KEMENTERIAN PENDIDIKAN, KEBUDAYAAN,
RISET DAN TEKNOLOGI
UNIVERSITAS MULAWARMAN
Rektorat Kampus Gunung Kelua, Jalan Kuaro, Samarinda75119, Kotak Pos 1068
Telepon (0541) 741118 Faximile (0541) 747479 - 732870
Laman: www.unmul.ac.id

KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN

NOMOR : 547 /UN17/HK/2022

TENTANG

PENGANGKATAN DOSEN PENGAMPU MATA KULIAH
PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM)
SEMESTER GENAP TAHUN AKADEMIK 2021/2022
PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA,
S1 BIOLOGI,S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS MULAWARMAN

REKTOR UNIVERSITAS MULAWARMAN,

Menimbang : a. bahwa untuk menjamin kepastian hukum dalam rangka tertib administrasi dan kelancaran pelaksanaan kegiatan belajar mengajar Program Merdeka Belajar Kampus Merdeka (MBKM) Semester Genap Tahun Akademik 2021/2022 pada Program Studi S1 Statistika, S1 Matematika, S1 Biologi, S1 Kimia, S1 Fisika dan S1 Geofisika Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Mulawarman, maka dipandang perlu mengangkat Dosen Pengampu Mata Kuliah;

b. bahwa berdasarkan pertimbangan sebagaimana dimaksud dalam huruf a, perlu menetapkan Keputusan Rektor Universitas Mulawarman tentang Pengangkatan Dosen Pengampu Mata Kuliah Program Merdeka Belajar Kampus Merdeka (MBKM) Semester Genap Tahun Akademik 2021/2022 pada Program Studi S1 Statistika, S1 Matematika, S1 Biologi, S1 Kimia, S1 Fisika dan S1 Geofisika Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Mulawarman;

Mengingat : 1. Undang-Undang RI Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional;
2. Undang-Undang RI Nomor 12 tahun 2012 tentang Pendidikan Tinggi;
3. Undang-Undang RI Nomor 5 tahun 2014 tentang Aparatur Sipil Negara;
4. Peraturan Pemerintah RI Nomor 23 Tahun 2005 tentang Pengelolaan Keuangan Badan Layanan Umum, sebagaimana telah diubah dengan Peraturan Pemerintah RI Nomor 74 Tahun 2012 tentang Perubahan Atas Peraturan Pemerintah RI Nomor 23 Tahun 2005 tentang Pengelolaan Keuangan Badan Layanan Umum;
5. Peraturan Pemerintah RI Nomor 37 Tahun 2009 tentang Dosen;
6. Peraturan Pemerintah RI Nomor 4 Tahun 2014 tentang Penyelenggaraan Pendidikan Tinggi dan Pengelolaan Perguruan Tinggi;
7. Keputusan Presiden RI Nomor 65 Tahun 1963 tentang Pendirian Universitas Mulawarman;
8. Peraturan Menteri Riset, Teknologi dan Pendidikan Tinggi RI Nomor 9 Tahun 2015 tentang Organisasi dan Tata Kerja Universitas Mulawarman, sebagaimana telah diubah dengan Peraturan Menteri Riset, Teknologi dan Pendidikan Tinggi RI Nomor 26 Tahun 2018 tentang Perubahan Atas Peraturan Menteri Riset, Teknologi dan Pendidikan Tinggi RI Nomor 9 Tahun 2015 tentang Organisasi dan Tata Kerja Universitas Mulawarman;

9. Peraturan Menteri Riset, Teknologi dan Pendidikan Tinggi RI Nomor 57 Tahun 2018 tentang Statuta Universitas Mulawarman;
10. Keputusan Menteri Keuangan RI Nomor 51/KMK.05/2009 tentang Penetapan Universitas Mulawarman sebagai Instansi Pemerintah yang Menerapkan Pengelolaan Keuangan Badan Layanan Umum;
11. Keputusan Menteri Riset, Teknologi, dan Pendidikan Tinggi RI Nomor 661/M/KPT.KP/2018 tentang Pemberhentian dan Pengangkatan Rektor Universitas Mulawarman Periode Tahun 2018-2022;
12. Peraturan Rektor Universitas Mulawarman Nomor 17 Tahun 2020 tentang Penyelenggaraan Pendidikan dan Pengajaran, Penelitian dan Pengabdian Kepada Masyarakat Berbasis Kampus Merdeka dan Merdeka Belajar;
13. Keputusan Rektor Universitas Mulawarman Nomor 109/OT/2006 Tahun 2006 tentang Peningkatan Status Unit Pelaksana FMIPA Menjadi Fakultas Matematika dan Ilmu Pengetahuan Alam (FMIPA) Universitas Mulawarman;
14. Keputusan Rektor Universitas Mulawarman Nomor 2414/KP2018 tentang Pemberhentian dan Pengangkatan Dekan Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Mulawarman Periode 2018-2022;

Memperhatikan : Surat Dekan Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Mulawarman Nomor 51/UN17.7/TU/2022 tanggal 12 Januari 2022, perihal Permohonan Penerbitan SK Rektor.

MEMUTUSKAN:

Menetapkan : KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN TENTANG PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S2 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

KESATU : Mengangkat nama-nama yang tercantum dalam lampiran yang tidak terpisahkan dari Keputusan ini sebagai Dosen Pengampu Mata Kuliah Program Merdeka Belajar Kampus Merdeka (MBKM) Semester Genap Tahun Akademik 2021/2022 pada Program Studi S1 Statistika, S1 Matematika, S1 Biologi, S1 Kimia, S1 Fisika dan S1 Geofisika Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Mulawarman.

KEDUA : Dosen Pengampu Mata Kuliah Program Merdeka Belajar Kampus Merdeka (MBKM) sebagaimana dimaksud pada diktum kesatu keputusan ini dalam melaksanakan tugasnya bertanggung jawab kepada Rektor Universitas Mulawarman melalui Dekan Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Mulawarman.

KETIGA : Pembiayaan akibat ditetapkannya keputusan ini dibebankan DIPA BLU Universitas Mulawarman, anggaran Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Mulawarman.

KEEMPAT : Keputusan ini berlaku sejak tanggal 3 Januari 2022.

KELIMA : Bilamana dikemudian hari terdapat kekeliruan dalam keputusan ini akan diubah dan diperbaiki sebagaimana mestinya.

Ditetapkan di Samarinda
pada tanggal 12 Januari 2022

REKTOR,

Prof. Ir. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN I
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

PROGRAM STUDI : S1-STATISTIKA

NO	KODE MK	MATA KULIAH	SKS/ SMT	JENIS MK (W/P)	KURIKULUM	DOSEN PENGAMPU MK
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	210700603W005	Statistika Dasar	3/I	W	2021	Dr. Sifriyani, S.Pd., M.Si Ika Purnamasari, M. Si
2	190701603W018	Analisis Regresi	3/IV	W	2019	Dr. Darnah Andi Nohe, M.Si Dr. M. Fathurahman, M.Si
3	190701603W020	Pengantar Metode Survei	3/IV	W	2019	Memi Nor Hayati, S.Si, M.Si Dr. M. Fathurahman, M.Si
4	190701603W021	Rancangan Percobaan	3/IV	W	2019	Dr. M. Fathurahman, M.Si Memi Nor Hayati, S.Si, M.Si
5	190701603W023	Statistika Pengendalian Mutu	3/IV	W	2019	Dr. Sri Wahyuningsih, M. Si Meiliyani Siringoringo, S.Si., M.Si
6	190701603P026	Biostatistik	3/IV	P	2019	Dr. Darnah Andi Nohe, M.Si Memi Nor Hayati, S.Si, M.Si
7	190701603W035	Data Mining	3/VI	W	2019	Surya Prangga, S.Si., M.Si Rito Goejantoro, S.Si., M. Si
8	190701603W036	Analisis Data Eksploratif	3/VI	W	2019	Ika Purnamasari, S.Si, M.Si Dr. Darnah A. Nohe, M.Si
9	190701603W037	Pengantar Model Linier	3/VI	W	2019	Dr. Sifriyani, S.Pd., M.Si Meiliyani Siringoringo, M.Si
10	190701603P039	Teori Antrian	3/VI	P	2019	Dr. Sri Wahyuningsih, M.Si Dr. M. Fathurahman, M.Si
11	190701603P040	Analisis Data Uji Hidup	3/VI	P	2019	Dr. Suyitno, S.Pd., M.Sc Nariza Wanti Wulan Sari, S.Si., M.Si
12	190701603P041	Ekonometrika	3/VI	P	2019	Dr. Sifriyani, S.Pd., M.Si Dr. Darnah Andi Nohe, M.Si
13	190701603P042	Matematika Asuransi	3/VI	P	2019	Dr. Suyitno, S.Pd., M.Sc Dr. Sri Wahyuningsih, M.Si

Ditetapkan di Samarinda

REKTOR,

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN II
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 STATISTIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN

Nama Dosen : Dr. Sri Wahyuningsih, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Statistika Pengendalian Mutu	W	Meiliyani Siringoringo, S.Si., M. Si	2	1	IV
2	Teori Antrian	P	Dr. M. Fathurahman, M.Si.	3	0	VI
3	Matematika Asuransi	P	Dr. Suyitno, S.Pd., M.Sc.	3	0	VI
Total				8	1	

Nama Dosen : Bito Gosjanteno, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Data Mining	W	Surya Prangga, S.Si, M.Si	2	1	VI
Total				2	1	

Nama Dosen : Dr. Darnah A. Nohe, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Analisis Regresi	W	Dr. M. Fathurahman, M.Si	2	1	IV
2	Analisis Data Eksploratif	W	Ika Purnamasari, S.Si, M.Si	2	1	VI
3	Ekonometrika	P	Dr. Sifriyani, S.Pd., M.Si	2	1	VI
4	Biostatistika	P	Memi Nor Hayati, S.Si., M.Si	2	1	IV
Total				8	4	

Nama Dosen : Dr. Suyitno, S.Pd., M.Sc

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Matematika Asuransi	P	Dr. Sri Wahyuningsih, M.Si	3	0	VI
2	Analisis Data Uji Hidup	P	Nariza Wanti Wulan Sari, S.Si., M.Si	2	1	VI
Total				5	1	

Nama Dosen : Dr. M. Fathurahman, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Rancangan Percobaan	W	Memi Nor Hayati, S.Si., M.Si	2	1	IV
2	Analisis Regresi	W	Dr. Darnah Andi Nohe, S.Si, M.Si	2	1	IV
3	Pengantar Metode Survei	W	Memi Nor Hayati, S.Si., M.Si	2	1	IV
4	Teori Antrian	P	Dr. Sri Wahyuningsih, M.Si	3	0	VI
Total				9	3	

Nama Dosen : Dr. Sifriyani, S.Pd., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Statistika Dasar	W	Ika Purnamasari, S.Si, M.Si	2	1	II
2	Pengantar Model Linier	W	Meiliyani Siringoringo, S.Si., M.Si	3	0	VI
3	Ekonometrika	P	Dr. Darnah Andi Nohe, S.Si, M.Si	2	1	VI
Total				7	2	

Nama Dosen : Ika Purnamasari, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Analisis Data Eksploratif	W	Dr. Darnah Andi Nohe, S.Si, M.Si	2	1	VI
2	Statistika Dasar	W	Dr. Sifriyani, S.Pd., M.Si	2	1	II
Total				4	2	

Nama Dosen : Memi Nor Hayati, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pengantar Metode Survei	W	Dr. M. Fathurahman, S.Si., M.Si	2	1	IV
2	Rancangan Percobaan	W	Dr. M. Fathurahman, S.Si., M.Si.	2	1	IV
3	Biostatistika	P	Dr. Darnah Andi Nohe, S.Si, M.Si	2	1	IV
Total				6	3	

Nama Dosen : Meiliyani Siringoringo, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pengantar Model Linier	W	Dr. Sifriyani, S.Pd., M.Si	3	0	VI
2	Statistika Pengendalian Mutu	W	Dr. Sri Wahyuningsih, M.Si	2	1	IV
Total				5	1	

Nama Dosen : Surya Prangga, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Data Mining	W	Rito Goejantoro, S.Si., M.Si	2	1	IV
Total				2	1	

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN III
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

PROGRAM STUDI : S1-MATEMATIKA

NO	KODE MK	MATA KULIAH	SKS/ SMT	JENIS MK (W/P)	KURIKULUM	DOSEN PENGAMPU MK
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	210706604W005	Aljabar Linier Elementer	4/II	W	2021	Yuki Novia Nasution, S.Si., M.Sc Qonita Qurrota A'yun, S.Si., M.Sc
2	190706603W014	Kalkulus Peubah Banyak	3/IV	W	2019	Dr. Syaripuddin, M.Si Yuki Novia Nasution, S.Si., M.Sc
3	190706603W016	Fungsi Kompleks	3/IV	W	2019	Moh. Nurul Huda, S.Si., M.Si
4	190706603W017	Metode Numerik	3/IV	W	2019	Dr. Syaripuddin, M.Si Wasono, S.Si., M.Si
5	190706603W019	Persamaan Diferensial Biasa	3/IV	W	2019	Wasono, S.Si., M.Si Yuki Novia Nasution, S.Si., M.Sc
6	190706602P022	Teori Koding	2/IV	P	2019	Qonita Qurrota A'yun, S.Si., M.Sc
7	190706602P025	Teori Graf	2/IV	P	2019	Fidia Deny Tisna Amijaya, S.Si., M.Si Qonita Qurrota A'yun, S.Si., M.Sc
8	190706603W040	Pemodelan Matematika	3/VI	W	2019	Dr. Syaripuddin, M.Si Yuki Novia Nasution, S.Si., M.Sc
9	190706604P044	Persamaan Differensial Numerik	4/VI	P	2019	Fidia Deny Tisna Amijaya, S.Si., M.Si Moh. Nurul Huda, S.Si., M.Si
10	190706603P050	Riset Operasi II	3/VI	P	2019	Dr. Syaripuddin, M.Si Wasono, S.Si., M.Si

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN IV
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 947 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 MATEMATIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN

Nama Dosen : Dr. Syaripuddin, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kalkulus Peubah Banyak	W	Yuki Novia Nasution, S.Si., M.Sc	3	0	IV
2	Metode Numerik	W	Wasono, S.Si., M.Si	2	1	IV
3	Pemodelan Matematika	W	Yuki Novia Nasution, S.Si., M.Sc	3	0	VI
4	Riset Operasi II	P	Wasono, S.Si., M.Si	3	0	VI
Total				11	1	

Nama Dosen : Yuki Novia Nasution, S.Si., M.Sc

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Aljabar Linier Elementer	W	Qonita Qurrota A'yun, S.Si., M.Sc	4	0	II
2	Kalkulus Peubah Banyak	W	Dr. Syaripuddin, M.Si	3	0	IV
3	Persamaan Diferensial Biasa	W	Wasono, S.Si., M.Si	3	0	IV
4	Pemodelan Matematika	W	Dr. Syaripuddin, M.Si	3	0	VI
Total				13	0	

Nama Dosen : Fidia Deny Tisna Amijaya, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Teori Graf	P	Qonita Qurrota A'yun, S.Si., M.Sc	2	0	IV
2	Persamaan Differensial Numerik	P	Moh. Nurul Huda, S.Si., M.Si	3	1	VI
Total				5	1	

Nama Dosen : Qonita Qurrota A'yun, S.Si., M.Sc

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Aljabar Linier Elementer	W	Yuki Novia Nasution, S.Si., M.Sc	4	0	II
2	Teori Koding	P	-	2	0	IV
3	Teori Graf	P	Fidia Deny Tisna Amijaya. S.Si., M.Si	2	0	IV
Total				8	0	

Nama Dosen : Wasono, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Metode Numerik	W	Dr. Syaripuddin, M.Si	2	1	IV
2	Persamaan Diferensial Biasa	W	Yuki Novia Nasution, S.Si., M.Sc	3	0	IV
3	Riset Operasi II	P	Dr. Syaripuddin, M.Si	3	0	VI
Total				8	1	

Nama Dosen : Moh. Nurul Huda, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Fungsi Kompleks	W	-	3	0	IV
2	Persamaan Differensial Numerik	P	Fidia Deny Tisna Amijaya. S.Si., M.Si	3	1	VI
Total				6	1	

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN V
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

PROGRAM STUDI : S1-BIOLOGI

NO	KODE MK	MATA KULIAH	SKS/ SMT/ KLS	JENIS MK (W/P)	KURIKULUM	DOSEN PENGAMPU MK
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	210702603W003	Anatomi Hewan	3/II	W	2021	Dr. Retno Aryani, M.Si Rudy Agung Nugroho, M.Si., Ph.D
2	190702603W022	Fisiologi Tumbuhan	3/IV/ A&B	W	2019	Dr. Dwi Susanto, M.Si Dr. Hetty Manurung, M.Si
3	190702603P055	Mikrobiologi Lingkungan	3/VI	P	2019	Imam Rosadi, S.Si., M.Si Dr. Ir. Samsurianto, M.Si
4	190702603P057	Genetika Molekuler Mikrobia	3/VI	P	2019	Dr. rer. nat. Bodhi Dharma, M.Si Imam Rosadi, S.Si., M.Si
5	190702603P061	Endrokrinologi	3/VI	P	2019	Dr. Retno Aryani, M.Si Rudy Agung Nugroho, M.Si., Ph.D

Ditetapkan di Samarinda

REKTOR,

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN VI
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 BIOLOGI FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN

Nama Dosen : Imam Rosadi, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Mikrobiologi Lingkungan	P	Dr. Syafrizal, MP	2	1	VI
2	Genetika Molekuler Mikrobia	P	Dr. rer. nat. Bodhi Dharma, M.Si	2	1	VI
Total				4	2	

Nama Dosen : Dr. Ir. Samsurianto, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Mikrobiologi Lingkungan	P	Imam Rosadi, S.Si., M.Si	2	1	VI
Total				2	1	

Nama Dosen : Dr. rer. nat. Bodhi Dharma, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Genetika Molekuler Mikrobia	P	Imam Rosadi, S.Si., M.Si	2	1	VI
Total				2	1	

Nama Dosen : Dr. Dwi Susanto, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Fisiologi Tumbuhan	W	Dr. Hetty Manurung, M.Si	2	1	IV
Total				2	1	

Nama Dosen : Dr. Hetty Manurung, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Fisiologi Tumbuhan	W	Dr. Dwi Susanto, M.Si	2	1	IV
Total				2	1	

Nama Dosen : Rudy Agung Nugroho, M.Si., Ph.D

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Anatomi Hewan	W	Dr. Retno Aryani, M.Si	2	1	II
2	Endokrinologi	P	Dr. Retno Aryani, M.Si	2	1	VI
Total				4	2	

Nama Dosen : Dr. Retno Aryani, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Anatomi Hewan	W	Rudy Agung Nugroho, M.Si., Ph.D	2	1	II
2	Endokrinologi	P	Rudy Agung Nugroho, M.Si., Ph.D	2	1	VI
Total				4	2	

Ditetapkan di Samarinda

REKTOR,

Prof. Ir. H. Masjaya, M.Si.
NIP. 19621231199103102[illegible]

LAMPIRAN VII
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

PROGRAM STUDI : S1-KIMIA

NO	KODE MK	MATA KULIAH	SKS/ SMT	JENIS MK (W/P)	KURIKULUM	DOSEN PENGAMPU MK
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	190703602P033	Ikatan Kimia	2/IV	P	2019	Dr. Rahmat Gunawan, M.Si Veliyana Londong, S.Si., M.Si
2	190703602P038	Kimia Batu Bara	2/IV	P	2019	Dr. Saibun Sitorus, M.Si Prof. Dr. Ir. Daniel, M.Si
3	190703603W024	Sintesa Kimia Anorganik	3/VI	W	2019	Dr. Noor Hindryawati, M.Si Irfan Ashari Hiyahara, M.Si
4	190703602P061	Nanoteknologi dan Nanomaterial	2/VI	P	2019	Dr. Noor Hindryawati, M.Si Irfan Ashari Hiyahara, M.Si
5	190703602P062	Analisis Runut	2/VI	P	2019	Prof. Dr. Aman Sentosa Panggabean, M.Si Drs. H. Alimuddin, M.Si
6	190703602P069	Oleokimia Dasar	2/VI	P	2019	Dr. Chairul Saleh, M.Si Ritson Purba, S.Si. M.Si
7	190703602P070	Biokimia Medisinal	2/VI	P	2019	Ritbey Ruga, M.P., Ph.D Djihan Ryn Pratiwi, S.Si., M.Si

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN VIII
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 KIMIA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 KIMIA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN

Nama Dosen : Prof. Dr. Ir. Daniel, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kimia Batu Bara	P	Dr. Saibun Sitorus, M.Si	2	0	IV
Total				2	0	

Nama Dosen : Dr. Saibun Sitorus, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kimia Batu Bara	P	Prof. Dr. Ir. Daniel, M.Si	2	0	IV
Total				2	0	

Nama Dosen : Prof. Dr. Aman Sentosa Panggabean, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Analisis Runut	P	Drs. H. Alimuddin, M.Si	2	0	VI
Total				2	0	

Nama Dosen : Dr. H. Alimuddin, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Analisis Runut	P	Prof. Dr. Aman Sentosa Panggabean, M.Si	2	0	VI
Total				2	0	

Nama Dosen : Dr. Chairul Saleh, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Oleokimia Dasar	P	Ritson Purba, S.Si. M.Si	2	0	VI
Total				2	0	

Nama Dosen : Ritson Purba, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Oleokimia Dasar	P	Dr. Chairul Saleh, M.Si	2	0	VI
Total				2	0	

Nama Dosen : Dr. Noor Hindryawati, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Sintesa Kimia Anorganik	W	Irfan Ashari Hiyahara, M.Si	3	0	VI
2	Nanoteknologi dan Nanomaterial	P	Irfan Ashari Hiyahara, M.Si	2	0	VI
Total				5	0	

Nama Dosen : Irfan Ashari Hiyahara, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Sintesa Kimia Anorganik	W	Dr. Noor Hindryawati, M.Si	3	0	VI
2	Nanoteknologi dan Nanomaterial	P	Dr. Noor Hindryawati, M.Si	2	0	VI
Total				5	0	

Nama Dosen : Dr. Rahmat Gunawan, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Ikatan Kimia	P	Veliyana Londong, S.Si., M.Si	2	0	IV
Total				2	0	

Nama Dosen : Veliyana Londong Allo, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Ikatan Kimia	P	Dr. Rahmat Gunawan, M.Si	2	0	IV
Total				2	0	

Nama Dosen : Ritbey Ruga, MP., Ph.D

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Biokimia Medisinal	P	Djihan Ryn Pratiwi, S.Si., M.Si	2	0	VI
Total				2	0	

Nama Dosen : Djihan Ryn Pratiwi, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Biokimia Medisinal	P	Ritbey Ruga, M.P., Ph.D	2	0	VI
Total				2	0	

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Ir. H. Masjaya, M.Si.

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LAMPIRAN IX
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

PROGRAM STUDI : S1-FISIKA

NO	KODE MK	MATA KULIAH	SKS/ SMT	JENIS MK (W/P)	KURIKULUM	DOSEN PENGAMPU MK
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	190704602W008	Fisika Lingkungan	2/II	W	2019	Dr. Mislan, M.Si Dadan Hamdani, M.Si
2	190704603P049	Biofisika	3/IV	P	2019	Kadek Subagiada, M.Si Devina Rayzy Perwitasari Sutaji Putri, S.Si., M.Sc
3	190704602W037	Kapita Selekta	2/VI	W	2019	Wahidah, S.Si., MT Rahmiati, S.Si., M.Sc
4	190704603P070	Pemodelan Oseanografi	3/VI	P	2019	Dr. Eng. Idris Mandang, M.Si Dr. Sc. Mustaid Yusuf, M.Si
5	190704603P066	Pengantar Mikro Prosesor	3/VI	P	2019	Dr. Syahrir, M.Si Ahmad Zarkasi, S.Si., M.Si

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Dr. H. Masjaya, M.Si.
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LAMPIRAN X
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 847 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 FISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 FISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN

Nama Dosen : Dr. Mislan, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Fisika Lingkungan	W	Dadan Hamdani, M.Si	2	0	II
Total				2	0	

Nama Dosen : Dadan Hamdani, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Fisika Lingkungan	W	Dr. Mislan, M.Si	2	0	II
Total				2	0	

Nama Dosen : Dr. Syahrir, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pengantar MikroProsesor	P	Ahmad Zarkasi, S.Si., M.Si	2	1	VI
Total				2	1	

Nama Dosen : Ahmad Zarkasi, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pengantar Mikroprosesor	P	Dr. Syahrir, M.Si	2	1	VI
Total				2	1	

Nama Dosen : Dr. Eng. Idris Mandang, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pemodelan Oseanografi	P	Dr. Sc. Mustaid Yusuf, M.Si	2	1	VI
Total				2	1	

Nama Dosen : Dr. Sc. Mustaid Yusuf, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pemodelan Oseanografi	P	Dr. Eng. Idris Mandang, M.Si	2	1	VI
Total				2	1	

Nama Dosen : Kadek Subagiada, S.Si., M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Biofisika	P	Devina Razy Perwitasari Sutaji Putri, S.Si., M.Sc	3	0	VI
Total				3	0	

Nama Dosen : Devina Rayzy Perwitasari Sutaji Putri, S.Si., M.Sc

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Biofisika	P	Kadek Subagiada, S.Si., M.Si	3	0	IV
Total				3	0	

Nama Dosen : Wahidah, S.Si., MT

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kapita Selekta	W	Rahmiati, S.Si., M.Sc	2	0	VI
Total				2	0	

Nama Dosen : Rahmiati, S.Si., M.Sc

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kapita Selekta	W	Wahidah, S.Si., MT	2	0	VI
Total				2	0	

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

LAMPIRAN XI
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 547 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
PENGANGKATAN DOSEN PENGAMPU MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PADA PROGRAM STUDI S1 STATISTIKA, S1 MATEMATIKA, S1 BIOLOGI, S1 KIMIA, S1 FISIKA DAN S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

PROGRAM STUDI : S1-GEOFISIKA

NO	KODE MK	MATA KULIAH	SKS/ SMT	JENIS MK (W/P)	KURIKULUM	DOSEN PENGAMPU MK
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	190707602P043	Geologi Cekungan Kutai	2/IV	P	2019	Dr. Syahrir, M.Si
						Dr. Ery Arifullah, Ph.D
2	190707603W030	Metode Geolistrik dan Elektromagnetik	3/VI	W	2019	Dr. Djayus, M.T
						Dr. Syahrir, M.Si
3	190707602W032	Kapita Selekta	2/VI	W	2019	Wahidah, S.Si, M.T
						Rahmiati, S.Si., M.Sc
4	190707603W035	Kuliah Lapangan Geofisika	3/VI	P	2019	Dr. Supriyanto, M.T
						Dr. Djayus, M.T
5	190707603P065	Pemodelan Oseanografi	3/VI	P	2019	Dr. Eng. Idris Mandang, M.Si
						Dr. Sc. Mustaid Yusuf, M.Si

Ditetapkan di Samarinda

REKTOR,

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI UNIVERSITAS MULAWARMAN REKTOR

Prof. Dr. H. Masjaya, M.Si.
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LAMPIRAN XII
KEPUTUSAN REKTOR UNIVERSITAS MULAWARMAN
NOMOR 847 /UN17/HK/2022
TANGGAL 12 JANUARI 2022
TENTANG
MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN.

MATRIKS MATA KULIAH PROGRAM MERDEKA BELAJAR KAMPUS MERDEKA (MBKM) SEMESTER GENAP TAHUN AKADEMIK 2021/2022 PROGRAM STUDI S1 GEOFISIKA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM UNIVERSITAS MULAWARMAN

Nama Dosen : Dr. Eng. Idris Mandang, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pemodelan Oseanografi	P	Dr. Sc. Mustaid Yusuf, M.Si	2	1	VI
Total				2	1	

Nama Dosen : Dr. Sc. Mustaid Yusuf, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Pemodelan Oseanografi	P	Dr. Eng. Idris Mandang, M.Si	2	1	VI
Total				2	1	

Nama Dosen : Dr. Syahrir, M.Si

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Geologi Cekungan Kutai	P	Dr. Ery Arifullah, Ph.D	2	0	IV
2	Metode Geolistrik dan Elektromagnetik	W	Dr. Djayus, MT	2	1	VI
Total				4	1	

Nama Dosen : Dr. Djayus, MT

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Metode Geolistrik dan Elektromagnetik	W	Dr. Syahrir, M.Si	2	1	VI
2	Kuliah Lapangan Geofisika	P	Dr. Supriyanto, M.T	0	3	VI
Total				2	4	

Nama Dosen : Dr. Supriyanto, MT

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kuliah Lapangan Geofisika	P	Dr. Djayus, MT	0	3	VI
Total				0	3	

Nama Dosen : Wahidah, S.Si., MT

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kapita Selekta	W	Rahmiati, S.Si., M.Sc	2	0	VI
Total				2	0	

Nama Dosen : Rahmiati, S.Si., M.Sc

NO	MATA KULIAH	W/P	DOSEN PARTNER	SKS		SMT
				TEORI	PRAKTEK	
1	Kapita Selekta	W	Wahidah, S.Si., M.T	2	0	VI
Total				2	0	

Ditetapkan di Samarinda

REKTOR,

Prof. Dr. H. Masjaya, M.Si.
NIP 196212311991031024

PENGANTAR MIKROKONTROLER

Pertemuan 1

Ahmad Zarkasi

KULIAH PENDAHULUAN

PENGANTAR TEKNOLOGI MIKROKONTROLER

Capaian Pembelajaran

- Mahasiswa memahami perbedaan mikrokontroler dan mikroprosesor
- Mahasiswa memahami perkembangan teknologi mikrokontroler
- Mahasiswa mengetahui implementasi mikrokontroler

Apakah Mikrokontroler itu?
Apakah sama dengan Mikroprosesor?
Apa bedanya dengan Komputer?

Computer is a machine that can be instructed to carry out sequences of arithmetic or logical operations automatically via computer programming.

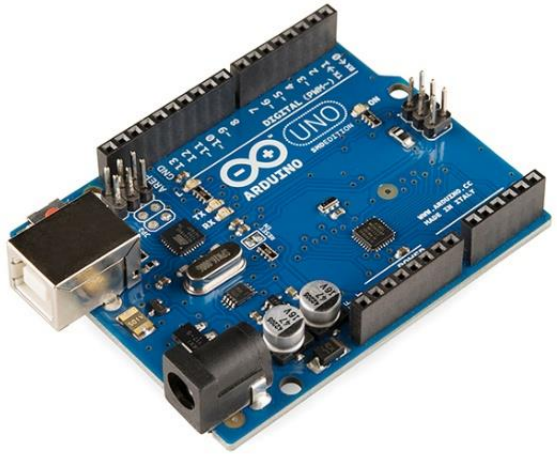
(*Source*: wkipedia.org).

Microprocessor is an electronic component that is used by a computer to do its work. It is a central processing unit on a single integrated circuit.

(*Source*: wkipedia.org).

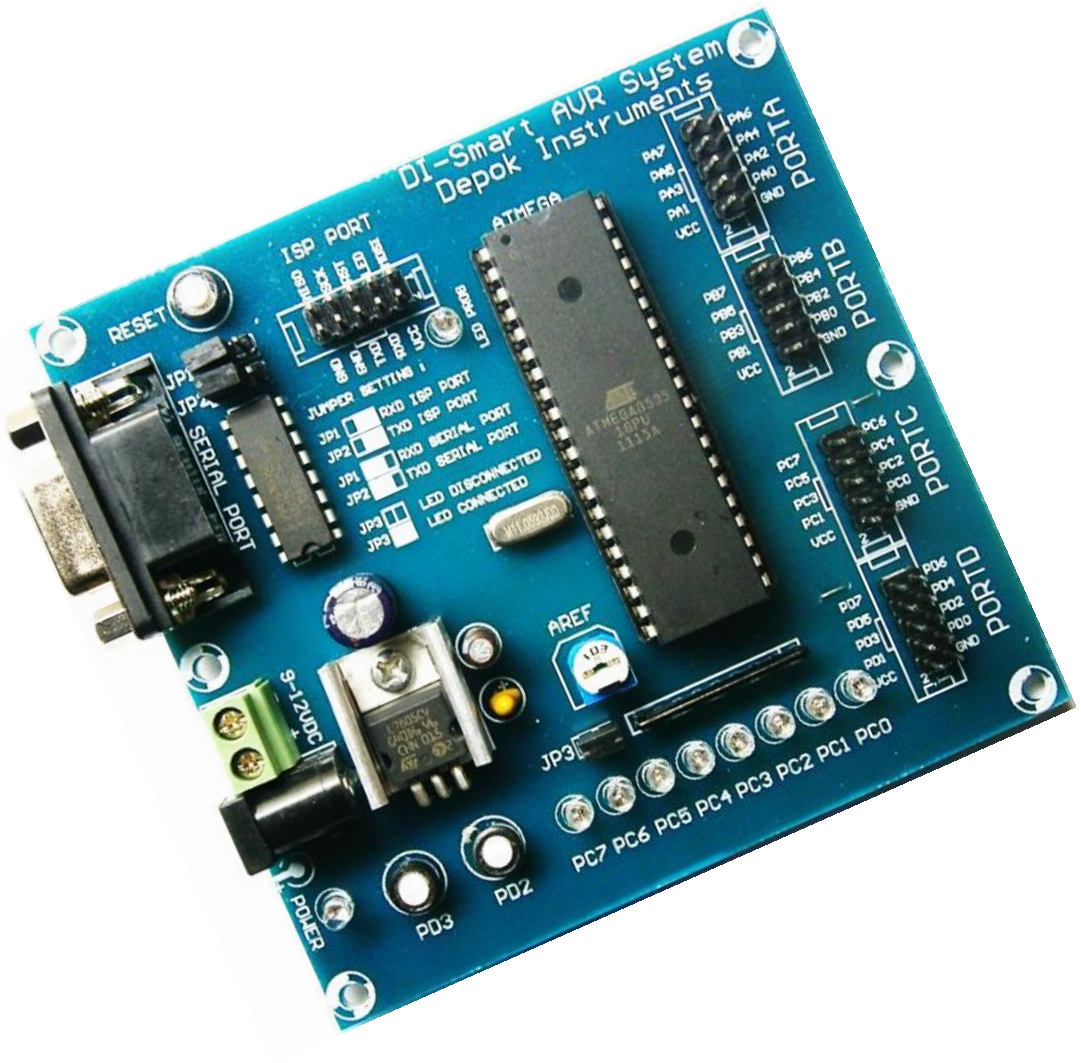
Computer Vs Microcontroller

- CPU
- HDD/SSD & RAM
- System Clock
- Peripheral
- Menjalankan berbagai fungsi dan dapat dieksekusi secara bersamaan



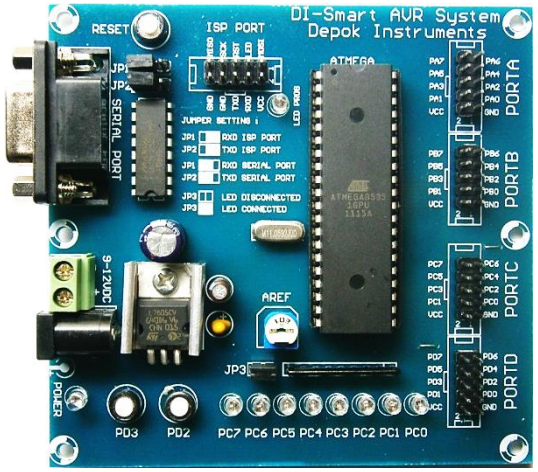
- CPU
- Memory
- System Clock
- Peripheral
- Dibuat untuk menjalankan fungsi khusus

Apakah Mikrokontroler itu?

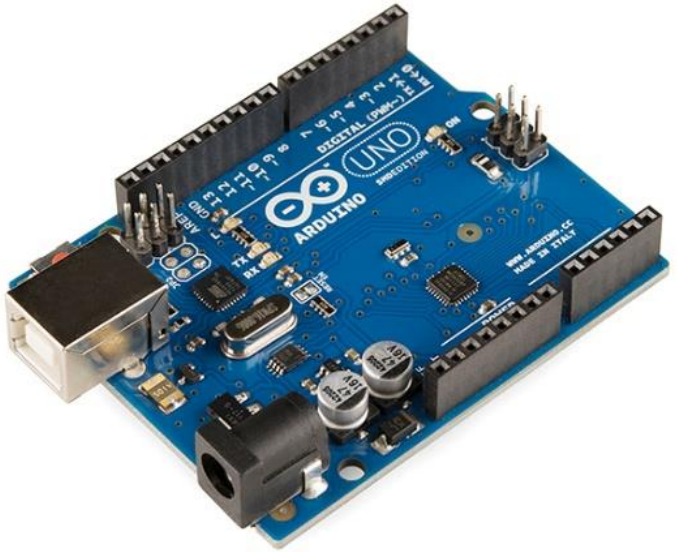


A **microcontroller** is a small and low-cost microcomputer, which is designed to perform the specific tasks of embedded systems (on chip/IC).

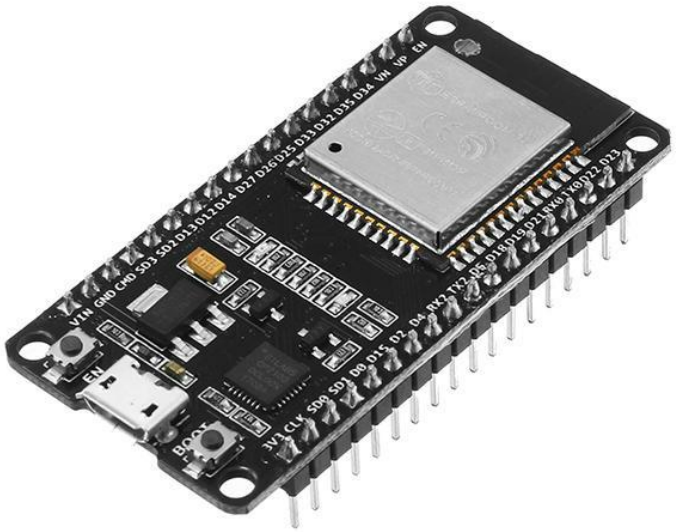
Beberapa jenis modul mikrokontroler yang populer



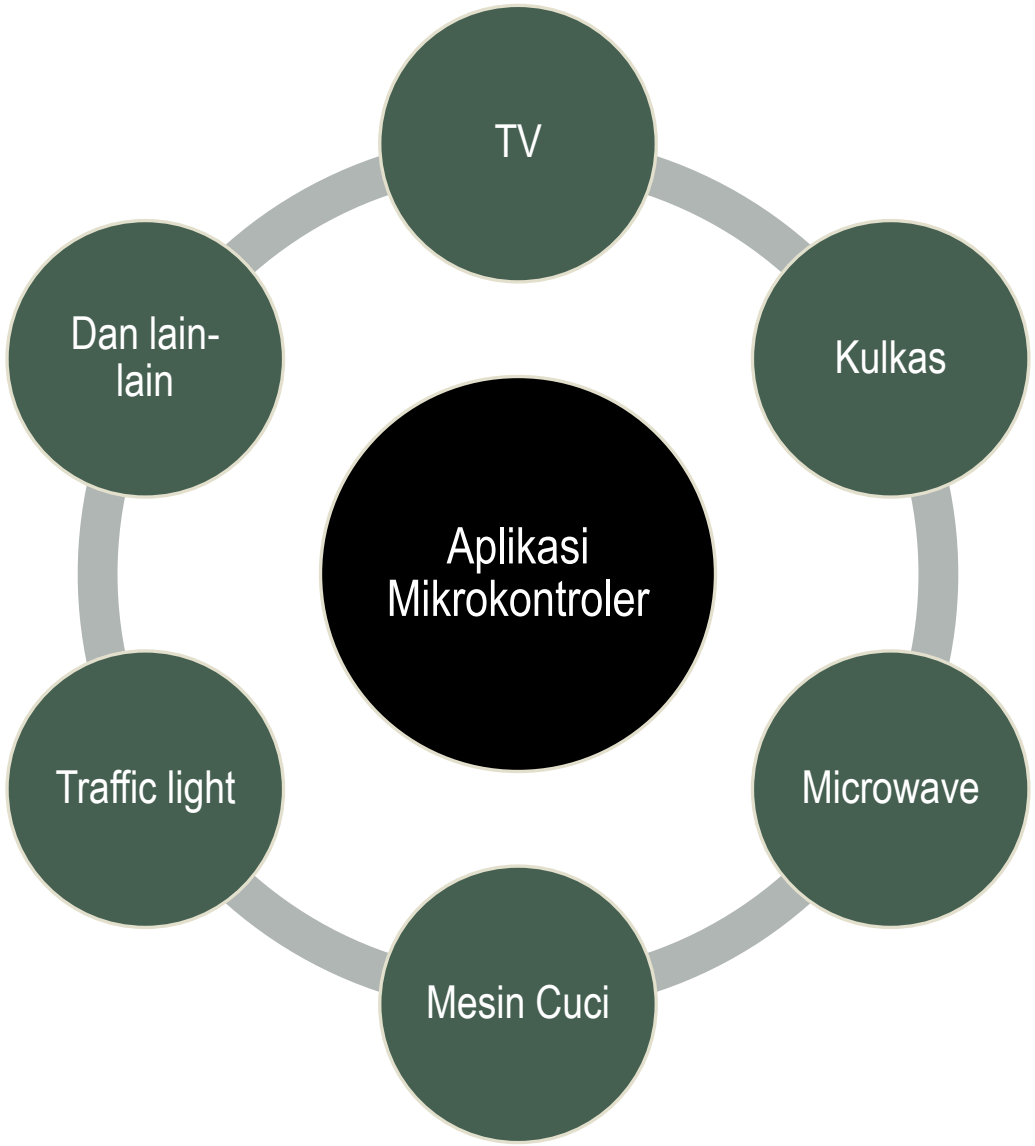
AVR



Arduino



ESP32


TV
Kulkas
Microwave
Mesin Cuci
Traffic light
Dan lain-lain
Aplikasi Mikrokontroler

Microcontroller Vs Microprocessor

Microcontroller	Microprocessor
Microcontrollers are used to execute a single task within an application.	Microprocessors are used for big applications.
Its designing and hardware cost is low.	Its designing and hardware cost is high.
Easy to replace.	Not so easy to replace.
It is built with CMOS technology, which requires less power to operate.	Its power consumption is high because it has to control the entire system.
It consists of CPU, RAM, ROM, I/O ports.	It doesn't consist of RAM, ROM, I/O ports. It uses its pins to interface to peripheral devices.

(*Source*: tutorialspoint.com)

MIKROKONTROLER 8051

8051 dan Turunannya

Merupakan jenis mikrokontroler 8bit yang paling terkenal, dikeluarkan oleh INTEL Corporation pada tahun 1981. Keberadaannya sudah sangat lama dan turunannya sangat banyak (ratusan ribu dari berbagai produsen).

Memory Program Internal

- Menggunakan *on-chip ROM*
- Ukuran *on-chip ROM* : 0kByte(8031), 4kByte(8051), 8kByte(8052)

RAM Internal

- Ukuran : 128Byte(8051), 256Byte(8052)

Memory Eksternal

- Memory program dan data dapat dikembangkan sampai 64kByte menggunakan memory eksternal.

MIKROKONTROLER 8051 (Lanjutan)

ATMEL

- Pertama kali mengenalkan AT89C51 dengan *programmable flash memory* (bisa dihapus dan ditulis kembali)
- Juga mengenalkan AT89S5X dengan kemampuan *In System Programmable*

INTEL

- Pendesain awal 8051
- Dokumentasi yang terkait dengan 8051 disa dilihat di :
  http://developer.intel.com/design/mcs51/docs_mcs51.htm.

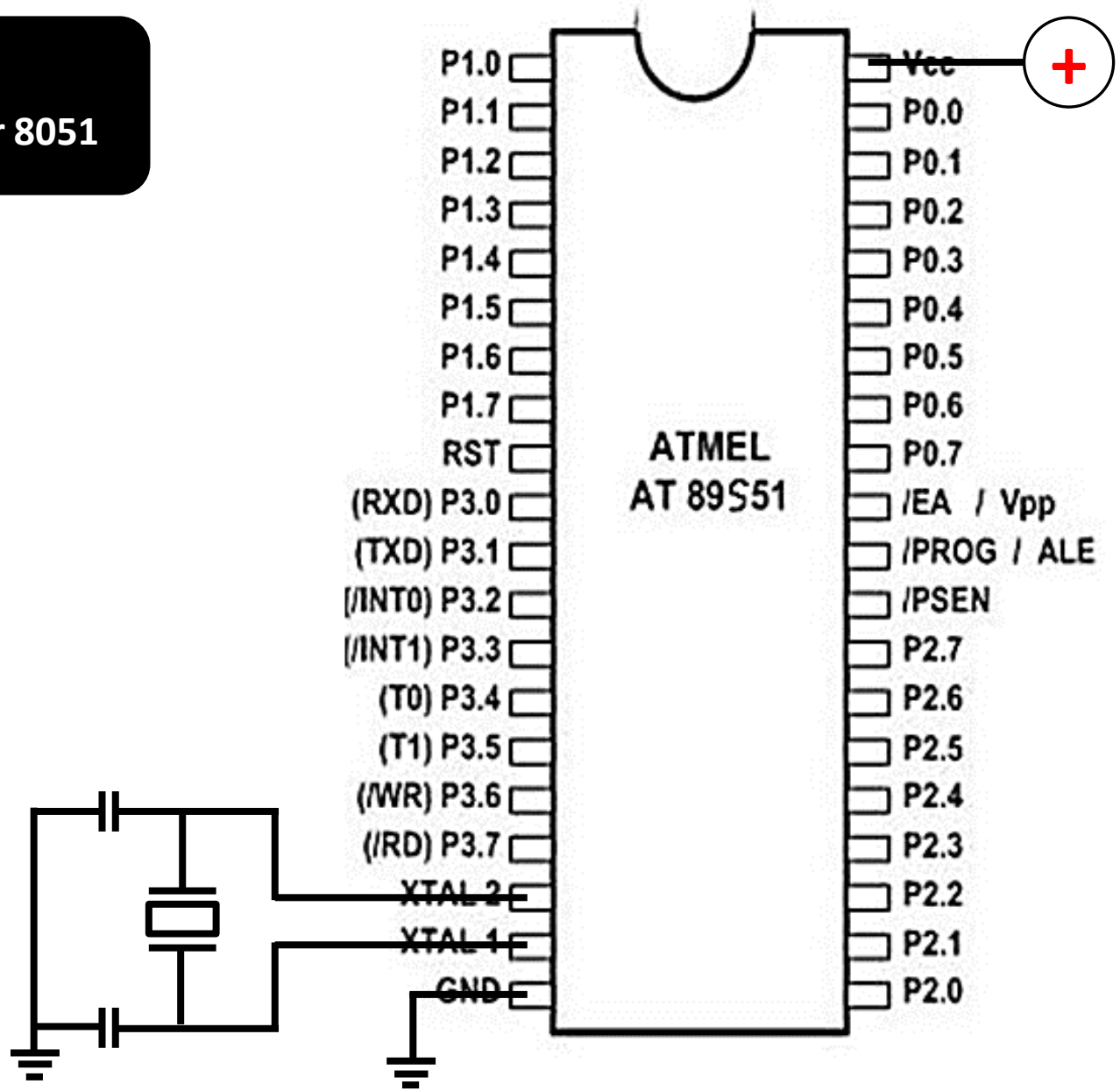
MAXIM (DALLAS SEMICONDUCTOR)

- Produk dari Maxim bisa dilihat di :
  http://www.maxim-ic.com/products/microcontrollers/high_speed.cfm

PHILLIPS

- Produk dari Phillips bisa dilihat di :
  http://www.standardics.philips.com/products/microcontrollers/

Contoh
Mikrokontroler 8051



MIKROKONTROLER AVR

AVR (dari ATMEL)

Merupakan mikrokontroler 8-bit *(RISC,* didasari dari *Harvard architecture)*, dengan instruksi selebar 16bit (8 bit opcode). Mikrokontroler ini merupakan pesaing PIC.

Memory Program

- Menggunakan *flash memory* (sampai 256k)
- Ukuran *flash memory* kadang bisa dilihat dari nama IC-nya (ATmega64x :64 kByte)
- *AVR* dapat mengambil instruksi berikutnya sementara instruksi saat ini masih dikerjakan (teknik *single level pipeline*)
- Sebagian besar instruksi butuh hanya 1 atau 2 siklus instruksi. Oleh karena itu AVR merupakan mikrokontroler yang relatif lebih cepat bila dibandingkan mikrokontroler 8bit lainnya.

Memory Data Internal

- Terbagi sbb : register internal (sebanyak 32 register 8bit), register I/O (sebanyak 64) dan SRAM (sampai 8k)

EEPROM Internal

- Sebagian AVR menyediakan EEPROM internal untuk penyimpanan data semi permanen (sampai 4kB).

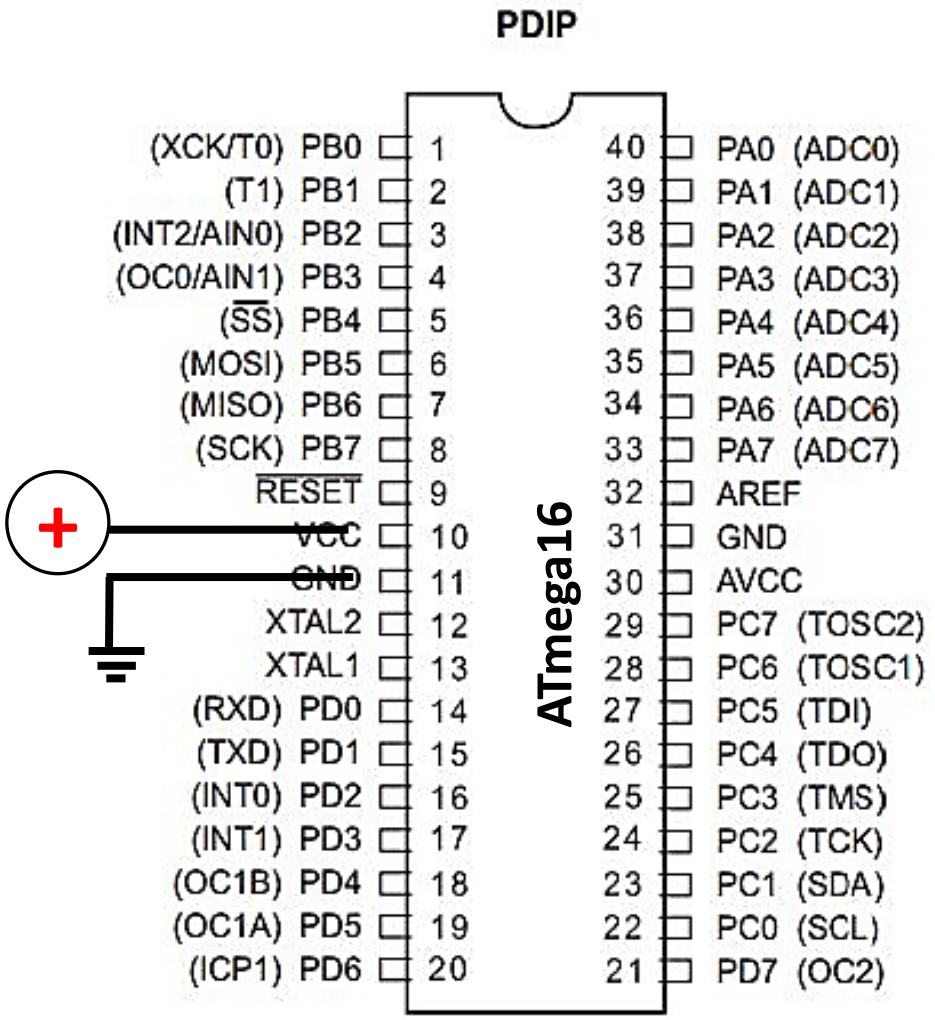
Kecepatan MCU

- Menggunakan clock sampai 16 MHz, sebagian sampai 20MHz

Pin Descriptions

Contoh Mikrokontroler AVR

- **VCC (pin number 10)**
  Digital supply voltage
- **GND (pin number 11 & 31)**
  Ground
- **PORT A (PA7..PA0/ pin number 33..40)**
  General I/O, Analog input for A/D Converter
- **PORT B (PB0..PB7/ pin number 22..29)**
  General I/O, Timer/Counter, Ext. Interrupt, Analog Comparator, SPI
- **PORT C (PC0..PC7/ pin number 22..29)**
  General I/O, TWI, JTAG, Timer oscillator
- **PORT D (PD0..PD7/ pin number 14..21)**
  General I/O, USART, Ext. Interrupt, Timer/Counter
- **RESET (pin number 9)**
  Reset MCU
- **XTAL1 & XTAL2 (pin number 12 & 13)**
  Input and output of inverting oscillator
- **AVCC (pin number 30)**
  Supply voltage pin for Port A and the A/D Converter
- **AREFF (pin number 32)**
  Analog reference for A/D Converter



MIKROKONTROLER AVR (Lanjutan)

KELUARGA AVR

tinyAVR

- Memori program : 1-8 kB
- IC : 8-20 pin
- Periferal dalam tinyAVR terbatas

megaAVR

- Memori program : 4-256 kB
- IC : 28-100 pin
- Mendukung lebih banyak kumpulan instruksi (perkalian dll)
- Menyediakan periferal yang lebih lengkap

AVR untuk aplikasi tertentu

- Contoh untuk *LCD controller*, *USB controller*, *advanced PWM* etc.

CATATAN

- **Sangat cocok bila kita membutuhkan MCU yang cukup cepat.**
- **Memudahkan kita yang ingin menggunakan kontroler seperti : CAN, USB, Ethernet dll, karena telah terintegrasi dalam sebagian periferal.**

SEKIAN DAN TERIMA KASIH

PENGANTAR MIKROKONTROLER

Pertemuan 2

Ahmad Zarkasi

MATERI BAHASAN

ARSITEKTUR AVR

Pin Descriptions

- **VCC (pin number 10)**
  Digital supply voltage
- **GND (pin number 11 & 31)**
  Ground
- **PORT A (PA7..PA0/ pin number 33..40)**
  General I/O, Analog input for A/D Converter
- **PORT B (PB0..PB7/ pin number 22..29)**
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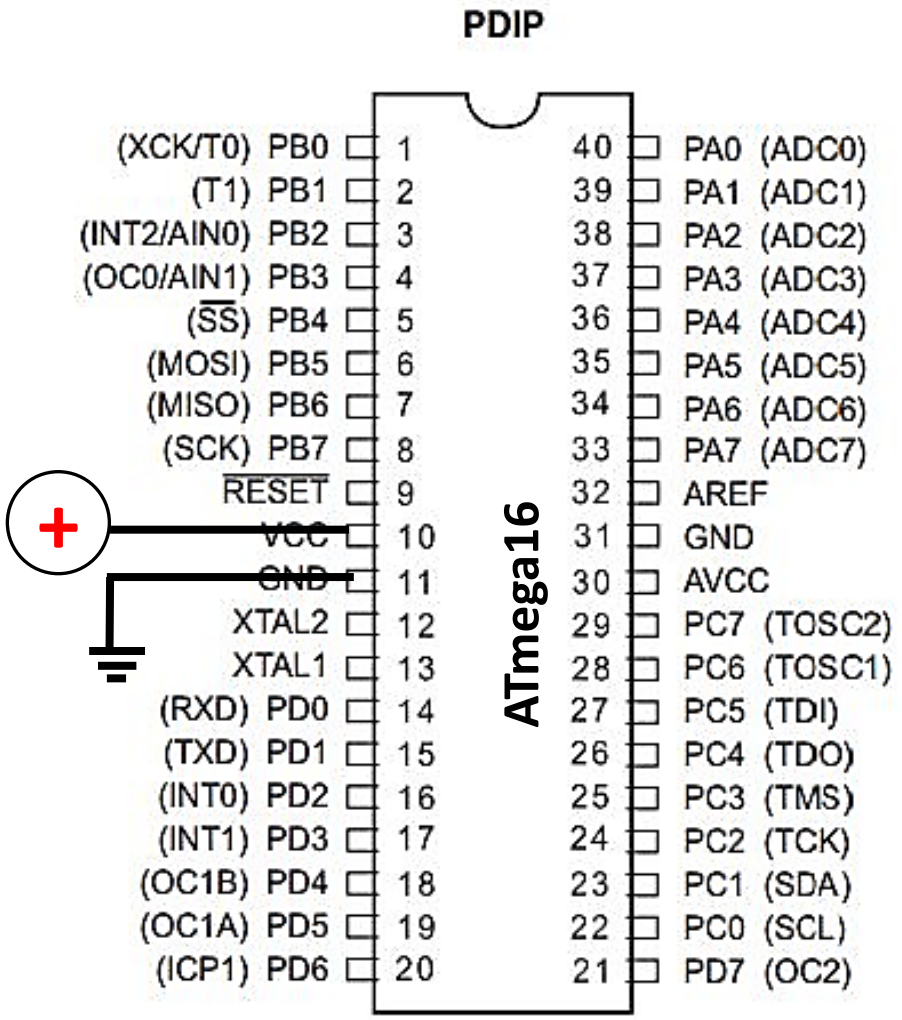
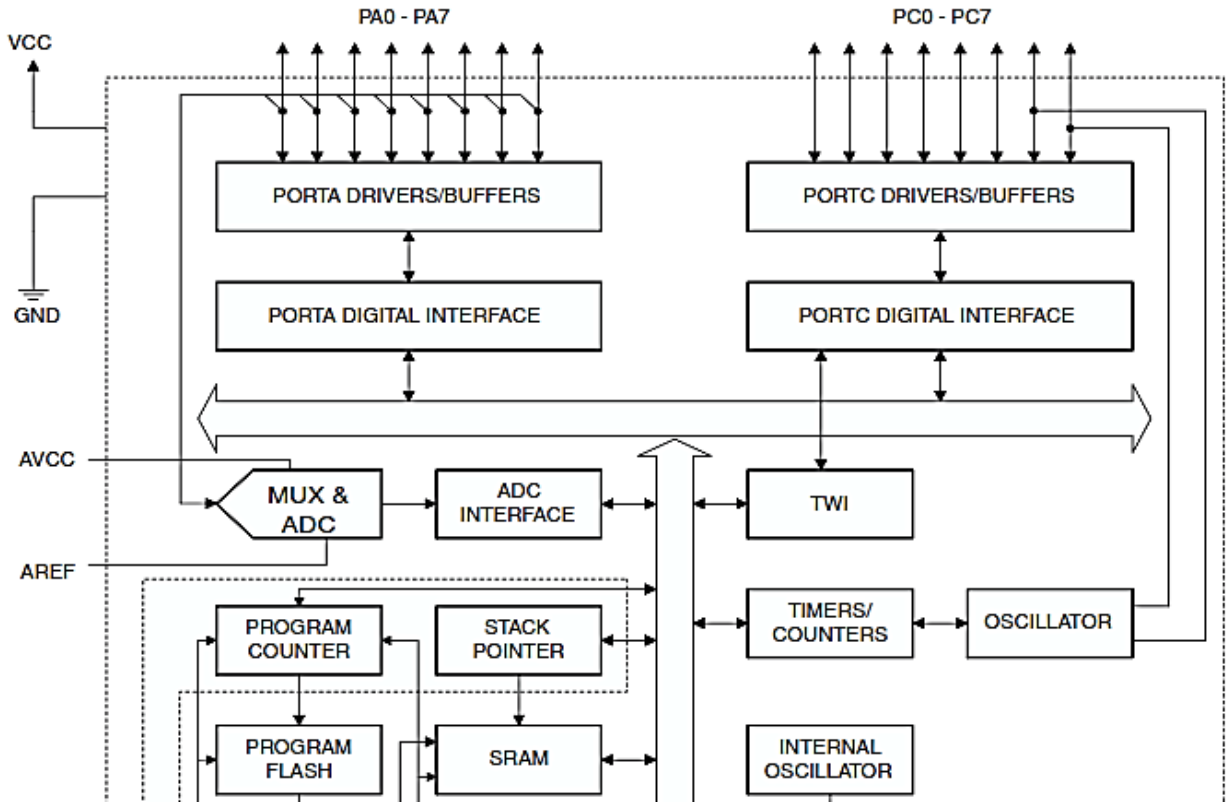
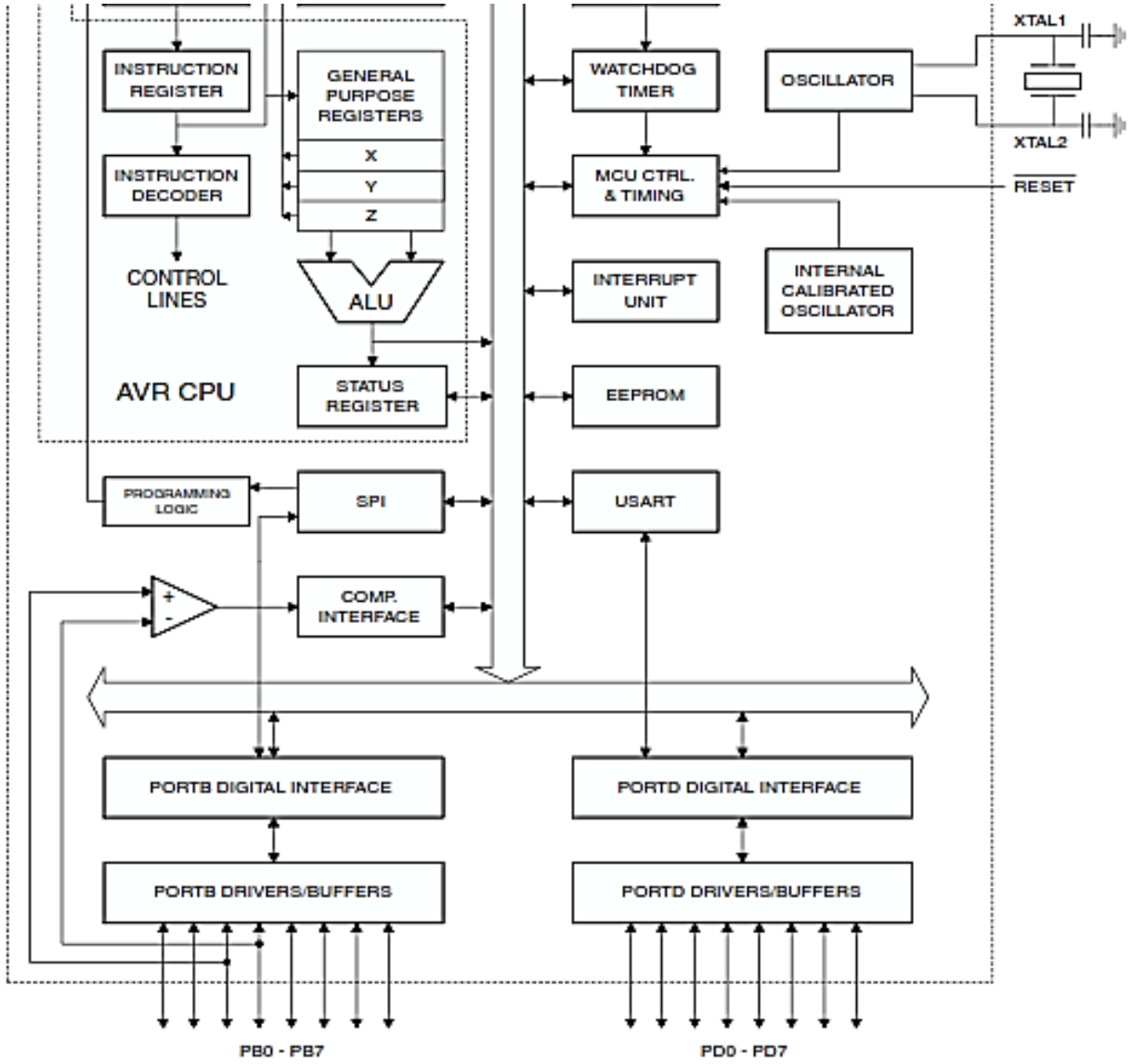
  Analog reference for A/D Converter



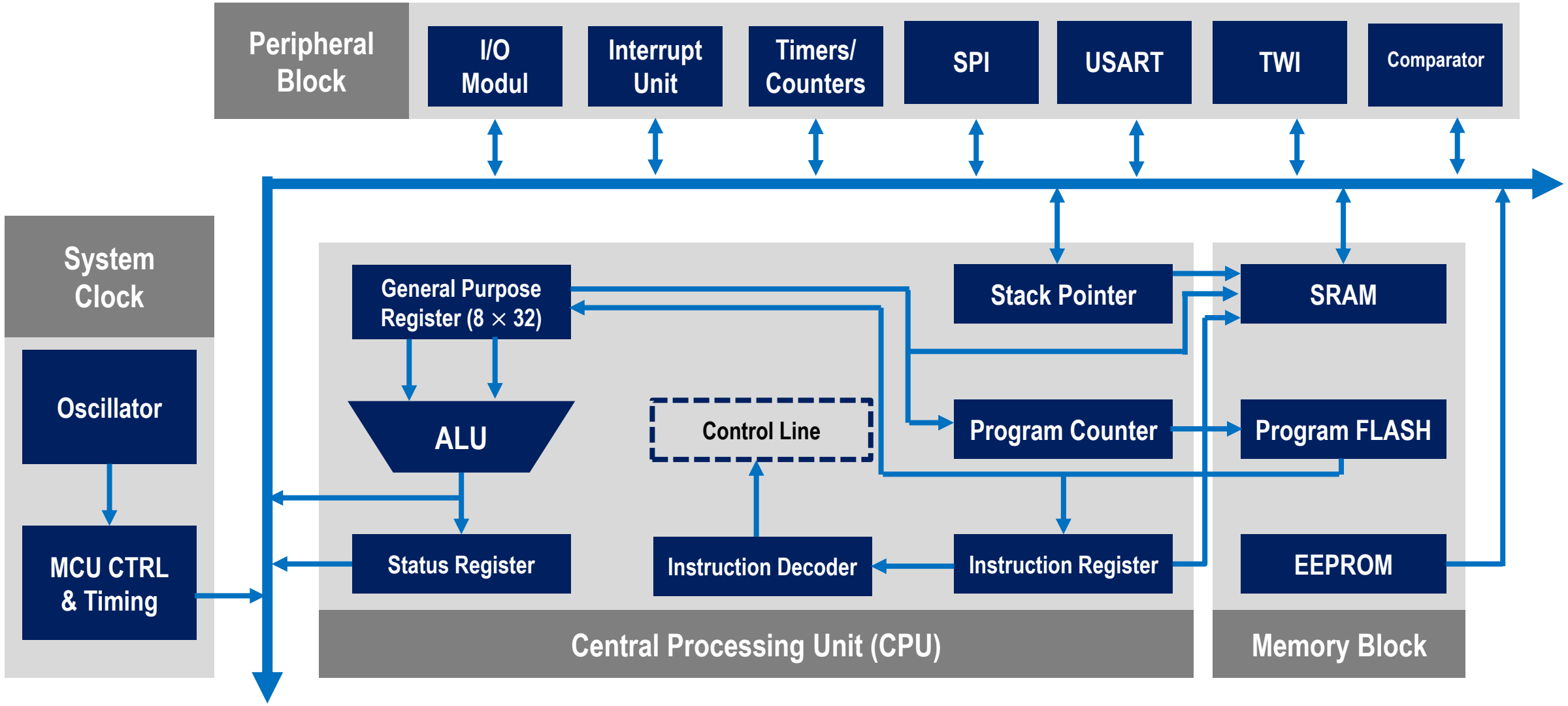
Blok Diagram ATmega16



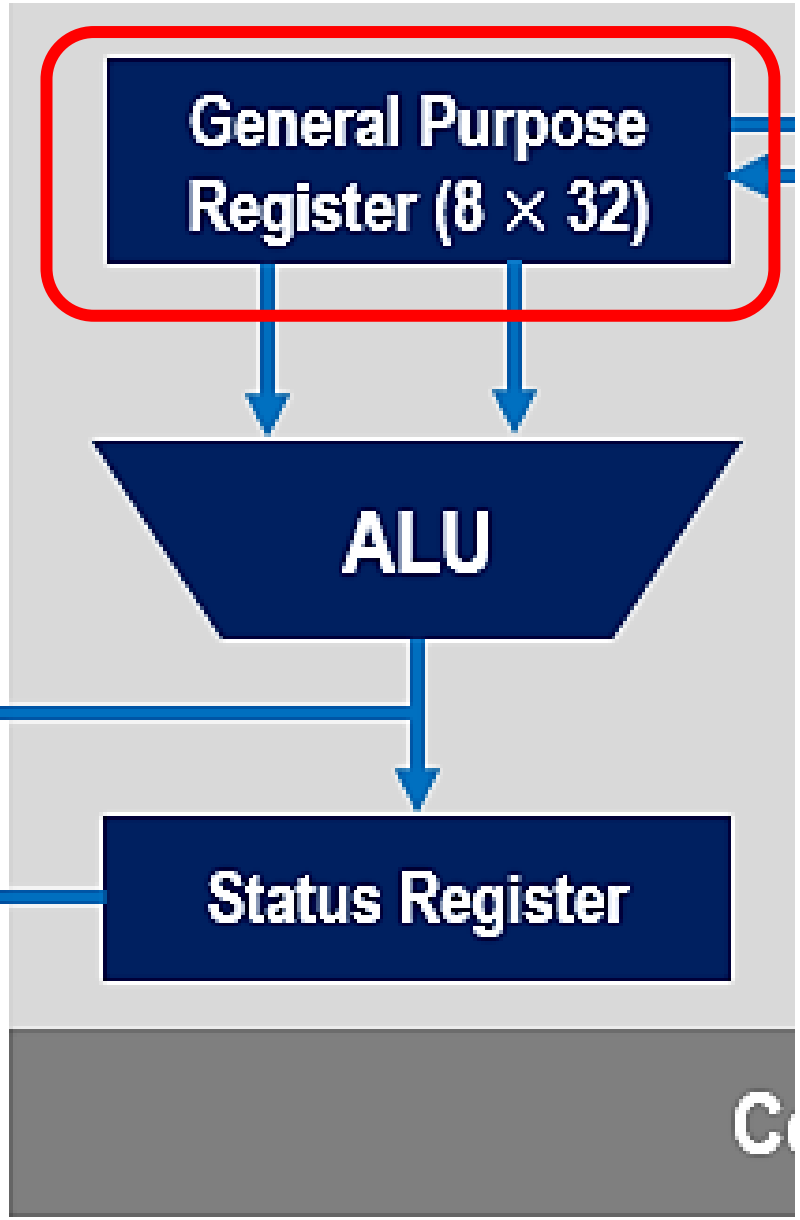
Blok Diagram ATmega16 (Lanjutan)



Arsitektur AVR (ATmega16)

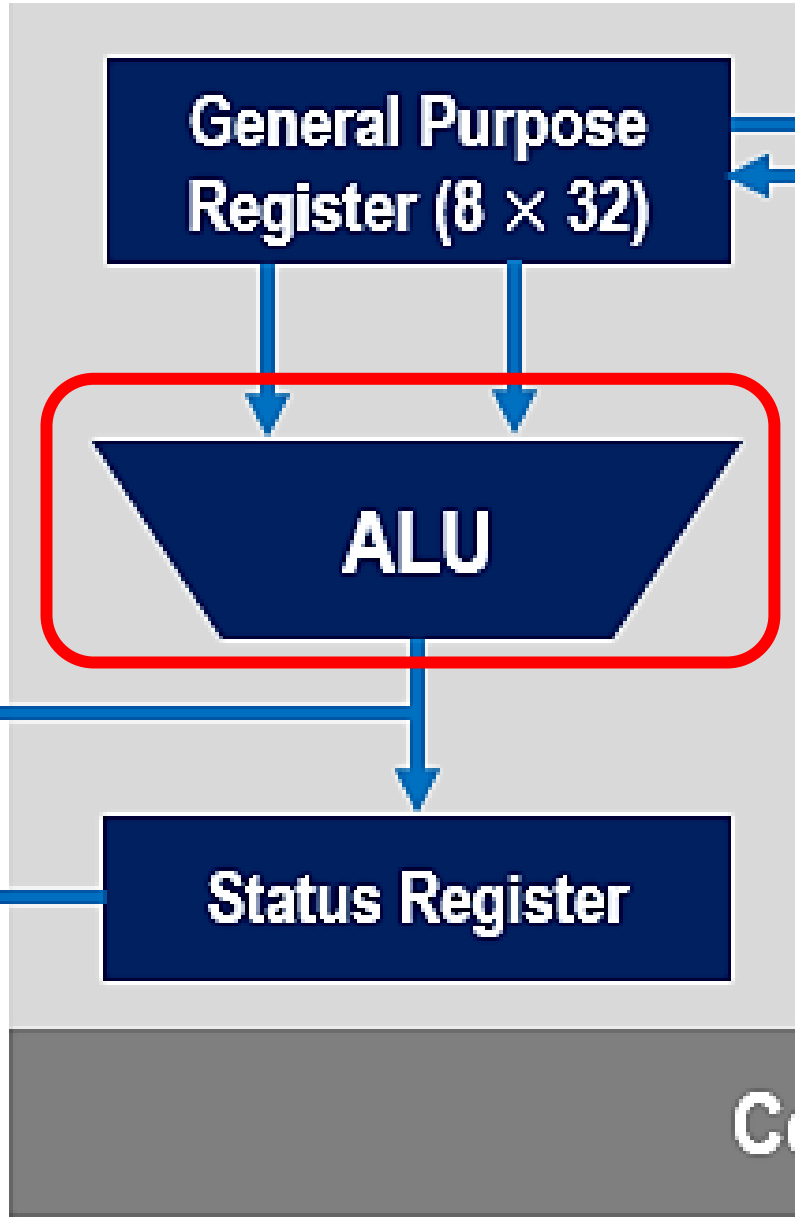


❖ Central Processing Unit

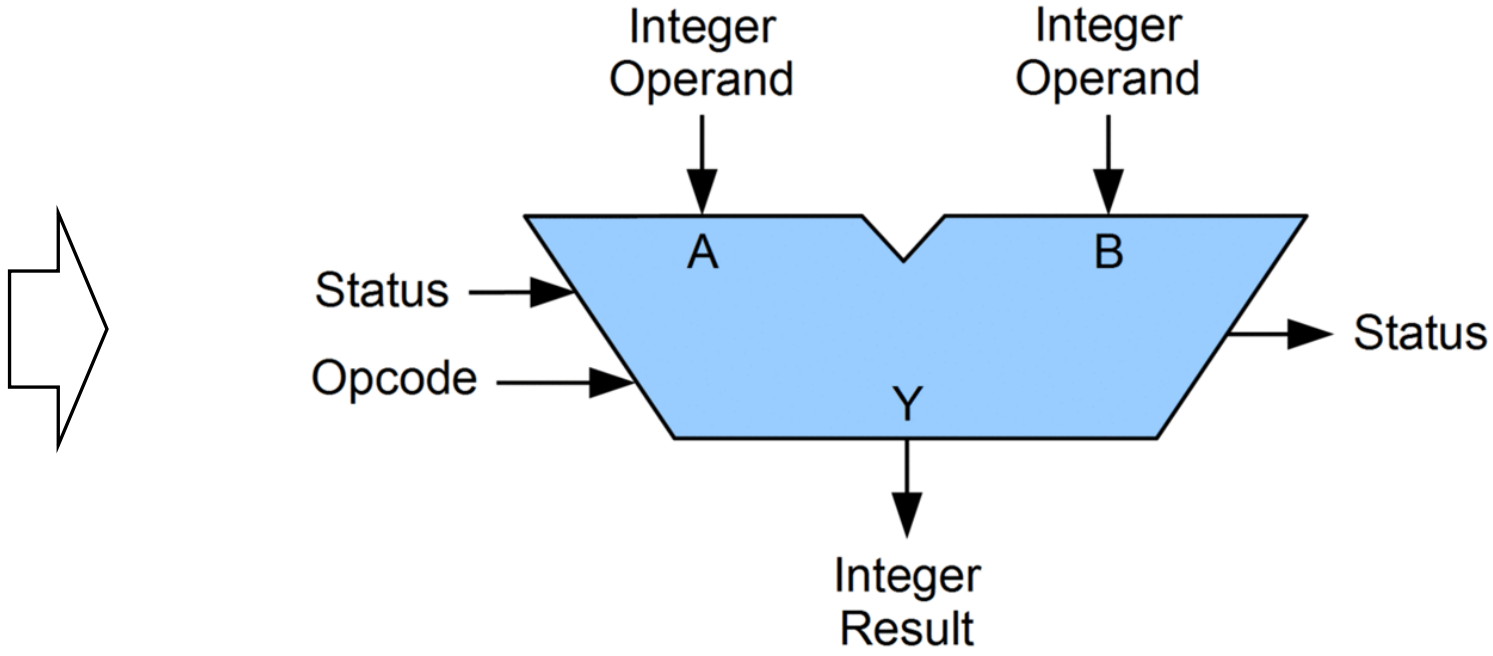


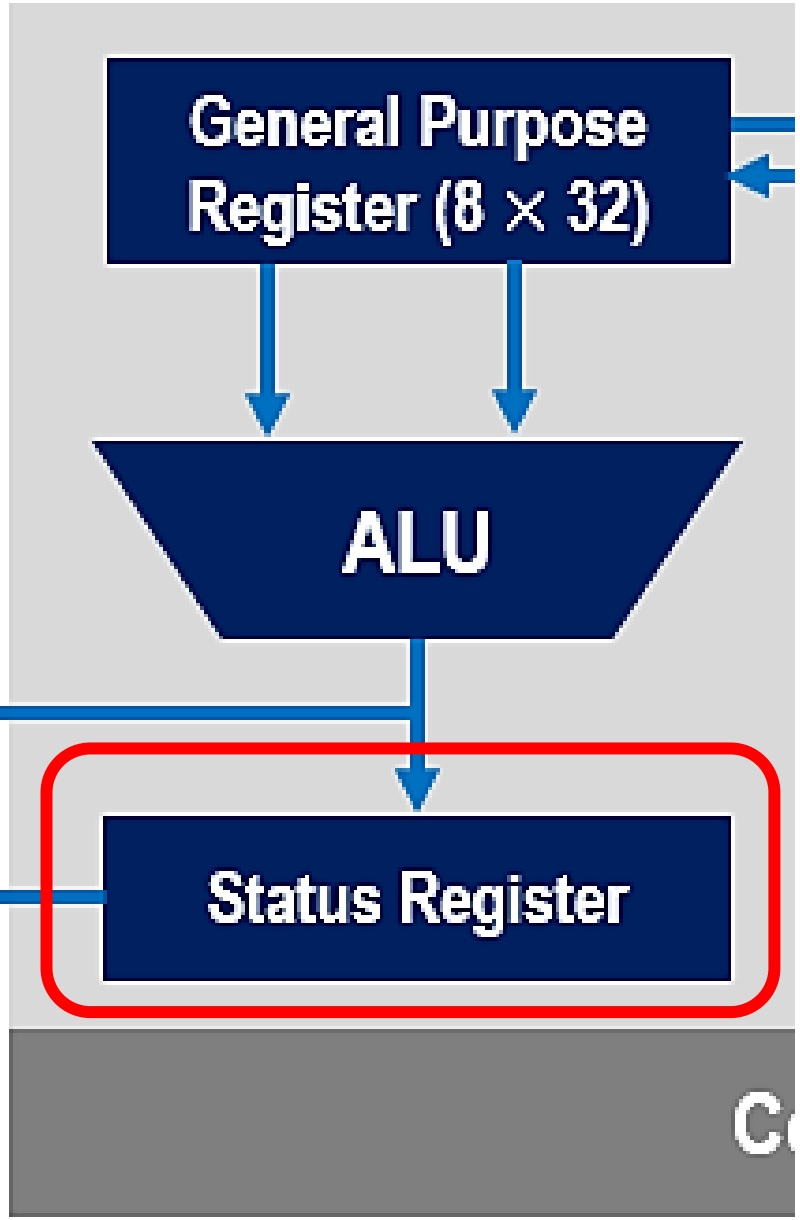
Register :
Sebuah slot yang berfungsi untuk menyimpan data, alamat, kode instruksi, dan bit status

	7 0	Addr.	
General Purpose Working Registers	R0	0x00	
	R1	0x01	
	R2	0x02	
	...		
	R13	0x0D	
	R14	0x0E	
	R15	0x0F	
	R16	0x10	
	R17	0x11	
	...		
	R26	0x1A	X-register Low Byte
	R27	0x1B	X-register High Byte
	R28	0x1C	Y-register Low Byte
	R29	0x1D	Y-register High Byte
	R30	0x1E	Z-register Low Byte
	R31	0x1F	Z-register High Byte

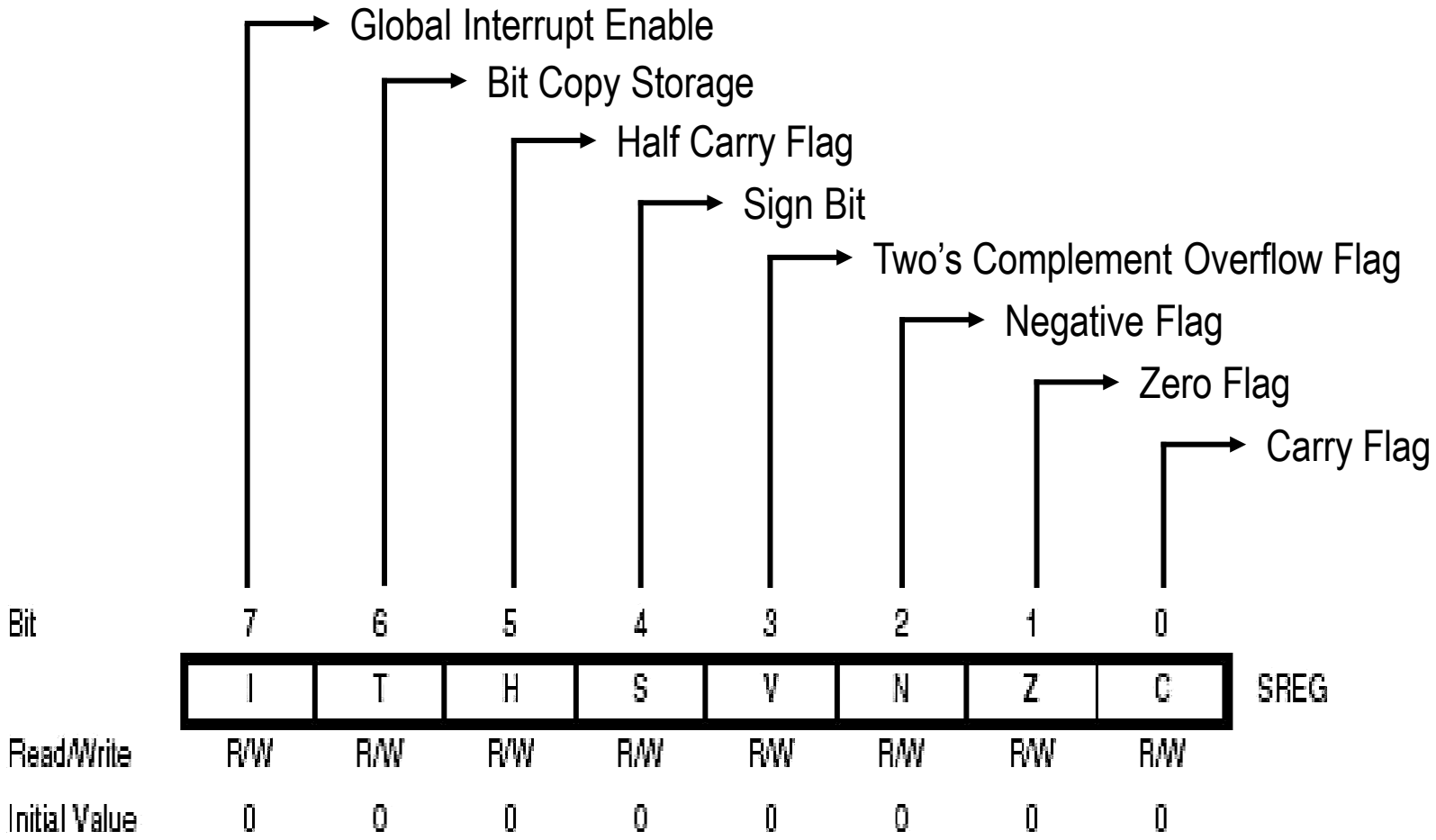


ALU (Arithmetic Logic Unit):
Berfungsi melakukan perhitungan matematika dan logika.





Status Register:
Berisi informasi tentang hasil operasi
operasi arithmetic logic unit.

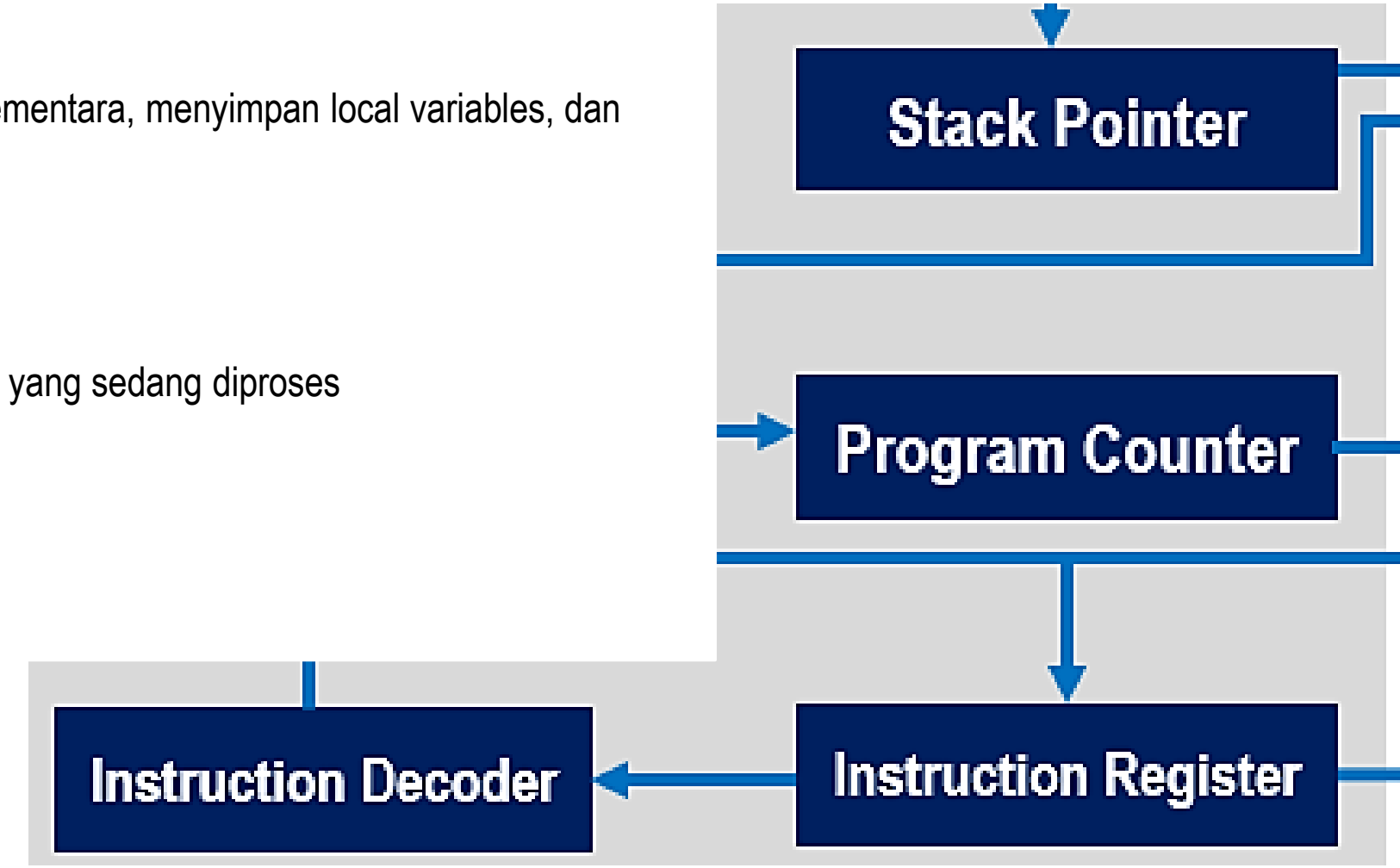


Stack Pointer:
Umumnya digunakan untuk menyimpan data sementara, menyimpan local variables, dan menyimpan alamat kembali setelah interrupt.

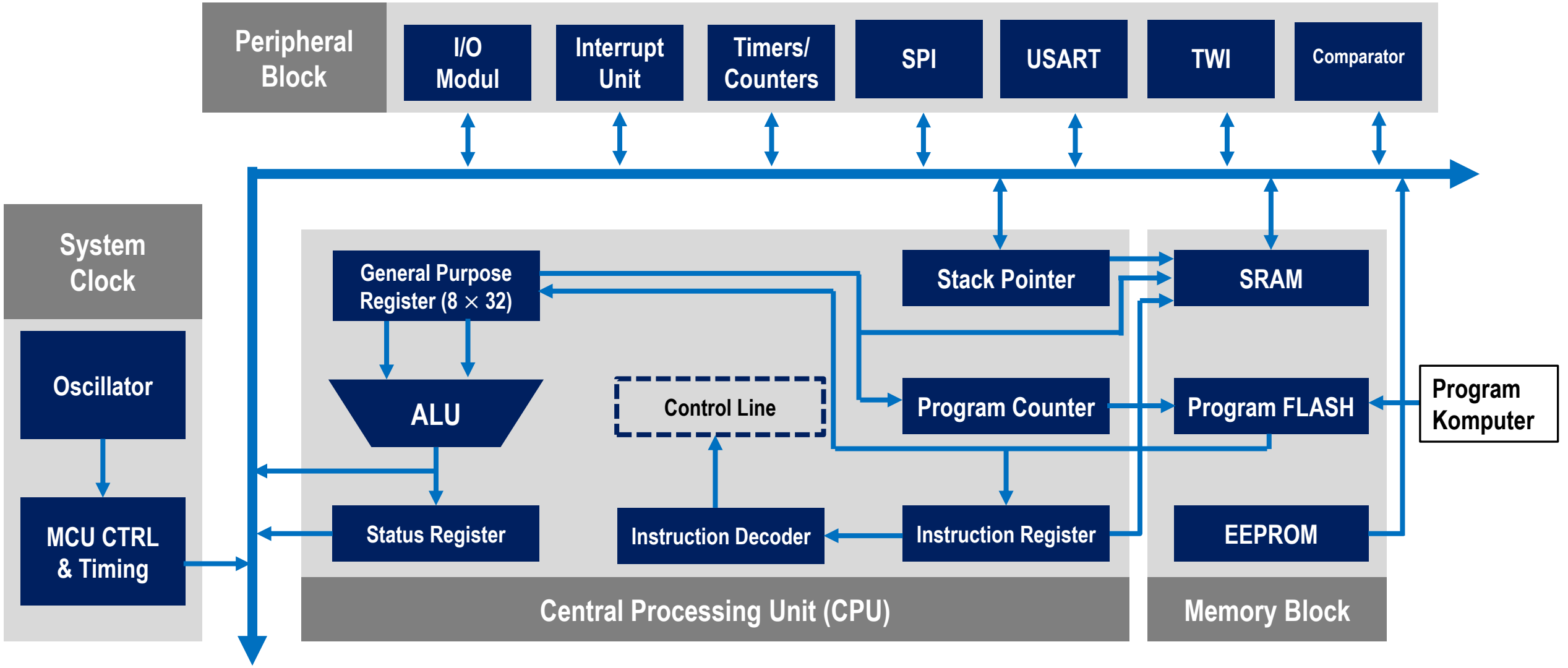
Program Counter
Menyimpan alamat memori yang berisi instruksi yang sedang diproses

Instruction Register
Berisi instruksi yang diproses oleh ALU

Instruction Decoder
Bertugas menerjemahkan instruksi dari instruction register



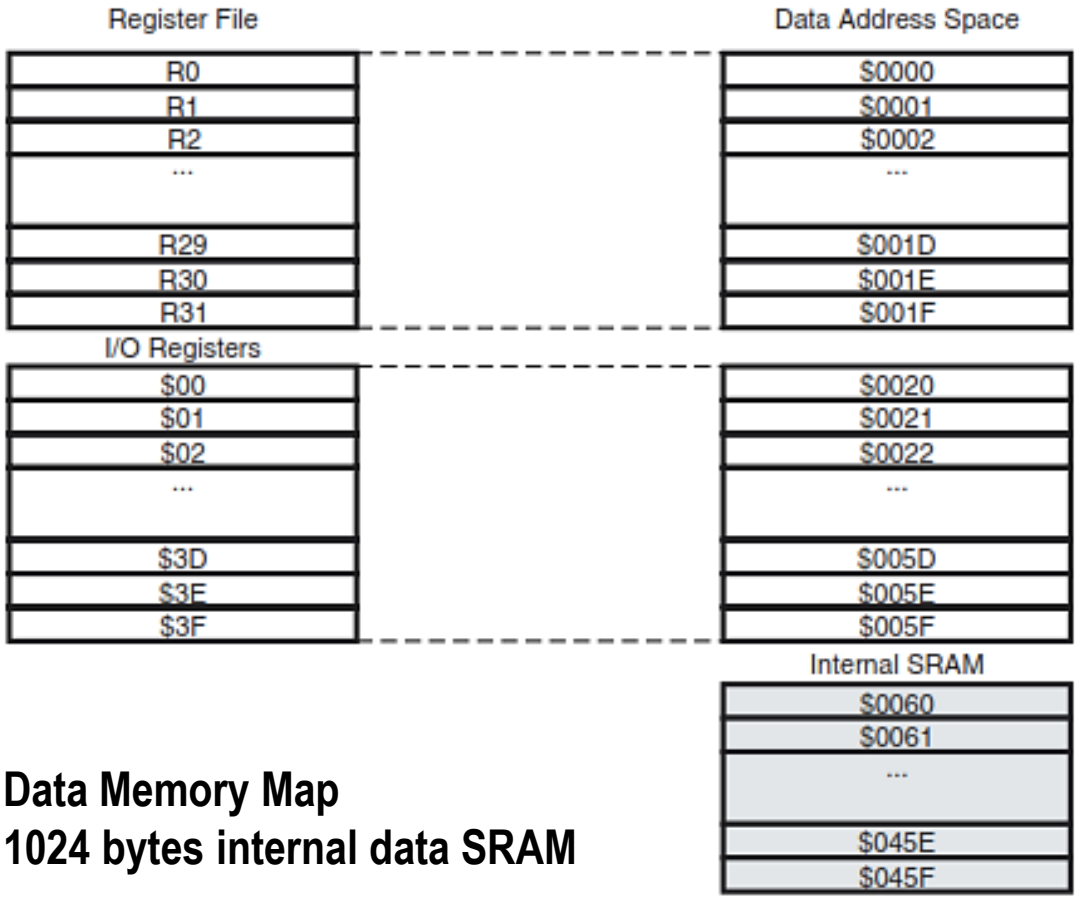
Arsitektur AVR (ATmega16)



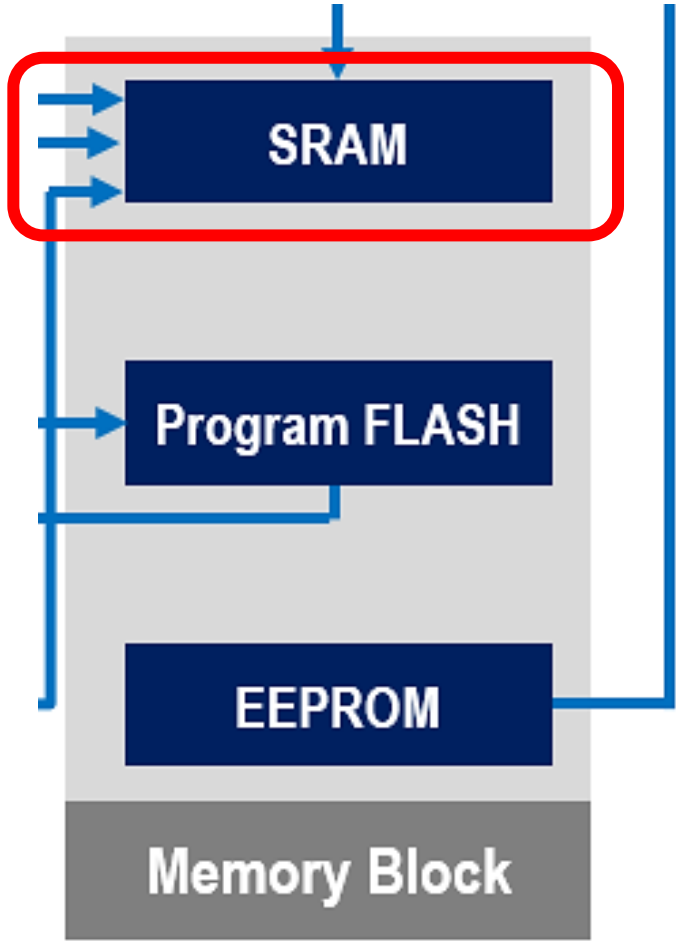
❖ Memory Block

SRAM (Static Random Access Memory)

- Menyimpan program saat program berjalan
- Jenis volatile memory
- Penyimpanan sementara
- Tidak memerlukan refresh berkala seperti DRAM

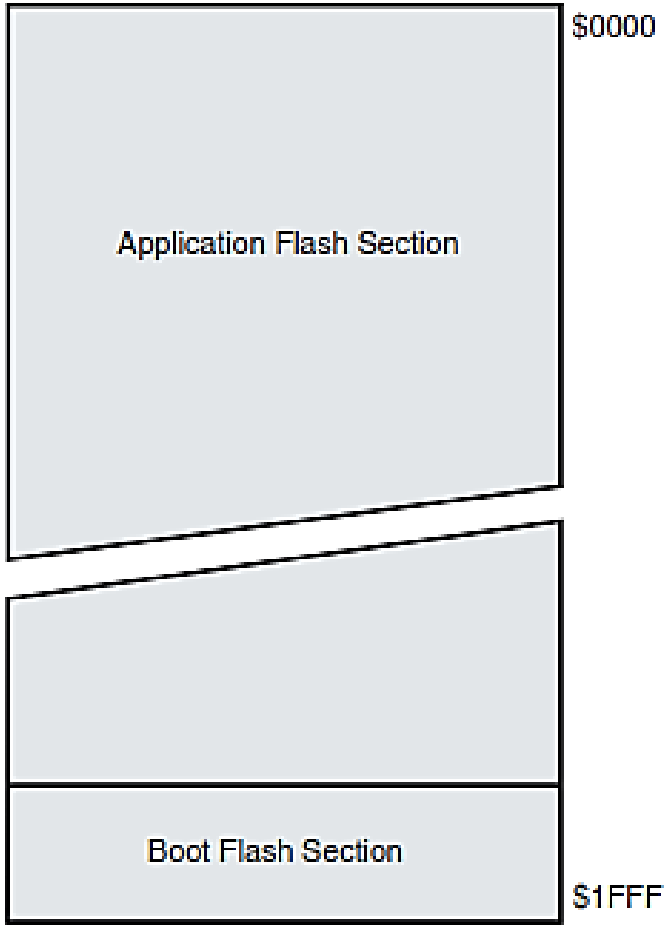


Data Memory Map
1024 bytes internal data SRAM

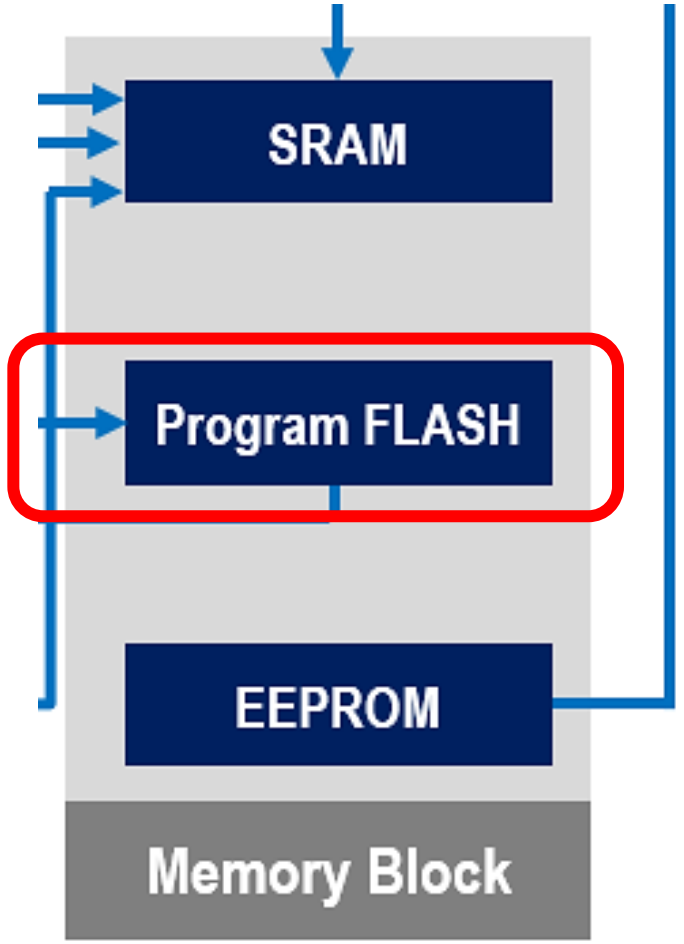


Program Flash

- Bertugas menyimpan kode program
- Bersifat non-volatile
- Program flash pada ATmega16 memiliki 10.000 kali siklus baca/tulis



Program Memory Map



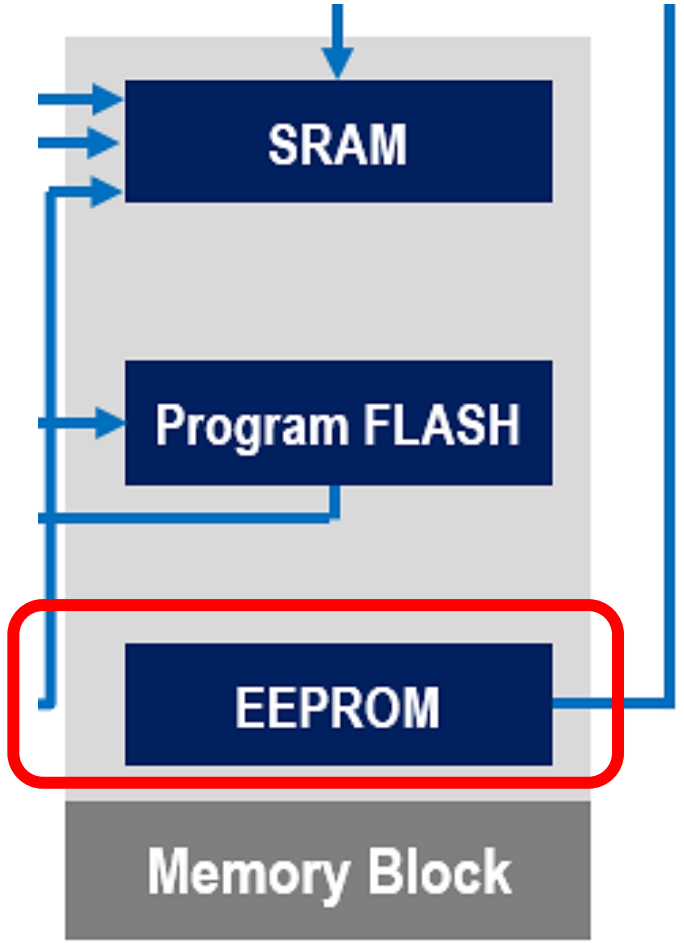
EEPROM (Electrically Erasable Programmable Read Only Memory)

- Bersifat non-volatile
- EEPROM pada ATmega16 memiliki 100.000 kali siklus baca/tulis

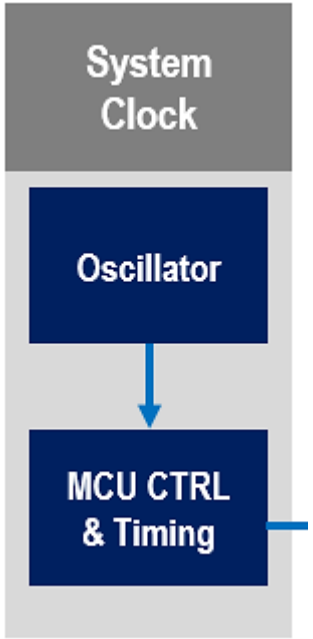
Bit	15	14	13	12	11	10	9	8	
	–	–	–	–	–	–	–	EEAR8	EEARH
	EEAR7	EEAR6	EEAR5	EEAR4	EEAR3	EEAR2	EEAR1	EEAR0	EEARL
	7	6	5	4	3	2	1	0	
Read/Write	R	R	R	R	R	R	R	R/W	
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	X	
	X	X	X	X	X	X	X	X	

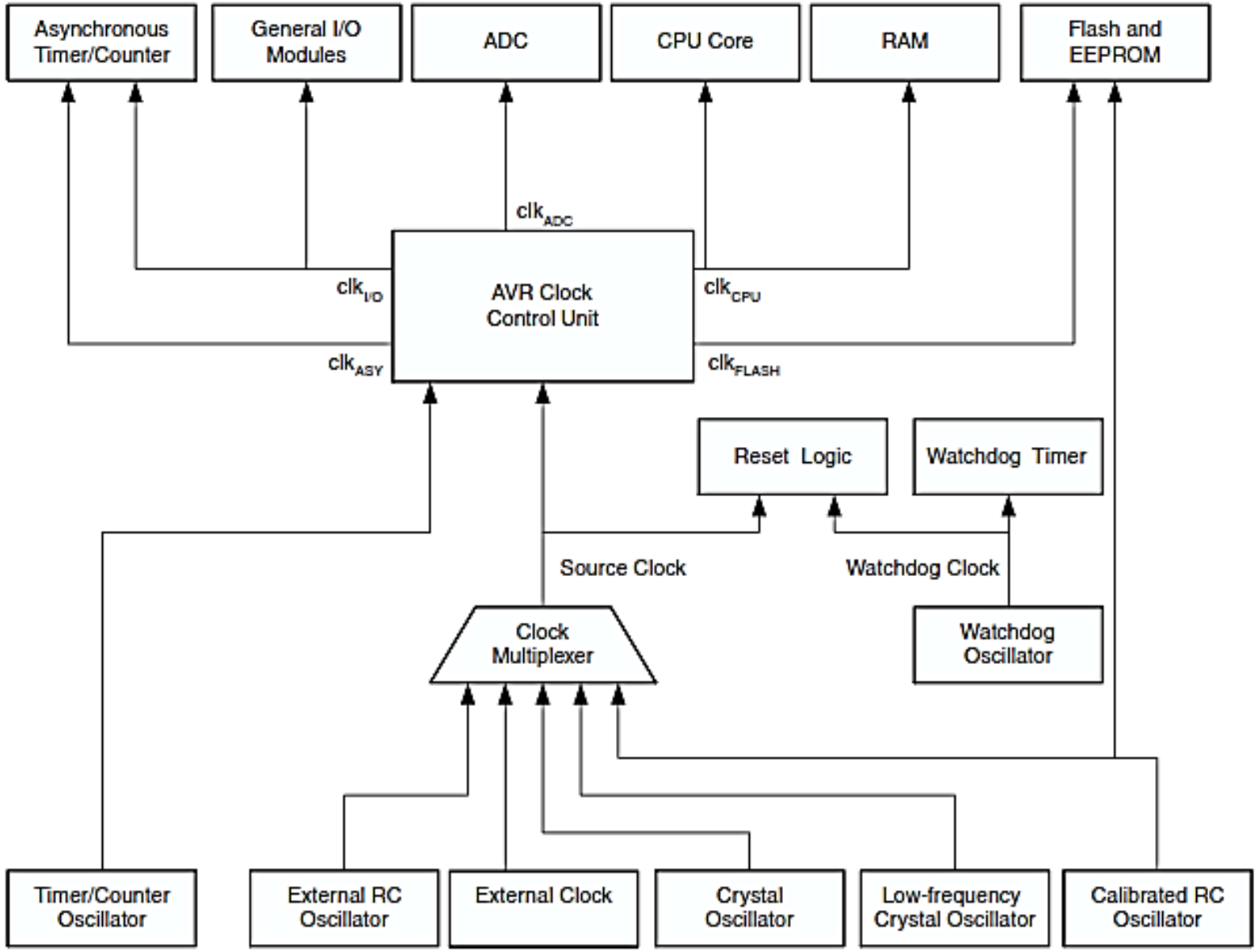
Bit	7	6	5	4	3	2	1	0	
	MSB							LSB	EEDR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Bit	7	6	5	4	3	2	1	0	
	–	–	–	–	EERIE	EEMWE	EEWE	EERE	EECR
Read/Write	R	R	R	R	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	X	0	



❖ System Clock



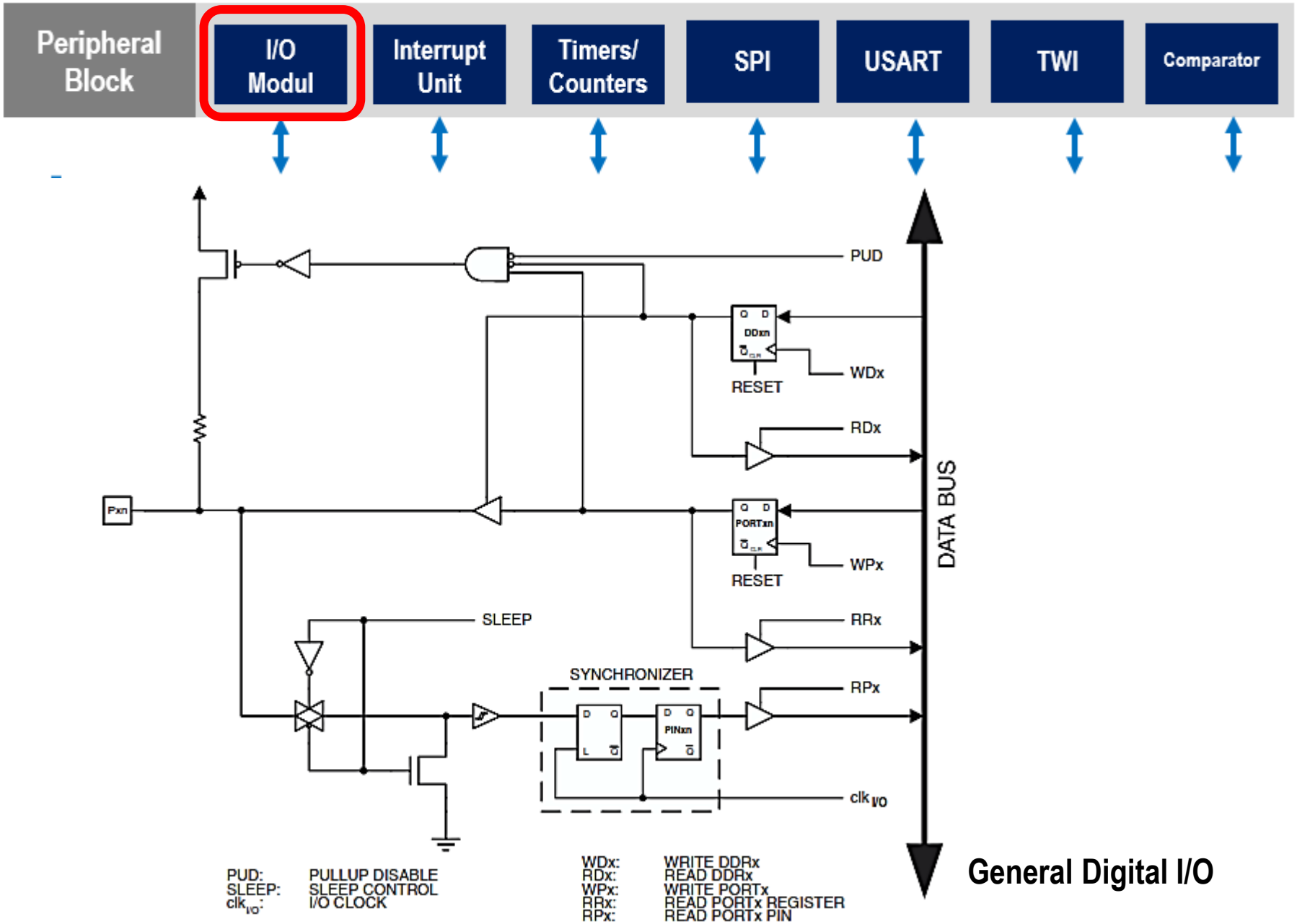


Clock Distribution

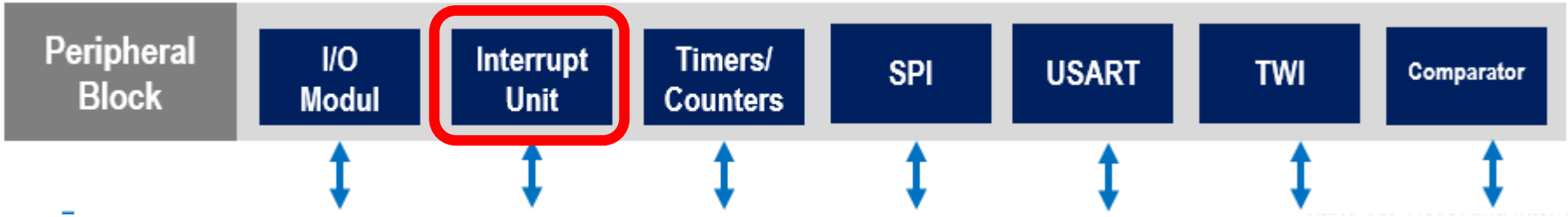
Device Clocking Option Select

Device Clocking Option	CKSEL3..0
External Crystal/Ceramic Resonator	1111 - 1010
External Low-frequency Crystal	1001
External RC Oscillator	1000 - 0101
Calibrated Internal RC Oscillator	0100 - 0001
External Clock	0000

❖ Peripheral Block



General Digital I/O



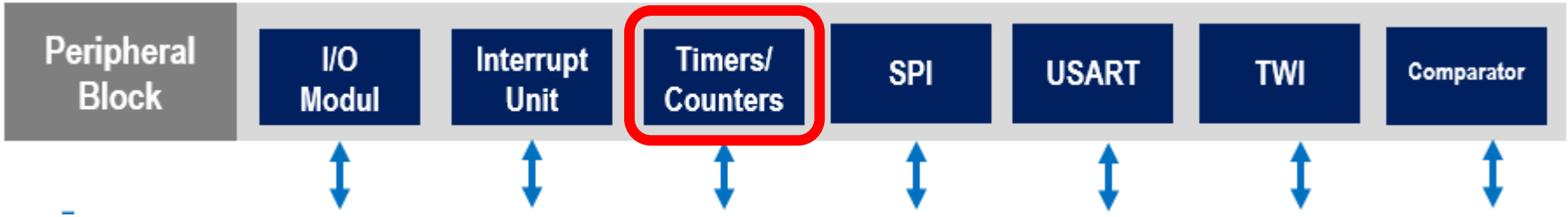
General Interrupt Control Register

Bit	7	6	5	4	3	2	1	0	
	INT1	INT0	INT2	–	–	–	IVSEL	IVCE	GICR
Read/Write	R/W	R/W	R/W	R	R	R	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Vector No**
  - An interrupt with a lower 'Vector No' will have a higher priority.
  - E.g., INT0 has a higher priority then INT1 and INT2.
- **Program Address**
  - The fixed memory location for a given interrupt handler.
  - E.g., in response to interrupt INT0, CPU runs instruction at $002.
- **Interrupt Vector Name**
  - This is the interrupt name, to be used with C macro ISR().

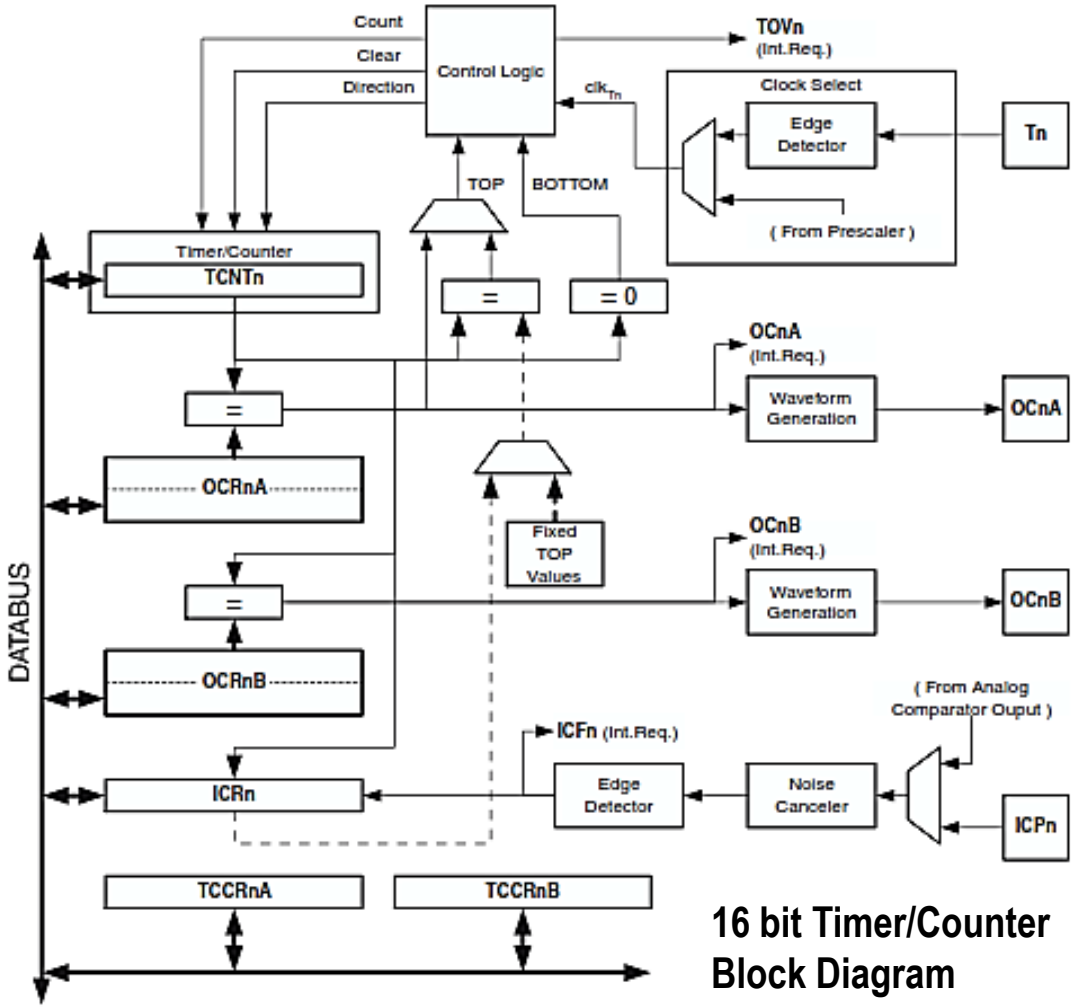
Reset and Interrupt Vectors

Vector No.	Program Address(2)	Source	Interrupt Definition
1	$000(1)	RESET	External Pin, Power-on Reset, Brown-out Reset, Watchdog Reset, and JTAG AVR Reset
2	$002	INT0	External Interrupt Request 0
3	$004	INT1	External Interrupt Request 1
4	$006	TIMER2 COMP	Timer/Counter2 Compare Match
5	$008	TIMER2 OVF	Timer/Counter2 Overflow
6	$00A	TIMER1 CAPT	Timer/Counter1 Capture Event
7	$00C	TIMER1 COMPA	Timer/Counter1 Compare Match A
8	$00E	TIMER1 COMPB	Timer/Counter1 Compare Match B
9	$010	TIMER1 OVF	Timer/Counter1 Overflow
10	$012	TIMER0 OVF	Timer/Counter0 Overflow
11	$014	SPI, STC	Serial Transfer Complete
12	$016	USART, RXC	USART, Rx Complete
13	$018	USART, UDRE	USART Data Register Empty
14	$01A	USART, TXC	USART, Tx Complete
15	$01C	ADC	ADC Conversion Complete
16	$01E	EE_RDY	EEPROM Ready
17	$020	ANA_COMP	Analog Comparator
18	$022	TWI	Two-wire Serial Interface
19	$024	INT2	External Interrupt Request 2
20	$026	TIMER0 COMP	Timer/Counter0 Compare Match
21	$028	SPM_RDY	Store Program Memory Ready

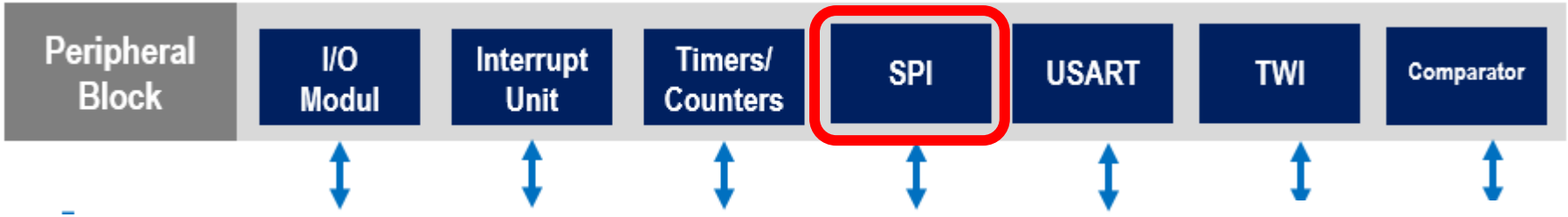


Tujuan Penggunaan Timer & Counter:

- Melaksanakan tugas secara berulang-ulang
- Mengendalikan kecepatan motor DC (PWM)
- Melakukan perhitungan (Counter)
- Membuat penundaan waktu (delay)

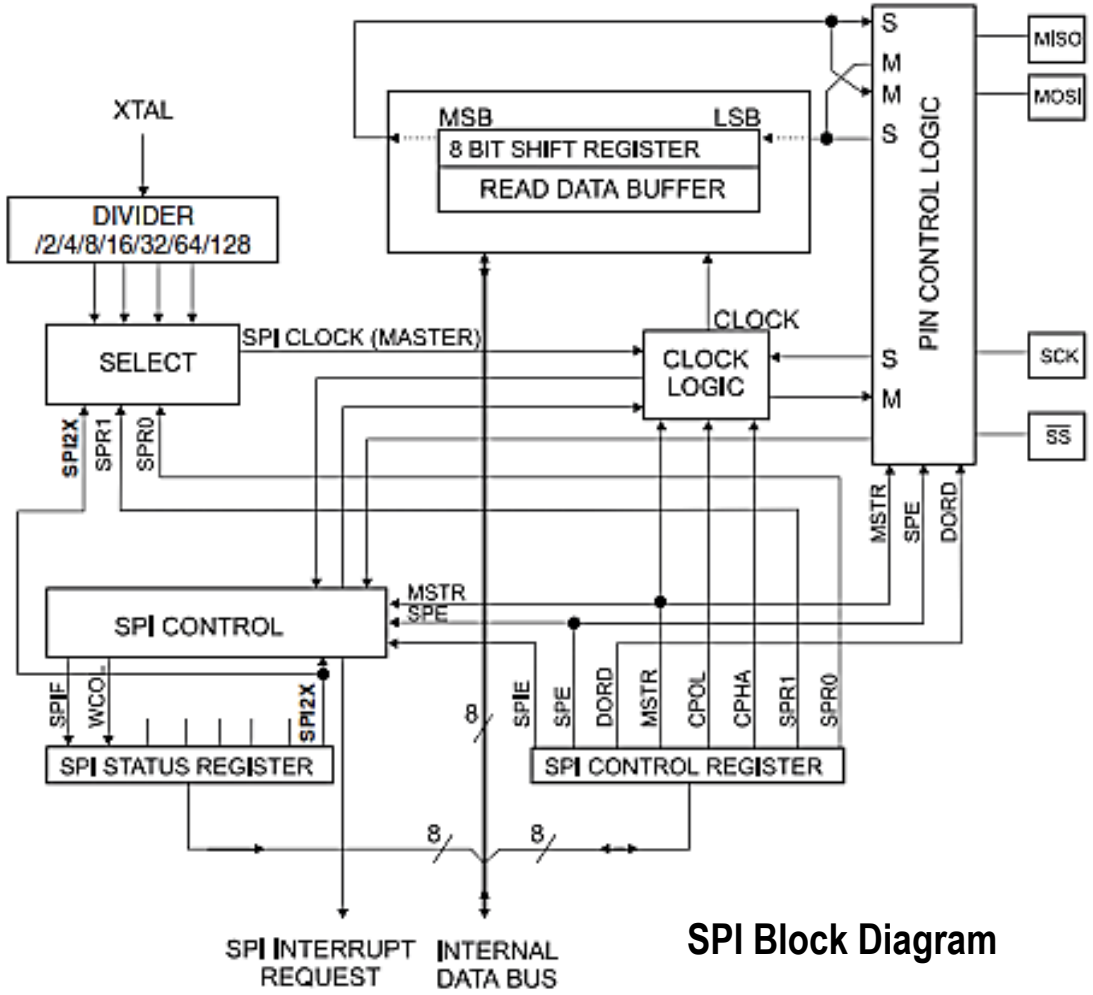


16 bit Timer/Counter Block Diagram



SPI Pin Overrides

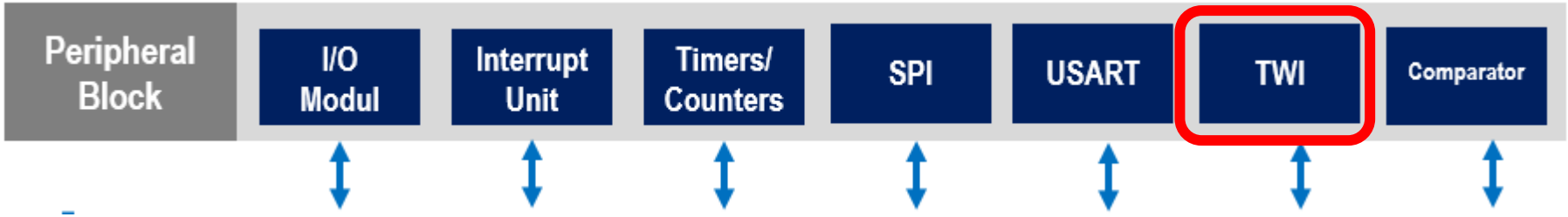
Pin	Direction, Master SPI	Direction, Slave SPI
MOSI	User Defined	Input
MISO	Input	User Defined
SCK	User Defined	Input
$\overline{SS}$	User Defined	Input



SPI Block Diagram

USART(Universal Synchronous Asynchronous Receiver/Transmitter)

- Mode sinkron dimana pengirim data mengeluarkan pulsa/clock untuk sinkronisasi data
- Mode asinkron, dimana pengirim data tidak mengeluarkan pulsa/clock, tetapi untuk proses sinkronisasi memerlukan inisialisasi, agar data yang diterima sama dengan data yang dikirimkan
- Pada proses inisialisasi, setiap perangkat yang terhubung harus memiliki baudrate yang sama

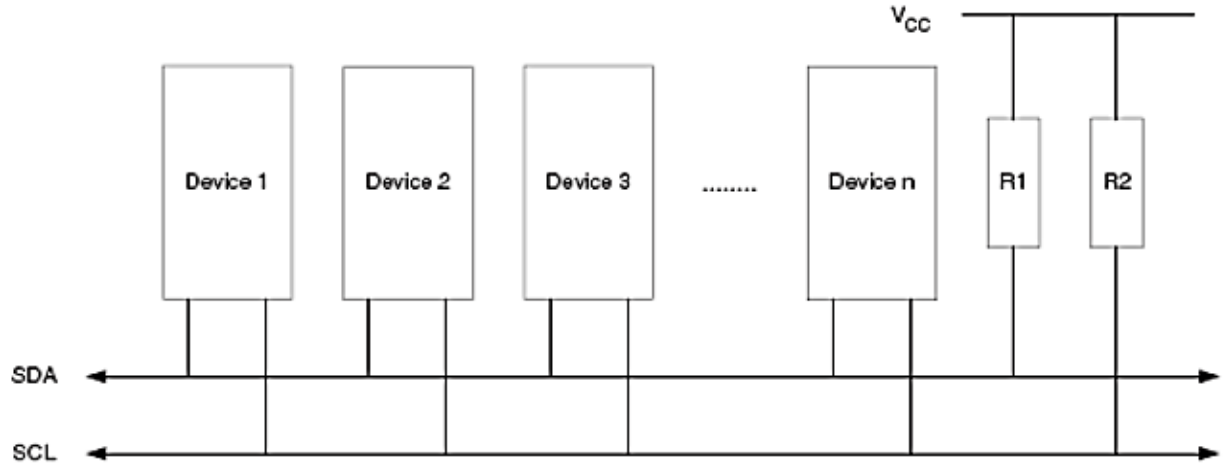


TWI (Two Wire Interface)

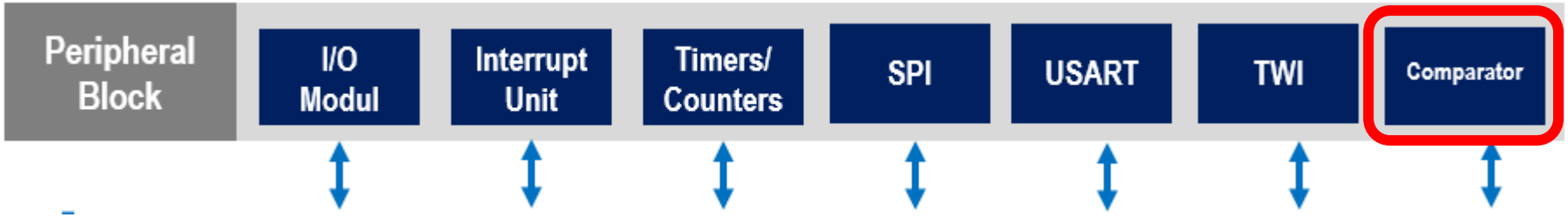
- Sebuah protokol untuk komunikasi serial antar IC
- Lebih fleksibel dari SPI

Term	Description
Master	The device that initiates and terminates a transmission. The master also generates the SCL clock.
Slave	The device addressed by a master.
Transmitter	The device placing data on the bus.
Receiver	The device reading data from the bus.

TWI Terminology

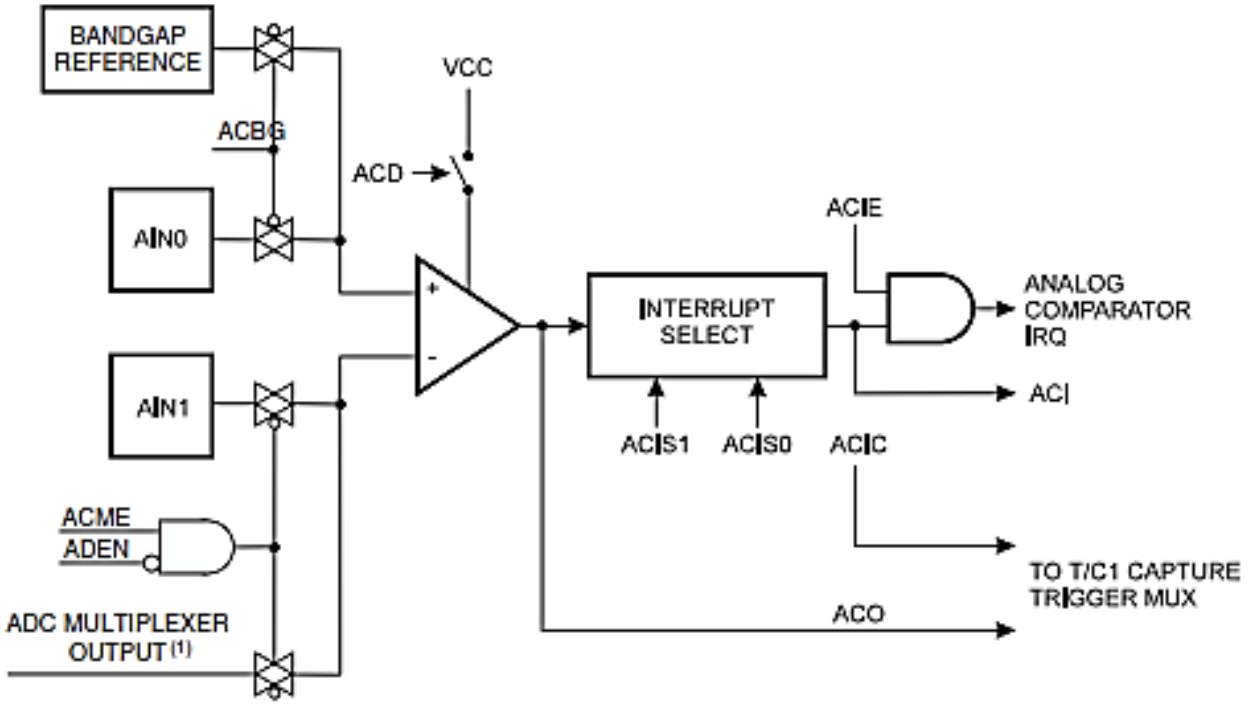


Typical TWI bus configuration



Comparator

- Untuk membandingkan tegangan input dengan sebuah referensi



Analog Comparator Block Diagram

SEKIAN DAN TERIMA KASIH

PENGANTAR MIKROKONTROLER

Pertemuan 3

Ahmad Zarkasi

Tugas 1

Buatlah simulasi sederhana dengan menggunakan LED berbasis mikrokontroler ATmega dengan compiler CodeVision AVR.

MATERI BAHASAN

PLATFORM ARDUINO

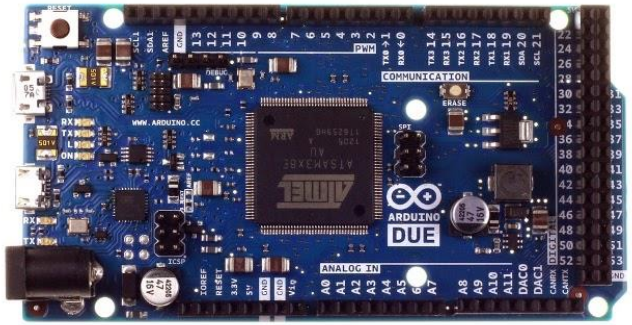
Apa itu Arduino?

- Arduino is a microcontroller-based open source electronic prototyping board which can be programmed with an easy-to-use Arduino IDE.
- Arduino consists of both a physical programmable circuit board and a piece of software, or IDE. The Arduino IDE uses simplified version of C++, making it easier to learn.
- The Uno is one of the more popular boards in the Arduino family and great choice for beginners.

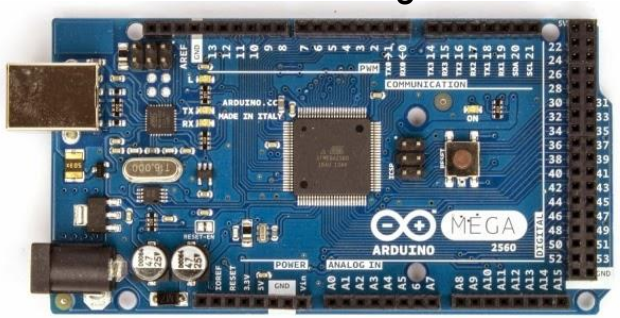
Beberapa Jenis Modul Arduino

Arduino Uno

Arduino Due

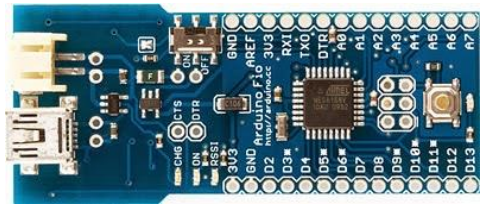


Arduino Mega

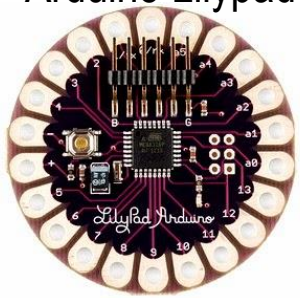


Arduino Leonardo

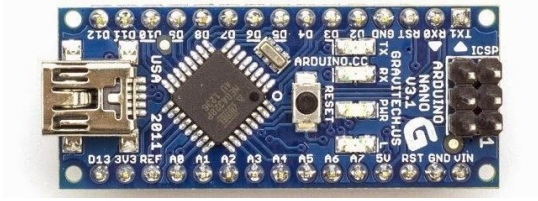
Arduino Fio



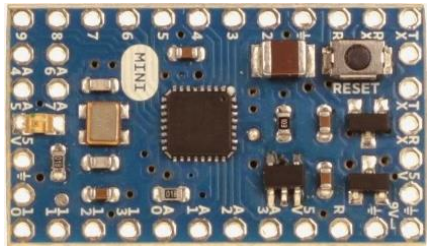
Arduino Lilypad



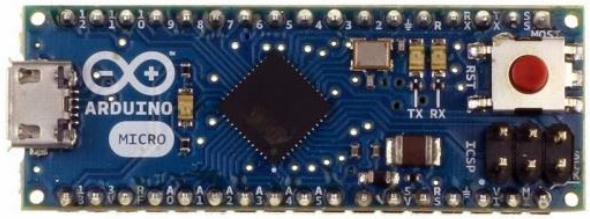
Arduino Nano



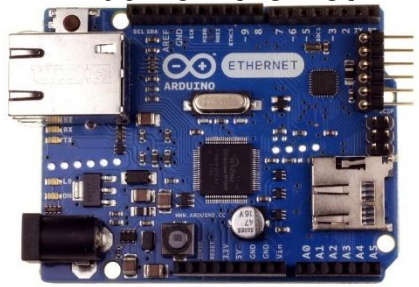
Arduino Mini



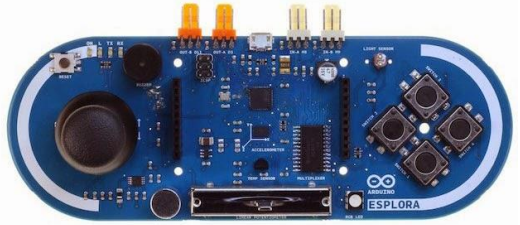
Arduino Micro



Arduino Ethernet



Arduino Esplora

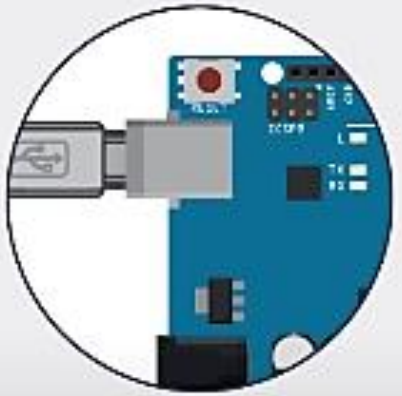


Arduino Robot

Bagian-bagian terpenting dari Arduino Uno

USB Connecter

- This is a printer USB port used to load a program from the Arduino IDE onto the Arduino board.



Power Port

- The Arduino board can be powered through a AC-to-DC adapter or a battery

- The power source can be connected by plugging ina 2.1mm center-positive plug into the power jack of the board
- The Arduino UNO board operates at a voltage of 5 volts, but it can withstand a maximum voltage of 20 volts
- If the board is supplied with a higher voltage, there is a voltage regulator (it sits between the power port and USB connector) that protects the board from burning out

Microcontroller

- It is the most prominently visible black rectangular chip with 28 pins. Think of it as the brains of your Arduino

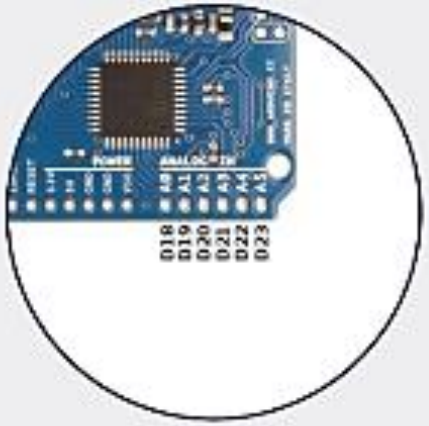
- The microcontroller used on the UNO board is Atmega328P by Atmel (a major microcontroller manufacturer)

Microcontroller

- Atmega328P has the following components in it
  - Flash memory of 32KB. The program loaded from the Arduino IDE is stored here
  - RAM of 2KB. This is runtime memory
  - CPU: It controls everything that goes on within the device. It fetches the program instructions from flash memory and runs it with the help of RAM
  - Electrically Erasable Programmable Read Only Memory (EEPROM) of 1KB. This is a type of nonvolatile memory, and it keeps the data even after device restart and reset
- Atmega328P is pre-programmed with bootloader. This allows you to directly upload a new Arduino program into the device, without using any external hardware programmer, making the Arduino UNO board easy to use

Analog input pins

- The Arduino UNO board has 6 analog input pins, labeled "Analog 0 to 5." These pins can read the signal from an analog sensor such as a temperature sensor and convert it into a digital value for system understanding



- These pins just measure voltage and not the current because they have very high internal resistance. Hence, only a small amount of current flows through these pins
- Although these pins are labeled analog and are analog input by default, these pins can also be used for digital input or output

Digital pins

- You can find these pins labeled “Digital 0 to 13.” These pins can be used as either input or output pins. When used as output, these pins act as a power supply source for the components connected to it and when used as input pins, they read the signals from the component connected to them

Crystal oscillator

- This is a quartz crystal oscillator which ticks 16 million times a second. On each tick, the microcontroller performs one operation, for example, addition, subtraction, etc

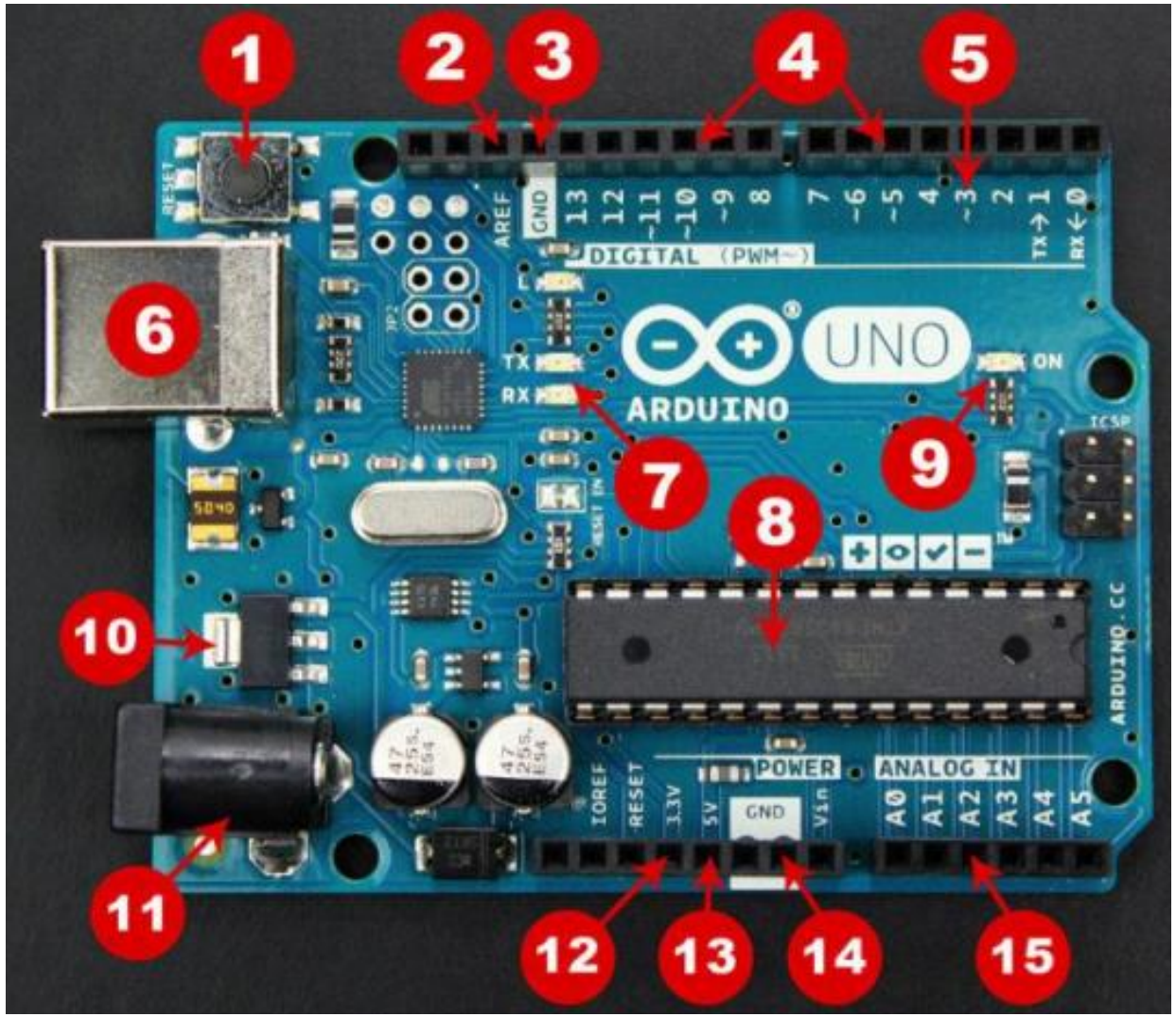
USB interface chip

- Think of this as a signal translator. It converts signals in the USB level to a level that an Arduino UNO board understands

TX RX indicator

- TX stands for transmit, and RX for receive. These are indicator LEDs which blink whenever the UNO board is transmitting or receiving data

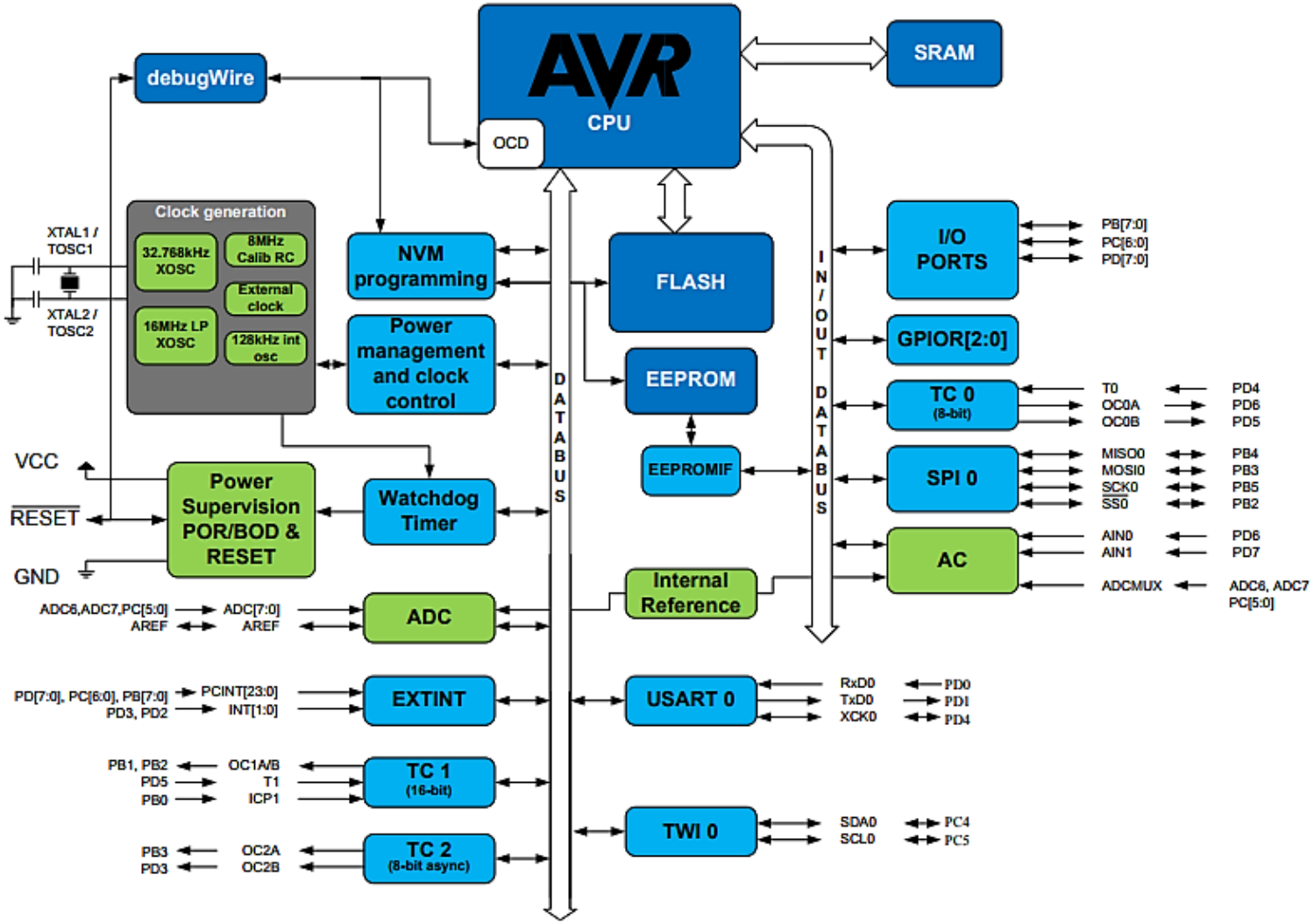
Ringkasan Bagian-bagian Arduino Uno



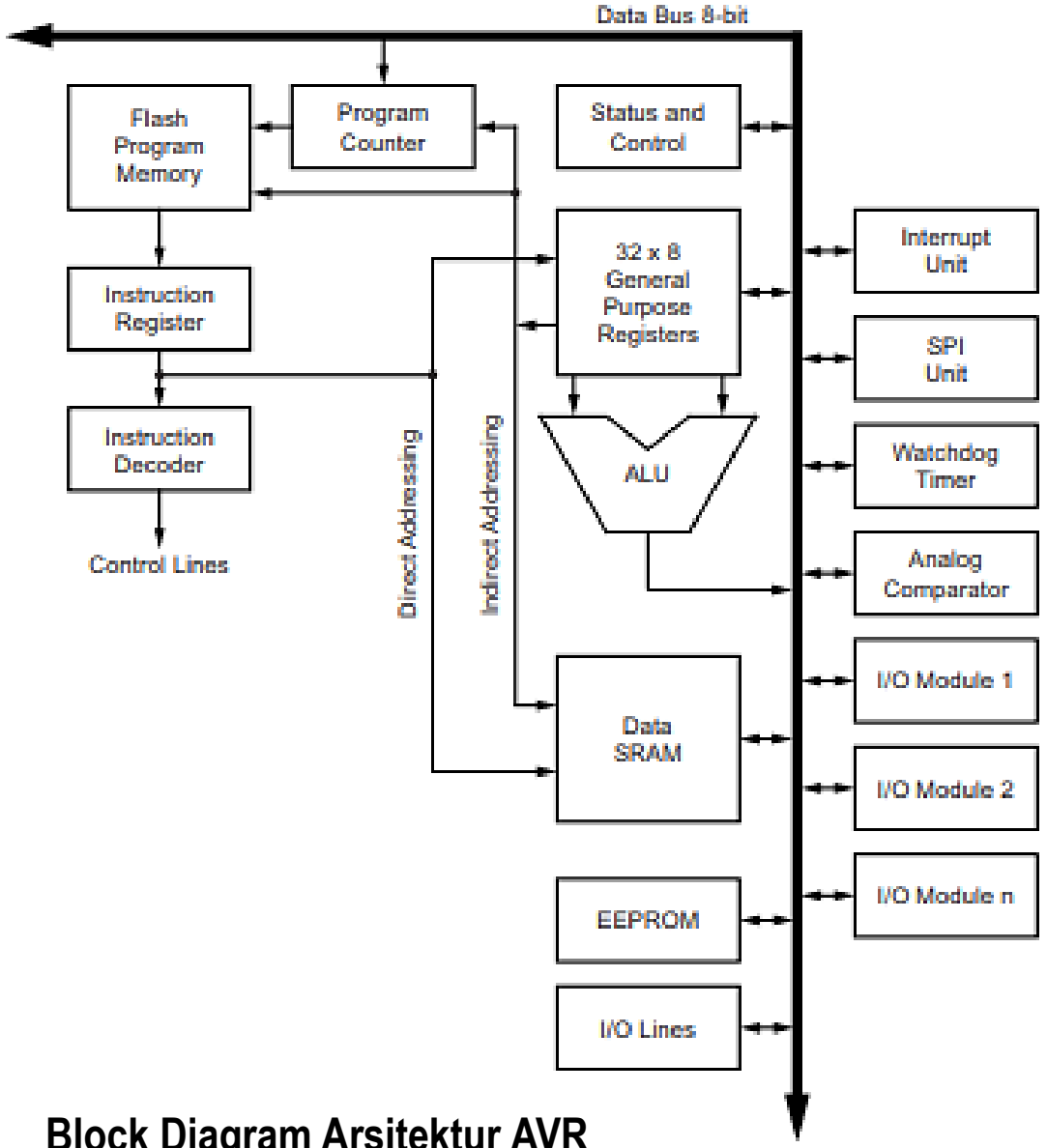
1. Reset Button
2. AREF
3. Ground Pin
4. Digital I/O
5. PWM
6. USB Connection
7. TX/RX
8. ATmega328P
9. Power LED Indicator
10. Voltage Regulator
11. DC Power Barrel Jack
12. 3.3V Pin
13. 5V Pin
14. Ground Pin
15. Analog Pin

ATmega328P

Block Diagram



ATmega328P



Block Diagram Arsitektur AVR

Tugas Simulasi

Buatlah sebuah project simulasi menggunakan Proteus sebagai media desain dan Arduino IDE sebagai compiler.

Penilaian:

- Tingkat kesulitan dan kreativitas.
- Presentasi

SEKIAN DAN TERIMA KASIH

PENGANTAR MIKROKONTROLER

Pertemuan 4

Ahmad Zarkasi

MATERI BAHASAN

PORT GPIO & REGISTER PADA AVR

Review

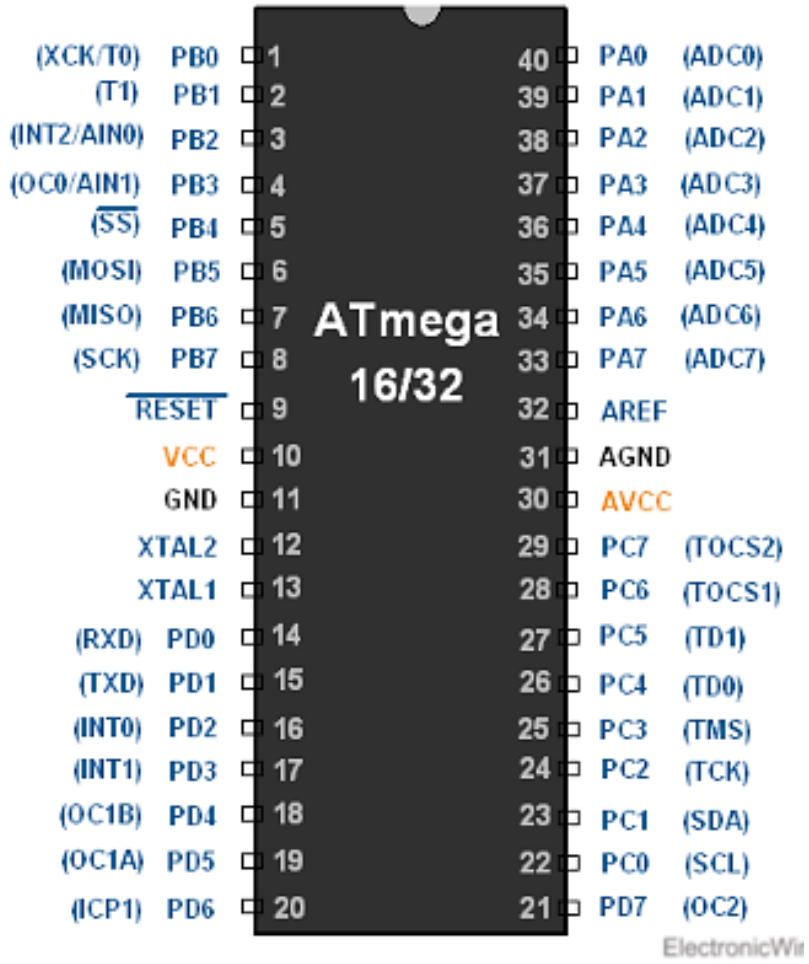
- AVR ATmega16 has 32 pins constituting four ports. The ports are listed below:
  1. PORT A
  2. PORT B
  3. PORT C
  4. PORT D

- Each pins of these four ports can be used as general-purpose inputs/outputs

- These pins can be configured as input or output using the three I/O registers for each port. These registers are listed below:
  1. DDRxregisters
  2. PINxregisters
  3. PORTxregisters

  (where x can be A, B, C, or D depending on which port registers are being addressed).

- Each pin also has some special functionality associated with it.



Pin Diagram of ATmega 16/32

DDRx (Data Direction Registers)

- These are 8-bit registers.
- These are used to configure the pins of the ports as input or output.
- Writing a one to the bits in this register sets those specific pins as output pins.
- Writing a zero to the bits in this register sets those specific pins as input pins.
- All bits in these registers can be read as well as written to.
- The initial value of these bits is zero.

Example:

1. Setting Port D as an output port:
   ```
   DDRD = 0xFF; atau DDRD=0b11111111;
   ```
2. Setting Port D as input port:
   ```
   DDRD = 0x00; DDRD=0b00000000;
   ```

PORTx : Data Registers

- These are 8-bit registers.
- These are used to put pins of the ports in a logic HIGH or logic LOW state.
- Writing a one to the bits in this register puts a LOW logic (0V) on those pins.
- All bits in these registers can be read as well as written to.
- The initial value of these bits is zero

Example:

We weill use the PORTx register of Port D to write a value 0x55 to Port D

```
PORTD = 0x55;
```

PINx : Input Pins Address Registers

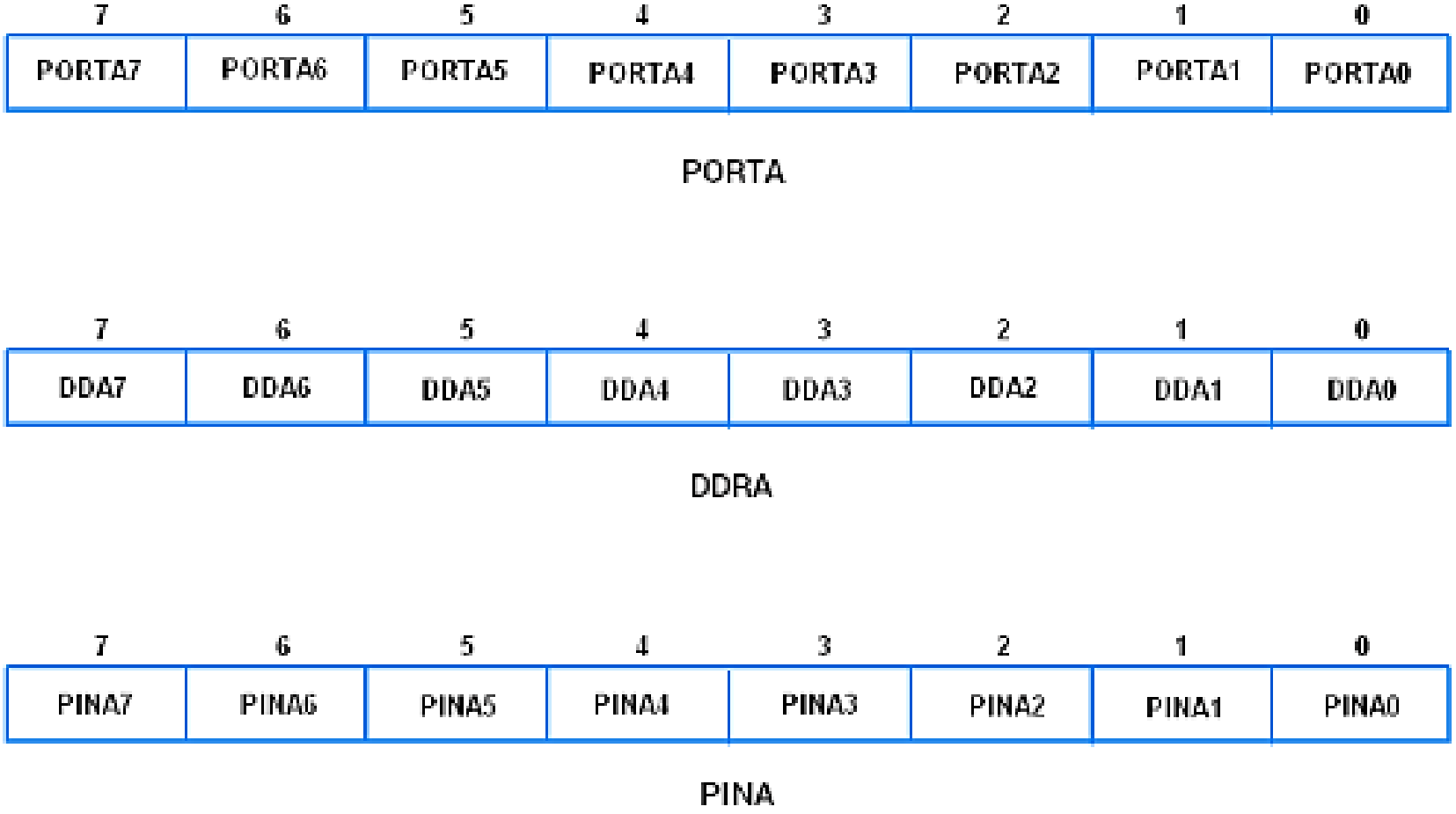
- These are 8-bit registers.
- These are used to read the values on the specific pins of the port.
- These bits are read-only bits and cannot be written to.

Example:

We well read the value on Port D in an 8-bit variable named ‘port_value’

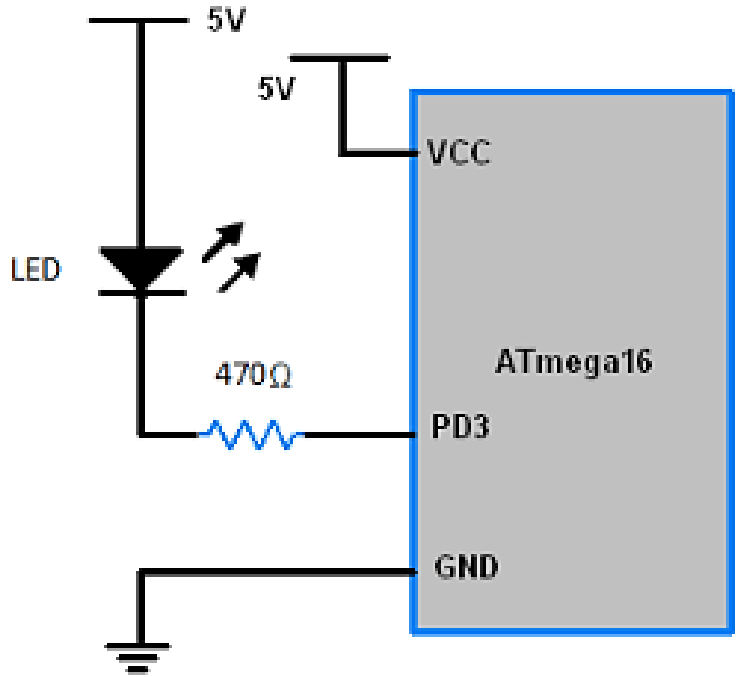
```
Port_value = PIND;
```

In the figure shown below, the above mentioned three registers for Port A are shown. These 8-bit registers.



Exercise

Lets write a code to program pin 3 of Port D as an output and use it to drive an LED. We sill toggle the LED with some delay.



MATERI BAHASAN

ADC pada AVR ATmega16

Definition

ADC (Analog to Digital Converter) is the most widely used device in embedded systems which is designed especially for data acquisition. In the AVR ATmega series normally 10-bit ADC is inbuilt in the controller.

Let us see how to use the ADC of AVR ATmega16 / ATmega32

Atmega16/32 supports eight ADC channels, which means we can connect eight analog input at a time. ADC channel 0 to channel 7 are present on PORT A. i.e. Pin no. 33 to 40.

ADC Pins of ATmega 16/32

Resolution

The controller has 10 bit ADC, which means we will get digital output 0 to 1023. i.e. when the input is 0V, the digital output will be 0V & when input is 5V (and Vref=5V), we will get the highest digital output corresponding to 1023 steps, which is 5V.

So controller ADC has 1023 steps and

- Step size with Vref =5V, so 5/1023 = 4,88 mV
- Step size with Vref=2.56V, so 2,56/1023 = 2,5 mV

So Digital data output will be $D_{out}=V_{in}$/step_size.

Specifications (ATmega16/32 ADC)

- It is 10-bit ADC.
- Converted output binary data is held in two special function 8-bit register ADCL (result Low) and ADCH (result in HIGH).
- ADC gives 10-bit output, so (ADCH:ADCL) only 10-bits are useful out of 16-bits.
- We have options to use this 10-bits as upper bits or lower bits.
- We also have three options for Vref
  1. AVcc (analog Vcc)
  2. Internal 2,56 V
  3. External Aref Pin
- If you decide to use Avcc or Vref pins as ADC voltage reference, you can make it more stable and increase the precision of ADC by connecting a capacitor between that pin and GND.

ADC Register

In AVR ADC, we need to understand four main register

1. **ADCH**: Holds digital converted data higher byte
2. **ADCL**: Holds digital converted data lower byte
3. **ADMUX**: ADC Multiplexer selection register
4. **ADCSRA**: ADC Control and status register

ADMUX Register

7	6	5	4	3	2	1	0
REFS1	REFS0	ADLAR	MUX4	MUX3	MUX2	MUX1	MUX0

ADCSRA Register:

7	6	5	4	3	2	1	0
ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0

SEKIAN DAN TERIMA KASIH

PENGANTAR MIKROKONTROLER

Pertemuan 5

Ahmad Zarkasi

MATERI BAHASAN

TIMER/COUNTER

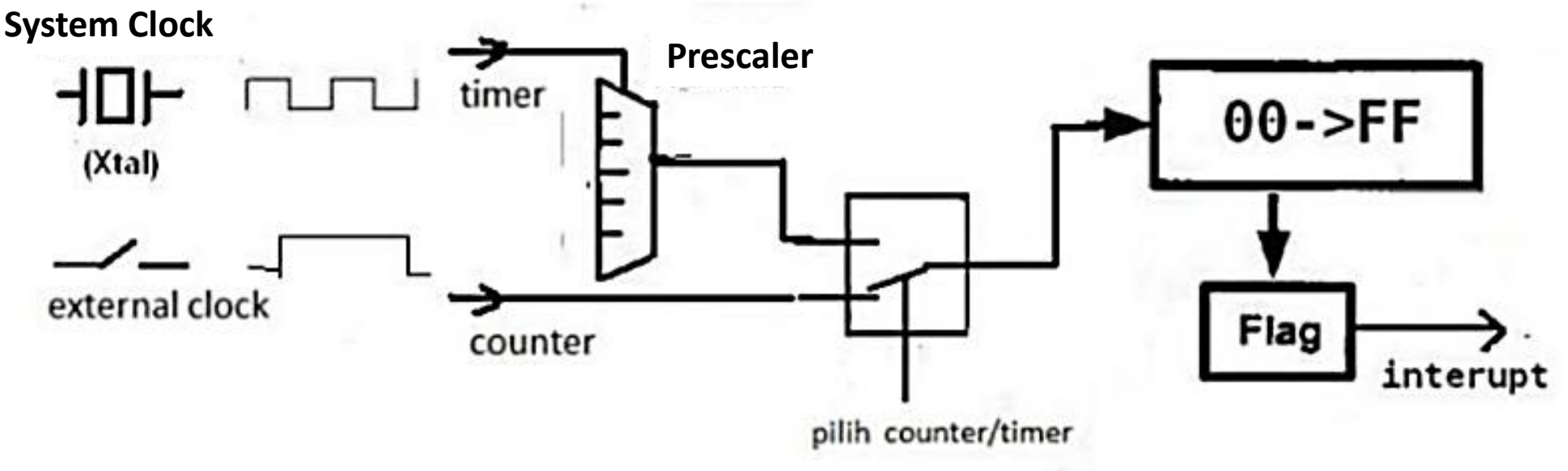
CAPAIAN PEMBELAJARAN

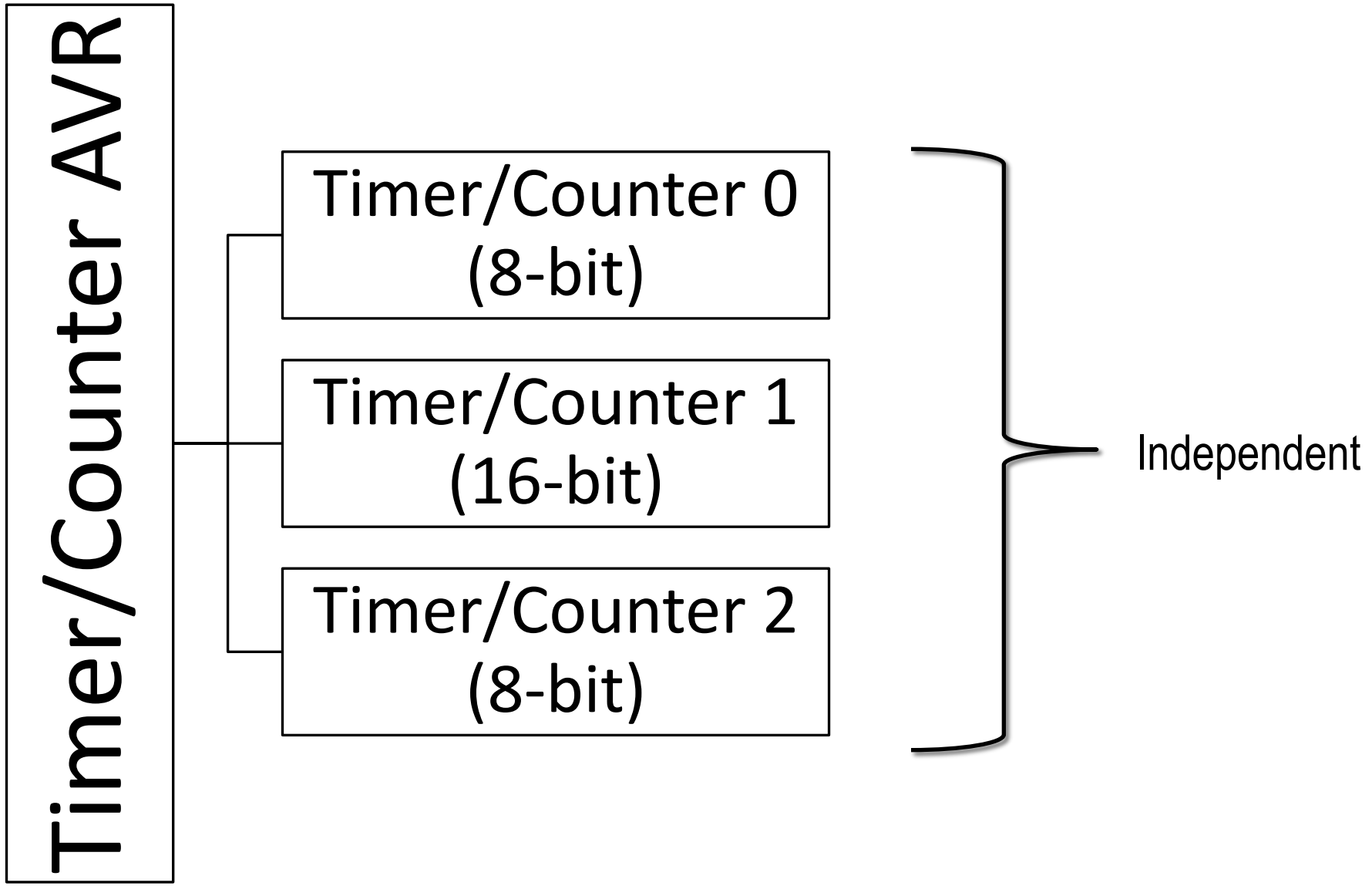
Setelah membahas materi kuliah ini, diharapkan mahasiswa dapat:

1. Memahami blok diagram Timer/Counter serta alur kerja yang berlaku di dalamnya
2. Memahami register-register pada Timer/Counter beserta kegunaannya

Timer/Counter

- Time function (starting program/execution)
- Other uses: timer, PWM, ADC, Oscillator

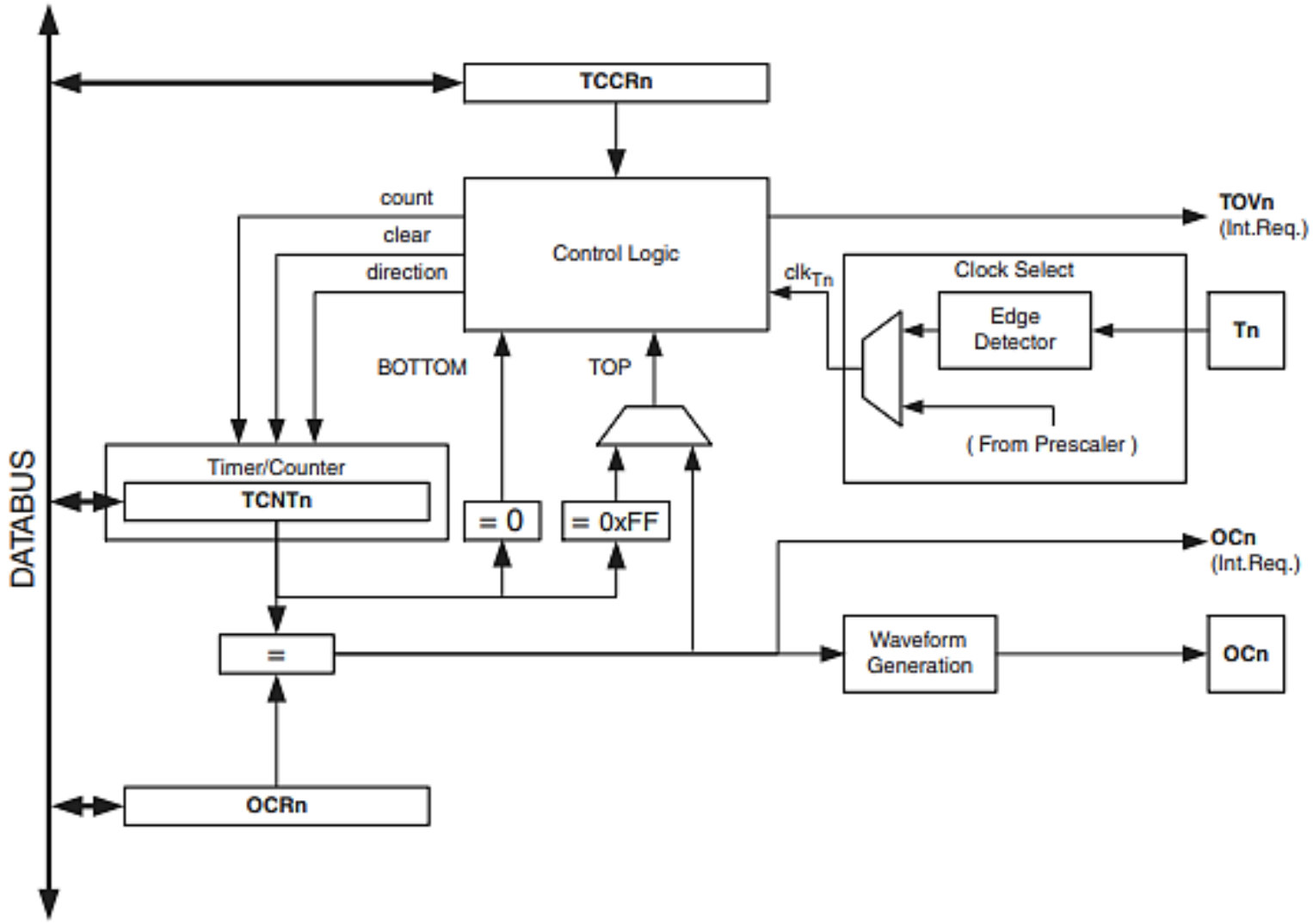



Timer/Counter AVR
Timer/Counter 0
(8-bit)
Timer/Counter 1
(16-bit)
Timer/Counter 2
(8-bit)
Independent

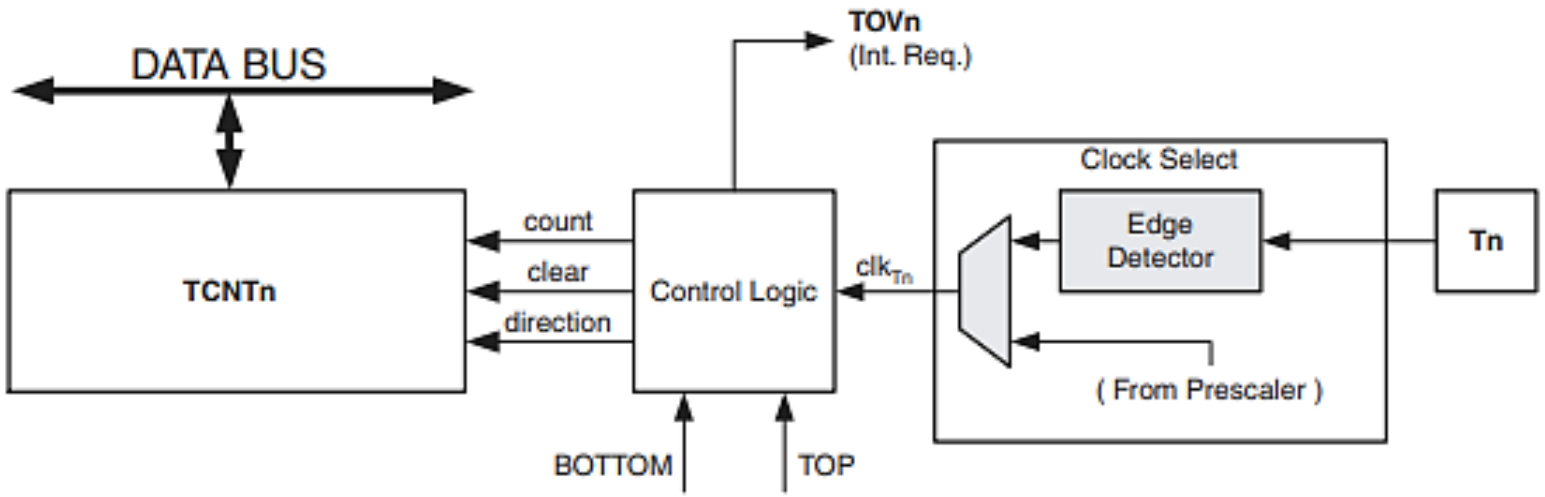
Timer/Counter 0

- Single Compare Unit Counter
- Clear Timer on Compare Match (Auto Reload)
- Phase Correct Pulse Width Modulator (PWM)
- Frequency Generator
- External Event Counter
- 10-bit Clock Prescaler
- Overflow and Compare Match Interrupt Sources (TOV0 and OCF0)

8-bit Timer/Counter Block Diagram



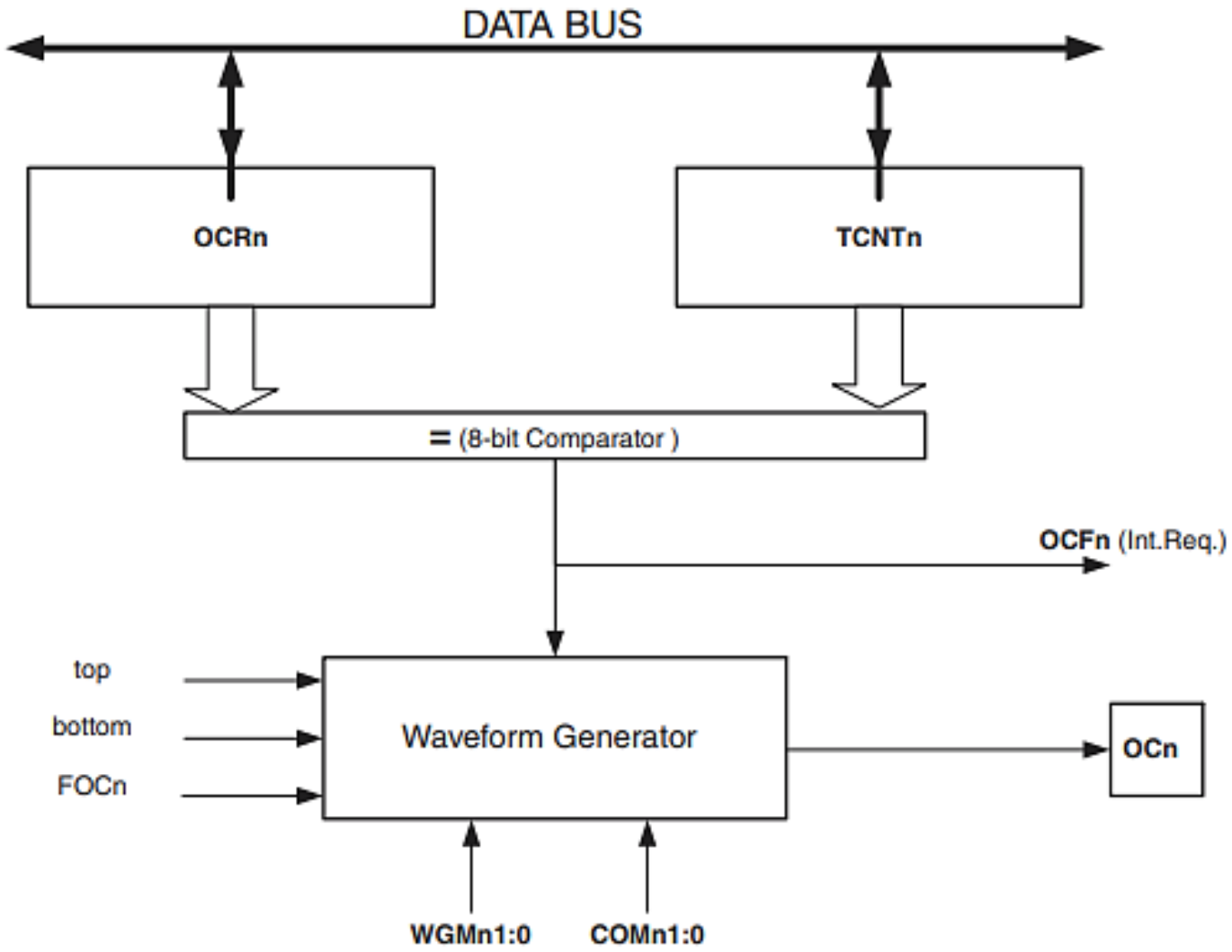
Counter Unit Block Diagram



Signal description (internal signals):

count	Increment or decrement TCNT0 by 1.
direction	Select between increment and decrement.
clear	Clear TCNT0 (set all bits to zero).
clk$_{Tn}$	Timer/Counter clock, referred to as clk$_{T0}$ in the following.
TOP	Signalize that TCNT0 has reached maximum value.
BOTTOM	Signalize that TCNT0 has reached minimum value (zero).

Output Compare Unit, Block Diagram



Timer/Counter Control Register - TCCR0

Bit	7	6	5	4	3	2	1	0	
	FOC0	WGM00	COM01	COM00	WGM01	CS02	CS01	CS00	TCCR0
Read/Write	W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – FOC0:** Force Output Compare
- **Bit 6,3 – WGM01:0:** Waveform Generation Mode
- **Bit 5:4 – COM01:0:** Compare Match Output Mode
- **Bit 2:0 – CS02:0:** Clock Select

Clock Select Bit Description

CS02	CS01	CS00	Description
0	0	0	No clock source (Timer/Counter stopped).
0	0	1	$clk_{I/O}$/(No prescaling)
0	1	0	$clk_{I/O}$/8 (From prescaler)
0	1	1	$clk_{I/O}$/64 (From prescaler)
1	0	0	$clk_{I/O}$/256 (From prescaler)
1	0	1	$clk_{I/O}$/1024 (From prescaler)
1	1	0	External clock source on T0 pin. Clock on falling edge.
1	1	1	External clock source on T0 pin. Clock on rising edge.

Timer/Counter Control Register - TCNT0

Bit	7	6	5	4	3	2	1	0	
	TCNT0[7:0]								TCNT0
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Output Compare Register - OCR0

Bit	7	6	5	4	3	2	1	0	
	OCR0[7:0]								OCR0
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Timer/Counter Interrupt Mask Register - TMSK

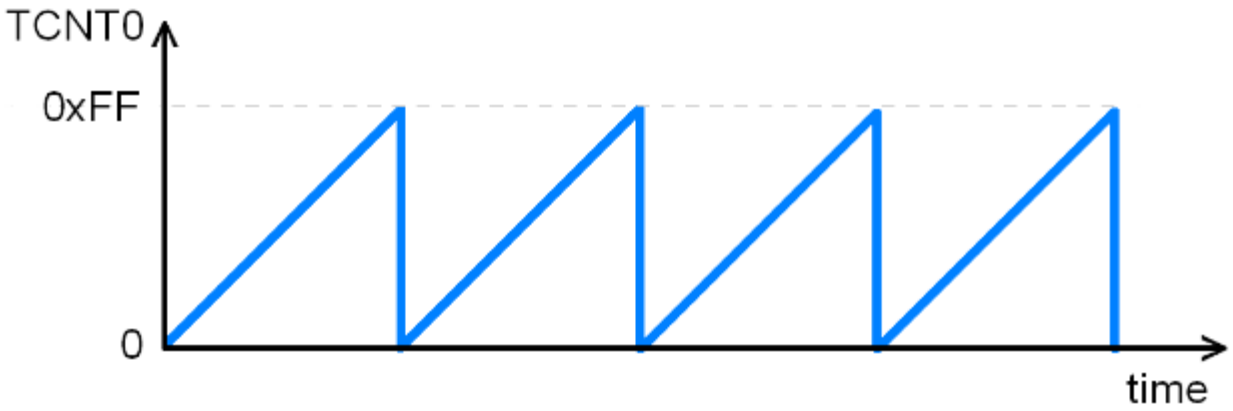
Bit	7	6	5	4	3	2	1	0	
	OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0	TIMSK
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Timer/Counter Interrupt Flag Register - TIFR

Bit	7	6	5	4	3	2	1	0	
	OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0	TIFR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Timer0 Overflow

Normal mode: When the counter overflows i.e. goes from 0xFF to 0x00, the TOV0 flag is set



Creating Delay Using Timer0

otes * Timer1.c *

```
#include <avr/io.h>

void T0delay();

int main(void)
{
    DDRB = 0xFF;          // PORTB sebagai output
        while(1)          // Untuk perulangan
        {
        PORTB=0x55;
        T0delay();        // Beri beberapa delay
        PORTB=0xAA;
        T0delay();
        }
}

void T0delay()
{
    TCNT0 = 0x25;         // Load untuk TCNT0
    TCCR0 = 0x01;         // Timer0, normal mode, no pre-scalar

    while((TIFR&0x01)==0);  //Tunggu TOV0 untuk roll over
    TCCR0 = 0;
    TIFR = 0x1;           /* Clear flag pada TOV0
}
```

Counting Delay (Fosc= 8MHz)

$$T = \frac{1}{F_{osc}} = \frac{1}{8 \times 10^6} = 0{,}125 \times 10^{-6} = 0{,}125\ \mu s$$

TCNT = 0x25
0xFF – 0x25 = 0xDA (218 desimal)

Tambahkan 1 siklus lagi untuk membangkitkan flag TOV0 = 219.

Total delay = 219 × 0,125 μs = **27,375 μs**

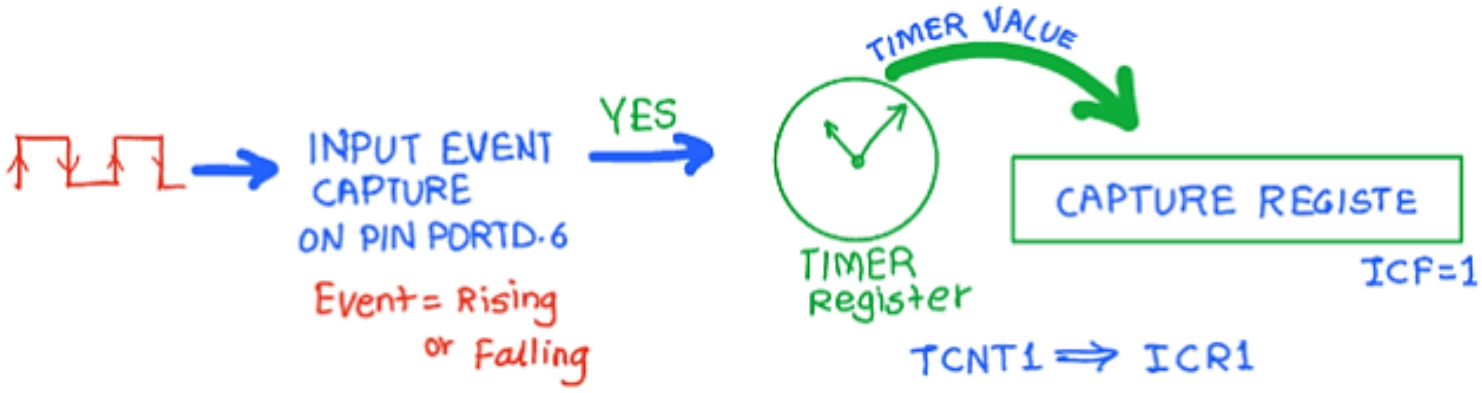
Timer Input Capture Mode in AVR ATmega16/ATmega32

The input capture function is used in many applications such as:

- Pulse width measurement
- Period measurement
- Capturing the time of an event

In AVR ATmega32, Timer1 can be used as input capture to detect and measure events happening outside the microcontroller.

Upon detection of a defined event i.e. rising edge or falling edge on ICP pin (PORTD.6), the TCNT1 (Timer/Counter register) value is loaded into the OCR1 (input capture) register and the ICP1 flag will get set.



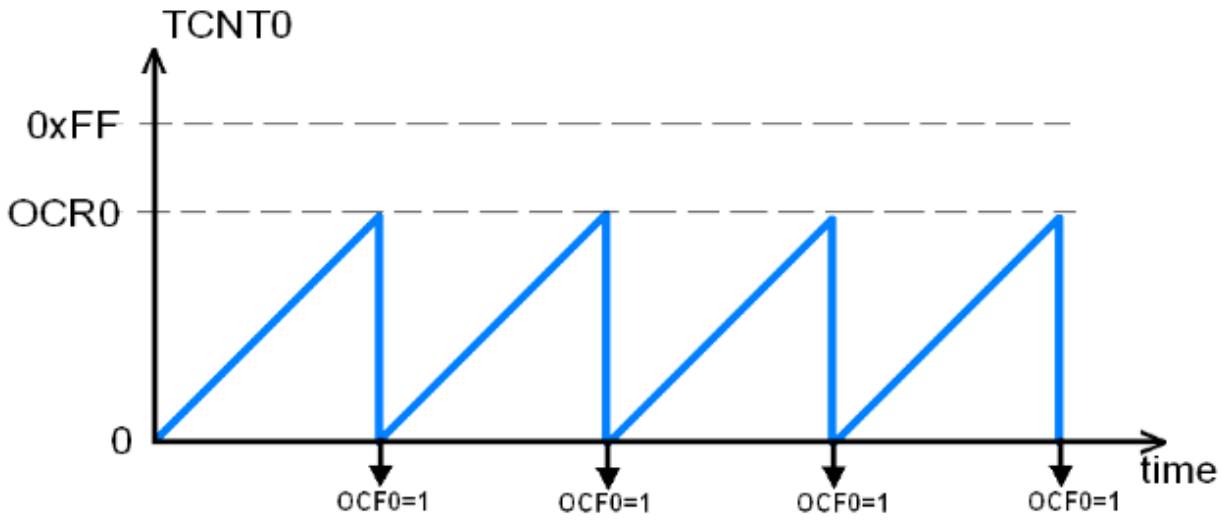
Clear Timer on Compare Match (CTC mode) in AVR ATmega16/ATmega32

Generally, compare model is used for generating periodic events or for generating waveforms.

In compare mode, there is one compare register, where we can set the value to compare with the Timer/Counter register value. Once the compare value matches with the timer/counter register value, a compare match occurs. The compare match event can be used for waveform generation.

In ATmega16/32, the Timer counts up until the value of TCTN0 (Timer/Counter register) register becomes equal to the content of OCR0 (Compare register). As soon as TCNT0 becomes equal to the OCR0, a compare match occurs, and then the timer will get cleared and the OCF0 flag will get set.

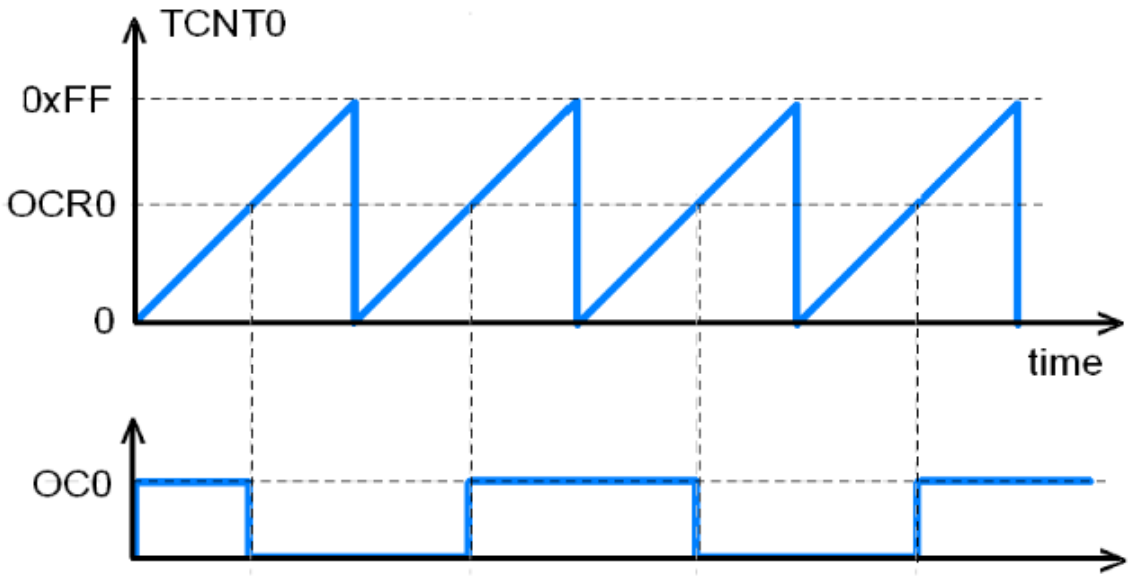
OCF0 flag is located in the TIFR register.



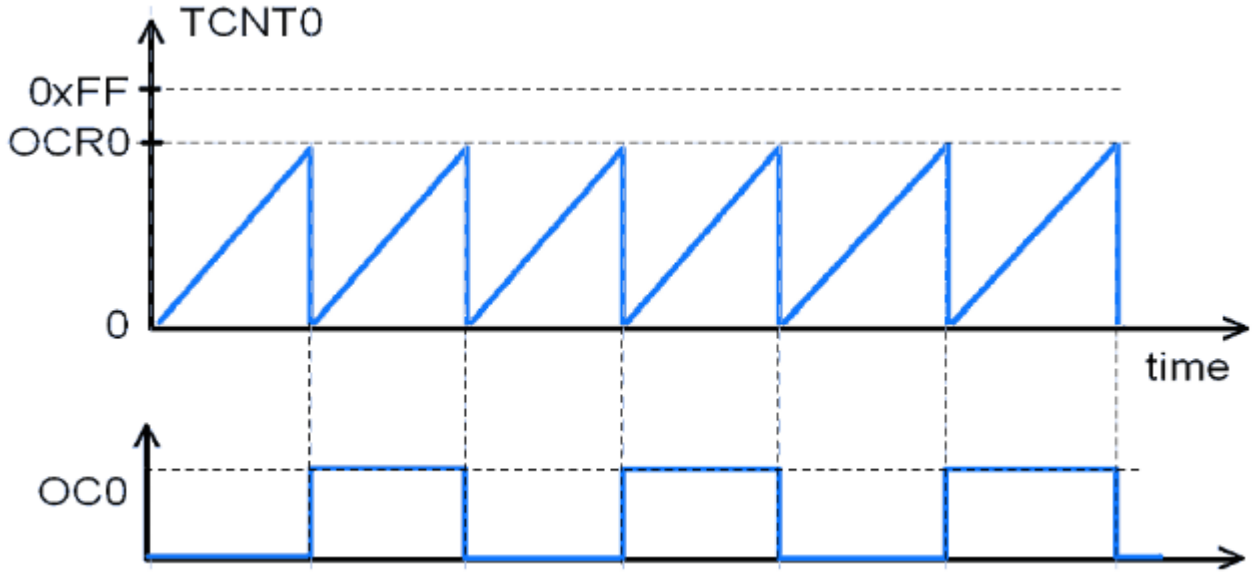
Clear Timer on Compare Match (CTC mode) in AVR ATmega16/ATmega32

```
#include "avr/io.h"
int main ( )
{
    DDRB = DDRB|(1<<3);
    TCCR0 = 0x11;    // normal mode, clk- no pre-scaling
    OCR0 = 100; // nilai compare compare value */
    while (1);
    return 0;
}
```

Normal Mode Vs CTC Mode



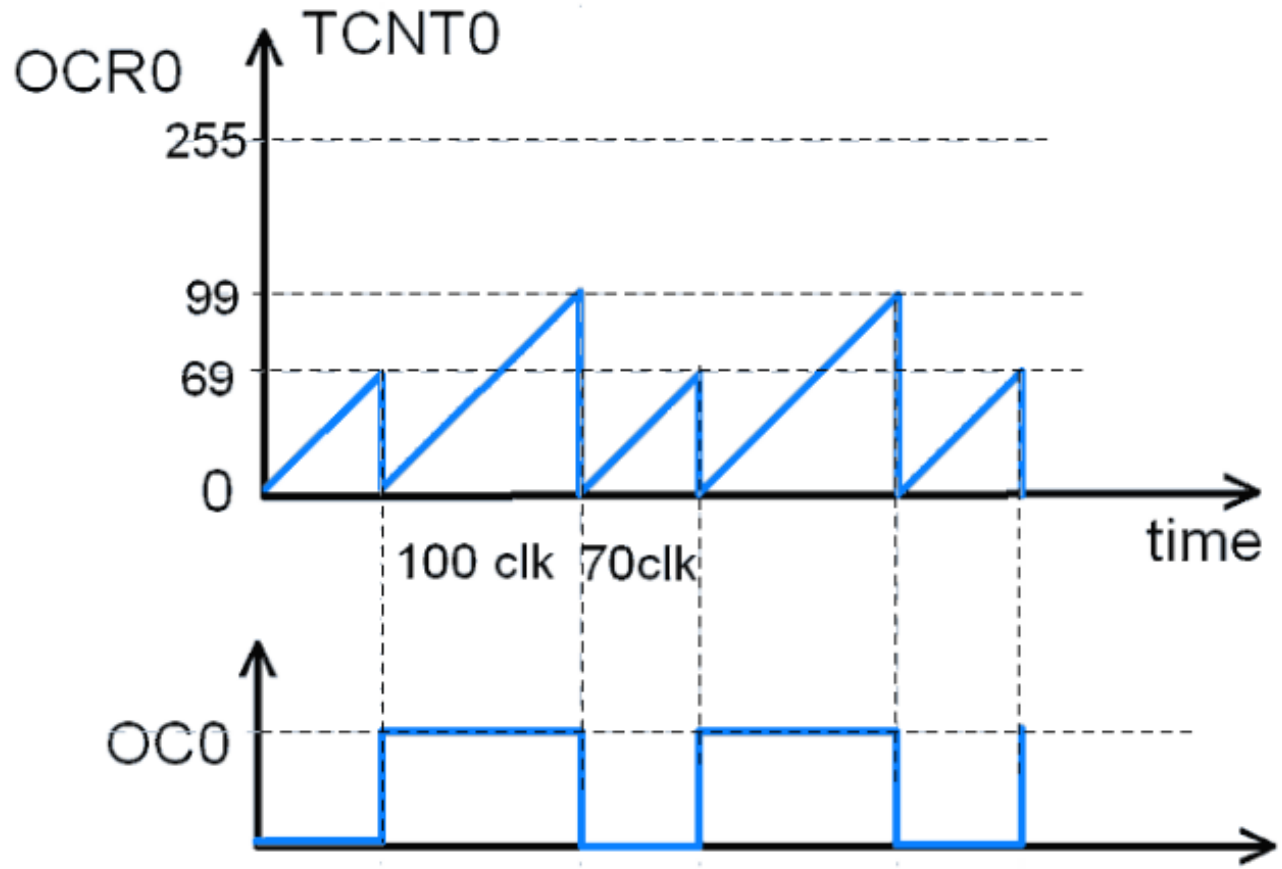
Waveform Generation Using Normal Mode



Waveform Generation Using CTC Mode

CTC Mode

We can change the value of OCR0 in runtime, to generate different pulses



SEKIAN DAN TERIMA KASIH

PENGANTAR MIKROKONTROLER

Pertemuan 6

Ahmad Zarkasi


MATERI BAHASAN
USART/UART in AVR ATmega16/ATmega32

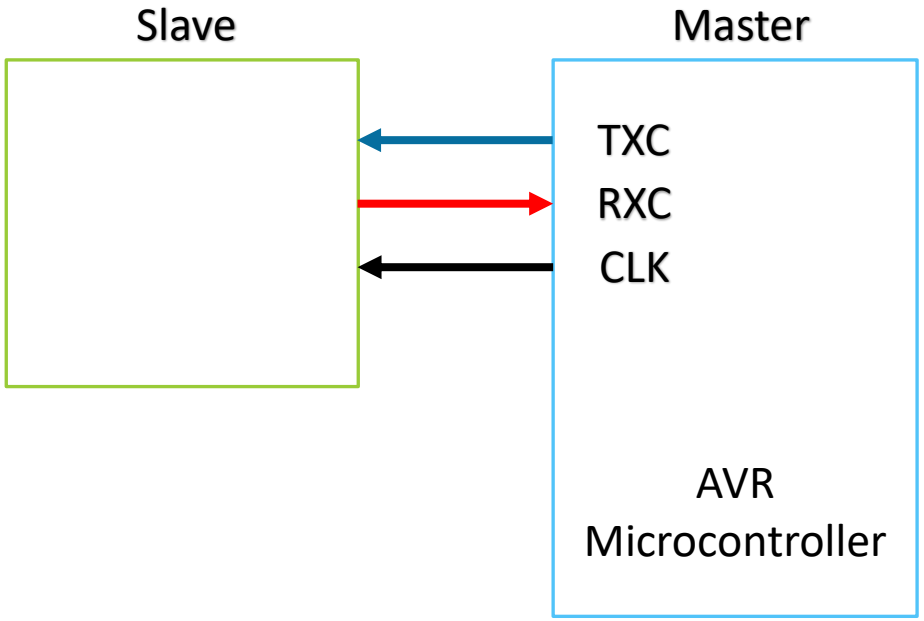
USART
(Universal Synchronous Asynchronous Receiver Transmitter)

Synchronous

sending and receiving data according to pulses of clock.
(e.g: SPI, I2C)

Asynchronous

data is independent of the clock and is transmitted and received without reference to a clock.
(e.g. RS 232)



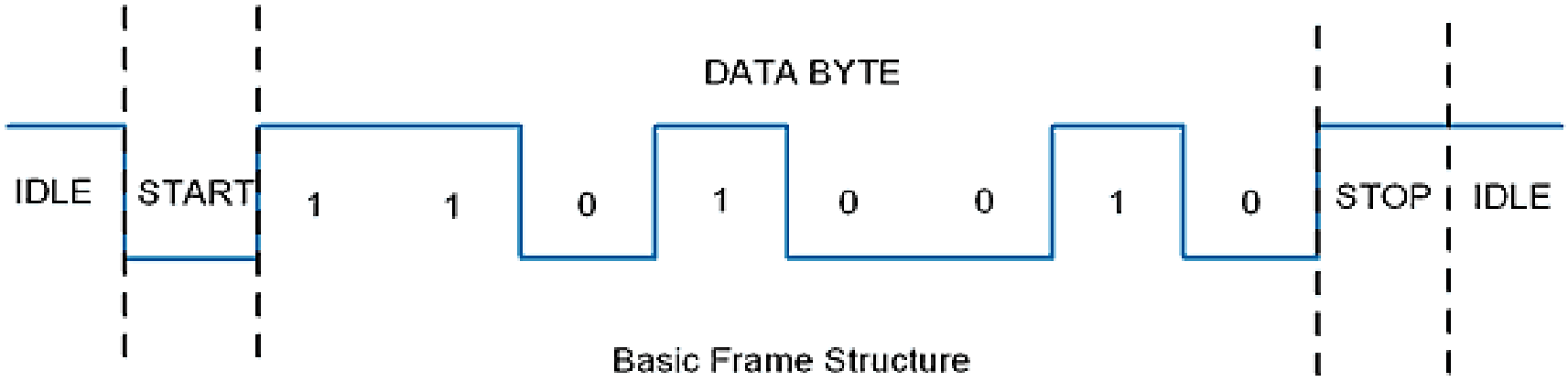
Introduction

AVR ATmega has flexible USART, which can be used for serial communication with other devices like computers, serial GSM, GPS modules, etc.

Before beginning with AVR USART, we will through the basic of serial communication.

Serial data framing

While sending/receiving data, some bits are added for the purpose of knowing the beginning/ending of data, etc. commonly used structure is: 8 data bits, 1 start bit (logic 0), and 1 stop bit (logic 1), as shown:



Basic Frame Structure

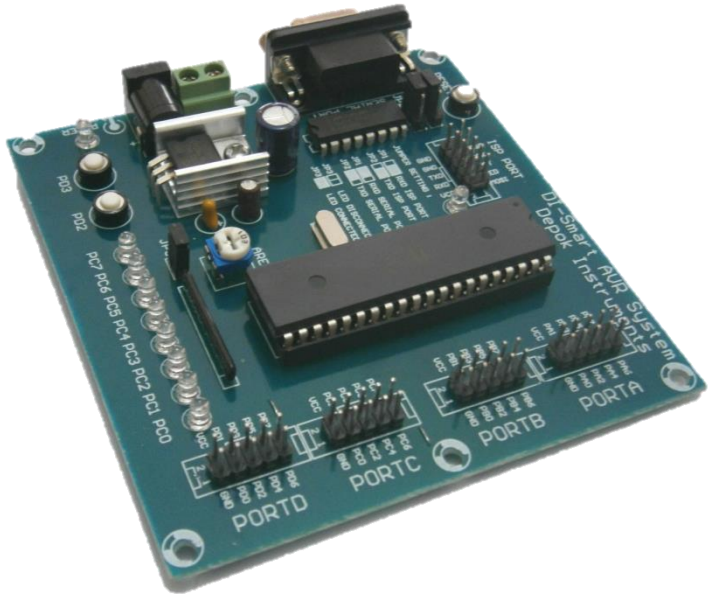
Speed (Baud Rate)

As we know the bit rate is “Number of bits per second (bps)”, also known as baud rate in binary system. Normally this defines how fast the serial line is. There are some standard baud rates defined e.g. 1200, 2400, 4800, 19200, 115200 bps, etc. Normally 9600 bps is used where speed is not critical issue.

Wires and Hardware Connection

Normally in USART, we only need Tx (Transmit), Rx (Receive), and GND wires.

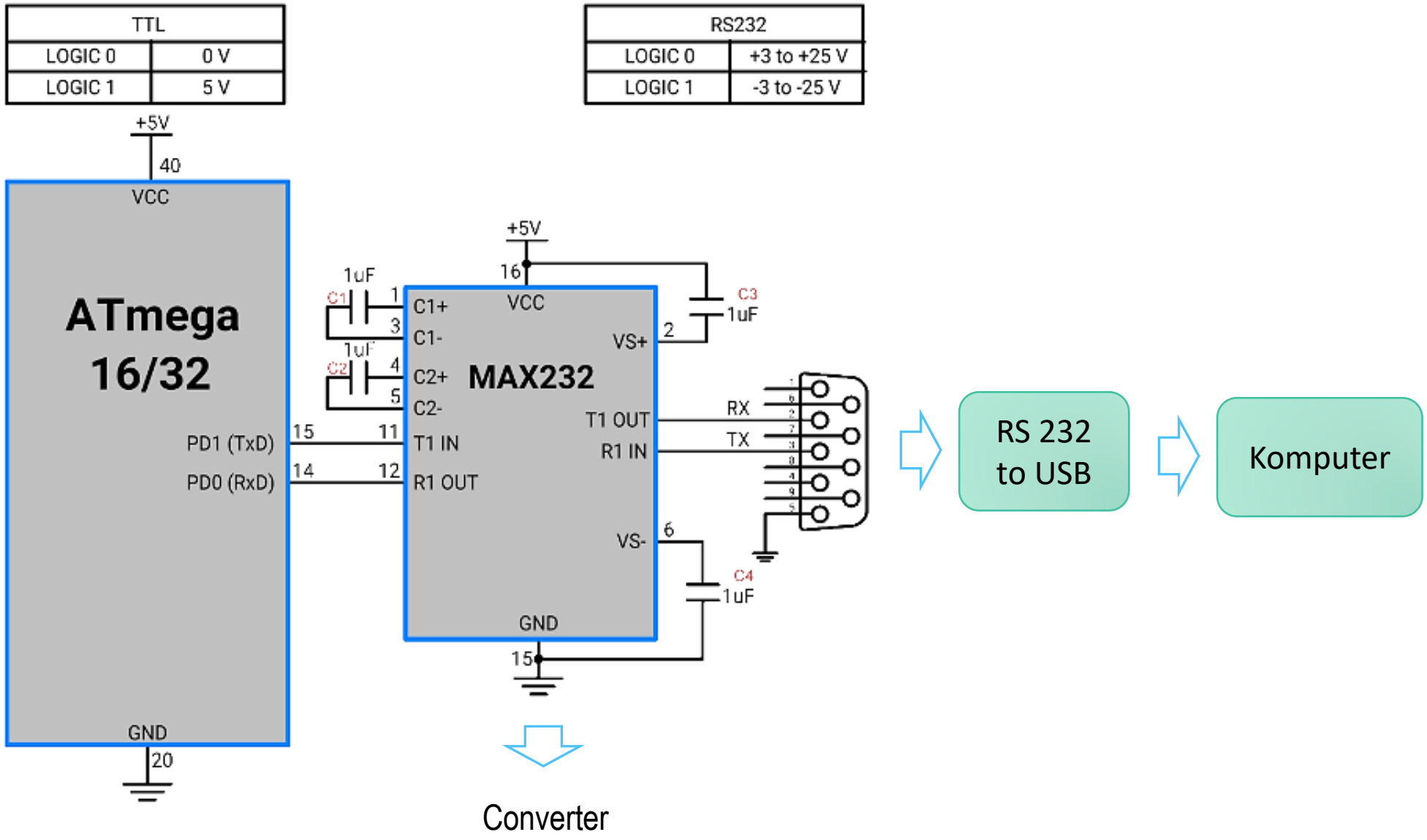
- AVR Atmega USART has a TTL voltage level which is 0V for logic 0 and 5V for logic 1.
- In computers and most of the old devices, RS232 protocol is used for serial communication i.e. +3V to +25V for logic zero and -3V to -25V for logic 1.



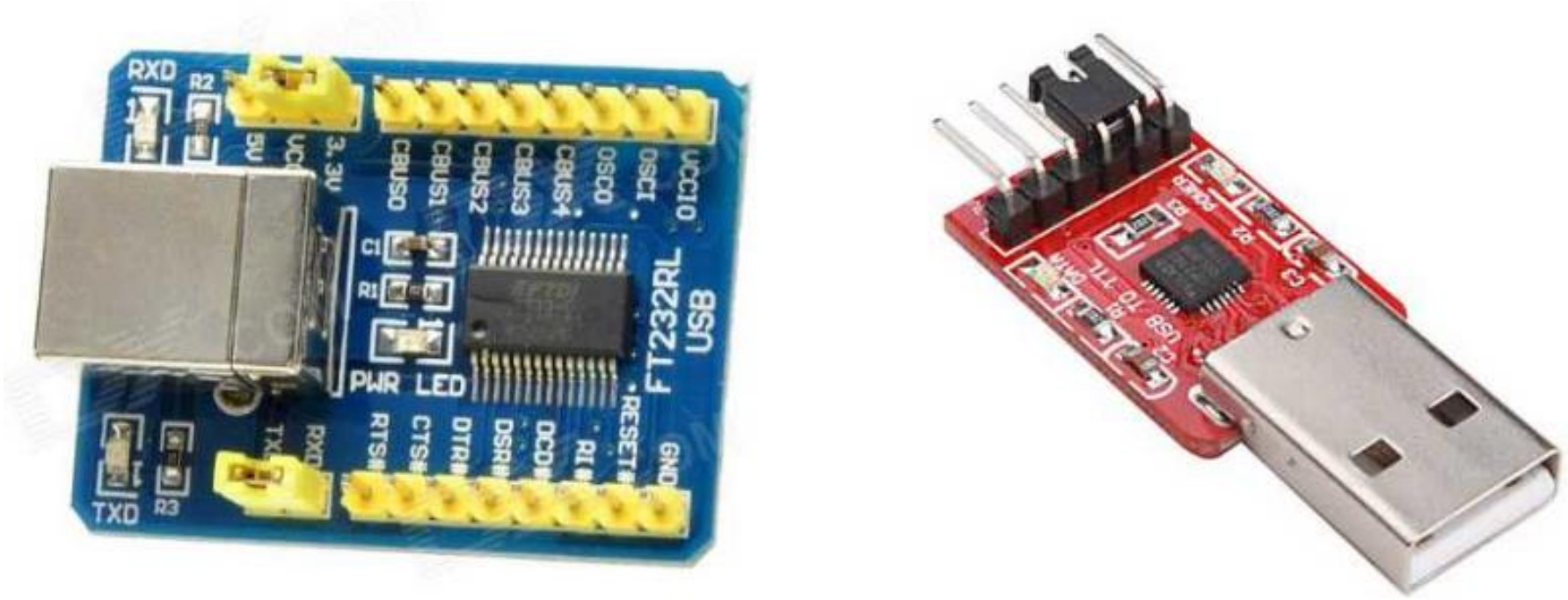
Tx

Rx

ATmega16/32 Serial Interface



With a new PC and laptops, there is no RS232 protocol and DB9 connector. We have to use serial to USB connector. There are various serial to USB connectors available e.g. CP2102, FT232RL, CH340, etc.

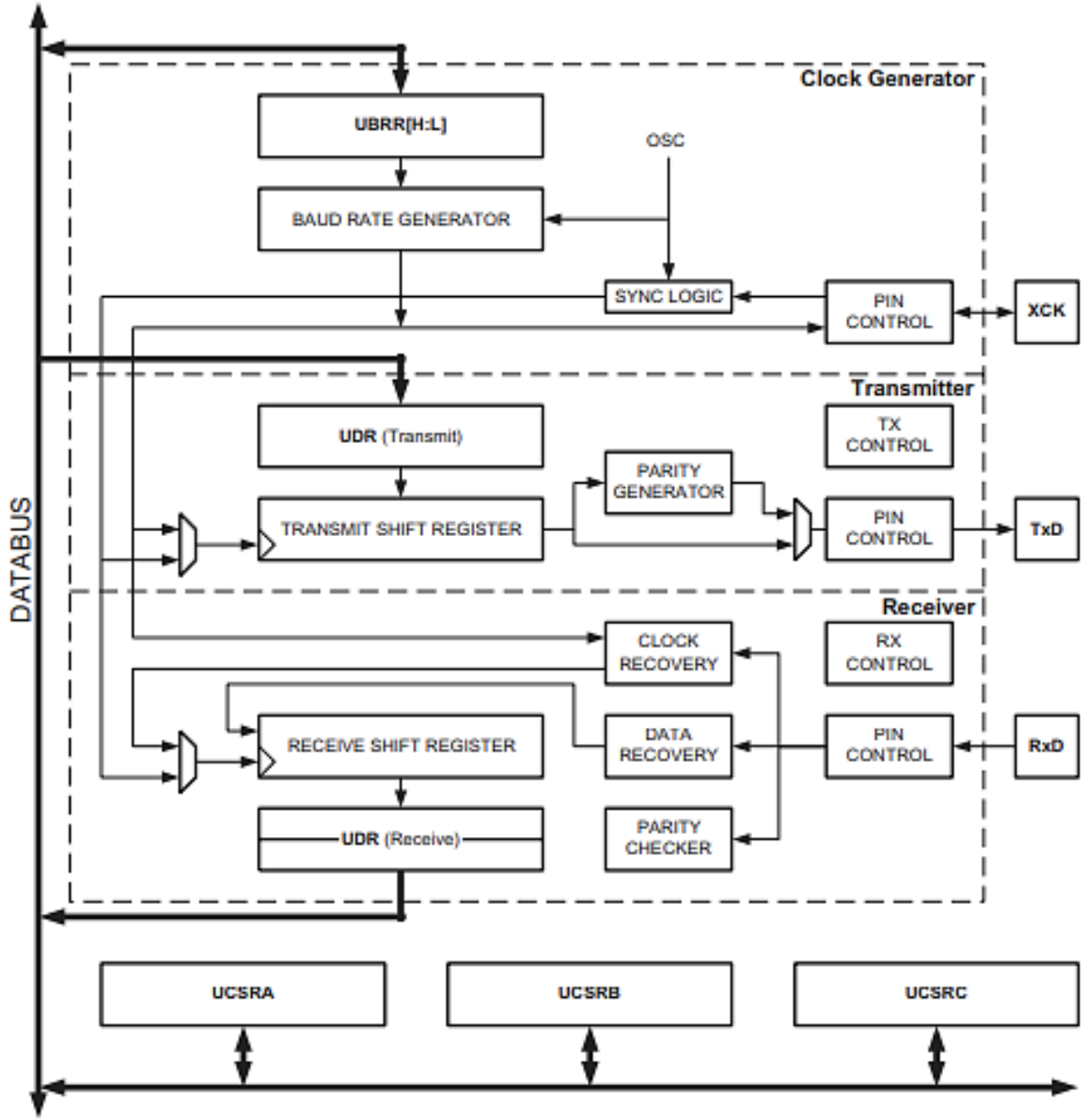


Serial to USB Converter

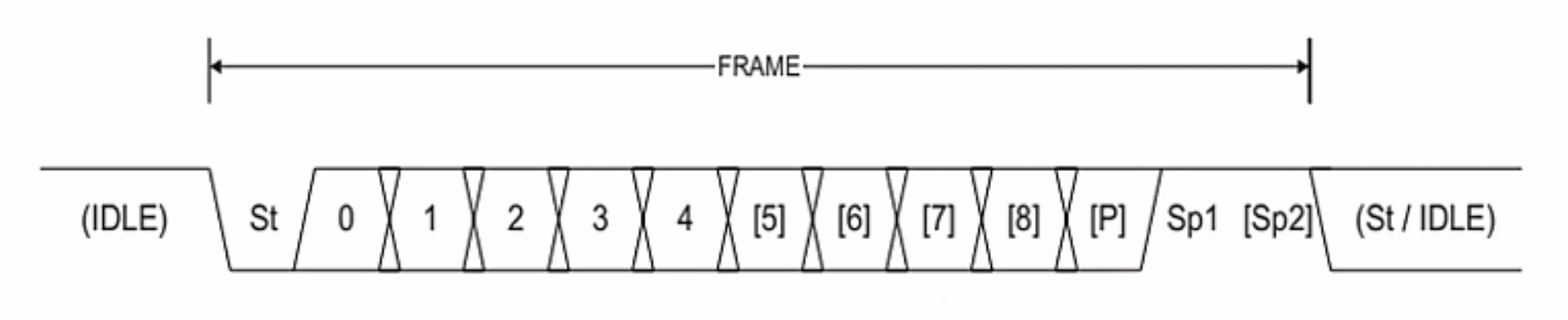
Features

- Full Duplex Operation (Independent Serial Receive and Transmit Registers)
- Asynchronous or Synchronous Operation
- Master or Slave Clocked Synchronous Operation
- High-Resolution Baud Rate Generator
- Supports Serial Frames with 5, 6, 7, 8, or 9 Data Bits and 1 or 2 Stop Bits
- Odd or Even Parity Generation and Parity Check Supported by Hardware (Data Validation)
- Data Over Run Detection
- Framing Error Detection
- Noise Filtering Includes False Start Bit Detection and Digital Low Pass Filter
- Three Separate Interrupts on TX Complete, TX Data Register Empty, and RX Complete
- Etc.

USART Block Diagram



Data Frame



- St : Start Bit
- n : Data Bit (0-8)
- Sp : Stop Bit
- P : Parity Bit

Registers

- UCSRA
- UCSRB
- UCSRC
- USRRH
- USRRL
- UDR

UBRR0L and UBRR0H – USART Baud Rate Registers

Bit	15	14	13	12	11	10	9	8	
	URSEL	–	–	–	UBRR (11:8)				UBRRH
	UBRR (7:0)								UBRRL
	7	6	5	7	3	2	1	0	

- **Bit 15 – URSEL : Register Select** (low:UBRH), (high:UCSRC)
- **Bit 14-12 – Reserve Bit**
- **Bit 11:10 – UBRR1:0** (Baudrate Setting)

UBRR = (f_{clock}/16*Baud) - 1

UCSR0A – USART Control and Status Register A

Bit	7	6	5	4	3	2	1	0
	RXC0	TXC0	UDRE0	FE0	DOR0	UPE0	U2X0	MPCM0
Read/Write	R	R/W	R	R	R	R	R	R
Initial Value	0	0	1	0	0	0	0	0

- **Bit 7 – RXC: USART Receive Complete** √ = 1, jika data siap dibaca

This flag bit is set when there are unread data in the receive buffer and cleared when the receive buffer is empty (i.e., does not contain any unread data). If the receiver is disabled, the receive buffer will be flushed and consequently the RXC bit will become zero. The RXC flag can be used to generate a Receive Complete interrupt (see description of the RXCIE bit).

- **Bit 6 – TXC: USART Transmit Complete** √ = 1, jika semua data terkirim

This flag bit is set when the entire frame in the transmit Shift Register has been shifted out and there are no new data currently present in the transmit buffer (UDR). The TXC flag bit is automatically cleared when a transmit complete interrupt is executed, or it can be cleared by writing a one to its bit location. The TXC flag can generate a Transmit Complete interrupt (see description of the TXCIE bit).

- **Bit 5 – UDRE: USART Data Register Empty** √ = 1, jika datanya kosong

The UDRE flag indicates if the transmit buffer (UDR) is ready to receive new data. If UDRE is one, the buffer is empty, and therefore ready to be written. The UDRE flag can generate a Data Register empty Interrupt (see description of the UDRIE bit).

UDRE is set after a reset to indicate that the transmitter is ready.

- **Bit 4 – FE: Frame Error**

This bit is set if the next character in the receive buffer had a Frame Error when received. i.e., when the first stop bit of the next character in the receive buffer is zero. This bit is valid until the receive buffer (UDR) is read. The FE bit is zero when the stop bit of received data is one. Always set this bit to zero when writing to UCSRA.

- **Bit 3 – DOR: Data OverRun**

This bit is set if a Data OverRun condition is detected. A Data OverRun occurs when the receive buffer is full (two characters), it is a new character waiting in the receive Shift Register, and a new start bit is detected. This bit is valid until the receive buffer (UDR) is read. Always set this bit to zero when writing to UCSRA.

- **Bit 2 – PE: Parity Error**

This bit is set if the next character in the receive buffer had a Parity Error when received and the parity checking was enabled at that point (UPM1 = 1). This bit is valid until the receive buffer (UDR) is read. Always set this bit to zero when writing to UCSRA.

- **Bit 1 – U2X: Double the USART Transmission Speed**

This bit only has effect for the asynchronous operation. Write this bit to zero when using synchronous operation.

Writing this bit to one will reduce the divisor of the baud rate divider from 16 to 8 effectively doubling the transfer rate for asynchronous communication.

- **Bit 0 – MPCM: Multi-processor Communication Mode**

This bit enables the Multi-processor Communication mode. When the MPCM bit is written to one, all the incoming frames received by the USART receiver that do not contain address information will be ignored. The transmitter is unaffected by the MPCM setting. For more detailed information see “Multi-processor Communication Mode” on page 154.

UCSR0B – USART Control and Status Register B

Bit	7	6	5	4	3	2	1	0
	RXCIE0	TXCIE0	UDRIE0	RXEN0	TXEN0	UCSZ02	RXB80	TXB80
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R	R/W
Initial Value	0	0	0	0	0	0	0	0

- **Bit 7 – RXCIE: RX Complete Interrupt Enable** √

Writing this bit to one enables interrupt on the RXC flag. A USART Receive Complete Interrupt will be generated only if the RXCIE bit is written to one, the Global Interrupt Flag in SREG is written to one and the RXC bit in UCSRA is set.

- **Bit 6 – TXCIE: TX Complete Interrupt Enable** √

Writing this bit to one enables interrupt on the TXC flag. A USART Transmit Complete Interrupt will be generated only if the TXCIE bit is written to one, the Global Interrupt Flag in SREG is written to one and the TXC bit in UCSRA is set.

- **Bit 5 – UDRIE: USART Data Register Empty Interrupt Enable**

Writing this bit to one enables interrupt on the UDRE flag. A Data Register Empty Interrupt will be generated only if the UDRIE bit is written to one, the Global Interrupt Flag in SREG is written to one and the UDRE bit in UCSRA is set.

- **Bit 4 – RXEN: Receiver Enable** √

Writing this bit to one enables the USART Receiver. The Receiver will override normal port operation for the RxD pin when enabled. Disabling the Receiver will flush the receive buffer invalidating the FE, DOR, and PE flags.

- **Bit 3 – TXEN: Transmitter Enable** √

Writing this bit to one enables the USART Transmitter. The Transmitter will override normal port operation for the TxD pin when enabled. The disabling of the Transmitter (writing TXEN to zero) will not become effective until ongoing and pending transmissions are completed, i.e., when the transmit Shift Register and transmit Buffer Register do not contain data to be transmitted. When disabled, the transmitter will no longer override the TxD port.

- **Bit 2 – UCSZ2: Character Size**

The UCSZ2 bits combined with the UCSZ1:0 bit in UCSRC sets the number of data bits (Character Size) in a frame the receiver and transmitter use.

- **Bit 1 – RXB8: Receive Data Bit 8**

RXB8 is the ninth data bit of the received character when operating with serial frames with nine data bits. Must be read before reading the low bits from UDR.

- **Bit 0 – TXB8: Transmit Data Bit 8**

TXB8 is the ninth data bit in the character to be transmitted when operating with serial frames with nine data bits. Must be written before writing the low bits to UDR.

UCSR0C – USART Control and Status Register C

Bit	7	6	5	4	3	2	1	0
	UMSEL01	UMSEL00	UPM01	UPM00	USBS0	UCSZ01	UCSZ0	UCPOL0
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Initial Value	0	0	0	0	0	1	1	0

- **Bit 7 – URSEL: Register Select** √ 0 → UBRRH, 1 → UCSRC

This bit selects between accessing the UCSRC or the UBRRH Register. It is read as one when reading UCSRC. The URSEL must be one when writing the UCSRC.

- **Bit 6 – UMSEL: USART Mode Select** √ 0 → asynchronous, 1 → synchronous

This bit selects between Asynchronous and Synchronous mode of operation.

- **Bit 5:4 – UPM1:0: Parity Mode** √

These bits enable and set type of parity generation and check. If enabled, the transmitter will automatically generate and send the parity of the transmitted data bits within each frame. The Receiver will generate a parity value for the incoming data and compare it to the UPM0 setting. If a mismatch is detected, the PE flag in UCSRA will be set.

- **Bit 3 – USBS: Stop Bit Select** √

This bit selects the number of Stop Bits to be inserted by the Transmitter. The Receiver ignores this setting.

- **Bit 2:1 – UCSZ1:0: Character Size** √ Menentukan banyak bit dalam 1 frame

The UCSZ1:0 bits combined with the UCSZ2 bit in UCSRB sets the number of data bits (Character Size) in a frame the Receiver and Transmitter use.

UDR0 – USART I/O Data Register

Bit	7	6	5	4	3	2	1	0
UDR (Read)	RXB7	RXB6	RXB5	RXB4	RXB3	RXB2	RXB1	RXB0
UDR (Write)	TXB7	TXB6	TXB5	TXB4	TXB3	TXB2	TXB1	TXB0
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Initial Value	0	0	0	0	0	0	0	0

- All data received by the receiver and data sent by the transmitter will be accommodated by the UDR
- To read the data received by the receiver can be done by reading the contents of this UDR.
- To send data through the transmitter it is enough to provide a UDR value.

USART Initialization

```
void USART_Init( unsigned int baud )
{
  /* Set baud rate */
  UBRRH = (unsigned char)(baud>>8);
  UBRRL = (unsigned char)baud;
  /* Enable receiver and transmitter */
  UCSRB = (1<<RXEN)|(1<<TXEN);
  /* Set frame format: 8data, 2stop bit */
  UCSRC = (1<<URSEL)|(1<<USBS)|(3<<UCSZ0);
}
```

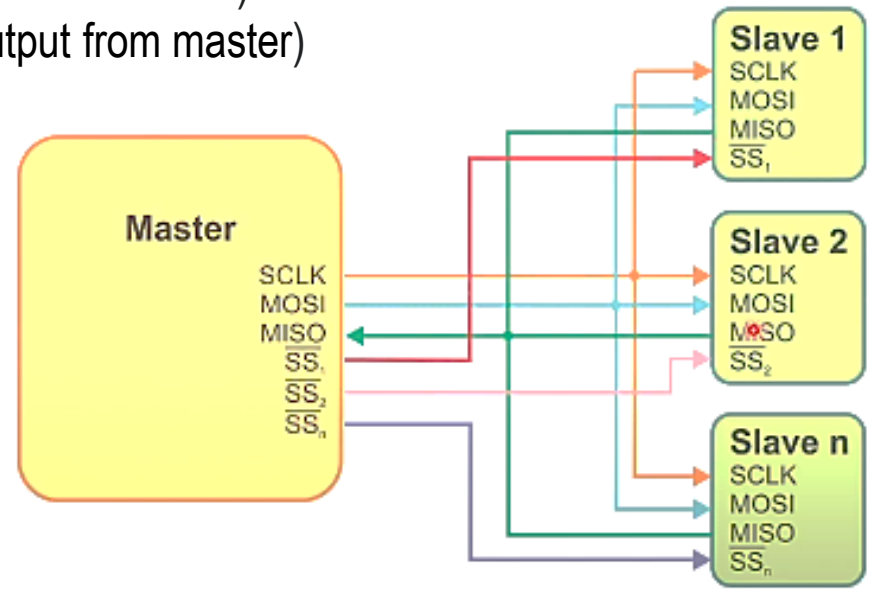
MATERI BAHASAN

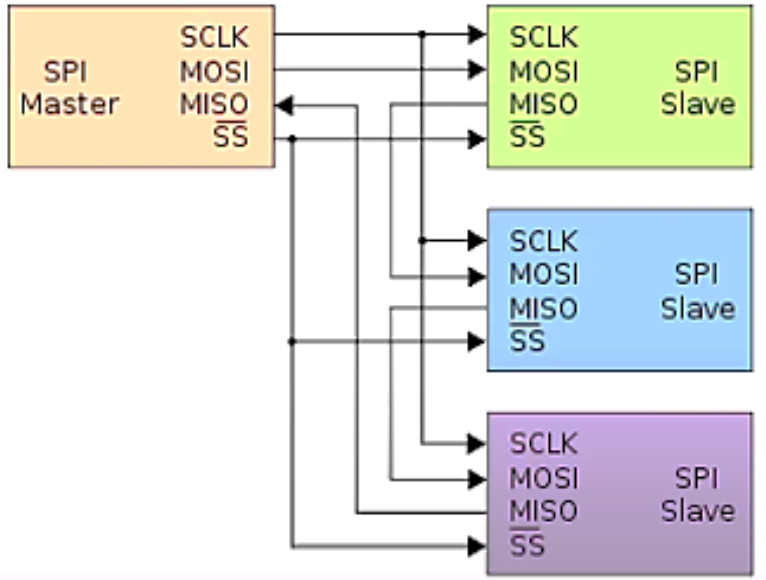
SPI (Serial Peripheral Interface)

SPI: The Serial Peripheral Interface (SPI) is a synchronous serial communication interface specification used for short-distance communication, primarily in embedded systems. SPI is an interface bus commonly used to send data between microcontrollers and small peripherals such as shift registers, sensors, and SD cards. It uses separate clock and data lines, along with a select line to choose the device you wish to talk to.

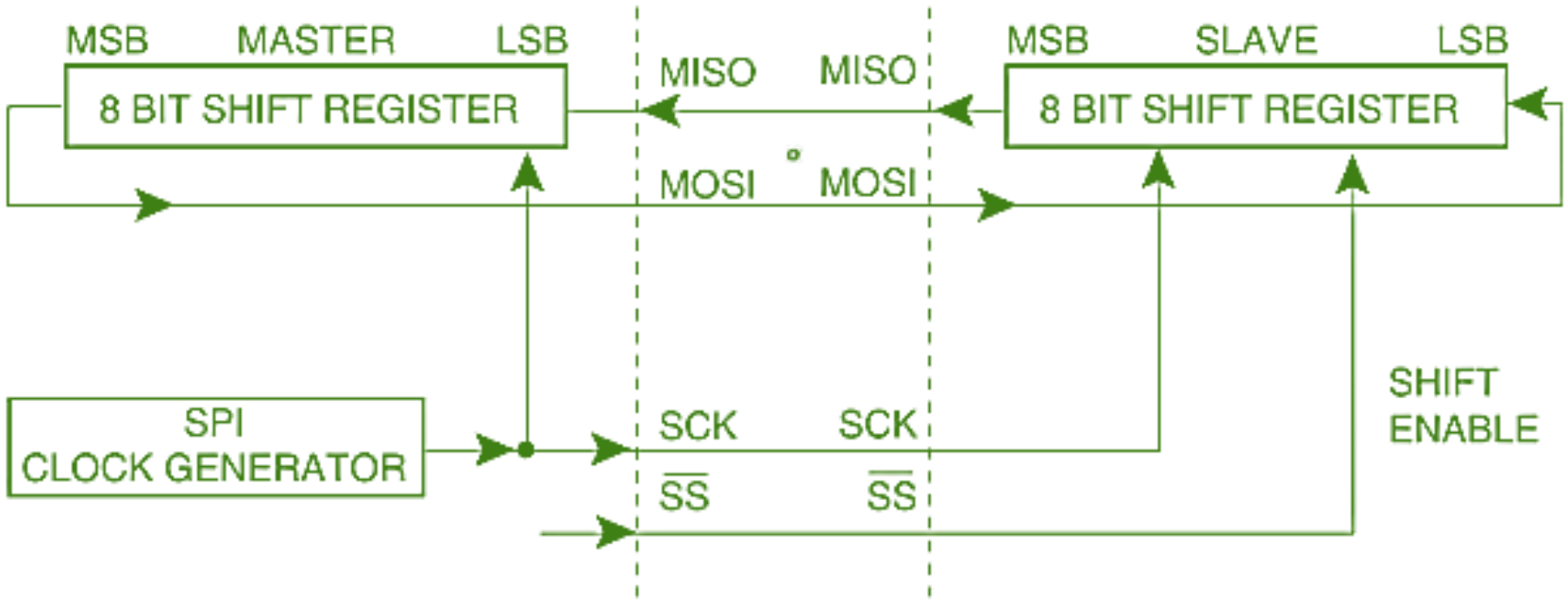
The SPI bus specifies four logic signals:

- SCLK: Serial Clock (output from master)
- MOSI: Master Out Slave In (data output from master)
- MISO: Master In Slave Out (data output from slave)
- SS: Slave Select (often active low, output from master)



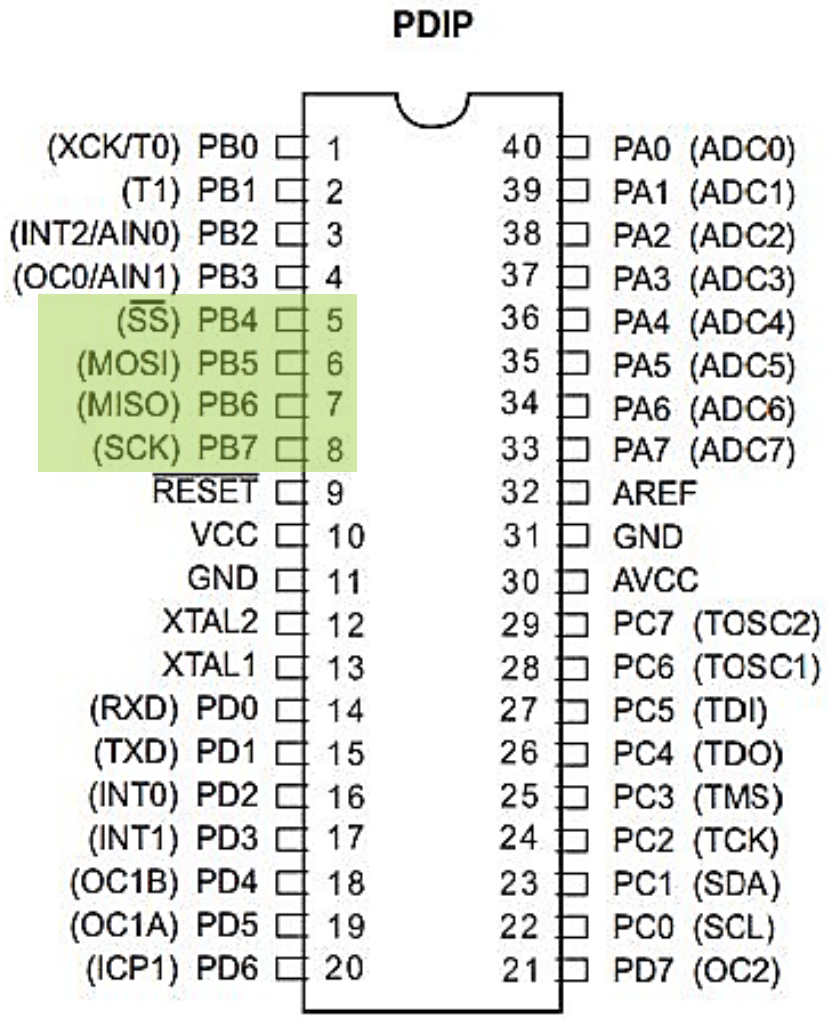


Master-Slave Interconnection



SPI Pin

Pin	Direction, Master SPI	Direction, Slave SPI
MOSI	User Defined	Input
MISO	Input	User Defined
SCK	User Defined	Input
$\overline{SS}$	User Defined	Input



SPI Control Register - SPCR

Bit	7	6	5	4	3	2	1	0	
	SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0	SPCR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – SPIE: SPI Interrupt Enable** √

This bit causes the SPI interrupt to be executed if SPIF bit in the SPSR Register is set and the if the global interrupt enable bit in SREG is set.

- **Bit 6 – SPE: SPI Enable** √

When the SPE bit is written to one, the SPI is enabled. This bit must be set to enable any SPI operations.

- **Bit 5 – DORD: Data Order**

When the DORD bit is written to one, the LSB of the data word is transmitted first.

When the DORD bit is written to zero, the MSB of the data word is transmitted first.

- **Bit 4 – MSTR: Master/Slave Select** √

This bit selects Master SPI mode when written to one, and Slave SPI mode when written logic zero. If $\overline{SS}$ is configured as an input and is driven low while MSTR is set, MSTR will be cleared, and SPIF in SPSR will become set. The user will then have to set MSTR to re-enable SPI Master mode.

- **Bit 3 – CPOL: Clock Polarity**
- **Bit 2 – CPHA: Clock Phase**
- **Bits 1, 0 – SPR1, SPR0: SPI Clock Rate Select 1 and 0**

SPI Status Register - SPSR

Bit	7	6	5	4	3	2	1	0	
	SPIF	WCOL	–	–	–	–	–	SPI2X	SPSR
Read/Write	R	R	R	R	R	R	R	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bit 7 – SPIF: SPI Interrupt Flag** √

When a serial transfer is complete, the SPIF flag is set. An interrupt is generated if SPIE in SPCR is set and global interrupts are enabled. If $\overline{SS}$ is an input and is driven low when the SPI is in Master mode, this will also set the SPIF flag.

- **Bit 6 – WCOL: Write COLlision flag**

The WCOL bit is set if the SPI Data Register (SPDR) is written during a data transfer. The WCOL bit (and the SPIF bit) are cleared by first reading the SPI Status Register with WCOL set, and then accessing the SPI Data Register.

- **Bit 5..1 – Res: Reserved Bits**

These bits are reserved bits in the ATmega16 and will always read as zero.

- **Bit 0 – SPI2X: Double SPI Speed Bit**

When this bit is written logic one the SPI speed (SCK Frequency) will be doubled when the SPI is in Master mode (see Table 58). This means that the minimum SCK period will be two CPU clock periods. When the SPI is configured as Slave, the SPI is only guaranteed to work at $f_{osc}/4$ or lower.

SPI Data Register - SPDR

Bit	7	6	5	4	3	2	1	0	
	MSB							LSB	SPDR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	X	X	X	X	X	X	X	X	Undefined

The SPI Data Register is a read/write register used for data transfer between the register file and the SPI Shift Register. Writing to the register initiates data transmission. Reading the register causes the Shift Register Receive buffer to be read.

```
void SPI_SlaveInit(void)
{
  /* Set MISO output, all others input */
  DDR_SPI = (1<<DD_MISO);
  /* Enable SPI */
  SPCR = (1<<SPE);
}

char SPI_SlaveReceive(void)
{
  /* Wait for reception complete */
  while(!(SPSR & (1<<SPIF)))
    ;
  /* Return data register */
  return SPDR;
}
```

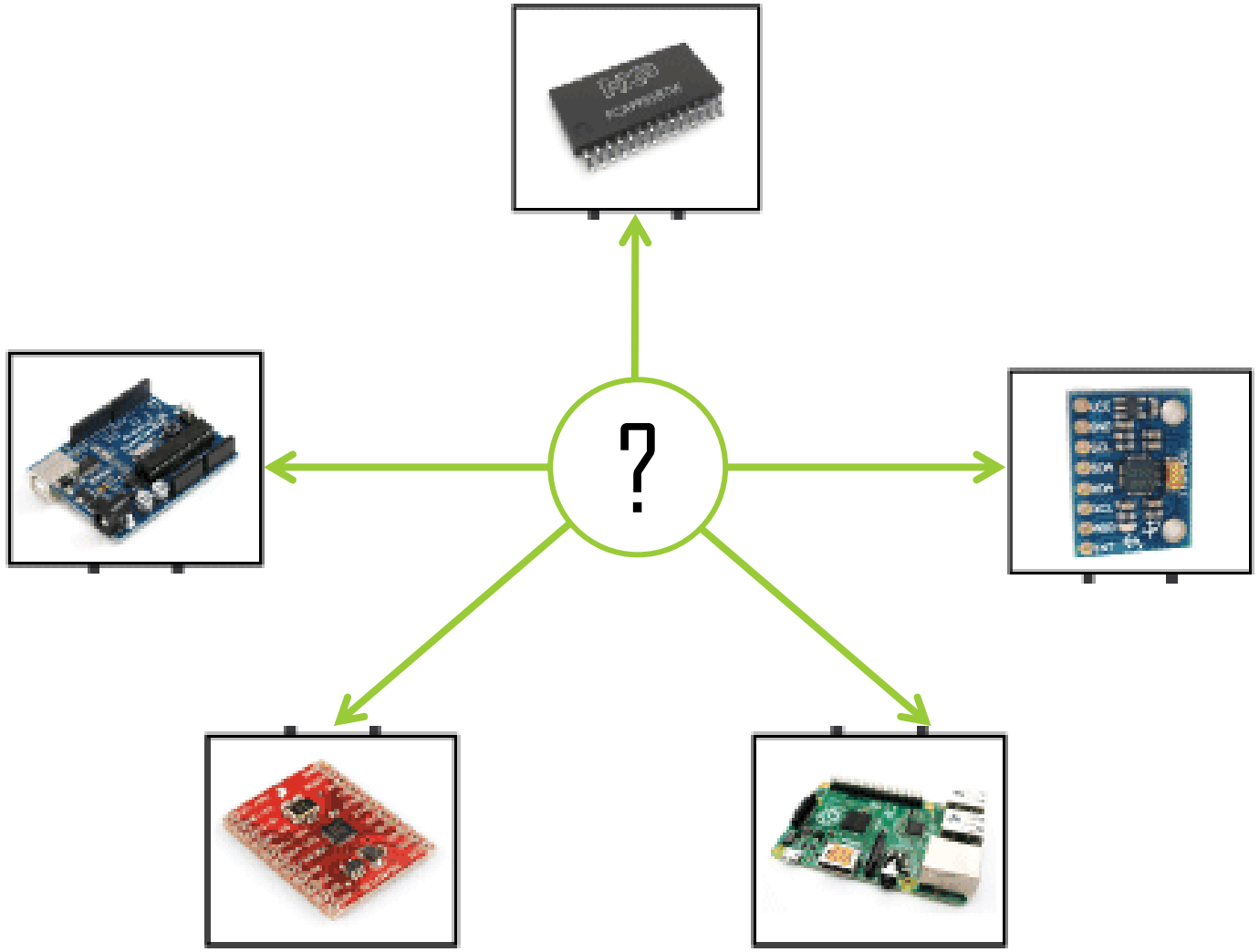
SEKIAN DAN TERIMA KASIH

PENGANTAR MIKROKONTROLER

Pertemuan 7

Ahmad Zarkasi

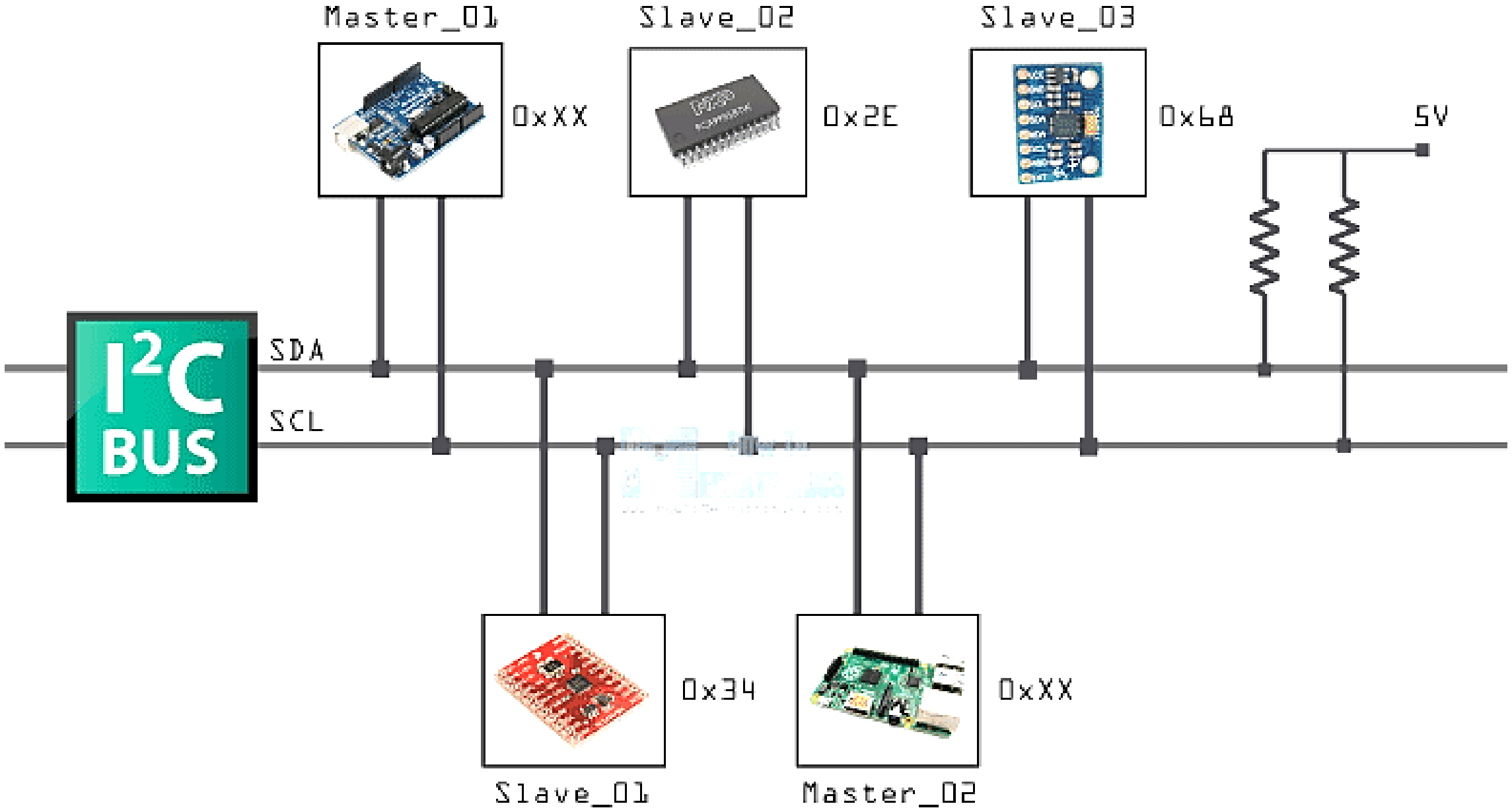

MATERI BAHASAN
TWO WRE INTERFACE (TWI)



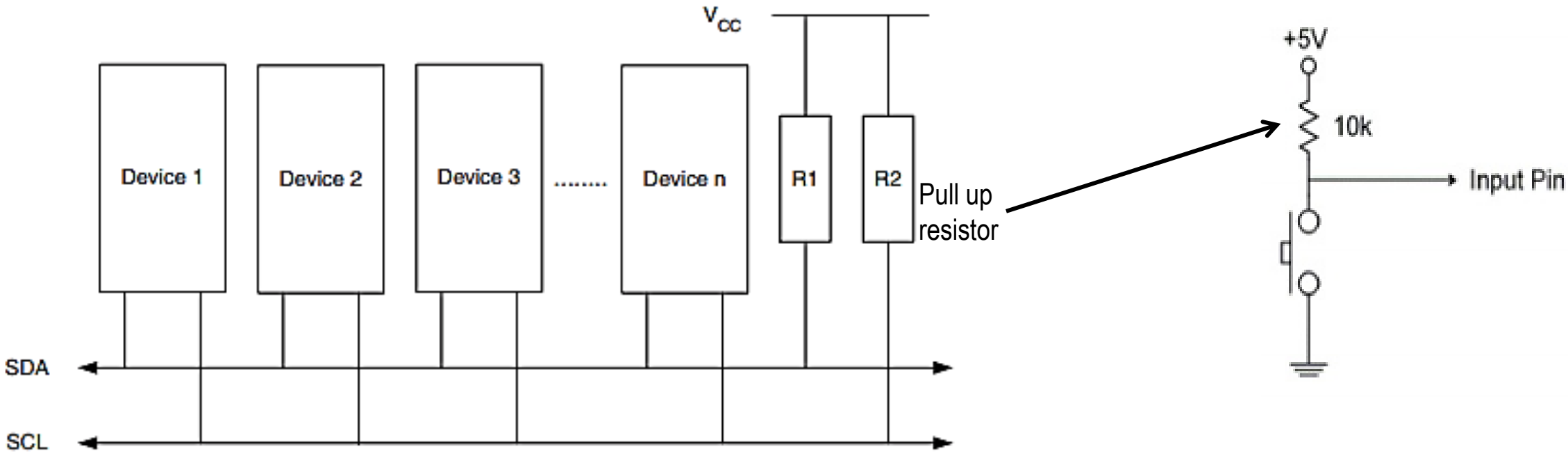
Basics

The **I2C** (**Inter-Integrated Circuit**) protocol, referred to as *I-squared-C*, *I-two-C*, or *IIC*) is two wire serial communication protocol for connecting low speed peripherals to a microcontroller or computer motherboard. I2C is ideally suited for typical microcontroller applications.

The TWI protocol allows the system designer to interconnect up to 128 different devices using only two bi-directional bus lines, one for clock (SCL) and one for dara (SDA). The only external hardware needed to implement the bus is a single pull-up resistor for each of the bus lines.


Master_01
0xXX
Slave_02
0x2E
Slave_03
0x68
5V
I²C BUS
SDA
SCL
0x34
0xXX
Slave_01
Master_02

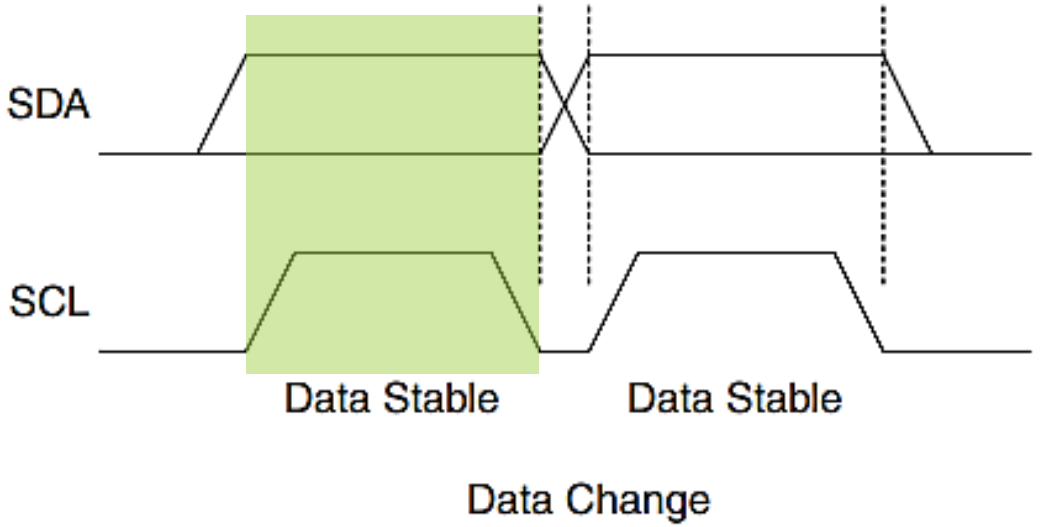
TWI Bus Interconnection



TWI Terminology

Term	Description
Master	The device that initiates and terminates a transmission. The master also generates the SCL clock.
Slave	The device addressed by a master.
Transmitter	The device placing data on the bus.
Receiver	The device reading data from the bus.

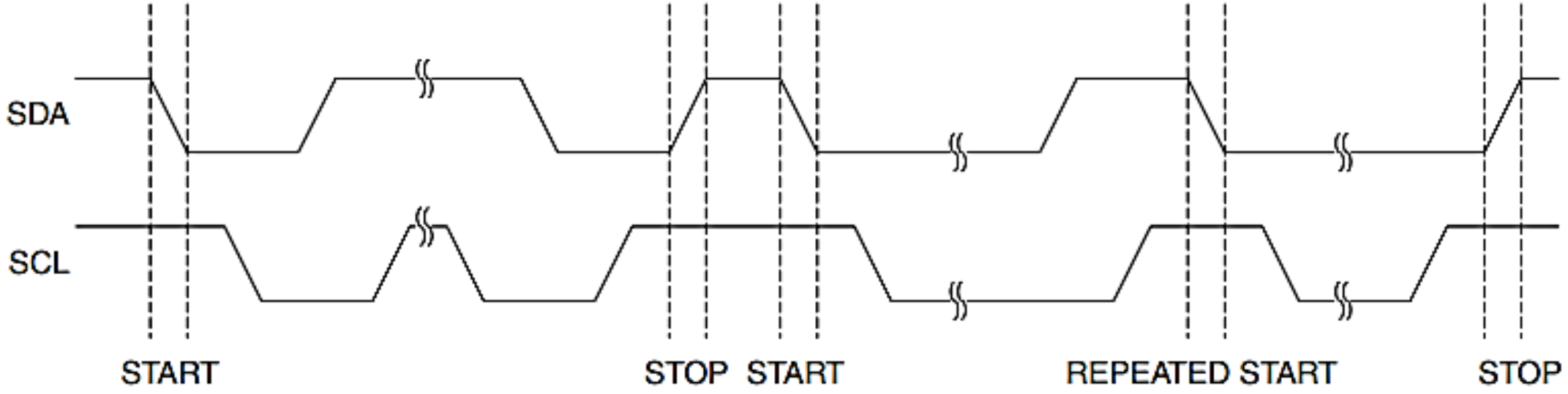
Data Validity



SDA = 0 or 1 & SCL=1 ⟶ Valid : 1 bit data

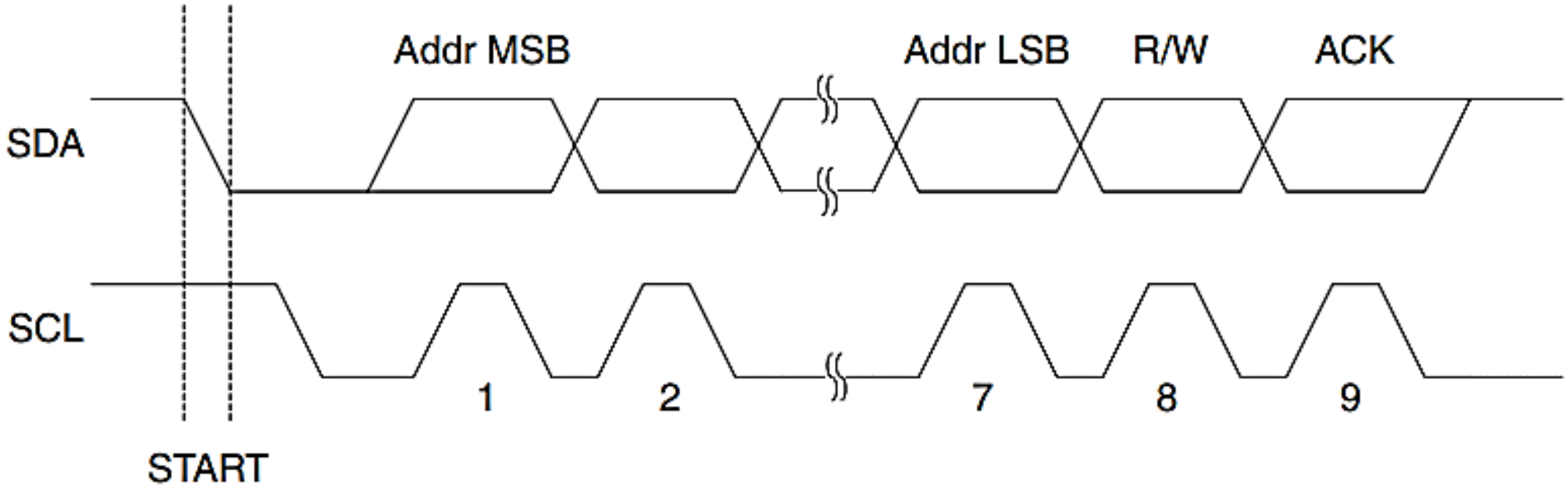
START, REPEATED START, and STOP Conditions

The master initiates and terminates a data transmission. The transmission is initiated when the master issues a START condition on the bus, and it is terminated when the master issues a STOP condition. Between a START and a STOP condition, the bus is considered busy, and no other master should try to seize control of the bus. A special case occurs when a new START condition is issued between a START and STOP condition. This is referred to as a REPEATED START condition, and is used when the master wishes to initiate a new transfer without releasing control of the bus. After a REPEATED START, the bus is considered busy until the next STOP.



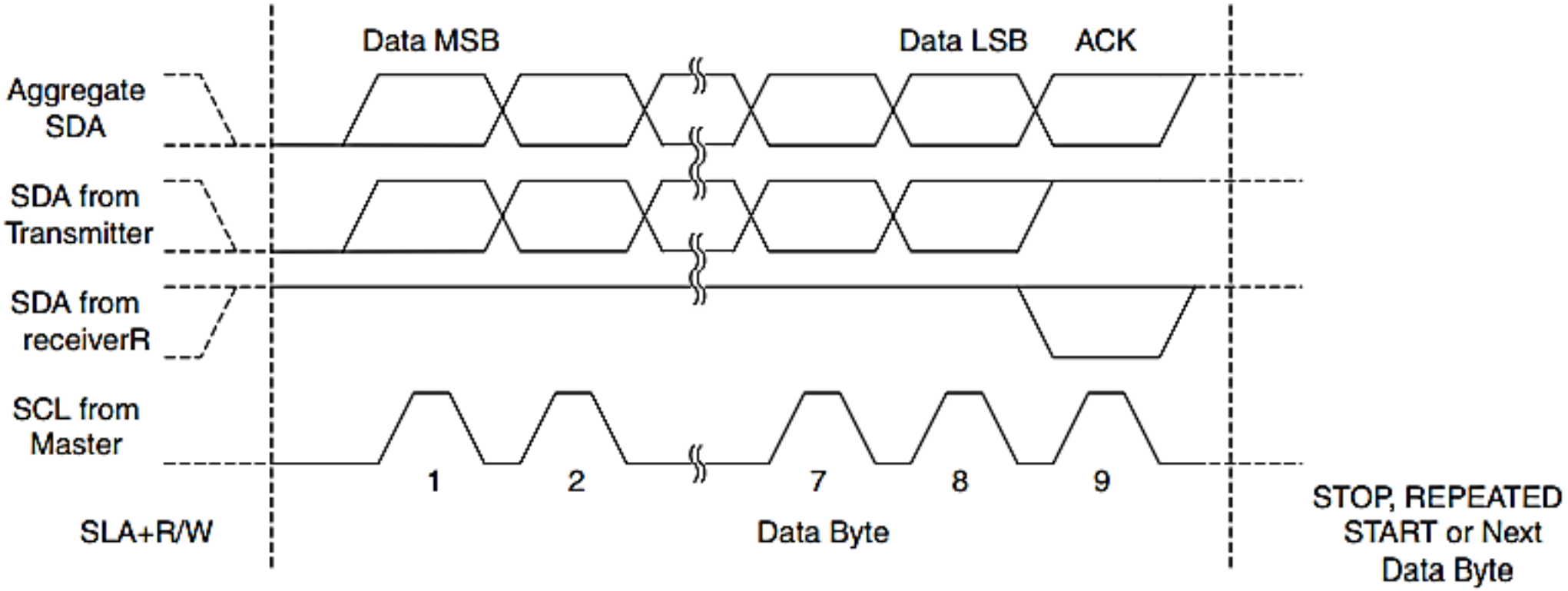
Address Packet Format

All address packets transmitted on the TWI bus are nine bits long, consisting of seven address bits, one READ/WRITE control bit and an acknowledge bit. If the READ/WRITE bit is set, a read operation is to be performed, otherwise a write operation should be performed. When a slave recognizes that it is being addressed, it should acknowledge by pulling SDA low in the ninth SCL (ACK) cycle.

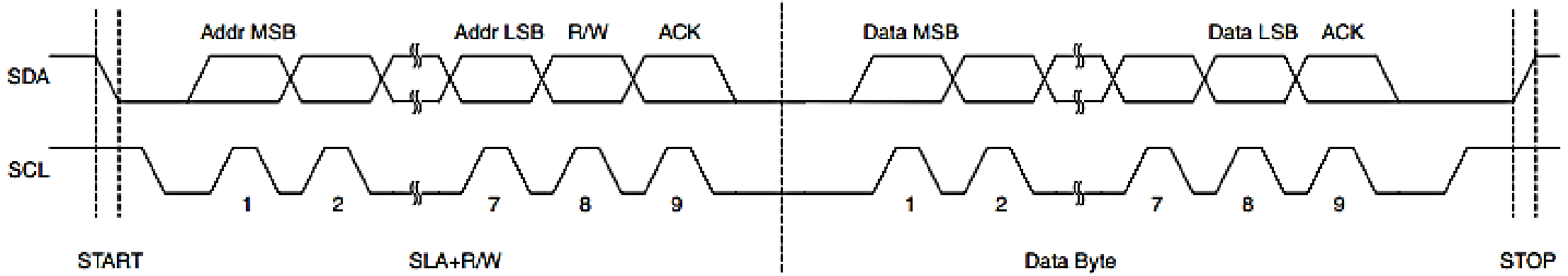


Data Packet Format

All data packets transmitted on the TWI bus are nine bits long, consisting of one data byte and an acknowledge bit. During a data transfer, the master generates the clock and the START and STOP conditions, while the receiver is responsible for acknowledging the reception. An Acknowledge (ACK) is signalled by the receiver pulling the SDA line low during the ninth SCL cycle. If the receiver leaves the SDA line high, a NACK is signalled.



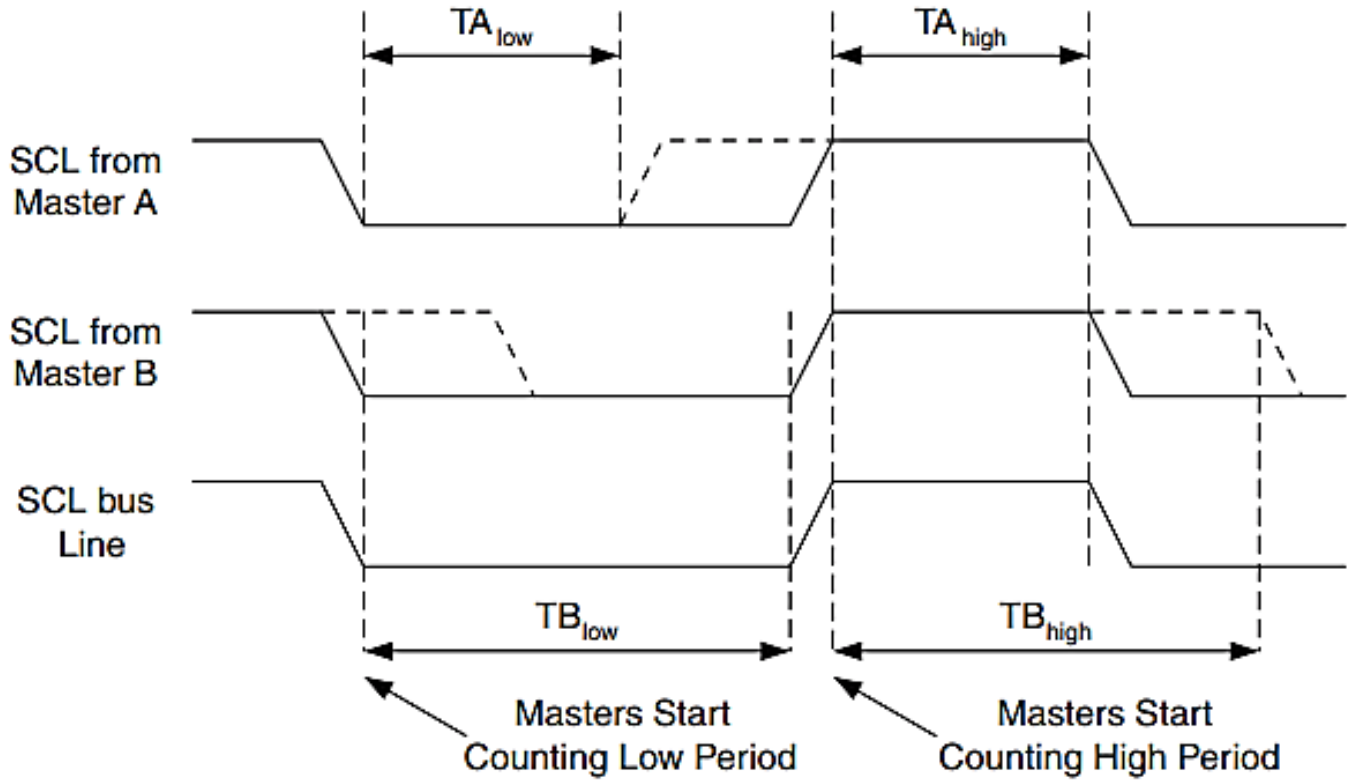
Combining Address and Data Packets into a Transmission



Typical Data Transmission

Multi-master Bus System

The TWI protocol allows bus systems with several masters. Special concerns have been taken in order to ensure that transmissions will proceed as normal, even if two or more masters initiate a transmission at the same time.

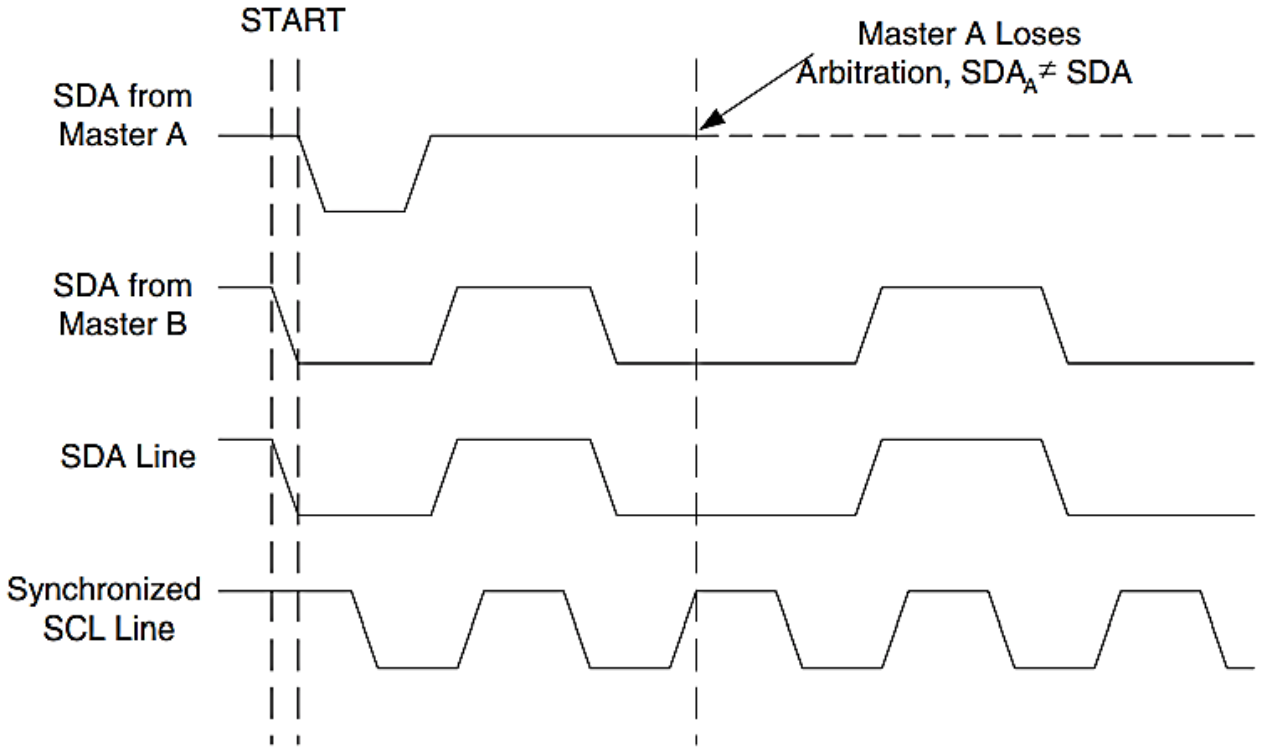


SCL Synchronization between Multiple Masters

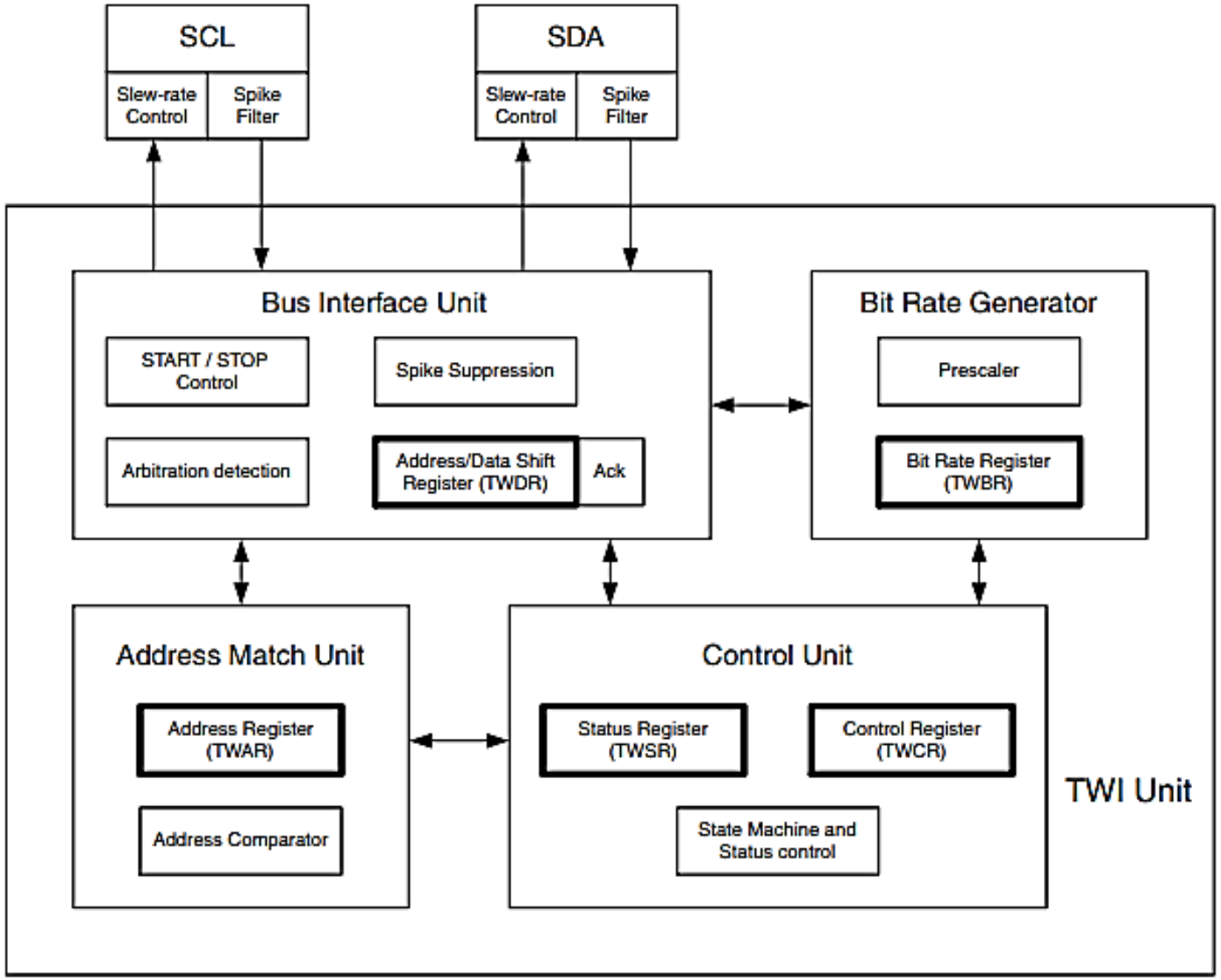
Arbitration

- An algorithm must be implemented allowing only one of the masters to complete the transmission. All other masters should cease transmission when they discover that they have lost the selection process. This selection process is called arbitration.
- Arbitration is carried out by all masters continuously monitoring the SDA line after outputting data. If the value read from the SDA line does not match the value the master had output, it has lost the arbitration. Note that a master can only lose arbitration when it outputs a high SDA value while another master outputs a low value.

Arbitration between Two Masters



Overview of The TWI Module



Bit Rate Generator

This unit controls the period of SCL when operating in a Master mode. The SCL period is controlled by settings in the TWI Bit Rate Register (TWBR) and the Prescaler bits in the TWI Status Register (TWSR).

$$\text{SCL frequency} = \frac{\text{CPU Clock frequency}}{16 + 2(\text{TWBR}) \cdot 4^{TWPS}}$$

- TWBR = Value of the TWI Bit Rate Register
- TWPS = Value of the prescaler bits in the TWI Status Register

TWI Bit Rate Register - TWBR

Bit	7	6	5	4	3	2	1	0	
	TWBR7	TWBR6	TWBR5	TWBR4	TWBR3	TWBR2	TWBR1	TWBR0	TWBR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- **Bits 7..0 – TWI Bit Rate Register**
  TWBR selects the division factor for the bit rate generator. The bit rate generator is a frequency divider which generates the SCL clock frequency in the Master modes.

TWI Control Register - TWCR

Bit	7	6	5	4	3	2	1	0	
	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE	TWCR
Read/Write	R/W	R/W	R/W	R/W	R	R/W	R	R/W	
Initial Value	0	0	0	0	0	0	0	0	

- Bit 7 – TWINT: TWI Interrupt Flag
- Bit 6 – TWEA: TWI Enable Acknowledge Bit
- Bit 5 – TWSTA: TWI START Condition Bit
- Bit 4 – TWSTO: TWI STOP Condition Bit
- Bit 3 – TWWC: TWI Write Collision Flag
- Bit 2 – TWEN: TWI Enable Bit
- Bit 1 – Res: Reserved Bit
- Bit 0 – TWIE: TWI Interrupt Enable

TWI Status Register - TWSR

Bit	7	6	5	4	3	2	1	0	
	TWS7	TWS6	TWS5	TWS4	TWS3	–	TWPS1	TWPS0	TWSR
Read/Write	R	R	R	R	R	R	R/W	R/W	
Initial Value	1	1	1	1	1	0	0	0	

- **Bits 7..3 – TWS: TWI Status**
- **Bit 2 – Res: Reserved Bit**
- **Bits 1..0 – TWPS: TWI Prescaler Bits**

TWPS1	TWPS0	Prescaler Value
0	0	1
0	1	4
1	0	16
1	1	64

TWI Data Register - TWDR

Bit	7	6	5	4	3	2	1	0	
	TWD7	TWD6	TWD5	TWD4	TWD3	TWD2	TWD1	TWD0	TWDR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	1	1	1	1	1	1	1	1	

- **Bits 7..0 – TWD: TWI Data Register**
  These eight bits contain the next data byte to be transmitted, or the latest data byte received on the Two-wire Serial Bus.

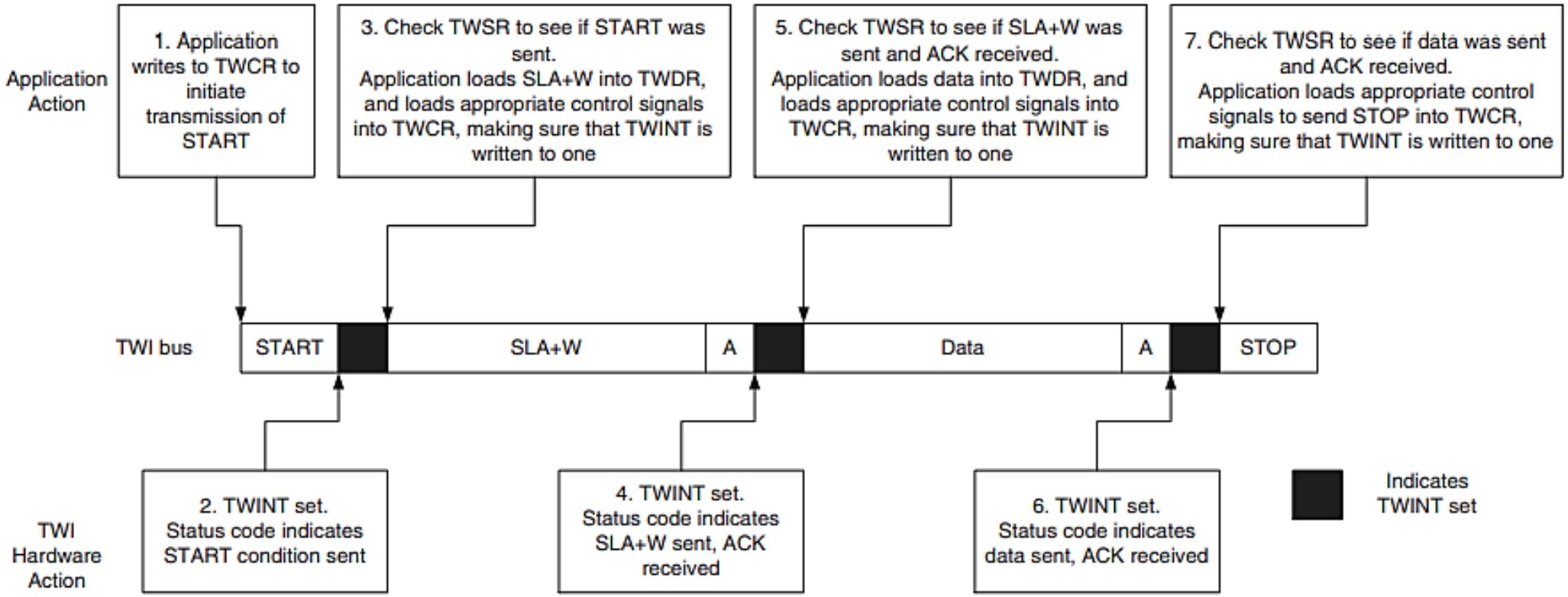
TWI (Slave) Address Register - TWAR

Bit	7	6	5	4	3	2	1	0	
	TWA6	TWA5	TWA4	TWA3	TWA2	TWA1	TWA0	TWGCE	TWAR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	1	1	1	1	1	1	1	0	

- **Bits 7..1 – TWA: TWI (Slave) Address Register**
  These seven bits constitute the slave address of the TWI unit.

- **Bit 0 – TWGCE: TWI General Call Recognition Enable Bit**
  If set, this bit enables the recognition of a General Call given over the Two-wire Serial Bus.

Interfacing the Application to the TWI in a Typical Transmission



C example	Comments
`TWCR = (1<<TWINT)|(1<<TWSTA)|` `(1<<TWEN)`	Send START condition
`while (!(TWCR & (1<<TWINT)))` `;`	Wait for TWINT flag set. This indicates that the START condition has been transmitted
`if ((TWSR & 0xF8) != START)` `ERROR();`	Check value of TWI Status Register. Mask prescaler bits. If status different from START go to ERROR
`TWDR = SLA_W;` `TWCR = (1<<TWINT) | (1<<TWEN);`	Load SLA_W into TWDR Register. Clear TWINT bit in TWCR to start transmission of address
`while (!(TWCR & (1<<TWINT)))` `;`	Wait for TWINT flag set. This indicates that the SLA+W has been transmitted, and ACK/NACK has been received.

`if ((TWSR & 0xF8) != MT_SLA_ACK)` `ERROR();`	Check value of TWI Status Register. Mask prescaler bits. If status different from MT_SLA_ACK go to ERROR
`TWDR = DATA;` `TWCR = (1<<TWINT) | (1<<TWEN);`	Load DATA into TWDR Register. Clear TWINT bit in TWCR to start transmission of data
`while (!(TWCR & (1<<TWINT)))` `;`	Wait for TWINT flag set. This indicates that the DATA has been transmitted, and ACK/NACK has been received.
`if ((TWSR & 0xF8) != MT_DATA_ACK)` `ERROR();`	Check value of TWI Status Register. Mask prescaler bits. If status different from MT_DATA_ACK go to ERROR
`TWCR = (1<<TWINT)|(1<<TWEN)|` `(1<<TWSTO);`	Transmit STOP condition

SEKIAN DAN TERIMA KASIH

PENGANTAR MIKROKONTROLER

Ahmad Zarkasi

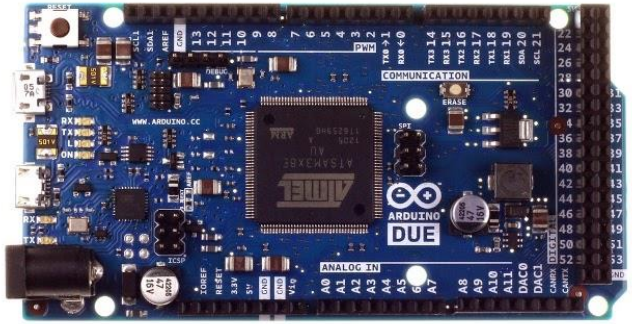
MATERI BAHASAN

PEMROGRAMAN ARDUINO Bag. 1

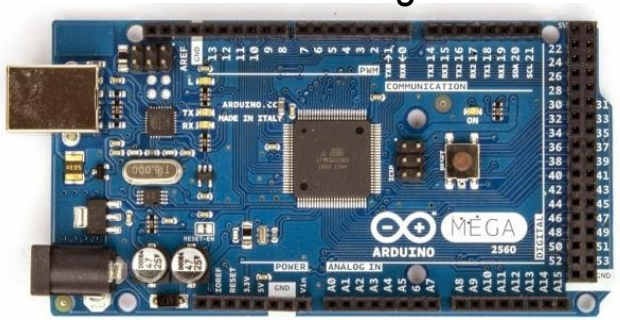
Beberapa Jenis Modul Arduino (Review)

Arduino Uno (Topik Bahasan)

Arduino Due

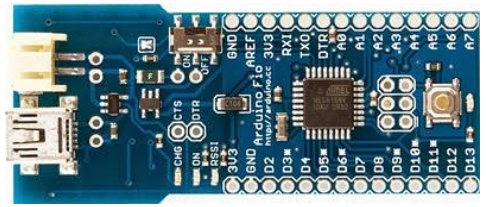


Arduino Mega

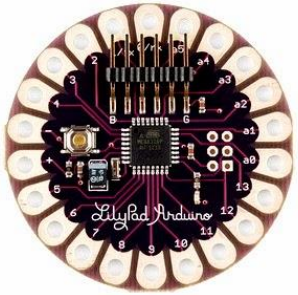


Arduino Leonardo

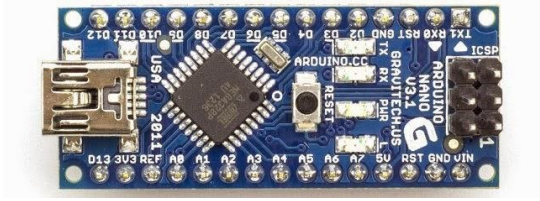
Arduino Fio



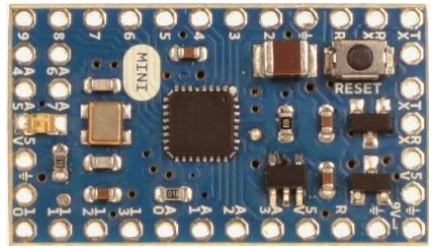
Arduino Lily



Arduino Nano

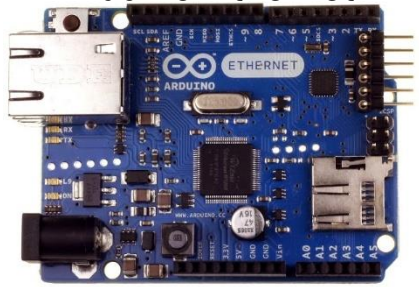


Arduino Mini

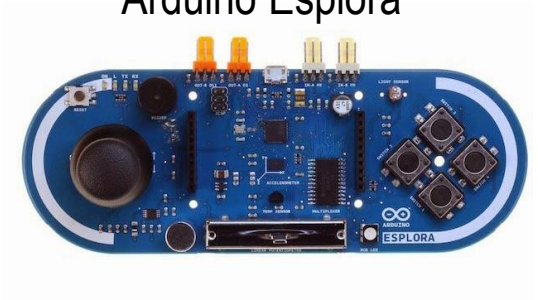


Arduino Micro

Arduino Ethernet

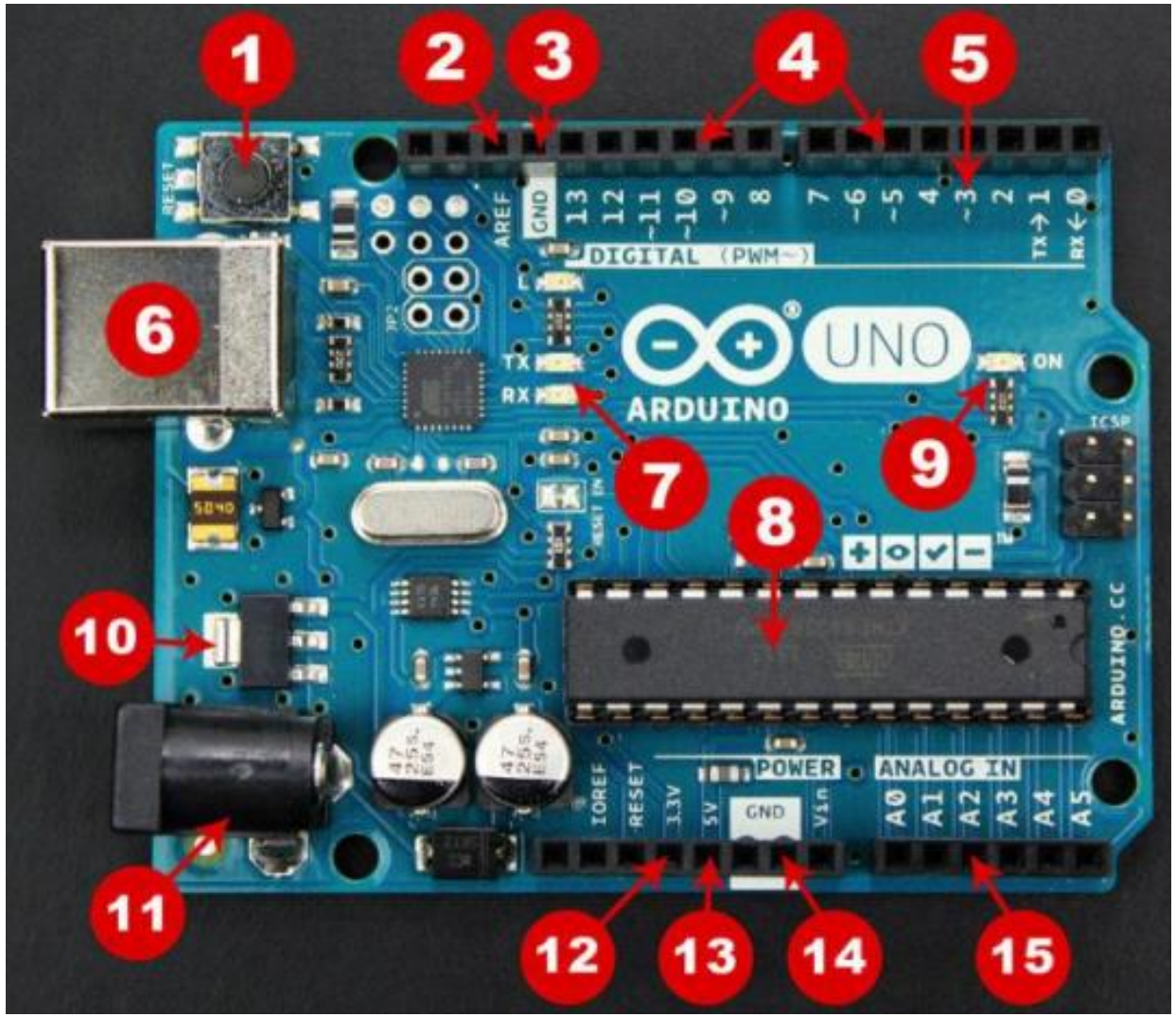


Arduino Esplora



Arduino Robot

Ringkasan Bagian-bagian Arduino Uno (Review)

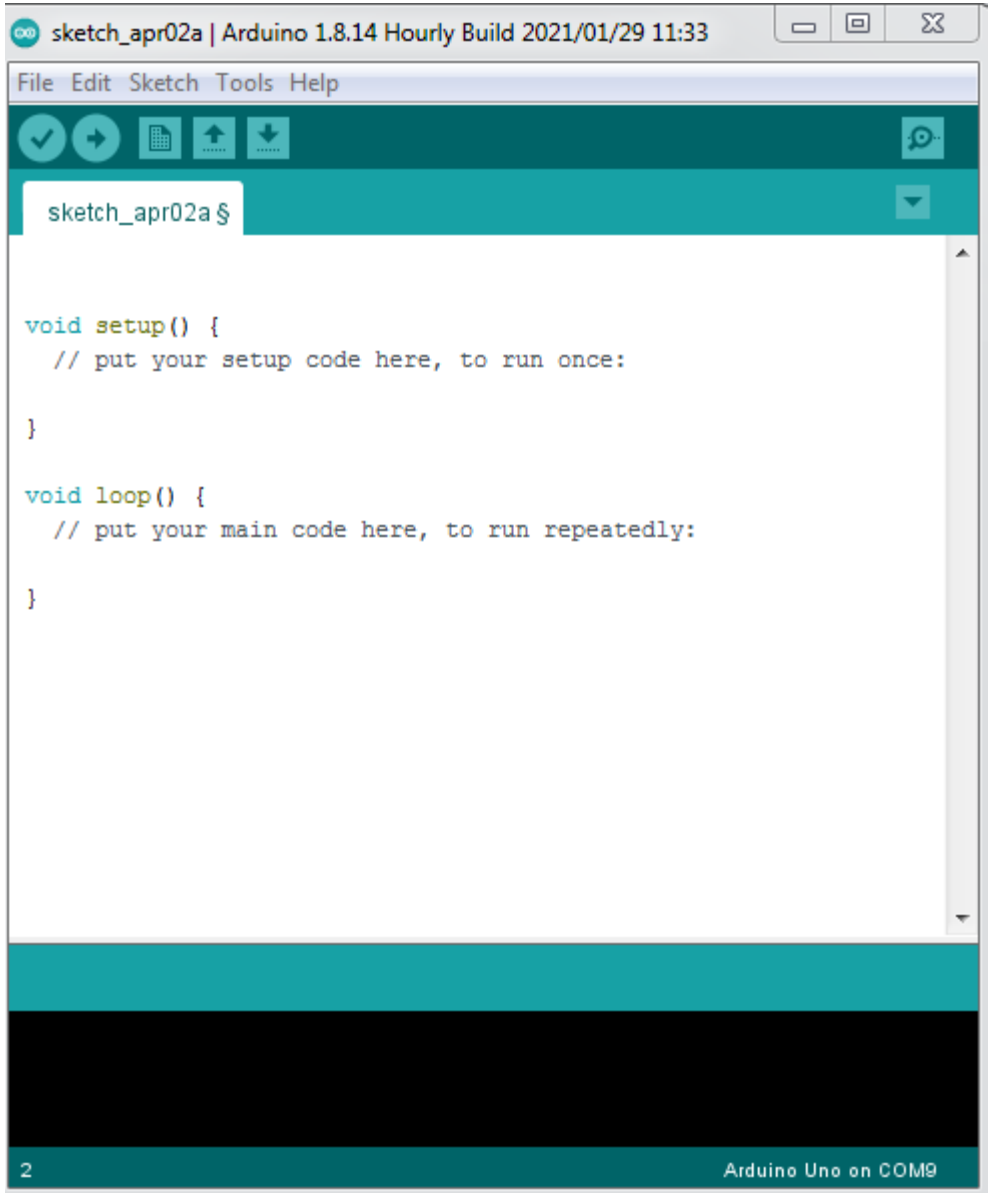


1. Reset Button
2. AREF
3. Ground Pin
4. Digital I/O
5. PWM
6. USB Connection
7. TX/RX
8. ATmega328P
9. Power LED Indicator
10. Voltage Regulator
11. DC Power Barrel Jack
12. 3.3V Pin
13. 5V Pin
14. Ground Pin
15. Analog Pin

Outline

1. Arduino IDE (Menu dan bagian-bagiannya)
2. Header, Void Setup, & Void Loop
3. Arduino Cheat Sheet
4. Tipe Data, Variabel, & Comment
5. digitalWrite (LED pada pin 13)
6. digitalWrite (4 LED)
7. For loop (4 LED)
8. Fungsi (4 LED)
9. Array 1D
10. digitalRead (Push Button)
11. Gerbang Logika AND & OR (2 Push Button, 3 LED)

1. Arduino IDE

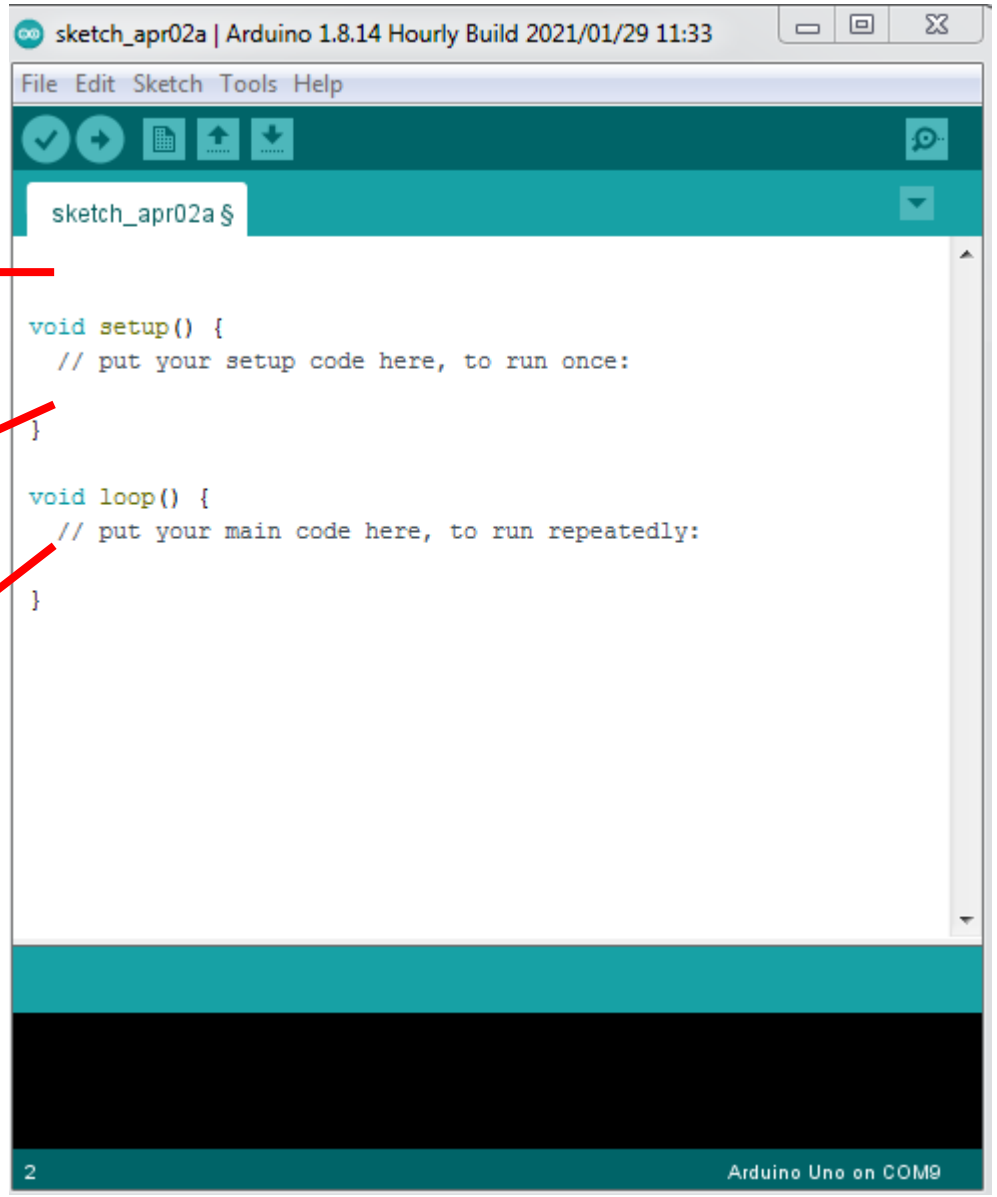


2. Header, Void Setup, & Void Loop

Header: Berisi deklarasi variabel, tipe data, dan lain-lain

Set up: Letak coding yang dieksekusi hanya sekali

Loop: Letak coding yang dieksekusi berulang-ulang



3. Arduino Cheat Sheet

Sketch Structures
- setup()
- loop()

Control Structures
- if
- if...else
- for
- switch case
- while
- do...while
- break
- continue
- return
- goto

Further Syntax
- ; (semicolon)
- {} (curley braces)
- // (single line comment)
- /**/ (multi-linecomment)
- #define
- #include

Arithmetic Operators
- = (assignment operator)
- + (addition)
- - (substraction)
- / (division)
- % (modulo)

Comparison Operators
- == (equal to)
- != (not equal to)
- < (less than)
- > (greater than)
- <= (less than or equal to)
- >= (greater than equal to)

Boolean Operators
- && (and)
- || (or)
- ! (not)

Pointer Access Operators
- * deference operator
- & reference operator

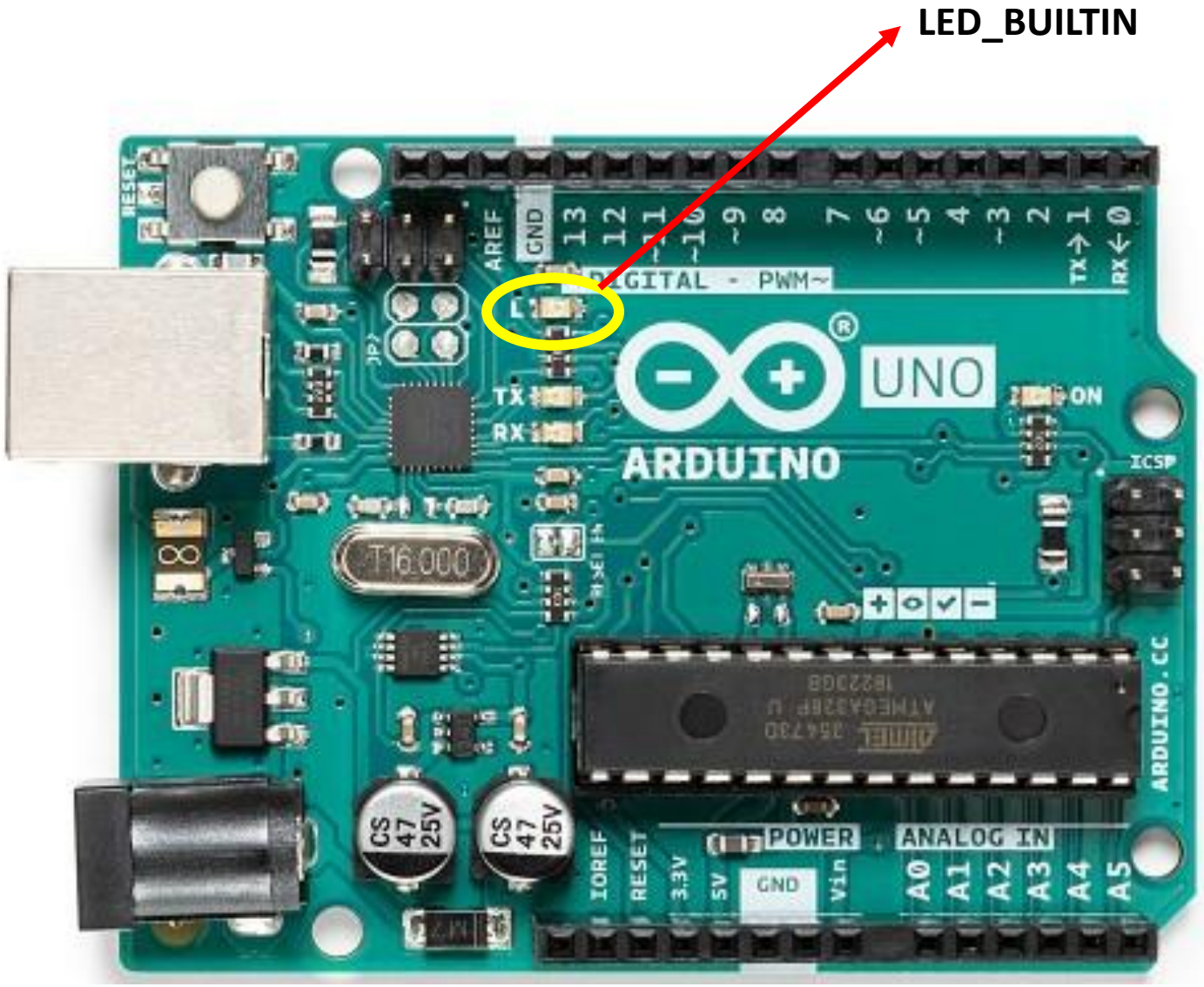
Bitwise Operators
- & (bitwise and)
- | (bitwise or)
- ^ (bitwise xor)
- ~ (bitwise not)
- << (bitshift left)
- >> (bitshift right)

Compound Operators
- ++ (increment)
- -- (decrement)
- += (compound addition)
- -= (compund substraction)
- *= (compound multiplication)
- /= (compound division)
- %= (compound modulo)
- &= (compound bitwise and)
- != (compound bitwise or)

4. Tipe Data, Variabel, dan Comment

Data Type	Size (Bytes)	Range of Values
void	0	null
bool/boolean	1	True/False
char	1	-128 to +127
unsigned char	1	0 to 255
byte	1	0 to 255
int	2	-32,768 to 32,767
unsigned int	2	0 to 65,535
word	2	0 to 65,535
long	4	-2,147,483,648 to 2,147,483,647
unsigned long	4	0 to 4,294,967,295
float	4	-3.4028235E+38 to 3.4028235E+38
double	4	-3.4028235E+38 to 3.4028235E+38
string	-	character array

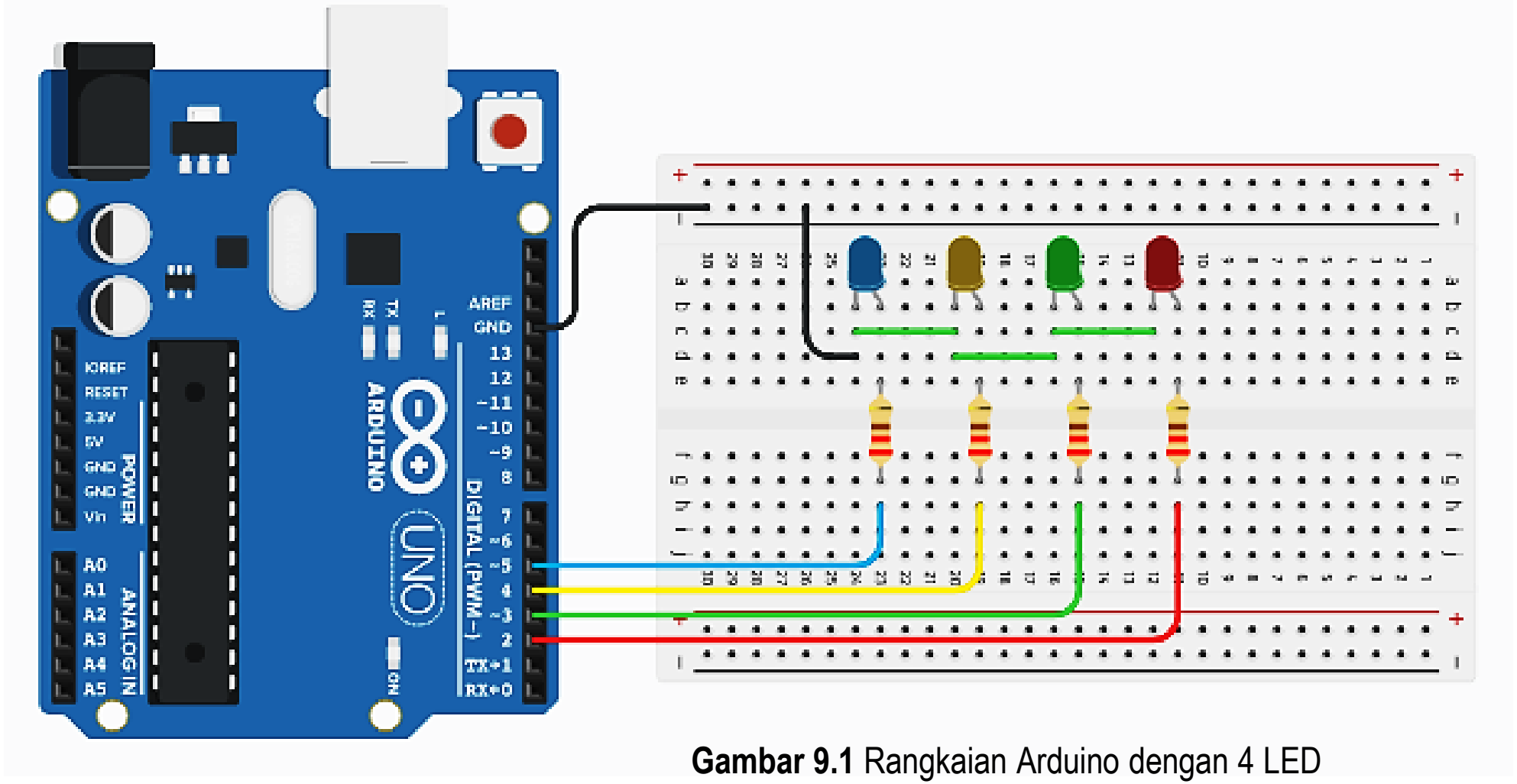
5. digitalWrite (LED pada pin 13)



Code 1: Led Built in

```
int Led = 13; // LED_BUILTIN

void setup() {
  pinMode (Led, OUTPUT);

}

void loop() {
  digitalWrite(Led, HIGH);
  delay(300);
  digitalWrite(Led, LOW);
  delay(300);

}
```

6. digitalWrite (4 LED)



Gambar 9.1 Rangkaian Arduino dengan 4 LED

Code 2: 4 Led

```
const int Led1=2;
const int Led2=3;
const int Led3=4;
const int Led4=5;

int waktu = 500;


void setup() {
  pinMode(Led1, OUTPUT);
  pinMode(Led2, OUTPUT);
  pinMode(Led3, OUTPUT);
  pinMode(Led4, OUTPUT);

}

void loop() {
  digitalWrite(Led1, HIGH);
  delay (waktu);
  digitalWrite(Led1, LOW);
  delay (waktu);
```

```
digitalWrite(Led2, HIGH);
  delay (waktu);
  digitalWrite(Led2, LOW);
  delay (waktu);
  digitalWrite(Led2, HIGH);
  delay (waktu);
  digitalWrite(Led2, LOW);
  delay (waktu);

digitalWrite(Led3, HIGH);
  delay (waktu);
  digitalWrite(Led3, LOW);
  delay (waktu);
  digitalWrite(Led3, HIGH);
  delay (waktu);
  digitalWrite(Led3, LOW);
  delay (waktu);
  digitalWrite(Led3, HIGH);
  delay (waktu);
  digitalWrite(Led3, LOW);
  delay (waktu);
```

```
digitalWrite(Led4, HIGH);
  delay (waktu);
  digitalWrite(Led4, LOW);
  delay (waktu);
  digitalWrite(Led4, HIGH);
  delay (waktu);
  digitalWrite(Led4, LOW);
  delay (waktu);
  digitalWrite(Led4, HIGH);
  delay (waktu);
  digitalWrite(Led4, LOW);
  delay (waktu);
  digitalWrite(Led4, HIGH);
  delay (waktu);
  digitalWrite(Led4, LOW);
  delay (waktu);

}
```

7. For Loop (4 LED)

Code 3: For Loop

Script sebelumnya (Code 2) terlihat sangat panjang dan tentu tidak efisien. Untuk mempersingkatnya kita dapat menggunakan for loop.

Syntax

```
for (initialization; condition; increment) {
  // statement(s);
}
```

```
const int Led1=2;
const int Led2=3;
const int Led3=4;
const int Led4=5;
int waktu=300;
int i;


void setup() {
  pinMode(Led1, OUTPUT);
  pinMode(Led2, OUTPUT);
  pinMode(Led3, OUTPUT);
  pinMode(Led4, OUTPUT);

}
```

```
void loop() {

  for(i=1; i<=1; i++){
    digitalWrite(Led1, HIGH);
    delay(waktu);
    digitalWrite(Led1, LOW);
    delay(waktu);
  }

    for(i=1; i<=2; i++){
    digitalWrite(Led2, HIGH);
    delay(waktu);
    digitalWrite(Led2, LOW);
    delay(waktu);
  }
```

```
 for(i=1; i<=3; i++){
    digitalWrite(Led3, HIGH);
    delay(waktu);
    digitalWrite(Led3, LOW);
    delay(waktu);
  }


  for(i=1; i<=4; i++){
    digitalWrite(Led4, HIGH);
    delay(waktu);
    digitalWrite(Led4, LOW);
    delay(waktu);
  }

}
```

8. Fungsi (4 LED)

Code 4: Contoh Fungsi

Jika Code 3 masih dirasa belum ringkas, kita dapat membuat fungsi tersendiri, yang nantinya akan dipanggil di void loop

```
const int Led1=2;
const int Led2=3;
const int Led3=4;
const int Led4=5;
int i;

void setup() {
  pinMode(Led1, OUTPUT);
  pinMode(Led2, OUTPUT);
  pinMode(Led3, OUTPUT);
  pinMode(Led4, OUTPUT);

}
void loop() {

kedip (1, 1, Led1, 500);
kedip (1, 2, Led2, 400);
kedip (1, 3, Led3, 300);
kedip (1, 4, Led4, 200);

}
```

```
void kedip (int nilaiAwal, int
nilaiAkhir, int Led, int waktu){

  for (i=nilaiAwal; i<=nilaiAkhir; i++){
  digitalWrite(Led, HIGH);
  delay (waktu);
  digitalWrite(Led, LOW);
  delay (waktu);
}

}
```

Jika diperhatikan, script di samping menjadi lebih ringkas dan fleksibel karena pengaturan berapa kali kedip pada led hanya perlu mengganti parameter yang ada di fungsi kedip .

Selain menggunakan fungsi, script ini juga dapat dipersingkat dengan menggunakan array.

9. Array 1D

Code 5: Contoh Array 1D

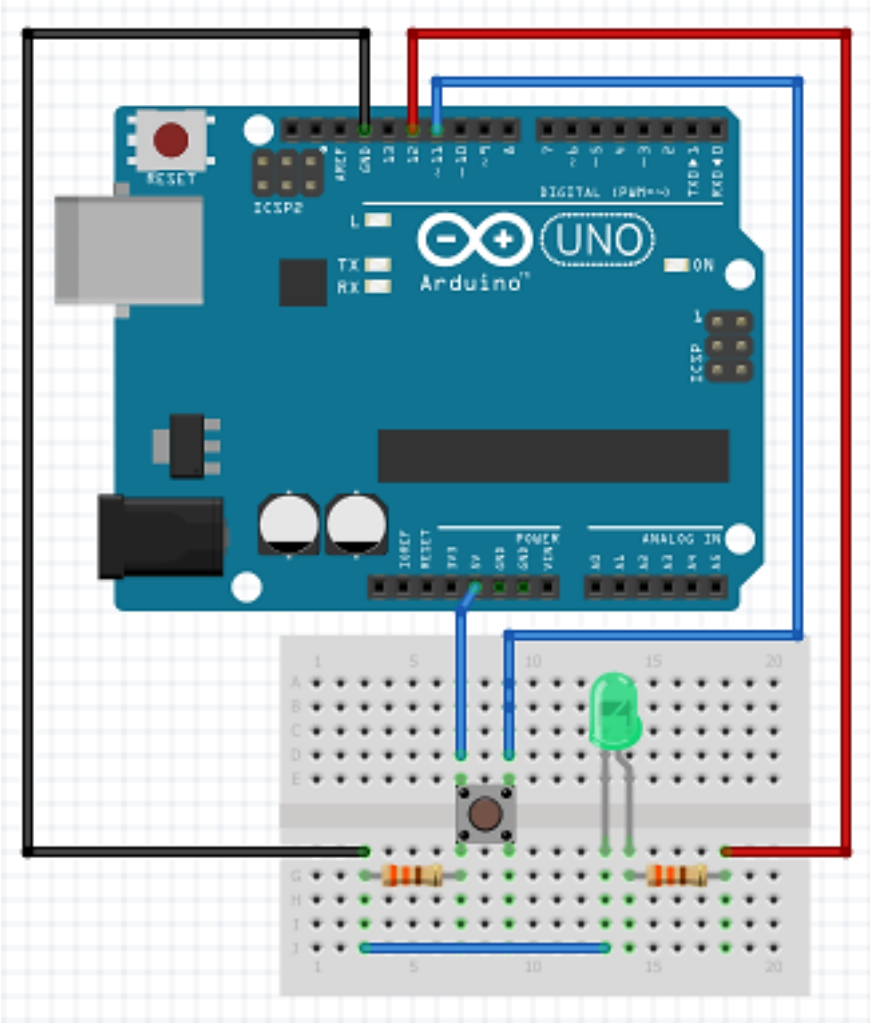
Instruksi:

Buatlah script menggunakan Arduino IDE untuk mensimulasikan 4 led yang nyala secara bergantian menggunakan array 1D.

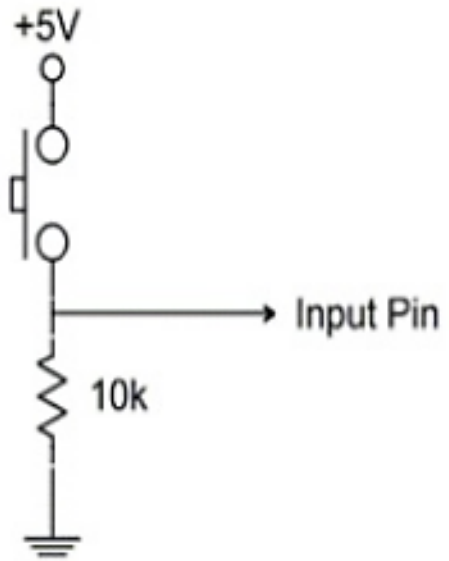
Note: Gunakan skema rangkaian 9.1

```
int led[4]={5, 4, 3, 2}; //indeks dimulai dari 0, berarti 0 s.d 4

void setup(){
  for (int i=0; i<=3; i++){
    pinMode(led[i], OUTPUT);
  }
}

void loop(){
  for (int i=0; i<=3; i++){
  digitalWrite(led[i], HIGH);
  delay(1000);
  digitalWrite(led[i], LOW);
  delay(1000);
  }

}
```

9. digitalRead (1 Push Button)



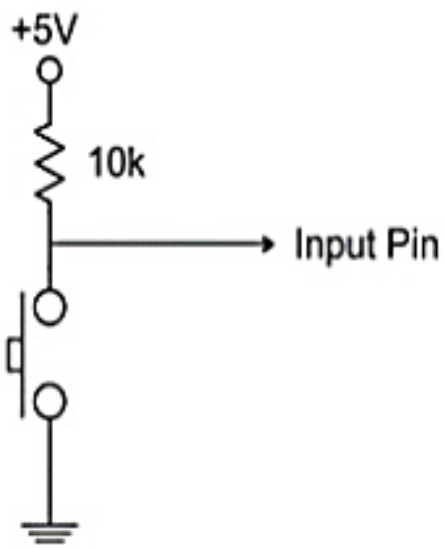
Resistor Pull Down



Default (LOW)

Merupakan rangkaian yang digunakan

Resistor Pull Up

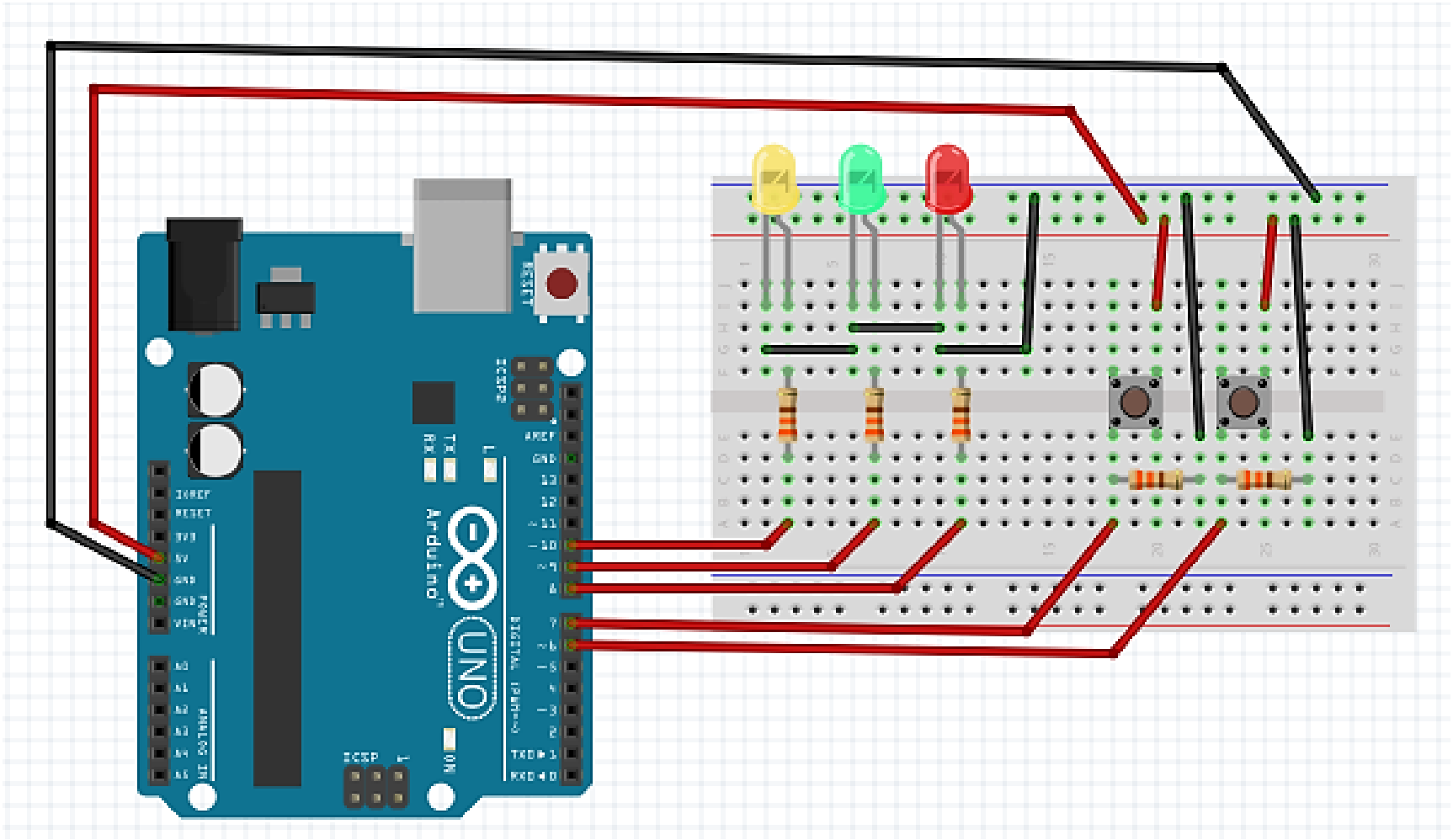


Default (HIGH)

Code 6: Push Button

```
const int Led = 12;
const int Pb = 11;

void setup() {
pinMode (Led, OUTPUT);
pinMode (Pb, INPUT);
Serial.begin(9600);
}

void loop() {
int nilaiPb = digitalRead (Pb);

if(nilaiPb==HIGH){
  digitalWrite (Led, HIGH);
}else{
  digitalWrite (Led, LOW);
}

Serial.println(nilaiPb);

}
```

10. Gerbang Logika AND & OR (2 Push Button, 3 LED)



Code 7: Logika AND

```
const int ledM=12;
const int ledH=11;
const int ledK=10;
const int pb1=7; //pb Merah
const int pb2=6; //pb Hijau
int nilaipb1;
int nilaipb2;

void setup() {
Serial.begin(9600);
pinMode(ledM, OUTPUT);
pinMode(ledH, OUTPUT);
pinMode(ledK, OUTPUT);
pinMode(pb1, INPUT);
pinMode(pb2, INPUT);

}



void loop() {
nilaipb1=digitalRead(pb1);
nilaipb2=digitalRead(pb2);
```

```
if(nilaipb1==0 && nilaipb2==0){
  digitalWrite(ledM, HIGH);
  digitalWrite(ledH, HIGH);
  digitalWrite(ledK, HIGH);
  }

if(nilaipb1==1 && nilaipb2==0){
  digitalWrite(ledM, LOW);
  digitalWrite(ledH, HIGH);
  digitalWrite(ledK, LOW);
  }

if(nilaipb1==0 && nilaipb2==1){
  digitalWrite(ledM, HIGH);
  digitalWrite(ledH, LOW);
  digitalWrite(ledK, LOW);
  }

if(nilaipb1==0 && nilaipb2==0){
  digitalWrite(ledM, HIGH);
  digitalWrite(ledH, HIGH);
  digitalWrite(ledK, LOW);
  }
```

```
if(nilaipb1==1 && nilaipb2==0){
  digitalWrite (ledM, HIGH);
}else{
  digitalWrite (ledM, LOW);
}

if(nilaipb1==0 && nilaipb2==1){
  digitalWrite (ledH, HIGH);
}else{
  digitalWrite (ledH, LOW);
}

if(nilaipb1==1 && nilaipb2==1){
  digitalWrite (ledK, HIGH);
}else{
  digitalWrite (ledK, LOW);
}

Serial.print(nilaipb1);
Serial.print(" | ");
Serial.println(nilaipb2);

}
```

Code 8: Logika OR

```
const int ledM=12;
const int ledH=11;
const int ledK=10;
const int pb1=7; //pb Merah
const int pb2=6; //pb Hijau
int nilaipb1;
int nilaipb2;

void setup() {
Serial.begin(9600);
pinMode(ledM, OUTPUT);
pinMode(ledH, OUTPUT);
pinMode(ledK, OUTPUT);
pinMode(pb1, INPUT);
pinMode(pb2, INPUT);

}



void loop() {
nilaipb1=digitalRead(pb1);
nilaipb2=digitalRead(pb2);
```

```
if(nilaipb1==1 || nilaipb2==1){
  digitalWrite(ledK, HIGH);
}else{
  digitalWrite(ledK, LOW);
}

Serial.print(nilaipb1);
Serial.print(" | ");
Serial.println(nilaipb2);

}
```

PENGANTAR MIKROKONTROLER

Ahmad Zarkasi

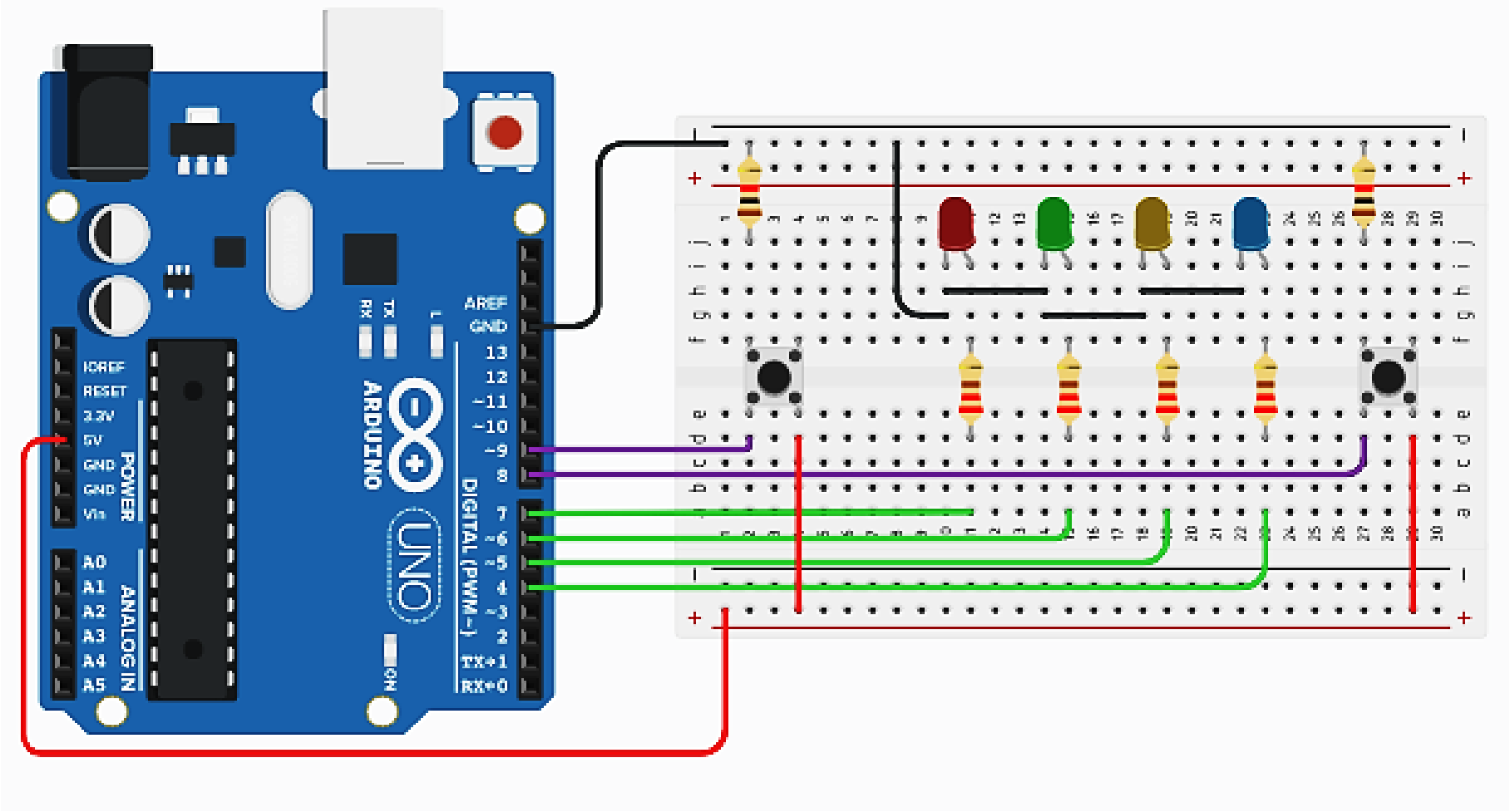
MATERI BAHASAN

PEMROGRAMAN ARDUINO Bag. 2

Outline

1. Switch Case
2. analogWrite (PWM)
3. Libraries
4. Sensor & Module
5. Coding Using Library
6. Coding Without Library

1. Switch Case



Code 9: Switch Case

```
const int led[4] = {7,6,5,4};
const int pb[2] = {8,9};
int j;

void setup(){

  for (int i=0; i<=3; i++){
    pinMode(led[i], OUTPUT);
  }

  for (int i=0; i<=1; i++){
    pinMode(pb[i], INPUT);
  }

  Serial.begin(9600);
}

void loop(){

  int nilaiPb1 =
digitalRead(pb[0]);
  int nilaiPb2 =
digitalRead(pb[1]);
```

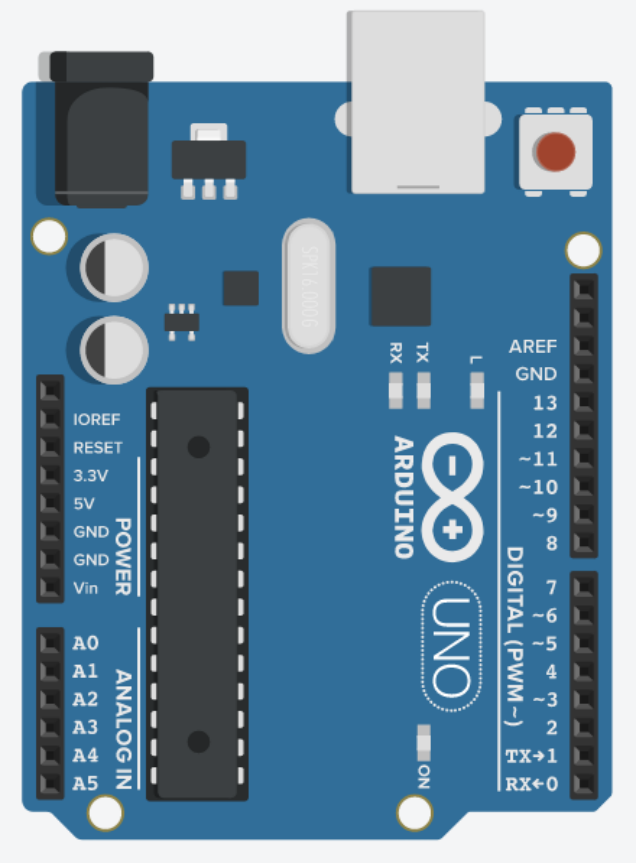
```
  if(nilaiPb1==HIGH){
    j++;
    delay(20);
  }
    if(nilaiPb2==HIGH){
    j--;
    delay(20);
  }

  switch (j){

    case 1:
    digitalWrite(led[0], HIGH);
    digitalWrite(led[1], LOW);
    digitalWrite(led[2], LOW);
    digitalWrite(led[3], LOW);
    break;

    case 2:
    digitalWrite(led[0], LOW);
    digitalWrite(led[1], HIGH);
    digitalWrite(led[2], LOW);
    digitalWrite(led[3], LOW);
    break;
```

```
    case 3:
    digitalWrite(led[0], LOW);
    digitalWrite(led[1], LOW);
    digitalWrite(led[2], HIGH);
    digitalWrite(led[3], LOW);
    break;

    case 4:
    digitalWrite(led[0], LOW);
    digitalWrite(led[1], LOW);
    digitalWrite(led[2], LOW);
    digitalWrite(led[3], HIGH);
    break;

    default:
    digitalWrite(led[0], LOW);
    digitalWrite(led[1], LOW);
    digitalWrite(led[2], LOW);
    digitalWrite(led[3], LOW);
    break;
  }

Serial.println(j);
}
```

2. PWM

Pulse width modulation (**PWM**), or **pulse-duration modulation** (**PDM**), is a method of reducing the average power delivered by an electrical signal, by effectively chopping it up into discrete parts.

Amplitude & Frequency : Constant



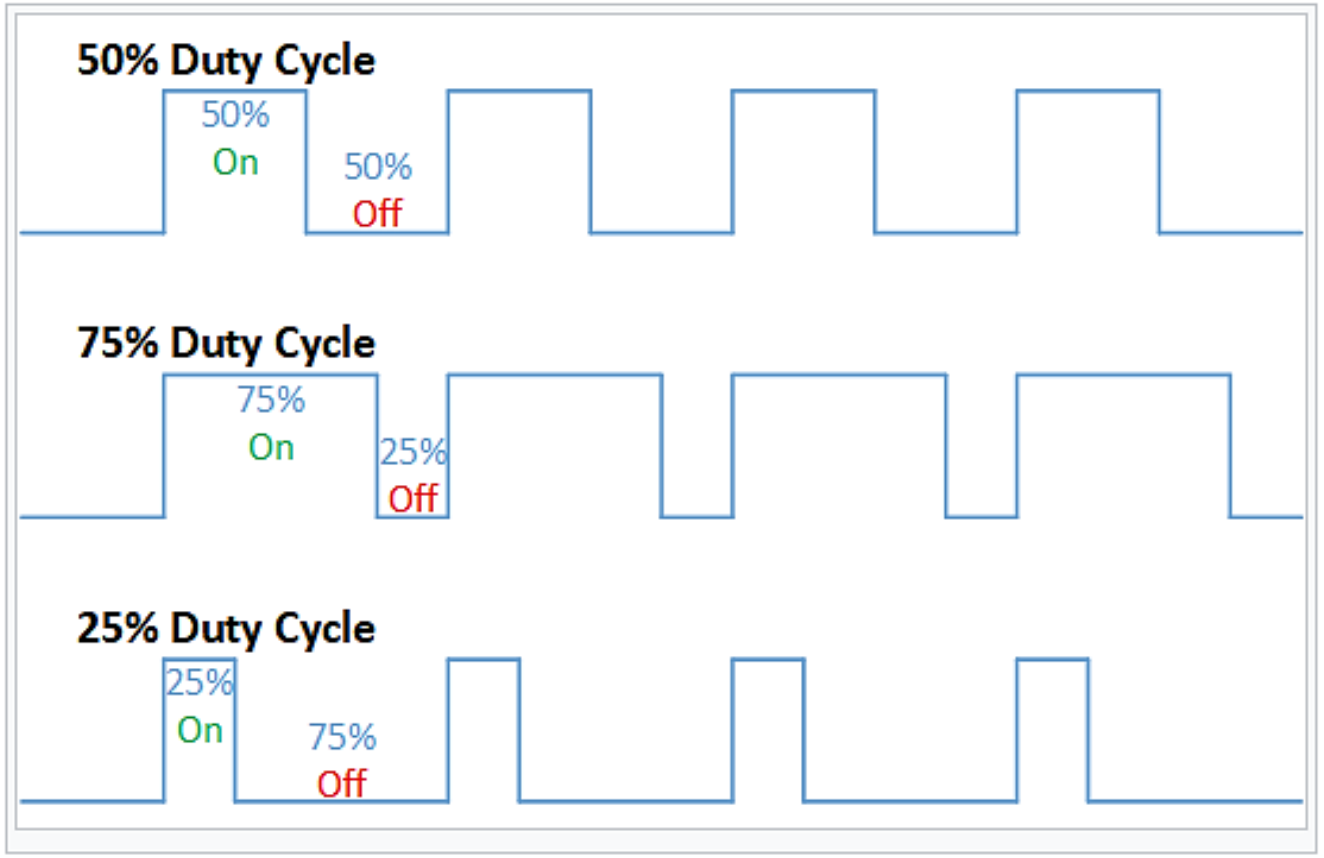
In Arduino UNO, PWM available on:

- **Pin 3**
- **Pin 5**
- **Pin 6**
- **Pin 9**
- **Pin 10**
- **Pin 11**

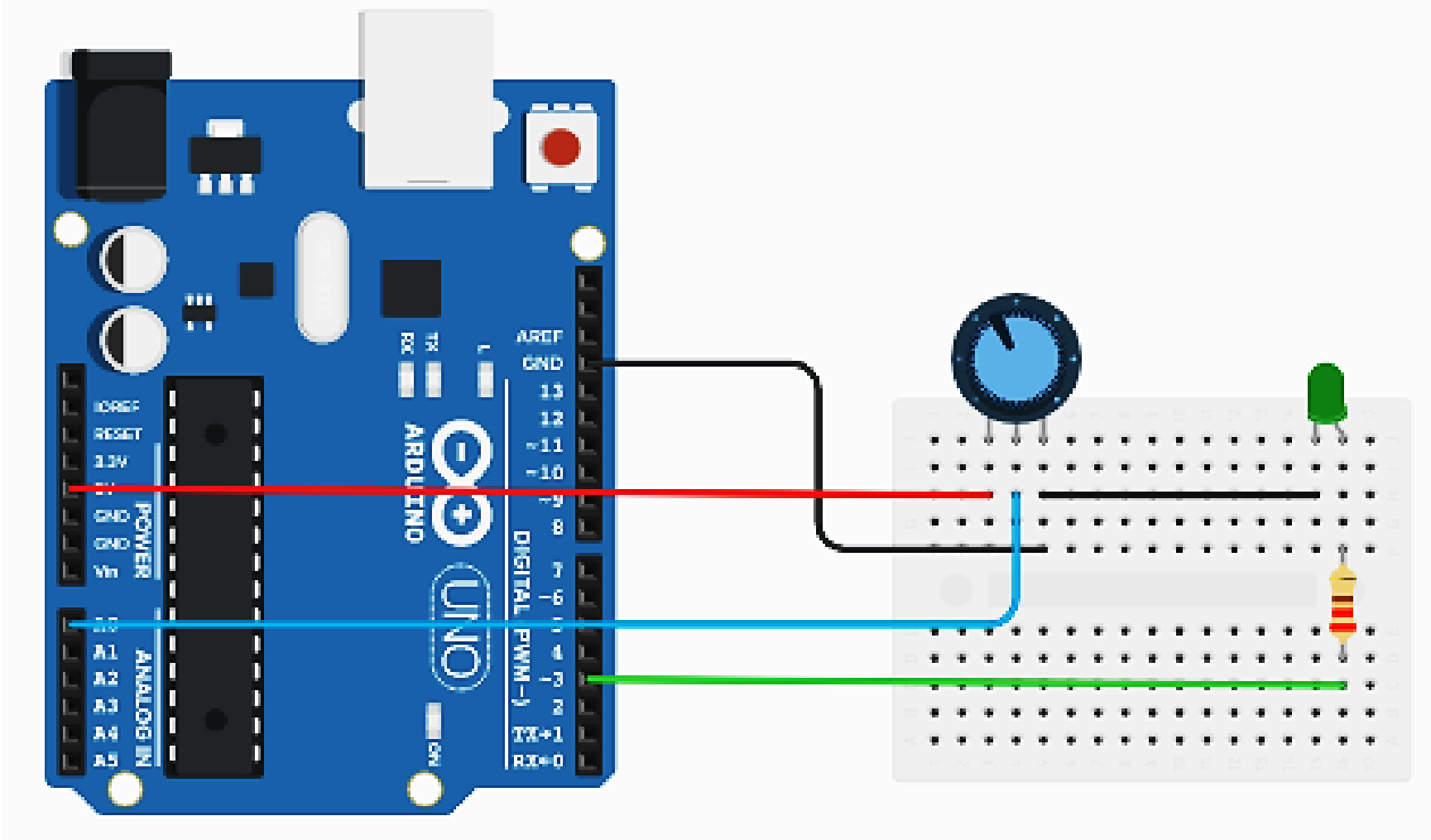
Duty Cycle

$$\text{DUTY} = \frac{T_{HIGH}}{T_{TOTAL}} \times 100\%$$

$$V_{OUT} = \text{DUTY} \times \text{Amplitude}$$



Contoh


IOREF
RESET
3.3V
5V
GND
GND
Vin
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
RX
TX
L
ARDUINO
UNO
AREF
GND
13
12
~11
~10
~9
8
7
~6
5
4
~3
2
TX→1
RX←0
DIGITAL (PWM~)

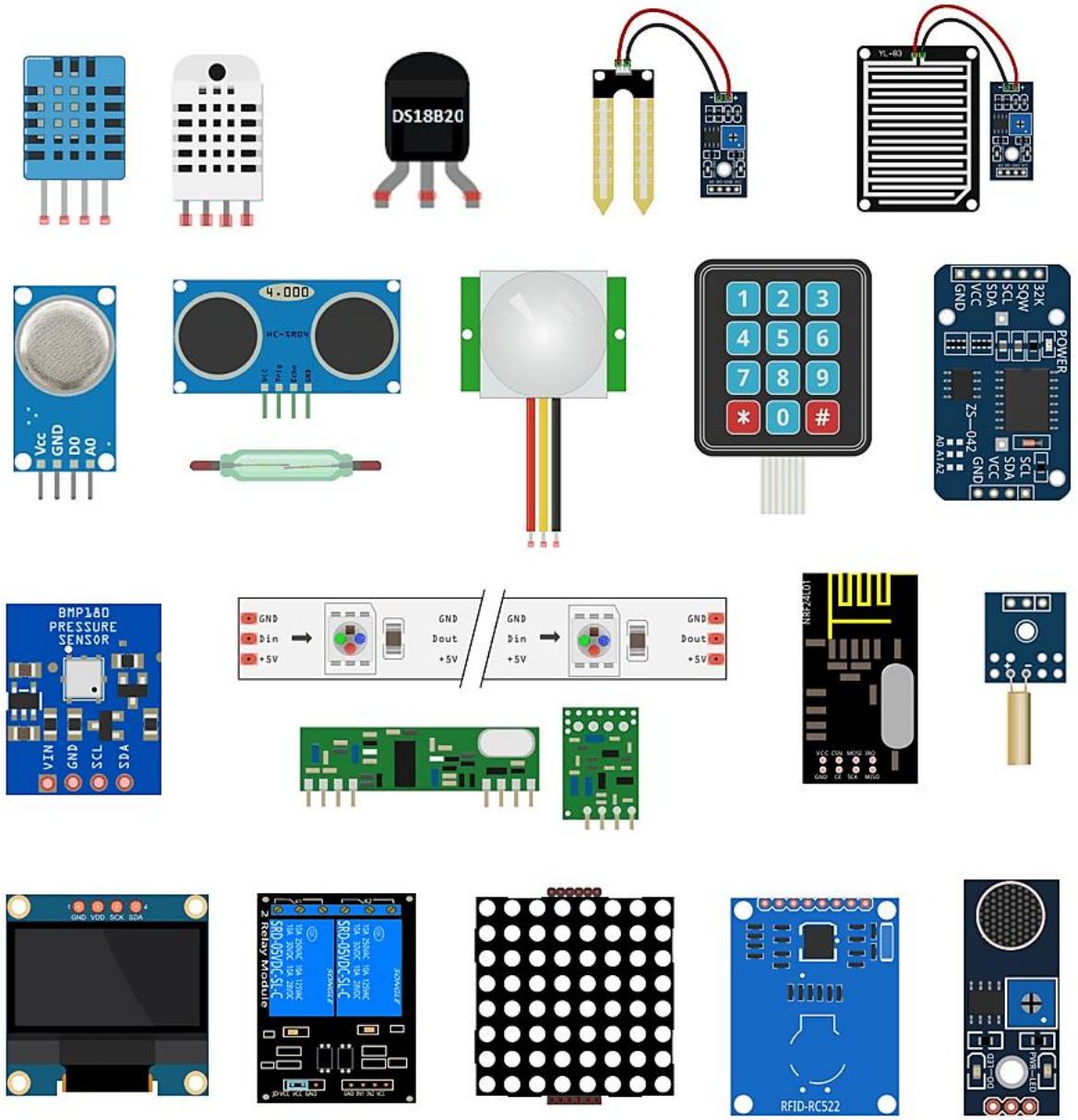
Code 10: PWM

3. Libraries

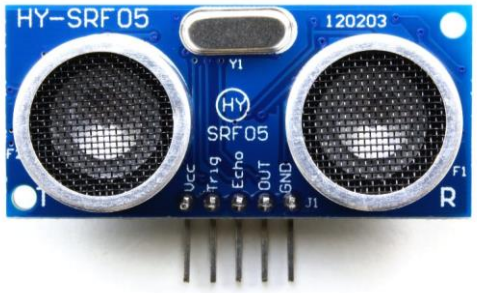
The Arduino environment can be extended through the use of libraries, just like most programming platforms. Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from Sketch > Import Library.
A number of libraries come installed with the IDE, but you can also download or create your own. See these instructions for details on installing libraries. There's also a tutorial on writing your own libraries. See the API Style Guide for information on making a good Arduino-style API for your library.

For more details:
https://www.arduino.cc/en/reference/libraries

4. Sensor & Module



5. Coding Using Library



Ultrasonic Sensor