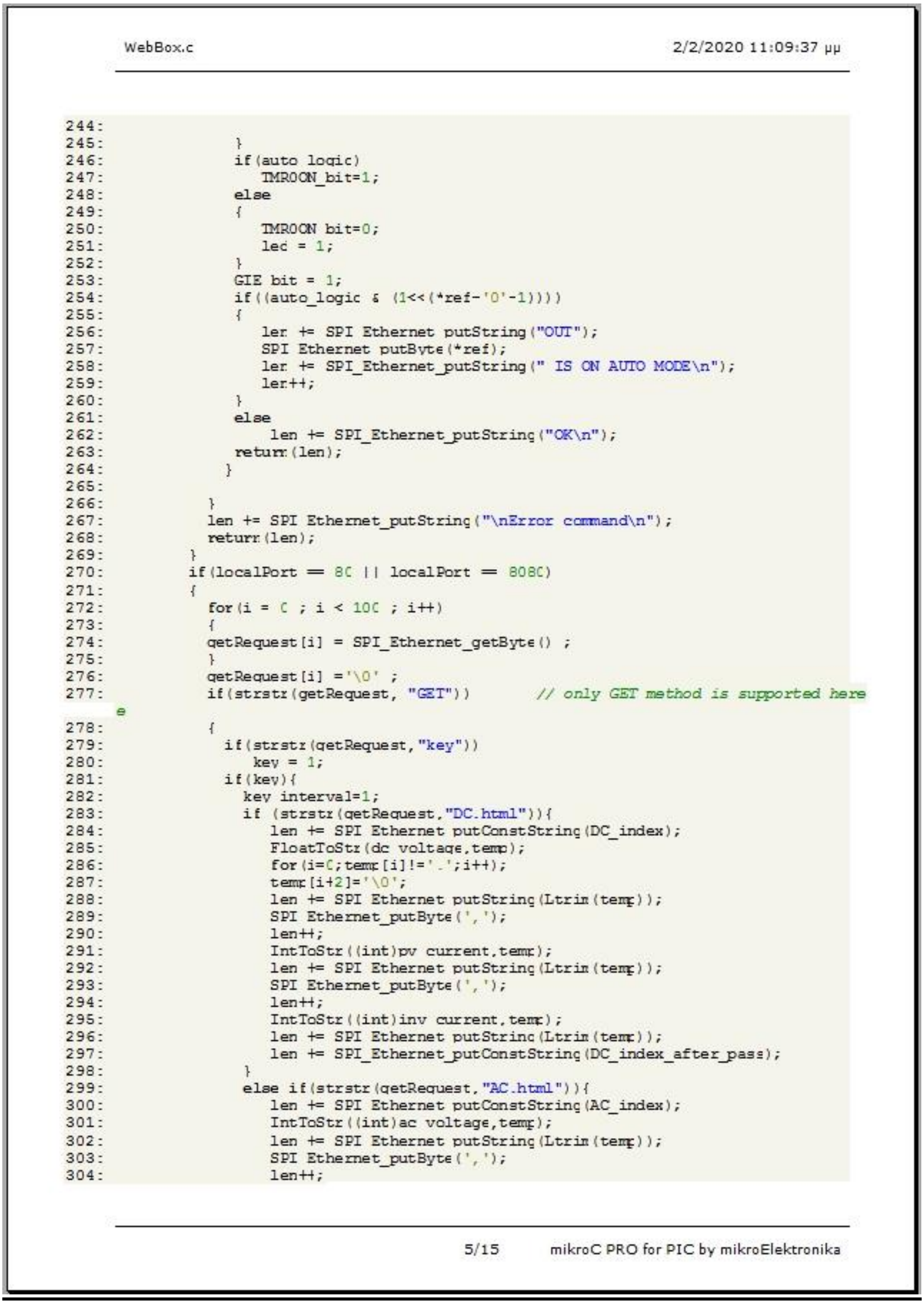
```
        len = 0;
        if(strstr(getRequest, "COM"))
        {
          if(strstr(getRequest, "=MREQ"))
          {
           len += SPI_Ethernet_putString("\MEASUREMENTS=");
           IntToStr((int)ac_voltage,temp);
           ref=Ltrim(temp);
           len += SPI_Ethernet_putString(ref);
           SPI_Ethernet_putByte(',');
           len++;
           IntToStr((int)ac_current,temp);
           len += SPI_Ethernet_putString(Ltrim(temp));
           SPI_Ethernet_putByte(',');
           len++;
            if (gen)
             len += SPI_Ethernet_putString("ON,");
            else
             len += SPI_Ethernet_putString("OFF,");
           IntToStr((int)dc_voltage,temp);
           len += SPI_Ethernet_putString(Ltrim(temp));
           SPI_Ethernet_putByte(',');
           len++;
           IntToStr((int)inv_current,temp);
           len += SPI_Ethernet_putString(Ltrim(temp));
           SPI_Ethernet_putByte(',');
           len++;
           IntToStr((int)pv_current,temp);
           len += SPI_Ethernet_putString(Ltrim(temp));
           SPI_Ethernet_putByte('\n');
           len++;
           return(len);
          }
          else if(strstr(getRequest, "=RESET"))
          {
           len += SPI_Ethernet_putString("\nOK\n");
           rest = 1;
           return(len);
          }
          else if(ref=strstr(getRequest, "=OUT"))
          {
           ref+=4;
           if(strstr(getRequest, "=READ"))
           {
             len += SPI_Ethernet_putString("OUTPUTS=");
             if(relay1)
               len += SPI_Ethernet_putString("ON ");
             else
               len += SPI_Ethernet_putString("OFF ");
             if(relay2)
               len += SPI_Ethernet_putString("ON ");
             else
               len += SPI_Ethernet_putString("OFF ");
             if(relay3)
               len += SPI_Ethernet_putString("ON ");
             else
               len += SPI_Ethernet_putString("OFF ");
             if(relay4)
               len += SPI_Ethernet_putString("ON ");
             else
               len += SPI_Ethernet_putString("OFF ");
             SPI_Ethernet_putByte('\n');
```

3/15 mikroC PRO for PIC by mikroElektronika

WebBox.c 2/2/2020 11:09:37 μμ

```
                  len++;
                  return(len);
                }
                else if(strstr(getRequest,"=ALLOFF"))
                {
                  relay1= 0;
                  relay2= 0;
                  relay3= 0;
                  relay4= 0;
                }
                else if(*ref>='1'&&*ref<='4')
                {
                 if(strstr(getRequest, "=EXT=ON"))
                 {
                    if ((*ref<='4'&&*ref>='1')&&logic_data[*ref-'0'-1]->a==0.0&&logic
c_data[*ref-'0'-1]->b==0.0&&logic_data[*ref-'0'-1]->c==0.0)
                       Relay_en_dis(*ref,on);
                    else
                       len += SPI_Ethernet_putString("ERROR NOT IN AUTO MODE 3\n");
                 }
                 else if(strstr(getRequest, "=EXT=OFF"))
                 {
                    if ((*ref<='4'&&*ref>='1')&&logic_data[*ref-'0'-1]->a==0.0&&logic
c_data[*ref-'0'-1]->b==0.0&&logic_data[*ref-'0'-1]->c==0.0)
                       Relay_en_dis(*ref,off);
                    else
                       len += SPI_Ethernet_putString("ERROR NOT IN AUTO MODE 3\n");
                 }
                 else if(strstr(getRequest, "=ON"))
                 {
                   if(!(auto_logic & (1<<(*ref-'0'-1))))
                      Relay_en_dis(*ref,on);
                   else
                      len += SPI_Ethernet_putString("ERROR ");
                 }
                 else if(strstr(getRequest, "=OFF"))
                 {
                   if(!(auto_logic & (1<<(*ref-'0'-1))))
                      Relay_en_dis(*ref,off);
                   else
                      len += SPI_Ethernet_putString("ERROR ");
                 }
                 else if(strstr(getRequest, "=AUTO=EN"))
                 {
                   Relay_en_dis(*ref,off);
                   auto_logic|=(1<<(*ref-'0'-1));
                   auto_logic&=0x0F;
                   time_1[*ref-'0'-1] = 0;
                   time_2[*ref-'0'-1] = 0;
                   GIE_bit = 0;
                   EEPROM_Write(0x000f,auto_logic);//0x000f address of auto_logic
                   Delay_ms(40);
                 }
                 else if(strstr(getRequest, "=AUTO=DIS"))
                 {
                   Relay_en_dis(*ref,off);
                   auto_logic&=~(1<<(*ref-'0'-1));
                   auto_logic&=0x0F;
                   GIE_bit = 0;
                   EEPROM_Write(0x000f,auto_logic);//0x000f address of auto_logic
                   Delay_ms(40);
                 }
```

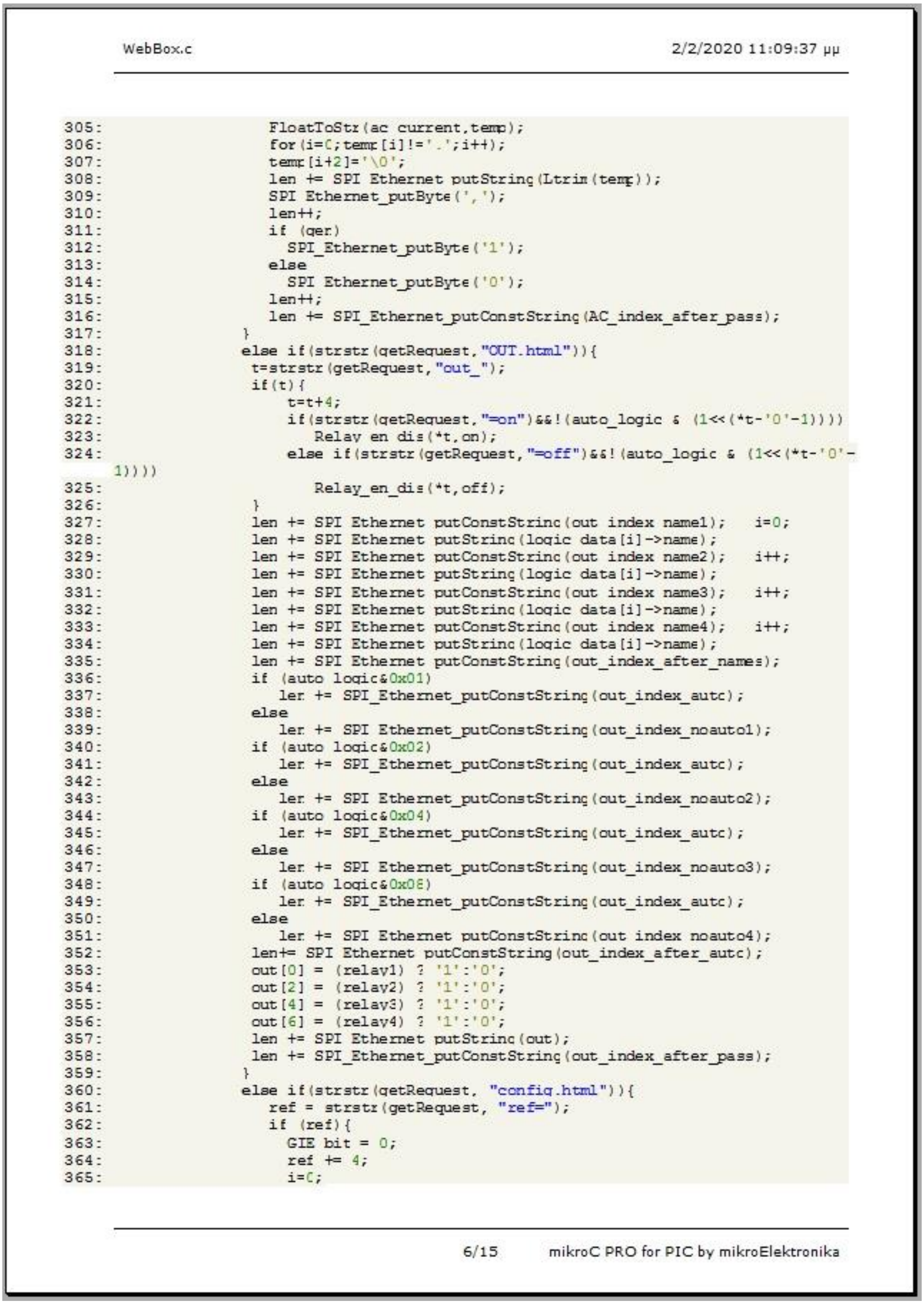
4/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

```
             }
             if(auto_logic)
                TMR0ON_bit=1;
             else
             {
                TMR0ON_bit=0;
                led = 1;
             }
             GIE_bit = 1;
             if((auto_logic & (1<<(*ref-'0'-1))))
             {
                len += SPI_Ethernet_putString("OUT");
                SPI_Ethernet_putByte(*ref);
                len += SPI_Ethernet_putString(" IS ON AUTO MODE\n");
                len++;
             }
             else
                 len += SPI_Ethernet_putString("OK\n");
             return(len);
            }

          }
          len += SPI_Ethernet_putString("\nError command\n");
          return(len);
        }
        if(localPort == 80 || localPort == 8080)
        {
          for(i = 0 ; i < 100 ; i++)
          {
          getRequest[i] = SPI_Ethernet_getByte() ;
          }
          getRequest[i] ='\0' ;
          if(strstr(getRequest, "GET"))       // only GET method is supported here
          {
            if(strstr(getRequest,"key"))
               key = 1;
            if(key){
              key_interval=1;
              if (strstr(getRequest,"DC.html")){
                 len += SPI_Ethernet_putConstString(DC_index);
                 FloatToStr(dc_voltage,temp);
                 for(i=0;temp[i]!='.';i++);
                 temp[i+2]='\0';
                 len += SPI_Ethernet_putString(Ltrim(temp));
                 SPI_Ethernet_putByte(',');
                 len++;
                 IntToStr((int)pv_current,temp);
                 len += SPI_Ethernet_putString(Ltrim(temp));
                 SPI_Ethernet_putByte(',');
                 len++;
                 IntToStr((int)inv_current,temp);
                 len += SPI_Ethernet_putString(Ltrim(temp));
                 len += SPI_Ethernet_putConstString(DC_index_after_pass);
              }
              else if(strstr(getRequest,"AC.html")){
                 len += SPI_Ethernet_putConstString(AC_index);
                 IntToStr((int)ac_voltage,temp);
                 len += SPI_Ethernet_putString(Ltrim(temp));
                 SPI_Ethernet_putByte(',');
                 len++;
```

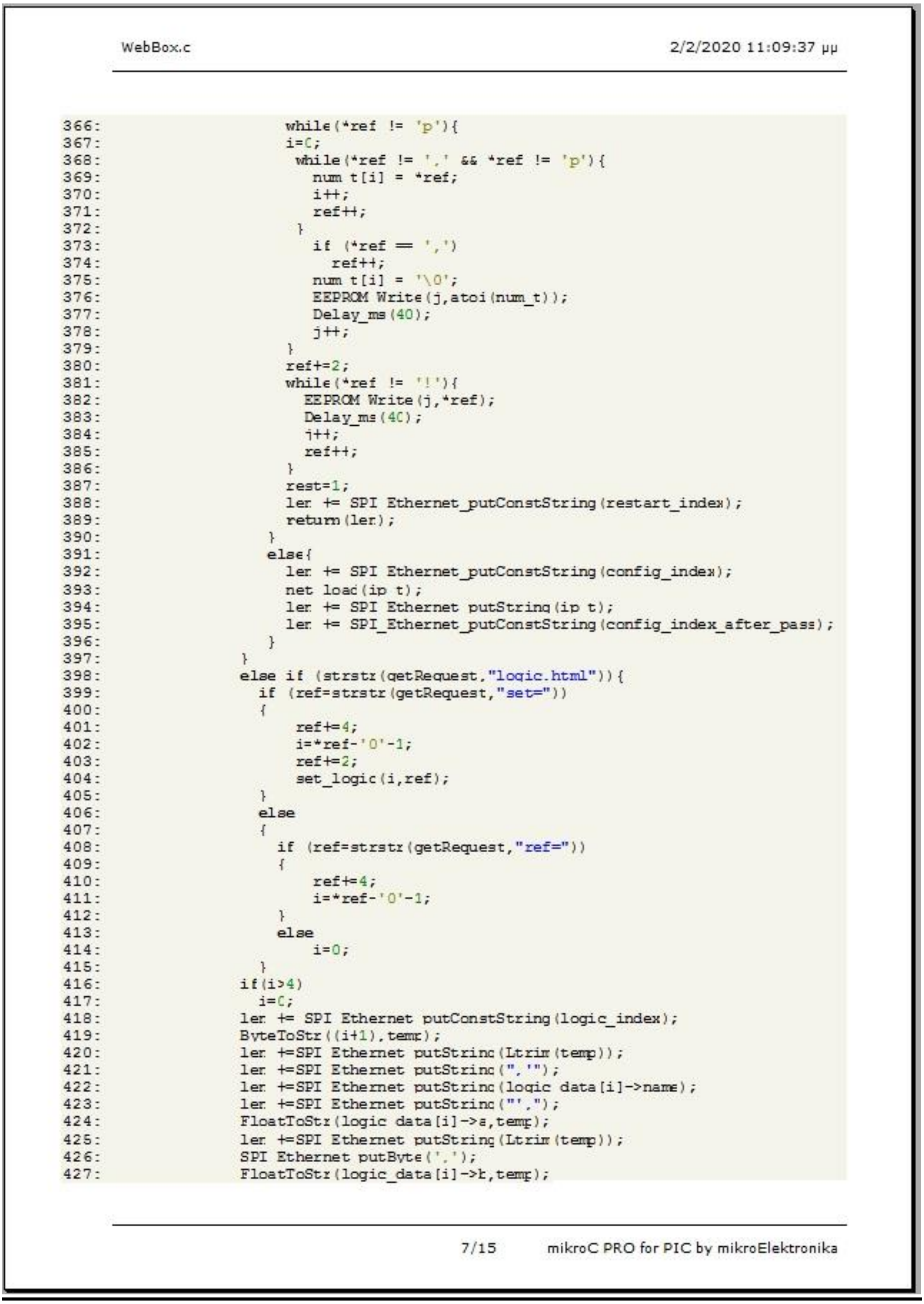
5/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

```c
           FloatToStr(ac_current,temp);
           for(i=0;temp[i]!='.';i++);
           temp[i+2]='\0';
           len += SPI_Ethernet_putString(Ltrim(temp));
           SPI_Ethernet_putByte(',');
           len++;
           if (gen)
             SPI_Ethernet_putByte('1');
           else
             SPI_Ethernet_putByte('0');
           len++;
           len += SPI_Ethernet_putConstString(AC_index_after_pass);
        }
        else if(strstr(getRequest,"OUT.html")){
         t=strstr(getRequest,"out_");
         if(t){
             t=t+4;
             if(strstr(getRequest,"=on")&&!(auto_logic & (1<<(*t-'0'-1))))
                Relay_en_dis(*t,on);
             else if(strstr(getRequest,"=off")&&!(auto_logic & (1<<(*t-'0'-1))))
                Relay_en_dis(*t,off);
         }
         len += SPI_Ethernet_putConstString(out_index_name1);   i=0;
         len += SPI_Ethernet_putString(logic_data[i]->name);
         len += SPI_Ethernet_putConstString(out_index_name2);   i++;
         len += SPI_Ethernet_putString(logic_data[i]->name);
         len += SPI_Ethernet_putConstString(out_index_name3);   i++;
         len += SPI_Ethernet_putString(logic_data[i]->name);
         len += SPI_Ethernet_putConstString(out_index_name4);   i++;
         len += SPI_Ethernet_putString(logic_data[i]->name);
         len += SPI_Ethernet_putConstString(out_index_after_names);
         if (auto_logic&0x01)
            len += SPI_Ethernet_putConstString(out_index_auto);
         else
            len += SPI_Ethernet_putConstString(out_index_noauto1);
         if (auto_logic&0x02)
            len += SPI_Ethernet_putConstString(out_index_auto);
         else
            len += SPI_Ethernet_putConstString(out_index_noauto2);
         if (auto_logic&0x04)
            len += SPI_Ethernet_putConstString(out_index_auto);
         else
            len += SPI_Ethernet_putConstString(out_index_noauto3);
         if (auto_logic&0x08)
            len += SPI_Ethernet_putConstString(out_index_auto);
         else
            len += SPI_Ethernet_putConstString(out_index_noauto4);
         len+= SPI_Ethernet_putConstString(out_index_after_auto);
         out[0] = (relay1) ? '1':'0';
         out[2] = (relay2) ? '1':'0';
         out[4] = (relay3) ? '1':'0';
         out[6] = (relay4) ? '1':'0';
         len += SPI_Ethernet_putString(out);
         len += SPI_Ethernet_putConstString(out_index_after_pass);
        }
        else if(strstr(getRequest, "config.html")){
           ref = strstr(getRequest, "ref=");
           if (ref){
             GIE_bit = 0;
             ref += 4;
             i=0;
```

6/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

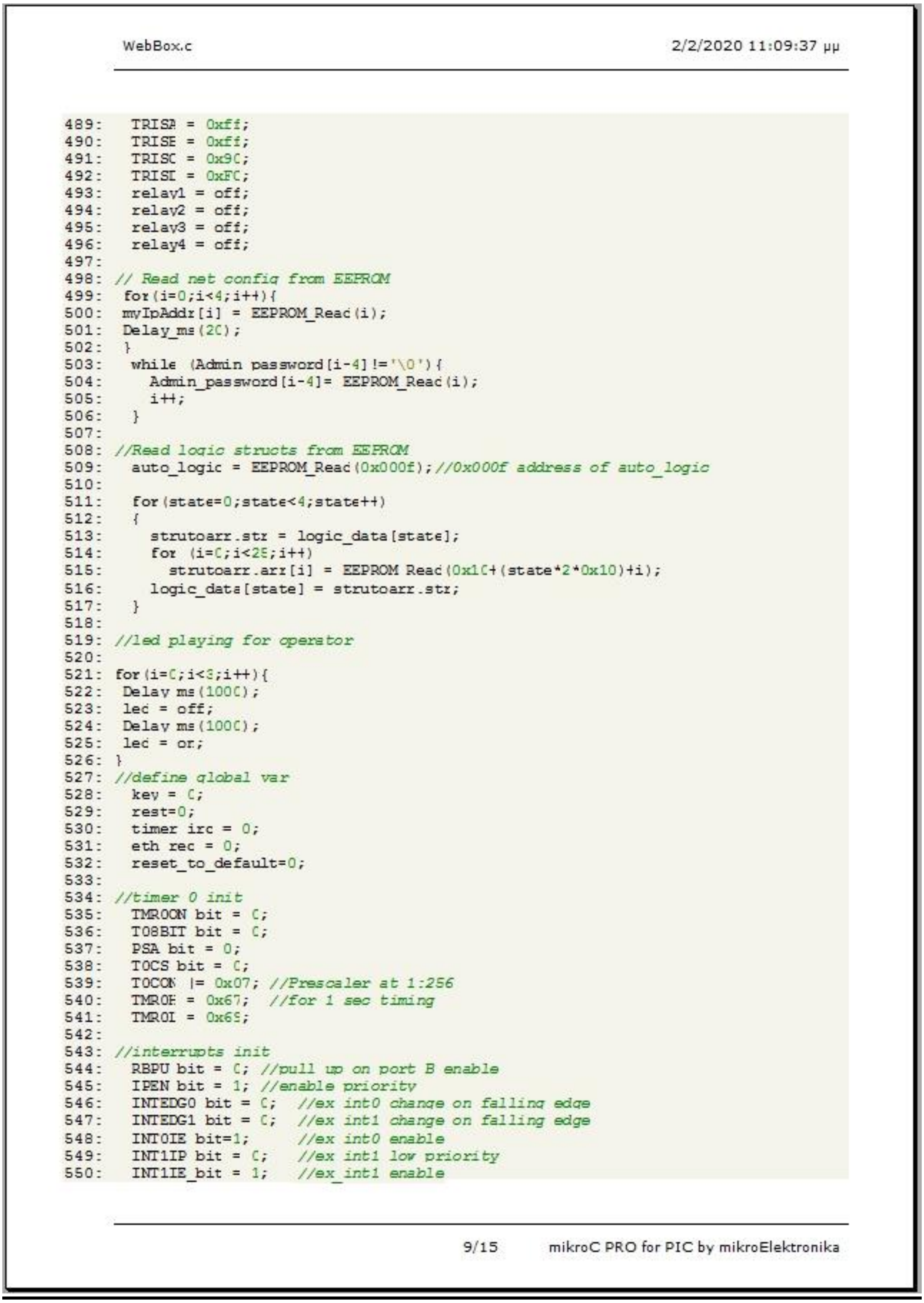
```
     while(*ref != 'p'){
     i=0;
      while(*ref != ',' && *ref != 'p'){
        num_t[i] = *ref;
        i++;
        ref++;
      }
        if (*ref == ',')
          ref++;
        num_t[i] = '\0';
        EEPROM_Write(j,atoi(num_t));
        Delay_ms(40);
        j++;
     }
     ref+=2;
     while(*ref != '!'){
       EEPROM_Write(j,*ref);
       Delay_ms(40);
       j++;
       ref++;
     }
     rest=1;
     len += SPI_Ethernet_putConstString(restart_index);
     return(len);
   }
   else{
     len += SPI_Ethernet_putConstString(config_index);
     net_load(ip_t);
     len += SPI_Ethernet_putString(ip_t);
     len += SPI_Ethernet_putConstString(config_index_after_pass);
   }
}
else if (strstr(getRequest,"logic.html")){
  if (ref=strstr(getRequest,"set="))
  {
      ref+=4;
      i=*ref-'0'-1;
      ref+=2;
      set_logic(i,ref);
  }
  else
  {
    if (ref=strstr(getRequest,"ref="))
    {
        ref+=4;
        i=*ref-'0'-1;
    }
    else
        i=0;
  }
if(i>4)
  i=0;
len += SPI_Ethernet_putConstString(logic_index);
ByteToStr((i+1),temp);
len +=SPI_Ethernet_putString(Ltrim(temp));
len +=SPI_Ethernet_putString(",'");
len +=SPI_Ethernet_putString(logic_data[i]->name);
len +=SPI_Ethernet_putString("',");
FloatToStr(logic_data[i]->a,temp);
len +=SPI_Ethernet_putString(Ltrim(temp));
SPI_Ethernet_putByte(',');
FloatToStr(logic_data[i]->b,temp);
```

7/15 mikroC PRO for PIC by mikroElektronika

WebBox.c 2/2/2020 11:09:37 μμ

```c
              len +=SPI_Ethernet_putString(Ltrim(temp));
              SPI_Ethernet_putByte(',');
              FloatToStr(logic_data[i]->c,temp);
              len +=SPI_Ethernet_putString(Ltrim(temp));
              SPI_Ethernet_putByte(',');
              IntToStr(logic_data[i]->t1,temp);
              len +=SPI_Ethernet_putString(Ltrim(temp));
              SPI_Ethernet_putByte(',');
              ByteToStr(logic_data[i]->t2,temp);
              len +=SPI_Ethernet_putString(Ltrim(temp));
              SPI_Ethernet_putByte(',');
              ByteToStr(auto_logic&(1<<(i)),temp);
              len += SPI_Ethernet_putString(Ltrim(temp));
              len += SPI_Ethernet_putConstString(logic_index_after_pass);
              len += 5;//for ',' chars
            }
            else
            {
              len += SPI_Ethernet_putConstString(login_index);
              SPI_Ethernet_putByte('"');
              len += SPI_Ethernet_putString(Admin_password);
              SPI_Ethernet_putByte('"');
              len += SPI_Ethernet_putConstString(login_index_after_pass);
              len+=2;
            }
          }
            else{
              len += SPI_Ethernet_putConstString(login_index);
              SPI_Ethernet_putByte('"');
              len += SPI_Ethernet_putString(Admin_password);
              SPI_Ethernet_putByte('"');
              len += SPI_Ethernet_putConstString(login_index_after_pass);
              len+=2;
            }
          }
        }
 return len;}

unsigned int SPI_Ethernet_UserUDP(unsigned char *remoteHost, unsigned int remotePort, unsigned int localPort, unsigned int reqLength, TEthPktFlags *flags){
 return 0;}

void SPI_Ethernet_IRQ_enable(){
 SPI_Ethernet_CS = 0;
 SPI1_Write(0x5E);
 SPI1_Write(0xC0);
 SPI_Ethernet_CS = 1;
 return;
}

//interrupt function
void interrupt(void);
void interrupt_low(void);


void main() {
  unsigned int ac_volt=0,dc[4]={0,0,0,0},ac_amp=0;
  unsigned char i,state,adc_interval=adc_interval_cost;
  SWDTEN_bit=0;//disable watchdog
  ADCON1 = 0x09;
  CMCON |= 0x07 ;
//define ports IO and variables
```

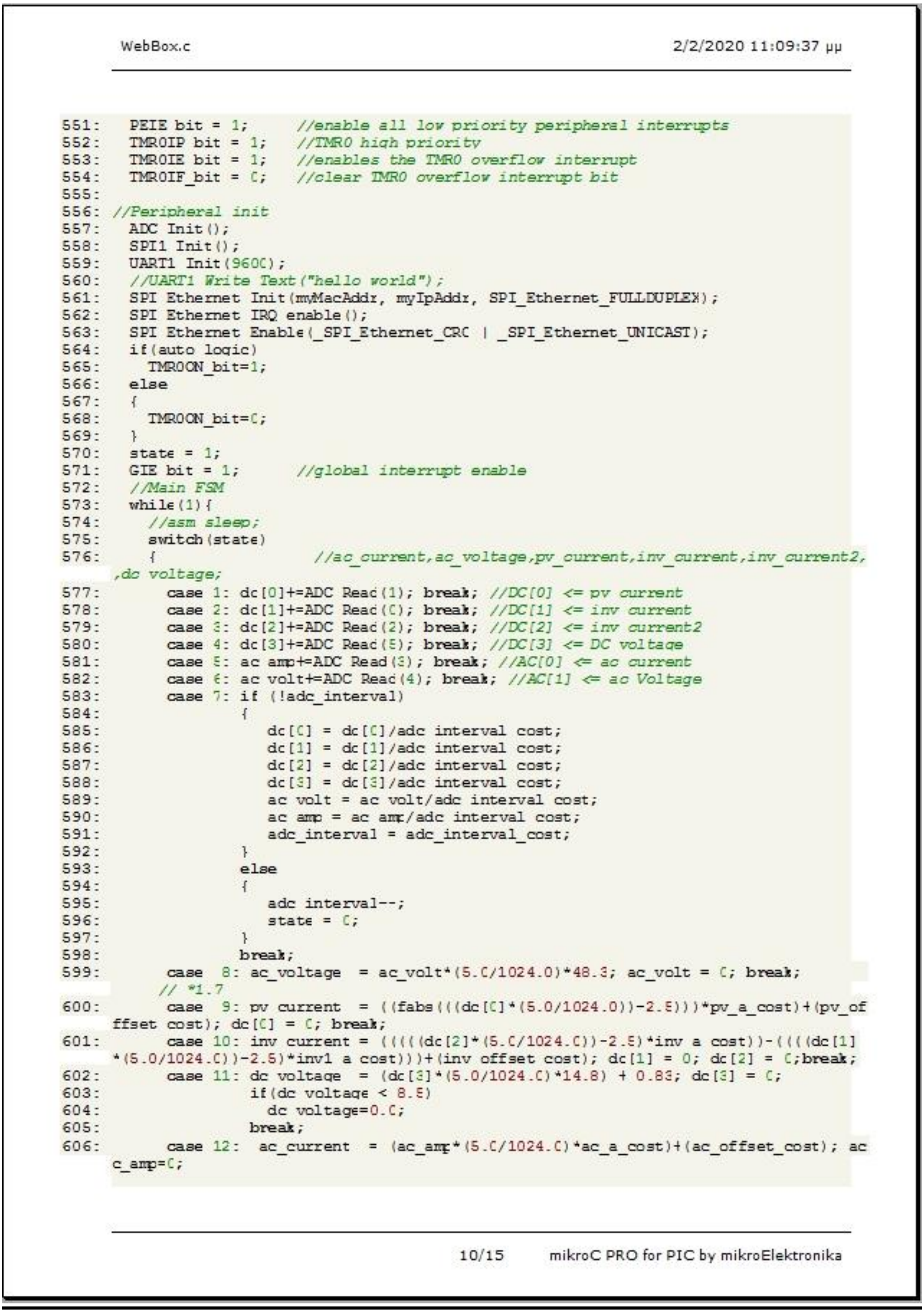
8/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

```
  TRISA = 0xff;
  TRISB = 0xff;
  TRISC = 0x9C;
  TRISD = 0xFC;
  relay1 = off;
  relay2 = off;
  relay3 = off;
  relay4 = off;

// Read net config from EEPROM
 for(i=0;i<4;i++){
 myIpAddr[i] = EEPROM_Read(i);
 Delay_ms(20);
 }
  while (Admin_password[i-4]!='\0'){
    Admin_password[i-4]= EEPROM_Read(i);
    i++;
  }

//Read logic structs from EEPROM
  auto_logic = EEPROM_Read(0x000f);//0x000f address of auto_logic

  for(state=0;state<4;state++)
  {
    strutoarr.str = logic_data[state];
    for (i=0;i<25;i++)
      strutoarr.arr[i] = EEPROM_Read(0x10+(state*2*0x10)+i);
    logic_data[state] = strutoarr.str;
  }

//led playing for operator

for(i=0;i<3;i++){
 Delay_ms(1000);
 led = off;
 Delay_ms(1000);
 led = on;
}
//define global var
  key = 0;
  rest=0;
  timer_irq = 0;
  eth_rec = 0;
  reset_to_default=0;

//timer 0 init
  TMR0ON_bit = 0;
  T08BIT_bit = 0;
  PSA_bit = 0;
  T0CS_bit = 0;
  T0CON |= 0x07; //Prescaler at 1:256
  TMR0H = 0x67;  //for 1 sec timing
  TMR0L = 0x69;

//interrupts init
  RBPU_bit = 0; //pull up on port B enable
  IPEN_bit = 1; //enable priority
  INTEDG0_bit = 0;  //ex int0 change on falling edge
  INTEDG1_bit = 0;  //ex int1 change on falling edge
  INT0IE_bit=1;     //ex int0 enable
  INT1IP_bit = 0;   //ex int1 low priority
  INT1IE_bit = 1;   //ex_int1 enable
```

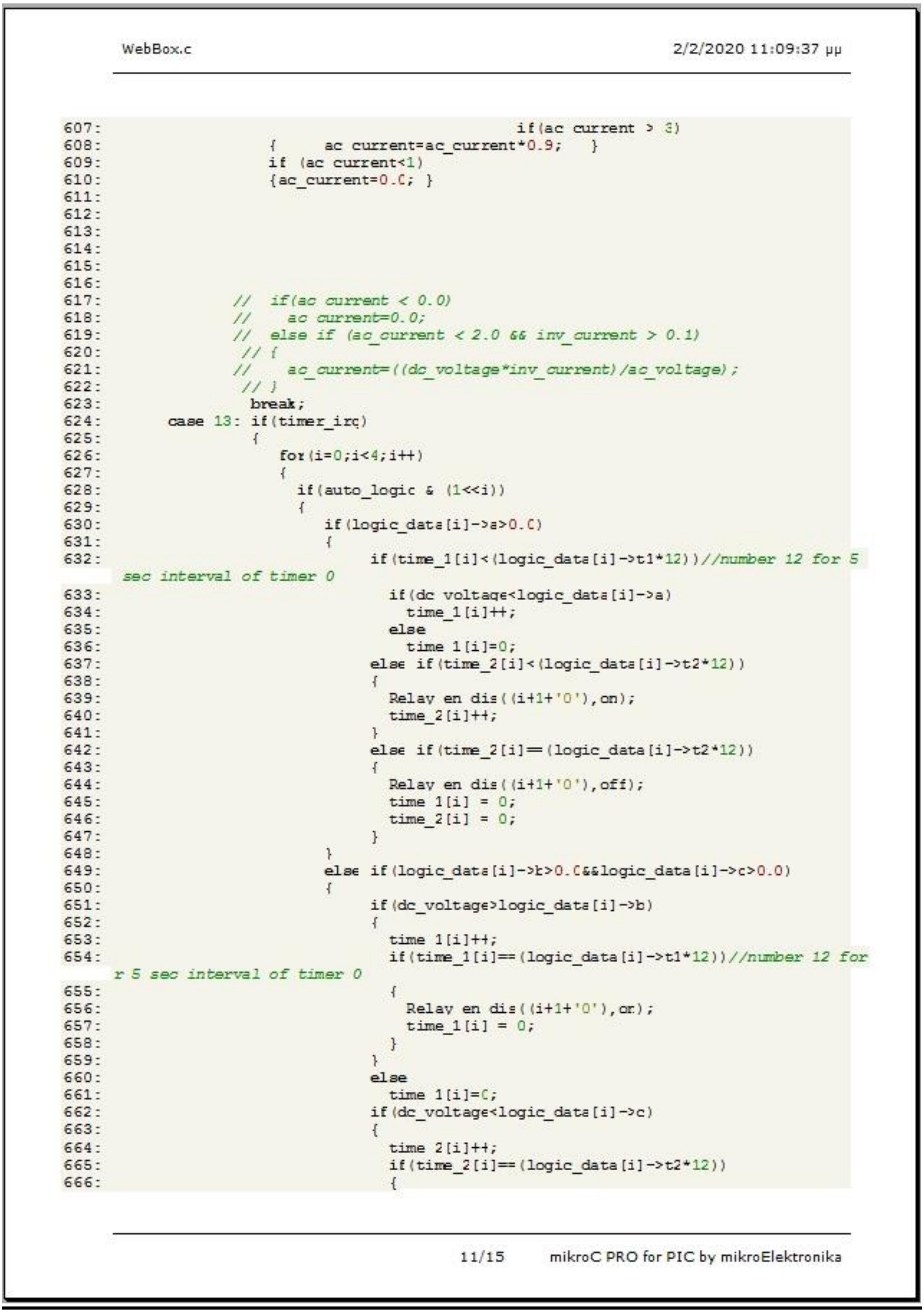
9/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

```
  PEIE_bit = 1;       //enable all low priority peripheral interrupts
  TMR0IP_bit = 1;    //TMR0 high priority
  TMR0IE_bit = 1;    //enables the TMR0 overflow interrupt
  TMR0IF_bit = 0;    //clear TMR0 overflow interrupt bit

//Peripheral init
  ADC_Init();
  SPI1_Init();
  UART1_Init(9600);
  //UART1_Write_Text("hello world");
  SPI_Ethernet_Init(myMacAddr, myIpAddr, SPI_Ethernet_FULLDUPLEX);
  SPI_Ethernet_IRQ_enable();
  SPI_Ethernet_Enable(_SPI_Ethernet_CRC | _SPI_Ethernet_UNICAST);
  if(auto_logic)
    TMR0ON_bit=1;
  else
  {
    TMR0ON_bit=0;
  }
  state = 1;
  GIE_bit = 1;        //global interrupt enable
  //Main FSM
  while(1){
    //asm sleep;
    switch(state)
    {                 //ac_current,ac_voltage,pv_current,inv_current,inv_current2,
,dc_voltage;
      case 1: dc[0]+=ADC_Read(1); break; //DC[0] <= pv current
      case 2: dc[1]+=ADC_Read(0); break; //DC[1] <= inv current
      case 3: dc[2]+=ADC_Read(2); break; //DC[2] <= inv current2
      case 4: dc[3]+=ADC_Read(5); break; //DC[3] <= DC voltage
      case 5: ac_amp+=ADC_Read(3); break; //AC[0] <= ac current
      case 6: ac_volt+=ADC_Read(4); break; //AC[1] <= ac Voltage
      case 7: if (!adc_interval)
              {
                 dc[0] = dc[0]/adc_interval_cost;
                 dc[1] = dc[1]/adc_interval_cost;
                 dc[2] = dc[2]/adc_interval_cost;
                 dc[3] = dc[3]/adc_interval_cost;
                 ac_volt = ac_volt/adc_interval_cost;
                 ac_amp = ac_amp/adc_interval_cost;
                 adc_interval = adc_interval_cost;
              }
              else
              {
                 adc_interval--;
                 state = 0;
              }
              break;
      case  8: ac_voltage  = ac_volt*(5.0/1024.0)*48.3; ac_volt = 0; break;
     // *1.7
      case  9: pv_current  = ((fabs(((dc[0]*(5.0/1024.0))-2.5)))*pv_a_cost)+(pv_of
ffset_cost); dc[0] = 0; break;
      case 10: inv_current = (((((dc[2]*(5.0/1024.0))-2.5)*inv_a_cost))-((((dc[1]
*(5.0/1024.0))-2.5)*inv1_a_cost)))+(inv_offset_cost); dc[1] = 0; dc[2] = 0;break;
      case 11: dc_voltage  = (dc[3]*(5.0/1024.0)*14.8) + 0.83; dc[3] = 0;
               if(dc_voltage < 8.5)
                 dc_voltage=0.0;
               break;
      case 12:  ac_current  = (ac_amp*(5.0/1024.0)*ac_a_cost)+(ac_offset_cost); ac
c_amp=0;
```

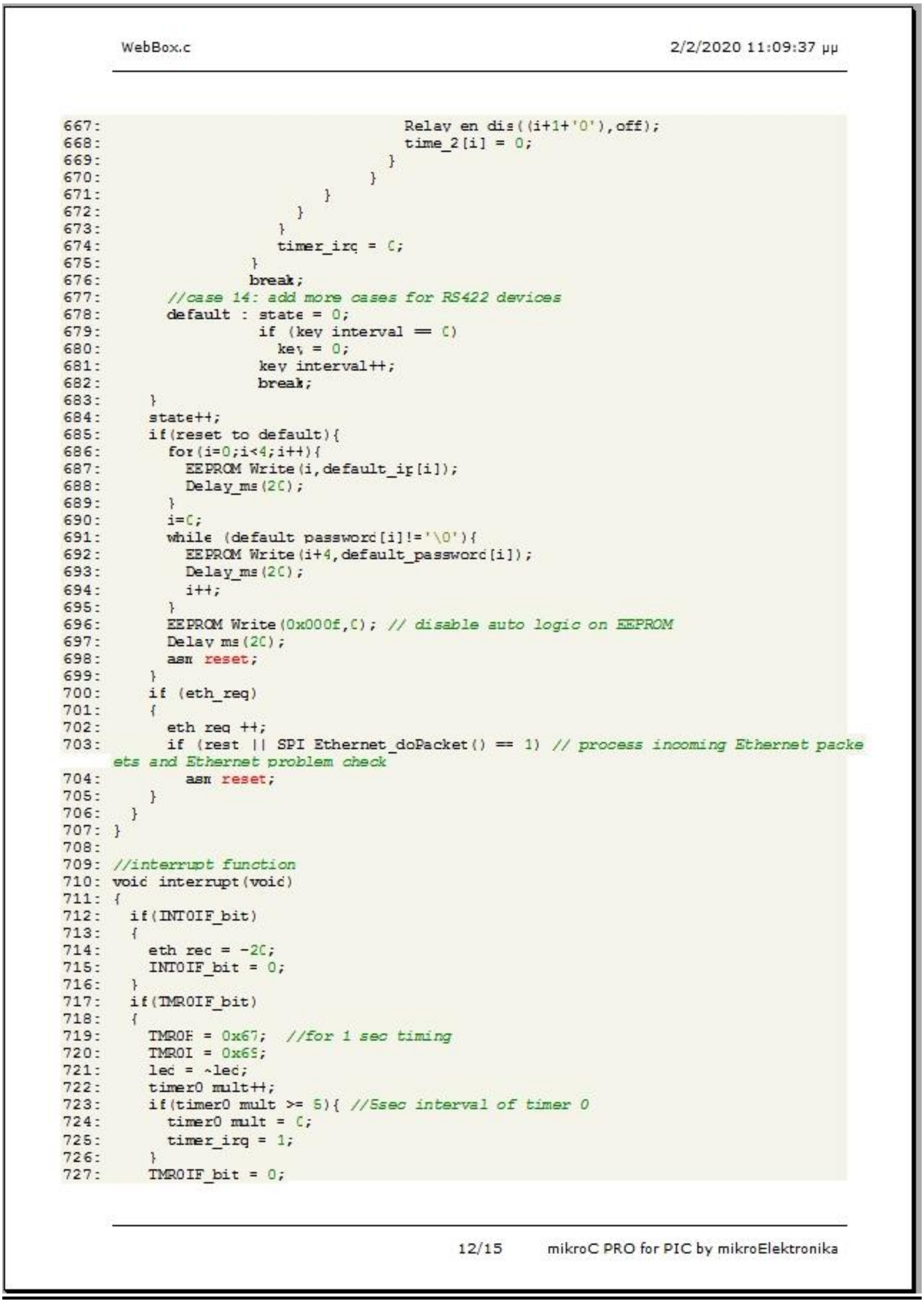
10/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

```c
                                            if(ac_current > 3)
                 {     ac_current=ac_current*0.9;    }
                 if (ac_current<1)
                 {ac_current=0.0; }





             //  if(ac_current < 0.0)
             //    ac_current=0.0;
             //  else if (ac_current < 2.0 && inv_current > 0.1)
              // {
             //    ac_current=((dc_voltage*inv_current)/ac_voltage);
              // }
               break;
      case 13: if(timer_irq)
               {
                  for(i=0;i<4;i++)
                  {
                    if(auto_logic & (1<<i))
                    {
                       if(logic_data[i]->a>0.0)
                       {
                            if(time_1[i]<(logic_data[i]->t1*12))//number 12 for 5 sec interval of timer 0
                              if(dc_voltage<logic_data[i]->a)
                                time_1[i]++;
                              else
                                time_1[i]=0;
                            else if(time_2[i]<(logic_data[i]->t2*12))
                            {
                              Relay_en_dis((i+1+'0'),on);
                              time_2[i]++;
                            }
                            else if(time_2[i]==(logic_data[i]->t2*12))
                            {
                              Relay_en_dis((i+1+'0'),off);
                              time_1[i] = 0;
                              time_2[i] = 0;
                            }
                       }
                       else if(logic_data[i]->b>0.0&&logic_data[i]->c>0.0)
                       {
                            if(dc_voltage>logic_data[i]->b)
                            {
                              time_1[i]++;
                              if(time_1[i]==(logic_data[i]->t1*12))//number 12 forr 5 sec interval of timer 0
                              {
                                Relay_en_dis((i+1+'0'),on);
                                time_1[i] = 0;
                              }
                            }
                            else
                              time_1[i]=0;
                            if(dc_voltage<logic_data[i]->c)
                            {
                              time_2[i]++;
                              if(time_2[i]==(logic_data[i]->t2*12))
                              {
```

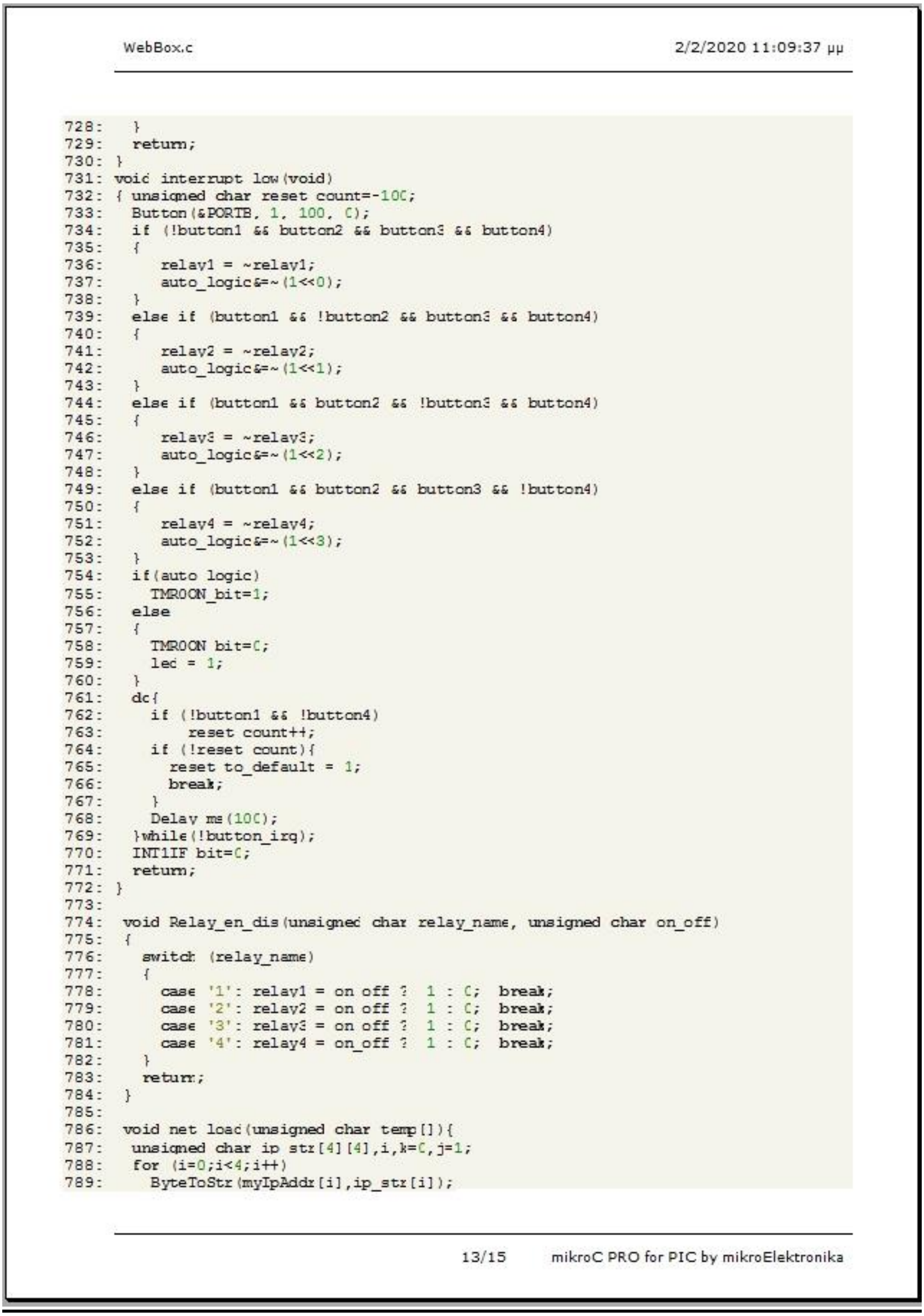
11/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

```
                                Relay_en_dis((i+1+'0'),off);
                                time_2[i] = 0;
                              }
                            }
                       }
                    }
                  }
                  timer_irq = 0;
               }
               break;
      //case 14: add more cases for RS422 devices
      default : state = 0;
                if (key_interval == 0)
                  key = 0;
                key_interval++;
                break;
    }
    state++;
    if(reset_to_default){
      for(i=0;i<4;i++){
        EEPROM_Write(i,default_ip[i]);
        Delay_ms(20);
      }
      i=0;
      while (default_password[i]!='\0'){
        EEPROM_Write(i+4,default_password[i]);
        Delay_ms(20);
        i++;
      }
      EEPROM_Write(0x000f,0); // disable auto logic on EEPROM
      Delay_ms(20);
      asm reset;
    }
    if (eth_req)
    {
      eth_req ++;
      if (rest || SPI_Ethernet_doPacket() == 1) // process incoming Ethernet packets and Ethernet problem check
        asm reset;
    }
  }
}

//interrupt function
void interrupt(void)
{
  if(INT0IF_bit)
  {
    eth_req = -20;
    INT0IF_bit = 0;
  }
  if(TMR0IF_bit)
  {
    TMR0H = 0x67;  //for 1 sec timing
    TMR0L = 0x69;
    led = ~led;
    timer0_mult++;
    if(timer0_mult >= 5){ //5sec interval of timer 0
      timer0_mult = 0;
      timer_irq = 1;
    }
    TMR0IF_bit = 0;
```

12/15 mikroC PRO for PIC by mikroElektronika



WebBox.c 2/2/2020 11:09:37 μμ

```
  }
  return;
}
void interrupt_low(void)
{ unsigned char reset_count=-100;
  Button(&PORTB, 1, 100, 0);
  if (!button1 && button2 && button3 && button4)
  {
     relay1 = ~relay1;
     auto_logic&=~(1<<0);
  }
  else if (button1 && !button2 && button3 && button4)
  {
     relay2 = ~relay2;
     auto_logic&=~(1<<1);
  }
  else if (button1 && button2 && !button3 && button4)
  {
     relay3 = ~relay3;
     auto_logic&=~(1<<2);
  }
  else if (button1 && button2 && button3 && !button4)
  {
     relay4 = ~relay4;
     auto_logic&=~(1<<3);
  }
  if(auto_logic)
    TMR0ON_bit=1;
  else
  {
    TMR0ON_bit=0;
    led = 1;
  }
  do{
    if (!button1 && !button4)
        reset_count++;
    if (!reset_count){
      reset_to_default = 1;
      break;
    }
    Delay_ms(100);
  }while(!button_irq);
  INT1IF_bit=0;
  return;
}

 void Relay_en_dis(unsigned char relay_name, unsigned char on_off)
 {
   switch (relay_name)
   {
     case '1': relay1 = on_off ?  1 : 0;  break;
     case '2': relay2 = on_off ?  1 : 0;  break;
     case '3': relay3 = on_off ?  1 : 0;  break;
     case '4': relay4 = on_off ?  1 : 0;  break;
   }
   return;
 }

 void net_load(unsigned char temp[]){
  unsigned char ip_str[4][4],i,k=0,j=1;
  for (i=0;i<4;i++)
    ByteToStr(myIpAddr[i],ip_str[i]);
```

13/15 mikroC PRO for PIC by mikroElektronika

WebBox.c 2/2/2020 11:09:37 μμ

```
  i=0;
  while (k<4){
    temp[j] = ip_str[k][i];
    i++;
    j++;
    if(i == 3){
      if (k < 3)
        temp[j]=',';
      j++;
      k++;
      i=0;
    }
  }
  j+=3;
  for(i=0;Admin_password[i]!='\0';i++,j++)
    temp[j]= Admin_password[i];
  temp[j]='"';
  temp[j+1]=']';
  temp[j+2]='\0';
  return;

 }

void set_logic(unsigned char n,char *ref)
{
 unsigned char value[7],i,j;
 unsigned int store_add;
 float t;
 //name decode
 for(i=0,j=0;*ref!=',';i++,ref++)
 {
   logic_data[n]->name[i]=*ref;
 }
 logic_data[n]->name[i]='\0';
 //A,B,C,T1,T2 decode
 for(j=0;j<5;j++)
 {
   ref++;
   for(i=0;*ref!=',';i++,ref++)
      value[i]=*ref;
   value[i]='\0';
   switch(j)
   {
      case 0: t=(ceil(atof(value)*10))/10; if(t<=60.0&&t>=0.0)logic_data[n]->a=t;
 break;
      case 1: t=(ceil(atof(value)*10))/10; if(t<=60.0&&t>=0.0)logic_data[n]->b=t;
 break;
      case 2: t=(ceil(atof(value)*10))/10; if(t<=60.0&&t>=0.0)logic_data[n]->c=t;
 break;
      case 3: store_add=abs(atoi(value));if(store_add<=4000)logic_data[n]->t1=stor
re add; break;
      case 4: store_add=abs(atoi(value));if(store_add<=4000)logic_data[n]->t2=stor
re add; break;
   }
 }
  ref++;
  if(*ref=='t')
  {
     auto_logic|=(1<<(n));
     time_1[n] = 0;
     time_2[n] = 0;
  }
```

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WebBox.c 2/2/2020 11:09:37 μμ

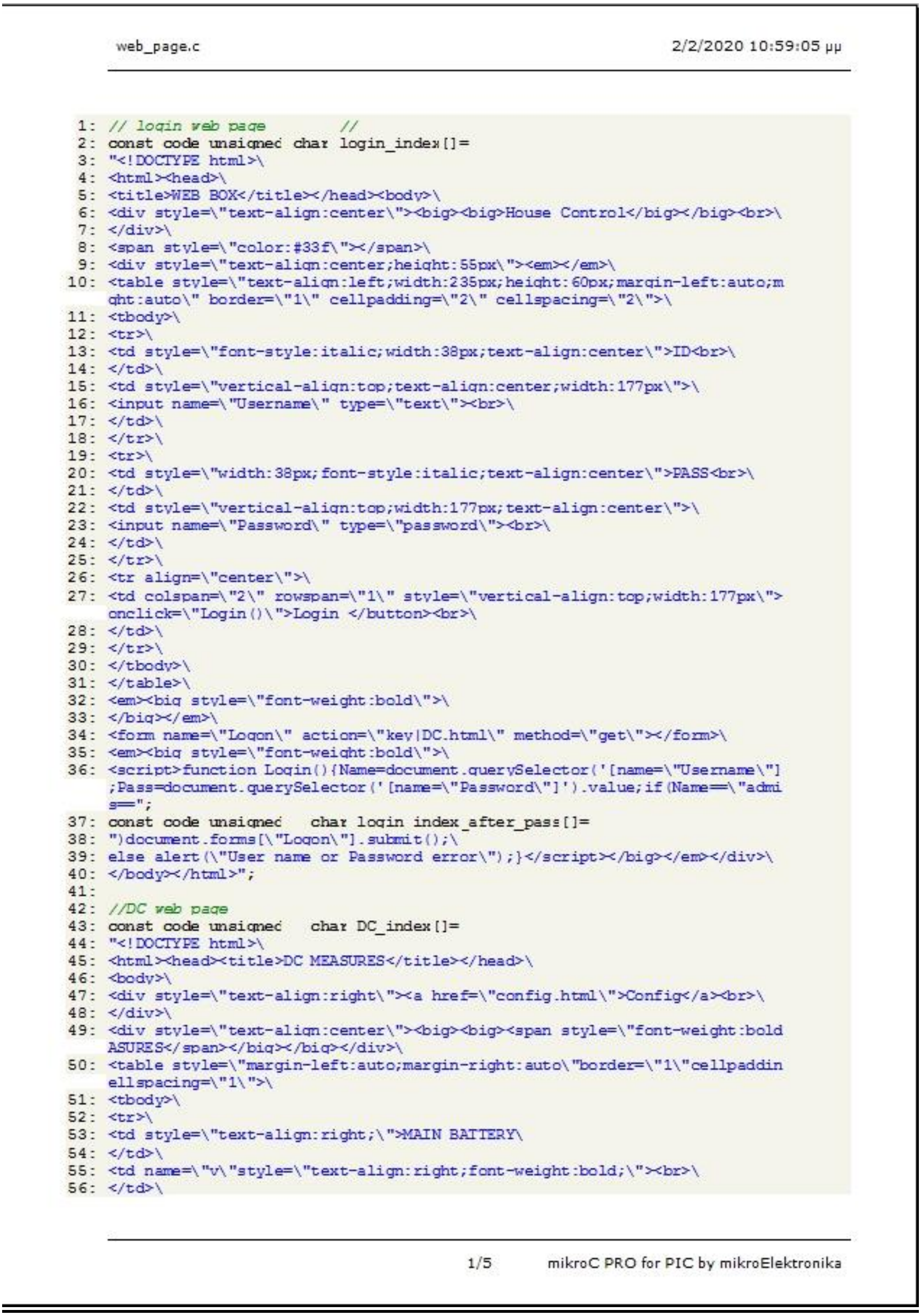
```c
  else if(*ref=='f')
     auto_logic&=~(1<<(r));
  Relay_en_dis((r+1+'0'),off);
  auto_logic&=0x0F;

  // EEPROM write of set logic struct
  store_add=0x10+(r*2*0x10);
  strutoarr.str = logic_data[n];
  GIE_bit = 0;
  EEPROM_Write(0x000f,auto_logic);//0x000f address of auto_logic
  Delay_ms(40);
  for (i=0;i<25;i++)
  {
     EEPROM_Write((store_add+i),strutoarr.arr[i]);//save logic_data to eeprom
     Delay_ms(40);
  }
  if(auto_logic)
    TMR0ON_bit=1;
  else
  {
    TMR0ON_bit=0;
    led = 1;
  }
  GIE_bit = 1;
 return;
}
```

15/15 mikroC PRO for PIC by mikroElektronika

8.2 Κώδικας html

WEBPAGE CODE



web_page.c 2/2/2020 10:59:05 μμ

```
// login web page        //
const code unsigned char login_index[]=
"<!DOCTYPE html>\
<html><head>\
<title>WEB BOX</title></head><body>\
<div style=\"text-align:center\"><big><big>House Control</big></big><br>\
</div>\
<span style=\"color:#33f\"></span>\
<div style=\"text-align:center;height:55px\"><em></em>\
<table style=\"text-align:left;width:235px;height:60px;margin-left:auto;m
ght:auto\" border=\"1\" cellpadding=\"2\" cellspacing=\"2\">\
<tbody>\
<tr>\
<td style=\"font-style:italic;width:38px;text-align:center\">ID<br>\
</td>\
<td style=\"vertical-align:top;text-align:center;width:177px\">\
<input name=\"Username\" type=\"text\"><br>\
</td>\
</tr>\
<tr>\
<td style=\"width:38px;font-style:italic;text-align:center\">PASS<br>\
</td>\
<td style=\"vertical-align:top;width:177px;text-align:center\">\
<input name=\"Password\" type=\"password\"><br>\
</td>\
</tr>\
<tr align=\"center\">\
<td colspan=\"2\" rowspan=\"1\" style=\"vertical-align:top;width:177px\">
onclick=\"Login()\">Login </button><br>\
</td>\
</tr>\
</tbody>\
</table>\
<em><big style=\"font-weight:bold\">\
</big></em>\
<form name=\"Logon\" action=\"key|DC.html\" method=\"get\"></form>\
<em><big style=\"font-weight:bold\">\
<script>function Login(){Name=document.querySelector('[name=\"Username\"]
;Pass=document.querySelector('[name=\"Password\"]').value;if(Name==\"admi
s==";
const code unsigned   char login index_after_pass[]=
")document.forms[\"Logon\"].submit();\
else alert(\"User name or Password error\");}</script></big></em></div>\
</body></html>";

//DC web page
const code unsigned   char DC_index[]=
"<!DOCTYPE html>\
<html><head><title>DC MEASURES</title></head>\
<body>\
<div style=\"text-align:right\"><a href=\"config.html\">Config</a><br>\
</div>\
<div style=\"text-align:center\"><big><big><span style=\"font-weight:bold
ASURES</span></big></big></div>\
<table style=\"margin-left:auto;margin-right:auto\"border=\"1\"cellpaddin
ellspacing=\"1\">\
<tbody>\
<tr>\
<td style=\"text-align:right;\">MAIN BATTERY\
</td>\
<td name=\"v\"style=\"text-align:right;font-weight:bold;\"><br>\
</td>\
```

1/5 mikroC PRO for PIC by mikroElektronika

web_page.c 2/2/2020 10:59:05 μμ

```
<td style=\"text-align:center;\">Volt</td>\
</tr>\
<tr>\
<td name=\"v\"style=\"text-align:right;\">BATTERY CHARGER CURRENT\
</td>\
<td name=\"v\"style=\"text-align:right;font-weight:bold;\"><br>\
</td>\
<td style=\"text-align:center;\">Amp</td>\
</tr>\
<tr>\
<td name=\"v\"style=\"text-align:right;\">INVERTER a CURRENT\
</td>\
<td name=\"v\"style=\"text-align:right;font-weight:bold;\"><br>\
</td>\
<td style=\"text-align:center;\">Amp</td>\
</tr>\
</tbody>\
</table>\
<div style=\"text-align:right\"><a href=\"AC.html\">AC Measure</a></div>\
<script>m=[";
const code unsigned   char DC index after pass[]=
"];s=document.getElementsByName('v');for(i=0;i<6;i+=2)s[i].innerHTML=m[i/
innerHTML=(m[2]<0)?s[3].innerHTML.replace(\"a\",\"CHARGING\"):\
s[3].innerHTML.replace(\"a\",\"INPUT\");setInterval(function(){location.r
,5000);</script>\
</body></html>";

//AC Web page
const code unsigned   char AC_index[]=
"<!DOCTYPE html>\
<html><head><title>AC MEASURES</title></head><body>\
<div style=\"text-align:right\"><a href=\"config.html\">Config</a><br></d
<div style=\"text-align:center\"><big><big><span style=\"font-weight:bold
ASURES</span></big></big></div>\
<table style=\"margin-left:auto;margin-right:auto\"border=\"1\"cellpaddin
ellspacing=\"1\">\
<tbody>\
<tr>\
<td style=\"text-align:center\">AC OUTPUT VOLTAGE\
</td>\
<td name=\"v\"style=\"text-align:right;font-weight:bold;\">\
</td>\
<td>Volt</td>\
</tr>\
<tr>\
<td style=\"text-align:center\">AC OUTPUT CURRENT\
</td>\
<td name=\"v\"style=\"text-align:right;font-weight:bold;\">\
</td>\
<td>Amp</td>\
</tr>\
<tr>\
<td style=\"text-align:center\">AC OUTPUT POWER\
</td>\
<td name=\"v\"style=\"text-align:right;font-weight:bold;\">\
</td>\
<td>VA</td>\
</tr>\
<tr>\
<td colspan=\"1\" rowspan=\"1\" style=\"text-align:center\">GENERATOR\
</td>\
<td style=\"text-align:center;font-weight:bold;\"name=\"v\"rowspan=\"1\"c
"2\">OFF\
```

2/5 mikroC PRO for PIC by mikroElektronika

web_page.c 2/2/2020 10:59:05 μμ

```
</td>\
</tr>\
</tbody>\
</table>\
<br>\
<div style=\"text-align:right\"><a href=\"OUT.html\">RELAY</a></div>\
<script>var m=[";
const code unsigned char AC_index_after_pass[]=
"];s=document.getElementsByName('v');for(i=0;i<2;i++)s[i].innerHTML=m[i];
erHTML=m[0]*m[1];if(m[2])s[3].innerHTML=\"ON\";setInterval(function(){loc
load()},5000);</script>\
</body></html>";

//output Web page
const code unsigned char out_index_name1[]=
"<!DOCTYPE html>\
<html><head><title>OUTPUT</title></head>\
<body>\
<div><a href=logic.html>AUTO</a></div>\
<div style=text-align:center><big><big><span style=font-weight:bold>RELAY
</big></big><br>\
</div>\
<form method=get>\
<table style=font-weight:bold;margin-left:auto;margin-right:auto>\
<tbody>\
<tr>\
<td name=o style=text-align:center;>";//OUTPUT 1
const code unsigned   char out_index_name2[]="</td>\
<td name=o style=text-align:center;>";//OUTPUT 2
const code unsigned   char out_index_name3[]="</td>\
<td name=o style=text-align:center;>";//OUTPUT 3
const code unsigned char out_index_name4[]="</td>\
<td name=o style=text-align:center;>";//OUTPUT 4
const code unsigned char out_index_after_names[]="</td></tr><tr>";
const code unsigned char out_index_noauto1[]="<td style=text-align:center;width:16
60px><button value=on name=out_1>ON</button><button value=off name=out_1>
ton></td>";
const code unsigned char out_index_noauto2[]="<td style=text-align:center;width:16
60px><button value=on name=out_2>ON</button><button value=off name=out_2>
ton></td>";
const code unsigned char out_index_noauto3[]="<td style=text-align:center;width:16
60px><button value=on name=out_3>ON</button><button value=off name=out_3>
ton></td>";
const code unsigned char out_index_noauto4[]="<td style=text-align:center;width:16
60px><button value=on name=out_4>ON</button><button value=off name=out_4>
ton></td>";
const code unsigned char out_index_after_auto[]="</tr>\
</tbody>\
</table>\
</form>\
<div style=text-align:right><a href=DC.html>DC Measure</a></div>\
<script>a=[";
const code unsigned char out_index_after_pass[]=
"];b=document.getElementsByName('o');for(i=0;i<4;i++)b[i].style.backgroun
green':'red';setInterval(function(){window.location.href='OUT.html'},2E3)
t>\</body></html>";

const code unsigned char out_index_auto[]="<td style=text-align:center;font-weight
t:bold;width:160px>AUTO</td>";


//Config Web page
```

3/5 mikroC PRO for PIC by mikroElektronika

web_page.c 2/2/2020 10:59:05 μμ

```
const code unsigned char config_index[]=
"<!DOCTYPE HTML>\
<html><body>\
<div style=text-align:center><span style=font-weight:bold>CONFIG</span><b
<table style=width:200px;height:136px;text-align:left;margin-left:auto;ma
ht:auto>\
<tbody>\
<tr>\
<td style=width:49px>IP</td>\
<td style=text-align:center;width:635px><input maxlength=15 name=t></td>\
</tr>\
<tr align=center>\
<td colspan=2 rowspan=1 style=vertical-align:top><big><span style=font-we
d>Password</span></big><br>\
</td>\
</tr>\
<tr>\
<td style=width:49px>Old</td>\
<td style=text-align:center;width:635px><input name=t type=password></td>
</tr>\
<tr>\
<td style=vertical-align:top>New</td>\
<td style=vertical-align:top;text-align:center><input maxlength=4 name=t
sword></td>\
</tr>\
<tr>\
<td style=width:49px>Verify</td>\
<td style=text-align:center;width:635px><input maxlength=4 name=t type=pa
/td>\
</tr>\
<tr>\
<td style=width:635px;text-align:center colspan=2 rowspan=1><button name=
lick=s_r()>Save&amp;Restart </button></td>\
</tr>\
</tbody>\
</table>\
<script>n=[";

const code unsigned   char config_index_after_pass[]="];\
ipf=/^(25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\.(25[0-5]|2[0-4][0-9]|[01]?[
]?)\.(25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\.(25[0-5]|2[0-4][0-9]|[01]?[0
?)$/;\
a=document.getElementsByName(\"t\");a[0].value=n[0];function s_r(){if(a[0
match(ipf)&&a[1].value==n[1]&&a[2].value==a[3].value&&a[3].value.length)\
{window.location.href=\"config.html\"+\"?ref=\"+a[0].value+\"p=\"+a[2].va
}else alert(\"Insert Error\");}</script>\
</div>\
</body></html>";

//Restart web page
const code unsigned   char restart_index[]=
"<!DOCTYPE html>\
<html><head>\
<title>Restart</title>\
</head><body>\
<div style=\"text-align: center;\"><big><big><big>System on Restart<br>\
</big>Please wait</big>\
</big><br>\
</div>\
<script>\
setTimeout(function(){alert(\"System Restarted\");window.location.href=\"
ml\";}, 3000);\
```

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web_page.c 2/2/2020 10:59:05 μμ

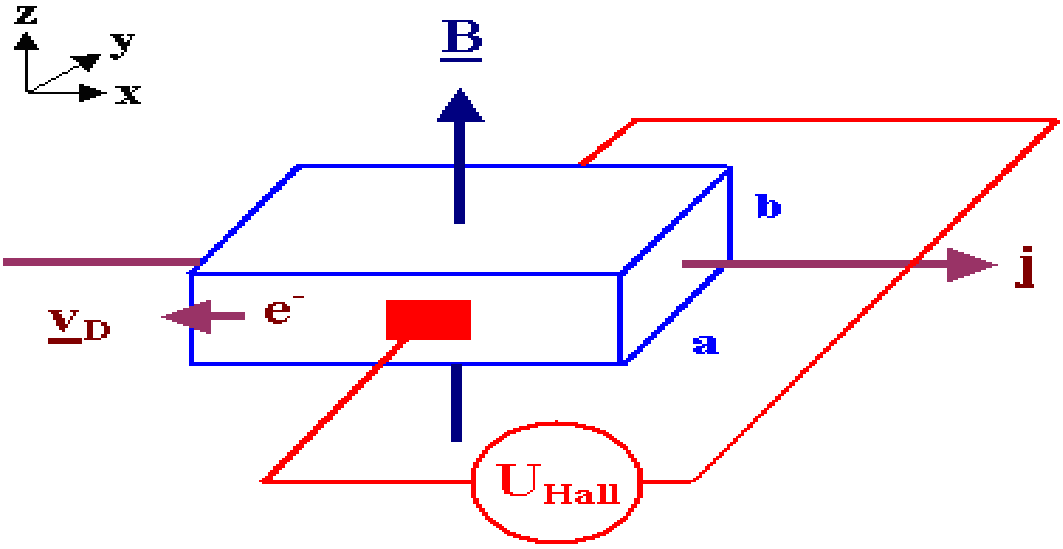
```
</script>\
</body></html>";

//logic web page
const code unsigned char logic_index[]=
"<!DOCTYPE html>\
<html><head><title>LOGIC</title>\
</head>\
<body>\
<table style=\"width:21px; height:21px;\"align=\"center\">\
<tbody>\
<tr>\
<td style=\"width:21px;\">OUT</td>\
<td style=\"width:21px;\">\
<select name=\"v\"onchange=\"R()\"><option>1</option><option>2</option><o
/option><option>4</option></select>\
</td>\
</tr>\
<tr>\
<td style=\"width:21px;\">NAME</td>\
<td style=\"width:21px;\"><input maxlength=\"8\"name=\"v\"></td>\
</tr>\
<tr>\
<td style=\"width:21px;\">A</td>\
<td style=\"width:21px;\"><input name=\"v\"></td>\
</tr>\
<tr>\
<td style=\"width:21px;\">B</td>\
<td style=\"width:21px;\"><input name=\"v\"></td>\
</tr>\
<tr>\
<td style=\"width:21px;\">C</td>\
<td style=\"width:21px;\"><input name=\"v\"></td>\
</tr>\
<tr>\
<td style=\"width:21px;\">T1</td>\
<td style=\"width:21px;\"><input name=\"v\"></td>\
</tr>\
<tr>\
<td style=\"width:21px;\">T2</td>\
<td style=\"width:21px;\"><input name=\"v\"></td>\
</tr>\
<tr>\
<td style=\"width:21px;\">EN</td>\
<td style=\"width:21px;\">\
<input type=\"checkbox\" name=\"v\">\
</td>\
</tr>\
</tbody>\
</table>\
<div style=\"text-align:center;\"><button onclick=\"S()\">SEND</button>\
<div style=\"text-align:right;\"><a href=\"OUT.html\">RELAY</a>\
</div>\
</div>\
<script>v=[";
const code unsigned char logic index after pass[]=
"];s=document.getElementsByName(\"v\");for(i=0;i<7;i++)s[i].value=v[i];s[
ed=v[7];function S(){for(i=0;i<7;i++)v[i]=s[i].value.replace(',','.');v[7
hecked;window.location.href=\"logic.html?set=\"+v}function R(){window.loc
ef=\"logic.html?ref=\"+s[0].value};</script>\
</body></html>";
```

5/5 mikroC PRO for PIC by mikroElektronika

ΠΑΡΑΡΤΗΜΑ

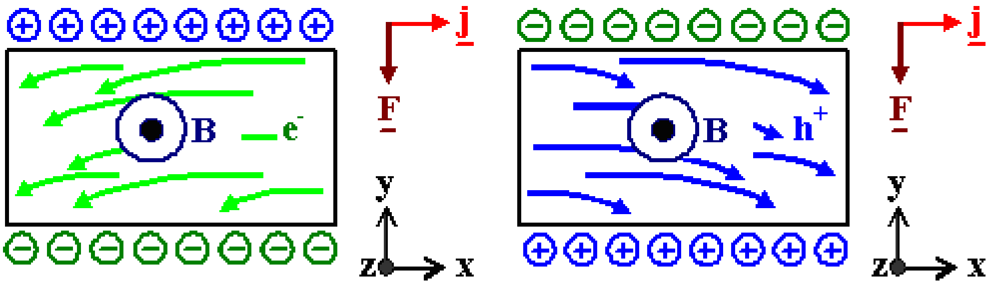
Φαινόμενο Hall

Αν θεωρήσουμε ένα σώμα (αγωγό ή ημιαγωγό) σε σχήμα ορθογώνιο παραλληλεπίπεδου με διαστάσεις όπως στο σχήμα. [2] Οι δύο απέναντι πλευρές του συνδέονται με μια πηγή διαφοράς δυναμικού V και αυτό το σώμα διαρρέεται από ένα ρεύμαIχ .[2] Κάθετα στη φορά του ρεύματος και παράλληλα προς τον άξονα του z εφαρμόζεταιμαγνητικό πεδίο μέτρου B. [2] Στους φορείς του ρεύματος (ηλεκτρόνια – οπές), λόγω της κίνησής τους κάθετα προς το μαγνητικό πεδίο, εξασκείται δύναμη$F = q \cdot \vec{v} \mathrm{x} \vec{B}$ όπου$\vec{v}$ η ταχύτητα του φορέα και q =± qγια οπές ή ηλεκτρόνια (q η απόλυτη τιμή του φορτίου του ηλεκτρονίου) .[2]



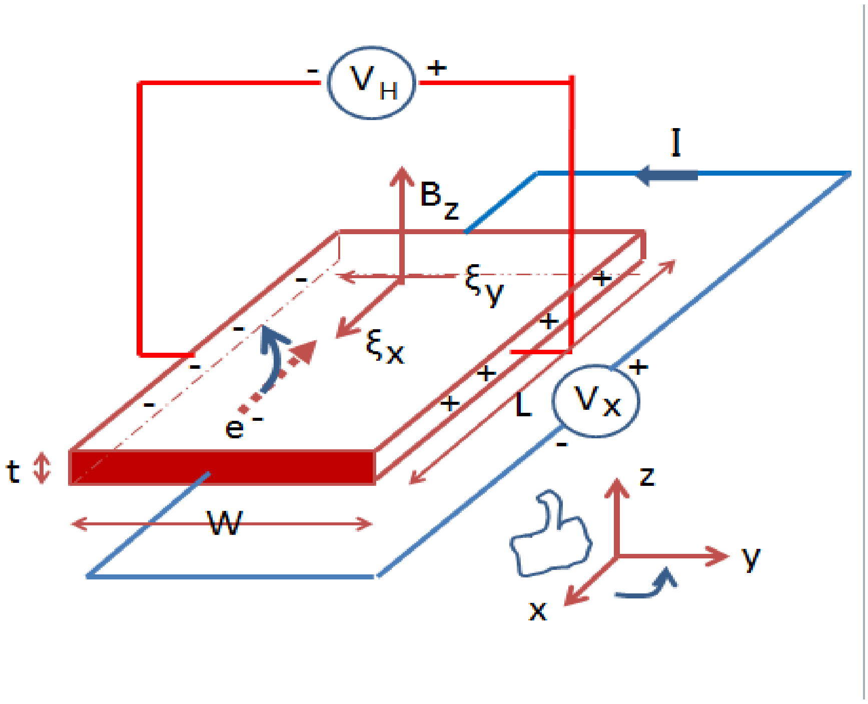
Σχήμα Φαινόμενο Hall

ΠΗΓΗ : https://www.tf.uni-kiel.de/matwis/amat/mw2_ge/kap_2/backbone/r2_1_3.html



Σχήμα Φαινόμενο Hall

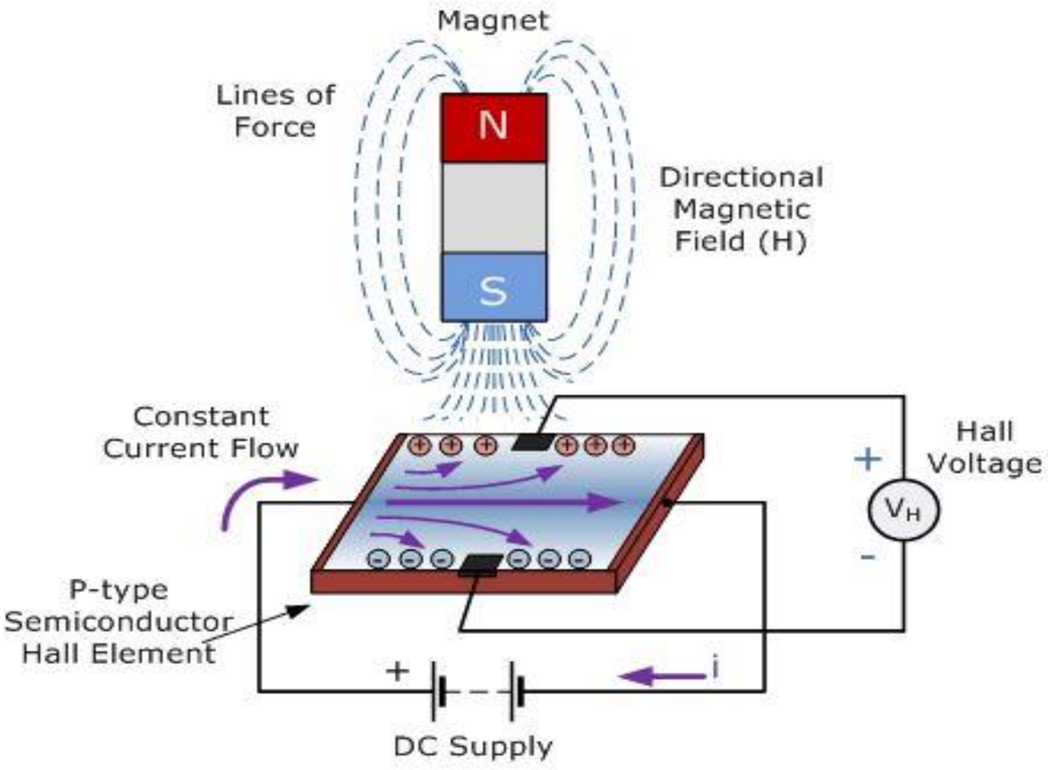
ΠΗΓΗ : https://www.tf.uni-kiel.de/matwis/amat/mw2_ge/kap_2/backbone/r2_1_3.html



Σχήμα Φαινόμενο Hall

Πηγη:https://commons.wikimedia.org/wiki/File:Hall_Effect.png

Η δύναμη$\vec{F}$ είναι κατά τον άξονα των y όπου και έχει την ίδια φορά και για τα δύο είδη φορέων (ηλεκτρόνια – οπές) γιατί εξαρτάται από το γινόμενο $q \cdot \vec{v}$.[2] Λόγω αυτής της δύναμης$\vec{F}$ οι φορείς εκτρέπονται κατά τον άξονα των y και τείνουν (το σώμα αυτό έχει πεπερασμένες διαστάσεις) να συσσωρευτούν στην ίδια πλευρά. [2].Και έτσι δημιουργείται ένα ηλεκτρικό πεδίο $\overrightarrow{E_H}$ (πεδίο Hall) το οποίο εμποδίζει την μετέπειτα συσσώρευση φορτίου. [2] Μεταξύ των ακροδεκτών a και b εμφανίζεται μια διαφορά δυναμικού VH, η λεγόμενη τάση Hall. [2] Αυτή η τάση Hallείναι ανάλογη του μέτρου του μαγνητικού πεδίου και της έντασης του ρεύματος, που διαρρέει το δείγμα. [2] Ο συντελεστής αναλογίας λέγεται συντελεστής Hall. Η μέτρηση της τάσης Hall δίνει απτά συμπεράσματα όπως για το είδος, τον αριθμό και την ευκινησία των φορέων του δείγματος. [2] Όπως είναι γνωστό, η κίνηση ενός σωματιδίου φορτίου q και μάζας m υπό την επίδραση ενός μαγνητικού πεδίου αλλά και ενός ηλεκτρικού πεδίου καθορίζεται από τη δύναμήLorentz$\overrightarrow{F_L}$=m·$\vec{\gamma}$=q· ($\vec{E} + \vec{v}$x$\vec{B}$) Εξίσωση 1.[2]

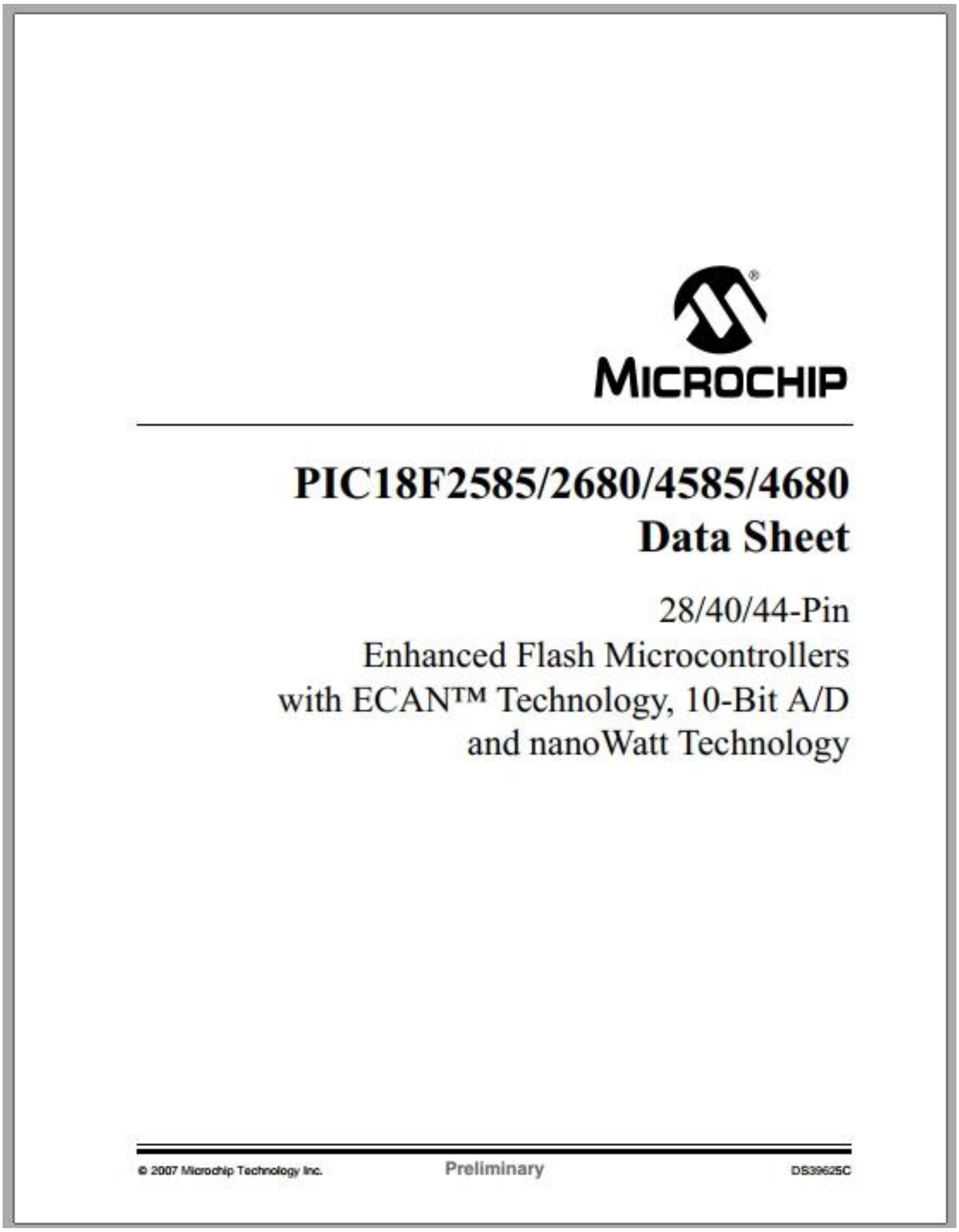


Σχήμα Φαινόμενο Hall

ΠΗΓΗ:https://blog.digilentinc.com/what-is-the-hall-effect/

[2] Πηγή : Πανεπιστήμιο Κρήτης προχωρημένα εργαστήρια φυσικής 1. Ελευθέριος Ηλιόπουλος

Φύλλα δεδομένων Μικροεπεξεργαστή



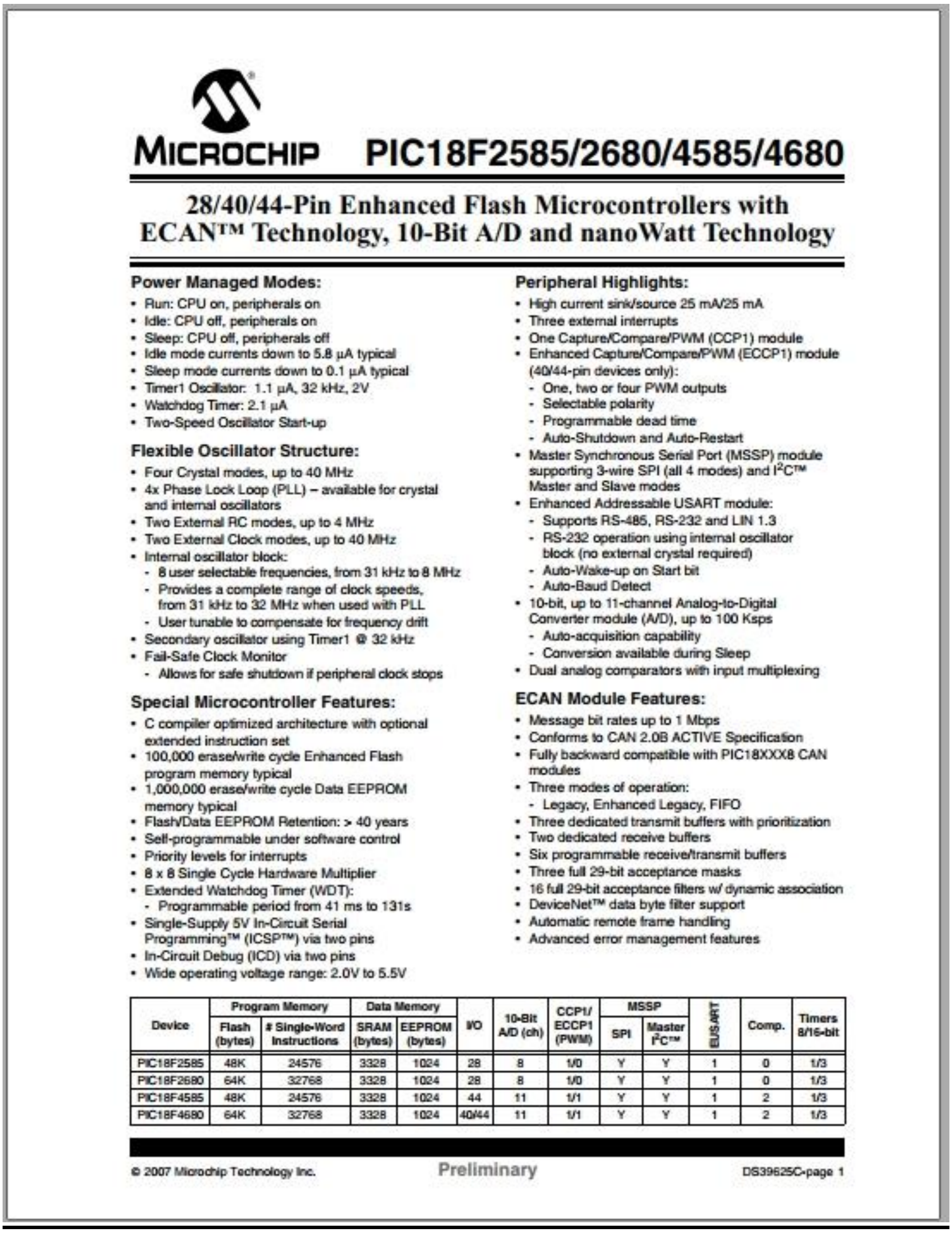
MICROCHIP

PIC18F2585/2680/4585/4680
Data Sheet

28/40/44-Pin
Enhanced Flash Microcontrollers
with ECAN™ Technology, 10-Bit A/D
and nanoWatt Technology

Preliminary

DS39625C



MICROCHIP

PIC18F2585/2680/4585/4680

28/40/44-Pin Enhanced Flash Microcontrollers with ECAN™ Technology, 10-Bit A/D and nanoWatt Technology

Power Managed Modes:

- Run: CPU on, peripherals on
- Idle: CPU off, peripherals on
- Sleep: CPU off, peripherals off
- Idle mode currents down to 5.8 µA typical
- Sleep mode currents down to 0.1 µA typical
- Timer1 Oscillator: 1.1 µA, 32 kHz, 2V
- Watchdog Timer: 2.1 µA
- Two-Speed Oscillator Start-up

Flexible Oscillator Structure:

- Four Crystal modes, up to 40 MHz
- 4x Phase Lock Loop (PLL) – available for crystal and internal oscillators
- Two External RC modes, up to 4 MHz
- Two External Clock modes, up to 40 MHz
- Internal oscillator block:
  - 8 user selectable frequencies, from 31 kHz to 8 MHz
  - Provides a complete range of clock speeds, from 31 kHz to 32 MHz when used with PLL
  - User tunable to compensate for frequency drift
- Secondary oscillator using Timer1 @ 32 kHz
- Fail-Safe Clock Monitor
  - Allows for safe shutdown if peripheral clock stops

Special Microcontroller Features:

- C compiler optimized architecture with optional extended instruction set
- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Flash/Data EEPROM Retention: > 40 years
- Self-programmable under software control
- Priority levels for interrupts
- 8 x 8 Single Cycle Hardware Multiplier
- Extended Watchdog Timer (WDT):
  - Programmable period from 41 ms to 131s
- Single-Supply 5V In-Circuit Serial Programming™ (ICSP™) via two pins
- In-Circuit Debug (ICD) via two pins
- Wide operating voltage range: 2.0V to 5.5V

Peripheral Highlights:

- High current sink/source 25 mA/25 mA
- Three external interrupts
- One Capture/Compare/PWM (CCP1) module
- Enhanced Capture/Compare/PWM (ECCP1) module (40/44-pin devices only):
  - One, two or four PWM outputs
  - Selectable polarity
  - Programmable dead time
  - Auto-Shutdown and Auto-Restart
- Master Synchronous Serial Port (MSSP) module supporting 3-wire SPI (all 4 modes) and I^{2}C™ Master and Slave modes
- Enhanced Addressable USART module:
  - Supports RS-485, RS-232 and LIN 1.3
  - RS-232 operation using internal oscillator block (no external crystal required)
  - Auto-Wake-up on Start bit
  - Auto-Baud Detect
- 10-bit, up to 11-channel Analog-to-Digital Converter module (A/D), up to 100 Ksps
  - Auto-acquisition capability
  - Conversion available during Sleep
- Dual analog comparators with input multiplexing

ECAN Module Features:

- Message bit rates up to 1 Mbps
- Conforms to CAN 2.0B ACTIVE Specification
- Fully backward compatible with PIC18XXX8 CAN modules
- Three modes of operation:
  - Legacy, Enhanced Legacy, FIFO
- Three dedicated transmit buffers with prioritization
- Two dedicated receive buffers
- Six programmable receive/transmit buffers
- Three full 29-bit acceptance masks
- 16 full 29-bit acceptance filters w/ dynamic association
- DeviceNet™ data byte filter support
- Automatic remote frame handling
- Advanced error management features

Device	Program Memory		Data Memory		I/O	10-Bit A/D (ch)	CCP1/ ECCP1 (PWM)	MSSP		EUSART	Comp.	Timers 8/16-bit
	Flash (bytes)	# Single-Word Instructions	SRAM (bytes)	EEPROM (bytes)				SPI	Master I^{2}C™			
PIC18F2585	48K	24576	3328	1024	28	8	1/0	Y	Y	1	0	1/3
PIC18F2680	64K	32768	3328	1024	28	8	1/0	Y	Y	1	0	1/3
PIC18F4585	48K	24576	3328	1024	44	11	1/1	Y	Y	1	2	1/3
PIC18F4680	64K	32768	3328	1024	40/44	11	1/1	Y	Y	1	2	1/3

Preliminary

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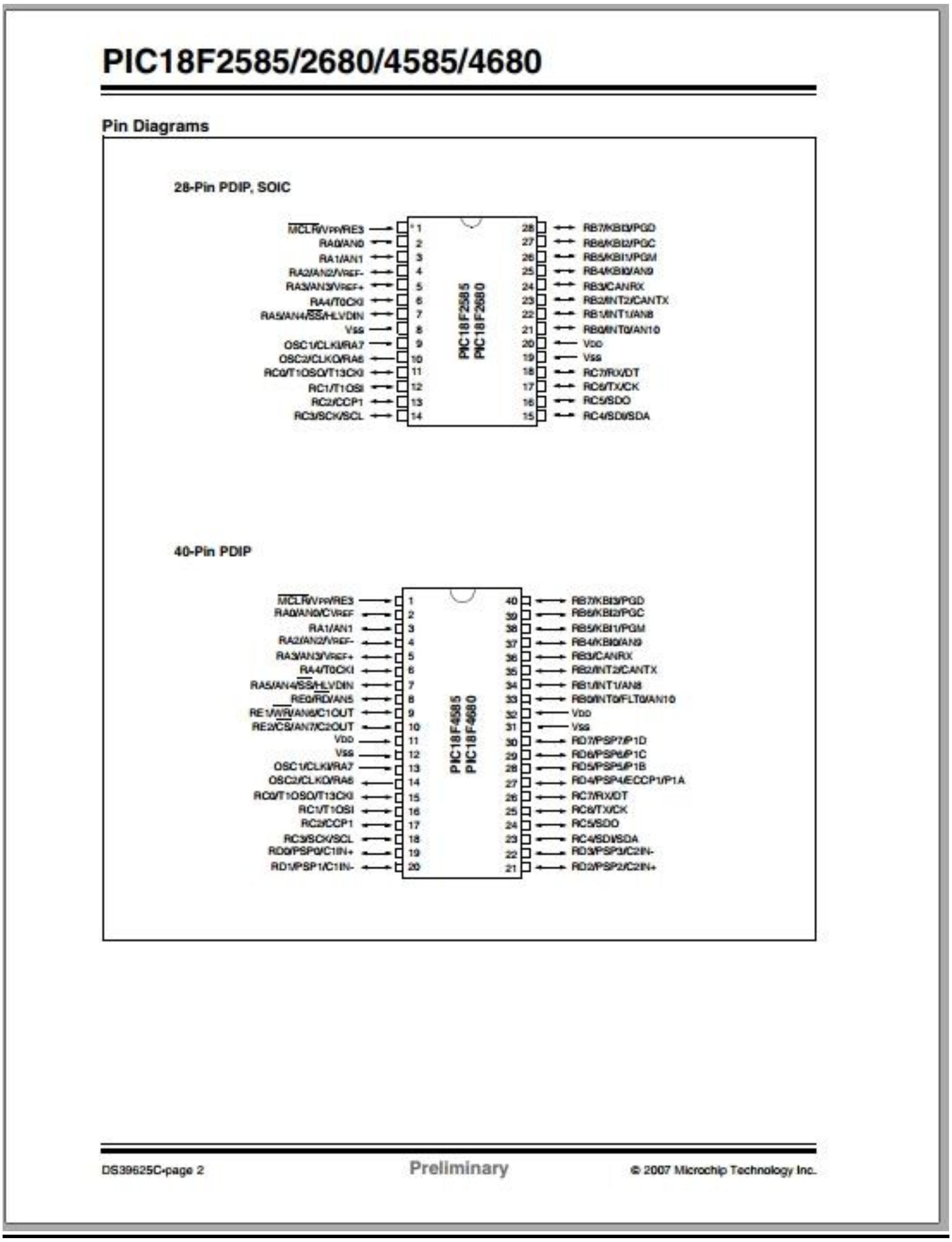

PIC18F2585/2680/4585/4680

Pin Diagrams

28-Pin PDIP, SOIC

40-Pin PDIP

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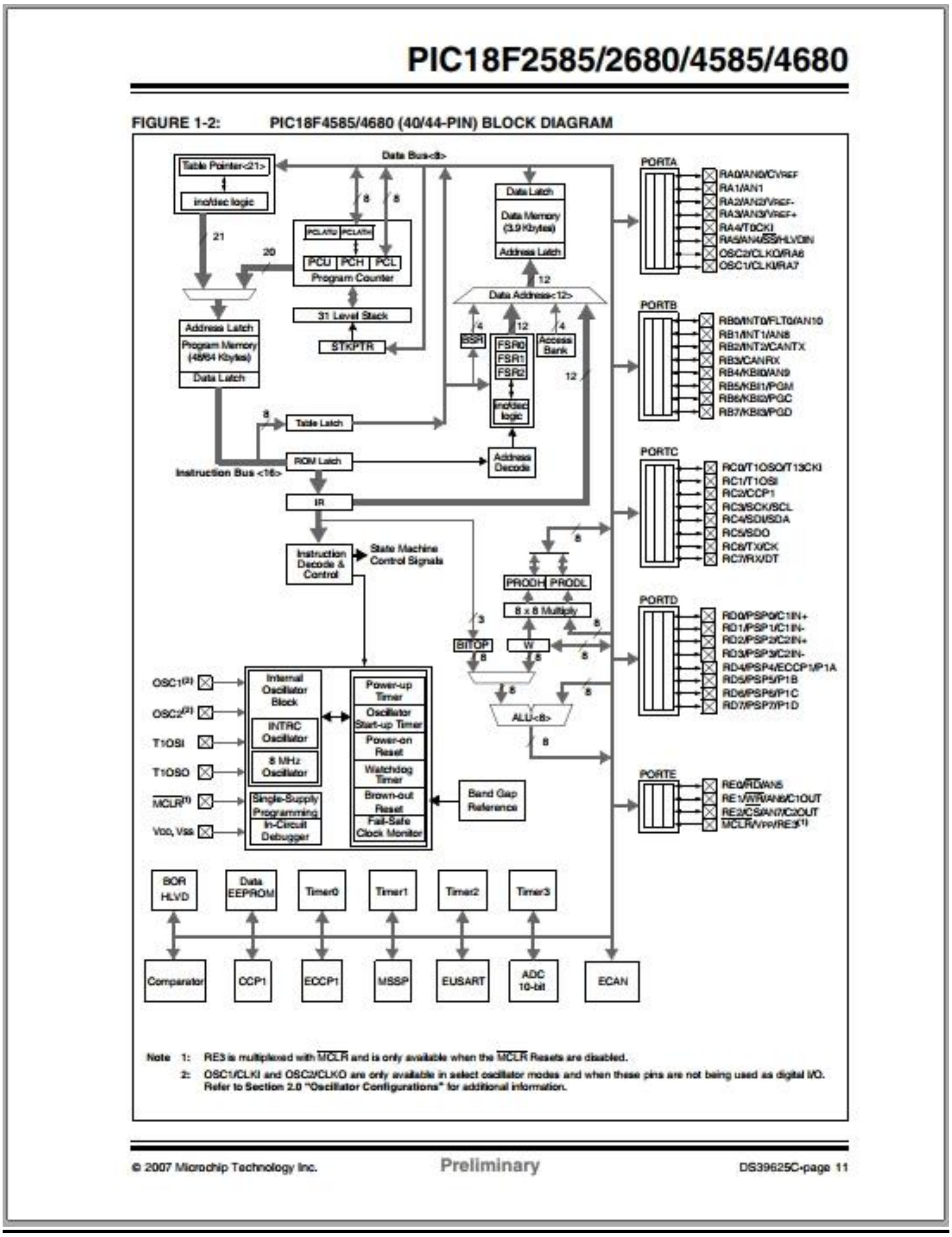

PIC18F2585/2680/4585/4680

FIGURE 1-2: PIC18F4585/4680 (40/44-PIN) BLOCK DIAGRAM

Note 1: RE3 is multiplexed with $\overline{\text{MCLR}}$ and is only available when the $\overline{\text{MCLR}}$ Resets are disabled.

2: OSC1/CLKI and OSC2/CLKO are only available in select oscillator modes and when these pins are not being used as digital I/O. Refer to **Section 2.0 "Oscillator Configurations"** for additional information.

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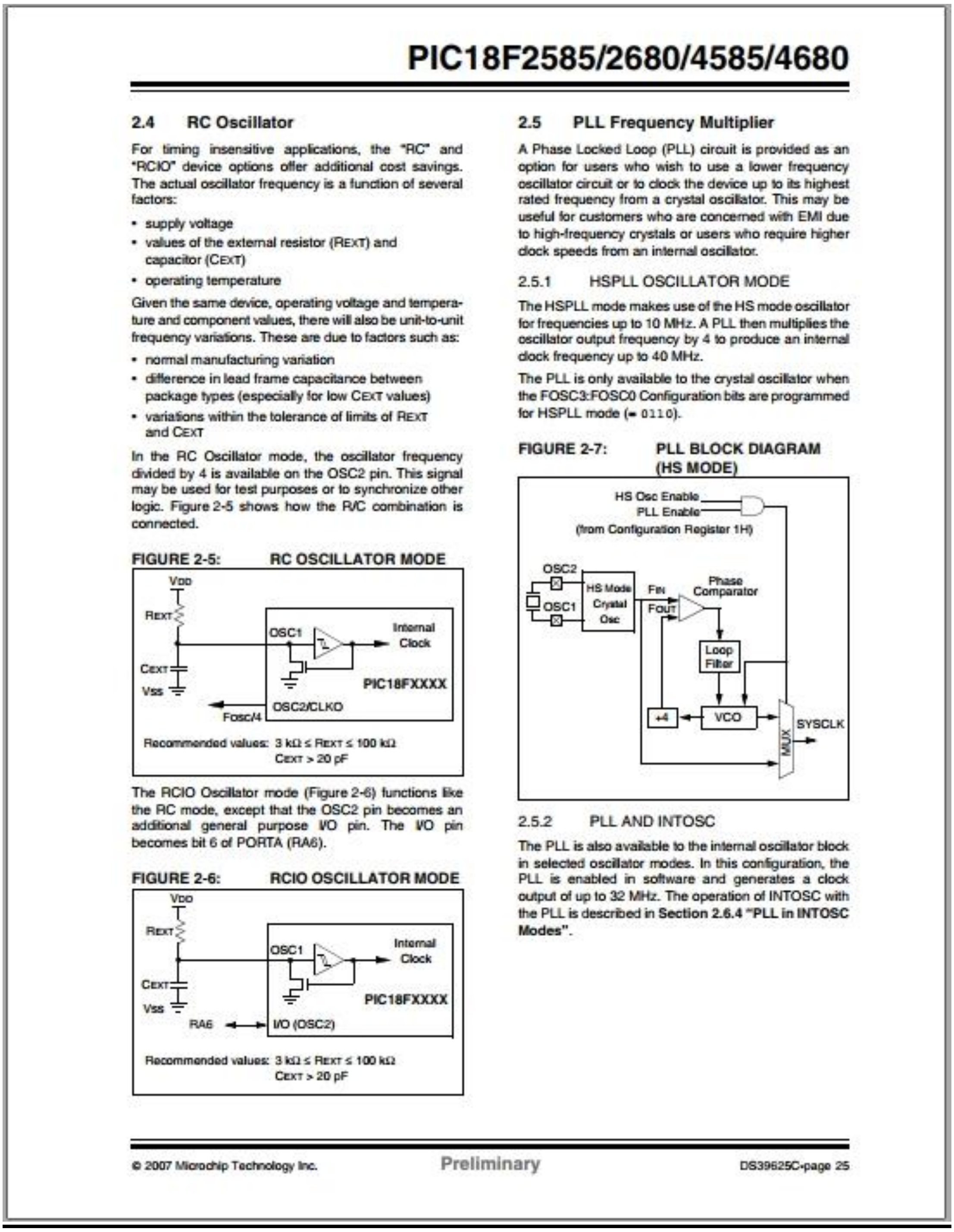


2.4 RC Oscillator

For timing insensitive applications, the "RC" and "RCIO" device options offer additional cost savings. The actual oscillator frequency is a function of several factors:

- supply voltage
- values of the external resistor (R_{EXT}) and capacitor (C_{EXT})
- operating temperature

Given the same device, operating voltage and temperature and component values, there will also be unit-to-unit frequency variations. These are due to factors such as:

- normal manufacturing variation
- difference in lead frame capacitance between package types (especially for low C_{EXT} values)
- variations within the tolerance of limits of R_{EXT} and C_{EXT}

In the RC Oscillator mode, the oscillator frequency divided by 4 is available on the OSC2 pin. This signal may be used for test purposes or to synchronize other logic. Figure 2-5 shows how the R/C combination is connected.

FIGURE 2-5: RC OSCILLATOR MODE

Recommended values: 3 kΩ ≤ R_{EXT} ≤ 100 kΩ
C_{EXT} > 20 pF

The RCIO Oscillator mode (Figure 2-6) functions like the RC mode, except that the OSC2 pin becomes an additional general purpose I/O pin. The I/O pin becomes bit 6 of PORTA (RA6).

FIGURE 2-6: RCIO OSCILLATOR MODE

Recommended values: 3 kΩ ≤ R_{EXT} ≤ 100 kΩ
C_{EXT} > 20 pF

2.5 PLL Frequency Multiplier

A Phase Locked Loop (PLL) circuit is provided as an option for users who wish to use a lower frequency oscillator circuit or to clock the device up to its highest rated frequency from a crystal oscillator. This may be useful for customers who are concerned with EMI due to high-frequency crystals or users who require higher clock speeds from an internal oscillator.

2.5.1 HSPLL OSCILLATOR MODE

The HSPLL mode makes use of the HS mode oscillator for frequencies up to 10 MHz. A PLL then multiplies the oscillator output frequency by 4 to produce an internal clock frequency up to 40 MHz.

The PLL is only available to the crystal oscillator when the FOSC3:FOSC0 Configuration bits are programmed for HSPLL mode (= `0110`).

FIGURE 2-7: PLL BLOCK DIAGRAM (HS MODE)

2.5.2 PLL AND INTOSC

The PLL is also available to the internal oscillator block in selected oscillator modes. In this configuration, the PLL is enabled in software and generates a clock output of up to 32 MHz. The operation of INTOSC with the PLL is described in **Section 2.6.4 "PLL in INTOSC Modes"**.

2.0 OSCILLATOR CONFIGURATIONS

2.1 Oscillator Types

PIC18F2585/2680/4585/4680 devices can be operated in ten different oscillator modes. The user can program the Configuration bits, FOSC3:FOSC0, in Configuration Register 1H to select one of these ten modes:

1.	LP	Low-Power Crystal
2.	XT	Crystal/Resonator
3.	HS	High-Speed Crystal/Resonator
4.	HSPLL	High-Speed Crystal/Resonator with PLL enabled
5.	RC	External Resistor/Capacitor with FOSC/4 output on RA6
6.	RCIO	External Resistor/Capacitor with I/O on RA6
7.	INTIO1	Internal Oscillator with FOSC/4 output on RA6 and I/O on RA7
8.	INTIO2	Internal Oscillator with I/O on RA6 and RA7
9.	EC	External Clock with FOSC/4 output
10.	ECIO	External Clock with I/O on RA6

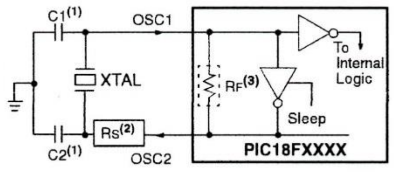
2.2 Crystal Oscillator/Ceramic Resonators

In XT, LP, HS or HSPLL Oscillator modes, a crystal or ceramic resonator is connected to the OSC1 and OSC2 pins to establish oscillation. Figure 2-1 shows the pin connections.

The oscillator design requires the use of a parallel cut crystal.

Note: Use of a series cut crystal may give a frequency out of the crystal manufacturer's specifications.

FIGURE 2-1: CRYSTAL/CERAMIC RESONATOR OPERATION (XT, LP, HS OR HSPLL CONFIGURATION)



Note 1: See Table 2-1 and Table 2-2 for initial values of C1 and C2.

2: A series resistor (RS) may be required for AT strip cut crystals.

3: RF varies with the oscillator mode chosen.

TABLE 2-1: CAPACITOR SELECTION FOR CERAMIC RESONATORS

Typical Capacitor Values Used:

Mode	Freq	OSC1	OSC2
XT	455 kHz	56 pF	56 pF
	2.0 MHz	47 pF	47 pF
	4.0 MHz	33 pF	33 pF
HS	8.0 MHz	27 pF	27 pF
	16.0 MHz	22 pF	22 pF

Capacitor values are for design guidance only.

These capacitors were tested with the resonators listed below for basic start-up and operation. **These values are not optimized.**

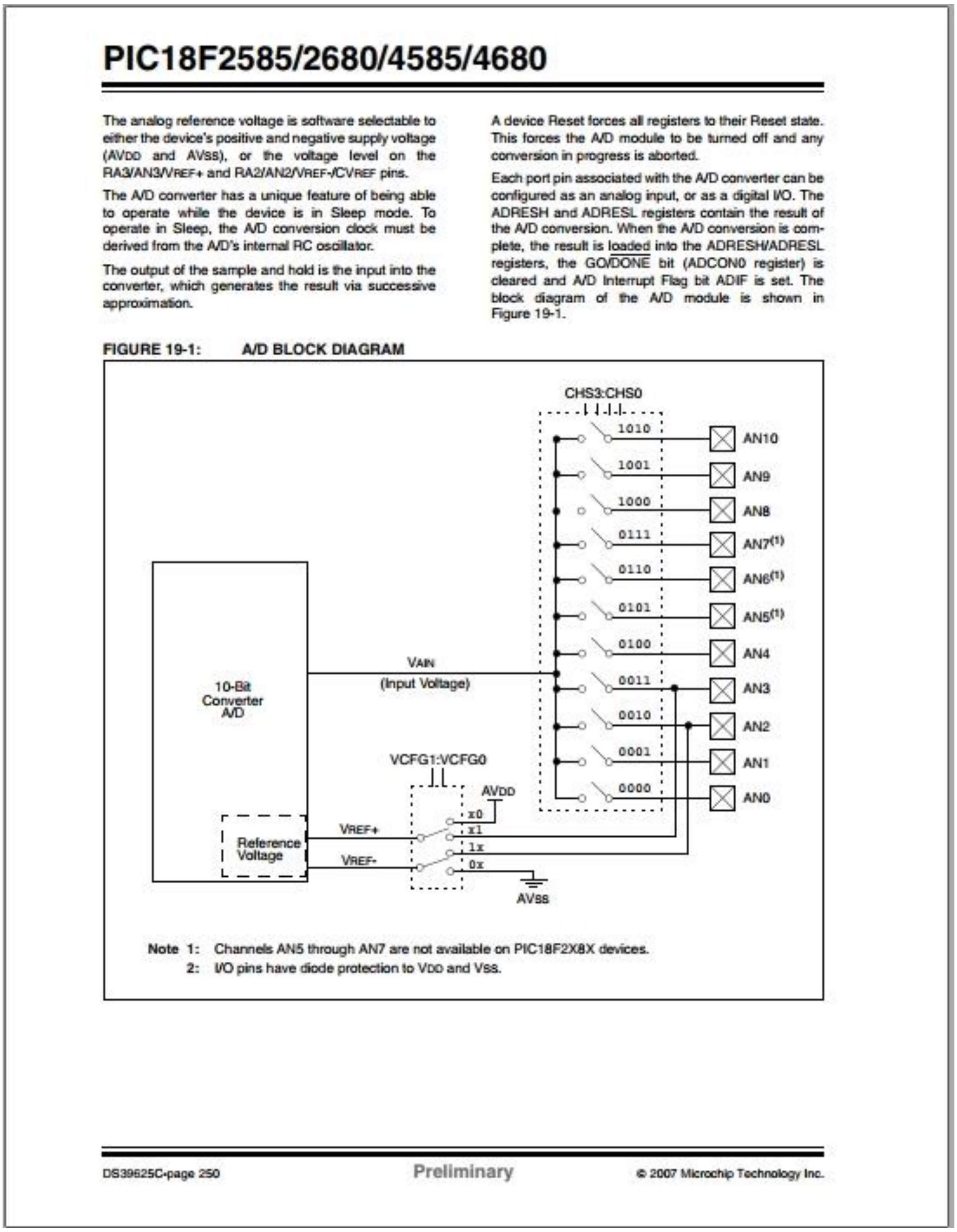
Different capacitor values may be required to produce acceptable oscillator operation. The user should test the performance of the oscillator over the expected VDD and temperature range for the application.

See the notes on page 24 for additional information.

Resonators Used:

455 kHz	4.0 MHz
2.0 MHz	8.0 MHz
16.0 MHz	

Note: When using resonators with frequencies above 3.5 MHz, the use of HS mode, rather than XT mode, is recommended. HS mode may be used at any VDD for which the controller is rated. If HS is selected, it is possible that the gain of the oscillator will overdrive the resonator. Therefore, a series resistor should be placed between the OSC2 pin and the resonator. As a good starting point, the recommended value of RS is 330Ω.



The analog reference voltage is software selectable to either the device's positive and negative supply voltage (AVDD and AVSS), or the voltage level on the RA3/AN3/VREF+ and RA2/AN2/VREF-/CVREF pins.

The A/D converter has a unique feature of being able to operate while the device is in Sleep mode. To operate in Sleep, the A/D conversion clock must be derived from the A/D's internal RC oscillator.

The output of the sample and hold is the input into the converter, which generates the result via successive approximation.

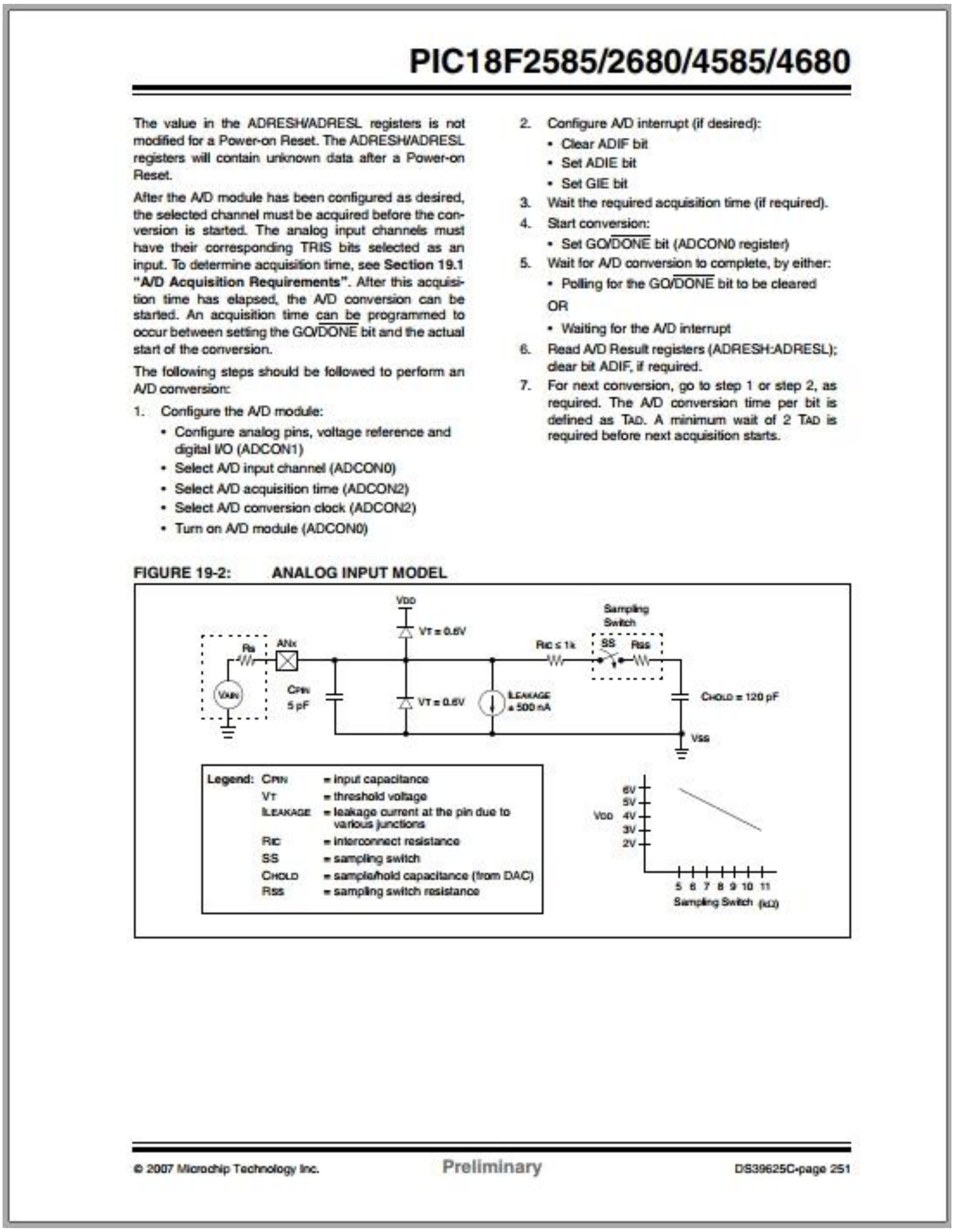
A device Reset forces all registers to their Reset state. This forces the A/D module to be turned off and any conversion in progress is aborted.

Each port pin associated with the A/D converter can be configured as an analog input, or as a digital I/O. The ADRESH and ADRESL registers contain the result of the A/D conversion. When the A/D conversion is complete, the result is loaded into the ADRESH/ADRESL registers, the GO/$\overline{\text{DONE}}$ bit (ADCON0 register) is cleared and A/D Interrupt Flag bit ADIF is set. The block diagram of the A/D module is shown in Figure 19-1.

FIGURE 19-1: A/D BLOCK DIAGRAM

Note 1: Channels AN5 through AN7 are not available on PIC18F2X8X devices.

2: I/O pins have diode protection to VDD and VSS.



The value in the ADRESH/ADRESL registers is not modified for a Power-on Reset. The ADRESH/ADRESL registers will contain unknown data after a Power-on Reset.

After the A/D module has been configured as desired, the selected channel must be acquired before the conversion is started. The analog input channels must have their corresponding TRIS bits selected as an input. To determine acquisition time, see **Section 19.1 "A/D Acquisition Requirements"**. After this acquisition time has elapsed, the A/D conversion can be started. An acquisition time can be programmed to occur between setting the GO/$\overline{\text{DONE}}$ bit and the actual start of the conversion.

The following steps should be followed to perform an A/D conversion:

1. Configure the A/D module:
    - Configure analog pins, voltage reference and digital I/O (ADCON1)
    - Select A/D input channel (ADCON0)
    - Select A/D acquisition time (ADCON2)
    - Select A/D conversion clock (ADCON2)
    - Turn on A/D module (ADCON0)
2. Configure A/D interrupt (if desired):
    - Clear ADIF bit
    - Set ADIE bit
    - Set GIE bit
3. Wait the required acquisition time (if required).
4. Start conversion:
    - Set GO/$\overline{\text{DONE}}$ bit (ADCON0 register)
5. Wait for A/D conversion to complete, by either:
    - Polling for the GO/$\overline{\text{DONE}}$ bit to be cleared

    OR
    - Waiting for the A/D interrupt
6. Read A/D Result registers (ADRESH:ADRESL); clear bit ADIF, if required.
7. For next conversion, go to step 1 or step 2, as required. The A/D conversion time per bit is defined as TAD. A minimum wait of 2 TAD is required before next acquisition starts.

FIGURE 19-2: ANALOG INPUT MODEL

Φύλλα δεδομένων αισθητήρα ACS758xCB

ACS758xCB

Thermally Enhanced, Fully Integrated, Hall-Effect-Based Linear Current Sensor IC with 100 µΩ Current Conductor

Not for New Design

These parts are in production but have been determined to be NOT FOR NEW DESIGN. This classification indicates that sale of this device is currently restricted to existing customer applications. The device should not be purchased for new design applications because obsolescence in the near future is probable. Samples are no longer available.

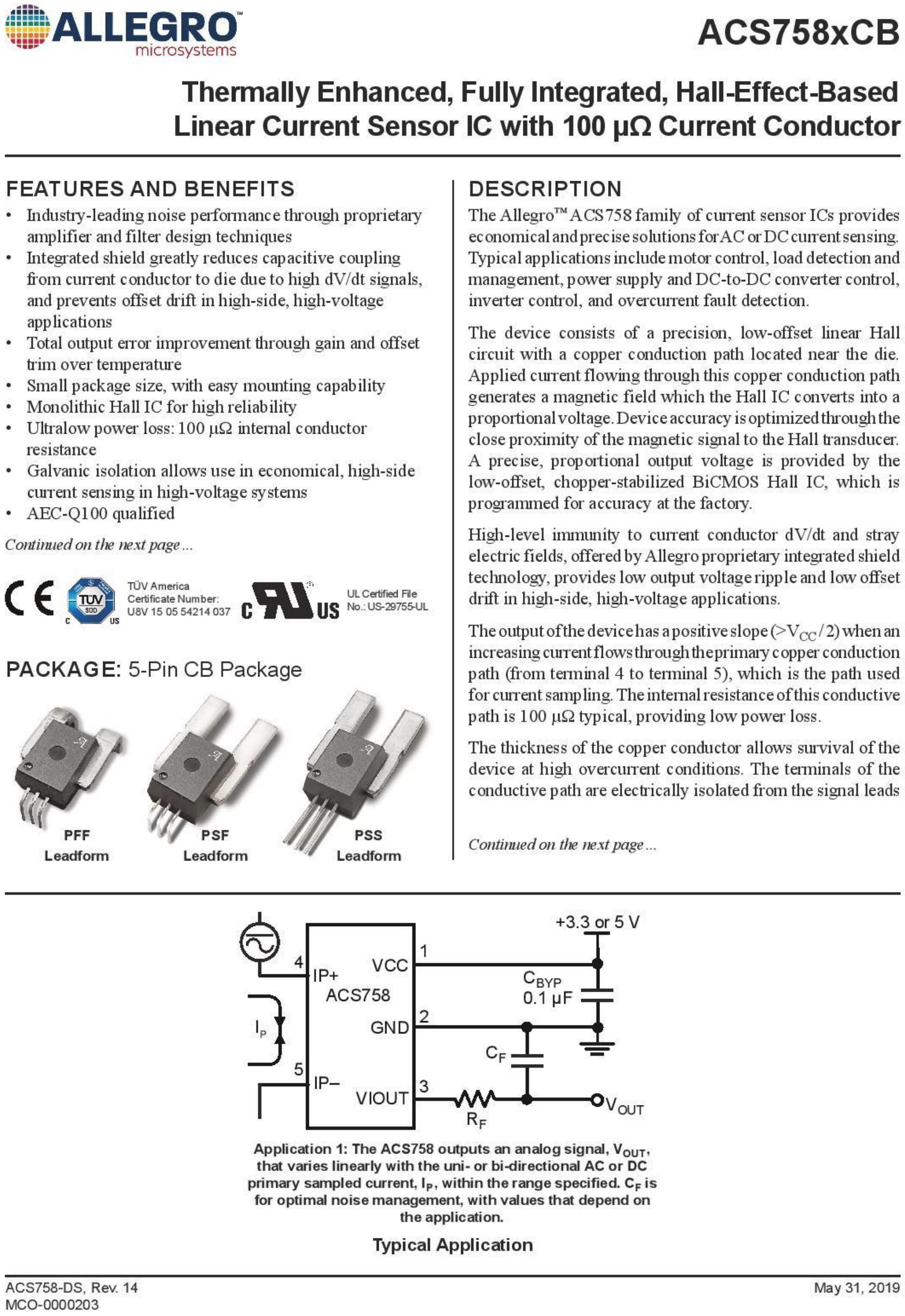
Date of status change: June 5, 2017

Recommended Substitutions:

For existing customer transition, and for new customers or new applications, use ACS770xCB or ACS772xCB.

NOTE: For detailed information on purchasing options, contact your local Allegro field applications engineer or sales representative.

Allegro MicroSystems reserves the right to make, from time to time, revisions to the anticipated product life cycle plan for a product to accommodate changes in production capabilities, alternative product availabilities, or market demand. The information included herein is believed to be accurate and reliable. However, Allegro MicroSystems assumes no responsibility for its use; nor for any infringements of patents or other rights of third parties which may result from its use.



ACS758xCB

Thermally Enhanced, Fully Integrated, Hall-Effect-Based Linear Current Sensor IC with 100 µΩ Current Conductor

FEATURES AND BENEFITS

- Industry-leading noise performance through proprietary amplifier and filter design techniques
- Integrated shield greatly reduces capacitive coupling from current conductor to die due to high dV/dt signals, and prevents offset drift in high-side, high-voltage applications
- Total output error improvement through gain and offset trim over temperature
- Small package size, with easy mounting capability
- Monolithic Hall IC for high reliability
- Ultralow power loss: 100 µΩ internal conductor resistance
- Galvanic isolation allows use in economical, high-side current sensing in high-voltage systems
- AEC-Q100 qualified

Continued on the next page…

TÜV America
Certificate Number:
U8V 15 05 54214 037

UL Certified File
No.: US-29755-UL

PACKAGE: 5-Pin CB Package

DESCRIPTION

The Allegro™ ACS758 family of current sensor ICs provides economical and precise solutions for AC or DC current sensing. Typical applications include motor control, load detection and management, power supply and DC-to-DC converter control, inverter control, and overcurrent fault detection.

The device consists of a precision, low-offset linear Hall circuit with a copper conduction path located near the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional output voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy at the factory.

High-level immunity to current conductor dV/dt and stray electric fields, offered by Allegro proprietary integrated shield technology, provides low output voltage ripple and low offset drift in high-side, high-voltage applications.

The output of the device has a positive slope ($>V_{CC}/2$) when an increasing current flows through the primary copper conduction path (from terminal 4 to terminal 5), which is the path used for current sampling. The internal resistance of this conductive path is 100 µΩ typical, providing low power loss.

The thickness of the copper conductor allows survival of the device at high overcurrent conditions. The terminals of the conductive path are electrically isolated from the signal leads

Continued on the next page…

Application 1: The ACS758 outputs an analog signal, V_{OUT}, that varies linearly with the uni- or bi-directional AC or DC primary sampled current, I_P, within the range specified. C_F is for optimal noise management, with values that depend on the application.

Typical Application

FEATURES AND BENEFITS (CONTINUED)

- 3.0 to 5.5 V, single supply operation
- 120 kHz typical bandwidth
- 3 µs output rise time in response to step input current
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis

DESCRIPTION (CONTINUED)

(pins 1 through 3). This allows the ACS758 family of sensor ICs to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The device is fully calibrated prior to shipment from the factory. The ACS758 family is lead (Pb) free. All leads are plated with 100% matte tin, and there is no Pb inside the package. The heavy gauge leadframe is made of oxygen-free copper.

Selection Guide

Part Number [1]	Package		Primary Sampled Current, I_P (A)	Sensitivity Sens (Typ.) (mV/A)	Current Directionality	T_{OP} (°C)	Packing [2]
	Terminals	Signal Pins					
ACS758LCB-050B-PFF-T	Formed	Formed	±50	40	Bidirectional	–40 to 150	34 pieces per tube
ACS758LCB-050U-PFF-T	Formed	Formed	50	60	Unidirectional		
ACS758LCB-100B-PFF-T	Formed	Formed	±100	20	Bidirectional		
ACS758LCB-100B-PSF-T	Straight	Formed	±100	20	Bidirectional		
ACS758LCB-100U-PFF-T	Formed	Formed	100	40	Unidirectional		
ACS758KCB-150B-PFF-T	Formed	Formed	±150	13.3	Bidirectional	–40 to 125	
ACS758KCB-150U-PSF-T	Straight	Formed	150	26.7	Unidirectional		
ACS758KCB-150B-PSS-T	Straight	Straight	±150	13.3	Bidirectional		
ACS758KCB-150U-PFF-T	Formed	Formed	150	26.7	Unidirectional		
ACS758ECB-200B-PFF-T	Formed	Formed	±200	10	Bidirectional	–40 to 85	
ACS758ECB-200B-PSF-T	Straight	Formed	±200	10	Bidirectional		
ACS758ECB-200U-PSF-T	Straight	Formed	200	20	Unidirectional		
ACS758ECB-200B-PSS-T	Straight	Straight	±200	10	Bidirectional		
ACS758ECB-200U-PFF-T	Formed	Formed	200	20	Unidirectional		

[1] Additional leadform options available for qualified volumes.
[2] Contact Allegro for additional packing options.

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Units
Forward Supply Voltage	V_{CC}		8	V
Reverse Supply Voltage	V_{RCC}		–0.5	V
Forward Output Voltage	V_{IOUT}		28	V
Reverse Output Voltage	V_{RIOUT}		–0.5	V
Output Source Current	$I_{OUT(Source)}$	VIOUT to GND	3	mA
Output Sink Current	$I_{OUT(Sink)}$	VCC to VIOUT	1	mA
Nominal Operating Ambient Temperature	T_{OP}	Range E	–40 to 85	°C
		Range K	–40 to 125	°C
		Range L	–40 to 150	°C
Maximum Junction	T_J(max)		165	°C
Storage Temperature	T_{stg}		–65 to 165	°C

ISOLATION CHARACTERISTICS

Characteristic	Symbol	Notes	Rating	Unit
Dielectric Strength Test Voltage [1]	V_{ISO}	Agency type-tested for 60 seconds per UL standard 60950-1, 2nd Edition	4800	VAC
Working Voltage for Basic Isolation	V_{WFSI}	For basic (single) isolation per UL standard 60950-1, 2nd Edition	990	VDC or V_{pk}
			700	V_{rms}
Working Voltage for Reinforced Isolation	V_{WFRI}	For reinforced (double) isolation per UL standard 60950-1, 2nd Edition	636	VDC or V_{pk}
			450	V_{rms}

[1] Allegro does not conduct 60-second testing. It is done only during the UL certification process.

THERMAL CHARACTERISTICS: May require derating at maximum conditions

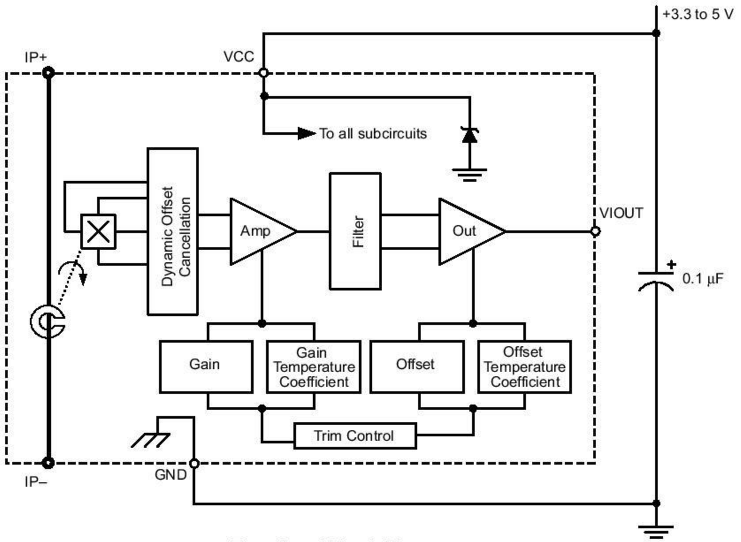
Characteristic	Symbol	Test Conditions [1]	Value	Unit
Package Thermal Resistance	$R_{\theta JA}$	Mounted on the Allegro evaluation board with 2800 mm^2 (1400 mm^2 on component side and 1400 mm^2 on opposite side) of 4 oz. copper connected to the primary leadframe and with thermal vias connecting the copper layers. Performance is based on current flowing through the primary leadframe and includes the power consumed by the PCB.	7	°C/W

[1] Additional thermal information available on the Allegro website

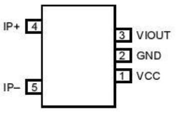
TYPICAL OVERCURRENT CAPABILITIES [2][3]

Characteristic	Symbol	Notes	Rating	Units
Overcurrent	I_{POC}	T_A = 25°C, 1 second duration, 1% duty cycle	1200	A
		T_A = 85°C, 1 second duration, 1% duty cycle	900	A
		T_A = 150°C, 1 second duration, 1% duty cycle	600	A

[2] Test was done with Allegro evaluation board. The maximum allowed current is limited by T_J(max) only.
[3] For more overcurrent profiles, please see FAQ on the Allegro website, www.allegromicro.com.



Functional Block Diagram



Pinout Diagram

Terminal List Table

Number	Name	Description
1	VCC	Device power supply terminal
2	GND	Signal ground terminal
3	VIOUT	Analog output signal
4	IP+	Terminal for current being sampled
5	IP–	Terminal for current being sampled

COMMON OPERATING CHARACTERISTICS [1]: Valid at T_{OP} = –40°C to 150°C and V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Supply Voltage [2]	V_{CC}		3	5.0	5.5	V
Supply Current	I_{CC}	Output open	–	10	13.5	mA
Power-On Delay	t_{POD}	T_A = 25°C	–	10	–	µs
Rise Time [3]	t_r	I_P step = 60% of I_P+, 10% to 90% rise time, T_A = 25°C, C_{OUT} = 0.47 nF	–	3	–	µs
Propagation Delay Time [3]	t_{PROP}	T_A = 25°C, C_{OUT} = 0.47 nF	–	1	–	µs
Response Time	$t_{RESPONSE}$	Measured as sum of t_{PROP} and t_r	–	4	–	µs
Internal Bandwidth [4]	BW_i	–3 dB; T_A = 25°C, C_{OUT} = 0.47 nF	–	120	–	kHz
Output Load Resistance	$R_{LOAD(MIN)}$	VIOUT to GND	4.7	–	–	kΩ
Output Load Capacitance	$C_{LOAD(MAX)}$	VIOUT to GND	–	–	10	nF
Primary Conductor Resistance	$R_{PRIMARY}$	T_A = 25°C	–	100	–	µΩ
Symmetry [3]	E_{SYM}	Over half-scale of I_P	99	100	101	%
Quiescent Output Voltage [5]	$V_{IOUT(QBI)}$	Bidirectional variant, I_P = 0 A, T_A = 25°C	–	$V_{CC}/2$	–	V
	$V_{IOUT(QUNI)}$	Unidirectional variant, I_P = 0 A, T_A = 25°C, $V_{IOUT(QUNI)}$ is ratiometric to V_{CC}	–	0.6	–	V
Ratiometry [3]	V_{RAT}	V_{CC} = 4.5 to 5.5 V	–	100	–	%

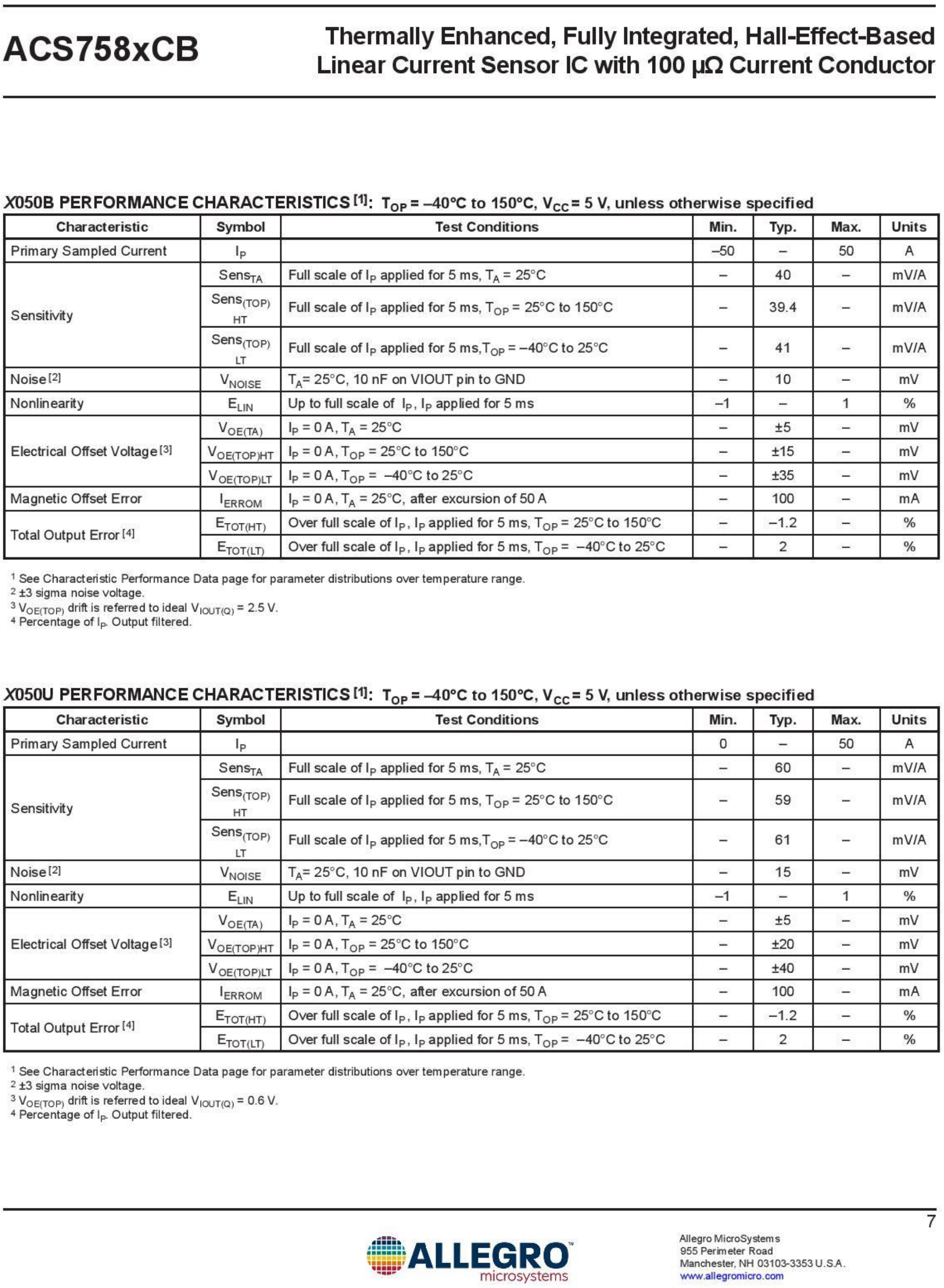
[1] Device is factory-trimmed at 5 V, for optimal accuracy.

[2] Devices are programmed for maximum accuracy at 5.0 V V_{CC} levels. The device contains ratiometry circuits that accurately alter the 0 A Output Voltage and Sensitivity level of the device in proportion to the applied V_{CC} level. However, as a result of minor nonlinearities in the ratiometry circuit additional output error will result when V_{CC} varies from the 5 V V_{CC} level. Customers that plan to operate the device from a 3.3 V regulated supply should contact their local Allegro sales representative regarding expected device accuracy levels under these bias conditions.

[3] See Characteristic Definitions section of this datasheet.

[4] Calculated using the formula $BW_i = 0.35 / t_r$.

[5] $V_{IOUT(Q)}$ may drift over the lifetime of the device by as much as ±25 mV.



X050B PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 150°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		–50	–	50	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	40	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	39.4	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	41	–	mV/A
Noise [2]	V_{NOISE}	T_A = 25°C, 10 nF on VIOUT pin to GND	–	10	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	–1	–	1	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 150°C	–	±15	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±35	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 50 A	–	100	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	–1.2	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	2	–	%

[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 2.5 V.
[4] Percentage of I_P. Output filtered.

X050U PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 150°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		0	–	50	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	60	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	59	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	61	–	mV/A
Noise [2]	V_{NOISE}	T_A = 25°C, 10 nF on VIOUT pin to GND	–	15	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	–1	–	1	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 150°C	–	±20	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±40	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 50 A	–	100	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	–1.2	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	2	–	%

[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 0.6 V.
[4] Percentage of I_P. Output filtered.

*X*100B PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 150°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		–100	–	100	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	20	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	19.75	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	20.5	–	mV/A
Noise [2]	V_{NOISE}	T_A= 25°C, 10 nF on VIOUT pin to GND	–	6	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	–1.25	–	1.25	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 150°C	–	±20	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±20	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 100 A	–	150	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	–1.3	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	2.4	–	%

[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 2.5 V.
[4] Percentage of I_P. Output filtered.

*X*100U PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 150°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		0	–	100	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	40	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	39.5	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	41	–	mV/A
Noise [2]	V_{NOISE}	T_A= 25°C, 10 nF on VIOUT pin to GND	–	12	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	–1.25	–	1.25	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 150°C	–	±20	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±20	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 100 A	–	150	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 150°C	–	–1.3	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	2.4	–	%

[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 0.6 V.
[4] Percentage of I_P. Output filtered.

X150B PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 125°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		–150	–	150	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	13.3	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 125°C	–	13.1	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	13.5	–	mV/A
Noise [2]	V_{NOISE}	T_A= 25°C, 10 nF on VIOUT pin to GND	–	4	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	– 1	–	1	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 125°C	–	±14	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±24	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 150 A	–	205	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 125°C	–	–1.8	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	1.6	–	%

[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 2.5 V.
[4] Percentage of I_P. Output filtered.

X150U PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 125°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		0	–	150	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	26.6	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 125°C	–	26.6	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	27.4	–	mV/A
Noise [2]	V_{NOISE}	T_A= 25°C, 10 nF on VIOUT pin to GND	–	8	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	– 1	–	1	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 125°C	–	±14	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±24	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 150 A	–	205	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 125°C	–	–1.8	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	1.6	–	%

[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 0.6 V.
[4] Percentage of I_P. Output filtered.

_X_200B PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 85°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		–200	–	200	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	10	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 85°C	–	9.88	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	10.13	–	mV/A
Noise [2]	V_{NOISE}	T_A= 25°C, 10 nF on VIOUT pin to GND	–	3	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	– 1	–	1	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 85°C	–	±15	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±25	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 200 A	–	230	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 85°C	–	–1.2	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	1.2	–	%

[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 2.5 V .
[4] Percentage of I_P. Output filtered.

_X_200U PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 85°C, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sampled Current	I_P		0	–	200	A
Sensitivity	$Sens_{TA}$	Full scale of I_P applied for 5 ms, T_A = 25°C	–	20	–	mV/A
	$Sens_{(TOP)HT}$	Full scale of I_P applied for 5 ms, T_{OP} = 25°C to 85°C	–	19.7	–	mV/A
	$Sens_{(TOP)LT}$	Full scale of I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	20.3	–	mV/A
Noise [2]	V_{NOISE}	T_A= 25°C, 10 nF on VIOUT pin to GND	–	6	–	mV
Nonlinearity	E_{LIN}	Up to full scale of I_P, I_P applied for 5 ms	– 1	–	1	%
Electrical Offset Voltage [3]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–	±5	–	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 85°C	–	±20	–	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–	±35	–	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 200 A	–	230	–	mA
Total Output Error [4]	$E_{TOT(HT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = 25°C to 85°C	–	–1.2	–	%
	$E_{TOT(LT)}$	Over full scale of I_P, I_P applied for 5 ms, T_{OP} = –40°C to 25°C	–	1.2	–	%

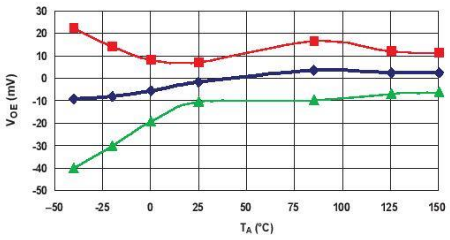
[1] See Characteristic Performance Data page for parameter distributions over temperature range.
[2] ±3 sigma noise voltage.
[3] $V_{OE(TOP)}$ drift is referred to ideal $V_{IOUT(Q)}$ = 0.6 V .
[4] Percentage of I_P. Output filtered.

CHARACTERISTIC PERFORMANCE DATA

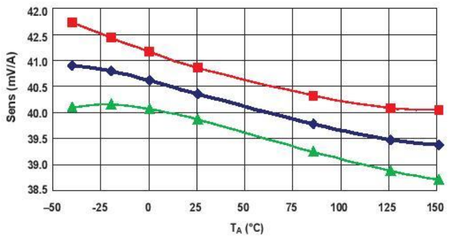
Data taken using the ACS758LCB-050B

Accuracy Data

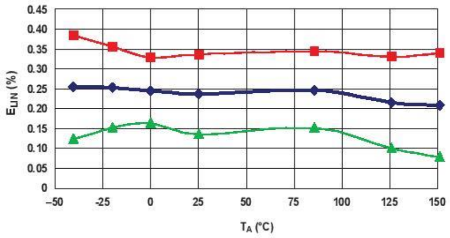
Electrical Offset Voltage versus Ambient Temperature



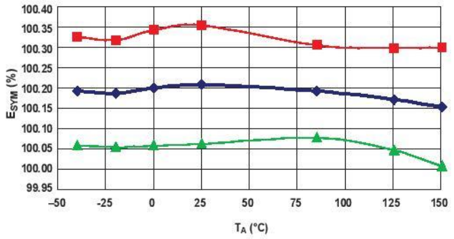
Sensitivity versus Ambient Temperature



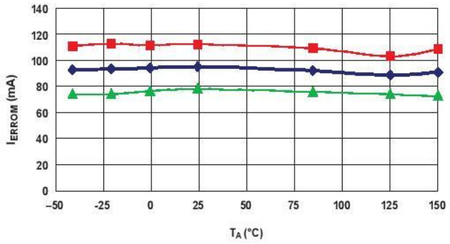
Nonlinearity versus Ambient Temperature



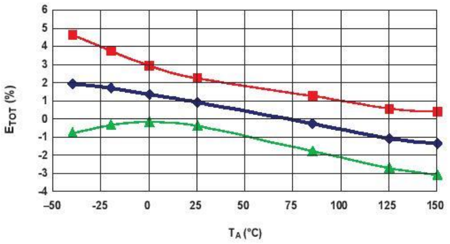
Symmetry versus Ambient Temperature



Magnetic Offset Error versus Ambient Temperature



Total Output Error versus Ambient Temperature



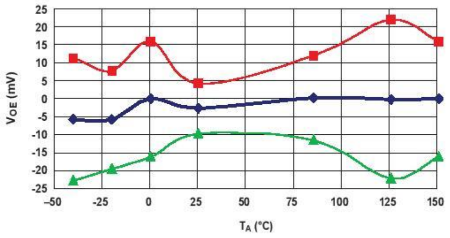
■ Typical Maximum Limit ◆ Mean ▲ Typical Minimum Limit

CHARACTERISTIC PERFORMANCE DATA

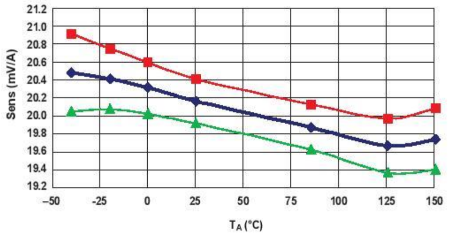
Data taken using the ACS758LCB-100B

Accuracy Data

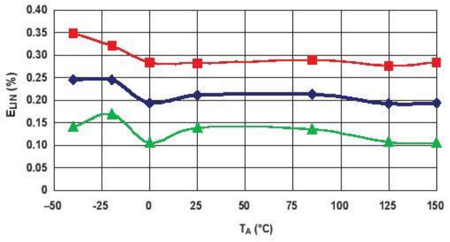
Electrical Offset Voltage versus Ambient Temperature



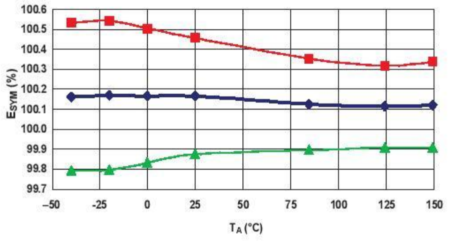
Sensitivity versus Ambient Temperature



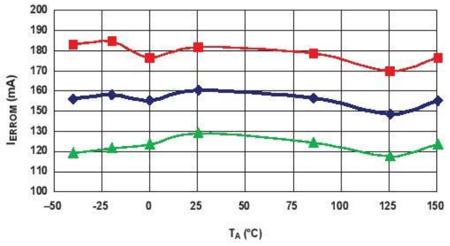
Nonlinearity versus Ambient Temperature



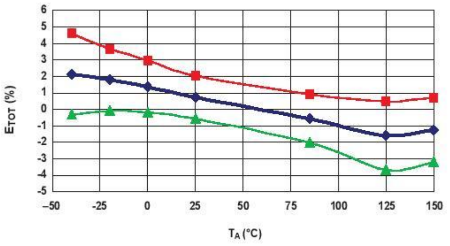
Symmetry versus Ambient Temperature



Magnetic Offset Error versus Ambient Temperature



Total Output Error versus Ambient Temperature

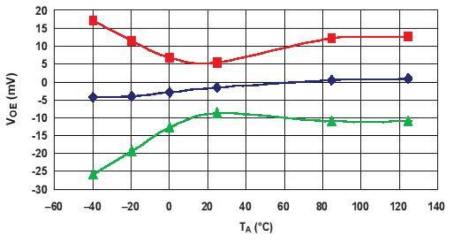


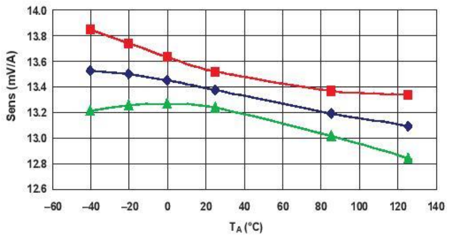
■ Typical Maximum Limit ◆ Mean ▲ Typical Minimum Limit

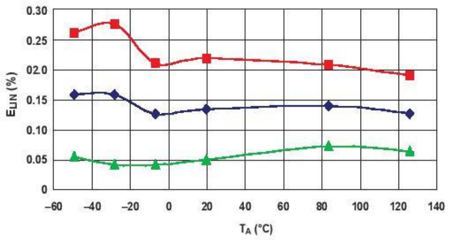
CHARACTERISTIC PERFORMANCE DATA

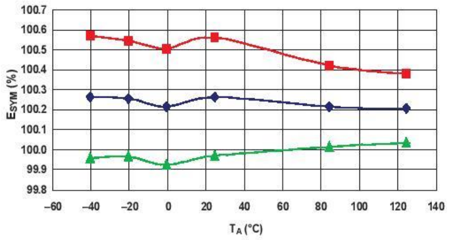
Data taken using the ACS758KCB-150B

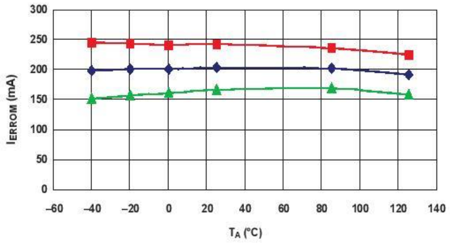
Accuracy Data

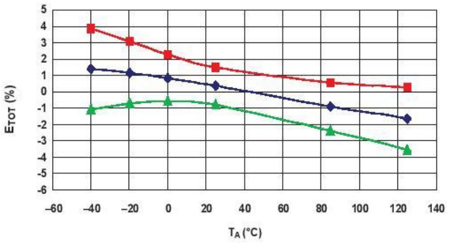

Electrical Offset Voltage versus Ambient Temperature


Sensitivity versus Ambient Temperature


Nonlinearity versus Ambient Temperature


Symmetry versus Ambient Temperature


Magnetic Offset Error versus Ambient Temperature

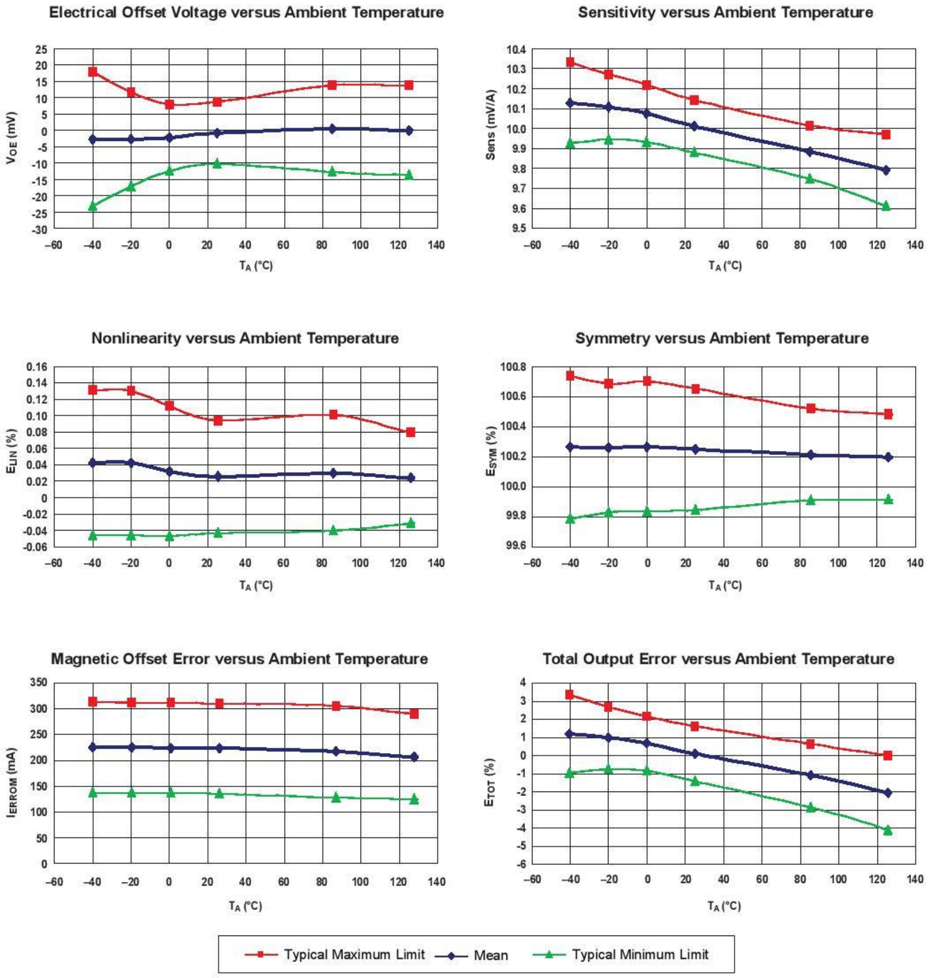

Total Output Error versus Ambient Temperature

🟥 Typical Maximum Limit ◆ Mean ▲ Typical Minimum Limit

CHARACTERISTIC PERFORMANCE DATA

Data taken using the ACS758ECB-200B

Accuracy Data



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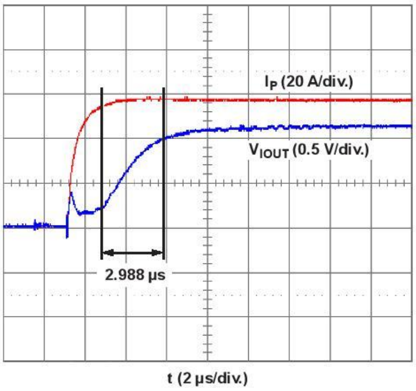
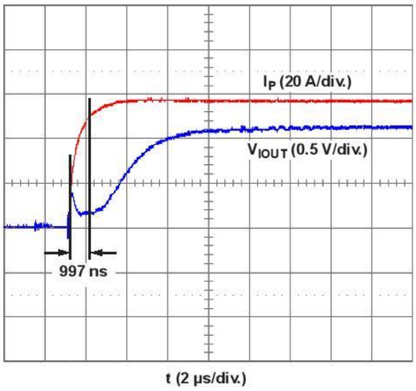
CHARACTERISTIC PERFORMANCE DATA
Data taken using the ACS758LCB-100B

Timing Data

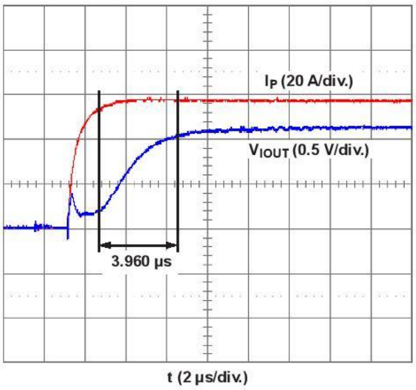
Rise Time



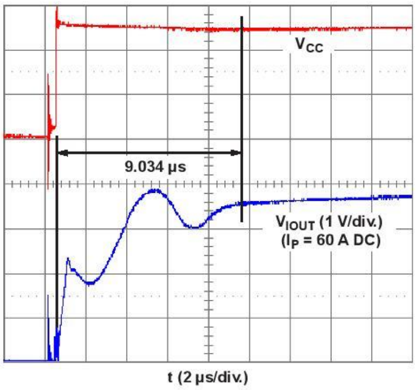
Propagation Delay Time



Response Time



Power-on Delay



CHARACTERISTIC DEFINITIONS

Definitions of Accuracy Characteristics

Sensitivity (Sens). The change in device output in response to a 1 A change through the primary conductor. The sensitivity is the product of the magnetic circuit sensitivity (G/A) and the linear IC amplifier gain (mV/G). The linear IC amplifier gain is programmed at the factory to optimize the sensitivity (mV/A) for the half-scale current of the device.

Noise (V_{NOISE}). The noise floor is derived from the thermal and shot noise observed in Hall elements. Dividing the noise (mV) by the sensitivity (mV/A) provides the smallest current that the device is able to resolve.

Nonlinearity (E_{LIN}). The degree to which the voltage output from the IC varies in direct proportion to the primary current through its half-scale amplitude. Nonlinearity in the output can be attributed to the saturation of the flux concentrator approaching the half-scale current. The following equation is used to derive the linearity:

$$100\left\{1-\left[\frac{\Delta\text{ gain}\times\%\text{ sat }(V_{\text{IOUT\_half-scale amperes}}-V_{\text{IOUT(Q)}})}{2\,(V_{\text{IOUT\_quarter-scale amperes}}-V_{\text{IOUT(Q)}})}\right]\right\}$$

where

Δ gain = the gain variation as a function of temperature changes from 25°C,

% sat = the percentage of saturation of the flux concentrator, which becomes significant as the current being sampled approaches half-scale $\pm I_P$, and

$V_{\text{IOUT\_half-scale amperes}}$ = the output voltage (V) when the sampled current approximates half-scale $\pm I_P$.

Symmetry (E_{SYM}). The degree to which the absolute voltage output from the IC varies in proportion to either a positive or negative half-scale primary current. The following equation is used to derive symmetry:

$$100\left(\frac{V_{\text{IOUT\_+ half-scale amperes}}-V_{\text{IOUT(Q)}}}{V_{\text{IOUT(Q)}}-V_{\text{IOUT\_–half-scale amperes}}}\right)$$

Ratiometry. The device features a ratiometric output. This means that the quiescent voltage output, V_{IOUTQ}, and the magnetic sensitivity, Sens, are proportional to the supply voltage, V_{CC}.

The ratiometric change (%) in the quiescent voltage output is defined as:

$$\Delta V_{\text{IOUTQ}(\Delta\text{V})}=\frac{V_{\text{IOUTQ(V}_{\text{CC}}\text{)}}/V_{\text{IOUTQ(5V)}}}{V_{\text{CC}}\;/\;5\text{ V}}\times 100\%$$

and the ratiometric change (%) in sensitivity is defined as:

$$\Delta\text{Sens}_{(\Delta\text{V})}=\frac{\text{Sens}_{(\text{V}_{\text{CC}})}\;/\;\text{Sens}_{(5\text{V})}}{V_{\text{CC}}\,/\,5\text{ V}}\times 100\%$$

Quiescent output voltage ($V_{IOUT(Q)}$). Quiescent output voltage ($V_{IOUT(Q)}$). The output of the device when the primary current is zero. For bidirectional devices, it nominally remains at $V_{CC}/2$. Thus, V_{CC} = 5 V translates into $V_{IOUT(QBI)}$ = 2.5 V. For unidirectional devices, it nominally remains at 0.12 × V_{CC}. Thus, V_{CC} = 5 V translates into $V_{IOUT(QUNI)}$ = 0.6 V. Variation in $V_{IOUT(Q)}$ can be attributed to the resolution of the Allegro linear IC quiescent voltage trim, magnetic hysteresis, and thermal drift.

Electrical offset voltage (V_{OE}). The deviation of the device output from its ideal quiescent value of $V_{CC}/2$ for bidirectional and 0.1 × V_{CC} for unidirectional devices, due to nonmagnetic causes.

Magnetic offset error (I_{ERROM}). The magnetic offset is due to the residual magnetism (remnant field) of the core material. The magnetic offset error is highest when the magnetic circuit has been saturated, usually when the device has been subjected to a full-scale or high-current overload condition. The magnetic offset is largely dependent on the material used as a flux concentrator. The larger magnetic offsets are observed at the lower operating temperatures.

Total Output Error (E_{TOT}). The maximum deviation of the actual output from its ideal value, also referred to as *accuracy*, illustrated graphically in the output voltage versus current chart on the following page.

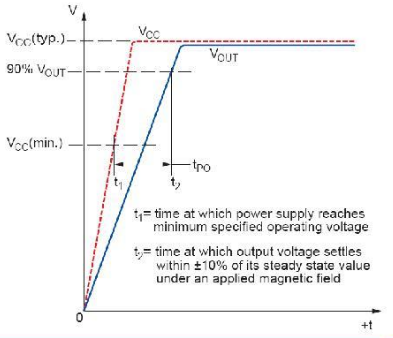
E_{TOT} is divided into four areas:

- **0 A at 25°C.** Accuracy at the zero current flow at 25°C, without the effects of temperature.
- **0 A over Δ temperature.** Accuracy at the zero current flow including temperature effects.
- **Half-scale current at 25°C.** Accuracy at the the half-scale current at 25°C, without the effects of temperature.
- **Half-scale current over Δ temperature.** Accuracy at the half-scale current flow including temperature effects.

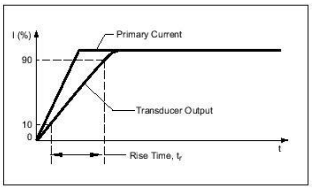
Definitions of Dynamic Response Characteristics

Power-On Time (t_{PO}). When the supply is ramped to its operating voltage, the device requires a finite time to power its internal components before responding to an input magnetic field.

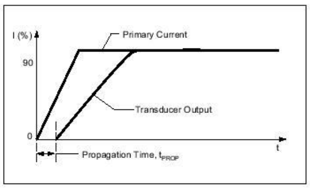
Power-On Time, t_{PO} , is defined as the time it takes for the output voltage to settle within ±10% of its steady state value under an applied magnetic field, after the power supply has reached its minimum specified operating voltage, V_{CC}(min), as shown in the chart at right.



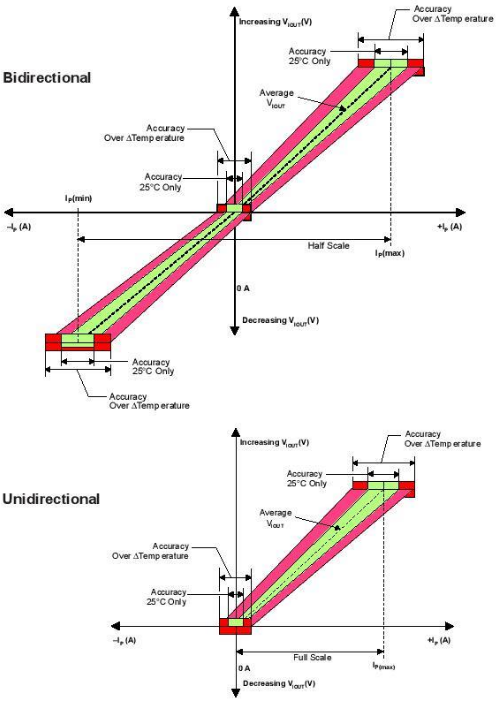
Rise time (t_r). The time interval between a) when the device reaches 10% of its full scale value, and b) when it reaches 90% of its full scale value. The rise time to a step response is used to derive the bandwidth of the device, in which $f(–3\text{ dB}) = 0.35 / t_r$. Both t_r and $t_{RESPONSE}$ are detrimentally affected by eddy current losses observed in the conductive IC ground plane.



Propagation delay (t_{PROP}). The time required for the device output to reflect a change in the primary current signal. Propagation delay is attributed to inductive loading within the linear IC package, as well as in the inductive loop formed by the primary conductor geometry. Propagation delay can be considered as a fixed time offset and may be compensated.



Output Voltage versus Sampled Current
Total Output Error at 0 A and at Half-Scale Current



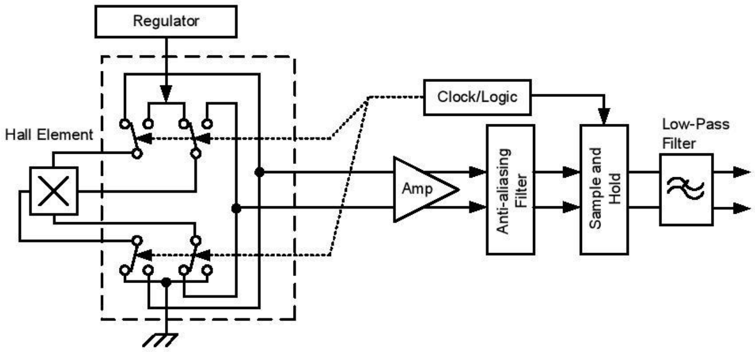
Chopper Stabilization Technique

Chopper Stabilization is an innovative circuit technique that is used to minimize the offset voltage of a Hall element and an associated on-chip amplifier. The technique nearly eliminates Hall IC output drift induced by temperature or package stress effects.

This offset reduction technique is based on a signal modulation-demodulation process. Modulation is used to separate the undesired DC offset signal from the magnetically induced signal in the frequency domain. Then, using a low-pass filter, the modulated DC offset is suppressed while the magnetically induced signal passes through the filter. The anti-aliasing filter prevents aliasing from happening in applications with high frequency signal components which are beyond the user's frequency range of interest.

As a result of this chopper stabilization approach, the output voltage from the Hall IC is desensitized to the effects of temperature and mechanical stress. This technique produces devices that have an extremely stable Electrical Offset Voltage, are immune to thermal stress, and have precise recoverability after temperature cycling.

This technique is made possible through the use of a BiCMOS process that allows the use of low-offset and low-noise amplifiers in combination with high-density logic integration and sample and hold circuits.

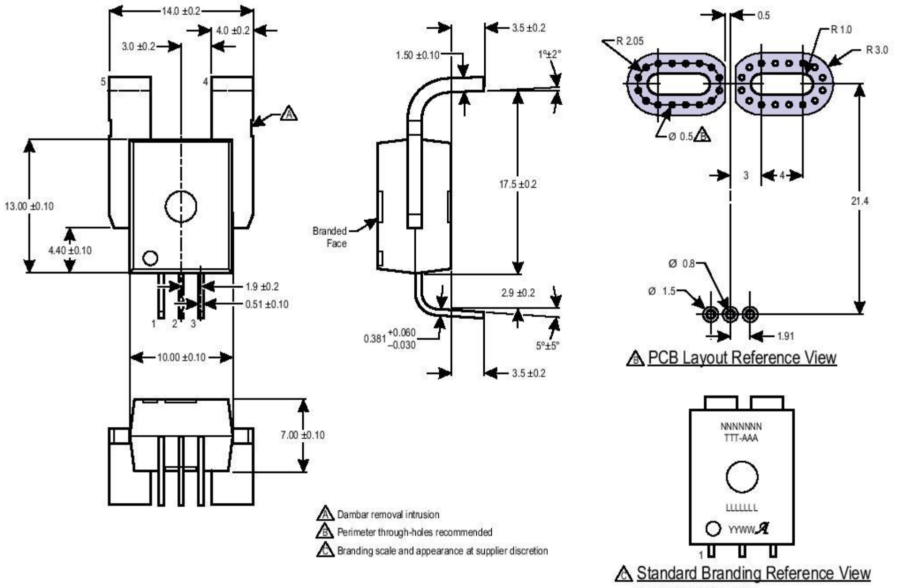


Concept of Chopper Stabilization Technique

PACKAGE OUTLINE DRAWINGS

For Reference Only – Not for Tooling Use

(Reference DWG-9111 & DWG-9110)
Dimensions in millimeters – NOT TO SCALE
Dimensions exclusive of mold flash, gate burs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown



A Dambar removal intrusion
B Perimeter through-holes recommended
C Branding scale and appearance at supplier discretion

B PCB Layout Reference View

C Standard Branding Reference View

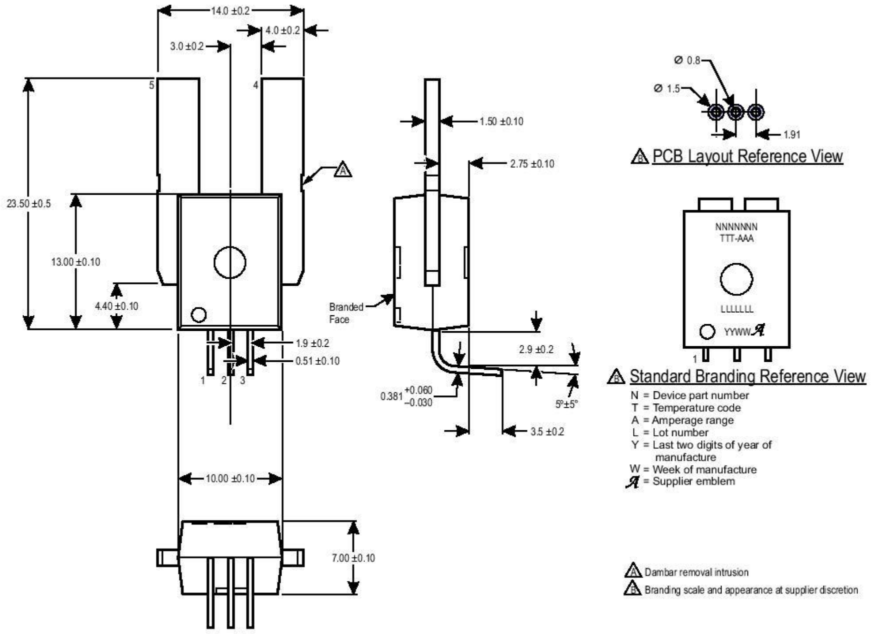
N = Device part number
T = Temperature code
A = Amperage range
L = Lot number
Y = Last two digits of year of manufacture
W = Week of manufacture
A = Supplier emblem

Creepage distance, current terminals to signal pins: 7.25 mm
Clearance distance, current terminals to signal pins: 7.25 mm
Package mass: 4.63 g typical

Package CB, 5-pin Package, Leadform PFF

For Reference Only – Not for Tooling Use

(Reference DWG-9111, DWG-9110)
Dimensions in millimeters – NOT TO SCALE
Dimensions exclusive of mold flash, gate burs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown



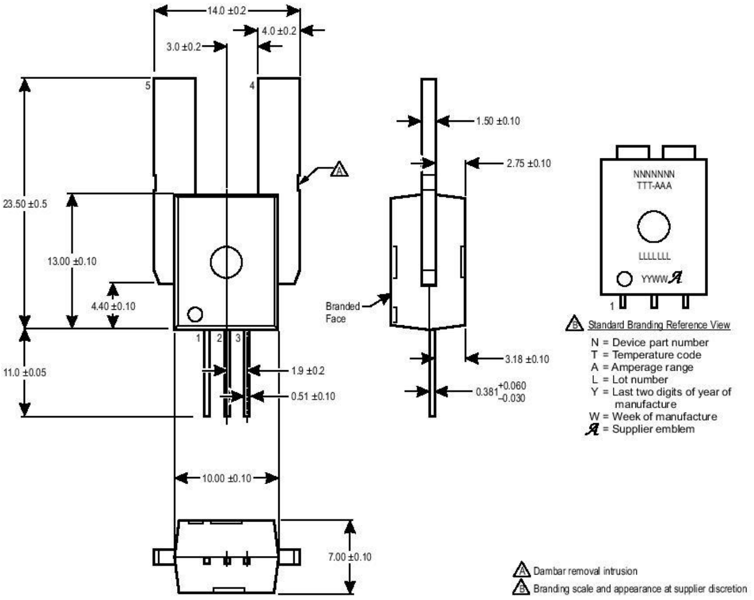
N = Device part number
T = Temperature code
A = Amperage range
L = Lot number
Y = Last two digits of year of manufacture
W = Week of manufacture
𝒜 = Supplier emblem

A Dambar removal intrusion
B Branding scale and appearance at supplier discretion

Package CB, 5-pin Package, Leadform PSF

For Reference Only – Not for Tooling Use

(Reference DWG-9111, DWG-9110)
Dimensions in millimeters – NOT TO SCALE
Dimensions exclusive of mold flash, gate burs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown



B Standard Branding Reference View

N = Device part number
T = Temperature code
A = Amperage range
L = Lot number
Y = Last two digits of year of manufacture
W = Week of manufacture
= Supplier emblem

A Dambar removal intrusion
B Branding scale and appearance at supplier discretion

Creepage distance, current terminals to signal pins: 7.25 mm
Clearance distance, current terminals to signal pins: 7.25 mm
Package mass: 4.63 g typical

Package CB, 5-pin Package, Leadform PSS

Revision History

Number	Date	Description
8	January 17, 2014	Update features list and product offering
9	April 7, 2015	Updated TUV certification and reformatted document
10	November 17, 2016	Updated PCB Layout Reference View in Package Outline Drawing on page 19
11	June 5, 2017	Updated product status
12	June 1, 2018	Updated recommended substitutions
13	December 5, 2018	Updated TUV/UL Certification
14	May 31, 2019	Updated TUV certificate mark

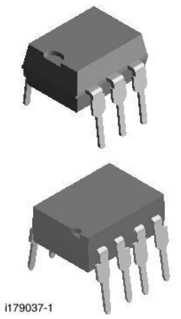
The products described herein are protected by U.S. patents: 6,781,359, 7,265,531, and 8,080,994.

For the latest version of this document, visit our website:

www.allegromicro.com

Φύλλα δεδομένων IL 250

Optocoupler, Phototransistor Output, AC Input, with Base Connection



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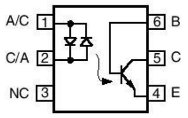
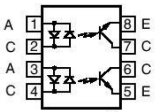




FEATURES

- AC or polarity insensitive inputs
- Built-in reverse polarity input protection
- Improved CTR symmetry
- Industry standard DIP package
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Ideal for AC signal detection and monitoring

AGENCY APPROVALS

- UL1577, file no. E52744, double protection
- cUL tested to CSA 22.2 bulletin 5A
- CSA 93751
- BSI EN 60950, BSI EN 60065
- DIN EN 60747-5-5 (VDE 0884-5)
- CQC GB4943.1-2011 and GB8898-2011 (suitable for installation altitude below 2000 m)

DESCRIPTION

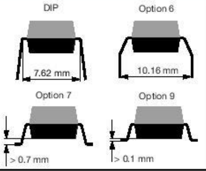
The IL250, IL251, IL252, ILD252 are bidirectional input optically coupled isolators consisting of two gallium arsenide infrared LEDs coupled to a silicon NPN phototransistor per channel.

The IL250 has a minimum CTR of 50 %, the IL251 has a minimum CTR of 20 %, and the IL252, ILD252 has a minimum CTR of 100 %.

The IL250, IL251, IL252 are single channel optocouplers. The ILD252 has two isolated channels in a single DIP package.

ORDERING INFORMATION

I	L	x	2	5	x	-	#	X	0	#	#	T
PART NUMBER							CTR BIN	PACKAGE OPTION				TAPE AND REEL



AGENCY CERTIFIED/PACKAGE	CTR (%)			
	SINGLE CHANNEL, 6 PIN			DUAL CHANNEL, 8 PIN
UL, CSA, BSI, CQC	**≥ 20**	**≥ 50**	**≥ 100**	**≥ 100**
DIP-#	IL251	IL250	IL252	-
SMD-#, option 7	-	IL250-X007	IL252-X007T (1)	-
SMD-#, option 9	IL251-X009T	IL250-X009T (1)	IL252-X009T (1)	-
VDE, UL, CSA, BSI, CQC	**≥ 20**	**≥ 50**	**≥ 100**	**≥ 100**
DIP-#	-	IL250-X001	IL252-X001	-
DIP-#, option 6	-	-	IL252-X016	-
SMD-#, option 7	-	-	IL252-X017T (1)	ILD252-X017

Notes

- Additional options may be possible, please contact sales office

(1) Also available in tubes; do not add "T" to end

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °C, unless otherwise specified)				
PARAMETER	**TEST CONDITION**	**SYMBOL**	**VALUE**	**UNIT**
INPUT				
Forward continuous current		I_F	60	mA
Power dissipation		P_{diss}	100	mW
Derate linearly from 25 °C			1.33	mW/°C
OUTPUT				
Collector emitter breakdown voltage		BV_{CEO}	30	V
Emitter base breakdown voltage		BV_{EBO}	5	V
Collector base breakdown voltage		BV_{CBO}	70	V
Power dissipation single channel		P_{diss}	200	mW
Power dissipation dual channel		P_{diss}	150	mW
Derate linearly from 25 °C single channel			2.6	mW/°C
Derate linearly from 25 °C dual channel			2	mW/°C
COUPLER				
Total dissipation single channel		P_{tot}	250	mW
Total dissipation dual channel		P_{tot}	400	mW
Derate linearly from 25 °C single channel			3.3	mW/°C
Derate linearly from 25 °C dual channel			5.3	mW/°C
Storage temperature		T_{stg}	-55 to +150	°C
Operating temperature		T_{amb}	-55 to +100	°C
Lead soldering time at 260 °C			10	s

Note

- Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
INPUT						
Forward voltage	$I_F = \pm 10$ mA	V_F	-	1.2	1.5	V
OUTPUT						
Collector emitter breakdown voltage	$I_C = 1$ mA	BV_{CEO}	30	50	-	V
Emitter base breakdown voltage	$I_E = 100$ µA	BV_{EBO}	7	10	-	V
Collector base breakdown voltage	$I_C = 10$ µA	BV_{CBO}	70	90	-	V
Collector emitter leakage current	$V_{CE} = 10$ V	I_{CEO}	-	5	50	nA
COUPLER						
Collector emitter saturation voltage	$I_F = \pm 16$ mA, $I_C = 2$ mA	V_{CEsat}	-	-	0.4	V

Note

- Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluation. Typical values are for information only and are not part of the testing requirements

CURRENT TRANSFER RATIO (T_{amb} = 25 °C, unless otherwise specified)							
PARAMETER	**TEST CONDITION**	**PART**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
I_C/I_F	I_F = ± 10 mA, V_{CE} = 10 V	IL250	CTR_{DC}	50	-	-	%
		IL251	CTR_{DC}	20	-	-	%
		IL252, ILD252	CTR_{DC}	100	-	-	%
Symmetry	I_F = ± 10 mA			0.50	1	2	

SWITCHING CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Turn-on time		t_{on}	-	TBD	-	μs
Turn-off time		t_{off}	-	TBD	-	μs

SAFETY AND INSULATION RATINGS				
PARAMETER	**TEST CONDITION**	**SYMBOL**	**VALUE**	**UNIT**
Climatic classification	According to IEC 68 part 1		55/100/21	
Comparative tracking index		CTI	175	
Maximum rated withstanding isolation voltage	t = 1 min	V_{ISO}	4420	V_{RMS}
Maximum transient isolation voltage		V_{IOTM}	10 000	V_{peak}
Maximum repetitive peak isolation voltage		V_{IORM}	890	V_{peak}
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C	R_{IO}	$\geq 10^{12}$	Ω
	V_{IO} = 500 V, T_{amb} = 100 °C	R_{IO}	$\geq 10^{11}$	Ω
Output safety power		P_{SO}	400	mW
Input safety current		I_{SI}	275	mA
Safety temperature		T_S	175	°C
Creepage distance			≥ 7	mm
Clearance distance			≥ 7	mm
Insulation thickness		DTI	≥ 0.4	mm

Note

- As per IEC 60747-5-5, § 7.4.3.8.2, this optocoupler is suitable for "safe electrical insulation" only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits

TYPICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

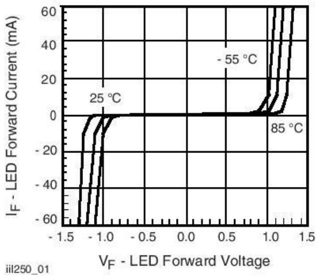


Fig. 1 - LED Forward Current vs.Forward Voltage

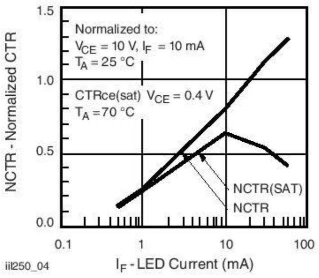


Fig. 4 - Normalized Non-Saturated and Saturated CTR vs. LED Current

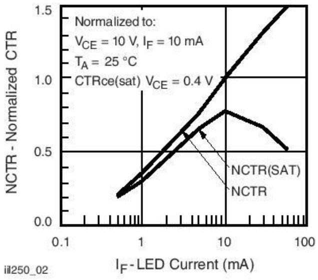


Fig. 2 - Normalized Non-Saturated and Saturated CTR vs. LED Current

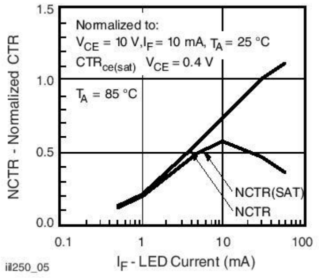


Fig. 5 - Normalized Non-Saturated and Saturated CTR vs. LED Current

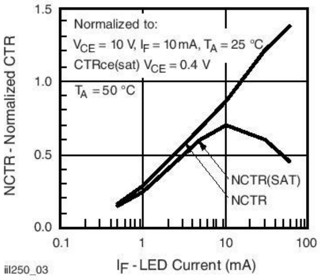


Fig. 3 - Normalized Non-Saturated and Saturated CTR vs. LED Current

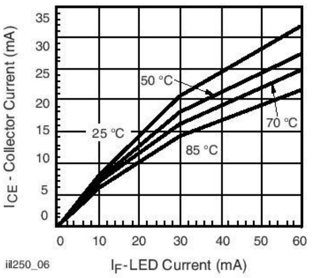


Fig. 6 - Collector Emitter Current vs. Temperature and LED Current

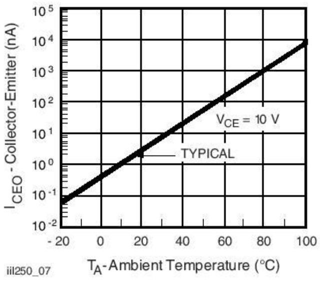


Fig. 7 - Collector Emitter Leakage Current vs.Temperature

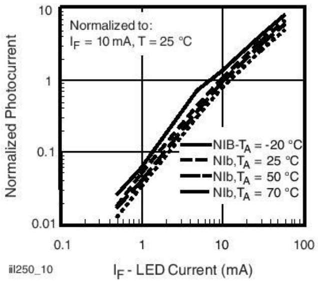


Fig. 10 - Normalized Photocurrent vs. I_F and Temperature

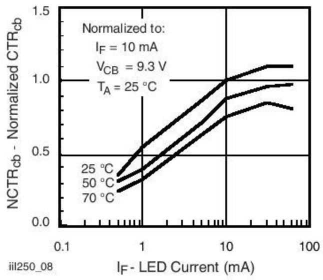


Fig. 8 - Normalized CTR_{CB} vs. LED Current and Temperature

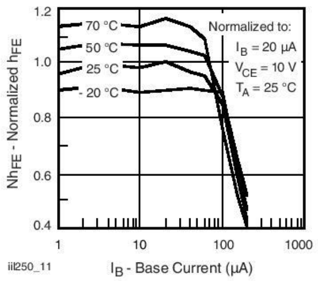


Fig. 11 - Normalized Non Saturated h_{FE} vs. Base Current and Temperature

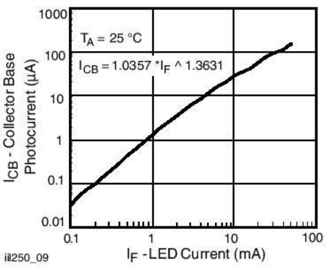


Fig. 9 - Collector Base Photocurrent vs. LED Current

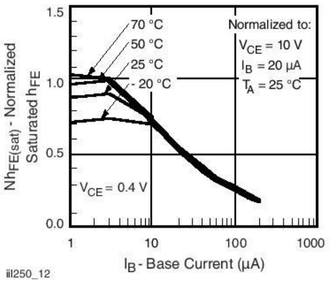


Fig. 12 - Normalized Saturated h_{FE} vs. Base Current and Temperature

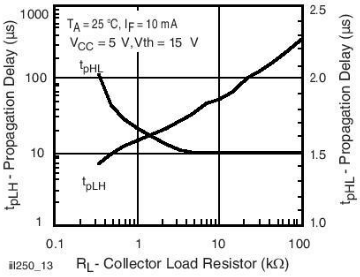


Fig. 13 - Propagation Delay vs. Collector Load Resistor

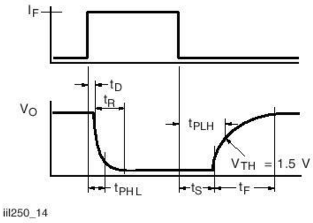


Fig. 14 - Switching Timing

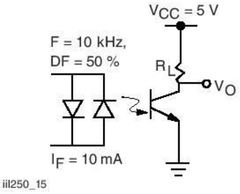
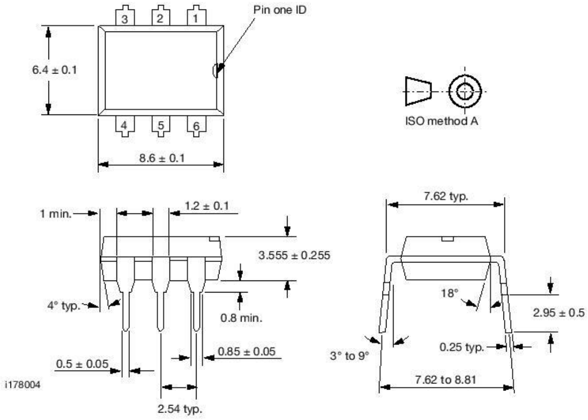
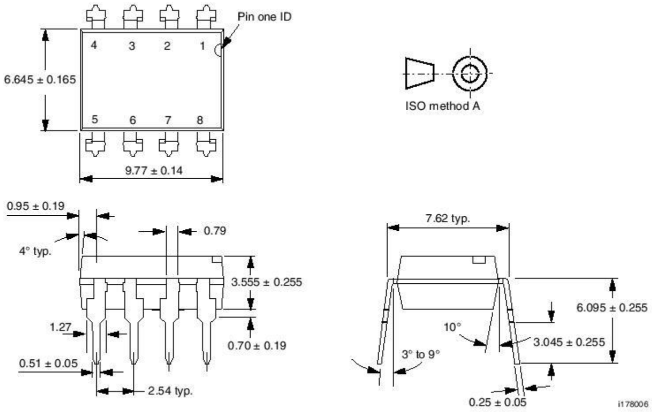
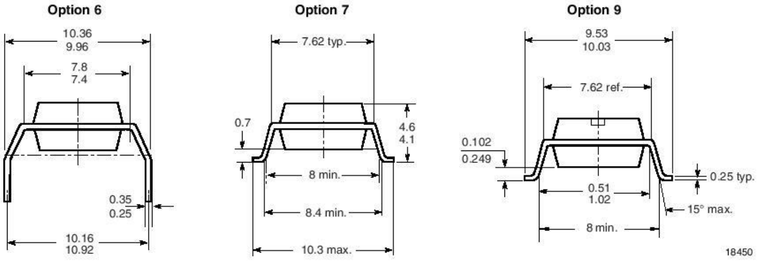


Fig. 15 - Switching Schematic

PACKAGE DIMENSIONS in inches (millimeters)







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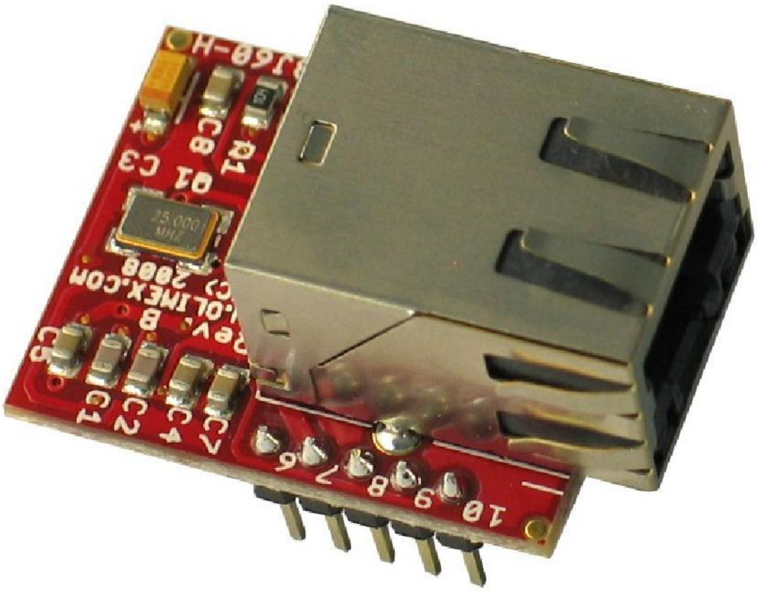
Φύλλα δεδομένων ENCJ60-H



ENC28J60-H development board

User's manual

All boards produced by Olimex are ROHS compliant

Document revision B, January 2015

INTRODUCTION

ENC28J60-H is world's smallest Ethernet controller development board with it's size of only 30×24mm. It provides easy connection to any microcontroller with only few ports via SPI which makes it perfect for adding Ethernet connectivity to embedded applications.

BOARD FEATURES

- ENC28J60 10 Mbit Ethernet controller
- on-board RJ45 connector with build in Ethernet transformer and two status LEDs
- easy interface to any microcontroller via SPI
- compact size in DIL 10 pin format, the distance between pin rows is 0.8''
- PCB: FR-4, 1.5 mm (0,062"), soldermask, white silkscreen component print
- Dimensions: 30×24 mm (1.18×0.95")

ELECTROSTATIC WARNING

The ENC28J60-H board is shipped in protective anti-static packaging. The board must not be subject to high electrostatic potentials. General practice for working with static sensitive devices should be applied when working with this board.

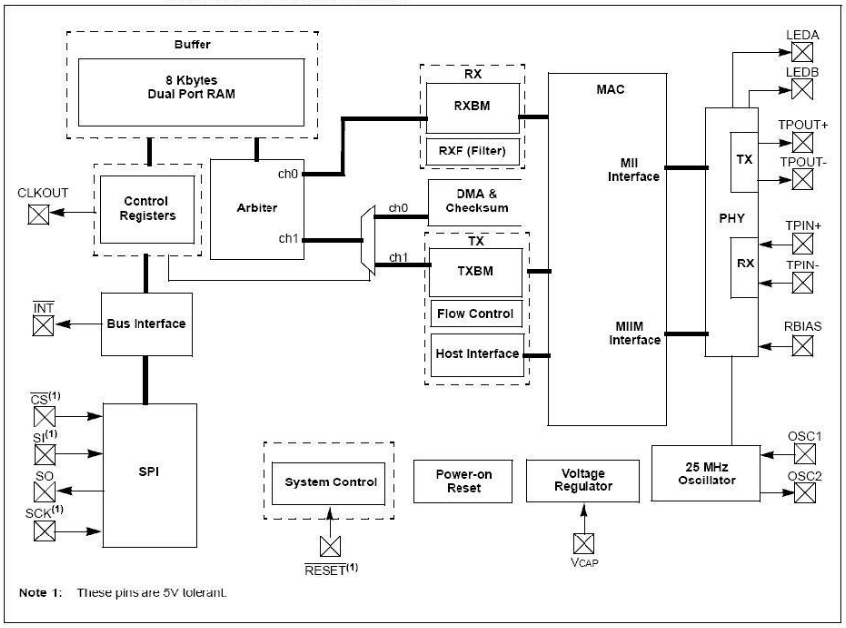
Ethernet Controller Features

ENC28J60-H board use ENC28J60 stand-alone Ethernet controller with these features:

- IEEE 802.3. Compatible Ethernet Controller
- Fully Compatible with 10/100/1000Base-T Networks
- Integrated MAC and 10Base-T PHY
- Supports One 10Base-T Port with Automatic Polarity Detection and Correction
- Supports Full and Half-Duplex modes
- Programmable Automatic Retransmit on Collision
- Programmable Padding and CRC Generation
- Programmable Automatic Rejection of Erroneous Packets
- SPI Interface with Clock Speeds Up to 20 MHz

BLOCK DIAGRAM

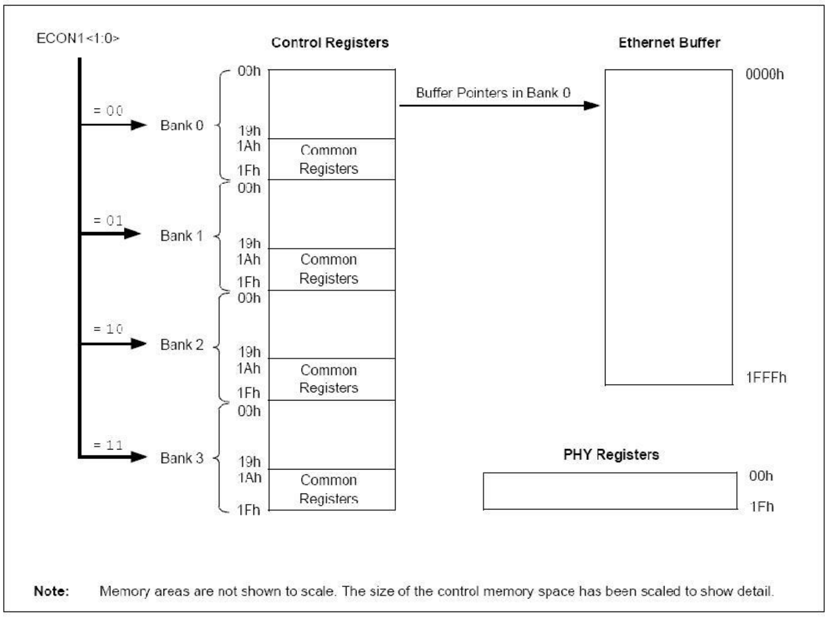
ENC28J60 BLOCK DIAGRAM



Note 1: These pins are 5V tolerant.

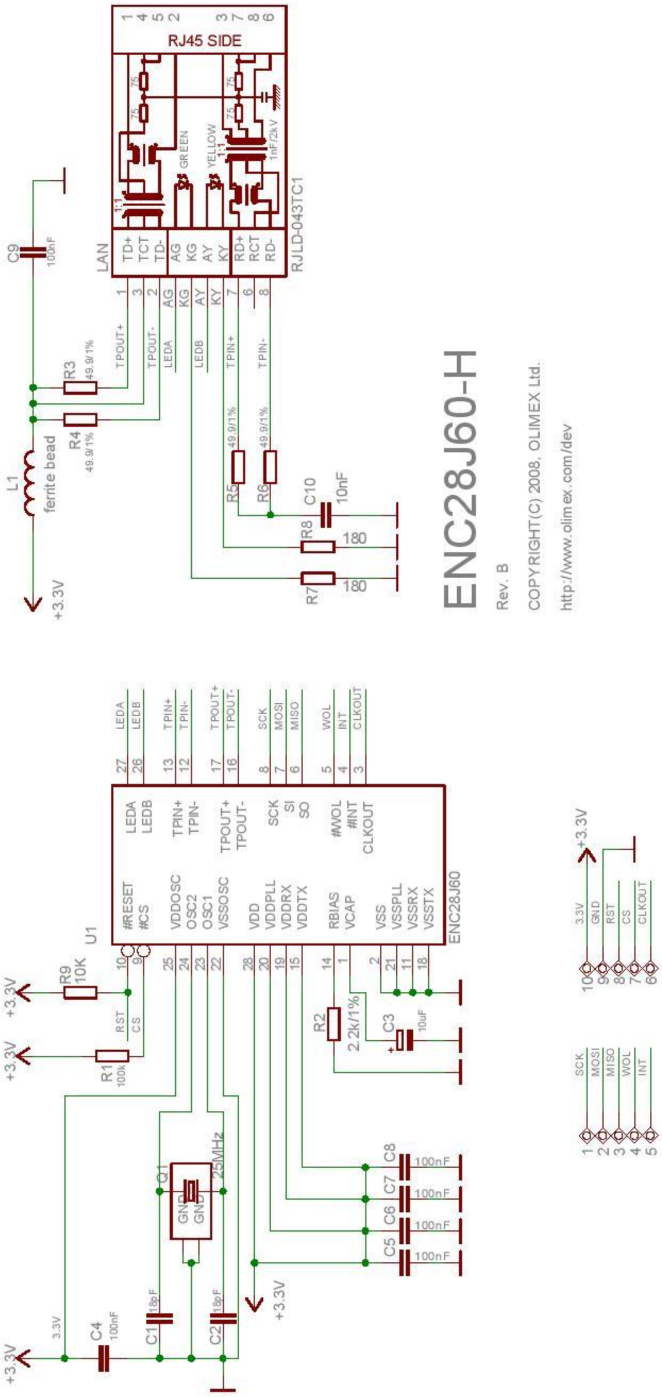
MEMORY MAP

ENC28J60 MEMORY ORGANIZATION



Note: Memory areas are not shown to scale. The size of the control memory space has been scaled to show detail.

SCHEMATIC



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POWER SUPPLY CIRCUIT

ENC28J60-H is typically power supplied by EXT pin 10 and pin 9.

RESET CIRCUIT

ENC28J60-H reset circuit includes EXT connector pin 8, U1 pin 10 and R9 (10k).

CLOCK CIRCUIT

Quartz crystal 25 MHz is connected to **ENC28J60** pin 23 (OSC1) and pin 24 (OSC2).

IMPORTANT: If the board has a quartz crystal rotated at 45 degrees relative to the pads provided do not panic. This is normal. We have two types of such crystals – one of them requires 4 pads, the other only 2 pads. That is why we have provided 4 pads to be able to fit both crystals. All boards Olimex manufactures pass automatized optical inspection after assembly and obvious misplacement like this is impossible to occur.

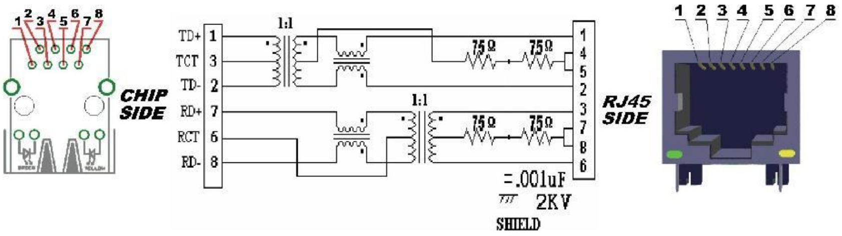
A tilted quartz is not a manufacturing error!

JUMPER DESCRIPTION

There are no configurable jumpers on the board.

CONNECTOR DESCRIPTIONS

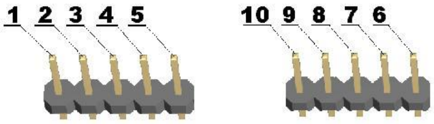
LAN



Pin #	Signal Name Chip Side	Pin #	Signal Name Chip Side
1	TX+	5	Not Connected (NC)
2	TX-	6	VDD
3	VDD	7	RX+
4	Not Connected (NC)	8	RX-

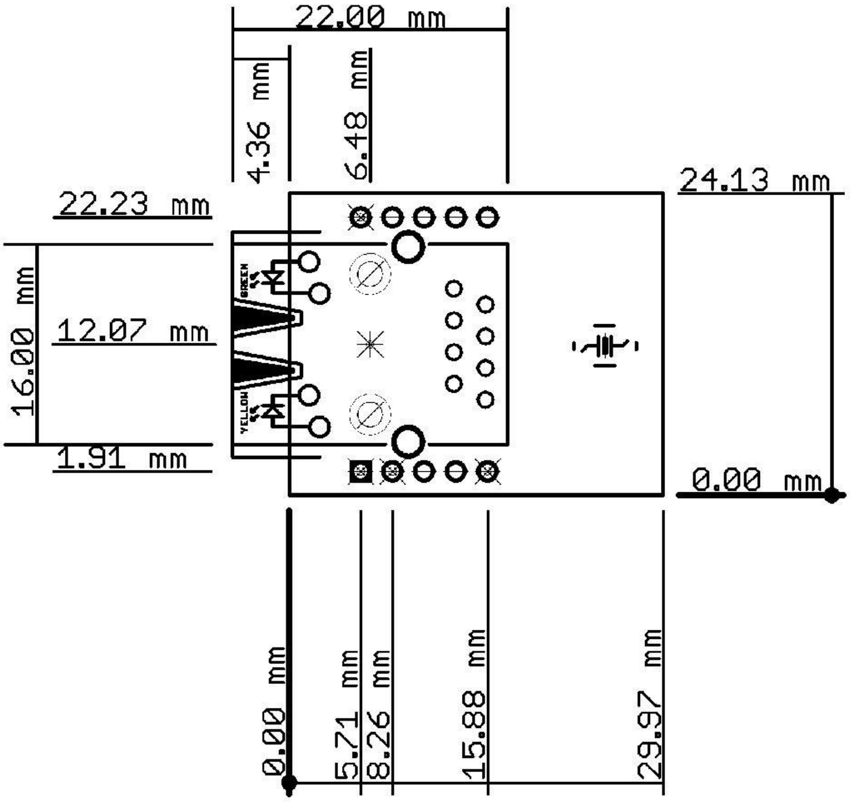
LED	Color	Usage
Right	Green	Link status
Left	Yellow	Activity status

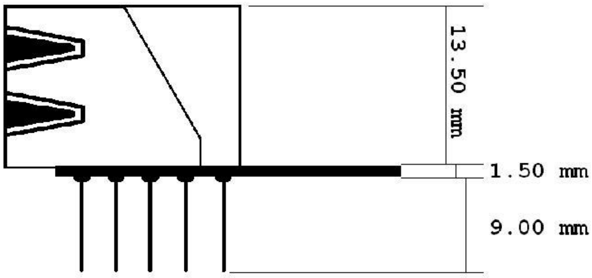
EXT



Pin#	Signal Name	Pin#	Signal Name
1	SCK	6	CLKOUT
2	MOSI	7	CS
3	MISO	8	RST
4	WOL	9	GND
5	INT	10	3.3V

MECHANICAL DIMENSIONS





AVAILABLE DEMO SOFTWARE

Please check the SOFTWARE section of the product page for a number of examples with different boards. The web page for ENC28J60-H is:

https://www.olimex.com/Products/Modules/Ethernet/ENC28J60-H/

ORDER CODE

ENC28J60-H – completely assembled and tested, includes ENC28J60 Ethernet controller

How to order?

You can purchase directly from our online shop or from any of our distributors. Note that usually it might be faster and cheaper to purchase Olimex products from our distributors. List of confirmed Olimex LTD distributors and resellers: https://www.olimex.com/Distributors

Please visit our web site www.olimex.com for more information.

REVISION HISTORY:

Board revision:

Board revision	**Notable changes**
B	Initial release of the board

Manual revision:

Document revision	**Notable changes**	**Modified page**
A	- Initial manual release	All
B, 23.01.15	- Cleared duplicate information - Added clarification about the rotated quartz crystal - Formatting improvements	All

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It is possible that the pictures in this manual differ from the latest revision of the board.

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THERE IS NO WARRANTY FOR THE DESIGN MATERIALS AND THE COMPONENTS USED TO CREATE ENC28J60-H. THEY ARE CONSIDERED SUITABLE ONLY FOR ENC28J60-H.

Φύλλα δεδομένων max13080E

MAX13080E–MAX13084E/ MAX13086E–MAX13089E

+5.0V, ±15kV ESD-Protected, Fail-Safe, Hot-Swap, RS-485/RS-422 Transceivers

General Description

The MAX13080E–MAX13089E +5.0V, ±15kV ESD-protected, RS-485/RS-422 transceivers feature one driver and one receiver. These devices include fail-safe circuitry, guaranteeing a logic-high receiver output when receiver inputs are open or shorted. The receiver outputs a logic-high if all transmitters on a terminated bus are disabled (high impedance). The MAX13080E family include a hot-swap capability to eliminate false transitions on the bus during power-up or hot insertion.

The MAX13080E/MAX13081E/MAX13082E feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-free data transmission up to 250kbps. The MAX13083E/MAX13084E also feature slew-rate-limited drivers but allow transmit speeds up to 500kbps. The MAX13086E/MAX13087E/ MAX13088E driver slew rates are not limited, making transmit speeds up to 16Mbps possible. The MAX13089E slew rate is pin selectable for 250kbps, 500kbps, and 16Mbps.

The MAX13082E/MAX13088E are intended for half-duplex communications, and the MAX13080E/ MAX13081E/MAX13083E/MAX13084E/MAX13086E/ MAX13087E are intended for full-duplex communications. The MAX13089E is selectable for half-duplex or full-duplex operation. It also features independently programmable receiver and transmitter output phase through separate pins.

The MAX13080E family transceivers draw 1.2mA of supply current when unloaded or when fully loaded with the drivers disabled. All devices have a 1/8-unit load receiver input impedance, allowing up to 256 transceivers on the bus.

The MAX13080E/MAX13083E/MAX13086E/MAX13089E are available in 14-pin PDIP and 14-pin SO packages. The MAX13081E/MAX13082E/MAX13084E/MAX13087E/ MAX13088E are available in 8-pin PDIP and 8-pin SO packages. The devices operate over the commercial, extended, and automotive temperature ranges.

Applications

Utility Meters
Lighting Systems
Industrial Control
Telecom
Security Systems
Instrumentation
Profibus

Features

- **+5.0V Operation**
- **Extended ESD Protection for RS-485/RS-422 I/O Pins ±15kV Human Body Model**
- **True Fail-Safe Receiver While Maintaining EIA/TIA-485 Compatibility**
- **Hot-Swap Input Structures on DE and $\overline{\text{RE}}$**
- **Enhanced Slew-Rate Limiting Facilitates Error-Free Data Transmission (MAX13080E–MAX13084E/MAX13089E)**
- **Low-Current Shutdown Mode (Except MAX13081E/MAX13084E/MAX13087E)**
- **Pin-Selectable Full-/Half-Duplex Operation (MAX13089E)**
- **Phase Controls to Correct for Twisted-Pair Reversal (MAX13089E)**
- **Allow Up to 256 Transceivers on the Bus**
- **Available in Industry-Standard 8-Pin SO Package**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX13080ECPD+	0°C to +70°C	14 PDIP
MAX13080ECSD+	0°C to +70°C	14 SO
MAX13080EEPD+	-40°C to +85°C	14 PDIP
MAX13080EESD+	-40°C to +85°C	14 SO
MAX13080EAPD+	-40°C to +125°C	14 PDIP
MAX13080EASD+	-40°C to +125°C	14 SO

+Denotes a lead(Pb)-free/RoHS-compliant package.

Ordering Information continued at end of data sheet.

Selector Guide, Pin Configurations, and Typical Operating Circuits appear at end of data sheet.

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maximintegrated.com.

19-3590; Rev 2; 11/11

MAX13080E–MAX13084E/
MAX13086E–MAX13089E

+5.0V, ±15kV ESD-Protected, Fail-Safe, Hot-Swap, RS-485/RS-422 Transceivers

ABSOLUTE MAXIMUM RATINGS

(All Voltages Referenced to GND)	
Supply Voltage (V_{CC})	+6V
Control Input Voltage ($\overline{RE}$, DE, SLR, H/$\overline{F}$, TXP, RXP)	-0.3V to +6V
Driver Input Voltage (DI)	-0.3V to +6V
Driver Output Voltage (Z, Y, A, B)	-8V to +13V
Receiver Input Voltage (A, B)	-8V to +13V
Receiver Input Voltage Full Duplex (A, B)	-8V to +13V
Receiver Output Voltage (RO)	-0.3V to (V_{CC} + 0.3V)
Driver Output Current	±250mA

Continuous Power Dissipation (T_A = +70°C)	
8-Pin SO (derate 5.88mW/°C above +70°C)	471mW
8-Pin Plastic DIP (derate 9.09mW/°C above +70°C)	727mW
14-Pin SO (derate 8.33mW/°C above +70°C)	667mW
14-Pin Plastic DIP (derate 10.0mW/°C above +70°C)	800mW
Operating Temperature Ranges	
MAX1308_EC_ _	0°C to +75°C
MAX1308_EE_ _	-40°C to +85°C
MAX1308_EA_ _	-40°C to +125°C
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C
Soldering Temperature (reflow)	+260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC ELECTRICAL CHARACTERISTICS

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DRIVER						
V_{CC} Supply-Voltage Range	V_{CC}		4.5		5.5	V
Differential Driver Output	V_{OD}	R_L = 100Ω (RS-422), Figure 1	3		V_{CC}	V
		R_L = 54Ω (RS-485), Figure 1	2		V_{CC}	
		No load			V_{CC}	
Change in Magnitude of Differential Output Voltage	ΔV_{OD}	R_L = 100Ω or 54Ω, Figure 1 (Note 2)			0.2	V
Driver Common-Mode Output Voltage	V_{OC}	R_L = 100Ω or 54Ω, Figure 1		V_{CC} / 2	3	V
Change in Magnitude of Common-Mode Voltage	ΔV_{OC}	R_L = 100Ω or 54Ω, Figure 1 (Note 2)			0.2	V
Input-High Voltage	V_{IH}	DE, DI, $\overline{RE}$, TXP, RXP, H/$\overline{F}$	3			V
Input-Low Voltage	V_{IL}	DE, DI, $\overline{RE}$, TXP, RXP, H/$\overline{F}$			0.8	V
Input Hysteresis	V_{HYS}	DE, DI, $\overline{RE}$, TXP, RXP, H/$\overline{F}$		100		mV
Input Current	I_{IN1}	DE, DI, $\overline{RE}$			±1	µA
Input Impedance First Transition		DE	1		10	kΩ
Input Current	I_{IN2}	TXP, RXP, H/$\overline{F}$ internal pulldown	10		40	µA
SRL Input-High Voltage			V_{CC} - 0.4			V
SRL Input-Middle Voltage			V_{CC} x 0.3		V_{CC} x 0.7	V
SRL Input-Low Voltage					0.4	V
SRL Input Current		SRL = V_{CC}			75	µA
		SRL = GND	-75			
Output Leakage (Y and Z) Full Duplex	I_O	DE = GND, V_{CC} = GND or V_{CC}; V_{IN} = +12V			125	µA
		V_{IN} = -7V	-100			

DC ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Short-Circuit Output Current	I_{OSD}	$0 \le V_{OUT} \le +12V$ (Note 3)	40		250	mA
		$-7V \le V_{OUT} \le V_{CC}$ (Note 3)	-250		-40	
		$0 \le V_{OUT} \le +12V$, $+85°C \le T_A \le +125°C$ (Note 3)	40		270	
		$-7V \le V_{OUT} \le V_{CC}$, $+85°C \le T_A \le +125°C$ (Note 3)	-270		-40	
Driver Short-Circuit Foldback Output Current	I_{OSDF}	$(V_{CC} - 1V) \le V_{OUT} \le +12V$ (Note 3)	20			mA
		$-7V \le V_{OUT} \le +1V$ (Note 3)			-20	
Thermal-Shutdown Threshold	T_{TS}			175		°C
Thermal-Shutdown Hysteresis	T_{TSH}			15		°C
Input Current (A and B)	$I_{A, B}$	DE = GND, V_{CC} = GND or V_{CC}; V_{IN} = +12V			125	µA
		DE = GND, V_{CC} = GND or V_{CC}; V_{IN} = -7V	-100			
RECEIVER						
Receiver Differential Threshold Voltage	V_{TH}	$-7V \le V_{CM} \le +12V$	-200	-125	-50	mV
Receiver Input Hysteresis	ΔV_{TH}	$V_A + V_B = 0V$		15		mV
RO Output-High Voltage	V_{OH}	I_O = -1mA	V_{CC} - 0.6			V
RO Output-Low Voltage	V_{OL}	I_O = 1mA			0.4	V
Three-State Output Current at Receiver	I_{OZR}	$0 \le V_O \le V_{CC}$			± 1	µA
Receiver Input Resistance	R_{IN}	$-7V \le V_{CM} \le +12V$	96			kΩ
Receiver Output Short-Circuit Current	I_{OSR}	$0V \le V_{RO} \le V_{CC}$			±110	mA
SUPPLY CURRENT						
Supply Current	I_{CC}	No load, $\overline{RE}$ = 0, DE = V_{CC}		1.2	1.8	mA
		No load, $\overline{RE}$ = V_{CC}, DE = V_{CC}		1.2	1.8	
		No load, $\overline{RE}$ = 0, DE = 0		1.2	1.8	
Supply Current in Shutdown Mode	I_{SHDN}	$\overline{RE}$ = V_{CC}, DE = GND		2.8	10	µA
ESD PROTECTION						
ESD Protection for Y, Z, A, and B		Human Body Model		±15		kV
		Contact Discharge IEC 61000-4-2		±6		kV

DRIVER SWITCHING CHARACTERISTICS
MAX13080E/MAX13081E/MAX13082E/MAX13089E WITH SRL = UNCONNECTED (250kbps)

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Propagation Delay	t_{DPLH}	C_L= 50pF, R_L= 54Ω, Figures 2 and 3	350		1800	ns
	t_{DPHL}		350		1800	
Driver Differential Output Rise or Fall Time	t_R , t_F	C_L= 50pF, R_L= 54Ω, Figures 2 and 3	400		1900	ns
Differential Driver Output Skew $\lvert t_{DPLH} - t_{DPHL}\rvert$	t_{DSKEW}	C_L= 50pF, R_L= 54Ω, Figures 2 and 3			250	ns
Maximum Data Rate			250			kbps
Driver Enable to Output High	t_{DZH}	Figure 4			2500	ns
Driver Enable to Output Low	t_{DZL}	Figure 5			2500	ns
Driver Disable Time from Low	t_{DLZ}	Figure 5			100	ns
Driver Disable Time from High	t_{DHZ}	Figure 4			100	ns
Driver Enable from Shutdown to Output High	$t_{DZH(SHDN)}$	Figure 4			5500	ns
Driver Enable from Shutdown to Output Low	$t_{DZL(SHDN)}$	Figure 5			5500	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

RECEIVER SWITCHING CHARACTERISTICS
MAX13080E/MAX13081E/MAX13082E/MAX13089E WITH SRL = UNCONNECTED (250kbps)

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Propagation Delay	t_{RPLH}	C_L = 15pF, Figures 6 and 7			200	ns
	t_{RPHL}				200	
Receiver Output Skew $\lvert t_{RPLH} - t_{RPHL}\rvert$	t_{RSKEW}	C_L = 15pF, Figures 6 and 7			30	ns
Maximum Data Rate			250			kbps
Receiver Enable to Output Low	t_{RZL}	Figure 8			50	ns
Receiver Enable to Output High	t_{RZH}	Figure 8			50	ns
Receiver Disable Time from Low	t_{RLZ}	Figure 8			50	ns
Receiver Disable Time from High	t_{RHZ}	Figure 8			50	ns
Receiver Enable from Shutdown to Output High	$t_{RZH(SHDN)}$	Figure 8			5500	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL(SHDN)}$	Figure 8			5500	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

DRIVER SWITCHING CHARACTERISTICS
MAX13083E/MAX13084E/MAX13089E WITH SRL = V_{CC} (500kbps)

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Propagation Delay	t_{DPLH}	C_L = 50pF, R_L = 54Ω, Figures 2 and 3	200		1000	ns
	t_{DPHL}		200		1000	
Driver Differential Output Rise or Fall Time	t_R , t_F	C_L = 50pF, R_L = 54Ω, Figures 2 and 3	250		900	ns
Differential Driver Output Skew $\lvert t_{DPLH} - t_{DPHL} \rvert$	t_{DSKEW}	C_L = 50pF, R_L = 54Ω, Figures 2 and 3			140	ns
Maximum Data Rate			500			kbps
Driver Enable to Output High	t_{DZH}	Figure 4			2500	ns
Driver Enable to Output Low	t_{DZL}	Figure 5			2500	ns
Driver Disable Time from Low	t_{DLZ}	Figure 5			100	ns
Driver Disable Time from High	t_{DHZ}	Figure 4			100	ns
Driver Enable from Shutdown to Output High	$t_{DZH(SHDN)}$	Figure 4			5500	ns
Driver Enable from Shutdown to Output Low	$t_{DZL(SHDN)}$	Figure 5			5500	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

RECEIVER SWITCHING CHARACTERISTICS
MAX13083E/MAX13084E/MAX13089E WITH SRL = V_{CC} (500kbps)

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Propagation Delay	t_{RPLH}	C_L = 15pF, Figures 6 and 7			200	ns
	t_{RPHL}				200	
Receiver Output Skew $\lvert t_{RPLH} - t_{RPHL} \rvert$	t_{RSKEW}	C_L = 15pF, Figures 6 and 7			30	ns
Maximum Data Rate			500			kbps
Receiver Enable to Output Low	t_{RZL}	Figure 8			50	ns
Receiver Enable to Output High	t_{RZH}	Figure 8			50	ns
Receiver Disable Time from Low	t_{RLZ}	Figure 8			50	ns
Receiver Disable Time from High	t_{RHZ}	Figure 8			50	ns
Receiver Enable from Shutdown to Output High	$t_{RZH(SHDN)}$	Figure 8			5500	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL(SHDN)}$	Figure 8			5500	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

DRIVER SWITCHING CHARACTERISTICS
MAX13086E/MAX13087E/MAX13088E/MAX13089E WITH SRL = GND (16Mbps)

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Propagation Delay	t_{DPLH}	C_L = 50pF, R_L= 54Ω, Figures 2 and 3			50	ns
	t_{DPHL}				50	
Driver Differential Output Rise or Fall Time	t_R , t_F	C_L = 50pF, R_L= 54Ω, Figures 2 and 3			15	ns
Differential Driver Output Skew $\lvert t_{DPLH}$ - $t_{DPHL}\rvert$	t_{DSKEW}	C_L = 50pF, R_L= 54Ω, Figures 2 and 3			8	ns
Maximum Data Rate			16			Mbps
Driver Enable to Output High	t_{DZH}	Figure 4			150	ns
Driver Enable to Output Low	t_{DZL}	Figure 5			150	ns
Driver Disable Time from Low	t_{DLZ}	Figure 5			100	ns
Driver Disable Time from High	t_{DHZ}	Figure 4			100	ns
Driver Enable from Shutdown to Output High	$t_{DZH(SHDN)}$	Figure 4			2200	ns
Driver Enable from Shutdown to Output Low	$t_{DZL(SHDN)}$	Figure 5			2200	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

RECEIVER SWITCHING CHARACTERISTICS
MAX13086E/MAX13087E/MAX13088E/MAX13089E WITH SRL = GND (16Mbps)

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Propagation Delay	t_{RPLH}	C_L = 15pF, Figures 6 and 7		50	80	ns
	t_{RPHL}			50	80	
Receiver Output Skew $\lvert t_{RPLH}$ - $t_{RPHL}\rvert$	t_{RSKEW}	C_L = 15pF, Figures 6 and 7			13	ns
Maximum Data Rate			16			Mbps
Receiver Enable to Output Low	t_{RZL}	Figure 8			50	ns
Receiver Enable to Output High	t_{RZH}	Figure 8			50	ns
Receiver Disable Time from Low	t_{RLZ}	Figure 8			50	ns
Receiver Disable Time from High	t_{RHZ}	Figure 8			50	ns
Receiver Enable from Shutdown to Output High	$t_{RZH(SHDN)}$	Figure 8			2200	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL(SHDN)}$	Figure 8			2200	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

Note 1: All currents into the device are positive. All currents out of the device are negative. All voltages are referred to device ground, unless otherwise noted.

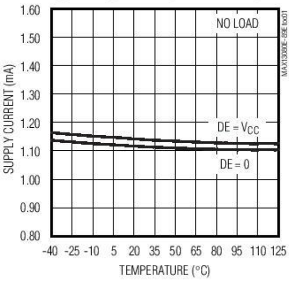
Note 2: ΔV_{OD} and ΔV_{OC} are the changes in V_{OD} and V_{OC}, respectively, when the DI input changes state.

Note 3: The short-circuit output current applies to peak current just prior to foldback current limiting. The short-circuit foldback output current applies during current limiting to allow a recovery from bus contention.

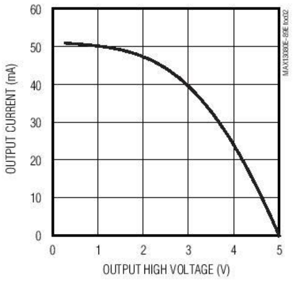
Typical Operating Characteristics

(V_{CC} = +5.0V, T_A = +25°C, unless otherwise noted.)

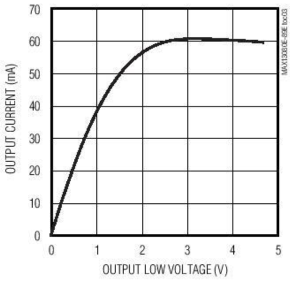
SUPPLY CURRENT vs. TEMPERATURE



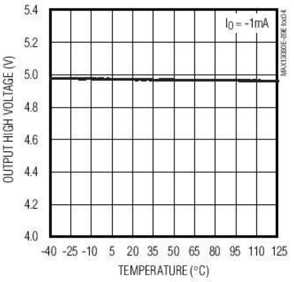
OUTPUT CURRENT vs. RECEIVER OUTPUT-HIGH VOLTAGE



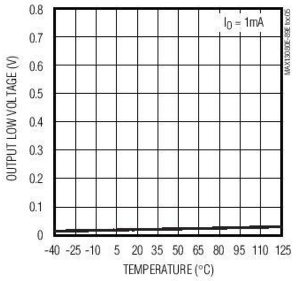
OUTPUT CURRENT vs. RECEIVER OUTPUT-LOW VOLTAGE



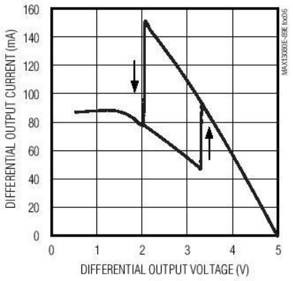
RECEIVER OUTPUT-HIGH VOLTAGE vs. TEMPERATURE



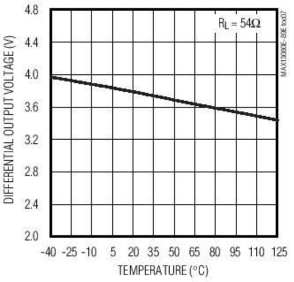
RECEIVER OUTPUT-LOW VOLTAGE vs. TEMPERATURE



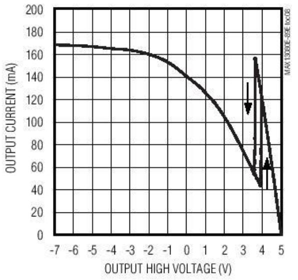
DRIVER DIFFERENTIAL OUTPUT CURRENT vs. DIFFERENTIAL OUTPUT VOLTAGE



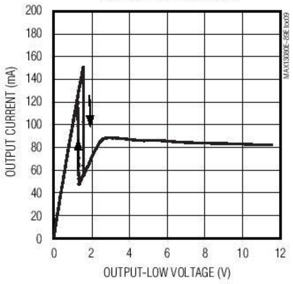
DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs. TEMPERATURE



OUTPUT CURRENT vs. TRANSMITTER OUTPUT-HIGH VOLTAGE

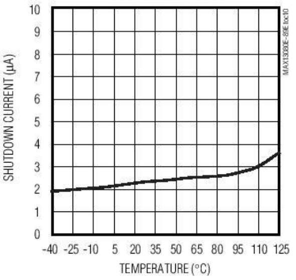


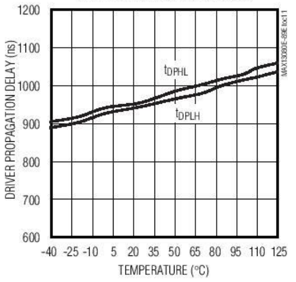
OUTPUT CURRENT vs. TRANSMITTER OUTPUT-LOW VOLTAGE

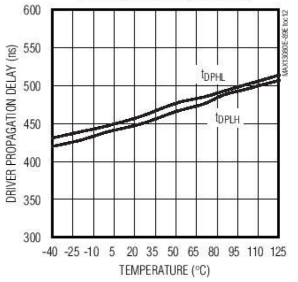


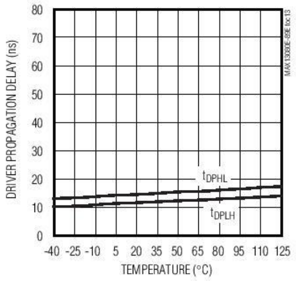
Typical Operating Characteristics (continued)

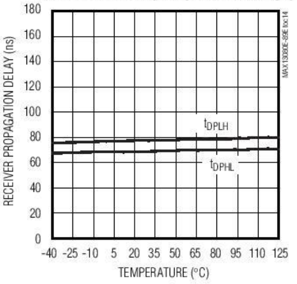
(V_{CC} = +5.0V, T_A = +25°C, unless otherwise noted.)

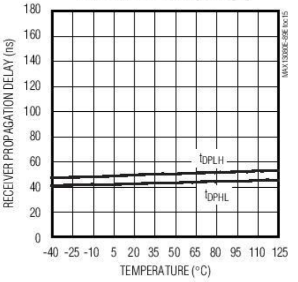

SHUTDOWN CURRENT vs. TEMPERATURE

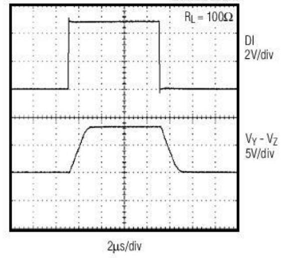

DRIVER PROPAGATION DELAY vs. TEMPERATURE (250kbps)

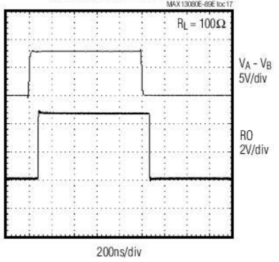

DRIVER PROPAGATION DELAY vs. TEMPERATURE (500kbps)


DRIVER PROPAGATION DELAY vs. TEMPERATURE (16Mbps)


RECEIVER PROPAGATION DELAY vs. TEMPERATURE (250kpbs AND 500kbps)

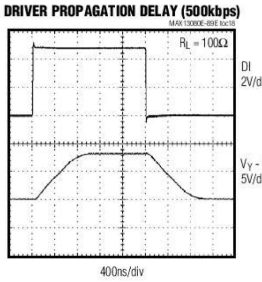

RECEIVER PROPAGATION DELAY vs. TEMPERATURE (16Mbps)

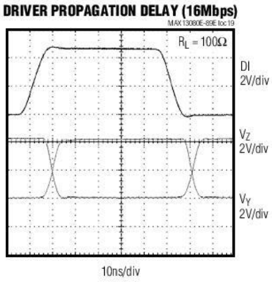

DRIVER PROPAGATION DELAY (250kbps)

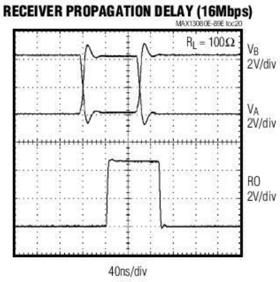

RECEIVER PROPAGATION DELAY (250kbps AND 500kbps)

Typical Operating Characteristics (continued)

(V_{CC} = +5.0V, T_A = +25°C, unless otherwise noted.)


DRIVER PROPAGATION DELAY (500kbps)


DRIVER PROPAGATION DELAY (16Mbps)


RECEIVER PROPAGATION DELAY (16Mbps)

Test Circuits and Waveforms

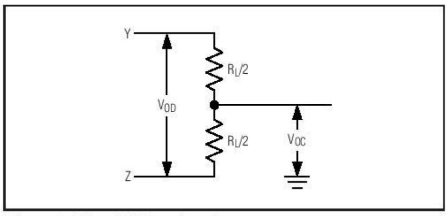


Figure 1. Driver DC Test Load

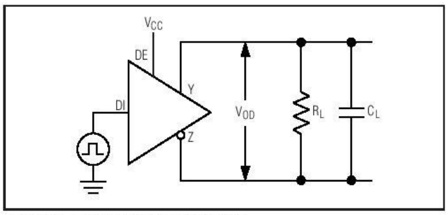


Figure 2. Driver Timing Test Circuit

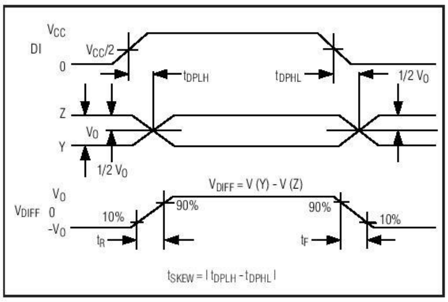


Figure 3. Driver Propagation Delays

Test Circuits and Waveforms (continued)

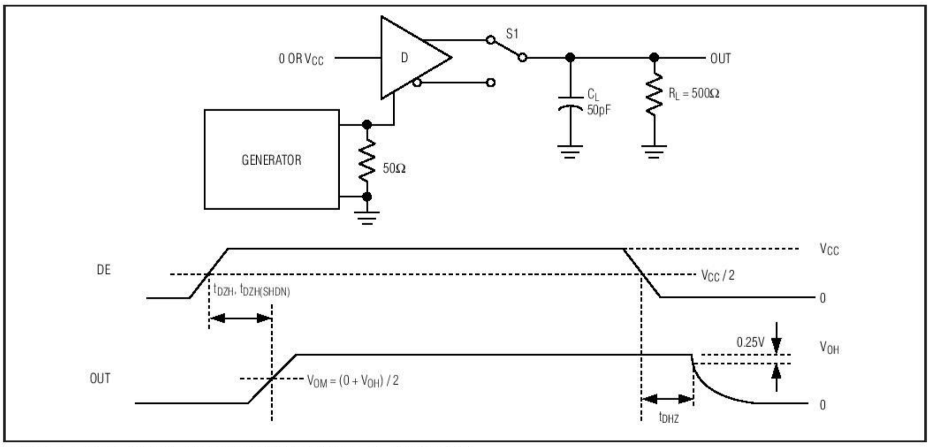


Figure 4. Driver Enable and Disable Times (t_{DHZ}, t_{DZH}, $t_{DZH(SHDN)}$)

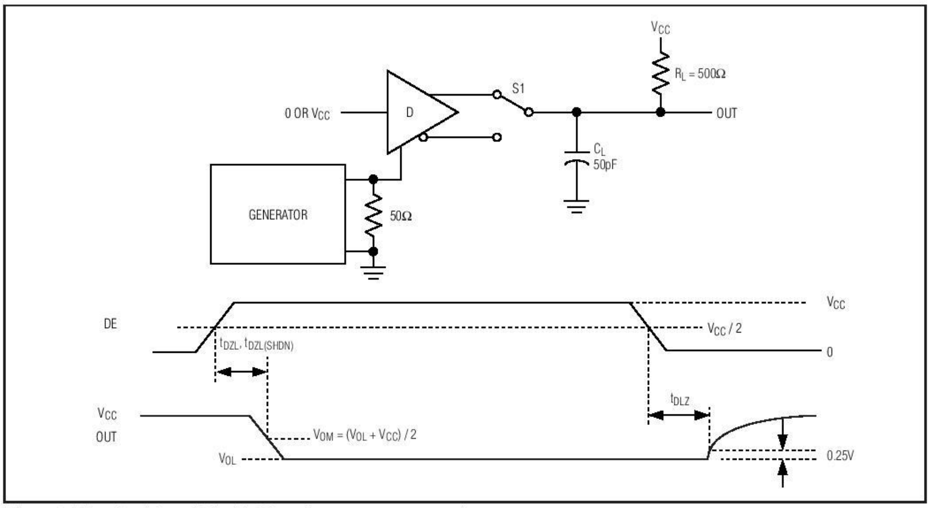


Figure 5. Driver Enable and Disable Times (t_{DZL}, t_{DLZ}, $t_{DLZ(SHDN)}$)

Test Circuits and Waveforms (continued)

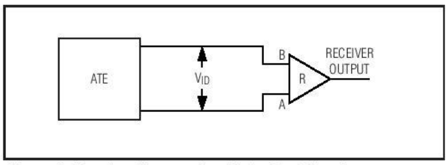


Figure 6. Receiver Propagation Delay Test Circuit

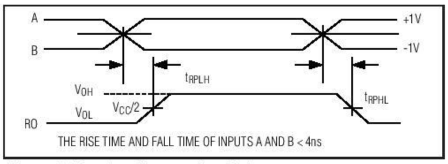


Figure 7. Receiver Propagation Delays

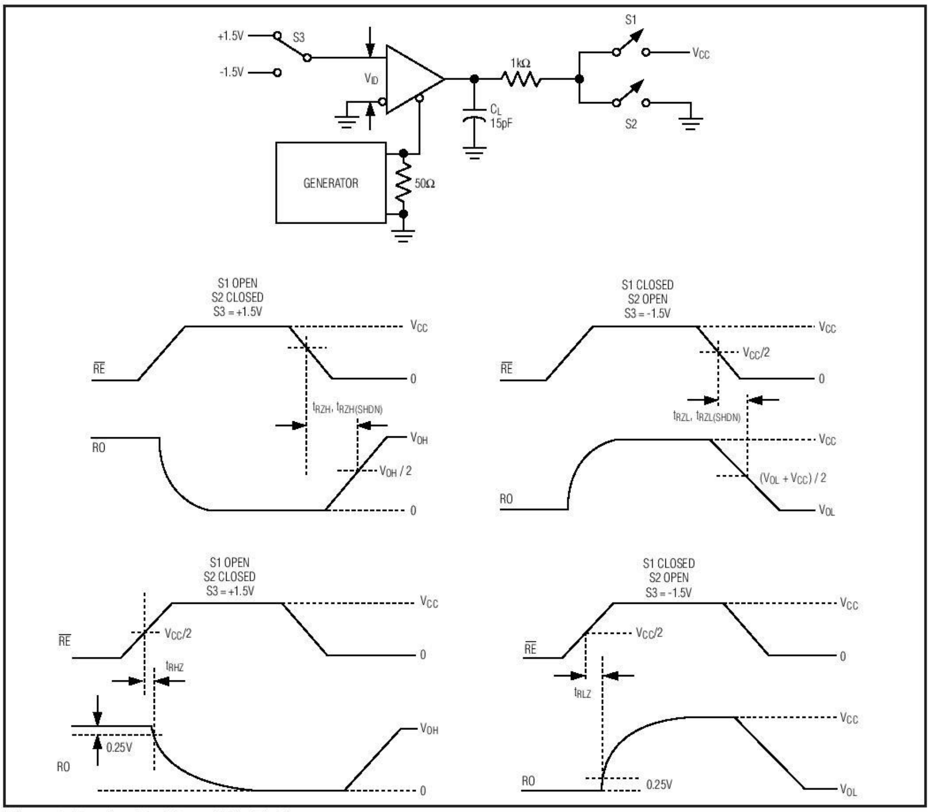


Figure 8. Receiver Enable and Disable Times

Pin Description

PIN					NAME	FUNCTION
MAX13080E MAX13083E MAX13086E	MAX13081E MAX13084E MAX13087E	MAX13082E MAX13088E	MAX13089E			
FULL-DUPLEX DEVICES		HALF-DUPLEX DEVICES	FULL-DUPLEX MODE	HALF-DUPLEX MODE		
1, 8, 13	—	—	—	—	N.C.	No Connect. Not internally connected, can be connected to GND.
—	—	—	1	1	H/$\overline{F}$	Half-/Full-Duplex Select Input. Connect H/$\overline{F}$ to V_{CC} for half-duplex mode; connect H/$\overline{F}$ to GND or leave unconnected for full-duplex mode.
2	2	1	2	2	RO	Receiver Output. When $\overline{RE}$ is low and if (A - B) ≥ -50mV, RO is high; if (A - B) ≤ -200mV, RO is low.
3	—	2	3	3	$\overline{RE}$	Receiver Output Enable. Drive $\overline{RE}$ low to enable RO; RO is high impedance when $\overline{RE}$ is high. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. $\overline{RE}$ is a hot-swap input (see the *Hot-Swap Capability* section for details).
4	—	3	4	4	DE	Driver Output Enable. Drive DE high to enable driver outputs. These outputs are high impedance when DE is low. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. DE is a hot-swap input (see the *Hot-Swap Capability* section for details).
5	3	4	5	5	DI	Driver Input. With DE high, a low on DI forces noninverting output low and inverting output high. Similarly, a high on DI forces noninverting output high and inverting output low.
—	—	—	6	6	SRL	Slew-Rate Limit Selector Input. Connect SRL to ground for 16Mbps communication rate; connect SRL to V_{CC} for 500kbps communication rate. Leave SRL unconnected for 250kbps communication rate.
6, 7	4	5	7	7	GND	Ground
—	—	—	8	8	TXP	Transmitter Phase. Connect TXP to ground or leave TXP unconnected for normal transmitter phase/polarity. Connect TXP to V_{CC} to invert the transmitter phase/polarity.
9	5	—	9	—	Y	Noninverting Driver Output
—	—	—	—	9	Y	Noninverting Driver Output and Noninverting Receiver Input*
10	6	—	10	—	Z	Inverting Driver Output
—	—	—	—	10	Z	Inverting Driver Output and Inverting Receiver Input*
11	7	—	11	—	B	Inverting Receiver Input
—	—	—	—	11	B	Receiver Input Resistors*
—	—	7	—	—	B	Inverting Receiver Input and Inverting Driver Output

Pin Description (continued)

PIN					NAME	FUNCTION
MAX13080E MAX13083E MAX13086E	MAX13081E MAX13084E MAX13087E	MAX13082E MAX13088E	MAX13089E			
FULL-DUPLEX DEVICES		HALF-DUPLEX DEVICES	FULL-DUPLEX MODE	HALF-DUPLEX MODE		
12	8	—	12	—	A	Noninverting Receiver Input
—	—	—	—	12	A	Receiver Input Resistors*
—	—	6	—	—	A	Noninverting Receiver Input and Noninverting Driver Output
—	—	—	13	13	RXP	Receiver Phase. Connect RXP to GND or leave RXP unconnected for normal transmitter phase/polarity. Connect RXP to V_{CC} to invert receiver phase/polarity.
14	1	8	14	14	V_{CC}	Positive Supply V_{CC} = +5.0V ±10%. Bypass V_{CC} to GND with a 0.1μF capacitor.

**MAX13089E only. In half-duplex mode, the driver outputs serve as receiver inputs. The full-duplex receiver inputs (A and B) still have a 1/8-unit load (96kΩ), but are not connected to the receiver.*

Function Tables

MAX13080E/MAX13083E/MAX13086E

TRANSMITTING				
INPUTS			OUTPUTS	
$\overline{RE}$	DE	DI	Z	Y
X	1	1	0	1
X	1	0	1	0
0	0	X	High-Z	High-Z
1	0	X	Shutdown	

RECEIVING			
INPUTS			OUTPUT
$\overline{RE}$	DE	A, B	RO
0	X	≥ -50mV	1
0	X	≤ -200mV	0
0	X	Open/ shorted	1
1	1	X	High-Z
1	0	X	Shutdown

MAX13081E/MAX13084E/MAX13086E/ MAX13087E

TRANSMITTING		
INPUT	OUTPUTS	
DI	Z	Y
1	0	1
0	1	0

RECEIVING	
INPUTS	OUTPUT
A, B	RO
≥ -50mV	1
≤ -200mV	0
Open/shorted	1

Function Tables (continued)

MAX13082E/MAX13088E

TRANSMITTING				
INPUTS			OUTPUTS	
$\overline{RE}$	DE	DI	B/Z	A/Y
X	1	1	0	1
X	1	0	1	0
0	0	X	High-Z	High-Z
1	0	X	Shutdown	

RECEIVING			
INPUTS			OUTPUTS
$\overline{RE}$	DE	A-B	RO
0	X	≥ -50mV	1
0	X	≤ -200mV	0
0	X	Open/ shorted	1
1	1	X	High-Z
1	0	X	Shutdown

MAX13089E

TRANSMITTING					
INPUTS				OUTPUTS	
TXP	$\overline{RE}$	DE	DI	Z	Y
0	X	1	1	0	1
0	X	1	0	1	0
1	X	1	1	1	0
1	X	1	0	0	1
X	0	0	X	High-Z	High-Z
X	1	0	X	Shutdown	

RECEIVING						
INPUTS						OUTPUTS
$H/\overline{F}$	RXP	$\overline{RE}$	DE	A, B	Y, Z	RO
0	0	0	X	> -50mV	X	1
0	0	0	X	< -200mV	X	0
0	1	0	X	> -50mV	X	0
0	1	0	X	< -200mV	X	1
1	0	0	0	X	> -50mV	1
1	0	0	0	X	< -200mV	0
1	1	0	0	X	> -50mV	0
1	1	0	0	X	< -200mV	1
0	0	0	X	Open/shorted	X	1
1	0	0	0	X	Open/shorted	1
0	1	0	X	Open/shorted	X	0
1	1	0	0	X	Open/shorted	0
X	X	1	1	X	X	High-Z
X	X	1	0	X	X	Shutdown

X = Don't care; shutdown mode, driver, and receiver outputs are high impedance.

Detailed Description

The MAX13080E–MAX13089E high-speed transceivers for RS-485/RS-422 communication contain one driver and one receiver. These devices feature fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted, or when they are connected to a terminated transmission line with all drivers disabled (see the *Fail-Safe* section). The MAX13080E/MAX13082E/MAX13083E/MAX13086E/MAX13088E/MAX13089E also feature a hot-swap capability allowing line insertion without erroneous data transfer (see the *Hot Swap Capability* section). The MAX13080E/MAX13081E/MAX13082E feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-free data transmission up to 250kbps. The MAX13083E/MAX13084E also offer slew-rate limits allowing transmit speeds up to 500kbps. The MAX13086E/MAX13087E/MAX13088Es' driver slew rates are not limited, making transmit speeds up to 16Mbps possible. The MAX13089E's slew rate is selectable between 250kbps, 500kbps, and 16Mbps by driving a selector pin with a three-state driver.

The MAX13082E/MAX13088E are half-duplex transceivers, while the MAX13080E/MAX13081E/ MAX13083E/MAX13084E/MAX13086E/MAX13087E are full-duplex transceivers. The MAX13089E is selectable between half- and full-duplex communication by driving a selector pin ($\text{H}/\overline{\text{F}}$) high or low, respectively.

All devices operate from a single +5.0V supply. Drivers are output short-circuit current limited. Thermal-shutdown circuitry protects drivers against excessive power dissipation. When activated, the thermal-shutdown circuitry places the driver outputs into a high-impedance state.

Receiver Input Filtering

The receivers of the MAX13080E–MAX13084E, and the MAX13089E when operating in 250kbps or 500kbps mode, incorporate input filtering in addition to input hysteresis. This filtering enhances noise immunity with differential signals that have very slow rise and fall times. Receiver propagation delay increases by 25% due to this filtering.

Fail-Safe

The MAX13080E family guarantees a logic-high receiver output when the receiver inputs are shorted or open, or when they are connected to a terminated transmission line with all drivers disabled. This is done by setting the receiver input threshold between -50mV and -200mV. If the differential receiver input voltage (A - B) is greater than or equal to -50mV, RO is logic-high. If (A - B) is less than or equal to -200mV, RO is logic-low. In the case of a terminated bus with all transmitters disabled, the receiver's differential input voltage is pulled to 0V by the termination. With the receiver thresholds of the MAX13080E family, this results in a logic-high with a 50mV minimum noise margin. Unlike previous fail-safe devices, the -50mV to -200mV threshold complies with the ±200mV EIA/TIA-485 standard.

Hot-Swap Capability (Except MAX13081E/MAX13084E/MAX13087E)

Hot-Swap Inputs

When circuit boards are inserted into a hot or powered backplane, differential disturbances to the data bus can lead to data errors. Upon initial circuit board insertion, the data communication processor undergoes its own power-up sequence. During this period, the processor's logic-output drivers are high impedance and are unable to drive the DE and $\overline{\text{RE}}$ inputs of these devices to a defined logic level. Leakage currents up to ±10µA from the high-impedance state of the processor's logic drivers could cause standard CMOS enable inputs of a transceiver to drift to an incorrect logic level. Additionally, parasitic circuit board capacitance could cause coupling of V_{CC} or GND to the enable inputs. Without the hot-swap capability, these factors could improperly enable the transceiver's driver or receiver.

When V_{CC} rises, an internal pulldown circuit holds DE low and $\overline{\text{RE}}$ high. After the initial power-up sequence, the pulldown circuit becomes transparent, resetting the hot-swap tolerable input.

Hot-Swap Input Circuitry

The enable inputs feature hot-swap capability. At the input there are two NMOS devices, M1 and M2 (Figure 9). When V_{CC} ramps from zero, an internal 7µs timer turns on M2 and sets the SR latch, which also turns on M1. Transistors M2, a 500µA current sink, and M1, a 100µA current sink, pull DE to GND through a 5kΩ resistor. M2 is designed to pull DE to the disabled state against an external parasitic capacitance up to 100pF that can drive DE high. After 7µs, the timer deactivates M2 while M1 remains on, holding DE low against three-state leakages that can drive DE high. M1 remains on until an external source overcomes the required input current. At this time, the SR latch resets and M1 turns off. When M1 turns off, DE reverts to a standard, high-impedance CMOS input. Whenever V_{CC} drops below 1V, the hot-swap input is reset.

For $\overline{\text{RE}}$ there is a complementary circuit employing two PMOS devices pulling $\overline{\text{RE}}$ to V_{CC}.

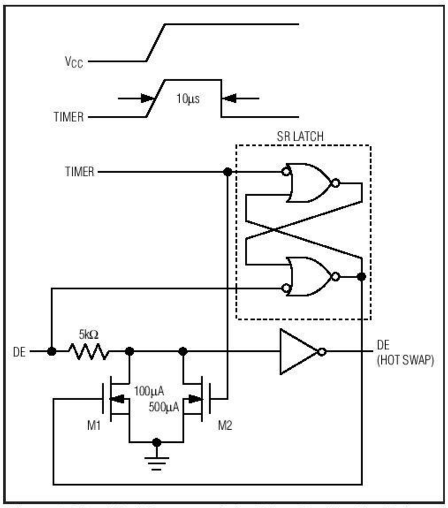


Figure 9. Simplified Structure of the Driver Enable Pin (DE)

MAX13089E Programming

The MAX13089E has several programmable operating modes. Transmitter rise and fall times are programmable, resulting in maximum data rates of 250kbps, 500kbps, and 16Mbps. To select the desired data rate, drive SRL to one of three possible states by using a three-state driver: V_{CC}, GND, or unconnected. For 250kbps operation, set the three-state device in high-impedance mode or leave SRL unconnected. For 500kbps operation, drive SRL high or connect it to V_{CC}. For 16Mbps operation, drive SRL low or connect it to GND. SRL can be changed during operation without interrupting data communications.

Occasionally, twisted-pair lines are connected backward from normal orientation. The MAX13089E has two pins that invert the phase of the driver and the receiver to correct this problem. For normal operation, drive TXP and RXP low, connect them to ground, or leave them unconnected (internal pulldown). To invert the driver phase, drive TXP high or connect it to V_{CC}. To invert the receiver phase, drive RXP high or connect it to V_{CC}. Note that the receiver threshold is positive when RXP is high.

The MAX13089E can operate in full- or half-duplex mode. Drive H/$\overline{\text{F}}$ low, leave it unconnected (internal pulldown), or connect it to GND for full-duplex operation. Drive H/$\overline{\text{F}}$ high for half-duplex operation. In full-duplex mode, the pin configuration of the driver and receiver is the same as that of a MAX13080E. In half-duplex mode, the receiver inputs are internally connected to the driver outputs through a resistor-divider. This effectively changes the function of the device's outputs. Y becomes the noninverting driver output and receiver input, Z becomes the inverting driver output and receiver input. In half-duplex mode, A and B are still connected to ground through an internal resistor-divider but they are not internally connected to the receiver.

±15kV ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs of the MAX13080E family of devices have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures to protect these pins against ESD of ±15kV without damage. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. After an ESD event, the MAX13080E family keep working without latchup or damage.

ESD protection can be tested in various ways. The transmitter outputs and receiver inputs of the MAX13080E family are characterized for protection to the following limits:

- ±15kV using the Human Body Model
- ±6kV using the Contact Discharge method specified in IEC 61000-4-2

ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test setup, test methodology, and test results.

Human Body Model

Figure 10a shows the Human Body Model, and Figure 10b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The MAX13080E family of devices helps you design equipment to meet IEC 61000-4-2, without the need for additional ESD-protection components.

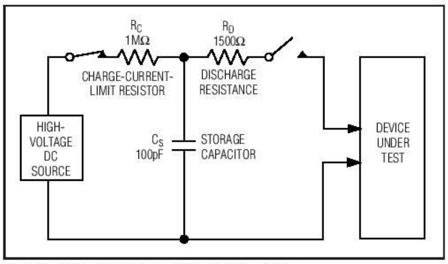


Figure 10a. Human Body ESD Test Model

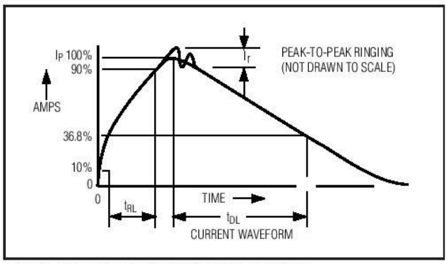


Figure 10b. Human Body Current Waveform

The major difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2 because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the Human Body Model. Figure 10c shows the IEC 61000-4-2 model, and Figure 10d shows the current waveform for IEC 61000-4-2 ESD Contact Discharge test.

Machine Model

The machine model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. The objective is to emulate the stress caused when I/O pins are contacted by handling equipment during test and assembly. Of course, all pins require this protection, not just RS-485 inputs and outputs.

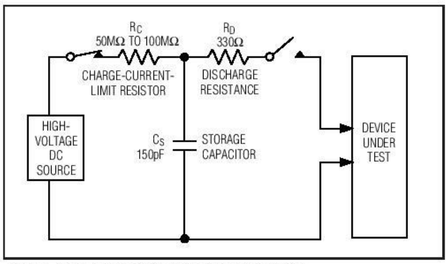


Figure 10c. IEC 61000-4-2 ESD Test Model

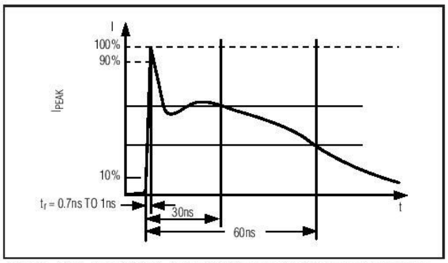


Figure 10d. IEC 61000-4-2 ESD Generator Current Waveform

Applications Information

256 Transceivers on the Bus

The standard RS-485 receiver input impedance is 12kΩ (1-unit load), and the standard driver can drive up to 32-unit loads. The MAX13080E family of transceivers has a 1/8-unit load receiver input impedance (96kΩ), allowing up to 256 transceivers to be connected in parallel on one communication line. Any combination of these devices, as well as other RS-485 transceivers with a total of 32-unit loads or fewer, can be connected to the line.

Reduced EMI and Reflections

The MAX13080E/MAX13081E/MAX13082E feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-free data transmission up to 250kbps. The MAX13083E/MAX13084E offer higher driver output slew-rate limits, allowing transmit speeds up to 500kbps. The MAX13089E with SRL = V_{CC} or unconnected are slew-rate limited. With SRL unconnected, the MAX13089E error-free data transmission is up to 250kbps. With SRL connected to V_{CC}, the data transmit speeds up to 500kbps.

Low-Power Shutdown Mode (Except MAX13081E/MAX13084E/MAX13087E)

Low-power shutdown mode is initiated by bringing both $\overline{RE}$ high and DE low. In shutdown, the devices typically draw only 2.8µA of supply current.

$\overline{RE}$ and DE can be driven simultaneously; the devices are guaranteed not to enter shutdown if $\overline{RE}$ is high and DE is low for less than 50ns. If the inputs are in this state for at least 700ns, the devices are guaranteed to enter shutdown.

Enable times t_{ZH} and t_{ZL} (see the *Switching Characteristics* section) assume the devices were not in a low-power shutdown state. Enable times $t_{ZH(SHDN)}$ and $t_{ZL(SHDN)}$ assume the devices were in shutdown state. It takes drivers and receivers longer to become enabled from low-power shutdown mode ($t_{ZH(SHDN)}$, $t_{ZL(SHDN)}$) than from driver/receiver-disable mode (t_{ZH}, t_{ZL}).

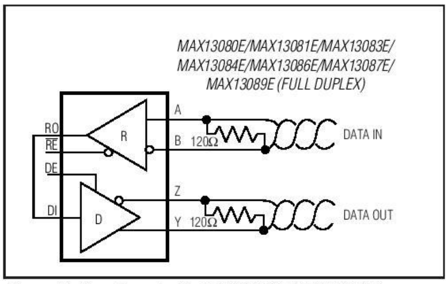


Figure 11. Line Repeater for MAX13080E/MAX13081E/MAX13083E/MAX13084E/MAX13086E/MAX13087E/MAX13089E in Full-Duplex Mode

Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus contention. The first, a foldback current limit on the output stage, provides immediate protection against short circuits over the whole common-mode voltage range (see the *Typical Operating Characteristics*). The second, a thermal-shutdown circuit, forces the driver outputs into a high-impedance state if the die temperature exceeds +175°C (typ).

Line Length

The RS-485/RS-422 standard covers line lengths up to 4000ft. For line lengths greater than 4000ft, use the repeater application shown in Figure 11.

Typical Applications

The MAX13082E/MAX13088E/MAX13089E transceivers are designed for bidirectional data communications on multipoint bus transmission lines. Figures 12 and 13 show typical network applications circuits.

To minimize reflections, terminate the line at both ends in its characteristic impedance, and keep stub lengths off the main line as short as possible. The slew-rate-limited MAX13082E and the two modes of the MAX13089E are more tolerant of imperfect termination.

Chip Information

PROCESS: BiCMOS

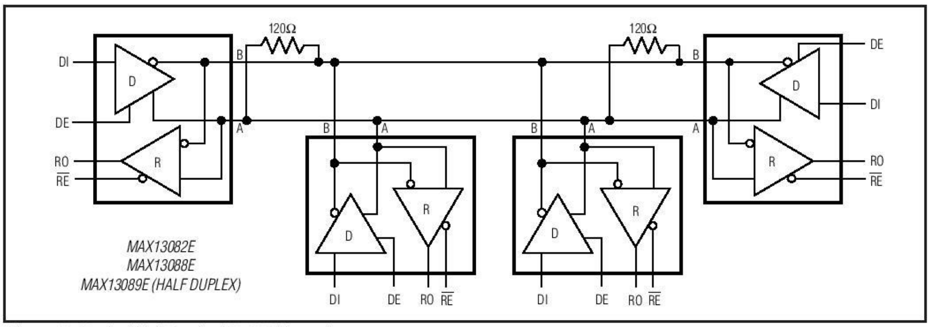
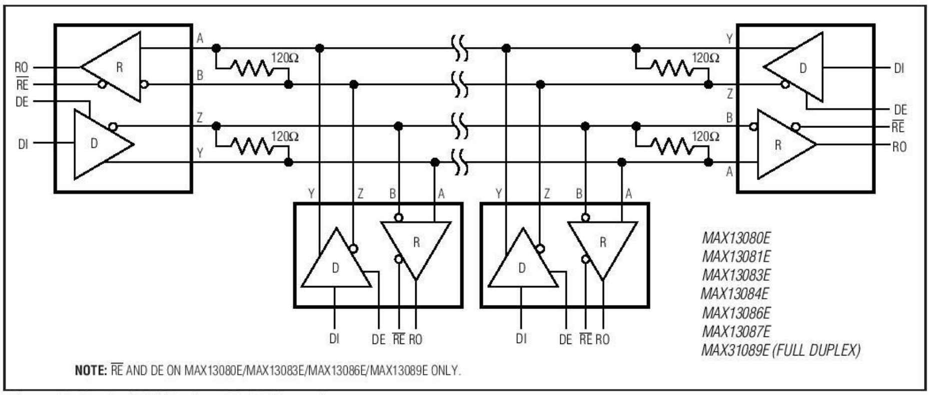


Figure 12. Typical Half-Duplex RS-485 Network



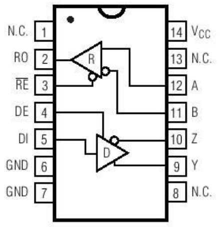
NOTE: $\overline{RE}$ AND DE ON MAX13080E/MAX13083E/MAX13086E/MAX13089E ONLY.

Figure 13. Typical Full-Duplex RS-485 Network

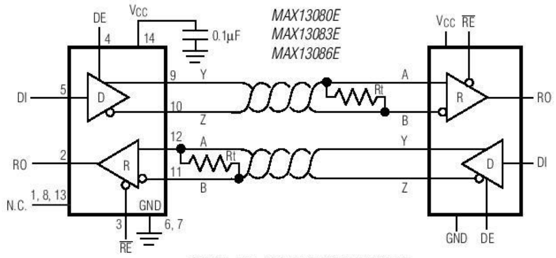
Selector Guide

PART	HALF/FULL DUPLEX	DATA RATE (Mbps)	SLEW-RATE LIMITED	LOW-POWER SHUTDOWN	RECEIVER/ DRIVER ENABLE	TRANSCEIVERS ON BUS	PINS
MAX13080E	Full	0.250	Yes	Yes	Yes	256	14
MAX13081E	Full	0.250	Yes	No	No	256	8
MAX13082E	Half	0.250	Yes	Yes	Yes	256	8
MAX13083E	Full	0.5	Yes	Yes	Yes	256	14
MAX13084E	Full	0.5	Yes	No	No	256	8
MAX13086E	Full	16	No	Yes	Yes	256	14
MAX13087E	Full	16	No	No	No	256	8
MAX13088E	Half	16	No	Yes	Yes	256	8
MAX13089E	Selectable	Selectable	Selectable	Yes	Yes	256	14

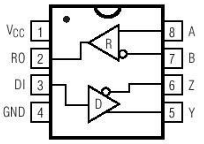
Pin Configurations and Typical Operating Circuits



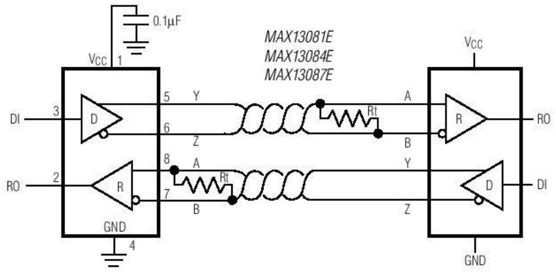
DIP/SO



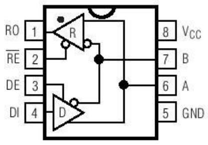
TYPICAL FULL-DUPLEX OPERATING CIRCUIT



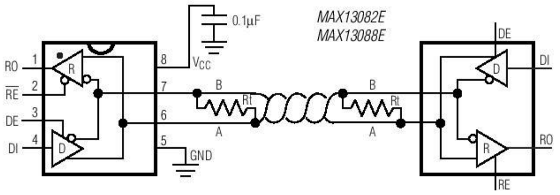
DIP/SO



TYPICAL FULL-DUPLEX OPERATING CIRCUIT



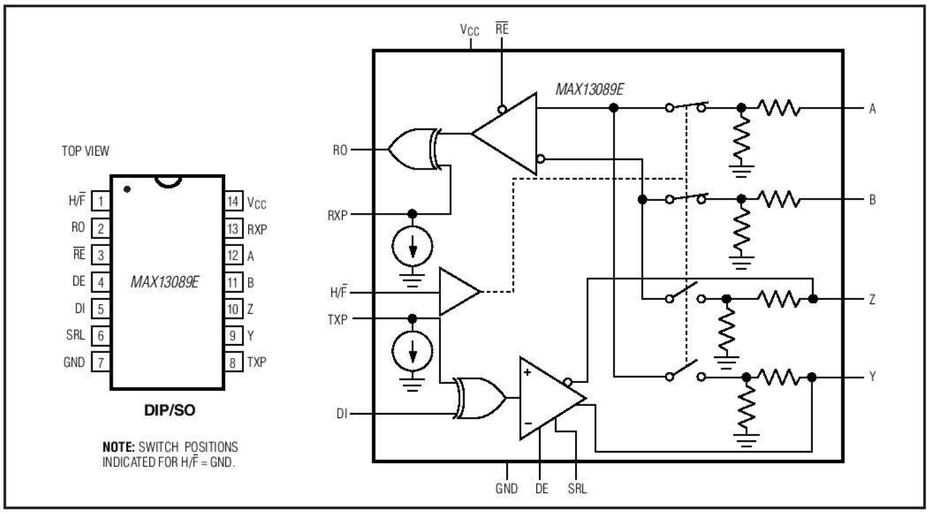
DIP/SO



TYPICAL HALF-DUPLEX OPERATING CIRCUIT

NOTE: PIN LABELS Y AND Z ON TIMING, TEST, AND WAVEFORMS DIAGRAMS.
SEE PINS A AND B WHEN DE IS HIGH.

Pin Configurations and Typical Operating Circuits (continued)



NOTE: SWITCH POSITIONS INDICATED FOR H/$\overline{F}$ = GND.

Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE
MAX13081ECPA+	0°C to +70°C	8 PDIP
MAX13081ECSA+	0°C to +70°C	8 SO
MAX13081EEPA+	-40°C to +85°C	8 PDIP
MAX13081EESA+	-40°C to +85°C	8 SO
MAX13081EAPA+	-40°C to +125°C	8 PDIP
MAX13081EASA+	-40°C to +125°C	8 SO
MAX13082ECPA+	0°C to +70°C	8 PDIP
MAX13082ECSA+	0°C to +70°C	8 SO
MAX13082EEPA+	-40°C to +85°C	8 PDIP
MAX13082EESA+	-40°C to +85°C	8 SO
MAX13082EAPA+	-40°C to +125°C	8 PDIP
MAX13082EASA+	-40°C to +125°C	8 SO
MAX13083ECPD+	0°C to +70°C	14 PDIP
MAX13083ECSD+	0°C to +70°C	14 SO
MAX13083EEPD+	-40°C to +85°C	14 PDIP
MAX13083EESD+	-40°C to +85°C	14 SO
MAX13083EAPD+	-40°C to +125°C	14 PDIP
MAX13083EASD+	-40°C to +125°C	14 SO
MAX13084ECPA+	0°C to +70°C	8 PDIP
MAX13084ECSA+	0°C to +70°C	8 SO
MAX13084EEPA+	-40°C to +85°C	8 PDIP
MAX13084EESA+	-40°C to +85°C	8 SO
MAX13084EAPA+	-40°C to +125°C	8 PDIP
MAX13084EASA+	-40°C to +125°C	8 SO
MAX13086ECPD+	0°C to +70°C	14 PDIP
MAX13086ECSD+	0°C to +70°C	14 SO
MAX13086EEPD+	-40°C to +85°C	14 PDIP
MAX13086EESD+	-40°C to +85°C	14 SO
MAX13086EAPD+	-40°C to +125°C	14 PDIP
MAX13086EASD+	-40°C to +125°C	14 SO
MAX13087ECPA+	0°C to +70°C	8 PDIP
MAX13087ECSA+	0°C to +70°C	8 SO
MAX13087EEPA+	-40°C to +85°C	8 PDIP
MAX13087EESA+	-40°C to +85°C	8 SO
MAX13087EAPA+	-40°C to +125°C	8 PDIP
MAX13087EASA+	-40°C to +125°C	8 SO
MAX13088ECPA+	0°C to +70°C	8 PDIP
MAX13088ECSA+	0°C to +70°C	8 SO
MAX13088EEPA+	-40°C to +85°C	8 PDIP
MAX13088EESA+	-40°C to +85°C	8 SO
MAX13088EAPA+	-40°C to +125°C	8 PDIP
MAX13088EASA+	-40°C to +125°C	8 SO
MAX13089ECPD+	0°C to +70°C	14 PDIP
MAX13089ECSD+	0°C to +70°C	14 SO
MAX13089EEPD+	-40°C to +85°C	14 PDIP
MAX13089EESD+	-40°C to +85°C	14 SO
MAX13089EAPD+	-40°C to +125°C	14 PDIP
MAX13089EASD+	-40°C to +125°C	14 SO

+Denotes a lead(Pb)-free/RoHS-compliant package.

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
8 PDIP	P8+2	21-0043	—
8 SO	S8+4	21-0041	90-0096
14 PDIP	P14+3	21-0043	—
14 SO	S14+1	21-0041	90-0112

MAX13080E–MAX13084E/ MAX13086E–MAX13089E

+5.0V, ±15kV ESD-Protected, Fail-Safe, Hot-Swap, RS-485/RS-422 Transceivers

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
2	11/11	Deleted all reference to the MAX13085E	1, 2, 3, 5, 12. 13, 14, 15, 16, 17, 18, 19, 20, 22

Φύλλα δεδομένων REG1117

Burr-Brown Products
from Texas Instruments

REG1117
REG1117A

SBVS001D – OCTOBER 1992 – REVISED JULY 2004

800mA and 1A Low Dropout Positive Regulator 1.8V, 2.5V, 2.85, 3.3V, 5V, and Adjustable

FEATURES

- FIXED AND ADJUSTABLE VERSIONS
- 2.85V MODEL FOR SCSI-2 ACTIVE TERMINATION
- OUTPUT CURRENT:
  REG1117: 800mA max
  REG1117A: 1A max
- OUTPUT TOLERANCE: ±1% max
- DROPOUT VOLTAGE:
  REG1117: 1.2V max at I_O = 800mA
  REG1117A: 1.3V max at I_O = 1A
- INTERNAL CURRENT LIMIT
- THERMAL OVERLOAD PROTECTION
- SOT-223 AND DDPAK SURFACE-MOUNT PACKAGES

APPLICATIONS

- SCSI-2 ACTIVE TERMINATION
- HAND-HELD DATA COLLECTION DEVICES
- HIGH EFFICIENCY LINEAR REGULATORS
- BATTERY-POWERED INSTRUMENTATION
- BATTERY MANAGEMENT CIRCUITS FOR NOTEBOOK AND PALMTOP PCs
- CORE VOLTAGE SUPPLY: FPGA, PLD, DSP, CPU

DESCRIPTION

The REG1117 is a family of easy-to-use three-terminal voltage regulators. The family includes a variety of fixed- and adjustable-voltage versions, two currents (800mA and 1A) and two package types (SOT-223 and DDPAK). See the chart below for available options.

Output voltage of the adjustable versions is set with two external resistors. The REG1117 low dropout voltage allows its use with as little as 1V input-output voltage differential.

Laser trimming assures excellent output voltage accuracy without adjustment. An NPN output stage allows output stage drive to contribute to the load current for maximum efficiency.

	800mA		1A	
VOLTAGE	SOT-223	DDPAK	SOT-223	DDPAK
1.8V			✓	✓
2.5V			✓	✓
2.85V	✓			
3.3V	✓	✓		
5V	✓			✓
Adjustable	✓		✓	✓

TEXAS INSTRUMENTS
www.ti.com

ABSOLUTE MAXIMUM RATINGS(1)

Power Dissipation	Internally Limited
Input Voltage	+15V
Operating Junction Temperature Range	–40°C to +125°C
Storage Temperature Range	–65°C to +150°C
Lead Temperature (soldering, 10s)(2)	+300°C

(1) Stresses above these ratings may cause permanent damage.

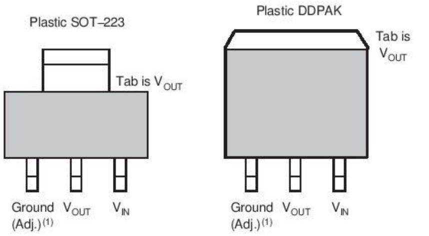
(2) See *Soldering Methods* section.

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

CONNECTION DIAGRAM

Front View



NOTE: (1) Adjustable–Voltage Model.

PACKAGE/ORDERING INFORMATION(1)

PRODUCT	V_O/I_O	PACKAGE-LEAD	PACKAGE DESIGNATOR	OPERATING TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
REG1117-2.85	2.85/800mA	SOT223-3	DCY	–40°C to +125°C	BB11172	REG1117-2.85	Rails, 80
						REG1117-2.85	Tape and Reel, 2500
REG1117-3.3	3.3/800mA	SOT223-3	DCY	–40°C to +125°C	BB11174	REG1117-3.3	Rails, 80
						REG1117-3.3	Tape and Reel, 2500
REG1117F-3.3	3.3/800mA	DDPAK-3	KTT	–40°C to +125°C	BB1117F4	REG1117F-3.3KTTT	Tape and Reel, 50
						REG1117F-3.3/500	Tape and Reel, 500
REG1117-5	5V/800mA	SOT223-3	DCY	–40°C to +125°C	BB11175	REG1117-5	Rails, 80
						REG1117-5	Tape and Reel, 2500
REG1117	Adj./800mA	SOT223-3	DCY	–40°C to +125°C	BB1117	REG1117	Rails, 80
						REG1117	Tape and Reel, 2500
REG1117A-1.8	1.8V/1A	SOT223-3	DCY	–40°C to +125°C	R111718	REG1117A-1.8	Rails, 80
						REG1117A-1.8	Tape and Reel, 2500
REG1117FA-1.8	1.8/1A	DDPAK-3	KTT	–40°C to +125°C	REG1117FA1.8	REG1117FA-1.8KTTT	Tape and Reel, 50
						REG1117FA-1.8/500	Tape and Reel, 500
REG1117A-2.5	2.5/1A	SOT223-3	DCY	–40°C to +125°C	R111725	REG1117A-2.5	Rails, 80
						REG1117A-2.5	Tape and Reel, 2500
REG1117FA-2.5	2.5/1A	DDPAK-3	KTT	–40°C to +125°C	REG1117FA2.5	REG1117FA-2.5KTTT	Tape and Reel, 50
						REG1117FA-2.5/500	Tape and Reel, 500
REG1117FA-5	5/1A	DDPAK-3	KTT	–40°C to +125°C	BB1117FA5.0	REG1117FA-5/KTTT	Tape and Reel, 50
						REG1117FA-5/500	Tape and Reel, 500
REG1117A	Adj./1A	SOT223-3	DCY	–40°C to +125°C	BB1117A	REG1117A	Rails, 80
						REG1117A	Tape and Reel, 2500
REG1117FA	Adj./1A	DDPAK-3	KTT	–40°C to +125°C	REG1117FA	REG1117FA/KTTT	Tape and Reel, 50
						REG1117FA/500	Tape and Reel, 500

(1) For the most current package and ordering information, see the Package Option Addendum located at the end of this data sheet.

ELECTRICAL CHARACTERISTICS

At T_J = +25°C, unless otherwise noted.

PARAMETER	CONDITION	REG1117, REG1117A MIN	TYP	MAX	UNIT
OUTPUT VOLTAGE					
REG1117-2.85	I_O = 10mA, V_{IN} = 4.85V	2.820	2.85	2.880	V
See Note 1	I_O = 0 to 800mA, V_{IN} = 4.05V to 10V	2.790	2.85	2.910	V
REG1117-3.3	I_O = 10mA, V_{IN} = 5.3V	3.270	3.30	3.330	V
See Note 1	I_O = 0 to 800mA, V_{IN} = 4.8V to 10V	3.240	3.30	3.360	V
REG1117-5	I_O = 10mA, V_{IN} = 7V	4.950	5.00	5.050	V
See Note 1	I_O = 0 to 800mA, V_{IN} = 6.5V to 10V	4.900	5.00	5.100	V
REG1117A-1.8	I_O = 10mA, V_{IN} = 3.8V	1.782	1.8	1.818	V
See Note 1	I_O = 0 to 1A, V_{IN} = 3.8V to 10V	1.764	1.8	1.836	V
REG1117A-2.5	I_O = 10mA, V_{IN} = 4.5V	2.475	2.5	2.525	V
See Note 1	I_O = 0 to 1A, V_{IN} = 4.5V to 10V	2.450	2.5	2.550	V
REG1117A-5	I_O = 10mA, V_{IN} = 7V	4.950	5.0	5.050	V
See Note 1	I_O = 0 to 1A, V_{IN} = 7V to 10V	4.900	5.0	5.100	V
REFERENCE VOLTAGE					
REG1117 (Adjustable)	I_O = 10mA, $V_{IN} - V_O$ = 2V	1.238	1.250	1.262	V
See Note 1	I_O = 10 to 800mA, $V_{IN} - V_O$ = 1.4 to 10V	1.225	1.250	1.280	V
REG1117A (Adjustable)	I_O = 10mA, $V_{IN} - V_O$ = 2V	1.238	1.250	1.262	V
See Note 1	I_O = 10mA to 1A, $V_{IN} - V_O$ = 1.4 to 10V	1.225	1.250	1.280	V
LINE REGULATION					
REG1117-2.85(1)	I_O = 0, V_{IN} = 4.25 to 10V		1	7	mV
REG1117-3.3(1)	I_O = 0, V_{IN} = 4.8 to 10V		2	7	mV
REG1117-5(1)	I_O = 0, V_{IN} = 6.5 to 15V		3	10	mV
REG1117 (Adjustable)(1)	I_O = 10mA, $V_{IN} - V_O$ = 1.5 to 13.75V		0.1	0.4	%
REG1117A (Adjustable)(1)	I_O = 10mA, $V_{IN} - V_O$ = 1.5 to 13.75V		0.1	0.4	%
REG1117A-1.8(1)	I_O = 0, V_{IN} = 3.8V to 10V		1	7	mV
REG1117A-2.5(1)	I_O = 0, V_{IN} = 4.5V to 10V		1	7	mV
REG1117A-5.0(1)	I_O = 0, V_{IN} = 7V to 15V		3	10	mV
LOAD REGULATION					
REG1117-2.85(1)	I_O = 0 to 800mA, V_{IN} = 4.25V		2	10	mV
REG1117-3.3(1)	I_O = 0 to 800mA, V_{IN} = 4.8V		3	12	mV
REG1117-5(1)	I_O = 0 to 800mA, V_{IN} = 6.5V		3	15	mV
REG1117 (Adjustable)(1)(2)	I_O = 10 to 800mA, $V_{IN} - V_O$ = 3V		0.1	0.4	%
REG1117A (Adjustable)(1)(2)	I_O = 10mA to 1A, $V_{IN} - V_O$ = 3V		0.1	0.4	%
REG1117A-1.8(1)	I_O = 0 to 1A, V_{IN} = 3.8V		2	10	mV
REG1117A-2.5	I_O = 0 to 1A, V_{IN} = 4.5V		2	10	mV
REG1117A-5	I_O = 0 to 1A, V_{IN} = 7.0V		3	15	mV
DROPOUT VOLTAGE(3)					
All Models(1)	I_O = 100mA		1.00	1.10	V
See Note 1	I_O = 500mA		1.05	1.15	V
REG1117 Models(1)	I_O = 800mA		1.10	1.20	V
REG1117A	I_O = 1A		1.2	1.30	V
See Note 1	I_O = 1A		1.2	1.55	V

(1) Specification applies over the full specified junction temperature range, 0°C to +125°C.
(2) REG1117 and REG1117A adjustable versions require a minimum load current for ±3% regulation.
(3) Dropout voltage is the input voltage minus output voltage that produces a 1% decrease in output voltage.
(4) Percentage change in unloaded output voltage before versus after a 30ms power pulse of I_O = 800mA (REG1117 models), I_O = 1A (REG1117A), $V_{IN} - V_O$ = 1.4V (reading taken 10ms after pulse).

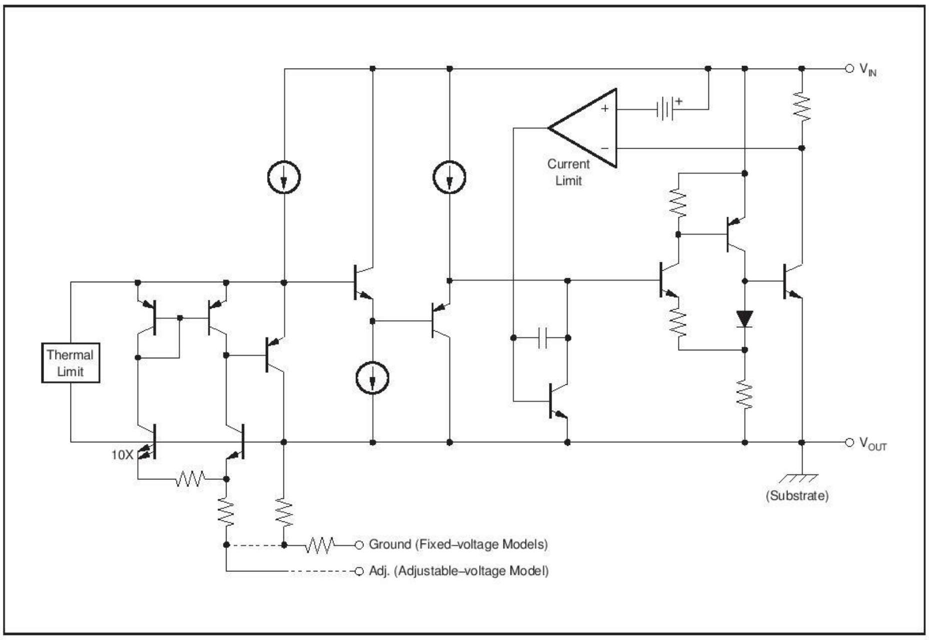
ELECTRICAL CHARACTERISTICS (continued)

At T_J = +25°C, unless otherwise noted.

		REG1117, REG1117A			
PARAMETER	**CONDITION**	**MIN**	**TYP**	**MAX**	**UNIT**
CURRENT LIMIT					
REG1117 Models	$V_{IN} - V_O = 5V$	800	950	1200	mA
REG1117A	$V_{IN} - V_O = 5V$	1000	1250	1600	mA
MINIMUM LOAD CURRENT					
Adjustable Models(1)(2)	$V_{IN} - V_O = 13.75V$		1.7	5	mA
QUIESCENT CURRENT					
Fixed-Voltage Models(1)	$V_{IN} - V_O = 5V$		4	10	mA
ADJUSTABLE PIN CURRENT(1)(2)	$I_O = 10mA$, $V_{IN} - V_O = 1.4$ to 10V		50	120	µA
vs Load Current, REG1117(1)	$I_O = 10mA$ to 800mA, $V_{IN} - V_O = 1.4$ to 10V		0.5	5	µA
vs Load Current, REG1117A(1)	$I_O = 10mA$ to 1A, $V_{IN} - V_O = 1.4$ to 10V		0.5	5	µA
THERMAL REGULATION					
All Models(4)	30ms Pulse		0.01	0.1	%/W
RIPPLE REJECTION					
All Models	f = 120Hz, $V_{IN} - V_{OUT} = 3V + 1V_{PP}$ Ripple		62		dB
TEMPERATURE DRIFT					
Fixed-Voltage Models	T_J = 0°C to +125°C		0.5		%
Adjustable Models	T_J = 0°C to +125°C		2		%
LONG-TERM STABILITY					
All Models	T_A = 125°C, 1000Hr		0.3		%
OUTPUT NOISE					
rms Noise, All Models	f = 10Hz to 10kHz		0.003		%
THERMAL RESISTANCE					
Thermal Resistance, θ_{JC}	(Junction-to-Case at Tab)				
3-Lead SOT-223 Surface-Mount			15		°C/W
3-Lead DDPAK Surface-Mount	f > 50Hz		2		°C/W
	dc		3		°C/W
Thermal Resistance, θ_{JA}	(Junction-to-Case at Tab)				
3-Lead DDPAK Surface-Mount	No Heatsink		65		°C/W

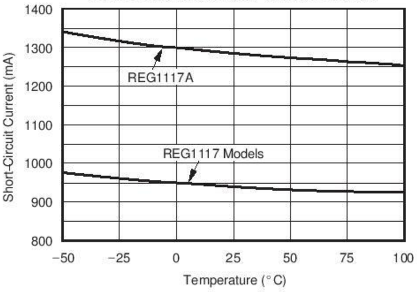
(1) Specification applies over the full specified junction temperature range, 0°C to +125°C.
(2) REG1117 and REG1117A adjustable versions require a minimum load current for ±3% regulation.
(3) Dropout voltage is the input voltage minus output voltage that produces a 1% decrease in output voltage.
(4) Percentage change in unloaded output voltage before versus after a 30ms power pulse of I_O = 800mA (REG1117 models), I_O = 1A (REG1117A), $V_{IN} - V_O$ = 1.4V (reading taken 10ms after pulse).

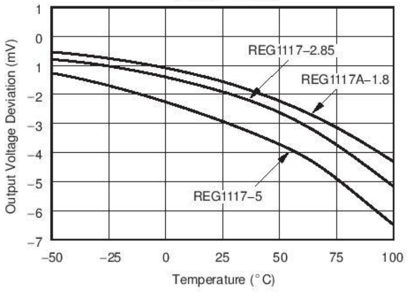
SIMPLIFIED SCHEMATIC

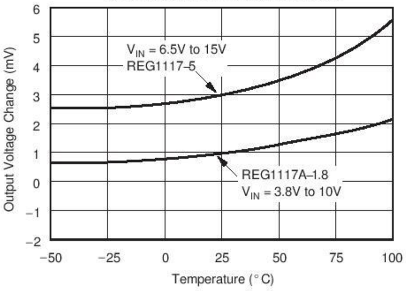


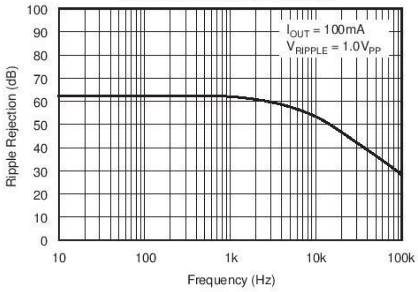
TYPICAL CHARACTERISTICS

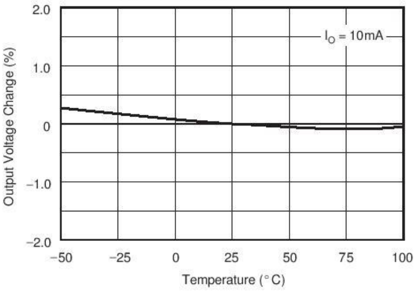
At $T_A = +25°C$, all models, unless otherwise noted.

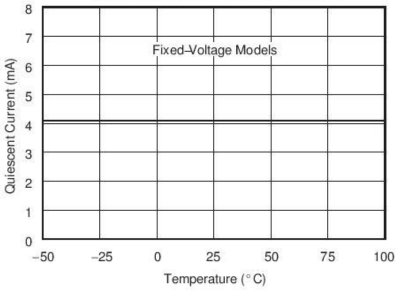

SHORT–CIRCUIT CURRENT vs TEMPERATURE


LOAD REGULATION
(ΔI_{LOAD} = 800mA)


LINE REGULATION vs TEMPERATURE

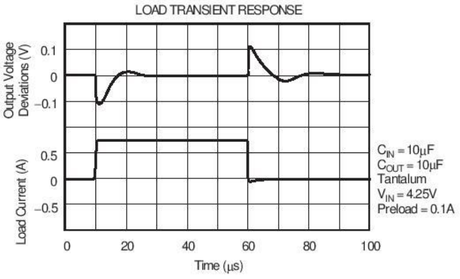

RIPPLE REJECTION vs FREQUENCY

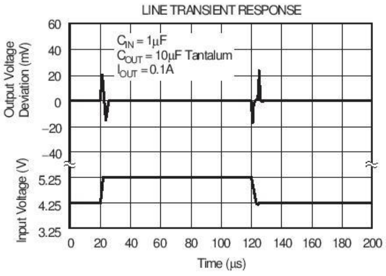

OUTPUT VOLTAGE vs TEMPERATURE


QUIESCENT CURRENT vs TEMPERATURE

TYPICAL CHARACTERISTICS (continued)

At $T_A = +25°C$, all models, unless otherwise noted.





APPLICATIONS INFORMATION

Figure 1 shows the basic hookup diagram for fixed-voltage models. All models require an output capacitor for proper operation, and for improving high-frequency load regulation; a 10µF tantalum capacitor is recommended. Aluminum electrolytic types of 50µF or greater can also be used. A high-quality capacitor should be used to assure that the ESR (Effective Series Resistance) is less than 0.5Ω.

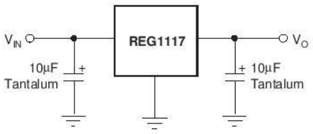


Figure 1. Fixed-Voltage Model—Basic Connections

Figure 2 shows a hookup diagram for the adjustable voltage model. Resistor values are shown for some commonly-used output voltages. Values for other voltages can be calculated from the equation shown in Figure 2. For best load regulation, connect R_1 close to the output pin and R_2 close to the ground side of the load as shown.

THERMAL CONSIDERATIONS

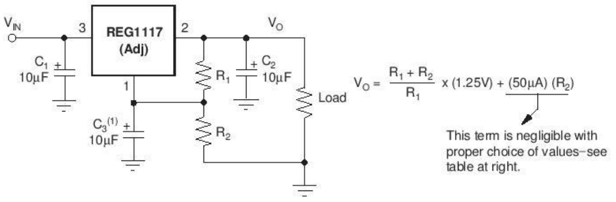
The REG1117 has current limit and thermal shutdown circuits that protect it from overload. The thermal shutdown activates at approximately T_J = 165°C. For continuous operation, however, the junction temperature should not be allowed to exceed 125°C. Any tendency to activate the thermal shutdown in normal use is an indication of an inadequate heat sink or excessive power dissipation. The power dissipation is equal to:

$$P_D = (V_{IN} - V_{OUT})\ I_{OUT}$$

The junction temperature can be calculated by:

$$T_J = T_A + P_D\ (\theta_{JA})$$

where T_A is the ambient temperature, and θ_{JA} is the junction-to-ambient thermal resistance.



$$V_O = \frac{R_1 + R_2}{R_1} \times (1.25V) + \underbrace{(50\mu A)\ (R_2)}$$

This term is negligible with proper choice of values–see table at right.

V_{OUT} (V)	R_1 (Ω)^(2)	R_2 (Ω)^(2)
1.25	Open	Short
1.5	750	147
2.1	158	107
2.85	169	215
3	137	191
3.3	115	187
5	113	340
10	113	787

NOTES: (1) C_3 optional. Improves high-frequency line rejection. (2) Resistors are standard 1% values.

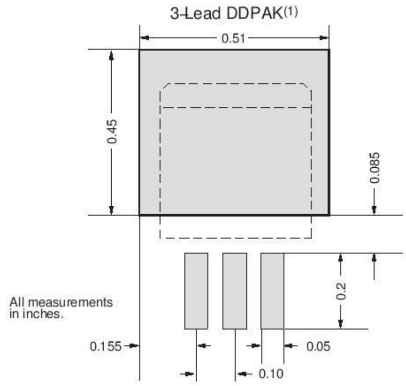
Figure 2. Adjustable-Voltage Model—Basic Connections

A simple experiment will determine whether the maximum recommended junction temperature is exceeded in an actual circuit board and mounting configuration: Increase the ambient temperature above that expected in normal operation until the device's thermal shutdown is activated. If this occurs at more than 40°C above the maximum expected ambient temperature, then T_J will be less than 125°C during normal operation.

The internal protection circuitry of the REG1117 was designed to protect against overload conditions. It was not intended to replace proper heat sinking. Continuously running the REG1117 into thermal shutdown will degrade reliability.

LAYOUT CONSIDERATIONS

The DDPAK (REG1117F-3.3 and REG1117FA) is a surface-mount power package that has excellent thermal characteristics. For best thermal performance, the mounting tab should be soldered directly to a circuit board copper area, as shown in Figure 3. Increasing the copper area improves heat dissipation. Figure 4 shows typical thermal resistance from junction-to-ambient as a function of the copper area.



NOTE: (1) For improved thermal performance increase footprint area. See Figure 4 (*Thermal Resistance vs Circuit Board Copper Area*).

Figure 3. DDPAK Footprint

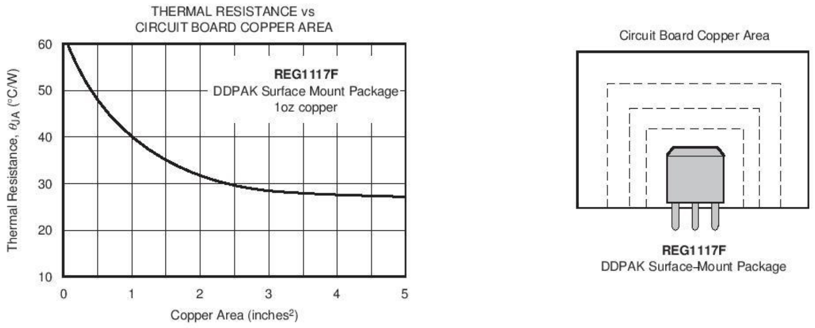


Figure 4. DDPAK Thermal Resistance versus Circuit Board Copper Area

The SOT-223 package derives heat sinking from conduction through its copper leads, especially the large mounting tab. These must be soldered to a circuit board with a substantial amount of copper remaining, as shown in Figure 5. Circuit board traces connecting the tab and the leads should be made as large as practical. The mounting tab of both packages is electrically connected to V_{OUT}.

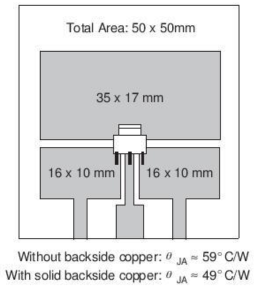


Figure 5. SOT-223 Circuit Board Layout Example

Other nearby circuit traces, including those on the back side of the circuit board, help conduct heat away from the device, even though they may not be electrically connected. Make all nearby copper traces as wide as possible and leave only narrow gaps between traces.

Table 1 shows approximate values of θ_{JA} for various circuit board and copper areas for the SOT-223 package. Nearby heat dissipating components, circuit board mounting conditions, and ventilation can dramatically affect the actual θ_{JA}. Proper heat sinking significantly increases the maximum power dissipation at a given ambient temperature, as shown in Figure 6.

Table 1. SOT-223 θ_{JA} for Various Board Configurations

TOTAL PC BOARD AREA	TOPSIDE[(1)] COPPER AREA	BACKSIDE COPPER AREA	SOT-223 THERMAL RESISTANCE JUNCTION-TO-AMBIENT
2500mm²	2500mm²	2500mm²	46°C/W
2500mm²	1250mm²	2500mm²	47°C/W
2500mm²	950mm²	2500mm²	49°C/W
2500mm²	2500mm²	0	51°C/W
2500mm²	1800mm²	0	53°C/W
1600mm²	600mm²	1600mm²	55°C/W
2500mm²	1250mm²	0	58°C/W
2500mm²	915mm²	0	59°C/W
1600mm²	600mm²	0	67°C/W
900mm²	340mm²	900mm²	72°C/W
900mm²	340mm²	0	85°C/W

(1) Tab is attached to the topside copper.

SOLDERING METHODS

Both REG1117 packages are suitable for infrared reflow and vapor-phase reflow soldering techniques. The high rate of temperature change that occurs with wave soldering or hand soldering can damage the REG1117.

INSPEC Abstract Number: B91007604, C91012627. Kelly, E.G. “Thermal Characteristics of Surface 5WK9Ω Packages.” The Proceedings of SMTCON. Surface Mount Technology Conference and Exposition: Competitive Surface Mount Technology, April 3–6, 1990, Atlantic City, NJ, USA. Abstract Publisher: IC Manage, 1990, Chicago, IL, USA.

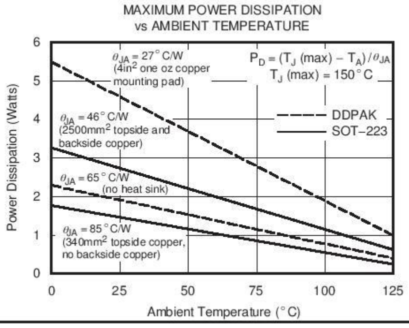


Figure 6. Maximum Power Dissipation versus Ambient Temperature

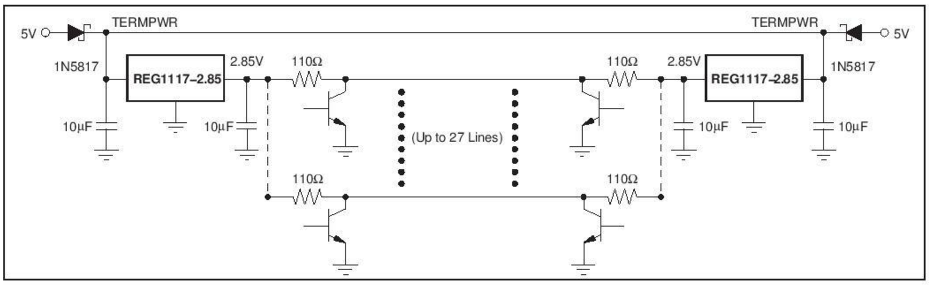


Figure 7. SCSI Active Termination Configuration

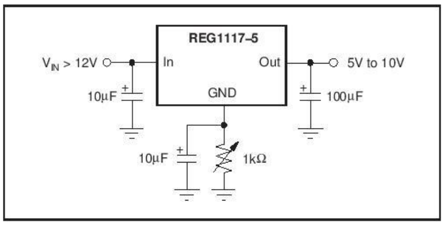


Figure 8. Adjusting Output of Fixed Voltage Models

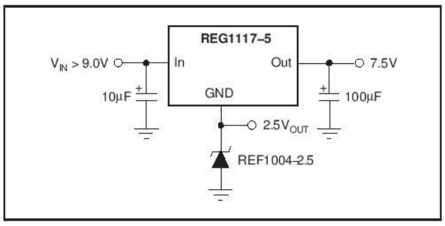


Figure 9. Regulator with Reference

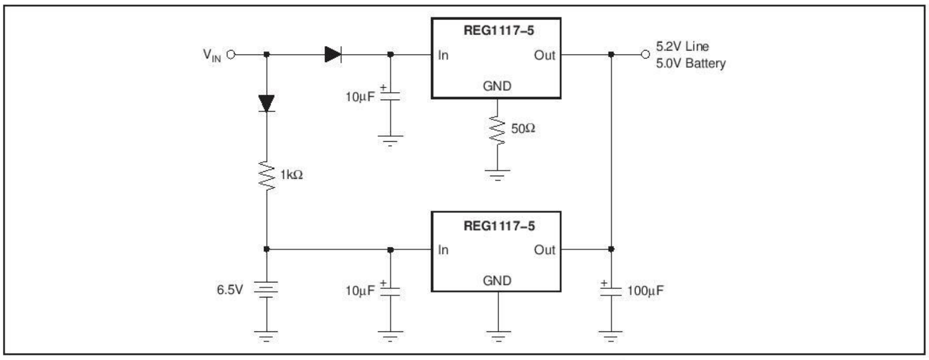


Figure 10. Battery Backed-Up Regulated Supply

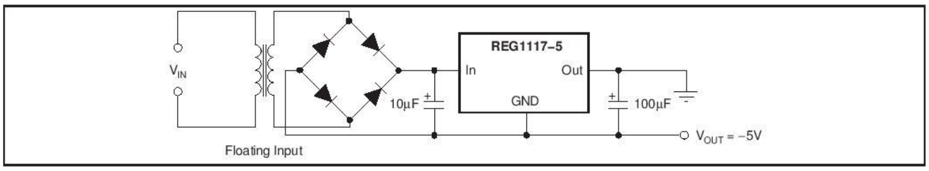


Figure 11. Low Dropout Negative Supply

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REG1117	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB1117	Samples
REG1117-2.85	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11172	Samples
REG1117-2.85/2K5	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11172	Samples
REG1117-2.85G4	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11172	Samples
REG1117-3.3	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11174	Samples
REG1117-3.3/2K5	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11174	Samples
REG1117-3.3/2K5G4	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11174	Samples
REG1117-3.3G4	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11174	Samples
REG1117-5	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11175	Samples
REG1117-5/2K5	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11175	Samples
REG1117-5G4	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB11175	Samples
REG1117/2K5	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB1117	Samples
REG1117/2K5G4	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB1117	Samples
REG1117A	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB1117A	Samples
REG1117A-1.8	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	R111718	Samples
REG1117A-1.8/2K5	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	R111718	Samples
REG1117A-1.8G4	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	R111718	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
REG1117A-2.5	ACTIVE	SOT-223	DCY	4	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	R111725	Samples
REG1117A-2.5/2K5	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	R111725	Samples
REG1117A/2K5	ACTIVE	SOT-223	DCY	4	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	BB1117A	Samples
REG1117F-3.3/500	ACTIVE	DDPAK/ TO-263	KTT	3	500	Green (RoHS & no Sb/Br)	CU SN | Call TI	Level-2-260C-1 YEAR	-40 to 125	REG1117F4	Samples
REG1117F33KTTTG3	OBSOLETE	DDPAK/ TO-263	KTT	3		TBD	Call TI	Call TI	0 to 0	REG1117F4	
REG1117FA-1.8KTTT	ACTIVE	DDPAK/ TO-263	KTT	3	50	Green (RoHS & no Sb/Br)	CU SN | Call TI	Level-2-260C-1 YEAR	-40 to 125	REG 1117FA1.8	Samples
REG1117FA-2.5/500	ACTIVE	DDPAK/ TO-263	KTT	3	500	Green (RoHS & no Sb/Br)	CU SN | Call TI	Level-2-260C-1 YEAR	-40 to 125	REG 1117FA2.5	Samples
REG1117FA-5.0/500	ACTIVE	DDPAK/ TO-263	KTT	3	500	Green (RoHS & no Sb/Br)	CU SN | Call TI	Level-2-260C-1 YEAR	-40 to 125	REG 1117FA5.0	Samples
REG1117FA/500	ACTIVE	DDPAK/ TO-263	KTT	3	500	Green (RoHS & no Sb/Br)	CU SN | Call TI	Level-2-260C-1 YEAR	-40 to 125	REG1117FA	Samples
REG1117FA1.8KTTTG3	ACTIVE	DDPAK/ TO-263	KTT	3	50	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	-40 to 125	REG 1117FA1.8	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

[4] There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

[5] Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

[6] Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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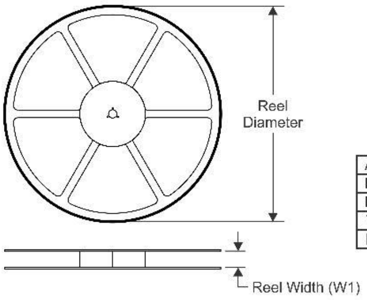
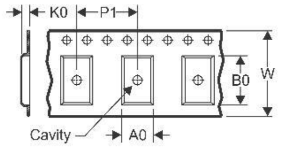
TAPE AND REEL INFORMATION

REEL DIMENSIONS

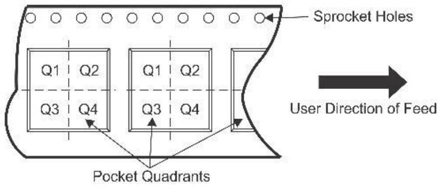


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

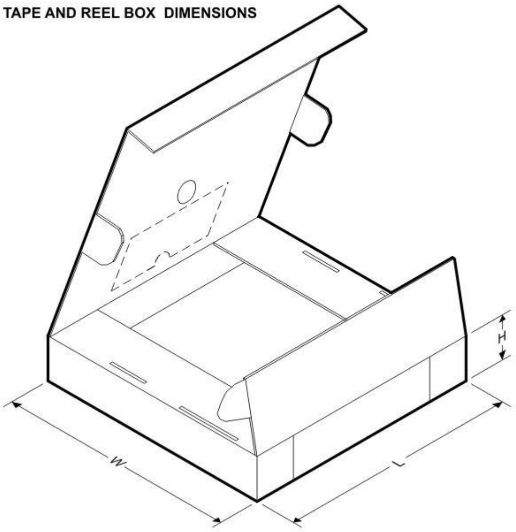
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
REG1117-2.85/2K5	SOT-223	DCY	4	2500	330.0	12.4	7.1	7.45	1.88	8.0	12.0	Q3
REG1117-3.3/2K5	SOT-223	DCY	4	2500	330.0	12.4	7.1	7.45	1.88	8.0	12.0	Q3
REG1117-5/2K5	SOT-223	DCY	4	2500	330.0	12.4	7.1	7.45	1.88	8.0	12.0	Q3
REG1117/2K5	SOT-223	DCY	4	2500	330.0	12.4	7.1	7.45	1.88	8.0	12.0	Q3
REG1117A-1.8/2K5	SOT-223	DCY	4	2500	330.0	12.4	7.1	7.45	1.88	8.0	12.0	Q3
REG1117A-2.5/2K5	SOT-223	DCY	4	2500	330.0	12.4	7.1	7.45	1.88	8.0	12.0	Q3
REG1117A/2K5	SOT-223	DCY	4	2500	330.0	12.4	7.1	7.45	1.88	8.0	12.0	Q3
REG1117F-3.3/500	DDPAK/ TO-263	KTT	3	500	330.0	24.4	10.6	15.6	4.9	16.0	24.0	Q2
REG1117FA-1.8KTTT	DDPAK/ TO-263	KTT	3	50	330.0	24.4	10.6	15.6	4.9	16.0	24.0	Q2
REG1117FA-2.5/500	DDPAK/ TO-263	KTT	3	500	330.0	24.4	10.6	15.6	4.9	16.0	24.0	Q2
REG1117FA-5.0/500	DDPAK/ TO-263	KTT	3	500	330.0	24.4	10.6	15.6	4.9	16.0	24.0	Q2
REG1117FA/500	DDPAK/ TO-263	KTT	3	500	330.0	24.4	10.6	15.6	4.9	16.0	24.0	Q2

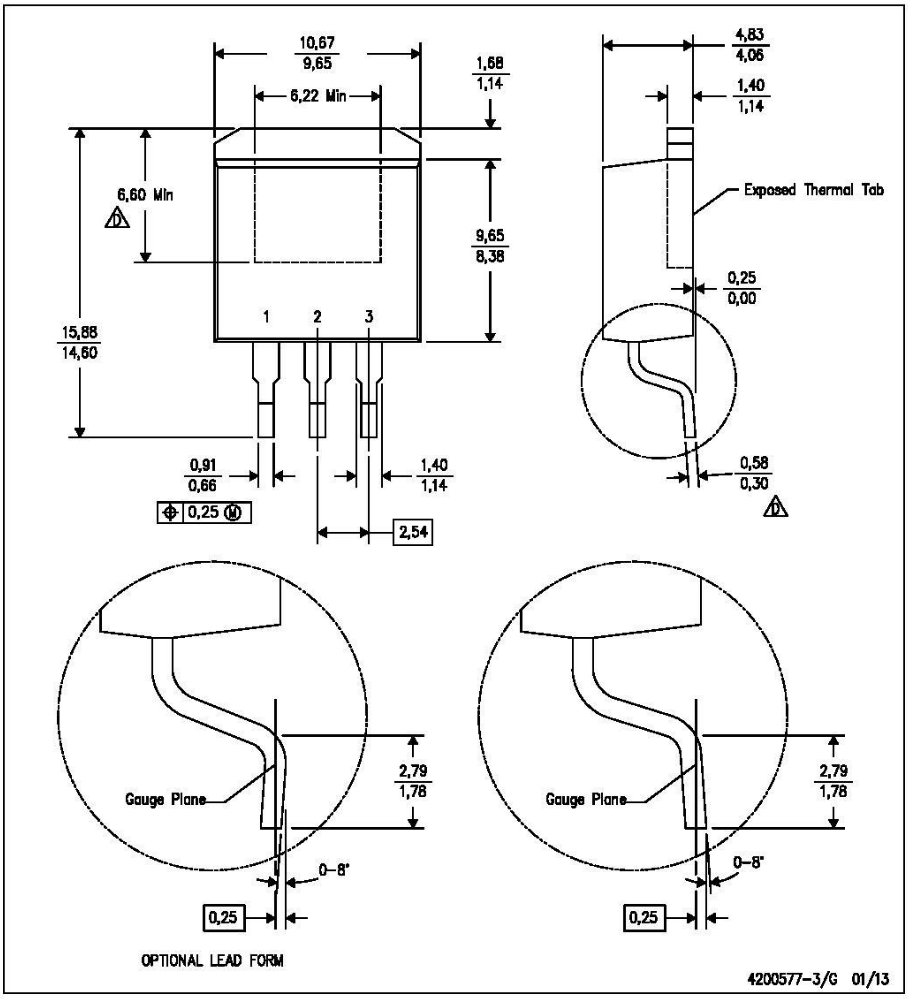
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

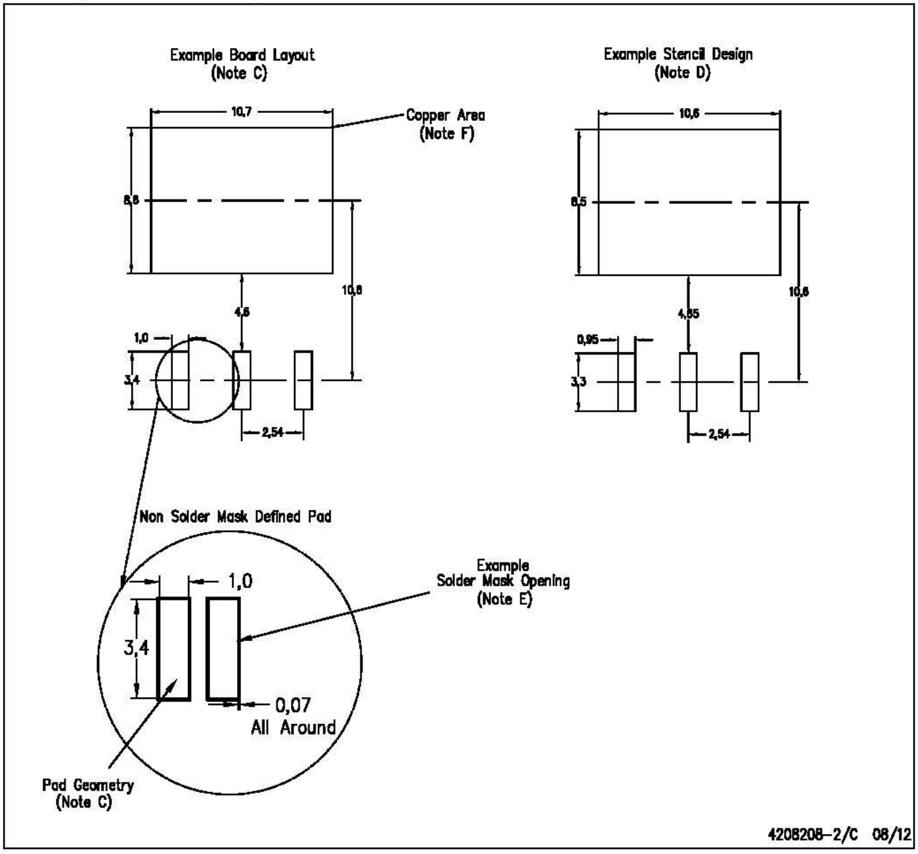
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
REG1117-2.85/2K5	SOT-223	DCY	4	2500	358.0	335.0	35.0
REG1117-3.3/2K5	SOT-223	DCY	4	2500	358.0	335.0	35.0
REG1117-5/2K5	SOT-223	DCY	4	2500	358.0	335.0	35.0
REG1117/2K5	SOT-223	DCY	4	2500	358.0	335.0	35.0
REG1117A-1.8/2K5	SOT-223	DCY	4	2500	358.0	335.0	35.0
REG1117A-2.5/2K5	SOT-223	DCY	4	2500	358.0	335.0	35.0
REG1117A/2K5	SOT-223	DCY	4	2500	358.0	335.0	35.0
REG1117F-3.3/500	DDPAK/TO-263	KTT	3	500	367.0	367.0	45.0
REG1117FA-1.8KTTT	DDPAK/TO-263	KTT	3	50	367.0	367.0	45.0
REG1117FA-2.5/500	DDPAK/TO-263	KTT	3	500	367.0	367.0	45.0
REG1117FA-5.0/500	DDPAK/TO-263	KTT	3	500	367.0	367.0	45.0
REG1117FA/500	DDPAK/TO-263	KTT	3	500	367.0	367.0	45.0

KTT (R–PSFM–G3) PLASTIC FLANGE–MOUNT PACKAGE



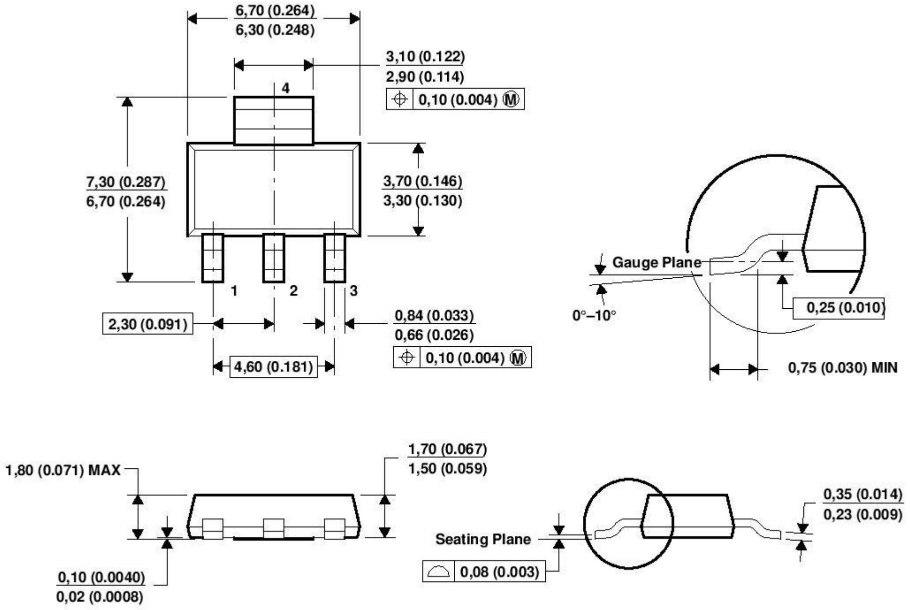
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
D Falls within JEDEC TO–263 variation AA, except minimum lead thickness and minimum exposed pad length.

KTT (R-PSFM-G3) PLASTIC FLANGE-MOUNT PACKAGE



NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-SM-782 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
- F. This package is designed to be soldered to a thermal pad on the board. Refer to the Product Datasheet for specific thermal information, via requirements, and recommended thermal pad size. For thermal pad sizes larger than shown a solder mask defined pad is recommended in order to maintain the solderable pad geometry while increasing copper area.

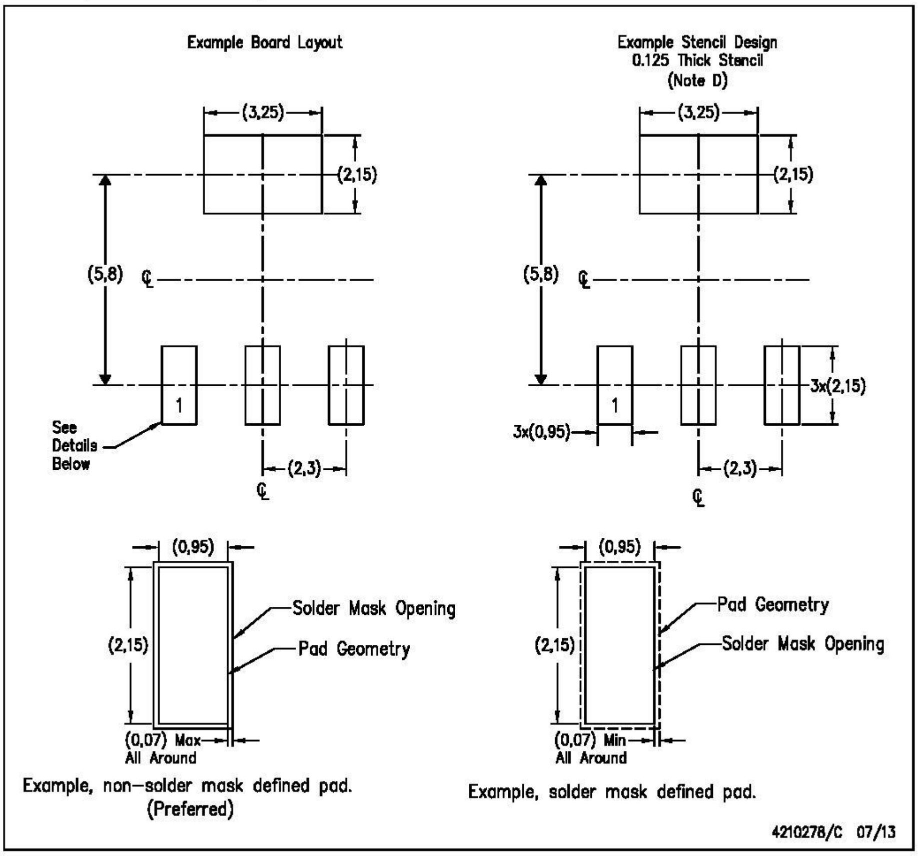
DCY (R-PDSO-G4) PLASTIC SMALL-OUTLINE



4202506/B 06/2002

NOTES:
- A. All linear dimensions are in millimeters (inches).
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion.
- D. Falls within JEDEC TO-261 Variation AA.

DCY (R–PDSO–G4) PLASTIC SMALL OUTLINE



NOTES:

A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil recommendations. Refer to IPC 7525 for stencil design considerations.

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Φύλλα δεδομένων SN74AS08

SN54ALS08, SN54AS08, SN74ALS08, SN74AS08
QUADRUPLE 2-INPUT POSITIVE-AND GATES

SDAS191A – APRIL 1982 – REVISED DECEMBER 1994

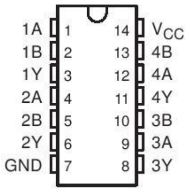
- **Package Options Include Plastic Small-Outline (D) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) 300-mil DIPs**

description

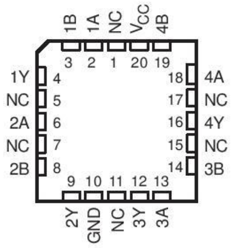
These devices contain four independent 2-input positive-AND gates. They perform the Boolean functions $Y = A \bullet B$ or $Y = \overline{\overline{A} + \overline{B}}$ in positive logic.

The SN54ALS08 and SN54AS08 are characterized for operation over the full military temperature range of −55°C to 125°C. The SN74ALS08 and SN74AS08 are characterized for operation from 0°C to 70°C.

SN54ALS08, SN54AS08 . . . J PACKAGE
SN74ALS08, SN74AS08 . . . D OR N PACKAGE
(TOP VIEW)



SN54ALS08, SN54AS08 . . . FK PACKAGE
(TOP VIEW)

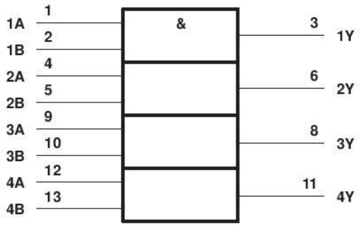


NC – No internal connection

FUNCTION TABLE
(each gate)

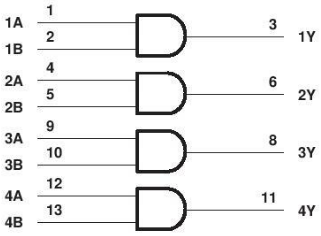
INPUTS		OUTPUT
A	B	Y
H	H	H
L	X	L
X	L	L

logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for the D, J, and N packages.

logic diagram (positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

Supply voltage, V_{CC} . . . . 7 V
Input voltage, V_I . . . . 7 V
Operating free-air temperature range, T_A: SN54ALS08 . . . . –55°C to 125°C
SN74ALS08 . . . . 0°C to 70°C
Storage temperature range . . . . –65°C to 150°C

[†] Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

		SN54ALS08			SN74ALS08			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8[‡]			0.8	V
				0.7[§]				
I_{OH}	High-level output current			–0.4			–0.4	mA
I_{OL}	Low-level output current			4			8	mA
T_A	Operating free-air temperature	–55		125	0		70	°C

[‡] Applies over temperature range –55°C to 70°C
[§] Applies over temperature range 70°C to 125°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN54ALS08			SN74ALS08			UNIT
			MIN	TYP[¶]	MAX	MIN	TYP[¶]	MAX	
V_{IK}	V_{CC} = 4.5 V,	I_I = –18 mA			–1.5			–1.5	V
V_{OH}	V_{CC} = 4.5 V to 5.5 V,	I_{OH} = –0.4 mA	V_{CC} –2			V_{CC} –2			V
V_{OL}	V_{CC} = 4.5 V	I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
		I_{OL} = 8 mA					0.35	0.5	
I_I	V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
I_{IH}	V_{CC} = 5.5 V,	V_I = 2.7 V			20			20	µA
I_{IL}	V_{CC} = 5.5 V,	V_I = 0.4 V			–0.1			–0.1	mA
I_O[#]	V_{CC} = 5.5 V,	V_O = 2.25 V	–20		–112	–30		–112	mA
I_{CCH}	V_{CC} = 5.5 V,	V_I = 4.5 V		1.3	2.4		1.3	2.4	mA
I_{CCL}	V_{CC} = 5.5 V,	V_I = 0		2.2	4		2.2	4	mA

[¶] All typical values are at V_{CC} = 5 V, T_A = 25°C.
[#] The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX†				UNIT
			SN54ALS08		SN74ALS08		
			MIN	MAX	MIN	MAX	
t_{PLH}	A or B	Y	2	14	4	14	ns
t_{PHL}			2	12.5	3	10	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)‡

Supply voltage, V_{CC} . . . . 7 V
Input voltage, V_I . . . . 7 V
Operating free-air temperature range, T_A: SN54AS08 . . . . –55°C to 125°C
SN74AS08 . . . . 0°C to 70°C
Storage temperature range . . . . –65°C to 150°C

‡ Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

		SN54AS08			SN74AS08			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			–2			–2	mA
I_{OL}	Low-level output current			20			20	mA
T_A	Operating free-air temperature	–55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN54AS08			SN74AS08			UNIT
			MIN	TYP§	MAX	MIN	TYP§	MAX	
V_{IK}	V_{CC} = 4.5 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}	V_{CC} = 4.5 V to 5.5 V,	I_{OH} = – 2 mA	V_{CC} – 2			V_{CC} – 2			V
V_{OL}	V_{CC} = 4.5 V,	I_{OL} = 20 mA		0.35	0.5		0.35	0.5	V
I_I	V_{CC} = 5.5 V,	V_I = 7 V			0.1			0.1	mA
I_{IH}	V_{CC} = 5.5 V,	V_I = 2.7 V			20			20	µA
I_{IL}	V_{CC} = 5.5 V,	V_I = 0.4 V			– 0.5			– 0.5	mA
I_O¶	V_{CC} = 5.5 V,	V_O = 2.25 V	–30		–112	–30		–112	mA
I_{CCH}	V_{CC} = 5.5 V,	V_I = 4.5 V		5.8	9.3		5.8	9.3	mA
I_{CCL}	V_{CC} = 5.5 V,	V_I = 0		14.9	24		14.9	24	mA

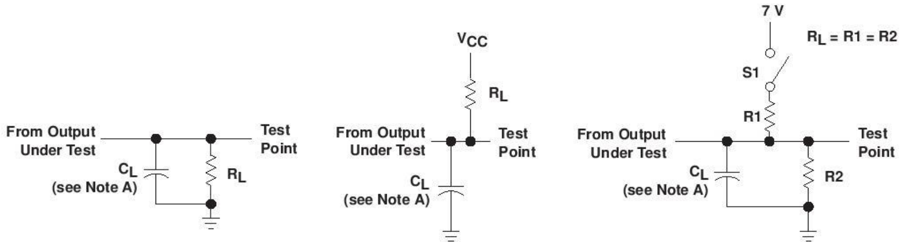
§ All typical values are at V_{CC} = 5 V, T_A = 25°C.
¶ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS}.

switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX†				UNIT
			SN54AS08		SN74AS08		
			MIN	MAX	MIN	MAX	
t_{PLH}	A or B	Y	1	6.5	1	5.5	ns
t_{PHL}			1	6.5	1	5.5	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

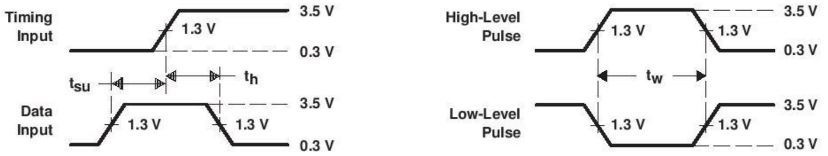
PARAMETER MEASUREMENT INFORMATION
SERIES 54ALS/74ALS AND 54AS/74AS DEVICES



LOAD CIRCUIT FOR BI-STATE TOTEM-POLE OUTPUTS

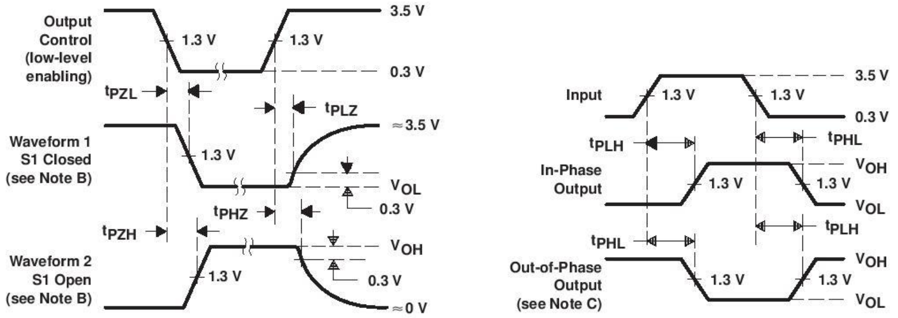
LOAD CIRCUIT FOR OPEN-COLLECTOR OUTPUTS

LOAD CIRCUIT FOR 3-STATE OUTPUTS



VOLTAGE WAVEFORMS SETUP AND HOLD TIMES

VOLTAGE WAVEFORMS PULSE DURATIONS

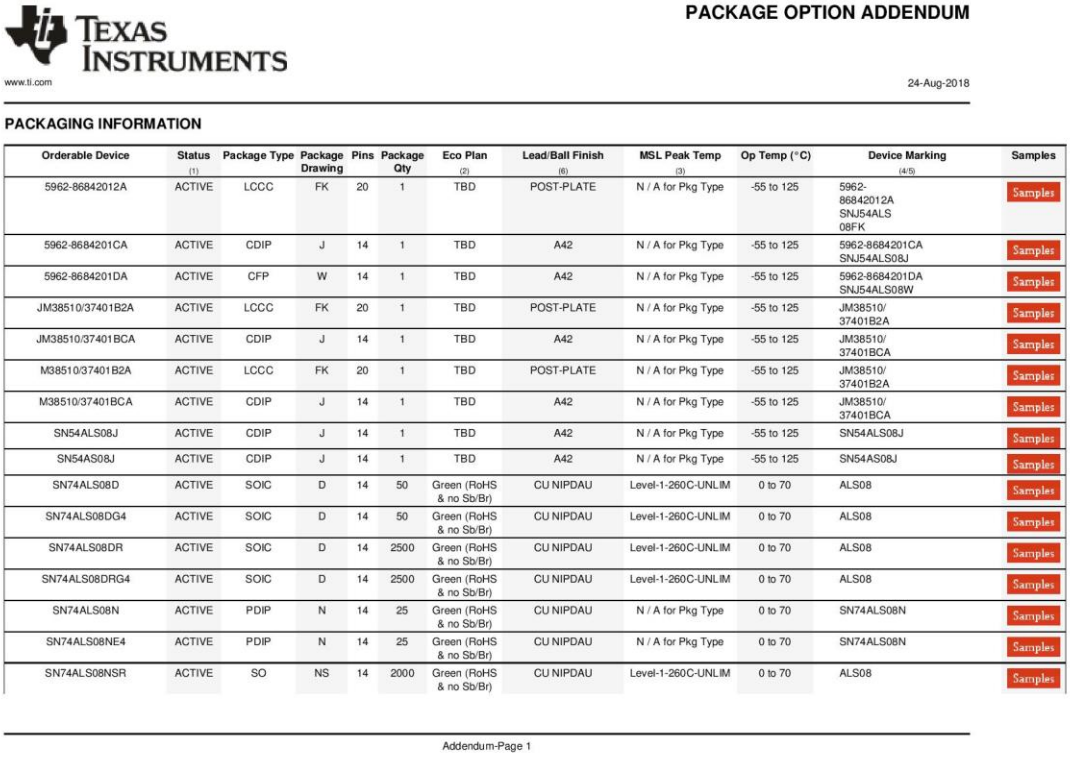


VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES

NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. When measuring propagation delay items of 3-state outputs, switch S1 is open.
D. All input pulses have the following characteristics: PRR ≤ 1 MHz, $t_r = t_f = 2$ ns, duty cycle = 50%.
E. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms



TEXAS INSTRUMENTS

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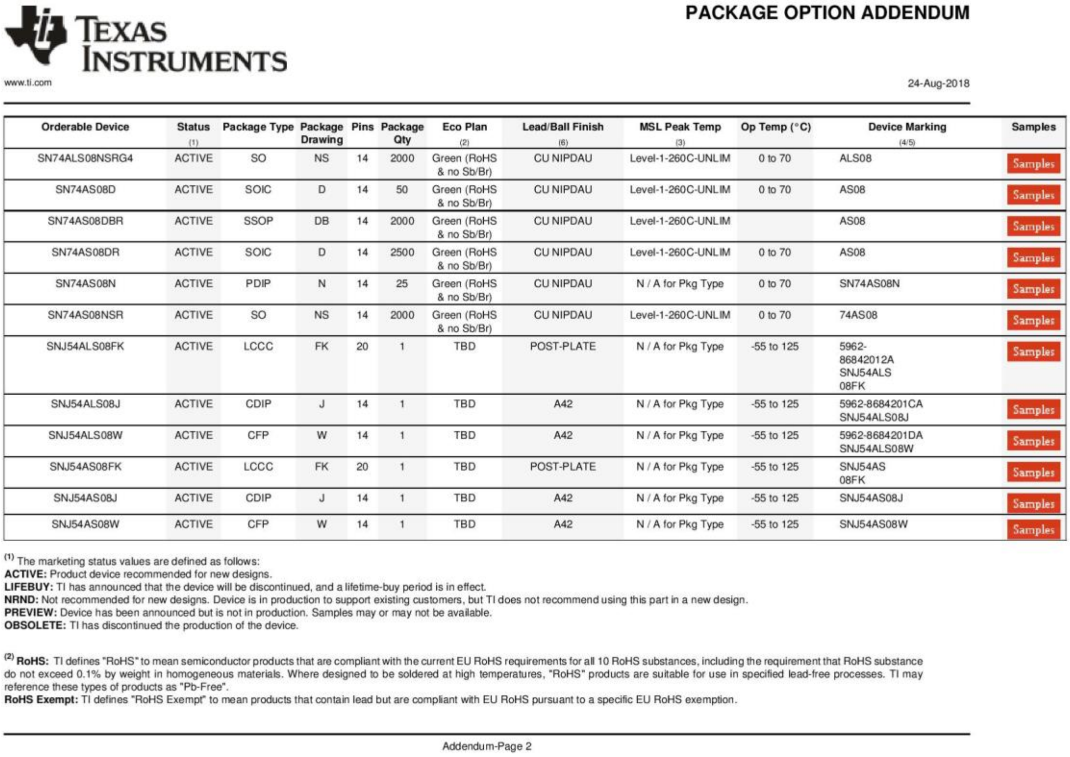
PACKAGE OPTION ADDENDUM

24-Aug-2018

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-86842012A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962- 86842012A SNJ54ALS 08FK	Samples
5962-8684201CA	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8684201CA SNJ54ALS08J	Samples
5962-8684201DA	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8684201DA SNJ54ALS08W	Samples
JM38510/37401B2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	JM38510/ 37401B2A	Samples
JM38510/37401BCA	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	JM38510/ 37401BCA	Samples
M38510/37401B2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	JM38510/ 37401B2A	Samples
M38510/37401BCA	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	JM38510/ 37401BCA	Samples
SN54ALS08J	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	SN54ALS08J	Samples
SN54AS08J	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	SN54AS08J	Samples
SN74ALS08D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS08	Samples
SN74ALS08DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS08	Samples
SN74ALS08DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS08	Samples
SN74ALS08DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS08	Samples
SN74ALS08N	ACTIVE	PDIP	N	14	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	0 to 70	SN74ALS08N	Samples
SN74ALS08NE4	ACTIVE	PDIP	N	14	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	0 to 70	SN74ALS08N	Samples
SN74ALS08NSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS08	Samples

Addendum-Page 1



TEXAS INSTRUMENTS

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PACKAGE OPTION ADDENDUM

24-Aug-2018

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74ALS08NSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS08	Samples
SN74AS08D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	AS08	Samples
SN74AS08DBR	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		AS08	Samples
SN74AS08DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	AS08	Samples
SN74AS08N	ACTIVE	PDIP	N	14	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	0 to 70	SN74AS08N	Samples
SN74AS08NSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	74AS08	Samples
SNJ54ALS08FK	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962- 86842012A SNJ54ALS 08FK	Samples
SNJ54ALS08J	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8684201CA SNJ54ALS08J	Samples
SNJ54ALS08W	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8684201DA SNJ54ALS08W	Samples
SNJ54AS08FK	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	SNJ54AS 08FK	Samples
SNJ54AS08J	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	SNJ54AS08J	Samples
SNJ54AS08W	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	SNJ54AS08W	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Addendum-Page 2

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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OTHER QUALIFIED VERSIONS OF SN54ALS08, SN54AS08, SN74ALS08, SN74AS08 :

- Catalog: SN74ALS08, SN74AS08

- Military: SN54ALS08, SN54AS08

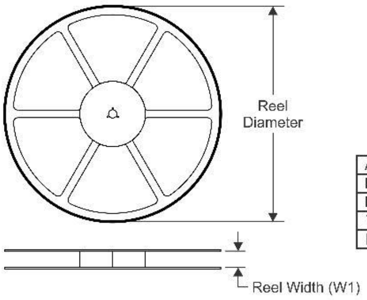
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

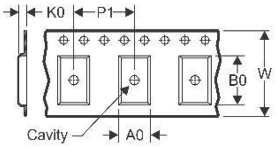
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

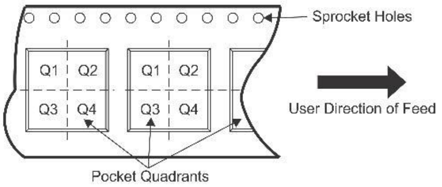


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

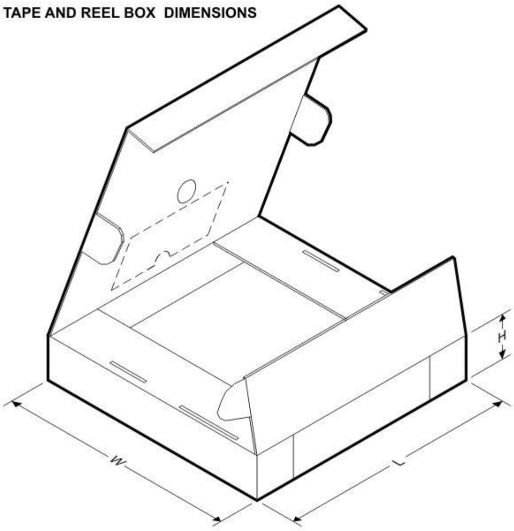
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74ALS08DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
SN74ALS08NSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
SN74AS08DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
SN74AS08NSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



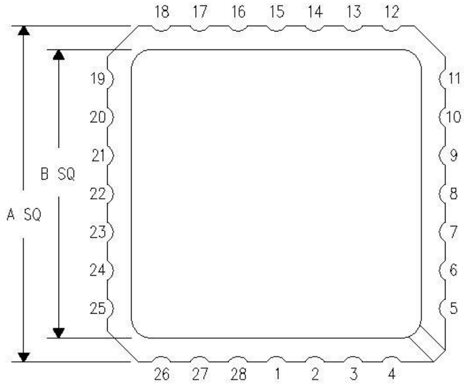
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ALS08DR	SOIC	D	14	2500	367.0	367.0	38.0
SN74ALS08NSR	SO	NS	14	2000	367.0	367.0	38.0
SN74AS08DR	SOIC	D	14	2500	367.0	367.0	38.0
SN74AS08NSR	SO	NS	14	2000	367.0	367.0	38.0

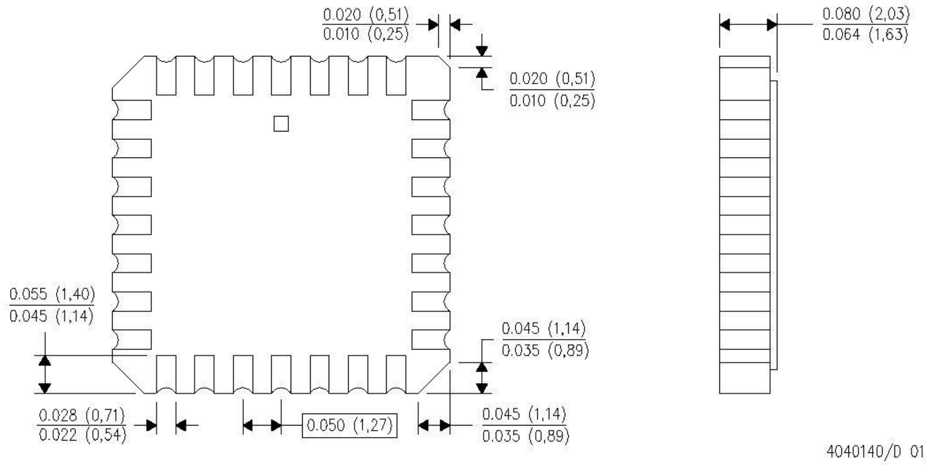
FK (S–CQCC–N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)

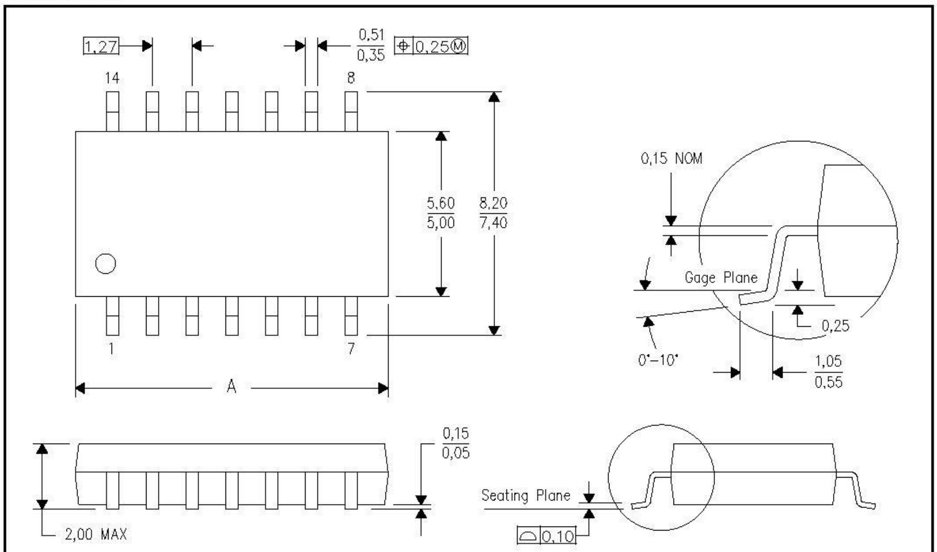


4040140/D 01/11

NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. This package can be hermetically sealed with a metal lid.
- D. Falls within JEDEC MS–004

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14-PINS SHOWN

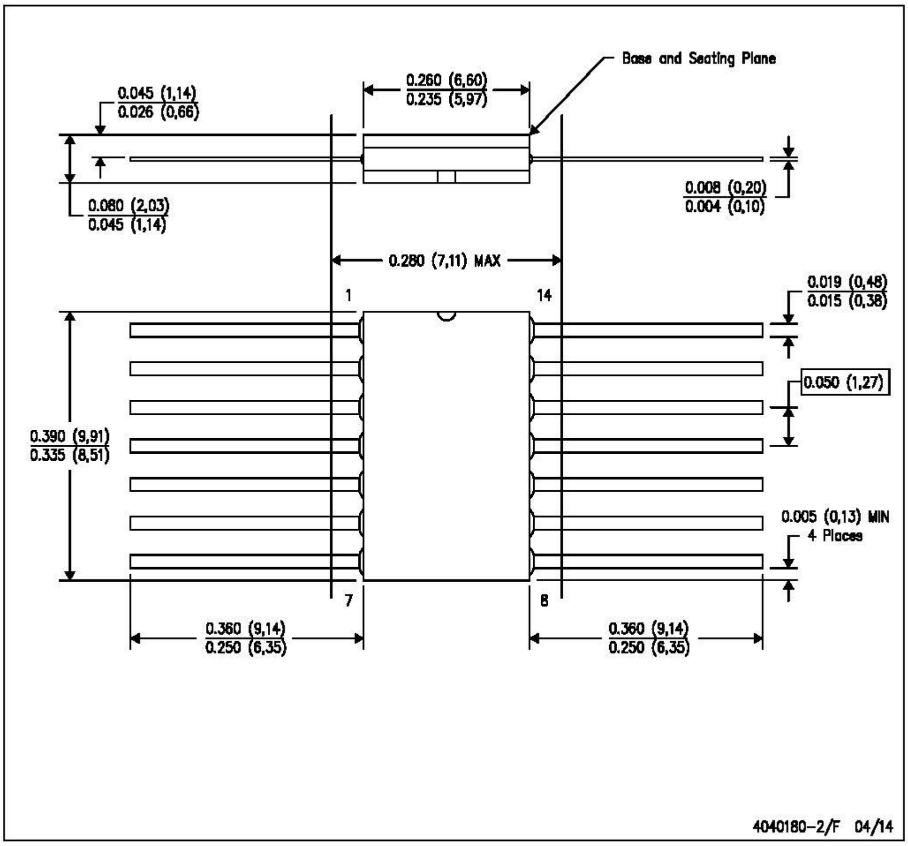


PINS ** / DIM	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

W (R–GDFP–F14) CERAMIC DUAL FLATPACK

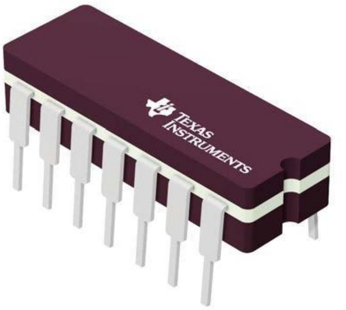


NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. This package can be hermetically sealed with a ceramic lid using glass frit.
- D. Index point is provided on cap for terminal identification only.
- E. Falls within MIL STD 1835 GDFP1–F14

J 14

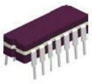
CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4040083-5/G

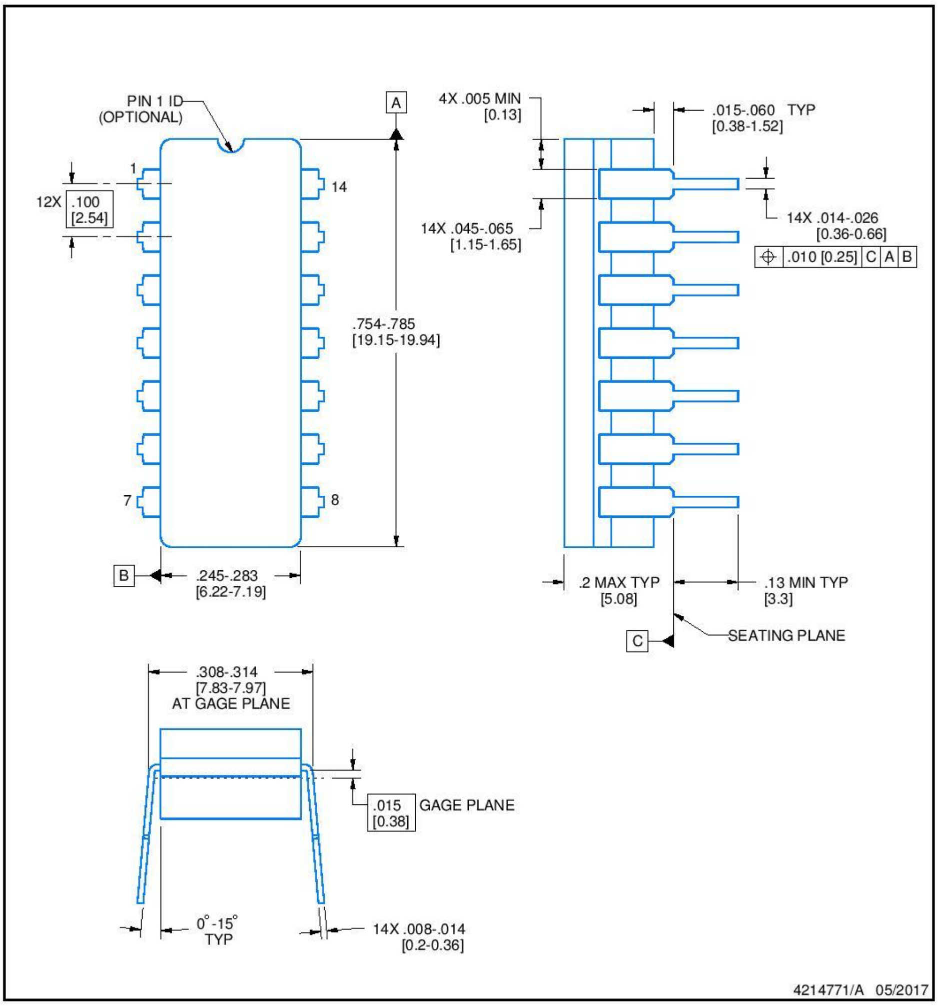


PACKAGE OUTLINE

J0014A

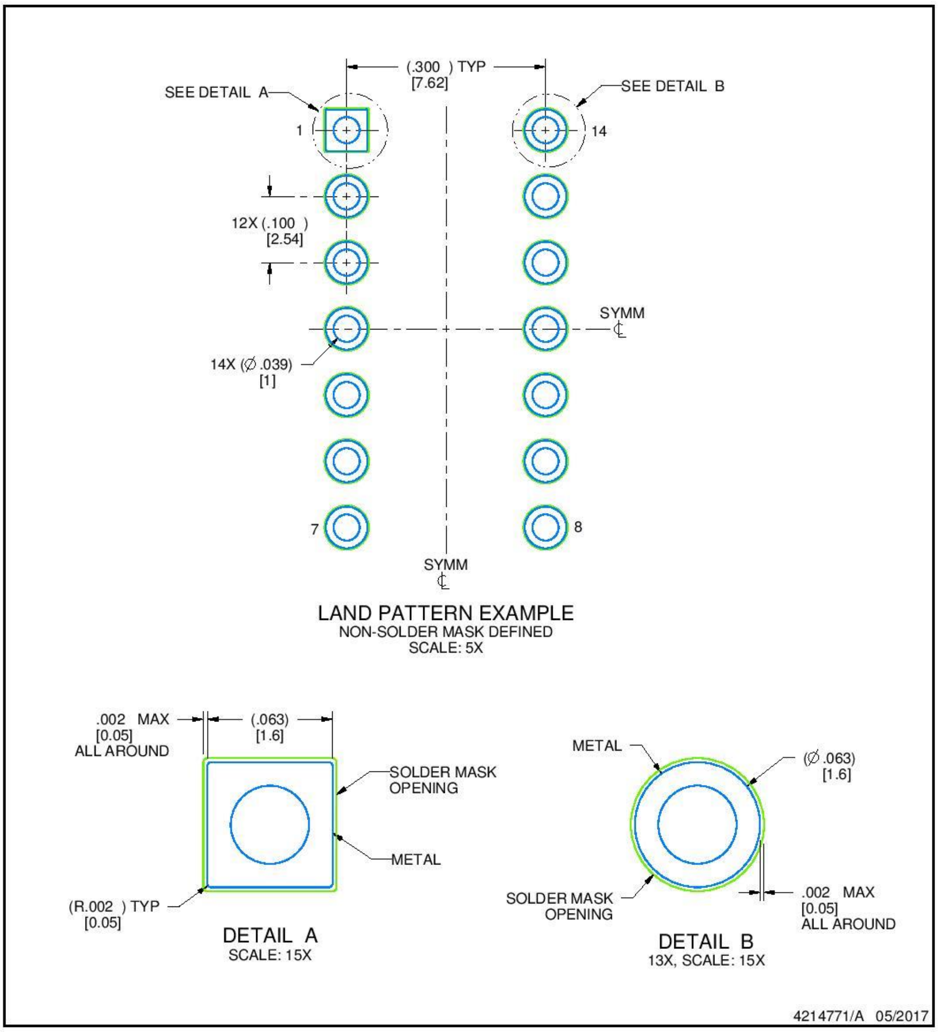
CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE

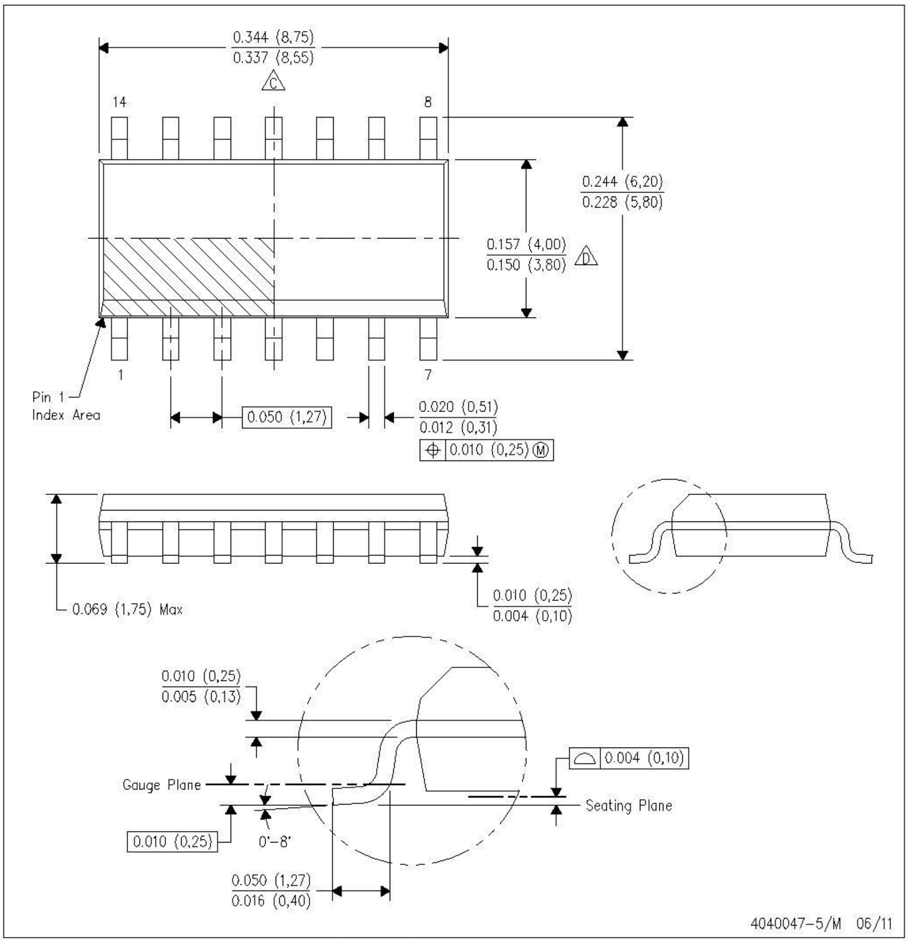


NOTES:

1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermitically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.

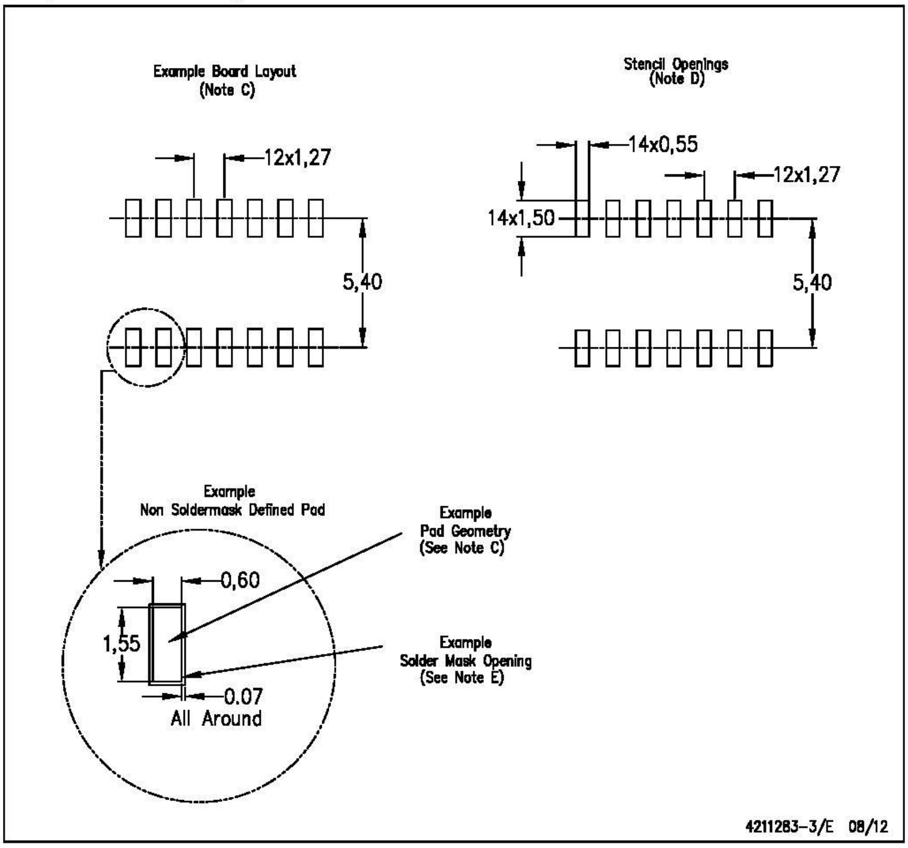

(.300) TYP
[7.62]
SEE DETAIL A
SEE DETAIL B
1
14
12X (.100)
[2.54]
SYMM
℄
14X (∅.039)
[1]
7
8
SYMM
℄
LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE: 5X
.002 MAX
[0.05]
ALL AROUND
(.063)
[1.6]
SOLDER MASK
OPENING
METAL
(R.002) TYP
[0.05]
DETAIL A
SCALE: 15X
METAL
(∅.063)
[1.6]
SOLDER MASK
OPENING
.002 MAX
[0.05]
ALL AROUND
DETAIL B
13X, SCALE: 15X
4214771/A 05/2017

D (R–PDSO–G14) PLASTIC SMALL OUTLINE



NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS–012 variation AB.

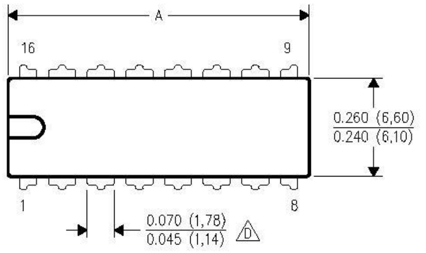
D (R–PDSO–G14) PLASTIC SMALL OUTLINE



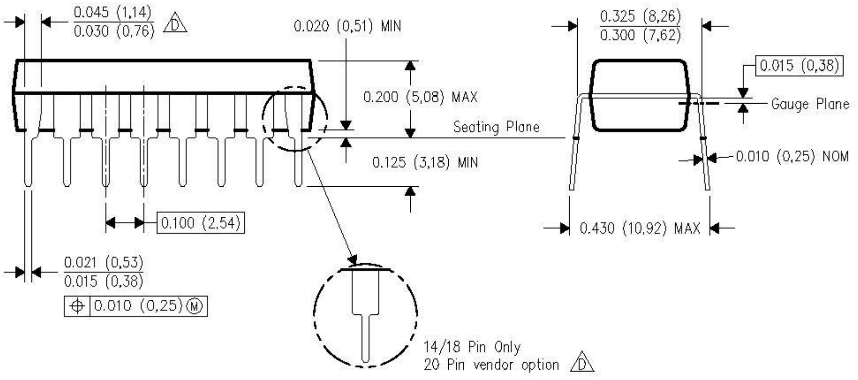
NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC–7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525 for other stencil recommendations.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

N (R–PDIP–T**) PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



PINS ** DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
C MS-001 VARIATION	AA	BB	AC	AD

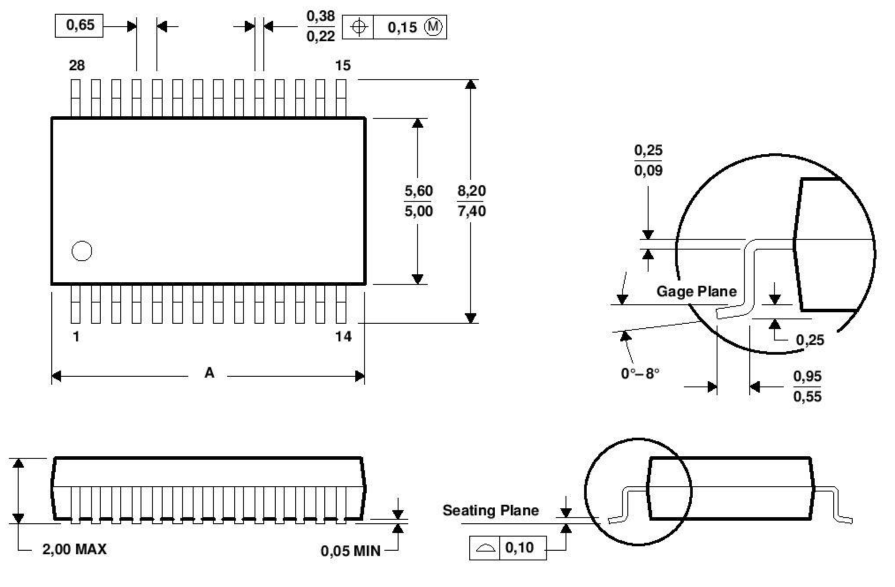


4040049/E 12/2002

NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
- D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

DB (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

28 PINS SHOWN



DIM \ PINS **	14	16	20	24	28	30	38
A MAX	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 /E 12/01

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-150

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Φύλλα δεδομένων finder-relays

finder

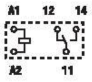
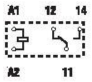
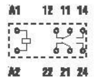
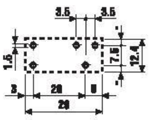
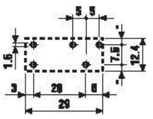
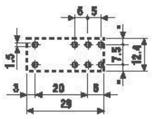
40 Series - Miniature PCB/Plug-in relays 8 - 10 - 16 A

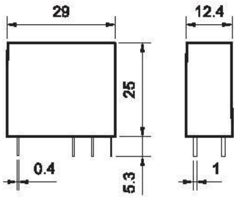
Features

1 & 2 Pole relay range
40.31 - 1 Pole 10 A (3.5 mm pin pitch)
40.51 - 1 Pole 10 A (5 mm pin pitch)
40.52 - 2 Pole 8 A (5 mm pin pitch)

PCB mount
- direct or via PCB socket
35 mm rail mount
- via screw and screwless sockets

- DC coils (standard or sensitive) & AC coils
- Cadmium Free contact material
- 8 mm, 6 kV (1.2/50 μs) isolation, coil-contacts
- UL Listing (certain relay/socket combinations)
- Flux proof: RT II standard, (RT III option)
- 95 series sockets
- Coil EMC suppression
- Timer accessories 86 series

40.31	40.51	40.52
		
• 3.5 mm contact pin pitch • 1 Pole 10 A • PCB or 95 series sockets	• 5 mm contact pin pitch • 1 Pole 10 A • PCB or 95 series sockets	• 5 mm contact pin pitch • 2 Pole 8 A • PCB or 95 series sockets
		
		
Copper side view	Copper side view	Copper side view



For UL Horsepower and Pilot Duty ratings
See "General technical information" page V

		40.31	40.51	40.52
Contact specification				
Contact configuration		1 CO (SPDT)	1 CO (SPDT)	2 CO (DPDT)
Rated current/Maximum peak current	A	10/20	10/20	8/15
Rated voltage/Maximum switching voltage	V AC	250/400	250/400	250/400
Rated load AC1	VA	2,500	2,500	2,000
Rated load AC15 (230 V AC)	VA	500	500	400
Single phase motor rating (230 V AC)	kW	0.37	0.37	0.3
Breaking capacity DC1: 30/110/220 V	A	10/0.3/0.12	10/0.3/0.12	8/0.3/0.12
Minimum switching load	mW (V/mA)	300 (5/5)	300 (5/5)	300 (5/5)
Standard contact material		AgNi	AgNi	AgNi
Coil specification				
Nominal voltage (U_N)	V AC (50/60 Hz)	6 - 12 - 24 - 48 - 60 - 110 - 120 - 230 - 240		
	V DC	5 - 6 - 7 - 9 - 12 - 14 - 18 - 21 - 24 - 28 - 36 - 48 - 60 - 90 - 110 - 125		
Rated power AC/DC/sens. DC	VA (50 Hz)/W/W	1.2/0.65/0.5	1.2/0.65/0.5	1.2/0.65/0.5
Operating range	AC	(0.8…1.1)U_N	(0.8…1.1)U_N	(0.8…1.1)U_N
	DC/sens. DC	(0.73…1.5)U_N/(0.73…1.75)U_N	(0.73…1.5)U_N/(0.73…1.75)U_N	(0.73…1.5)U_N/(0.73…1.75)U_N
Holding voltage	AC/DC	0.8 U_N /0.4 U_N	0.8 U_N /0.4 U_N	0.8 U_N /0.4 U_N
Must drop-out voltage	AC/DC	0.2 U_N /0.1 U_N	0.2 U_N /0.1 U_N	0.2 U_N /0.1 U_N
Technical data				
Mechanical life AC/DC	cycles	$10 \cdot 10^6/20 \cdot 10^6$	$10 \cdot 10^6/20 \cdot 10^6$	$10 \cdot 10^6/20 \cdot 10^6$
Electrical life at rated load AC1	cycles	$200 \cdot 10^3$	$200 \cdot 10^3$	$100 \cdot 10^3$
Operate/release time	ms	7/3 - (12/4 sensitive)	7/3 - (12/4 sensitive)	7/3 - (12/4 sensitive)
Insulation between coil and contacts (1.2/50 μs)	kV	6 (8 mm)	6 (8 mm)	6 (8 mm)
Dielectric strength between open contacts	V AC	1,000	1,000	1,000
Ambient temperature range	°C	–40…+85	–40…+85	–40…+85
Environmental protection		RT II**	RT II**	RT II**
Approvals (according to type)		RINA		

** See general technical information "Guidelines for automatic flow solder processes" page II .

finder

40 Series - Miniature PCB/Plug-in relays 8 - 10 - 16 A

Features

40.61 - 1 Pole 16 A (5 mm pin pitch)
40.xx.6 - Bistable versions of the 40.31, 40.51, 40.52 & 40.61 relays

PCB mount
- direct or via PCB socket
35 mm rail mount
- via screw and screwless sockets

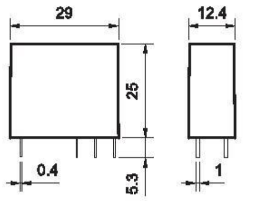
- DC coils & AC coils
- Cadmium Free option available
- 8 mm, 6 kV (1.2/50 μs) isolation, coil-contacts
- UL Listing (certain 40.61 relay/socket combinations)
- Flux proof: RT II standard, (RT III option)
- 95 series sockets
- Coil EMC suppression
- Timer accessories 86 series

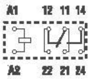
40.61

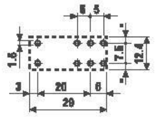
- 5 mm contact pin pitch
- 1 Pole 16 A
- PCB or 95 series sockets

40.xx.6

- Bistable (single coil) versions of 40.31/51/52/61
- PCB or 95 series sockets







Copper side view

Bistable version (1 coil) types:

40.31.6...
40.51.6...
40.52.6...
40.61.6...
For wiring diagrams see page 8

For UL Horsepower and Pilot Duty ratings
See "General technical information" page V

		40.61	40.xx.6
Contact specification			
Contact configuration		1 CO (SPDT)	
Rated current/Maximum peak current	A	16/30*	
Rated voltage/Maximum switching voltage	V AC	250/400	See relays
Rated load AC1	VA	4,000	40.31
Rated load AC15 (230 V AC)	VA	750	40.51
Single phase motor rating (230 V AC)	kW	0.55	40.52
Breaking capacity DC1: 30/110/220 V	A	16/0.3/0.12	40.61
Minimum switching load	mW (V/mA)	500 (10/5)	
Standard contact material		AgCdO	
Coil specification			
Nominal voltage (U_N)	V AC (50/60 Hz)	6-12-24-48-60-110-120-230-240	5 - 6 - 12 - 24 - 48 - 110
	V DC	***See table	5 - 6 - 12 - 24 - 48 - 110
Rated power AC/DC/sens. DC	VA (50 Hz)/W/W	1.2/0.65/0.5	1.0/1.0/—
Operating range	AC	$(0.8...1.1)U_N$	$(0.8...1.1)U_N$
	DC/sens. DC	$(0.73...1.5)U_N/(0.8...1.5)U_N$	$(0.8...1.1)U_N$/—
Holding voltage	AC/DC	$0.8\ U_N\ /0.4\ U_N$	—
Must drop-out voltage	AC/DC	$0.2\ U_N\ /0.1\ U_N$	—
Technical data			
Mechanical life AC/DC	cycles	$10 \cdot 10^6/20 \cdot 10^6$	See relays
Electrical life at rated load AC1	cycles	$100 \cdot 10^3$	40.31
Operate/release time	ms	7/3 - (12/4 sensitive)	40.51
Insulation between coil and contacts (1.2/50 μs)	kV	6 (8 mm)	40.52
Dielectric strength between open contacts	V AC	1,000	40.61
Ambient temperature range	°C	–40…+85	Min. impulse duration
Environmental protection		RT II**	≥ 20 ms
Approvals (according to type)		D FI N RINA S c UL us NF VDE	

* With the $AgSnO_2$ material the maximum peak current is 120 A - 5 ms on normally open contact.

*** Nominal voltage (U_N): 5 - 6 - 7 - 9 - 12 - 14 - 18 - 21 - 24 - 28 - 36 - 48 - 60 - 90 - 110 - 125 V DC

** See general technical information "Guidelines for automatic flow solder processes" page II.

40 Series - Miniature PCB/Plug-in relays 8 - 10 - 16 A

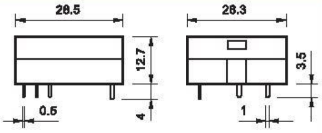
Features

1 Pole relay range

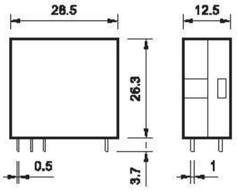
40.11	**- 1 Pole 10 A (Flat pack)**
40.11-2016	**- 1 Pole 16 A (Flat pack)**
40.41	**- 1 Pole 10 A (Vertical)**

PCB mount
- direct or via PCB socket (40.41 version)

- DC coils
- Cadmium Free option available
- 8 mm, 6 kV (1.2/50 μs) isolation, coil-contacts
- 40.41 - NO version available

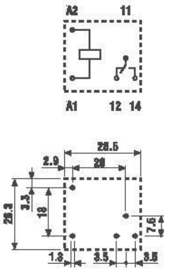
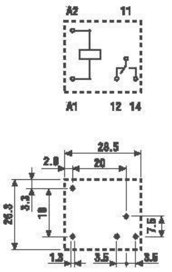
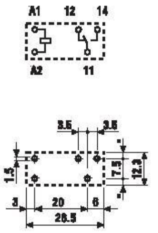


40.11



40.41

For UL Horsepower and Pilot Duty ratings
See "General technical information" page V

		40.11	40.11-2016	40.41
				
		• 1 Pole 10 A • Flat pack • PCB mount	• 1 Pole 16 A • Flat pack • PCB mount	• 1 Pole 10 A • Vertical • PCB or 95 series socket
		 A2 11 A1 12 14 28.5 2.9 20 26.3 3.3 18 7.5 1.3 3.5 3.5 Copper side view	 A2 11 A1 12 14 28.5 2.9 20 26.3 3.3 18 7.5 1.3 3.5 3.5 Copper side view	 A1 12 14 A2 11 3.5 3.5 1.5 7.5 12.3 3 20 6 28.5 Copper side view
Contact specification				
Contact configuration		1 CO (SPDT)	1 CO (SPDT)	1 CO (SPDT)
Rated current/Maximum peak current	A	10/20	16/30	10/20
Rated voltage/Maximum switching voltage	V AC	250/400	250/400	250/400
Rated load AC1	VA	2,500	4,000	2,500
Rated load AC15 (230 V AC)	VA	500	750	500
Single phase motor rating (230 V AC)	kW	0.37	0.55	0.37
Breaking capacity DC1: 30/110/220 V	A	10/0.3/0.12	16/0.3/0.12	10/0.3/0.12
Minimum switching load	mW (V/mA)	300 (5/5)	500 (10/5)	300 (5/5)
Standard contact material		AgCdO	AgCdO	AgCdO
Coil specification				
Nominal voltage (U_N)	V AC (50/60 Hz)	–	–	–
	V DC	6 - 12 - 24 - 48 - 60	6 - 12 - 24 - 48	6 - 12 - 24 - 48 - 60
Rated power AC/DC/sens. DC	VA (50 Hz)/W/W	–/–/0.5	–/–/0.5	–/–/0.5
Operating range	AC	–	–	–
	DC/sens. DC	–/(0.73…1.75)U_N	–/(0.73…1.5)U_N	–/(0.73…1.75)U_N
Holding voltage	AC/DC	–/0.4 U_N	–/0.4 U_N	–/0.4 U_N
Must drop-out voltage	AC/DC	–/0.1 U_N	–/0.1 U_N	–/0.1 U_N
Technical data				
Mechanical life AC/DC	cycles	–/20 · 10^6	–/20 · 10^6	–/20 · 10^6
Electrical life at rated load AC1	cycles	200 · 10^3	50 · 10^3	200 · 10^3
Operate/release time	ms	12/4	12/4	12/4
Insulation between coil and contacts (1.2/50 μs)	kV	6 (8 mm)	6 (8 mm)	6 (8 mm)
Dielectric strength between open contacts	V AC	1,000	1,000	1,000
Ambient temperature range	°C	–40…+70	–40…+70	–40…+70
Environmental protection		RT I	RT I	RT I
Approvals (according to type)				

Ordering information

Example: 40 series PCB relay, 2 CO (DPDT), 230 V AC coil.

A B C D
4 0 . 5 2 . 8 . 2 3 0 . 0 0 0 0

Series

Type
1 = PCB - 3.5 mm pinning, flat
3 = PCB - 3.5 mm pinning
4 = PCB - 3.5 mm pinning
5 = PCB - 5 mm pinning
6 = PCB - 5 mm pinning

No. of poles
1 = 1 pole
for: 40.11, 10 A/16 A
40.31, 10 A
40.41, 10 A
40.51, 10 A
40.61, 16 A
2 = 2 pole
for: 40.52, 8 A

Coil version
6 = AC/DC bistable
7 = Sensitive DC
8 = AC (50/60 Hz)
9 = DC

Coil voltage
See coil specifications

A: Contact material
0 = Standard AgNi for 40.31/51/52, AgCdO for 40.61
2 = AgCdO (standard for 40.11/41)
4 = $AgSnO_2$
5 = AgNi + Au (5 μm)

B: Contact circuit
0 = CO (nPDT)
3 = NO (nPST)

D: Special versions
0 = Standard
1 = Wash tight (RT III)
3 = High temperature (+ 125 °C) wash tight

C: Options
0 = None
16 = With rated current 16 A (for 40.11)

Selecting features and options: only combinations in the same row are possible.
Preferred selections for best availability are shown in **bold.**

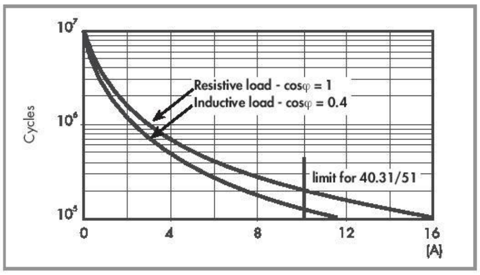
Type	Coil version	A	B	C	D
40.11	sensitive DC	**2** - 4	**0**	**0**	**0**
40.11	sensitive DC	**2** - 4	0	16	/
40.41	sensitive DC	0 - **2**	**0** - 3	**0**	**0**
40.31/51	AC-sens. DC	**0** - 2 - 5	**0** - 3	**0**	**0** - 1
40.31/51	DC	**0** - 2 - 5	**0** - 3	**0**	**0** - 1 - 3
40.52	AC-sens. DC	**0** - 2 - 5	**0** - 3	**0**	**0** - 1
40.52	DC	**0** - 2 - 5	**0** - 3	**0**	**0** - 1 - 3
40.61	AC-sens. DC	**0** - 4	**0** - 3	**0**	**0** - 1
40.61	DC	**0** - 4	**0** - 3	**0**	**0** - 1 - 3
40.31/51/52/61	bistable	**0**	**0**	**0**	**0**

Technical data

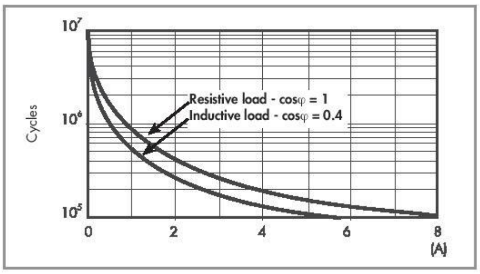
		1 pole		2 pole	
Insulation according to EN 61810-1					
Nominal voltage of supply system	V AC	230/400		230/400	
Rated insulation voltage	V AC	250	400	250	400
Pollution degree		3	2	3	2
Insulation between coil and contact set					
Type of insulation		Reinforced (8 mm)		Reinforced (8 mm)	
Overvoltage category		III		III	
Rated impulse voltage	kV (1.2/50 μs)	6		6	
Dielectric strength	V AC	4,000		4,000	
Insulation between adjacent contacts					
Type of insulation		—		Basic	
Overvoltage category		—		II	
Rated impulse voltage	kV (1.2/50 μs)	—		2.5	
Dielectric strength	V AC	—		2,000	
Insulation between open contacts					
Type of disconnection		Micro-disconnection		Micro-disconnection	
Dielectric strength	V AC/kV (1.2/50 μs)	1,000/1.5		1,000/1.5	
Conducted disturbance immunity					
Burst (5...50)ns, 5 kHz, on A1 - A2		EN 61000-4-4		level 4 (4 kV)	
Surge (1.2/50 μs) on A1 - A2 (differential mode)		EN 61000-4-5		level 3 (2 kV)	
Other data					
Bounce time: NO/NC	ms	2/5			
Vibration resistance (5…55)Hz: NO/NC	g	10/4 (1 changeover)		15/3 (2 changeover)	
Shock resistance	g	13			
Power lost to the environment without contact current	W	0.6			
with rated current	W	1.2 (40.11/31/41/51)		2 (40.61/52/40.11-2016)	
Recommended distance between relays mounted on PCB	mm	≥ 5			

Contact specification

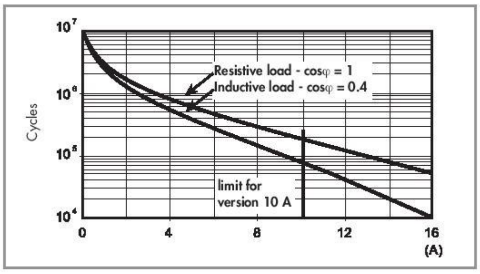
F 40 - Electrical life (AC) v contact current
Types 40.31/51/61



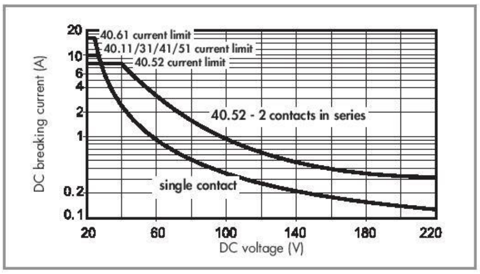
F 40 - Electrical life (AC) v contact current
Type 40.52



F 40 - Electrical life (AC) v contact current
Types 40.11/41



H 40 - Maximum DC1 breaking capacity



- When switching a resistive load (DC1) having voltage and current values under the curve, an electrical life of ≥ $100 \cdot 10^3$ can be expected.
- In the case of DC13 loads, the connection of a diode in parallel with the load will permit a similar electrical life as for a DC1 load.
  Note: the release time for the load will be increased.

Coil specifications

DC coil data - 0.65 W standard (types 40.31/51/52/61)

Nominal voltage	Coil code	Operating range		Resistance	Rated coil consumption
U_N		U_{min}	U_{max}	R	I at U_N
V		V	V	Ω	mA
5	**9**.005	3.65	7.5	38	130
6	**9**.006	4.4	9	55	109
7	**9**.007	5.1	10.5	75	94
9	**9**.009	6.6	13.5	125	72
12	**9**.012	8.8	18	220	55
14	**9**.014	10.2	21	300	47
18	**9**.018	13.1	27	500	36
21	**9**.021	15.3	31.5	700	30
24	**9**.024	17.5	36	900	27
28	**9**.028	20.5	42	1,200	23
36	**9**.036	26.3	54	2,000	18
48	**9**.048	35	72	3,500	14
60	**9**.060	43.8	90	5,500	11
90	**9**.090	65.7	135	12,500	7.2
110	**9**.110	80.3	165	18,000	6.2
125	**9**.125	91.2	188	23,500	5.3

DC coil data - 0.5 W sensitive (types 40.31/51/52/61)

Nominal voltage	Coil code	Operating range		Resistance	Rated coil consumption
U_N		U_{min}*	U_{max}**	R	I at U_N
V		V	V	Ω	mA
5	**7**.005	3.7	8.8	50	100
6	**7**.006	4.4	10.5	75	80
7	**7**.007	5.1	12.2	100	70
9	**7**.009	6.6	15.8	160	56
12	**7**.012	8.8	21	300	40
14	**7**.014	10.2	24.5	400	35
18	**7**.018	13.2	31.5	650	27.7
21	**7**.021	15.4	36.9	900	23.4
24	**7**.024	17.5	42	1,200	20
28	**7**.028	20.5	49	1,600	17.5
36	**7**.036	26.3	63	2,600	13.8
48	**7**.048	35	84	4,800	10
60	**7**.060	43.8	105	7,200	8.4
90	**7**.090	65.7	157	16,200	5.6
110	**7**.110	80.3	192	23,500	4.7
125	**7**.125	91.2	219	32,000	3.9

*U_{min} = 0.8 U_N for 40.61 **U_{max} = 1.5 U_N for 40.61

DC coil data - 0.5 W sensitive (types 40.11/41)

Nominal voltage	Coil code	Operating range		Resistance	Rated coil consumption
U_N		U_{min}	U_{max}*	R	I at U_N
V		V	V	Ω	mA
6	**7**.006	4.4	10.5	75	80
12	**7**.012	8.8	21	300	40
24	**7**.024	17.5	42	1,200	20
48	**7**.048	35	84	4,600	10.4
60	**7**.060	43.8	105	7,200	8.3

*U_{max} = 1.5 U_N for 40.11-2016

AC coil data (types 40.31/51/52/61)

Nominal voltage	Coil code	Operating range		Resistance	Rated coil consumption
U_N		U_{min}	U_{max}	R	I at U_N (50Hz)
V		V	V	Ω	mA
6	**8**.006	4.8	6.6	21	168
12	**8**.012	9.6	13.2	80	90
24	**8**.024	19.2	26.4	320	45
48	**8**.048	38.4	52.8	1,350	21
60	**8**.060	48	66	2,100	16.8
110	**8**.110	88	121	6,900	9.4
120	**8**.120	96	132	9,000	8.4
230	**8**.230	184	253	28,000	5
240	**8**.240	192	264	31,500	4.1

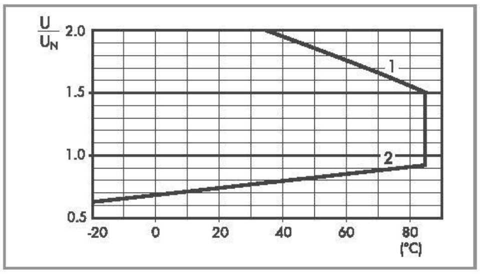
AC/DC coil data - bistable (types 40.31/51/52/61)

Nominal voltage	Coil code	Operating range		Resistance	Rated coil consumption	DC: Release resistance**
U_N		U_{min}	U_{max}	R	I at U_N	R_{DC}
V		V	V	Ω	mA	Ω
5	**6**.005	4	5.5	23	215	37
6	**6**.006	4.8	6.6	33	165	62
12	**6**.012	9.6	13.2	130	83	220
24	**6**.024	19.2	26.4	520	40	910
48	**6**.048	38.4	52.8	2,100	21	3,600
110	**6**.110	88	121	11,000	10	16,500

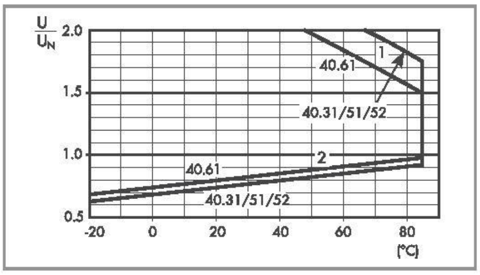
** R_{DC} = Resistance in DC, R_{AC} = 1.3 x R_{DC} 1W

Coil specifications

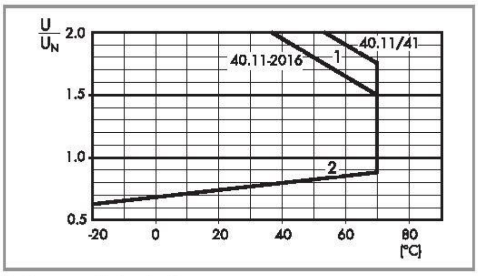
R 40 - DC coil operating range v ambient temperature
Standard coil



R 40 - DC coil operating range v ambient temperature
Sensitive coil, types 40.31/51/52/61

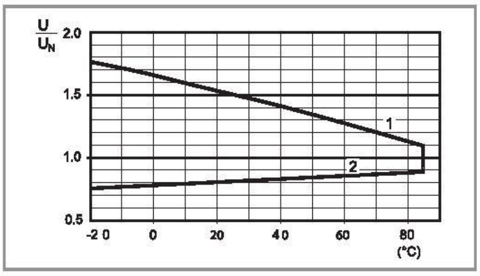


R 40 - DC coil operating range v ambient temperature
Sensitive coil, types 40.11/41



1 - Max. permitted coil voltage.
2 - Min. pick-up voltage with coil at ambient temperature.

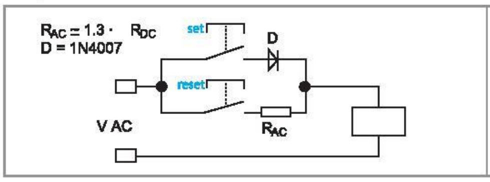
R 40 - AC coil operating range v ambient temperature



1 - Max. permitted coil voltage.
2 - Min. pick-up voltage with coil at ambient temperature.

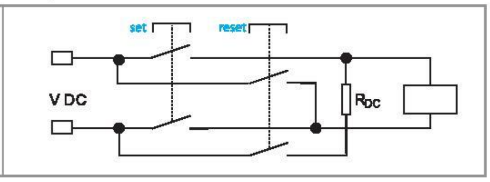
Wiring diagram for 40 series bistable coil version

AC Operation



On momentary closure of the SET switch the relay is magnetised through the diode and the relay contacts transfer to the set position and remain in this position.
On momentary closure of the RESET switch the relay is demagnetised through limiting resistor (R_{AC}) and the contacts return to the reset position.

DC Operation



On momentary closure of the SET switch the relay is magnetised and the relay contacts transfer to the set position and remain in this position.
On momentary closure of the RESET switch the relay is demagnetised through limiting resistor (R_{DC}) and the contacts return to the reset position.

Notes: The minimum SET or RESET impulse time is 20 ms. The maximum time can be continuous. In practice, always ensure that the SET and RESET contacts cannot be operated simultaneously.

Φύλλα δεδομένωνLM7805

FAIRCHILD
SEMICONDUCTOR®

April 1999
Revised December 2005

LM7805 • LM7806 • LM7808 • LM7809 • LM7810 • LM7812 • LM7815 • LM7818 • LM7824 • LM7805A • LM7806A • LM7808A •LM7809A • LM7810A • LM7812A • LM7815A • LM7818A • LM7824A

3-Terminal 1A Positive Voltage Regulator

General Description

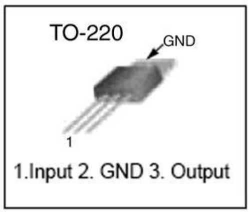
The LM78XX series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Features

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 12, 15, 18, 24
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

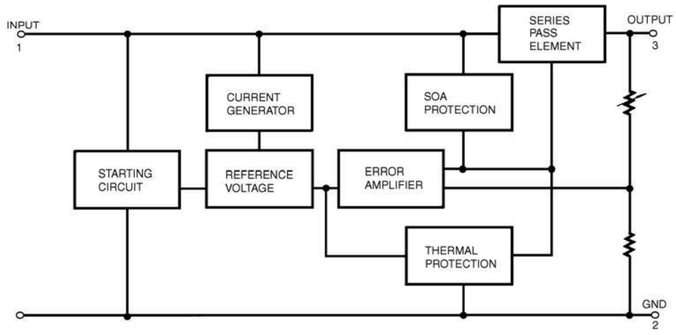
Ordering Code:

Product Number	Output Voltage Tolerance	Package	Operating Temperature
LM7805CT	±4%	TO-220	−40°C - +125°C
LM7806CT			
LM7808CT			
LM7809CT			
LM7810CT			
LM7812CT			
LM7815CT			
LM7818CT			
LM7824CT			
LM7805ACT	±2%		0°C - +125°C
LM7806ACT			
LM7808ACT			
LM7809ACT			
LM7810ACT			
LM7812ACT			
LM7815ACT			
LM7818ACT			
LM7824ACT			



1.Input 2. GND 3. Output

Internal Block Diagram



Absolute Maximum Ratings(Note 1)

Parameter	Symbol	Value	Unit
Input Voltage (for V_O = 5V to 18V)	V_I	35	V
(for V_O = 24V)	V_I	40	V
Thermal Resistance Junction-Cases (TO-220)	$R_{\theta JC}$	5	°C/W
Thermal Resistance Junction-Air (TO-220)	$R_{\theta JA}$	65	°C/W
Operating Temperature Range	T_{OPR}	0 ~ +125	°C
LM78xx		–40 ~ +125	°C
LM78xxA		0 ~ +125	°C
Storage Temperature Range	T_{STG}	–65 ~ +150	°C

Note 1: Absolute maximum ratings are those values beyond which damage to the device may occur. The datasheet specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. Fairchild does not recommend operation outside datasheet specifications.

Electrical Characteristics (LM7805)

(Refer to the test circuits. $-40°C < T_J < 125°C$, I_O = 500mA, V_I = 10V, C_I = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	T_J = +25°C		4.8	5.0	5.2	V
		5mA ≤ I_O ≤ 1A, P_O ≤ 15W, V_I = 7V to 20V		4.75	5.0	5.25	
Line Regulation	Regline	T_J = +25°C	V_O = 7V to 25V	–	4.0	100	mV
(Note 2)			V_I = 8V to 12V	–	1.6	50.0	
Load Regulation	Regload	T_J = +25°C	I_O = 5mA to 1.5mA	–	9.0	100	mV
			I_O = 250mA to 750mA	–	4.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	0.03	0.5	mA
		V_I = 7V to 25V		–	0.3	1.3	
Output Voltage Drift (Note 3)	$\Delta V_O/\Delta T$	I_O = 5mA		–	–0.8	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	42.0	–	µV/V_O
Ripple Rejection (Note 3)	RR	f = 120Hz, V_O = 8V to 18V		62.0	73.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 3)	rO	f = 1KHz		–	15.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	230	–	mA
Peak Current (Note 3)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 2: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 3: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7806)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 11V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		5.75	6.0	6.25	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 8.0V$ to 21V		5.7	6.0	6.3	
Line Regulation	Regline	$T_J = +25°C$	$V_I = 8V$ to 25V	–	5.0	120	mV
(Note 4)			$V_I = 9V$ to 13V	–	1.5	60.0	
Load Regulation	Regload	$T_J = +25°C$	$I_O = 5mA$ to 1.5mA	–	9.0	120	mV
(Note 4)			$I_O = 250mA$ to 750mA	–	3.0	60.0	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to 1A		–	–	0.5	mA
		$V_I = 8V$ to 25V		–	–	1.3	
Output Voltage Drift (Note 5)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	-0.8	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	45.0	–	$\mu V/V_O$
Ripple Rejection (Note 5)	RR	f = 120Hz, $V_O = 8V$ to 18V		62.0	73.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 5)	rO	f = 1KHz		–	19.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	250	–	mA
Peak Current (Note 5)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 4: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 5: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7808)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 14V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		7.7	8.0	8.3	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 10.5V$ to 23V		7.6	8.0	8.4	
Line Regulation	Regline	$T_J = +25°C$	$V_I = 10.5V$ to 25V	–	5.0	160	mV
(Note 6)			$V_I = 11.5V$ to 17V	–	2.0	80.0	
Load Regulation	Regload	$T_J = +25°C$	$I_O = 5mA$ to 1.5mA	–	10.0	160	mV
(Note 6)			$I_O = 250mA$ to 750mA	–	5.0	80.0	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to 1A		–	0.05	0.5	mA
		$V_I = 10.5V$ to 25V		–	0.5	1.0	
Output Voltage Drift (Note 7)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	-0.8	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	52.0	–	$\mu V/V_O$
Ripple Rejection (Note 7)	RR	f = 120Hz, $V_O = 11.5V$ to 21.5V		56.0	73.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 7)	rO	f = 1KHz		–	17.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	230	–	mA
Peak Current (Note 7)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 6: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 7: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7809)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 15V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		8.65	9.0	9.35	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 11.5V$ to 24V		8.6	9.0	9.4	
Line Regulation	Regline	$T_J = +25°C$	$V_I = 11.5V$ to 25V	–	6.0	180	mV
(Note 8)			$V_I = 12V$ to 17V	–	2.0	90.0	
Load Regulation	Regload	$T_J = +25°C$	$I_O = 5mA$ to 1.5mA	–	12.0	180	mV
(Note 8)			$I_O = 250mA$ to 750mA	–	4.0	90.0	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to 1A		–	–	0.5	mA
		$V_I = 11.5V$ to 26V		–	–	1.3	
Output Voltage Drift (Note 9)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	−1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	58.0	–	$\mu V/V_O$
Ripple Rejection (Note 9)	RR	f = 120Hz, $V_O = 13V$ to 23V		56.0	71.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 9)	rO	f = 1KHz		–	17.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	250	–	mA
Peak Current (Note 9)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 8: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 9: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7810)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 16V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		9.6	10.0	10.4	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 12.5V$ to 25V		9.5	10.0	10.5	
Line Regulation	Regline	$T_J = +25°C$	$V_I = 12.5V$ to 25V	–	10.0	200	mV
(Note 10)			$V_I = 13V$ to 25V	–	3.0	100	
Load Regulation	Regload	$T_J = +25°C$	$I_O = 5mA$ to 1.5mA	–	12.0	200	mV
(Note 10)			$I_O = 250mA$ to 750mA	–	4.0	400	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.1	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to 1A		–	–	0.5	mA
		$V_I = 12.5V$ to 29V		–	–	1.0	
Output Voltage Drift (Note 11)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	−1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	58.0	–	$\mu V/V_O$
Ripple Rejection (Note 11)	RR	f = 120Hz, $V_O = 13V$ to 23V		56.0	71.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 11)	rO	f = 1KHz		–	17.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	250	–	mA
Peak Current (Note 11)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 10: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 11: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7812)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 19V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		11.5	12.0	12.5	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 14.5V$ to 27V		11.4	12.0	12.6	
Line Regulation	Regline	$T_J = +25°C$	$V_I = 14.5V$ to 30V	–	10.0	240	mV
(Note 12)			$V_I = 16V$ to 22V	–	3.0	120	
Load Regulation	Regload	$T_J = +25°C$	$I_O = 5mA$ to 1.5mA	–	11.0	240	mV
(Note 12)			$I_O = 250mA$ to 750mA	–	5.0	120	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.1	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to 1A		–	0.1	0.5	mA
		$V_I = 14.5V$ to 30V		–	0.5	1.0	
Output Voltage Drift (Note 13)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	−1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	76.0	–	$\mu V/V_O$
Ripple Rejection (Note 13)	RR	f = 120Hz, $V_I = 15V$ to 25V		55.0	71.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 13)	rO	f = 1KHz		–	18.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	230	–	mA
Peak Current (Note 13)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 12: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 13: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7815)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 23V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		14.4	15.0	15.6	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 17.5V$ to 30V		14.25	15.0	15.75	
Line Regulation	Regline	$T_J = +25°C$	$V_I = 17.5V$ to 30V	–	11.0	300	mV
(Note 14)			$V_I = 20V$ to 26V	–	3.0	150	
Load Regulation	Regload	$T_J = +25°C$	$I_O = 5mA$ to 1.5mA	–	12.0	300	mV
(Note 14)			$I_O = 250mA$ to 750mA	–	4.0	150	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.2	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to 1A		–	–	0.5	mA
		$V_I = 17.5V$ to 30V		–	–	1.0	
Output Voltage Drift (Note 15)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	−1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	90.0	–	$\mu V/V_O$
Ripple Rejection (Note 15)	RR	f = 120Hz, $V_I = 18.5V$ to 28.5V		54.0	70.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 15)	rO	f = 1KHz		–	19.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	250	–	mA
Peak Current (Note 15)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 14: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 15: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7818)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 27V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		17.3	18.0	18.7	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 21V$ to $33V$		17.1	18.0	18.9	
Line Regulation (Note 12)	Regline	$T_J = +25°C$	$V_I = 21V$ to $33V$	–	15.0	360	mV
			$V_I = 24V$ to $30V$	–	5.0	180	
Load Regulation (Note 12)	Regload	$T_J = +25°C$	$I_O = 5mA$ to $1.5mA$	–	15.0	360	mV
			$I_O = 250mA$ to $750mA$	–	5.0	180	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.2	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to $1A$		–	–	0.5	mA
		$V_I = 21V$ to $33V$		–	–	1.0	
Output Voltage Drift (Note 17)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	-1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	110	–	$\mu V/V_O$
Ripple Rejection (Note 17)	RR	f = 120Hz, $V_I = 22V$ to $32V$		53.0	69.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 17)	rO	f = 1KHz		–	22.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	250	–	mA
Peak Current (Note 17)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 16: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 17: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7824)

(Refer to the test circuits. $-40°C < T_J < 125°C$, $I_O = 500mA$, $V_I = 33V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		23.0	24.0	25.0	V
		$5mA \le I_O \le 1A$, $P_O \le 15W$, $V_I = 27V$ to $38V$		22.8	24.0	25.25	
Line Regulation (Note 18)	Regline	$T_J = +25°C$	$V_I = 27V$ to $38V$	–	17.0	480	mV
			$V_I = 30V$ to $36V$	–	6.0	240	
Load Regulation (Note 18)	Regload	$T_J = +25°C$	$I_O = 5mA$ to $1.5mA$	–	15.0	480	mV
			$I_O = 250mA$ to $750mA$	–	5.0	240	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.2	8.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to $1A$		–	0.1	0.5	mA
		$V_I = 27V$ to $38V$		–	0.5	1.0	
Output Voltage Drift (Note 19)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	-1.5	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, $T_A = +25°C$		–	60.0	–	$\mu V/V_O$
Ripple Rejection (Note 19)	RR	f = 120Hz, $V_I = 28V$ to $38V$		50.0	67.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 19)	rO	f = 1KHz		–	28.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	230	–	mA
Peak Current (Note 19)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 18: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 19: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7805A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 10V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	T_J = +25°C		4.9	5.0	5.1	V
		I_O = 5mA to 1A, $P_O \leq$ 15W, V_I = 7.5V to 20V		4.8	5.0'	5.2	
Line Regulation	Regline	V_I = 7.5V to 25V, I_O = 500mA		–	5.0	50.0	mV
(Note 20)		V_I = 8V to 12V		–	3.0	50.0	
		T_J = +25°C	V_I = 7.3V to 20V	–	5.0	50.0	
			V_I = 8V to 12V	–	1.5	25.0	
Load Regulation	Regload	T_J = +25°C, I_O = 5mA to 1.5mA		–	9.0	100	mV
(Note 20)		I_O = 5mA to 1mA		–	9.0	100	
		I_O = 250mA to 750mA		–	4.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.0	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 8V to 25V, I_O = 500mA		–	–	0.8	
		V_I = 7.5V to 20V, T_J = +25°C		–	–	0.8	
Output Voltage Drift (Note 21)	$\Delta V_O/\Delta T$	I_O = 5mA		–	−0.8	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 21)	RR	f = 120Hz, I_O = 500mA, V_I = 8V to 18V		–	68.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 21)	rO	f = 1KHz		–	17.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 21)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 20: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 21: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7806A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 11V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	T_J = +25°C		5.58	6.0	6.12	V
		I_O = 5mA to 1A, $P_O \leq$ 15W, V_I = 8.6V to 21V		5.76	6.0	6.24	
Line Regulation (Note 22)	Regline	V_I = 8.6V to 25V, I_O = 500mA		–	5.0	60.0	mV
		V_I = 9V to 13V		–	3.0	60.0	
		T_J = +25°C	V_I = 8.3V to 21V	–	5.0	60.0	
			V_I = 9V to 13V	–	1.5	30.0	
Load Regulation (Note 22)	Regload	T_J = +25°C, I_O = 5mA to 1.5mA		–	9.0	100	mV
		I_O = 5mA to 1mA		–	4.0	100	
		I_O = 250mA to 750mA		–	5.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	4.3	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 19V to 25V, I_O = 500mA		–	–	0.8	
		V_I = 8.5V to 21V, T_J = +25°C		–	–	0.8	
Output Voltage Drift (Note 23)	$\Delta V_O/\Delta T$	I_O = 5mA		–	–0.8	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 23)	RR	f = 120Hz, I_O = 500mA, V_I = 9V to 19V		–	65.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 23)	rO	f = 1KHz		–	17.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 23)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 22: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 23: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7808A)

(Refer to the test circuits. $0°C < T_J < 125°C$, $I_O = 1A$, $V_I = 14V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage	V_O	$T_J = +25°C$		7.84	8.0	8.16	V
		$I_O = 5mA$ to $1A$, $P_O \leq 15W$, $V_I = 10.6V$ to $23V$		7.7	8.0	8.3	
Line Regulation (Note 24)	Regline	$V_I = 10.6V$ to $25V$, $I_O = 500mA$		–	6.0	80.0	mV
		$V_I = 11V$ to $17V$		–	3.0	80.0	
		$T_J = +25°C$	$V_I = 10.4V$ to $23V$	–	6.0	80.0	
			$V_I = 11V$ to $17V$	–	2.0	40.0	
Load Regulation (Note 24)	Regload	$T_J = +25°C$, $I_O = 5mA$ to $1.5mA$		–	12.0	100	mV
		$I_O = 5mA$ to $1mA$		–	12.0	100	
		$I_O = 250mA$ to $750mA$		–	5.0	50.0	
Quiescent Current	I_Q	$T_J = +25°C$		–	5.0	6.0	mA
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to $1A$		–	–	0.5	mA
		$V_I = 11V$ to $25V$, $I_O = 500mA$		–	–	0.8	
		$V_I = 10.6V$ to $23V$, $T_J = +25°C$		–	–	0.8	
Output Voltage Drift (Note 25)	$\Delta V_O/\Delta T$	$I_O = 5mA$		–	–0.8	–	mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$, $T_A = +25°C$		–	10.0	–	$\mu V/V_O$
Ripple Rejection (Note 25)	RR	$f = 120Hz$, $I_O = 500mA$, $V_I = 11.5V$ to $21.5V$		–	62.0	–	dB
Dropout Voltage	V_{DROP}	$I_O = 1A$, $T_J = +25°C$		–	2.0	–	V
Output Resistance (Note 25)	rO	$f = 1KHz$		–	18.0	–	mΩ
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25°C$		–	250	–	mA
Peak Current (Note 25)	I_{PK}	$T_J = +25°C$		–	2.2	–	A

Note 24: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 25: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7809A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 15V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
Output Voltage	V_O	T_J = +25°C		8.82	9.0	9.16	V
		I_O = 5mA to 1A, P_O ≤ 15W, V_I = 11.2V to 24V		8.65	9.0	9.35	
Line Regulation (Note 26)	Regline	V_I = 11.7V to 25V, I_O = 500mA		–	6.0	90.0	mV
		V_I = 12.5V to 19V		–	4.0	45.0	
		T_J = +25°C	V_I = 11.5V to 24V	–	6.0	90.0	
			V_I = 12.5V to 19V	–	2.0	45.0	
Load Regulation (Note 26)	Regload	T_J = +25°C, I_O = 5mA to 1.0mA		–	12.0	100	mV
		I_O = 5mA to 1mA		–	12.0	100	
		I_O = 250mA to 750mA		–	5.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.0	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 12V to 25V, I_O = 500mA		–	–	0.8	
		V_I = 11.7V to 25V, T_J = +25°C		–	–	0.8	
Output Voltage Drift (Note 27)	$\Delta V_O/\Delta T$	I_O = 5mA		–	-1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 27)	RR	f = 120Hz, I_O = 500mA, V_I = 12V to 22V		–	62.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 27)	rO	f = 1KHz		–	17.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 27)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 26: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 27: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7810A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 16V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
Output Voltage	V_O	T_J = +25°C		9.8	10.0	10.2	V
		I_O = 5mA to 1A, $P_O \le$ 15W, V_I = 12.8V to 25V		9.6	10.0	10.4	
Line Regulation (Note 28)	Regline	V_I = 12.8V to 26V, I_O = 500mA		–	8.0	100	mV
		V_I = 13V to 20V		–	4.0	50.0	
		T_J = +25°C	V_I = 12.5V to 25V	–	8.0	100	
			V_I = 13V to 20V	–	3.0	50.0	
Load Regulation (Note 28)	Regload	T_J = +25°C, I_O = 5mA to 1.5mA		–	12.0	100	mV
		I_O = 5mA to 1mA		–	12.0	100	
		I_O = 250mA to 750mA		–	5.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.0	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 12.8V to 25V, I_O = 500mA		–	–	0.8	
		V_I = 13V to 26V, T_J = +25°C		–	–	0.5	
Output Voltage Drift (Note 29)	$\Delta V_O/\Delta T$	I_O = 5mA		–	−1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 29)	RR	f = 120Hz, I_O = 500mA, V_I = 14V to 24V		–	62.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 29)	rO	f = 1KHz		–	17.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 29)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 28: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 29: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7812A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 19V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
Output Voltage	V_O	T_J = +25°C		11.75	12.0	12.25	V
		I_O = 5mA to 1A, $P_O \leq$ 15W, V_I = 14.8V to 27V		11.5	12.0	12.5	
Line Regulation (Note 30)	Regline	V_I = 14.8V to 30V, I_O = 500mA		–	10.0	120	mV
		V_I = 16V to 22V		–	4.0	120	
		T_J = +25°C	V_I = 14.5V to 27V	–	10.0	120	
			V_I = 16V to 22V	–	3.0	60.0	
Load Regulation (Note 30)	Regload	T_J = +25°C, I_O = 5mA to 1.5mA		–	12.0	100	mV
		I_O = 5mA to 1mA		–	12.0	100	
		I_O = 250mA to 750mA		–	5.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.1	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 14V to 27V, I_O = 500mA		–	–	0.8	
		V_I = 15V to 30V, T_J = +25°C		–	–	0.8	
Output Voltage Drift (Note 31)	$\Delta V_O/\Delta T$	I_O = 5mA		–	–1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 31)	RR	f = 120Hz, I_O = 500mA, V_I = 14V to 24V		–	60.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 31)	rO	f = 1KHz		–	18.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 31)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 30: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 31: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7815A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 23V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
Output Voltage	V_O	T_J = +25°C		14.75	15.0	15.3	V
		I_O = 5mA to 1A, $P_O \leq$ 15W, V_I = 17.7V to 30V		14.4	15.0	15.6	
Line Regulation (Note 32)	Regline	V_I = 17.4V to 30V, I_O = 500mA		–	10.0	150	mV
		V_I = 20V to 26V		–	5.0	150	
		T_J = +25°C	V_I = 17.5V to 30V	–	11.0	150	
			V_I = 20V to 26V	–	3.0	75.0	
Load Regulation (Note 32)	Regload	T_J = +25°C, I_O = 5mA to 1.5mA		–	12.0	100	mV
		I_O = 5mA to 1mA		–	12.0	100	
		I_O = 250mA to 750mA		–	5.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.2	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 17.5V to 30V, I_O = 500mA		–	–	0.8	
		V_I = 17.5V to 30V, T_J = +25°C		–	–	0.8	
Output Voltage Drift (Note 33)	$\Delta V_O/\Delta T$	I_O = 5mA		–	−1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 33)	RR	f = 120Hz, I_O = 500mA, V_I = 18.5V to 28.5V		–	58.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 33)	rO	f = 1KHz		–	19.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 33)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 32: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 33: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7818A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 27V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
Output Voltage	V_O	T_J = +25°C		17.64	18.0	18.36	V
		I_O = 5mA to 1A, $P_O \leq$ 15W, V_I = 21V to 33V		17.3	18.0	18.7	
Line Regulation (Note 34)	Regline	V_I = 21V to 33V, I_O = 500mA		–	15.0	180	mV
		V_I = 21V to 33V		–	5.0	180	
		T_J = +25°C	V_I = 20.6V to 33V	–	15.0	180	
			V_I = 24V to 30V	–	5.0	90.0	
Load Regulation (Note 34)	Regload	T_J = +25°C, I_O = 5mA to 1.5mA		–	15.0	100	mV
		I_O = 5mA to 1mA		–	15.0	100	
		I_O = 250mA to 750mA		–	7.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.2	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 12V to 33V, I_O = 500mA		–	–	0.8	
		V_I = 12V to 33V, T_J = +25°C		–	–	0.8	
Output Voltage Drift (Note 35)	$\Delta V_O/\Delta T$	I_O = 5mA		–	–1.0	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 35)	RR	f = 120Hz, I_O = 500mA, V_I = 22V to 32V		–	57.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 35)	rO	f = 1KHz		–	19.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 35)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 34: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 35: These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (LM7824A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O = 1A, V_I = 33V, C_I = 0.33µF, C_O = 0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
Output Voltage	V_O	T_J = +25°C		23.5	24.0	24.5	V
		I_O = 5mA to 1A, $P_O \leq$ 15W, V_I = 27.3V to 38V		23.0	24.0	25.0	
Line Regulation (Note 36)	Regline	V_I = 27V to 38V, I_O = 500mA		–	18.0	240	mV
		V_I = 21V to 33V		–	6.0	240	
		T_J = +25°C	V_I = 26.7V to 38V	–	18.0	240	
			V_I = 30V to 36V	–	6.0	120	
Load Regulation (Note 36)	Regload	T_J = +25°C, I_O = 5mA to 1.5mA		–	15.0	100	mV
		I_O = 5mA to 1mA		–	15.0	100	
		I_O = 250mA to 750mA		–	7.0	50.0	
Quiescent Current	I_Q	T_J = +25°C		–	5.2	6.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		–	–	0.5	mA
		V_I = 27.3V to 38V, I_O = 500mA		–	–	0.8	
		V_I = 27.3V to 38V, T_J = +25°C		–	–	0.8	
Output Voltage Drift (Note 37)	$\Delta V_O/\Delta T$	I_O = 5mA		–	−1.5	–	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A = +25°C		–	10.0	–	µV/V_O
Ripple Rejection (Note 37)	RR	f = 120Hz, I_O = 500mA, V_I = 28V to 38V		–	54.0	–	dB
Dropout Voltage	V_{DROP}	I_O = 1A, T_J = +25°C		–	2.0	–	V
Output Resistance (Note 37)	rO	f = 1KHz		–	20.0	–	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A = +25°C		–	250	–	mA
Peak Current (Note 37)	I_{PK}	T_J =+25°C		–	2.2	–	A

Note 36: Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Note 37: These parameters, although guaranteed, are not 100% tested in production.

Typical Performance Characteristics

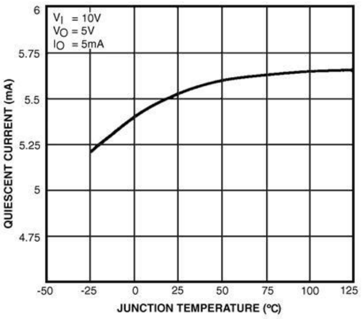


FIGURE 1. Quiescent Current

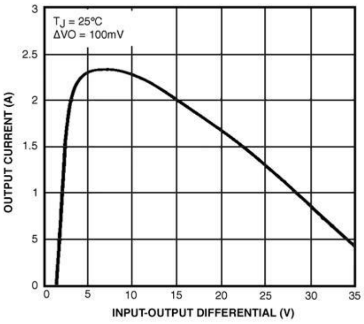


FIGURE 2. Peak Output Current

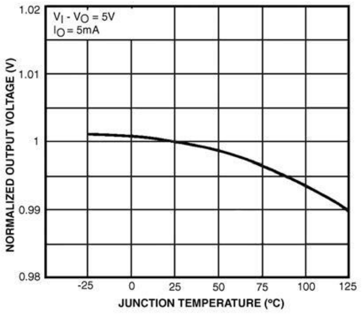


FIGURE 3. Output Voltage

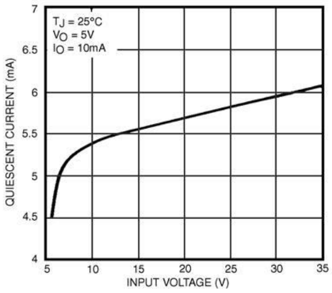


FIGURE 4. Quiescent Current

Typical Applications

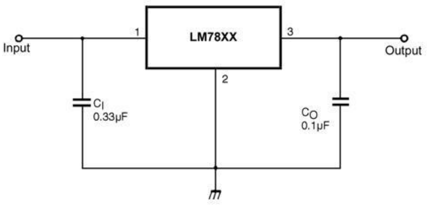


FIGURE 5. DC Parameters

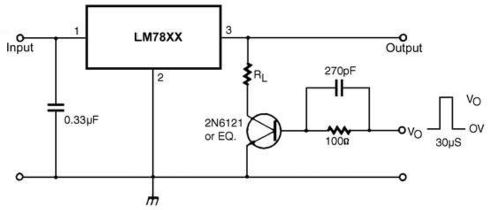


FIGURE 6. Load Regulation

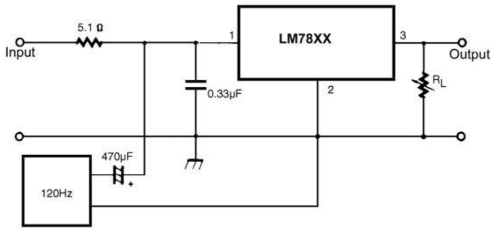


FIGURE 7. Ripple Rejection

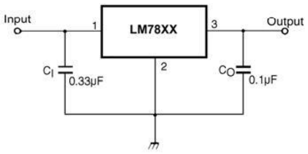
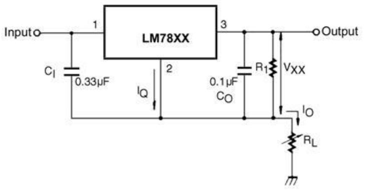


FIGURE 8. Fixed Output Regulator

Typical Applications (continued)



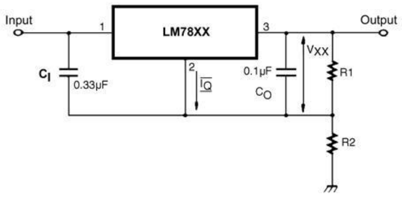
$$I_O = \frac{V_{XX}}{R_1} + I_Q$$

FIGURE 9.

Note: To specify an output voltage, substitute voltage value for "XX". A common ground is required between the Input and the Output voltage. The input voltage must remain typically 2.0V above the output voltage even during the low point on the input ripple voltage.

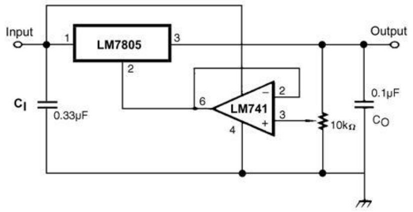
Note: C_I is required if regulator is located an appreciable distance from the power supply filter.

Note: C_O improves stability and transient response.



$$I_{RI} \geq 5\ I_Q$$
$$V_O = V_{XX}\ (1\ R_2 / R_1) + I_Q\ R_2$$

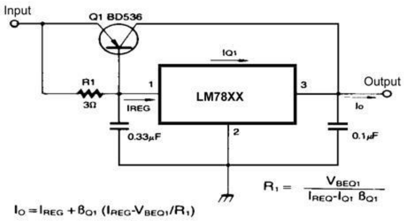
FIGURE 10. Circuit for Increasing Output Voltage



$$I_{RI} \geq 5\ I_Q$$
$$V_O = V_{XX}\ (1\ R_2 / R_1) + I_Q\ R_2$$

FIGURE 11. Adjustable Output Regulator (7V to 30V)

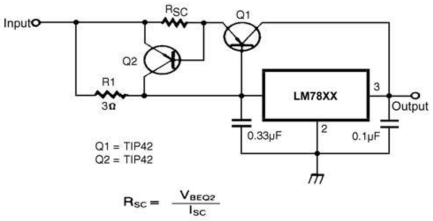
Typical Applications (continued)



$$R_1 = \frac{V_{BEQ1}}{I_{REQ}-I_{Q1}\ \beta_{Q1}}$$

$$I_O = I_{REG} + \beta_{Q1}\ (I_{REG}-V_{BEQ1}/R_1)$$

FIGURE 12. High Current Voltage Regulator



Q1 = TIP42
Q2 = TIP42

$$R_{SC} = \frac{V_{BEQ2}}{I_{SC}}$$

FIGURE 13. High Output Current with Short Circuit Protection

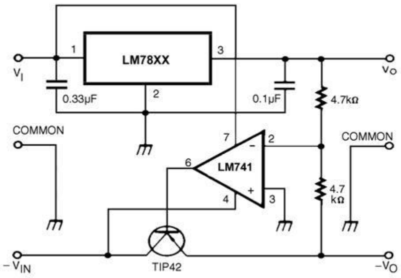


FIGURE 14. Tracking Voltage Regulator

Typical Applications (continued)

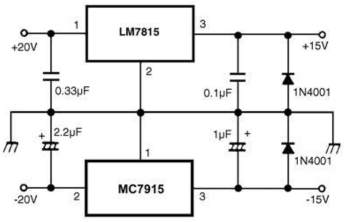


FIGURE 15. Split Power Supply (±15V - 1A)

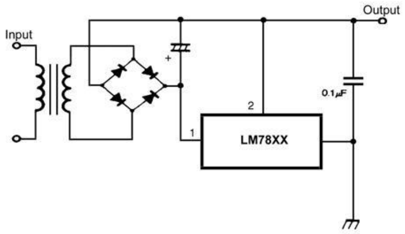


FIGURE 16. Negative Output Voltage Circuit

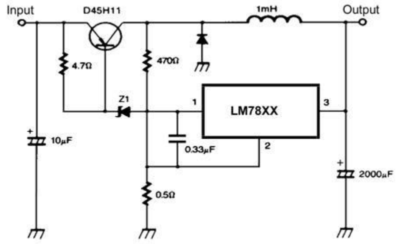
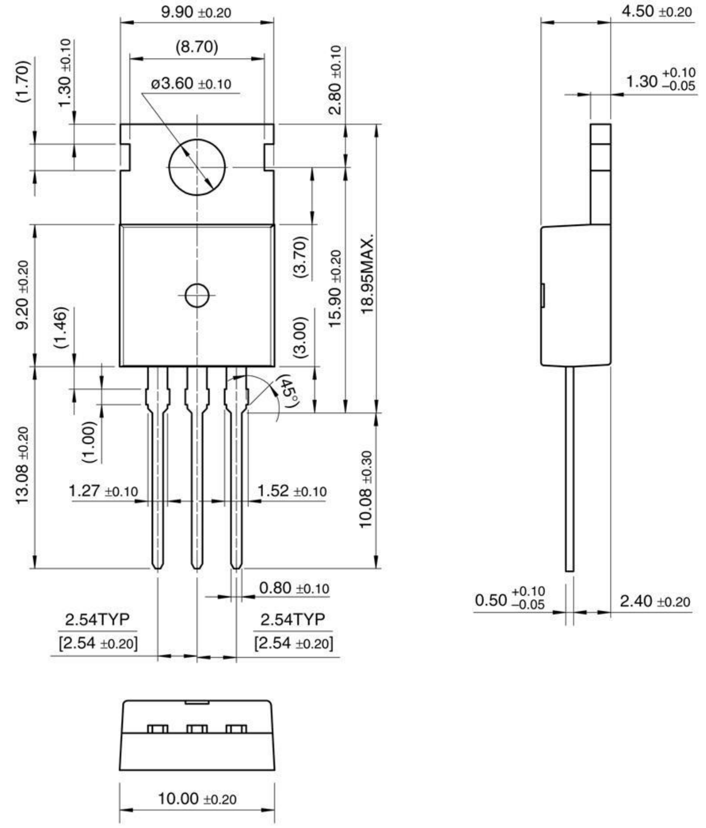


FIGURE 17. Switching Regulator

Physical Dimensions inches (millimeters) unless otherwise noted

TO-220



Package Number TO-220

DISCLAIMER

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild Semiconductor. The datasheet is printed for reference information only.